Welcome to the CLU-IN Internet Seminar

Greener Cleanups - EPA's Methodology for Understanding and Reducing a Project's Environmental Footprint (Final)

Sponsored by: U.S. EPA, Office of Superfund Remediation and Technology Innovation

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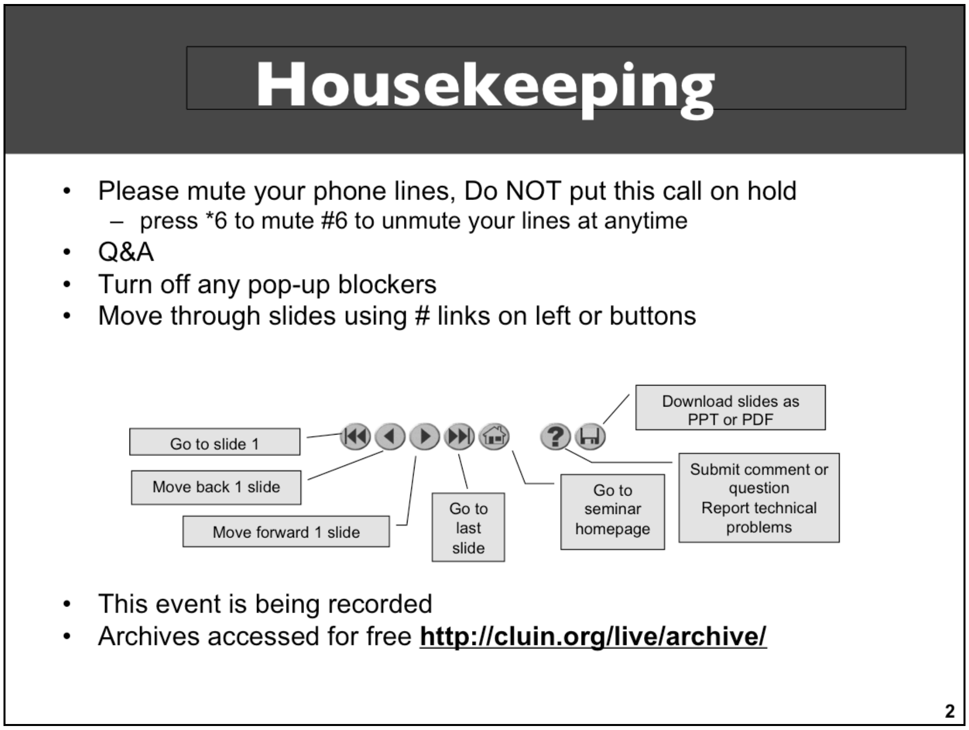

Although I'm sure that some of you have these rules memorized from previous CLU-IN events, let's run through them quickly for our new participants.

Please mute your phone lines during the seminar to minimize disruption and background noise. If you do not have a mute button, press *6 to mute #6 to unmute your lines at anytime. Also, please do NOT put this call on hold as this may bring delightful, but unwanted background music over the lines and interupt the seminar.

You should note that throughout the seminar, we will ask for your feedback. You do not need to wait for Q&A breaks to ask questions or provide comments. To submit comments/questions and report technical problems, please use the ? Icon at the top of your screen. You can move forward/ backward in the slides by using the single arrow buttons (left moves back 1 slide, right moves advances 1 slide). The double arrowed buttons will take you to 1st and last slides respectively. You may also advance to any slide using the numbered links that appear on the left side of your screen. The button with a house icon will take you back to main seminar page which displays our agenda, speaker information, links to the slides and additional resources. Lastly, the button with a computer disc can be used to download and save today's presentation materials.

With that, please move to slide 3.

Greener Cleanups - EPA's Methodology for Understanding and Reducing a Project's Environmental Footprint (Final)

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Seminar Outline

GOAL: Introduce EPA's methodology for environmental footprint analysis of remediation projects

- Introduction
- Methodology Overview
- Application of the Methodology
- Key Considerations for Interpreting the Results
- Interpreting and Using the Results
- Next Steps
- Q&A

Methodology is available at www.cluin.org/greenremediation

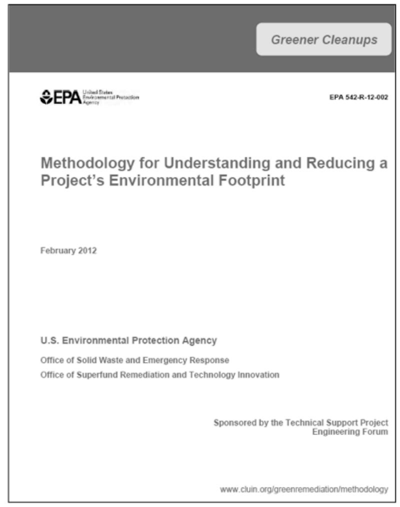
Introduction

Carlos Pachon

Methodology for Understanding & Reducing a Project's Environmental Footprint

- Built around five core elements of a greener cleanup, as identified in OSWER's "Principles for Greener Cleanups"*
- Remedy selection process remains the same in all cleanup programs
- Footprints are not required, but if conducted this is the preferred approach

*http://www.epa.gov/oswer/greenercleanups


Greener Cleanups

EPA 542-R-12-002

Methodology for Understanding and Reducing a Project's Environmental Footprint

February 2012

U.S. Environmental Protection Agency

Office of Solid Waste and Emergency Response

Office of Superfund Remediation and Technology Innovation

Sponsored by the Technical Support Project Engineering Forum

www.cluin.org/greenremediation/methodology

Methodology for Understanding & Reducing a Project's Environmental Footprint (2)

- Provides common footprint metrics and a process to quantify them
- Designed to be generally compatible with existing "footprinting" tools
- Based on lessons learned from multiple projects

- Goal of an assessment – Identify the most significant contributors to a project's environmental footprint and better focus efforts to reduce it
- Includes common conversion factors, contents of materials frequently used for cleanup, and typical energy demands of equipment deployed in the field

Methodology Protocol

- Based on pilot projects, the cost of a footprint analysis ranges from $5-$15k
- Costs are lower if done concurrent with other planning and design activities
- Applies to all common remedies at any stage (design, construction, operation)

Step 1: Set Goals and Scope of Analysis

Step 2: Gather Remedy Information

Step 3: Quantify Onsite Materials and Waste Metrics

Step 4: Quantify Onsite Water Metrics

Step 5: Quantify Energy and Air Metrics

Step 6: Qualitatively Describe Affected Ecosystem Services

Step 7: Present Results

Methodology Document

- Main section: The basics of an environmental footprint
  - Introduction
  - Metrics
  - Footprint methodology
  - Considerations for interpreting the footprint
  - Approaches to reducing the footprint
- Appendices: The "mechanics" of a footprint
  - A. Exhibits
  - B. Tables/data presentation formats
  - C. Footprint reduction scenarios
    - Materials and Waste (3)
    - Water (3)
    - Energy and Air (2)

Methodology is available at www.cluin.org/greenremediation

Information Flow

- Exhibits (17) help manage raw data and understand the flow of information
- Tables/data presentation formats (9 Tables) summarize the information collected and generated
  - Table B1 includes all suggested footprint metrics
  - When undertaking a footprint, one or more elements may screen out

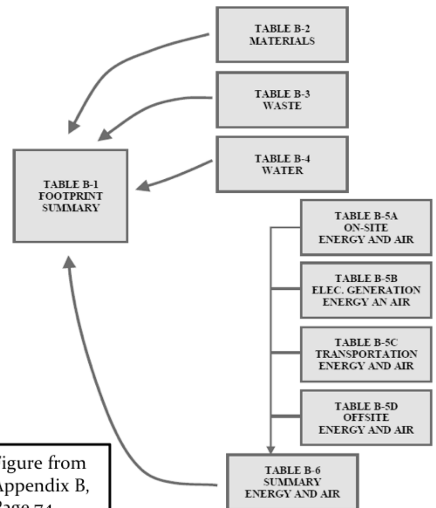


Figure from Appendix B, Page 74

Methodology Applicability

Does the methodology call for life-cycle assessment (LCA)?

- It calculates the green remediation metrics but does not apply an "impact assessment" as typically needed in a full LCA
- Materials and waste target the on-site use and generation rather than off-site (boundary difference)
- Energy and emissions have fairly broad system boundaries

Does the methodology consider social and economic factors?

- The methodology focuses on the environmental footprint of a contaminated site remediation project
- Social and economic factors are addressed in EPA cleanup programs through existing processes such as community involvement requirements and EPA's Superfund Redevelopment Initiative

Green Remediation Metrics

Energy

- Total energy used
- Total energy voluntarily derived from renewable resources

Air

- Greenhouse gases
- Criteria pollutants (NOx, SOx, PM)
  - On-site emissions
  - Total emissions
- Hazardous air pollutants (HAPs)
  - On-site emissions
  - Total emissions

Water

- On-site water use (including public/potable water)
  - Quantity
  - Source of water
  - Fate of used and treated water

Green Remediation Metrics (2)

Materials & Waste

- Refined (including manufactured) materials used on-site
  - Quantity and % from recycled materials
- Bulk, unrefined materials used on-site
  - Quantity and % from recycled materials
- Waste
  - Hazardous waste generated on-site
  - Non-hazardous waste generated on-site
  - % of total potential waste generated on-site that is recycled or reused

Land & Ecosystems

- Currently qualitative evaluation

Methodology Applicability

Where and when is the methodology used?

- The methodology process and results are of value . . .
  - For all types of cleanup projects
  - For all cleanup programs
  - Throughout the various phases of a cleanup project

How will EPA use the methodology?

- Train EPA technical staff on ways to understand and reduce the footprint
- Conduct footprint analyses at its own sites when and where appropriate
- Facilitate the evaluation of environmental footprint studies submitted to EPA by outside parties

Methodology Overview

Doug Sutton

Materials & Waste Highlights

- Straightforward accounting of materials used on-site
  - Refined/manufactured (e.g., steel, chemicals)
  - Unrefined/minor processing (e.g., soil, sand, gravel)

- Straightforward accounting of waste generated on-site
  - Hazardous
  - Non-hazardous
  - Percentage recycled or reused

- Example tables for organizing input and results

Much of section is rules of thumb or general assistance for creating an inventory of materials and waste

Water Highlights

- Straightforward accounting of on-site water use, considering site-specific factors
  - Source of water used
  - Quantity of water used
  - Use of water
  - Fate of water after use

Use of site-specific factors allows for development of site-specific water use metric

Energy & Emission Highlights

- Three-step process
  - Inventory remedy materials and services
  - Calculate electricity and fuel use
  - Convert electricity, fuel, materials, and into energy and air metrics
- Organize calculations into four categories
  - On-site (similar to Scope 1 in EO 13514)
  - Electricity generation (Scope 2 in EO 13514)
  - Transportation (part of Scope 3 in EO 13514)
  - Other off-site materials and services (part of Scope 3 in EO 13514)
- Provides help estimating and calculating values
- Helps with determining appropriate level of detail
- Provides referenced footprint conversion factors

Uses some info from Materials & Waste and from Water Sections

Methodology Steps

Seven Steps

1. Set Goals and Scope of Analysis
2. Gather Remedy Information
3. Quantify Onsite Materials & Waste Metrics
4. Quantify Onsite Water Metrics
5. Quantify Energy & Air Metrics
6. Qualitatively Describe Affected Ecosystem Services
7. Present Results

Application of the Methodology

Doug Sutton

Example Application

Application at a hypothetical P&T system

- P&T system designed to treat arsenic
- System expected to operate for 30 years
- Treatment plant removes arsenic through co-precipitation
  - Intensive chemical usage
  - Substantial waste generation
- Discharge treated water to the nearby creek
- Local electricity generation mix similar that of California
- Remedy is in design stage
- Results used to help identify green remediation practices to be included in system design

1 Set Goals and Scope of Analysis

① Set Goals and Scope of Analysis

- Scope of analysis
  - System construction, O&M, and performance monitoring
  - Focus on groundwater remedy only
  - Assume system is used for other purposes at conclusion of remedy
- Study boundary is established by EPA methodology
- Functional unit of analysis
  - Remedy life-cycle from construction through operation
  - Substantial waste generation

2 Gather Remedy Information

② Gather Remedy Information

Remedy Item/Activity	Quantity/Information
Number, depth, and design of extraction wells	6-inch wells, 600 ft total
Length, size, and type of piping	3,000 ft of 6-inch HDPE
Extraction rate	700 gpm
Treatment plant construction	80 ft x 100 ft x 30 ft
Information for estimating utility use	Pumps, mixers, HVAC, lighting
Information for estimating waste generation	Influent loading
Information for estimating chemical use	Influent loading
Monitoring program (frequency, locations, parameters)	Annual, 100 wells, arsenic
Transportation distances	Various

Typical information from Feasibility Study, Design, Implementation/O&M, and Optimization

② Screening Limits

- Screening limits to refine input information
  - Exclude items with estimated footprint contribution smaller than 1% of largest footprint contribution
  - Exclude items with estimate footprint smaller than a specified magnitude

Metric	Units	Largest Contributor	Largest Contribution	1% of Largest Contribution	Magnitude Limit	Screening Limit
Refined materials	ton	NaOH	3,072	31	1	31
Unrefined materials	ton	Aggregate	1,150	12	1	12
Waste	ton	Sludge	7,800	78	1	78
Public water	gal	Poly blending	360,000,000	3,600,000	5,000	3,600,000
On-site NOx+SOx+PM10	lb	Nat. gas	7,100	71	100	100
On-site HAPs	lb	Nat. gas	5	0.05	10	10
Total energy use	SU	Electricity	39,000,000	390,000	1,000	390,000

Based on professional judgment, exclude items with a footprint smaller than the "screening limits"

② Examples of Excluded Items

Metric	Example Excluded Items
Refined materials	• Piping • Well casing and grout • Valves fittings • Process equipment & controls
Unrefined materials	• Sand for well construction
Waste	• Used sampling equipment • Used gloves • Packaging
Public water	• Water for equipment decontamination • Water for well drilling
On-site NOx+SOx+PM10	• Gasoline powered generators for sampling
On-site HAPs	• Gasoline powered generators for sampling
Total energy use	• Gasoline powered generators for sampling • Personnel transport • Heavy equipment transport

3 Estimate Materials & Waste Metrics

EPA

③ Refined Materials

Material and Use	Units	Quantity	Conversion to lbs	% Recycled or Reused Content	Material Quantity (lbs) Recycled	Material Quantity (lbs) Virgin
Refined Materials (lbs)						
Building steel	ft^3	240,000	1 lbs/ft^3	55%	132,000	108,000
Concrete reinforcing steel	ft^2	40,000	1.3 lbs/ft^2	55%	28,600	23,400
Cement portion of concrete	ft^3	20,000	22 lbs/ft^3	0%	0	440,000
Sodium hydroxide (20%)	gal	3,011,250	2.04 lbs/gal	0%	0	6,144,000
Hydrogen peroxide (50%)	gal	295,650	4.96 lbs/gal	0%	0	1,467,000
Ferric chloride (37%)	gal	1,368,750	4.33 lbs/gal	0%	0	5,928,000
…			…	…	…	…
…			…	…	…	…
Refined Materials Subtotals (lbs):					160,600	15,179,900
Refined Materials Total (lbs):					15,340,500	
% of Refined Materials that is Recycled or Reused Content					~1%	

Provided by User | Provided by Methodology | Calculated | Metric Results

③ Unrefined Materials

Material and Use	Unit	Common Quantity	Conversion Factor	% Recycled or Reused Content	Material Quantity (tons)	
					Recycled	Virgin
Unrefined Materials (tons)						
Aggregate for concrete	ft^3	741 cy	1.55 tons/cy	0%	0	1,150
Unrefined Materials Subtotals (tons):					0	1,150
Unrefined Materials Total (tons):					1,150	
% of Unrefined Materials that is Recycled or Reused Content					0%	

Provided by User

Provided by Methodology

Calculated

Metric Results

Footprint Methodology – 4/18/12

30

③ Waste

Waste or Used Material	Quantity
Recycled or Reused Waste (tons)	
Reused On-Site: None	0
Recycled or Reused Off-Site: None	0
Total Recycled or Reused Waste:	0
Landfilled Waste (tons)	
Hazardous Waste Disposed	
7,800 tons of dewatered precipitated metal sludge	7,800
Non-Hazardous Waste Disposed: None	0
Disposed Waste Total:	7,800
Total Waste:	7,800
% of Total Waste Recycled or Reused:	0%

Metric Results

Footprint Methodology – 4/18/12

31

4 Estimate On-Site Water Metrics

④ Water

Water Resource	Description of Quality of Water Used	Volume Used (1000's gallons)	Uses	Fate of Used Water
Public water supply	Potable	360,000	Blending polymer	Creek
Extracted groundwater Aquifer: **"Shallow"**	Marginal quality	11,000,000	Treatment	Creek
Surface water Intake Location: **None**	**None**			
Reclaimed water Source: **None**	**None**			
Collected/diverted storm water	**None**			
Other water resource	**None**			

Water (Alternate Scenario)

Water Resource	Description of Quality of Water Used	Volume Used (1000's gallons)	Uses	Fate of Used Water
Public water supply	Potable	360,000	Blending polymer	Creek
Extracted groundwater Aquifer: **"Ogallala"**	Vital Aquifer	11,000,000	Treatment	Creek
Surface water Intake Location: **None**	**None**			
Reclaimed water Source: **None**	**None**			
Collected/diverted storm water	**None**			
Other water resource	**None**			

5 Estimate Energy & Air Metrics

EPA

5.1 Inventory & Screening

	Remedy Item/Activity	Quantity	Energy Screening Units
Equipment Operation	Well installation (drill rig)	<1,000 ft	<50,000
	Electrical equipment for 30 years	39,000,000 kWh	39,000,000
	Building heat with natural gas	>50,000 therms	>500,000
Transportation	Miles of personnel transport for 30 years	<500,000 miles	<250,000
	Ton-miles of materials transport for 30 years	>2 million	>660,000
Materials (from Materials & Waste)	Building and concrete reinforcing steel	292,000 lbs	292,000
	Concrete for building foundation	1,450 tons	2,900,000
	Chemical usage for 30 years	13,500,000 lbs	13,500,000
Off-site Services	Hazardous waste disposal for 30 years	7,800 tons	78,000
	Laboratory analysis for 30 years	<$100,000	<$100,000

- (dark shading) Included because exceeds screening limit (390,000)
- (light shading) Included because readily available
- (no shading) Excluded because below screening limit (390,000)

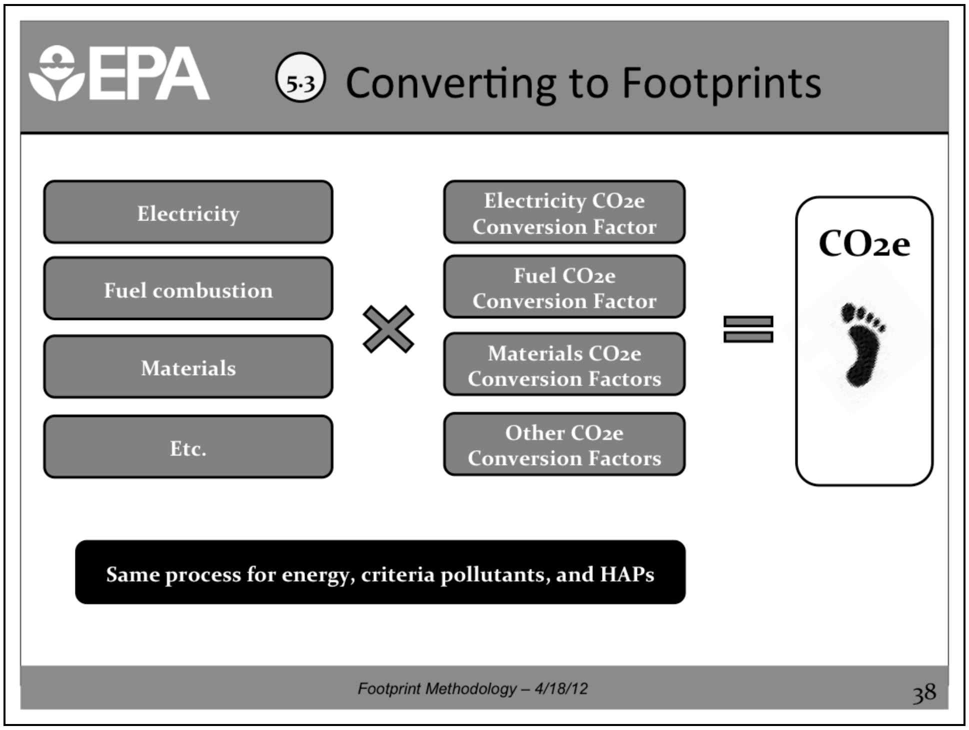
Additional information required beyond typical remediation information

5.2 Energy Usage

Electrical equipment	⟹	Electricity usage
Natural gas equipment	⟹	Natural gas usage
Transportation and equipment	⟹	Fuel usage

Remedy Item/Activity	Energy Usage
Electrical use for extraction & treatment	33,000,000 kWh
Electrical use for lighting and HVAC	6,000,000 kWh
Natural gas use (building heat)	710,000 therms
Fuel use for materials transportation	491,510 gallons diesel

** For display only… Table does not include all significant energy contributions for remedy*



EPA
5.3 Converting to Footprints
Electricity
Fuel combustion
Materials
Etc.
Electricity CO2e Conversion Factor
Fuel CO2e Conversion Factor
Materials CO2e Conversion Factors
Other CO2e Conversion Factors
CO2e
Same process for energy, criteria pollutants, and HAPs
Footprint Methodology – 4/18/12
38

5.3 Converting to Footprints

	Inventory Component	Quantity	Energy Footprint (MMBtus)	CO2e Footprint* (tons)
On-site	On-site elec. use Natural gas use Equipment use	39,000,000 kWh 710,000 therms 1,010 gals fuel	133,000 73,000 134	0 4,650 11
Elec. Gen.	Electricity gen.	39,000,000 kWh	269,000	16,497
Transportation	Diesel	491,510 gallons	68,000	5,530
Off-site	Materials Waste disposal Electricity trans. Public water Other	17,500,000 lbs 7800 tons 39,000,000 kWh 360,000,000 gals Other	310,000	19,022
		Total	**853,000**	**45,710**

** Only energy and CO2e footprints shown for example. Criteria pollutants, and HAPs not shown.*

6 Qualitatively Describe Effects on Ecosystem Services

In its current form, the methodology suggests the use of qualitative descriptions of the effects of a remedy on land and ecosystem services such as nutrient uptake and erosion control. Concepts related to ecosystem services are available online from EPA's Ecosystem Services Research Program at http://www.epa.gov/ecology.

7

Present Results

7 Environmental Footprint Summary

What does this mean?

What do I do with it?

Parameter	Footprint
Total Energy	853,000 MMBtu
% from Renewable Energy	0%
GHG Emissions	45,710 tons
Total Criteria Pollutant emissions	637,000 lbs
On-site Criteria Pollutant emissions	7,800 lbs
Total HAP emissions	4,100 lbs
On-site HAP emissions	6 lbs
Public water use	360,000,000 gallons
Other on-site water use	Marginal impact
Refined materials use (% from recycled material)	15.3 million lbs (1%)
Unrefined materials use (% from recycled material)	1,150 tons (0%)
Hazardous waste	7,800 tons
Non-hazardous waste	0 tons
% of total on-site waste recycled or reused	0%

Key Considerations for Interpreting the Results

Karen Scheuermann

Keep in Mind during the Analysis …

What activities/materials are being omitted?

- Materials used in small amounts
- Infrequent activities

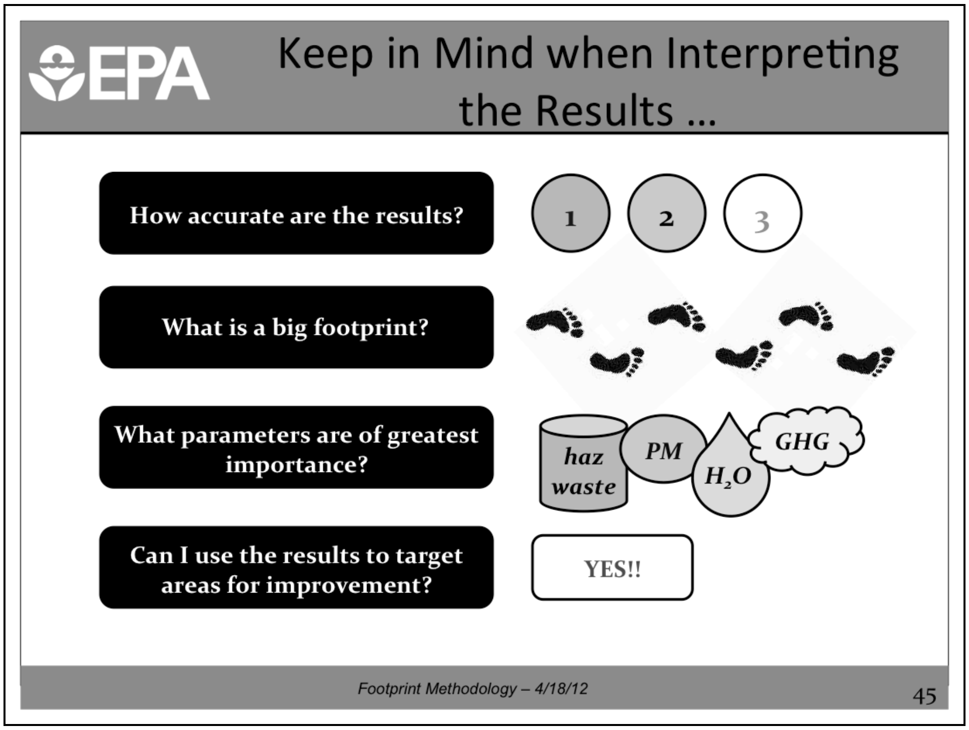
What are the greatest sources of error or uncertainty?

- Undetermined aspects of remedy design
- Remedy timeframes
- Footprint conversions factors

How can the analysis address these uncertainties?

- Evaluate alternative designs
- Perform sensitivity analyses
- Conduct additional research

Document the sources of error and uncertainty and how they are addressed


EPA
Keep in Mind when Interpreting the Results …
How accurate are the results?
1
2
3
What is a big footprint?
What parameters are of greatest importance?
haz waste
PM
H_2O
GHG
Can I use the results to target areas for improvement?
YES!!
Footprint Methodology – 4/18/12
45

How Accurate are the Results?

1. **Think about uncertainties in overall scope.**
   In our case study, the pump and treat is expected to continue 30 years.

2. **Uncertainty in major contributors to the footprint.**
   For greenhouse gas emissions…
   - electricity use
   - chemical use
   - natural gas for building heat

3. **Be aware of estimates in the calculations.**
   - footprint conversion factors
   - fuel usage estimates
   - transportation distances

Keep in mind…. The results of footprint analyses are estimates to help guide future footprint reduction actions, and are not exact numbers!

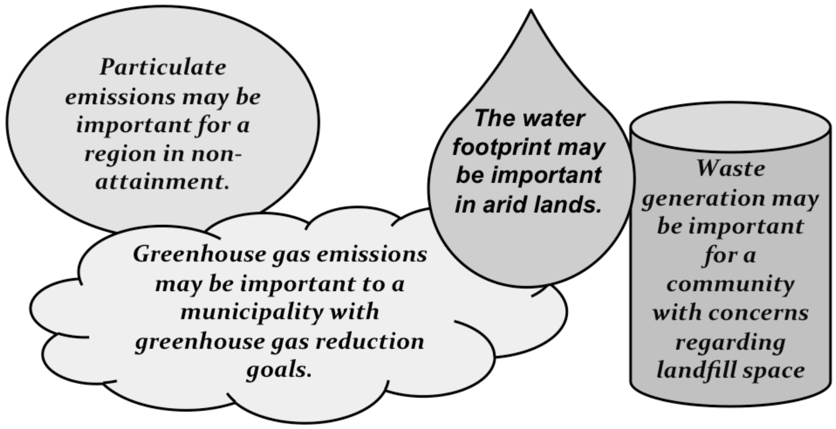
What is a Big Footprint?

- What is the right benchmark for comparison?
- How does the footprint for a particular remedy compare to…
  - footprints of similar remedies in your organization's portfolio?
  - your organization's overall footprint?
  - footprints of other similar remedies?
- Are there goals that you or your organization set for…
  - magnitude of footprint reductions
  - percentage footprint reduction
- Are there footprint reduction goals that have been recommended for your organization by another party?

A small percentage reduction of a large footprint can be a large magnitude reduction

What Parameters are of Greatest Importance?

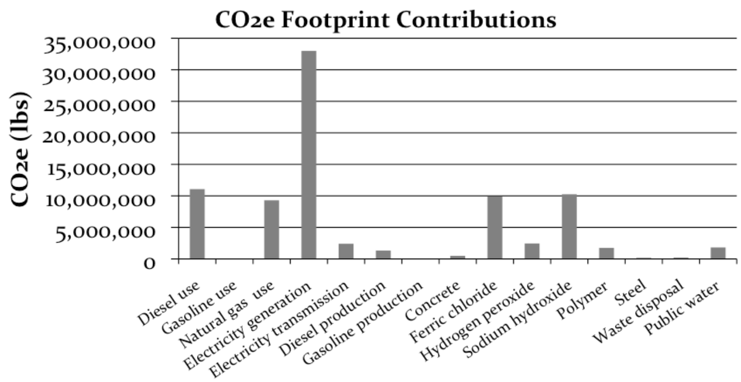
This will depend on the conditions specific to the site and on the values important to site stakeholders.



Can I Use the Results to Target Areas for Improvement?

YES!!

A footprint analysis can give you results that highlight the key contributors.



Interpreting and Using the Results

Kira Lynch

Primary Uses of Results

Reporting numbers to those who are asking for them

Mr. Supervisor:

Our [footprint] = **Too Big**

Sincerely,
Mr. Green

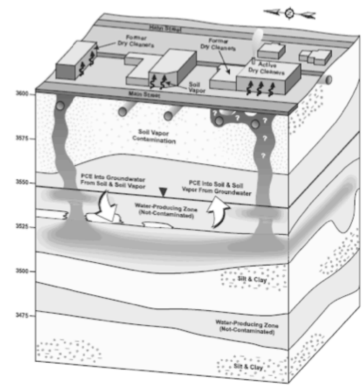
We will primarily discuss footprint reduction

Assistance in reducing footprints

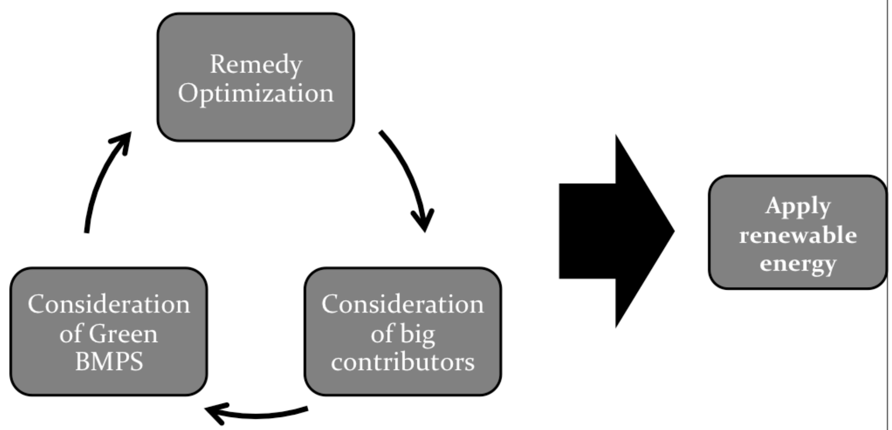
Approaches to Footprint Reduction

Small environmental footprints are consistent with good science and engineering

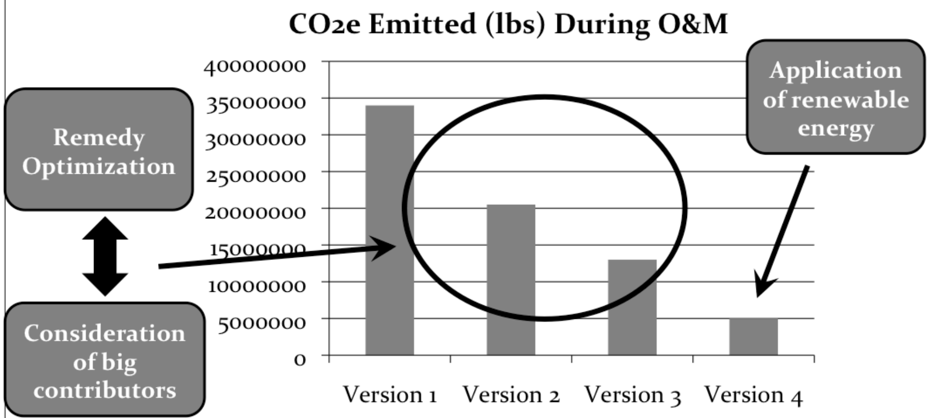
- Minimizing footprints and large footprint reductions come from…
  - An accurate conceptual site model (CSM)
  - Well-characterized source areas and contaminant plumes
  - Appropriate remedy selection
  - Sound engineering
  - Streamlined performance monitoring



Effective Approach for Footprint Reduction

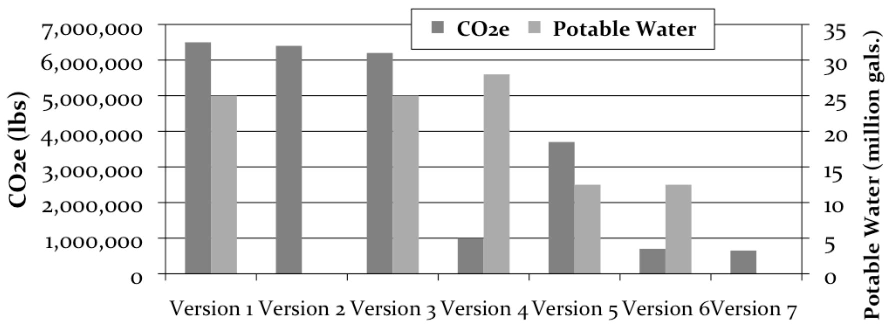


Example at a P&T System



Version 1 – *Baseline: air stripping → GAC → discharge to sanitary sewer*
Version 2 – *Enhance air stripping and eliminate GAC*
Version 3 – *Enhance air stripping and eliminate GAC and discharge to surface water*
Version 4 – *Version 3 plus application of renewable energy*

Example for Bioremediation Remedy



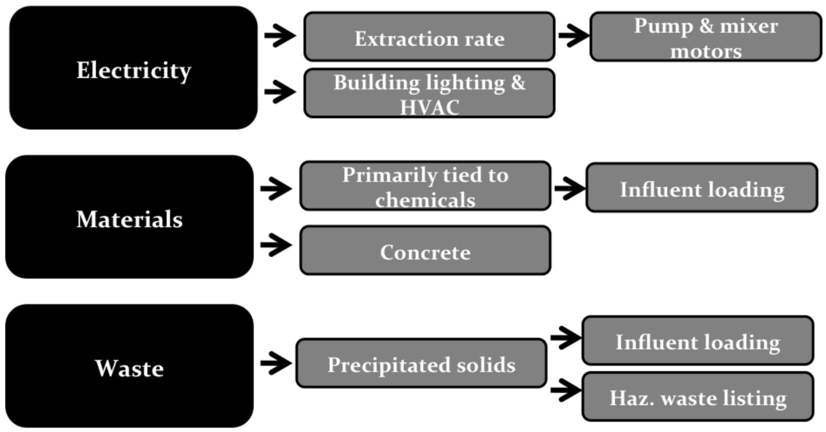
Version 1 – *Baseline injection of emulsified vegetable oil with potable water*
Version 2 – *Injection with extracted groundwater*
Version 3 – *Use of biodiesel for materials transport and drill rig operation*
Version 4 – *Use appropriate "off-spec" or waste food-grade product for bioremediation nutrient*
Version 5 – *Refine CSM and confirm source area is 50% smaller*
Version 6 – *Refine CSM and use appropriate "off-spec" product for nutrient*
Version 7 – *Refine CSM, use off-spec product for nutrient, use extracted groundwater, use biodiesel*

Back to Our Example P&T System

What are the big contributors?

Footprint Parameter	Primary Contributors
Total Energy	Electricity & Materials
GHG Emissions	Electricity & Materials
Criteria Pollutant emissions	Electricity & Materials
HAP emissions	Electricity & Materials
Public water use	Polymer blending
Other on-site water use	GW Extraction
Off-site water use	Electricity & Materials
Refined materials use & % from recycled material	Chemicals
Unrefined materials use & % from recycled material	Aggregate for concrete
Hazardous waste	Influent loading
Non-hazardous waste	N/A

What Controls the Big Contributors?



Addressing Big Contributors

CSM Related

- Can we optimize the extraction rate?
- Can source removal/stabilization reduce influent concentration?

Process Optimization

- Are there substitutes for process components that can reduce electricity or chemical use?
- Are motors oversized or throttled back? Are variable frequency drives used where appropriate?

Addressing Big Contributors (2)

Traditional Energy Efficiency

- Can we adjust building HVAC and lighting operation?
- Can we use more efficient HVAC and lighting technologies?

Managing Waste

- Are there other chemicals (preferably a waste stream) that we can use?

Green BMPs & Renewable Energy

- Can we use renewable or alternative energy?
  - On-site renewable energy
  - Purchased renewable energy
  - Combined heat and power

What about the Small Contributors?

Transportation

Transportation is not always a "small" contributor

- Carpooling → reduce gasoline usage by 10,000 gallons
- Mix chemicals on-site → reduce diesel usage by ~20,000 gallons
- Waste to local facility → reduce diesel usage by ~53,000 gallons

Total energy reduction of ~11,000 MMBtu (~2% of total energy use by remedy)

Small percentage reduction but large magnitude

Small % reductions may be lost in a footprint analysis where other contributors dominate. ⇒ **Use BMPs to achieve these reductions, and use footprint methodology to help quantify reductions**

Next Steps

Hilary Thornton

EPA

Training and Tech Transfer

In-house training in 2012 at the

- "Train the Trainer" session at TSP Meeting in Oklahoma City on May 2
- EPA Region 9 on May 16
  (Future regional training sessions will be planned as budget & travel permit)
- NARPM in October

Training via internet seminars
www.cluin.org

Additional example applications and case studies will be posted
www.cluin.org/greenremediation

Tools and Support

EPA

- EPA is releasing footprint spreadsheets it uses that are consistent with the final methodology and made publicly available on www.cluin.org/greenremediation.
  - Use of these spreadsheets is optional
  - Spreadsheets are fairly self-explanatory, but do not come with a user manual or technical support
- EPA Green Remediation Coordinators and the EPA Engineering Forum will be available to answer questions regarding the methodology.

Other Tools

Other Organizations

- Tools have been developed by other organizations, examples include…

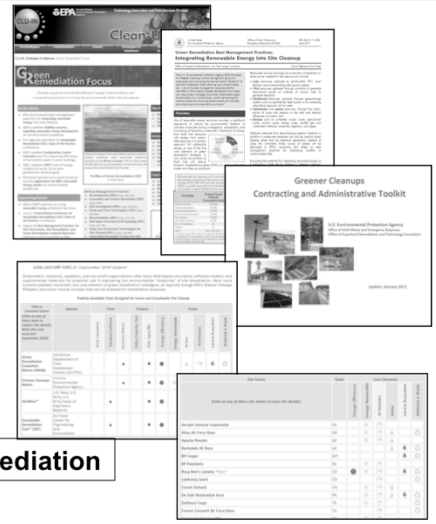
➢ SiteWise™ ➢ Sustainable Remediation Tool (SRT™)	➢ Life-cycle assessment tools ➢ Proprietary consultant tools

- These tools have not been evaluated by EPA, and may have varying degrees of consistency with the methodology

EPA will not endorse individual tools

Other GR Resources & Tools

- Website
- BMP toolkit
- Contracting toolkit
- Footprint evaluation tools & examples
- Site profiles (30)
- HQ & regional policies or strategies
- News, training, & conferences



www.clu-in.org/greenremediation

EPA

Questions

Resources & Feedback

- To view a complete list of resources for this seminar, please visit the **Additional Resources**
- Please complete the **Feedback Form** to help ensure events like this are offered in the future

Need confirmation of your participation today?

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68