ASTM STANDARD GUIDE
FOR GREENER CLEANUPS

QUANTITATIVE EVALUATION
(SECTION 7)

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Goal of this segment of the training

Become familiar with the Quantitative Evaluation process described in the ASTM Standard Guide

Know how to proceed when conducting a Quantitative Evaluation at your site

Conducting a Quantitative Evaluation will require expertise/experience that may be developed in-house or obtained through consultation.
1) Overview/Protocol for Quantitative Evaluation 10 min
2) Footprint Analyses and Life Cycle Assessments 5 min
3) Key Topics in Quantitative Evaluation 5 min
4) What to Keep in Mind for a Quantitative Evaluation 5 min
5) Resources and Q/A 5 min
Overview of Quantitative Evaluation

Reminder

Two Paths in the ASTM Standard Guide

One Path

Apply the Best Management Practices (BMPs)

Another Path

Conduct a Quantitative Evaluation then Apply the BMPs

The user chooses whether to do a Quantitative Evaluation. The choice will depend on the complexity of the site and the reasons for using the ASTM Standard.
Overview of Quantitative Evaluation

Purpose of a Quantitative Evaluation

Provide information on the most significant contributions to a cleanup’s *environmental footprint*

Estimate potential footprint reductions to be achieved by specific BMPs

What do we mean by “environmental footprint”?

The emissions, resource use, and waste generation associated with cleanup activities
Overview of Quantitative Evaluation

Quantitative Evaluation in the context of Greener Cleanups

Before Quantitative Evaluation

Conduct Quantitative Evaluation → Identify Areas for Reduction → Select and Apply BMPs → Achieve Footprint Reductions

original clean-up ————————> greener clean-up

After
There are 7 steps in the Quantitative Evaluation as described in the ASTM Standard Guide.
**Step 1**
Goals and Scope Definition

User identifies the **goal** of the study (i.e., questions to be answered)

Similar Sites *may have* Different Goals

Testing Options / BMPs

- Pump and Treat
- Pump and Treat + *UV*
- Pump and Treat + *Re-injected GW*
- Pump and Treat + *Grid Electricity*
- Pump and Treat + *Solar Power*

Evaluate Year to Year

- Pump and Treat – Years 1 - 5
- Pump and Treat – Years 6 - 10
- Pump and Treat – Years 11 - 15
- Pump and Treat – Years 16 - 20
- Close-out Years 21 & 22
Step 1
Goals and Scope Definition

User establishes the scope (i.e., how to conduct the evaluation)

Choose One of Two Approaches

Footprint Analysis

OR

Life Cycle Assessment

We will discuss the differences between a footprint analysis and a Life Cycle Assessment in the next section
**Step 2**

**Boundary Definition**

User determines the activity, geographic, and temporal boundaries of the study.

**Activity Boundary**
- Pump and treat activities
- **but** bioremediation activities not included

**Geographic Boundary**
- Activities within fence line of site
- **and** off-site support activities also included

**Temporal Boundary**
- Timeframe of site activities
- **and** timeframe before and after site activities
**Step 3**
Core Elements

User determines which core elements to include in the evaluation

Evaluate all core elements that are expected to be of importance to the clean-up

Document reasons for any core elements that are not included

Identify environmental trade-offs across core elements

Recall our Core Elements

- Materials & Waste
- Energy
- Air & Atmosphere
- Land & Ecosystems
- Water
**Step 3**
Core Elements

In some cases, we may apply a BMP that decreases the footprint in one core element but increases the footprint in another core element.

**What do we mean by trade-offs across core elements?**

We select a new treatment reagent with a smaller greenhouse gas footprint.

But this may...

... increase the volume of water used in the process...

... and increase the amount of waste generated by the process.
**Step 4** Collect and Organize Information

This deals with the specifics of identifying appropriate data bases

**Step 5** Perform Calculations

Using either footprint analysis tool or Life Cycle Assessment software

**Step 6** Perform Sensitivity Analyses

To assess the confidence and uncertainty of the results

The user collects data and crunches the numbers in a manner consistent with:

- goals and scope
- boundary conditions
- core elements

Appendix X4 in the ASTM Standard Guide provides background and details.
**Protocol for Quantitative Evaluation**

**Step 7**

Documentation

- **Present and interpret results of the quantitative evaluation**
  - Summarize all steps in the evaluation
  - Identify significant contributors to the core elements
  - Recommend actions to reduce the environmental footprint

**Documentation of the Quantitative Evaluation at the Green Hills Site**

*The user makes documentation of the Quantitative Evaluation publicly available*
Protocol for Quantitative Evaluation

**Step 7**
Documentation

- identify contributors to the core elements
- recommend BMPs for footprint reduction

**Example**

### Greenhouse gas emissions

![Chart showing greenhouse gas emissions](chart.png)

Diesel used in transportation

- Tons CO2e
- Onsite grid electricity use
- Onsite diesel use
- Generation of grid electricity use
- Transportation diesel use
- Transportation gasoline use
- HDPE
- Lime
- Clean fill
- Drain rock
- Diesel produced
- Gasoline produced
- Public water
- Offsite solid waste disposal
- Offsite hazardous waste disposal
- Offsite laboratory analysis
The user chooses whether to do a Quantitative Evaluation

**Wrapping Up the Overview/Protocol**

The user should:

- Clearly identify the goal, scope, and boundaries of the evaluation
- Determine which core elements to include in the evaluation
- Crunch the numbers
- Present and interpret the results in a publicly available report
### Topics

1. Overview/Protocol for Quantitative Evaluation  
   - 10 min

2. Footprint Analyses and Life Cycle Assessments  
   - 5 min

3. Key Topics in Quantitative Evaluation  
   - 5 min

4. What to Keep in Mind for a Quantitative Evaluation  
   - 5 min

5. Resources and Q/A  
   - 5 min
Footprint Analyses and LCAs

Section 7 Quantitative Evaluation

Footprint Analyses

- Includes less of the life-cycle
- Input databases are less comprehensive
- Output metrics are less comprehensive

As a general rule...

Life Cycle Assessment (LCA)

- Includes more of the life-cycle
- Input databases are more comprehensive
- Output metrics are more comprehensive

Two approaches to Quantitative Evaluation

- Data gathering
- Develop output metrics
- Report impact results

- YES
- NO
What do we mean by “report impact results”?

HAPs = Hazardous Air Pollutants
LCA = Life-Cycle Assessment
The user should choose the approach and calculator/tool/software that best suits the goals, scope, and boundaries identified for the site.
Quantitative Evaluation

**Topics**

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Section 7: Quantitative Evaluation

Key Topic #1

Quantitative Evaluation is Most Useful for Complex Sites and Remedies

As a general rule...

Relatively complex site...

- multiple activities
- long time frame
- unique technologies

Quantitative Evaluation usually can help to:

- Find “hidden” contributors
- Prioritize BMPs
- Identify “trade-offs”

Relatively simple site...

- single activity
- short time frame
- standard technologies

Quantitative Evaluation generally not needed:

- Hidden contributors are unlikely
- BMP selection is easy
- “Trade-offs” unlikely
Key Topics in Quantitative Evaluation

Identifying Core Elements to Include in the Quantitative Evaluation

The default should be to include all five Core Elements. However, some Core Elements may be more important than others at your site.

- **Particulate emissions** may be important for a region in non-attainment.
- **Greenhouse gas emissions** may be important to a municipality with greenhouse gas reduction goals.
- **Waste generation** may be important for a community with concerns regarding landfill space.
- **The water footprint** may be important in arid lands.
The Quantitative Evaluation can be conducted at any phase of the cleanup.

With feedback loops for selecting BMPs.
### Topics

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What to Keep in Mind

When you conduct a Quantitative Evaluation ...

... ask the following general questions:

- Are the goals, scope, and boundaries clearly defined?
- Are all five core elements addressed?
- Have trade-offs across core elements been described?
- Have the significant contributors to the footprint been identified?
- Have recommendations been made for footprint reduction?

If not addressed, has a rationale been provided?
What to Keep in Mind

When you conduct a Quantitative Evaluation ...

... ask a few key questions on specifics:

Has the local grid mix been used in the calculations?

Have the off-site activities been included in the evaluation?

Have the technologies been modeled accurately?

- Has the local grid mix been used in the calculations?
  - If there is large grid electricity demand at your site ...

- Have the off-site activities been included in the evaluation?
  - If there are a lot of off-site support activities for your site ...

- Have the technologies been modeled accurately?
  - If there are unique technologies at your site ...

- lab analyses
- waste disposal
- POTW
- wind turbine
- engineered wetlands
- landfill gas combustion
What to Keep in Mind

When you conduct a Quantitative Evaluation ...

... be curious. What is driving the results?

My site has only a pump and treat system ...

... so why is transport diesel fuel such a big contributor?

The pump and treat system at my site uses a lot of grid electricity ...

... so why isn’t the greenhouse gas footprint bigger?

Perhaps treatment reagents and treatment wastes are being trucked great distances, resulting in large diesel fuel usage.

Perhaps the local grid electricity is based primarily on hydropower, resulting in a smaller greenhouse gas footprint.
Wrap-Up

We hope this has provided basic information about Quantitative Evaluations

You can find specific information in the ASTM Standard Guide

If you conduct a Quantitative Evaluation for your site ...

... we think you will find the results very useful ...

... and it should help you gain a better understanding of your site and remedy!
Quantitative Evaluation

**Topics**

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   10 min

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Section 7
Quantitative Evaluation

Resources

Cluin.org/greenremediation

Footprint Assessment

Methodology

EPA's Methodology for Understanding and Reducing a Project's Environmental Footprint supplements EPA's 2008 green remediation primer (EPA 542-1). An approach to quantify energy, air, land, waste that comprise the environment remedial area. It also provides suggestions on how to continue the remedy selection, design, implementation phases. After finalizing the methodology in 2012, EPA publically released the Spreadsheets for Environmental Footprint Analysis (SEFA), which are designed to help users monitor methodology's metrics on a site-specific basis.

A Standard Guide for Greener Cleanups

EPA representatives worked with ASTM International to develop a consensus-based standard intended to encourage property owners, responsible parties, developers, and communities to voluntarily use greener practices for contaminated site cleanup. As a part of the standard development process, EPA's Office of Solid Waste and Emergency Response (OSWER), EPA regional offices, and stakeholders developed a framework outlining the desired outcomes of a potential standard for greener cleanups. The framework reflected EPA's Greener Cleanup Standards, which focus on five core elements associated with a cleanup project's environmental footprint.

ASTM International issued the final Standard Guide for Greener Cleanups (E2893-13) in November 2013. The guide includes:

- A systematic protocol to identify, prioritize, select, implement, and report on the use of best management practices (BMPs) to reduce the environmental footprint of cleanup activities.
- A list outlining more than 160 greener cleanup BMPs that are linked to the core elements of a greener cleanup and to relevant cleanup technologies.
- Guidelines to quantify the environmental footprint of cleanup activities.
Resources

EPA’s Footprint Methodology (full document)
www.clu-in.org/greenremediation/subtab_b3.cfm

EPA’s Footprint Methodology (2-page fact sheet)

EPA’s SEFA Worksheets (for footprint analysis)
www.clu-in.org/greenremediation/subtab_b3.cfm

SEFA Webinar (archived Oct 28, 2014)
http://www.clu-in.org/conf/tio/SEFA_102814/

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Thank you for your interest in Greener Cleanups!

BMP Fact Sheets
www.clu-in.org/greenremediation/

Profiles of Green Remediation
www.clu-in.org/greenremediation/tab_d.cfm

Archived Webinars
www.clu-in.org/greenremediation/subtab_b6.cfm

Other Related Topics
ASTM STANDARD GUIDE FOR GREENER CLEANUPS

QUANTITATIVE EVALUATION (SECTION 7)

Contact for questions on this presentation

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