



ASTM STANDARD GUIDE *FOR GREENER CLEANUPS*

QUANTITATIVE EVALUATION (SECTION 7)

Carlos Pachon, US EPA OSRTI
Deb Goldblum, US EPA Region 3
Karen Scheuermann, US EPA Region 9

December 10 & 11, 2014

Quantitative Evaluation

**Goal of this segment
of the training**

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

and

**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.**

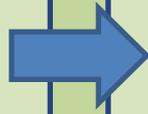
Quantitative Evaluation

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 |

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

and/or

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*

*Quantitative
Evaluation*

Before



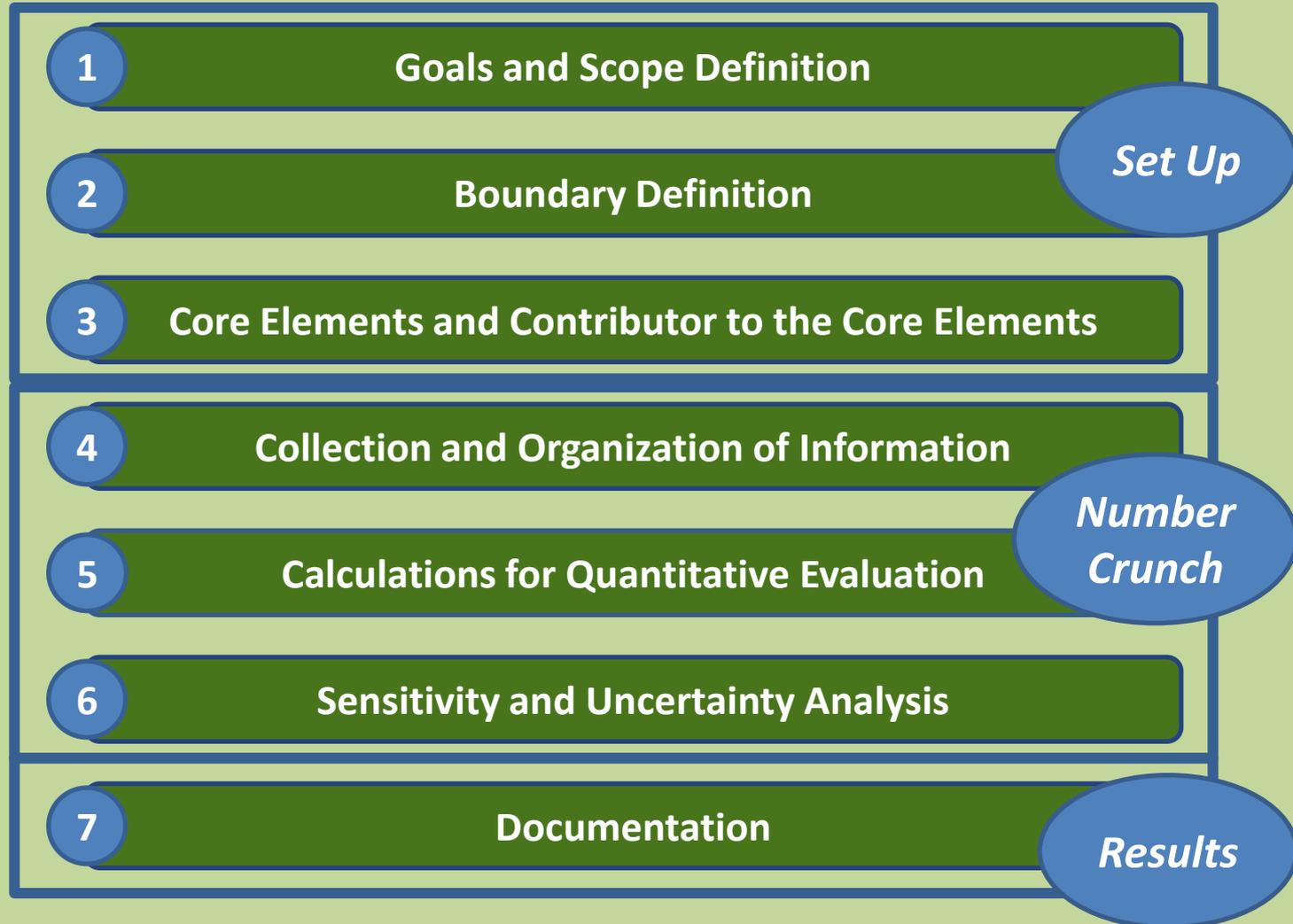
After



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

Protocol for Quantitative Evaluation

There are 7 steps in the Quantitative Evaluation as described in the ASTM Standard Guide.



Protocol for Quantitative Evaluation

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

One
Site

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*

Another
Site

Evaluate Year to Year

Pump and Treat – Years 1 - 5

Pump and Treat – Years 6 - 10

Pump and Treat – Years 11 - 15

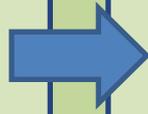
Pump and Treat – Years 16 - 20

Close-out Years 21 & 22

Protocol for Quantitative Evaluation

Step 1

Goals and Scope
Definition



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

One aspect
of the
"scope"

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

Protocol for Quantitative Evaluation

Step 2

Boundary Definition

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

Activity Boundary

Example

Pump and treat activities

but
bioremediation activities not included

Geographic Boundary

Example

Activities within fence line of site

and
off-site support activities also included

Temporal Boundary

Example

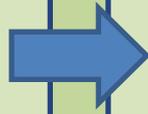
Timeframe of site activities

and
timeframe before and after site activities

Protocol for Quantitative Evaluation

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



Protocol for Quantitative Evaluation

Step 3

Core Elements

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

Example

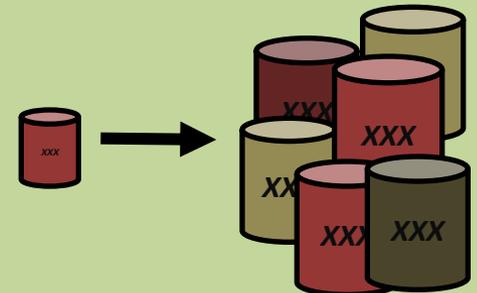
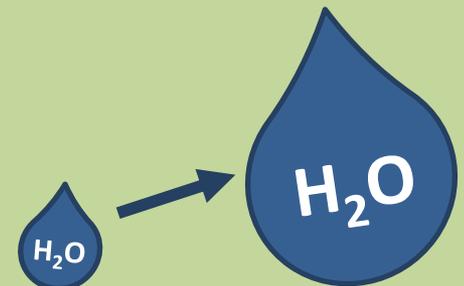
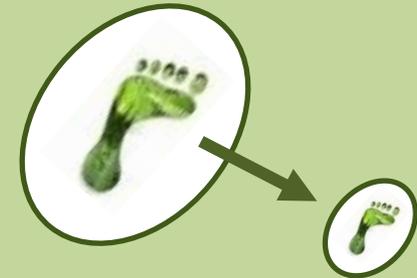
In some cases, we may apply a BMP that decreases the footprint in one core element but increases the footprint in another core element

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.



Protocol for Quantitative Evaluation

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**

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

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

**Summarize all
steps in the
evaluation**

**Identify significant
contributors to the
core elements**

**Recommend actions
to reduce the
environmental footprint**

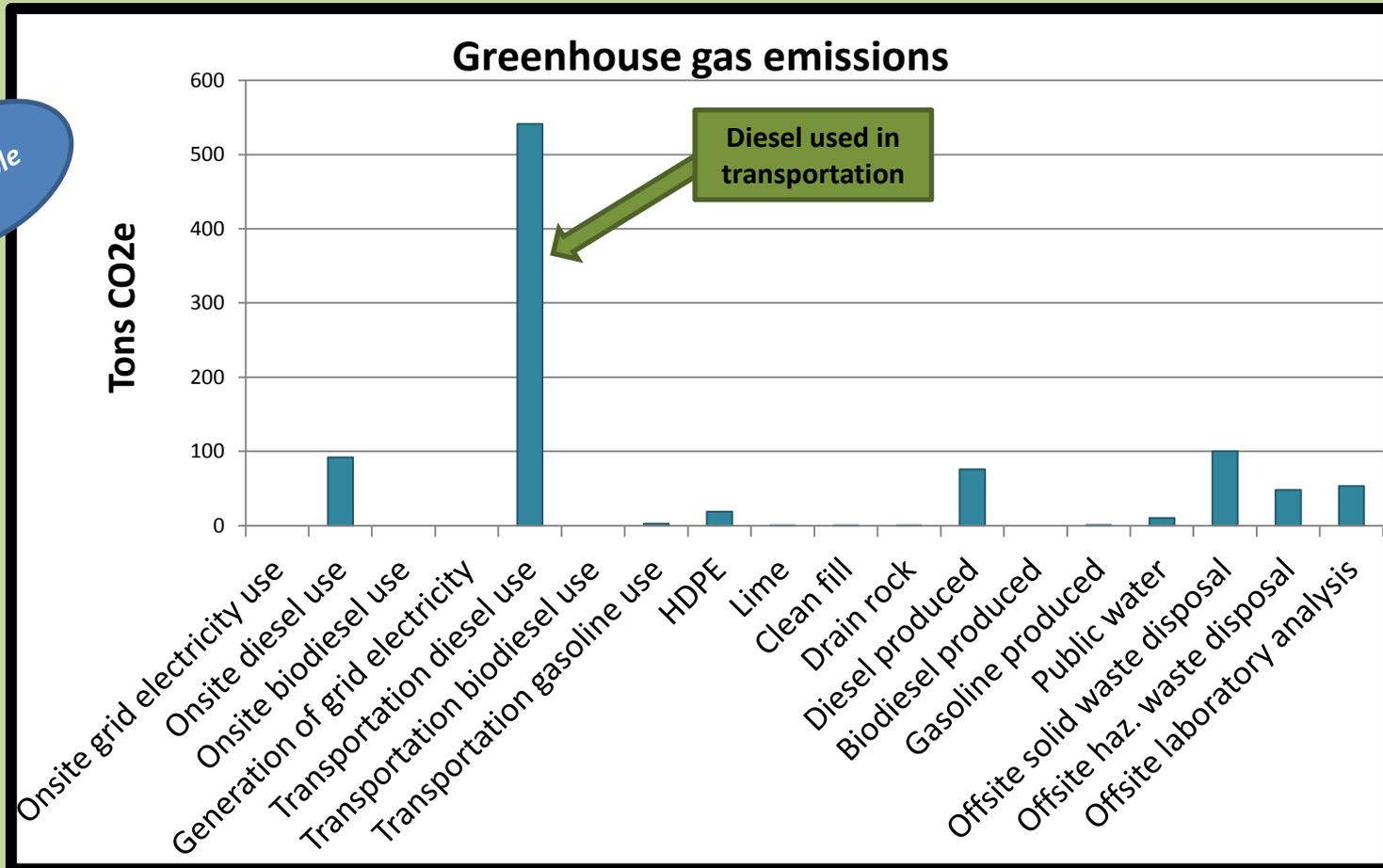
Protocol for Quantitative Evaluation

Step 7

Documentation

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

Example



Overview/Protocol of Quantitative Evaluation

Wrapping Up the Overview/Protocol

Key
Messages

The user chooses whether to do a Quantitative Evaluation

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

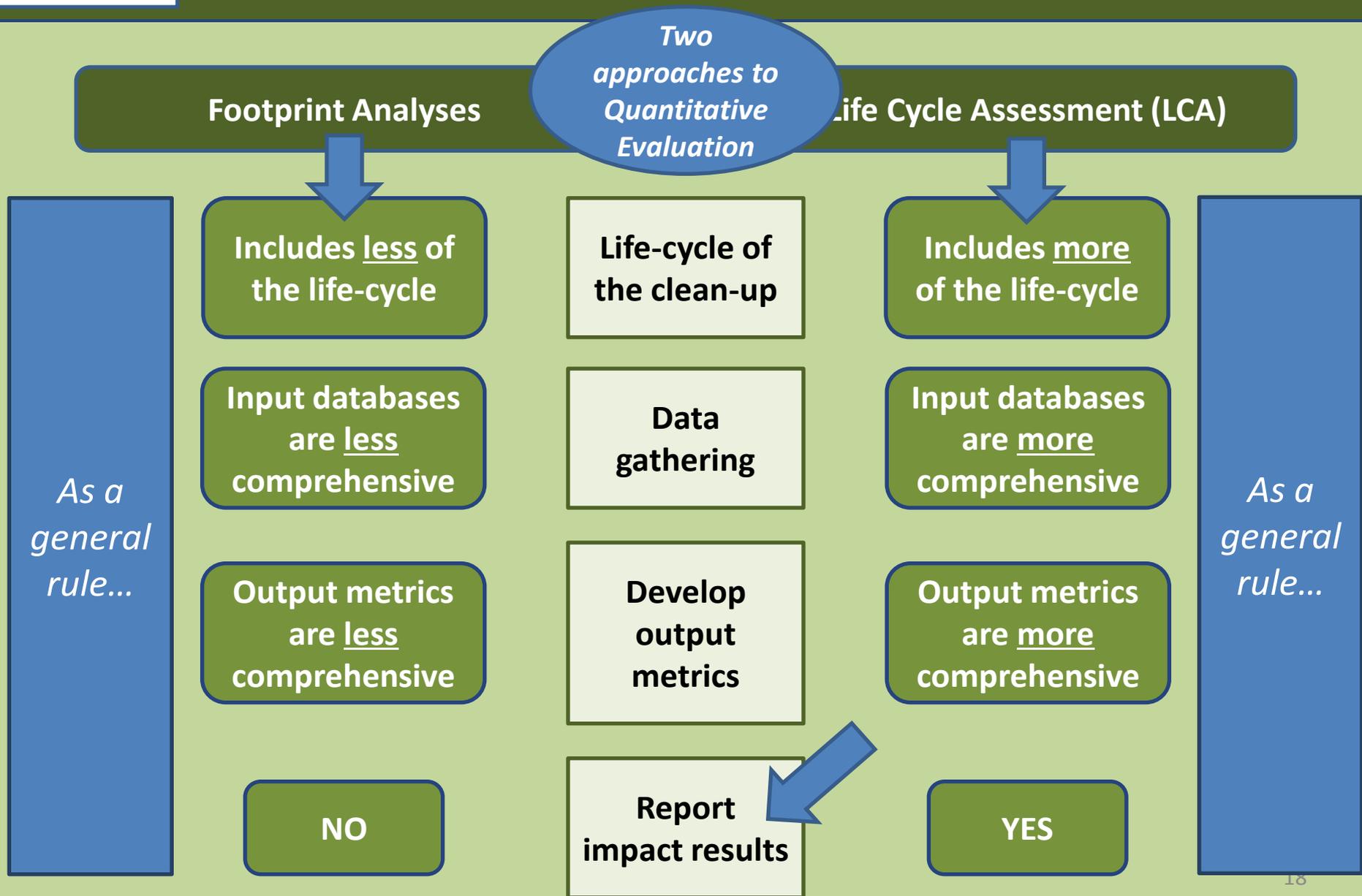
Present and interpret the results in a
publicly available report

Quantitative Evaluation

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



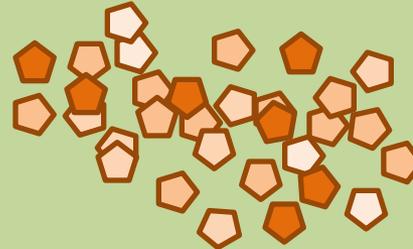
Footprint Analyses and LCAs

What do we mean by “report impact results”?

LCA

Footprint Analysis

HAPs



Metric
12 lbs HAPs
emitted to the air

Example

But what are the impacts from the HAPs?

Ecotoxicity

Human Health

Ozone Depletion

Acidification

HAPs = Hazardous Air Pollutants
LCA = Life-Cycle Assessment

Footprint Analyses and LCAs

*Additional
notes*

Footprint Analyses

Sustainable Remediation Tool (SRT)

SiteWise

Spreadsheets for Environmental
Footprint Analysis (SEFA)

Consultant's In-House Worksheets

*Generally quicker and easier to
conduct*

Life Cycle Assessment (LCA)

SimaPro

GaBi

*Generally more involved and
requires specialized training and
expertise*

*At same
site*

*Different tools and software will give different results,
due to different built-in scopes and boundaries.*

*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

- | | | |
|--|---------------|---|
| 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 | |

Key Topics in 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

Key Topic #2

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.

The water footprint may be important in arid lands.

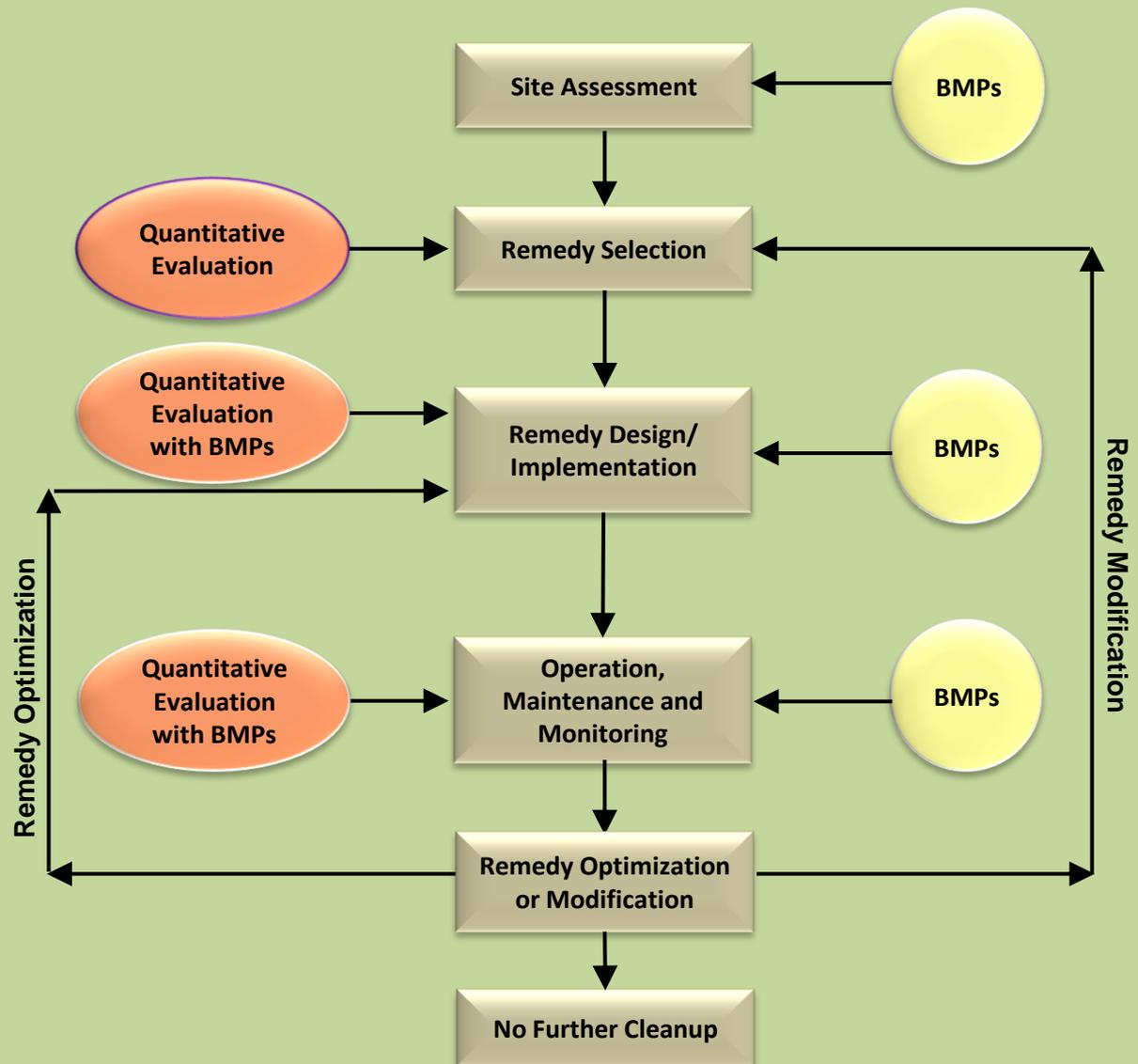
Waste generation may be important for a community with concerns regarding landfill space.

Key Topics in Quantitative Evaluation

Key Topic
#3

The
Quantitative
Evaluation
can be
conducted
at any phase
of the
cleanup.

*With feedback
loops for
selecting
BMPs.*



Quantitative Evaluation

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 | |

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:

*If there is large
grid electricity
demand at your
site ...*

Has the local grid mix been used in the calculations?



*If there are
a lot of off-site
support activities
for your site...*

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

lab
analyses

waste
disposal

POTW

*If there are
unique
technologies at
your site ...*

Have the technologies been modeled accurately?

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 ?*

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

*The pump and treat
system at my site uses a
lot of grid electricity ...
... so why isn't the
greenhouse gas footprint
bigger ?*

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 ...

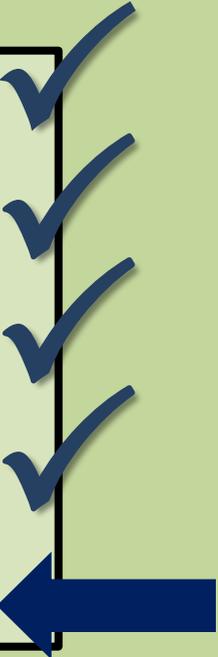
*... we think you will find the
results very useful ...*

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

Quantitative Evaluation

Topics

- | | |
|--|---------------|
| 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 |



Cluin.org/greenremediation

Green Remediation Focus

Footprint Assessment

• Home

Methodology



EPA's **Methodology for Understanding and Reducing a Project's Environmental Footprint** supplements EPA's 2008 green remediation primer (EPA 542-F) with an approach to quantify energy, air, and waste that comprise the environmental footprint of a remedial action. It also provides suggestions on how to integrate environmental considerations during the remedy selection, design, implementation, and monitoring phases. After finalizing the methodology in 2012, EPA publicly released the **Spreadsheets for Environmental Footprint Analysis (SEFA)**, which are designed to help users apply the methodology's metrics on a site-specific basis.

Spreadsheets for Environmental Footprint Analysis (SEFA) **Updated August 2014**



EPA's **Spreadsheets for Environmental Footprint Analysis (SEFA)** are designed to assist EPA in conducting an

Green Remediation Focus

A Standard Guide for Greener Cleanups

• Home



May 22, 2013, Web Seminar:

EPA's Methodology for Understanding and Reducing Environmental Footprint. This seminar discussed the regulatory framework, summarized the methodology, and explained the steps of performing an environmental footprint assessment. [>>> Click here to view the archived webinar.](#)

EPA representatives worked with ASTM International to develop a consensus-based standard intended to encourage property owners, agencies, responsible parties, developers and communities to voluntarily use greener practices for contaminated site cleanup. As part of the standard development process, EPA's Office of Solid Waste and Emergency Response (OSWER), EPA regional offices and states developed a framework outlining the desired outcomes of a potential standard for greener cleanups. The framework reflected EPA's **Greener Cleanups**, 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



April 25, 2014, Web Seminar:

ASTM Greener Cleanup Standard Guide: An Introduction
This seminar provided insight on development of the new **Standard Guide for Greener Cleanups (ASTM E2893-13)**.

Resources

Resources

EPA's Footprint Methodology (full document)

www.clu-in.org/greenremediation/subtab_b3.cfm

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

www.clu-in.org/greenremediation/methodology/docs/GR_Overview_of_Footprint_Methodology_FS_3-29-12.pdf

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/

Contacts

Carlos Pachon, EPA OSRTI
pachon.carlos@epa.gov

Deb Goldblum, EPA Region 3
goldblum.Deborah@epa.gov

Karen Scheuermann, EPA Region 9
scheuermann.karen@epa.gov

*Thank you for your
interest in Greener
Cleanups!*



Other Related Topics

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

Quantitative Evaluation

**ASTM STANDARD GUIDE
FOR GREENER CLEANUPS**

**QUANTITATIVE
EVALUATION
(SECTION 7)**



***Contact for questions on this
presentation →***

**Karen Scheuermann, US EPA Region 9
scheuermann.karen@epa.gov**