Moving Towards Sustainable Remediation: Overview and Concepts

Daniel M. Powell, Chief
Technology Integration and Information Branch
US EPA, Office of Superfund Remediation and Technology Innovation
Washington, DC

United States Environmental Protection Agency

Northeast Waste Management Officials Association
December 2013

Themes

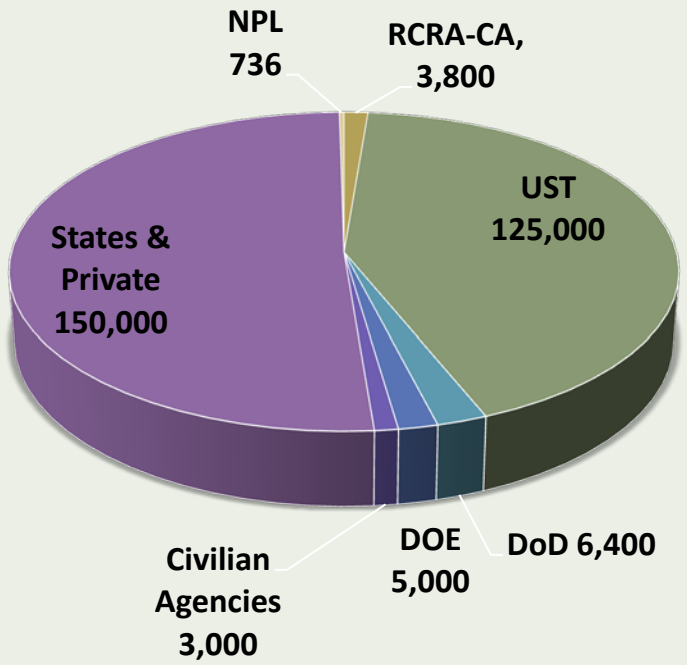
- **We have made significant progress in pollution prevention and remediating legacy contaminated sites, but we still have work to do**
- **EPA seeks to further reduce the environmental footprint of cleanups, while integrating community interests, and supporting economic growth**
- **A wealth of resources are available to aid in understanding of green remediation concepts, applications**
- **Several evolving concepts helping us achieve protectiveness at lower cost and environmental footprint (later)**

EPA Contaminated Site Programs: We Still a Lot of Remediation Work to Do

- We have made great progress cleaning up contaminated sites but…
- National Academies of Sciences estimates 126,000 sites across US still have contaminated groundwater, and their closure expected to cost at least $110 billion to $127 billion
- We continue to invest over $8 billion a year in remediation (USEPA, EBJ)
- We have opportunity to take lessons learned over the past decades, and apply innovations and best management practices to future sites

Estimated Number of Contaminated Sites (USEPA 2004)
(United States, Cleanup horizon: 2004 – 33)

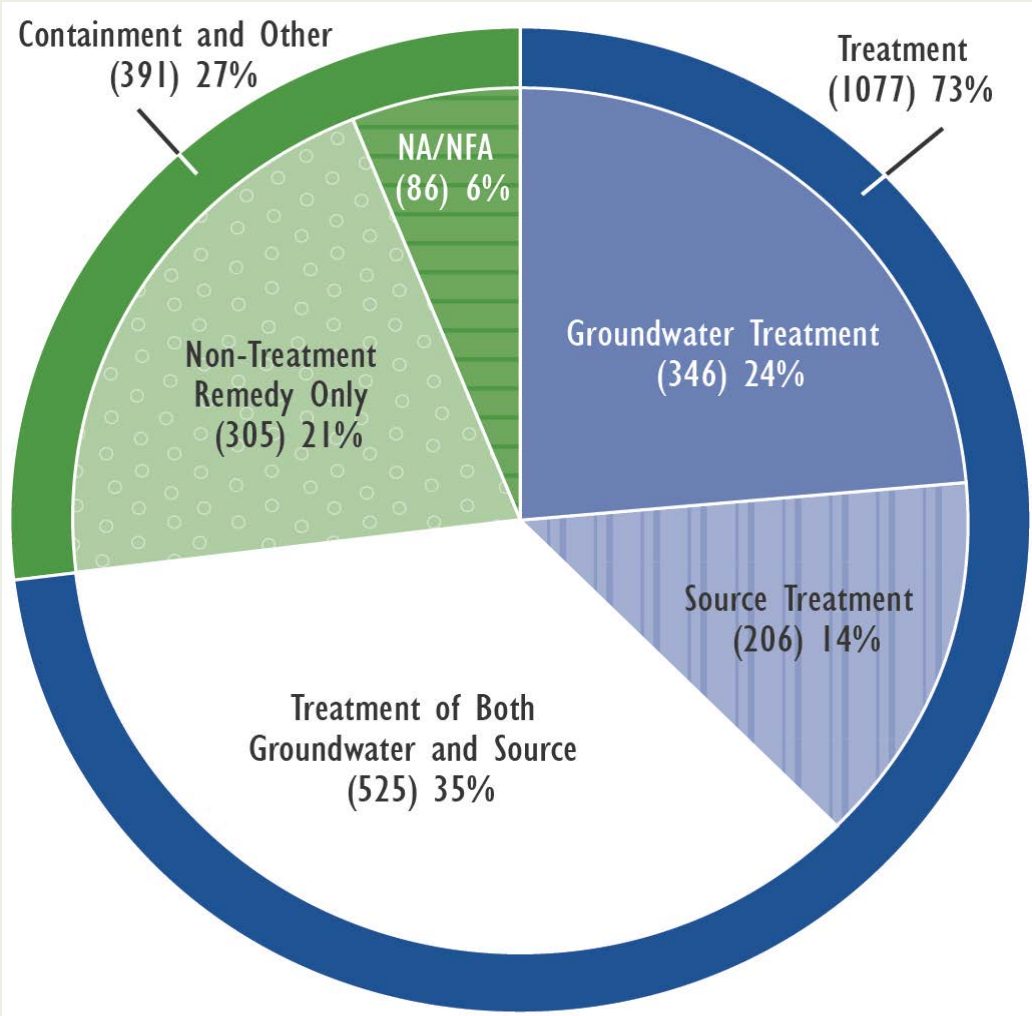
Total Sites = 294,000



Sources: www.clu-in.org/market; http://www.nationalacademies.org/ http://www.ebiusa.com/

Remediation: The "Big Picture"- Remedy Types at National Priority List Sites

- Superfund law established a preference for treatment and permanent remedies
- In early years that was a challenge; we did not have many alternatives to contain, burn, or pump and treat remedies
- Over time Superfund program has succeeded in implementing treatment remedies at over 70% of NPL sites
- At many sites we are treating both soil and groundwater contamination



Total number of sites with remedies = 1,468, 1982-2011

In Situ Source Treatment Technologies at Superfund Sites

- About 45% of treatment remedies for source control are currently in situ (in place)
- We are seeing fewer developments in new technologies, and more innovation in design, construction and operation of commercial technologies
- More aggressive remedies used to tackle source areas (such as in situ thermal treatment , chemical oxidation)
- Often coupled with groundwater remedies, treatment and non-treatment

Technology	Total 2009-2011	Percent 2009-2011
In Situ		
Soil Vapor Extraction	25	14%
Chemical Treatment	17	10%
Solidification/Stabilization	11	6%
Multi-Phase Extraction	9	5%
In Situ Thermal Treatment	7	4%
Bioremediation	5	3%
Subaqueous Reactive Cap	2	1%
Flushing	1	1%
Fracturing	1	1%
Phytoremediation	1	1%
Total In Situ	**79**	**45%**

Groundwater Remedy Types Recently Selected in Superfund

- Groundwater pump and treat still common, but we see more in situ treatment remedies
- Monitored natural attenuation is used either alone or in combination
- Concept of "adaptive management" gaining ground: Actively monitoring operating systems to determine optimal transition time and place between remedy components

Remedy Type and Technologies	Total (FY09–11)	Percent (FY09–11)
Groundwater Pump and Treat	**44**	**12%**
In Situ Treatment of Groundwater	**78**	**21%**
Bioremediation	49	13%
Chemical Treatment	27	7%
Air Sparging	14	4%
Permeable Reactive Barrier	8	2%
In-Well Air Stripping	2	1%
Multi-Phase Extraction	2	1%
MNA of Groundwater	**56**	**15%**
Groundwater Containment (VEB)	**6**	**2%**
Engineered (Constructed) Wetland	**3**	**1%**
Other Groundwater	**177**	**49%**
Institutional Controls	173	48%
Alternative Water Supply	13	4%
Engineering Controls	2	1%

Sustainability : U.S. Policy Drivers at Many Levels

- **Executive Order 13514: Federal Leadership in Environmental, Energy, and Economic Performance**

  It is the policy of the United States that Federal agencies shall increase energy efficiency; measure, report, and reduce their greenhouse gas emissions from direct and indirect activities; conserve and protect water resources through efficiency, reuse, and stormwater management; eliminate waste, recycle, and prevent pollution (President Obama)

- **EPA Strategic Plan 2011-2015: Goal 3: Cleaning Up Communities and Advancing Sustainable Development**

  EPA's Superfund program will implement its green remediation strategy to reduce the energy, water, and materials used during site cleanups while ensuring that protective remedies are implemented (Administrator Lisa Jackson)

- **EPA Office of Solid Waste & Emergency Response Policy (OSWER): Principles for Greener Cleanups**

  As a matter of policy, OSWER's goal is to evaluate cleanup actions comprehensively to ensure protection of human health and the environment and to reduce the environmental footprint of cleanup activities, to the maximum extent possible. (OSWER Assistant Administrator Mathy Stanislaus)

- **Regional policies and action plans**

- **… consistent with regulatory requirements**

Challenge: Lowering the Environmental Footprint of Site Cleanup Projects

Green Remediation

The practice of considering all environmental effects of remedy implementation and incorporating options to minimize the environmental footprints of cleanup actions.

*as defined by US EPA, *a.k.a.* greening response actions, greener cleanups, etc.

2010 Superfund Strategy

- **Sets out the Superfund Program's plans to promote green remediation practices during site cleanups without compromising cleanup goals**
- **Covers three areas:**
  - Policy and Guidance
  - Resource Development and Program Implementation
  - Evaluation
- **Includes 9 "Key Actions"; each action includes several implementation activities (42 total)**
- **Majority have been implemented**

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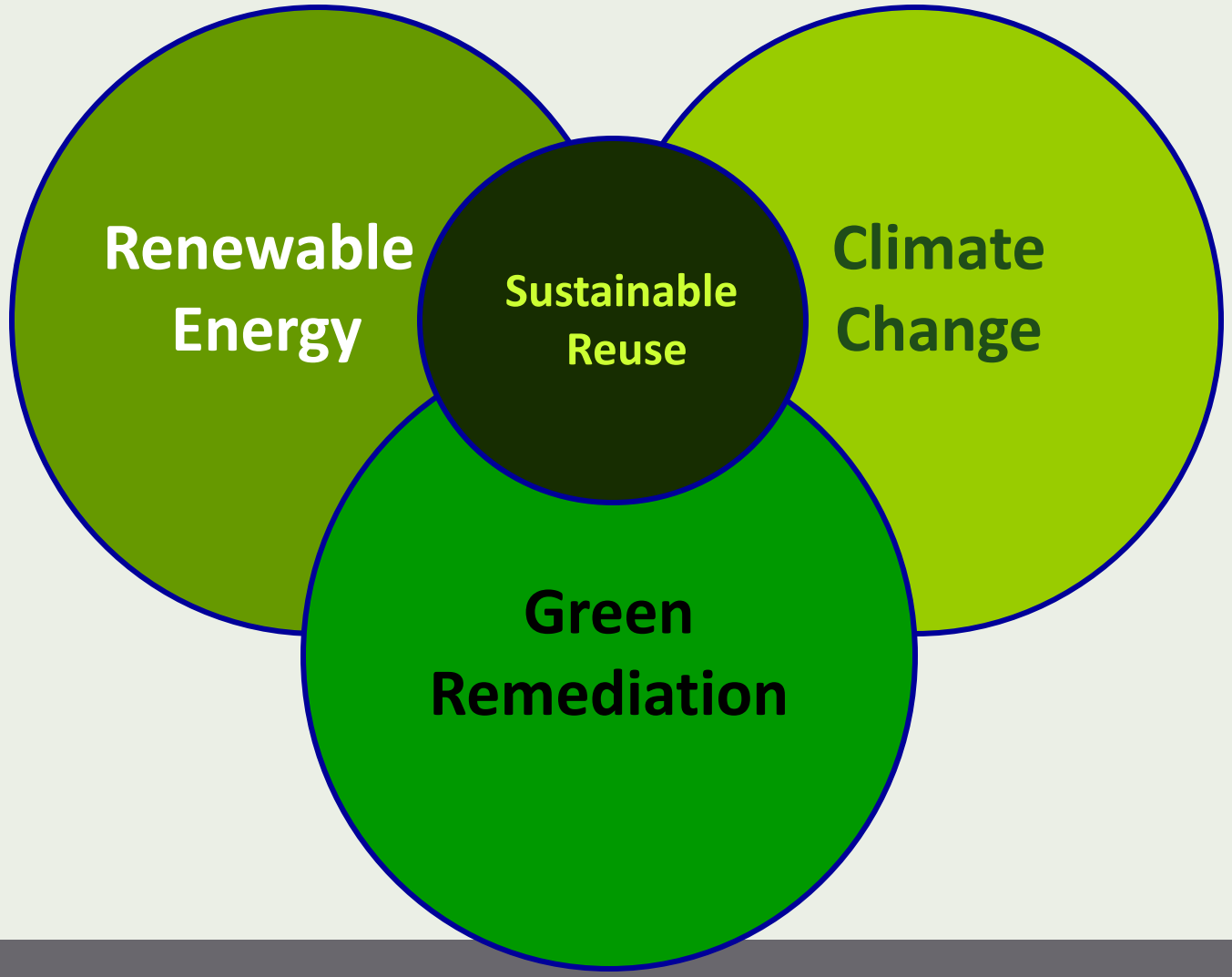
Related But Not Synonymous



Sustainability in Superfund Site Remediation

- **Social:**
  - Engaging communities in site cleanup decisions
  - Turning contaminated sites into community assets
- **Economic:**
  - Redevelopment in blighted areas (aligns with smart growth goals)
  - Fostering employment opportunities in communities where sites are cleaned up
  - Rising property values in communities
  - Remediation in the U.S.: A $7billion/year economic engine
- **Environmental:**
  - Protecting Human Health and the Environment
  - Liberating contaminated sites for reuse (1 remediated acre redeveloped = 4 acres of green field development)
- **Challenge: A smaller environmental footprint cleaning up sites**

Community Involvement (CI): Robust "Social" leg in Superfund

- By Law, Superfund requires community input in remedy decisions and implementation
- EPA parallels the International Association for Public Participation 7 "core values of public participation"
- EPA has a CI policy since 1981, and nearly 100 CI Coordinators across the 10 regional offices
- Technical assistance (grants and services) are provided to ensure communities are independently advised on challenging technical issues
- Our experience shows good CI results in better remedies
- Environmental justice link

…members of the public affected by a Superfund site have a right to know what the Agency is doing in their community and to have a say in the decision-making process. (Superfund Community Involvement Handbook).

Fostering Redevelopment and Economic Opportunities

- In Superfund, Remedial Action Objectives factor *reasonably anticipated future land use*.*
- EPA serves as an active partner in helping to return sites to productive uses
  - » Funding reuse assessments and redevelopment planning
  - » Removing reuse barriers, real or perceived
  - » Partnering with local governments, communities, developers, and other interested stakeholders
- Beyond cleanup: Sites ready for anticipated reuse is a key Superfund "GPRA" goal
- Annually 300 businesses at 142 Superfund sites with redevelopment has taken place generate $8.8 billion in sales, 25,000 jobs and $1.6 billion in employment income

Implementation of GR in EPA Contaminated Site Programs

- Define internal policies, strategies and program action plans:
  - Cross-Agency Principles for all cleanup programs
  - Superfund green remediation strategy & 40 action items
  - Regional sustainability and green remediation strategies
  - Update contracting language to reflect new practices
- Develop technical guidance for practitioners
  - Best management practice fact sheets (13 to date)
  - Environmental footprint evaluation methodology
- Leverage voluntary market driven options
  - ASTM Standard Guide for Greener Cleanups

Addressing the Environmental Leg of Sustainability: Core Elements of Green Remediation

Energy and Air Emissions

- **Reduced emissions of criteria pollutants (PM, SOx, NOx) and greenhouse gases (GHG)**
  - » Maintaining, repowering, or retrofitting diesel engines
- **Energy efficiency practices**
  - » High-efficiency equipment
  - » Variable frequency drives
  - » Low-emission vehicles and carpooling
  - » Use of local materials and services
  - » Combined heat and power
- **Renewable energy**
  - » On-site renewable energy
  - » Purchased renewable energy

An off-grid, 770-watt PV system at Brooks Camp, AK, powered an air sparging pump used for treating groundwater contaminated by former underground storage tanks.

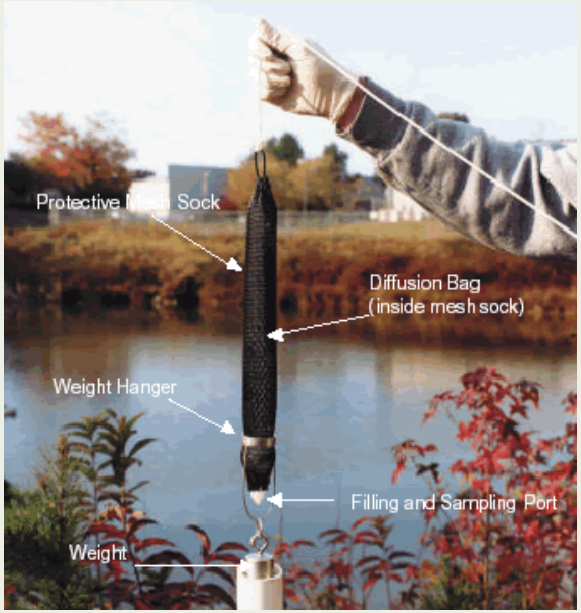
Water Use and Conservation

- **Seek beneficial use of extracted and treated water**
- **Optimize capture zones of groundwater pump & treat (P&T) systems**
- **Divert clean water around impacted areas**
- **Use less-refined water resources when possible**
- **Manage stormwater runoff to protect surface water quality**
- **Infiltrate diverted stormwater for aquifer storage**

Portable closed-loop wheel washing systems for reducing onsite and offsite trackout during construction

Materials & Waste

- **Reduce Material Use**
  - » Alternative materials or chemicals
  - » Materials with recycled content
  - » Materials from waste products
- **Source unrefined materials locally and/or from recycled sources**
- **Minimize hazardous and non-hazardous waste generated on site**
- **Reuse or recycle waste generated on site**



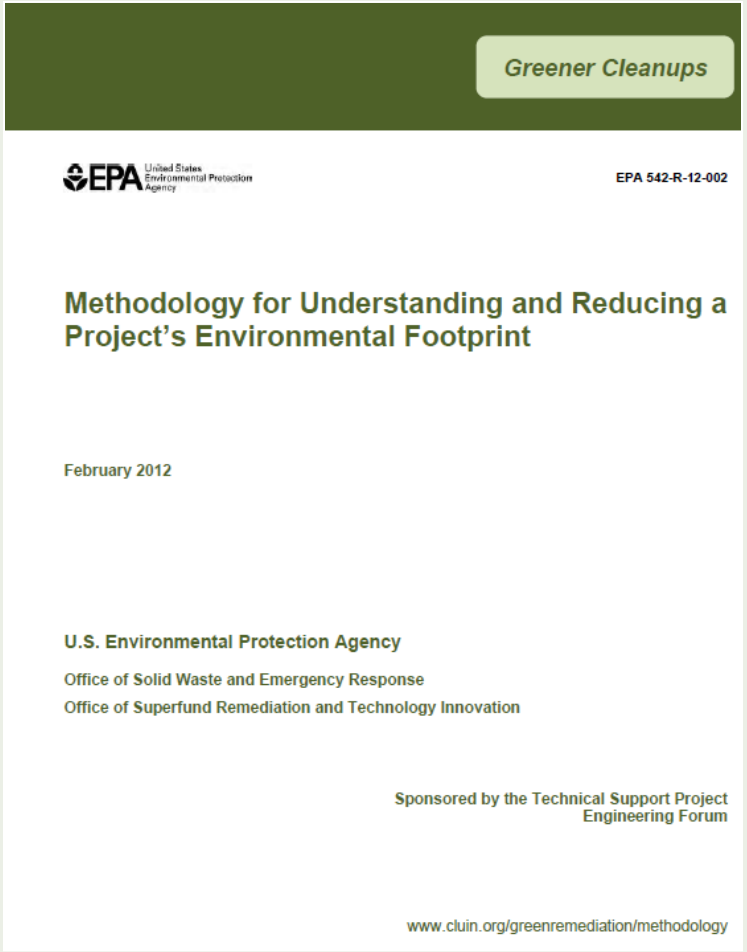
Use of passive diffusion bag samplers reduces or eliminates purge water associated with well sampling.

Options for Implementing Green Remediation

- **Direct Use of Best Management Practices (BMPs)**
  - Excavation and Surface Restoration
  - Site Investigation
  - Pump and Treat Technologies
  - Bioremediation
  - Soil Vapor Extraction & Air Sparging
  - Clean Fuel & Emission Technologies for Site Cleanup
  - Integrating Renewable Energy into Site Cleanup
  - Sites with Leaking Underground Storage Tank Systems
  - Landfill Cover Systems & Energy Production
  - Mining Sites
  - Implementing In Situ Thermal Technologies
  - Overview of EPA's Methodology to Address the Environmental Footprint of Site Cleanup

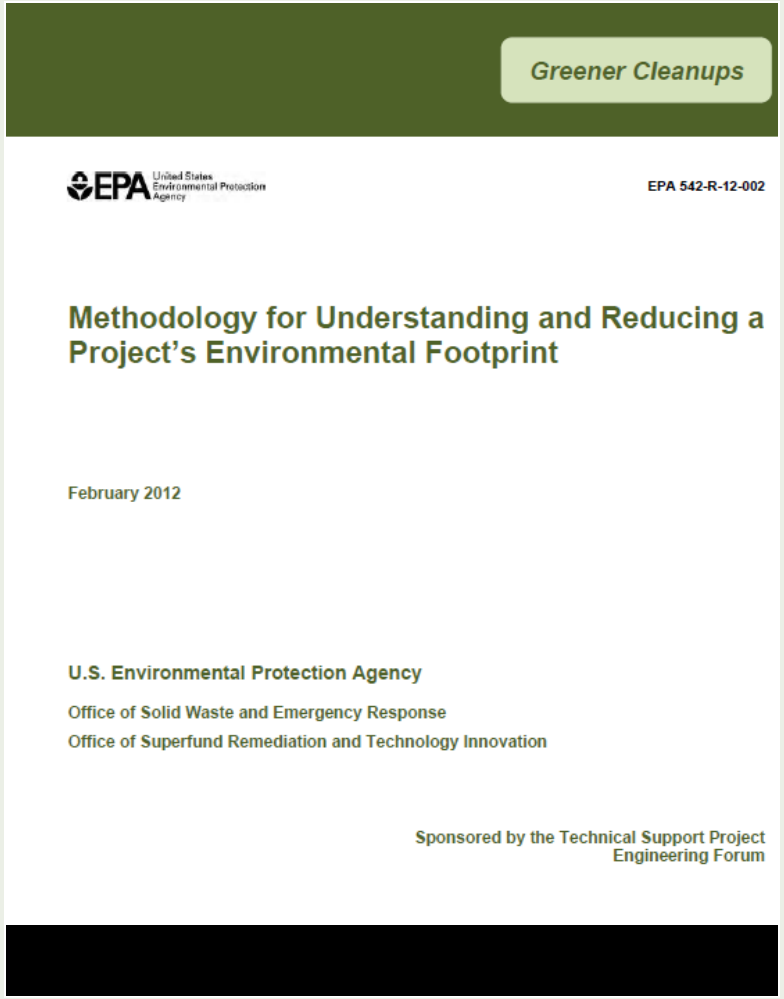
www.cluin.org/greenremediation/

- **For Complex Projects – Apply Footprint Methodology**



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
- One of 40 action items identified from the Superfund Green Remediation Strategy



Methodology for Understanding & Reducing a Project's Environmental Footprint

- **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 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

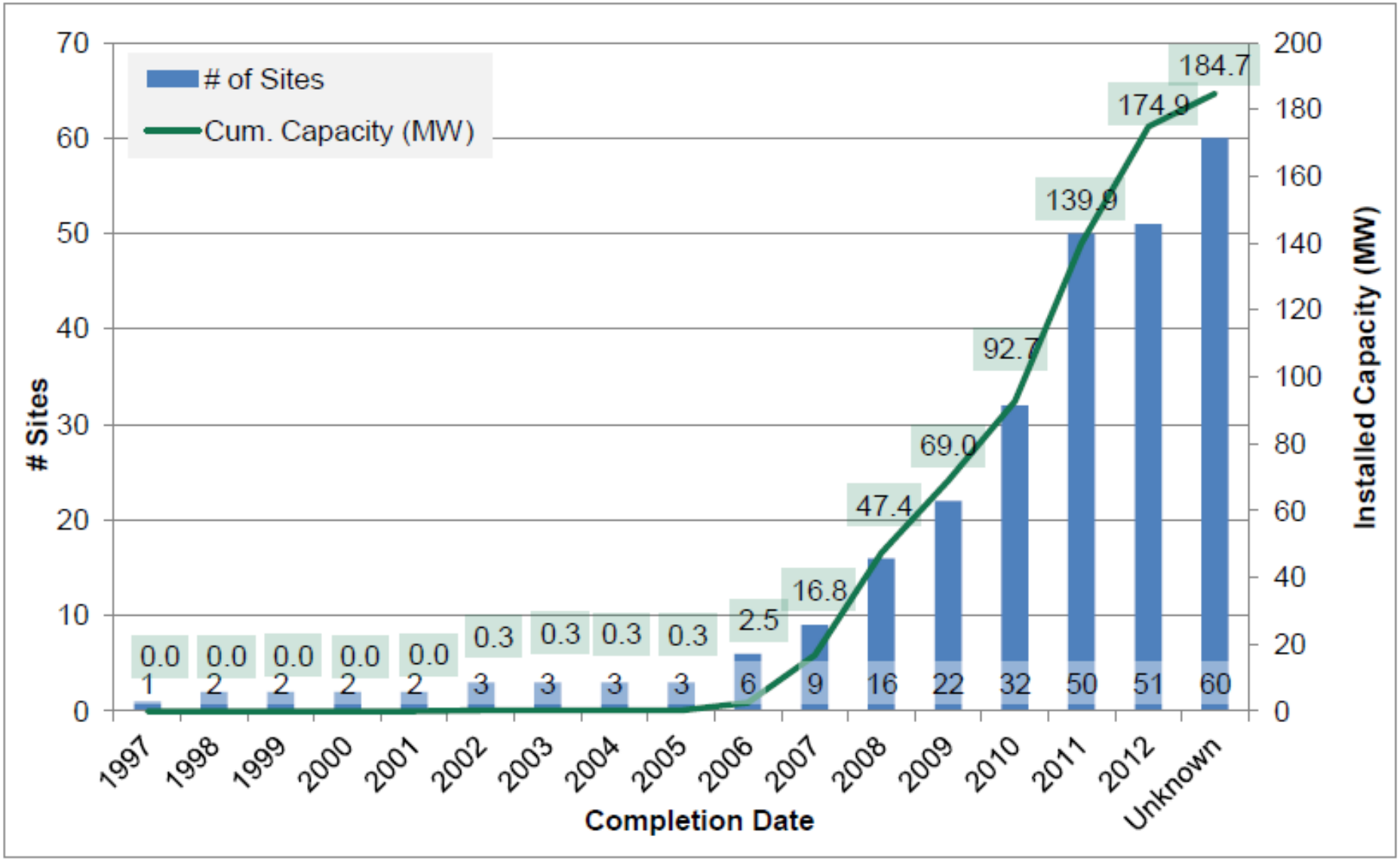
Footprint Reduction Opportunities: The Superfund Energy & Greenhouse Gas Example

- Site cleanups often involve energy-intensive remedies (see below)
- The annual carbon footprint of Superfund remedies is estimated at over 400kMT CO2e
- Use less: Optimizations completed at over 200 Superfund pump and treat systems
- Renewables: 185MW renewable capacity has been installed on contaminated sites*
- RECs for the rest: Superfund purchased 100k RECs in 2012

Technology	Estimated Energy Annual Average ($kWh*10^3$)	Total Estimated Energy Use in 2008-2030 ($kWh*10^3$)
Pump & Treat	489,607	11,260,969
Thermal Desorption	92,919	2,137,126
Multi-Phase Extraction	18,679	429,625
Air Sparging	10,156	233,599
Soil Vapor Extraction	6,734	154,890
Technology Total	***618,095***	***14,216,209***

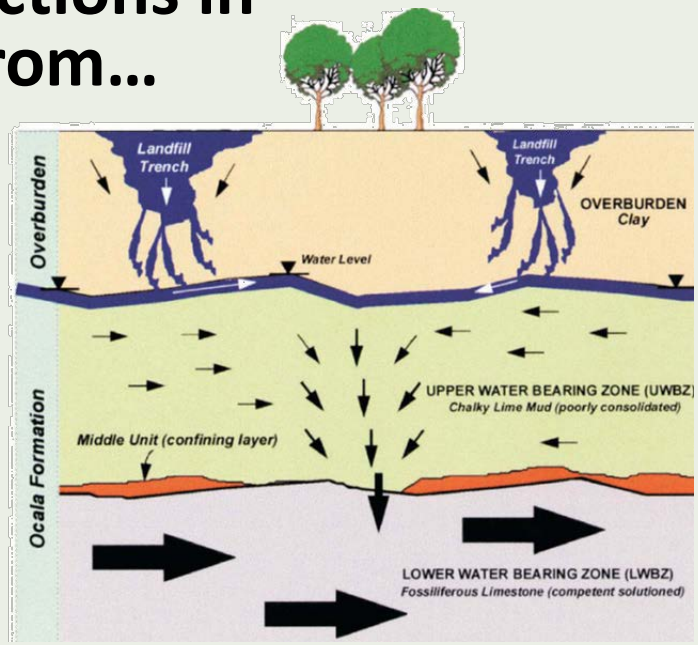
* www.epa.gov/renewableenergyland/docs/repowering_trackingmatrix_oct12.pdf

Contaminated Lands with Renewable Energy



Summary: Leveraging innovation efficient remedies with a lower environmental footprint

- **Cost effectiveness and large reductions in environmental footprints come from…**
  - » Accurate CSM
  - » Well-characterized source areas and contaminant plumes
  - » Optimal remedial strategy
  - » Adaptive management
  - » Streamlined performance monitoring



- **Further footprint reductions are achieved applying green remediation best management practices**
- **As a result, we sustainably protect human health and the environment prepare sites for reuse**

Information and Resources

- **Guidance Documents**
- **Free Technical Webinars (live, archived)**
- **Technical Bulletins**
- **Fact Sheets**
- **Case Studies and Project Profiles**
- **Technology Descriptions**
- **Current and In-depth Information:**
  - » BMPs for common cleanup approaches
  - » Policy information at Federal and State level
  - » Assessing a project's environmental footprint
  - » Technical support

Hazardous Waste Clean-Up Information (CLU-IN)
www.cluin.org/

Superfund Remedies Report
www.cluin.org/asr

US EPA
www.epa.gov/oswer/greenercleanups

Information and Resources

- **Sources and resources outside of EPA**
  - » ASTM
  - » Interstate Technology and Regulatory Council
  - » Federal Remediation Technologies Roundtable
  - » International
  - » SuRF

http://cluin.org/greenremediation/

Thank You!

Dan Powell
powell.dan@epa.gov

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