Federal Remediation Technologies Roundtable General Meeting

Reston, VA

June 25, 2015

25 Years of Technology Innovation: 1990-2015

Daniel Powell, Chief

Technology Integration and Information Branch

Office of Superfund Remediation and Technology Innovation

The Starting Point

- Innovative Treatment Technologies: Technologies whose routine use is inhibited by lack of data on performance and cost.
- 1990 Mandates/Drivers
  - Preference for treatment (Superfund Amendments and Reauthorization Act or SARA)
    - Move away from "dig and haul," capping
    - Permanence
  - Land Disposal Restrictions – In Situ
  - Very limited menu of treatment options
    - Soil: Incineration, maybe solidification
    - Groundwater: Pump and treat

Early Cleanups in Superfund

- Superfund Law Enacted in 1980 in response to a need to protect citizens from the dangers posed by abandoned or uncontrolled hazardous waste sites
- Superfund was a powerful law that resulted in immediate action at many priority sites
- The challenge was new, and the need for action prevailed
- Technical solutions were few, and we applied what we knew

Technology Innovation Directions: c 1990

- Treatment, soil (surface, vadose zone)
- Groundwater treatment, very limited options
- Characterization, *not so much*
- Bioremediation
  - Exxon-Valdez
  - Natural attenuation, *hmmm….*
- Ex-situ treatments
  - Soil washing
  - Solvent extraction
  - Thermal desorption
  - Bioreactors

The Starting Point

- Superfund Remedies: Early Years (1982-1985)

	Containment	Treatment
Soil Remedies	75%	25%
	Pump & Treat	**In-Situ Treatment**
Groundwater remedies	90%	3%

RD&D: Many Options

- U.S. EPA: Superfund Innovative Technology Evaluation (SITE) Program
- Department of Energy, EM-50
- Department of Defense
- State programs
- Non-profit, private sector
  - NETAC
  - PERF
- Cost and performance information at a premium

FRTR Direction: 1990's

- Sharing information, information resources
- Better information for decision makers
- Demonstration projects
- Information exchange
- Public-private partnerships
  - Remediation Technology Development Forum
  - Clean Sites
  - Technology testing centers
- Leveraging investment
- Biggest focus on remediation

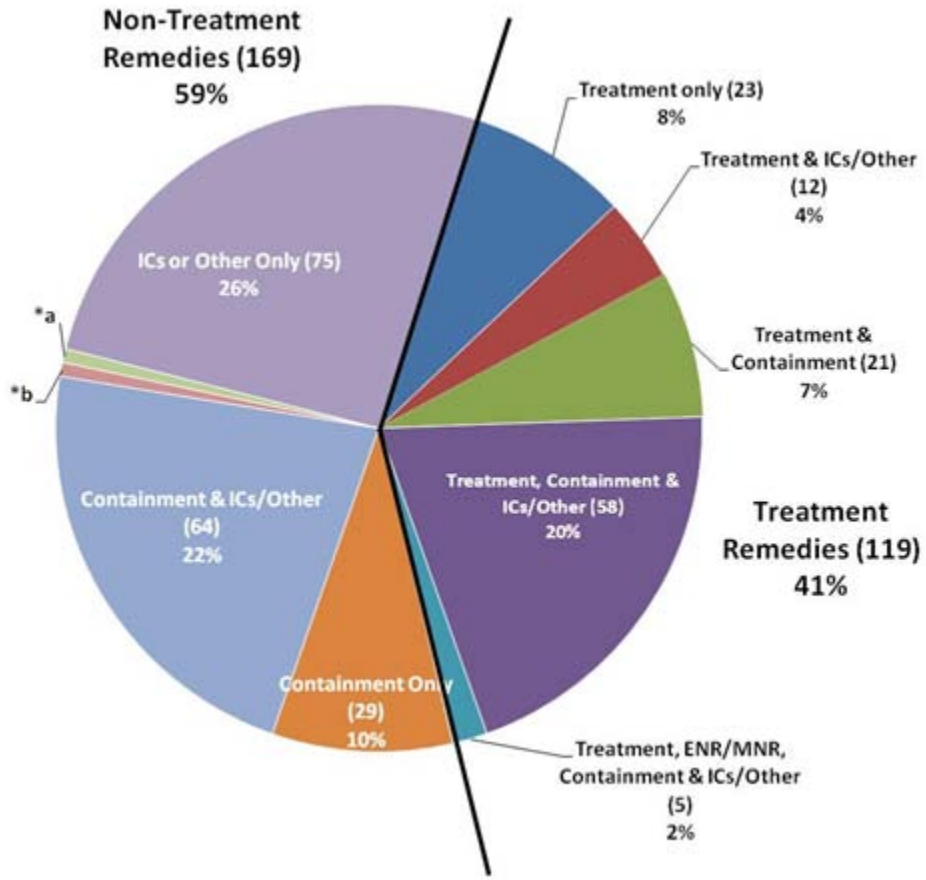
Evolution of Technology: 1995-2005

- Treatment trains
- Platforms vs. individual technologies
- Greater focus on groundwater, broader use of alternative technologies
- RD&D money, a shrinking pie
- Emerging concepts
  - Triad
  - Optimization
  - Reuse, land revitalization
- Building library of cost and performance information, case studies

Evolution of Technology: 2005-Present

- Big growth in Brownfields, land revitalization directions
- Maturation of Triad concepts: approach vs. technologies
- Maturation of optimization
  - Beyond RSE, LTMO
  - Beyond pump and treat
- Growth and maturation in source treatment
  - Thermal approaches
  - Oxidation

Superfund Remedies for Sources[1] (2009–2011)



- Remedies often selected and applied in combination
- For example, over 30% of treatment remedies were selected with other types of remedies
- We now have a rich mix of remedies available and mature consulting and engineering sector to implement them

1. "Sources", include soil, sediment, solid waste, NAPL

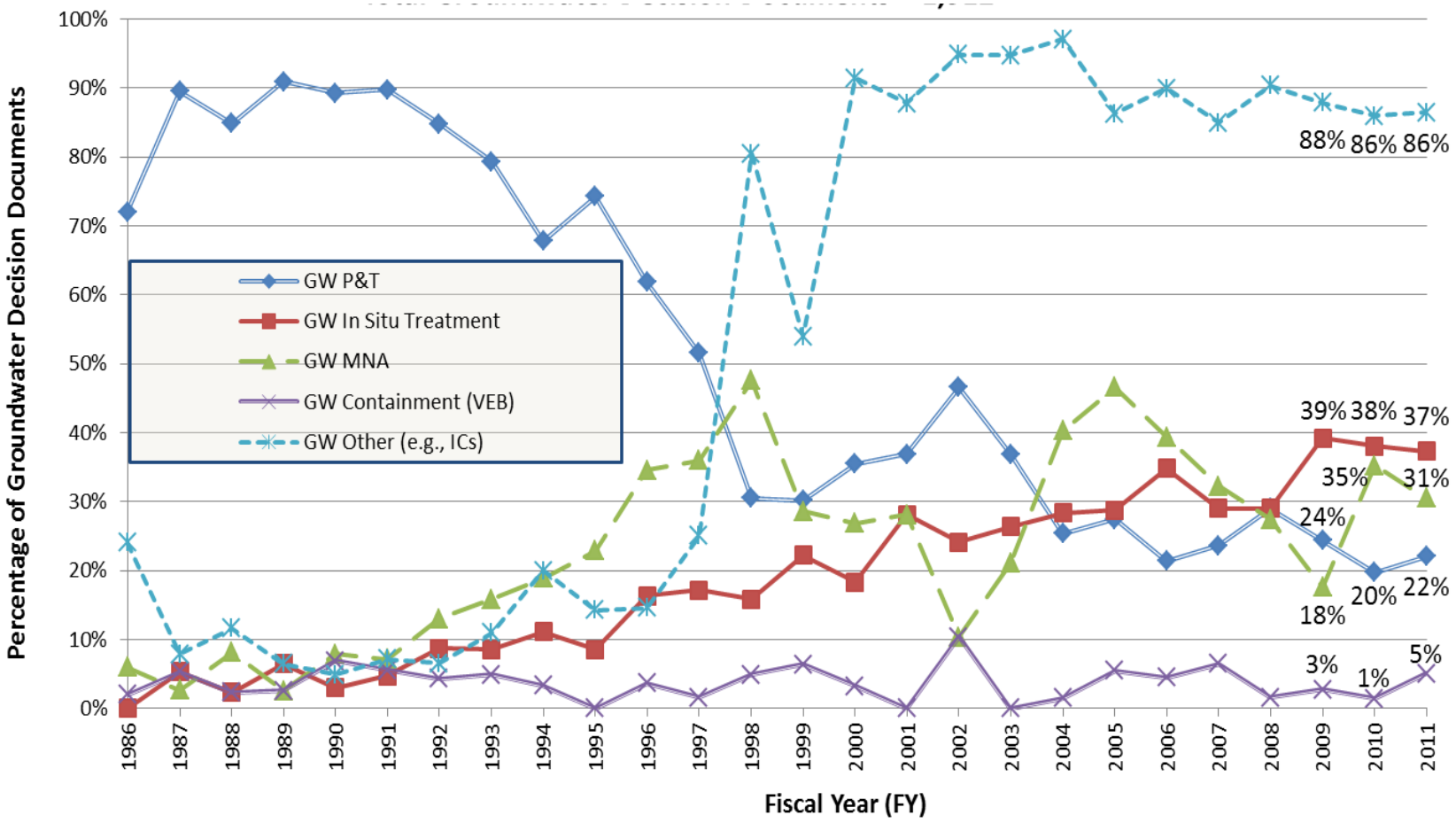
In Situ Source Treatment Technologies at Superfund Sites

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%**

- 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

Trends in Superfund Groundwater Remedies Selection (1986–11)

Total Groundwater Decision Documents = 1,912

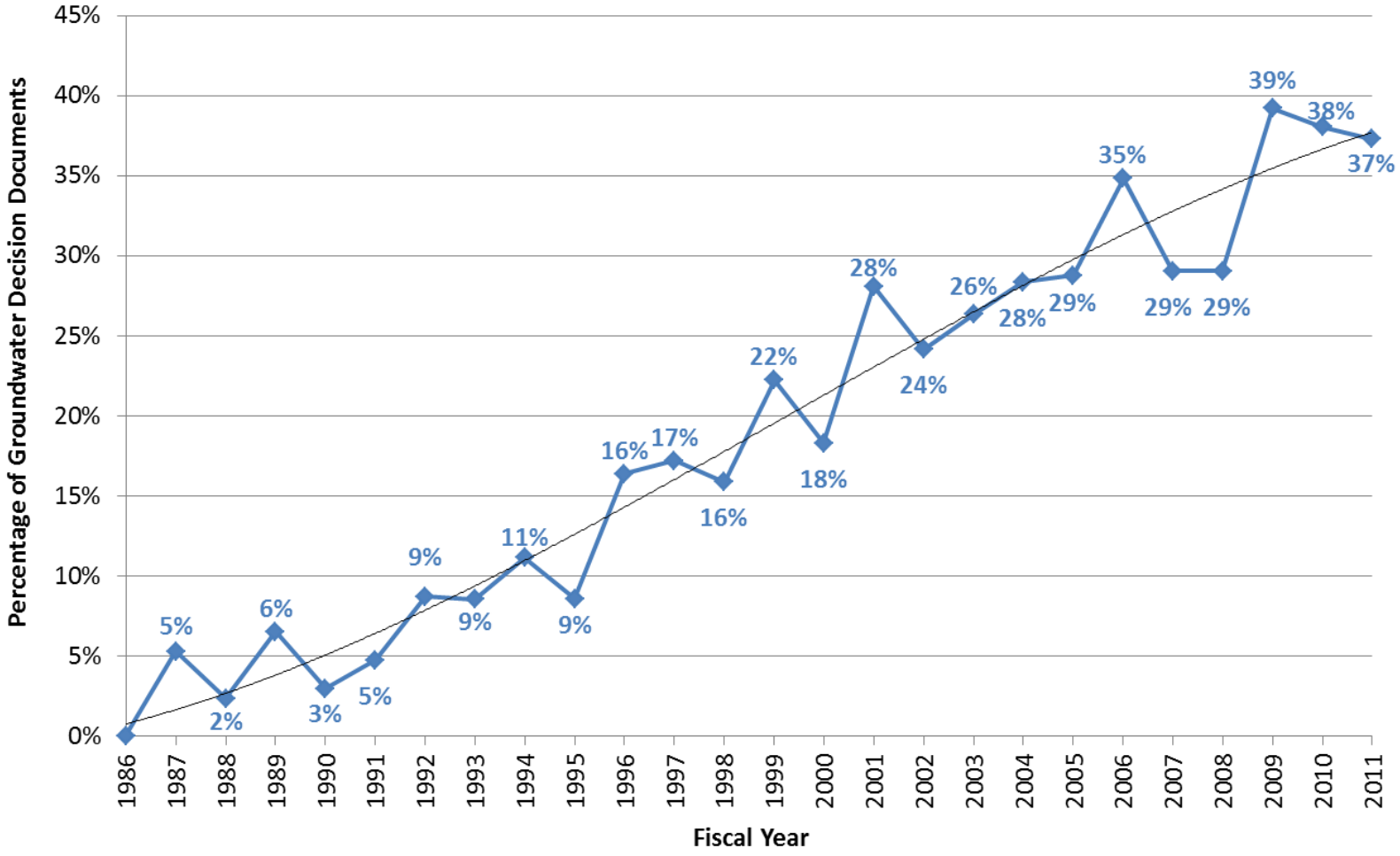


Groundwater Remedy Types Recently Selected in Superfund

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%

- 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

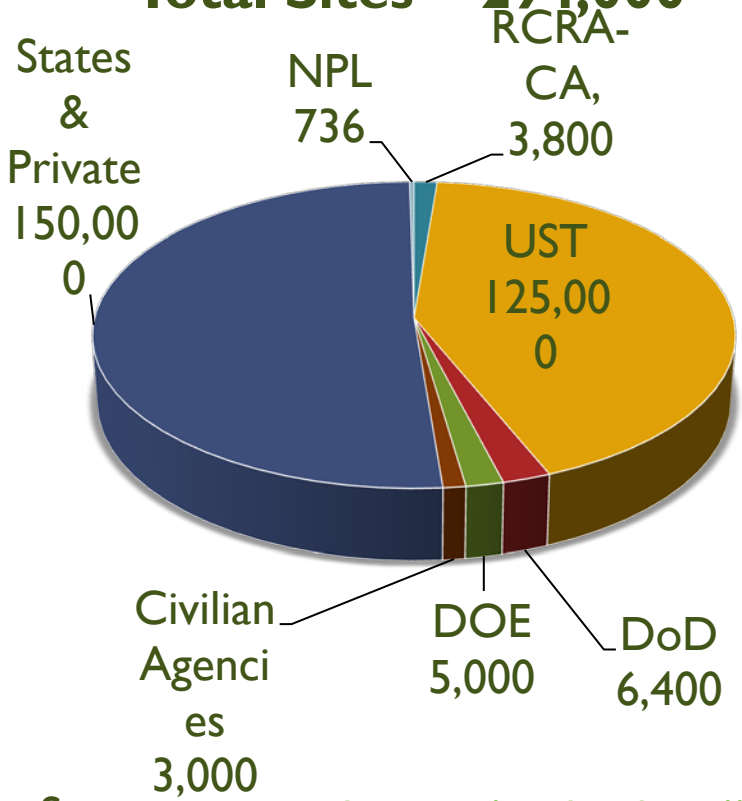
In Situ Groundwater Treatment: Increasing Use in Superfund



U.S. Contaminated Site Programs: We Still a Lot of Remediation Work to Do

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

Total Sites = 294,000



- We have made great progress cleaning up contaminated sites but…
  - National Academies of Sciences estimates 126,000 sites across U.S. 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

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

Evolution of Technology: Moving Forward

- High resolution site characterization approaches
  - Many data points
  - An evolving conceptual site model
  - Data management tools and visualization of data
- Green and Sustainable Remediation
  - Approaches
  - Components
  - Energy use, GHGs and climate change adaptation
- Addressing complexity of sites/"big" sites
- Bioavailability

Moving Forward

- Focusing and pursuing site cleanup needs
  - Specifics are important
    - Beyond contaminant/media
    - Clearly stating need
    - Providing performance metrics in statement of need
    - Characterization tools – focus on decisions, decisonmakers
  - Need a path forward
    - If we decide we need it, what are we going to do about it?
    - Funding options
      - Map
      - Leverage
    - Path to site use

Example of Needs Statement
Monitoring Technologies c. 2007

- **Air Emissions Monitoring -**Continuous emissions monitors for thermal hazardous waste treatment systems; remote sensing for fence-line monitoring of fugitive emissions
- **Characterizing and Monitoring Mining Sites-** Monitoring technologies for mining waste sites
- **Contaminated Sediment Characterization-** Sampling and analytical technologies for potentially contaminated sediment
- **Field Methods -** Screening for dioxin contamination; detection of perchlorate in water-pesticides and their degradation products; MTBE in groundwater
- **Indoor Air Quality-** Monitoring vapor intrusion into buildings
- **In-Situ Monitoring Systems-** Sensor technologies for long term monitoring of groundwater, treatment system performance; leak detection for small municipal landfills
- **Laboratory Analytical Methods-** New monitoring methods for total cyanides and cyanide speciation
- **Monitoring Effectiveness of In-Situ Remedies-** Monitors of natural attenuation and other in-situ systems
- **Non-invasive Subsurface Chemical Detection Systems-** Technologies for locating and monitoring DNAPL contamination; technologies for mercury and heavy metals in soils
- **Underground Storage Tanks-** Leak detection methods for underground storage tanks and pipes