

Sustainable Nano-based Remediation: Current Issues and Concerns - USEPA Perspectives

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Greg Gervais, P.E.

Technology Innovation and Field Services Division
US EPA OSWER Office of Superfund Remediation &
Technology Innovation

Applications of Nanotechnology
for Safe and Sustainable
Environmental Remediations

Nano-4-Rem
ANSSER_s



Presentation Outline

- Technology Innovation and Superfund
- ENPs for Site Remediation – Promise and Realities of Powerful Advancement
- Sustainable Nano-based Remediation
 - Perceptions
 - Questions
 - Careful Adoption
- Summary and More Info

Technology Innovation and Superfund

Alphabet Soup for Lunch

- OSWER
- RCRA
- CERCLA
- NPL
- OSRTI
- TIFSD
- ENPs
- nZVI
- EZVI



Office of Solid Waste and Emergency Response (OSWER)

- Develops haz waste standards & regulations (RCRA)
- Regulates land disposal & waste (RCRA)
- Cleans up contaminated property & prepares it for reuse (Brownfields, RCRA, Superfund)
- Helps to prevent, plans for, and responds to emergencies (Oil spills, Chemical releases, Decontamination)

Office of Superfund Remediation and Technology Innovation (OSRTI)

- “Superfund Remedial Headquarters”
- Manages EPA’s long-term Superfund response program
- Develops remedial cleanup policy and guidance
- Promotes innovative technologies to assess and clean up Superfund, other contaminated sites (Technology Innovation and Field Services Division, TIFSD)

OSRTI TIFSD

- Provides information about characterization and treatment technologies (Clu-in.org , TechDirect, TNT Newsletter, Case Studies, Technology Focus Areas, Tech Webinars)
- **Advocates more effective, less costly technologies**
- Provides national leadership for the delivery of analytical chemistry services for regional and state decision makers to use at Superfund and Brownfield sites
- Provides technical assistance and science support to environmental emergencies

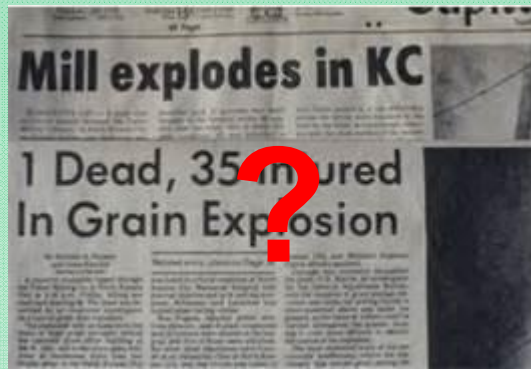
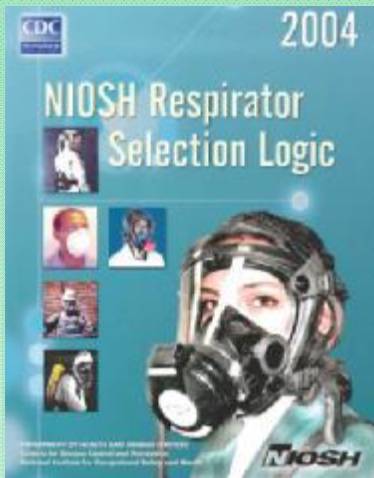
ENPs for Site Remediation

- The promise of remediation performance advances
 - particle size benefits
 - can remediate many contaminants
 - flavors of ZVI reduce PCE, TCE, c-DCE, VC, 1,1,1-TCA, PCBs, halogenated aromatics, nitroaromatics, As, Cr⁺⁶, nitrate, perchlorate, sulfate, and cyanide
 - TiO₂ mineralizes many pesticides via photocatalysis
 - new uses and implementation methods
 - oleophilic slurries, emulsions
 - reactive sediment caps (Souhail's RAC)

ENPs for Site Remediation

- The realities (so far)
 - ex situ easier than in situ
 - water treatment unit ops vs. ISCR
 - same or bigger in situ ‘delivery’ challenges
 - agglomeration (sticky situation)
 - fast kinetics & high reactivity = ‘gone baby gone’ ?
 - storage & handling safety

Storage & Handling Safety



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 - storage & handling safety
 - ENP material cost vs. alternative materials
 - emerging science, practices for safe use

We've been tracking Nano-4-Rem...



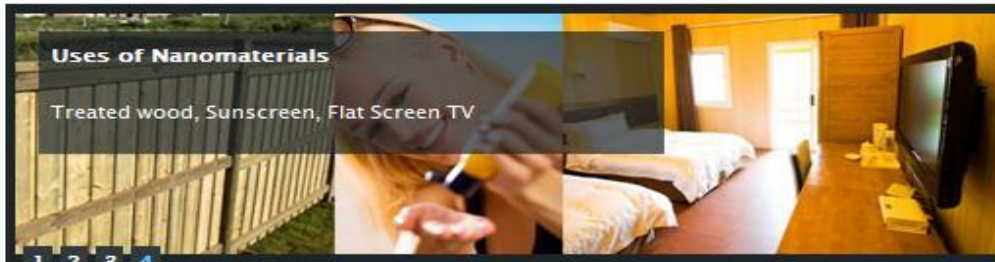
...for almost 10 years

Sustainable Nano-based Remediation

- Perceptions affecting sustainability
 - nZVI reaction 100%, byproduct ‘just rust’
 - Danger of *a priori* assumptions & nano
- Key questions
 - safe use ENPs for remediation? site workers? people near site? The environment?
 - ENP & existing regulatory framework
 - where is ‘implications’ research heading?
 - Ex. EPA-led research: www.epa.gov/nanoscience/

Nanotechnology & Nanomaterials Research

[Contact Us](#) [Share](#)



Key Links

[Chemical Safety Research
Control of Nanomaterials](#)

[Nanomaterials Research Coordination Team](#)

[Nanomaterial Research Fact Sheet,
Risk Assessment](#)

Commercial processes and products that use nanomaterials are growing rapidly and these tiny products are increasingly found in paint, fabrics, cosmetics, treated wood, electronics and sunscreen. Nanomaterials can be 100,000 times thinner than a strand of hair and they exhibit unique properties different than the same chemical substances in a larger size. Nanomaterials provide opportunities for the development of innovative products that provide advances in technologies and medicine. EPA is using scientific methods to research what nanomaterials are, how they act, travel and change over time. This research is used by EPA's [Chemical Safety and Pollution Prevention Office](#) and others making chemical decisions to inform policy and regulatory decisions to better protect human health and the environment.

Exposure & Nanomaterials Properties

The unique composition/properties of nanomaterials—their size, diversity and countless uses—pose challenges to assessing the risks they pose to human health and the environment. EPA is researching the properties of nanomaterials to better detect, quantify and describe them.

- Ecosystem Health Effects Research
- Human Health Effects Research
- Detecting, quantifying and characterizing nanomaterials
- Characterizing Nanomaterial Properties
- Examining Nanoparticles Impact on Fuel Emissions and Air Pollution

[Learn more about Exposure/Characterizing Properties...](#)

Risk Assessments

EPA is using the comprehensive environmental assessment (CEA) approach to identify and prioritize research to support future assessments and risk management decisions.

- CEA Approach
- Nanoscale Silver in Disinfectant Spray Case Study
- Carbon Nanotube Case Study: A comparison of multi-walled carbon nanotube and decabromodiphenyl ether flame retardant coatings applied to upholstery textiles
- Nanomaterial Case Studies: Nanoscale Titanium Dioxide in Water Treatment and in Topical Sunscreen

[Learn more about Risk Assessments...](#)

Life Cycle Assessment

EPA scientists are evaluating the life cycle of consumer products (including raw material extraction, processing, manufacturing, benefits of the product, use, recycling and ultimate disposal) containing nanomaterials to inventory the environmental and health impacts. The research findings can be used to update and create new risk assessments.

- Carbon nanotubes (used in flat panel television displays, automobile dashboard panel)
- Micronized Copper Treated Lumber (used to build decks on homes)
- *Dispersed Nanomaterials (found in paint, fabric)*

Sustainability

EPA researchers have developed alternative ways to apply nanomaterials to minimize environmental and human health impacts.

- Nano Zero Valent Iron (emerging option for treatment of contaminated soil and groundwater)
- Nanoparticle useful in cleaning up "Polychlorinated Biphenyls" or PCBs
- Nanoparticles Impact of Fuel Emissions and Air Pollution

[Learn more about Sustainability...](#)

Other Research Topics

- [Research homepage](#)
- [Air Research](#)
- [Human Health Research](#)
- [Water Research](#)

Top Three Questions

1. [What is nanotechnology?](#)
2. [Why is EPA studying nanotechnology?](#)
3. [Are nanomaterials safe?](#)

[More Questions](#)

Reports & Other Resources

- [Nanomaterial Case Study: Multiwalled Carbon Nanotube](#)
- [Publications](#)
- [Nanomaterial Case Study: Nanoscale Silver in Disinfectant Spray \(Final Report\)](#)
- [EPA Science Matters Newsletter](#)

[More Reports & Other Resources](#)

Related Links

- [2008 Nano Technology Conference Proceedings, volumes 1 and 2 \(PDF\) \(600 pp, 11.5MB\)](#)
- [Nanotechnology Review Article](#)
- [Environmental Futures Project \[\\[EXIT Disclaimer\\]\]\(#\)](#)
- [EPA and ILSI Research Foundation Partnership \[\\[EXIT Disclaimer\\]\]\(#\)](#)

[More Related Links](#)

Sustainable Nano-based Remediation

- More key questions
 - screening ENP remedial technologies vs. others?
 - performance, cost, and impact of technology
 - innovative vs. baseline vs. ‘proven’ technologies
 - sharing best practices for nanoremediation?
 - THIS workshop
 - bottom-line on H&S from OSHA, NIOSH, EPA
 - peer-reviewed science, case studies
 - NanoHUB.org , Clu-In.org/nano
- ‘Careful adoption’

Unintended Consequences

Replacing Leaded Gas...

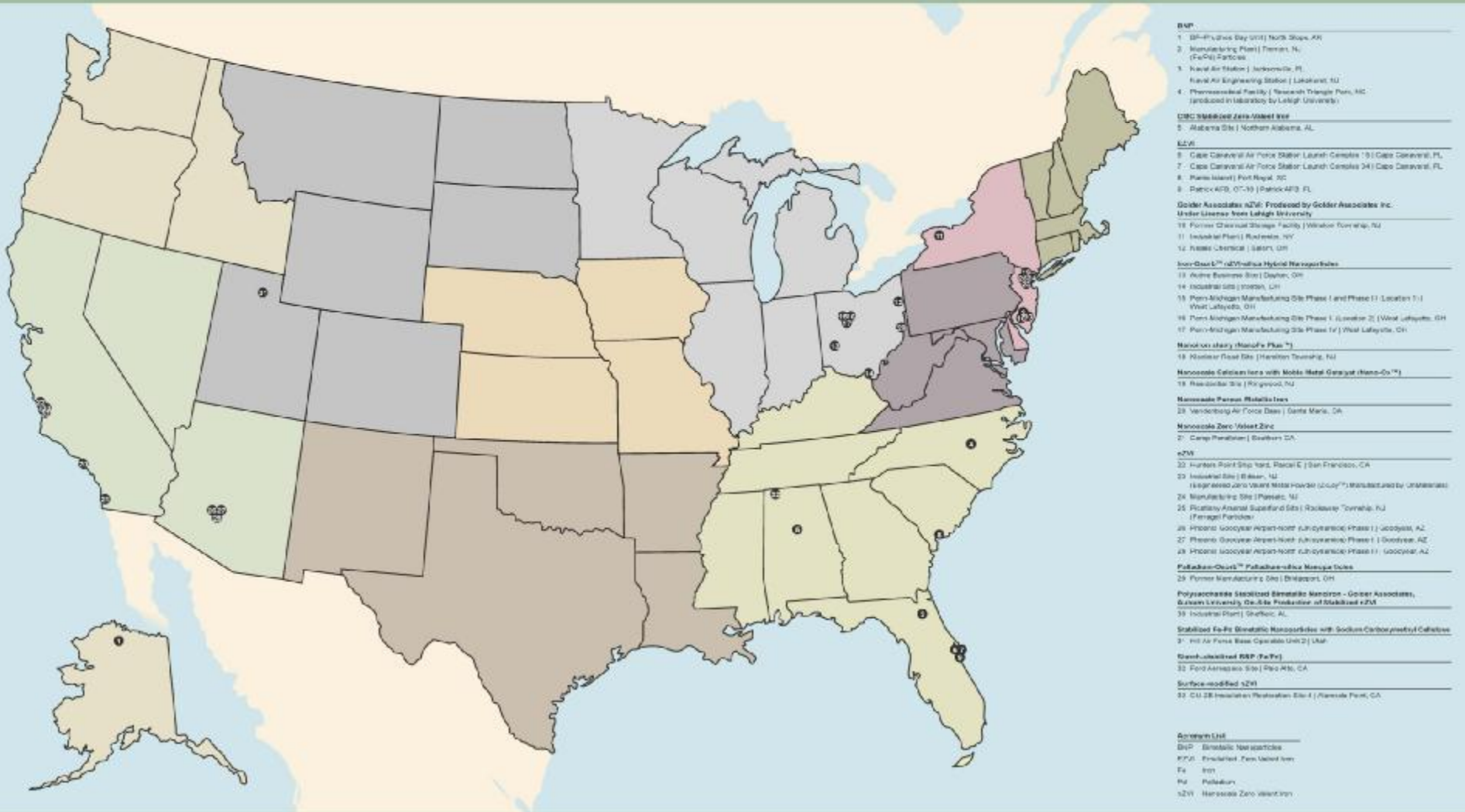


...With MTBE

Summary



Hazardous Waste Cleanup Sites in the U.S. Leveraging Engineered Nanoparticles for Remediation



For More Info

- www.epa.gov/superfund
- www.epa.gov/nanoscience/
- www.cluin.org
 - Technology data
 - Focus areas (e.g., www.cluin.org/nano)
 - Searchable remediation databases
- www.cluin.org/studio
 - Internet seminar schedules and registration
 - Archived seminars
- www.frtr.gov



Questions?



Greg Gervais
Office of Superfund Remediation and
Technology Innovation
gervais.gregory@epa.gov

