Contaminated Sites

Characterization, Assessment and Remediation
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Organization of Summary

- Contaminated Sites
  - Practice
    - Sustainability
    - Monitoring
  - Research
    - Nanotechnology
    - Models
    - Characterization
    - In Situ Destruction
  - Education
    - Breadth
    - Standardization
    - Regulations
    - Economics
Geoenvironmental Practice

- Stewardship: managing and budgeting for long-term cleanup
- Sustainability: planning for the future
- Integration of research and practice and disciplines
- Collaboration between specialized professionals
- Long-term & Comprehensive Monitoring
- Practical Models
Stewardship

- Broaden the focus of clean-up to include remediation and long-term (inter-generational) management of sites.
- Participate in public policy and regulatory decisions, both technology and health based.
Sustainability

- Consider the long-term impacts/consequences of actions
- Attempt to be pre-emptive
- Participate in regulatory activities and public policy development
- Participate in education (teaching, curriculum, accreditation, project sponsorship)
Monitoring

- Broaden in terms of spatial coverage, target and participatory constituents
- Cost effective
- Utilization of *in situ* sensors and real-time data transfer
- Archive in electronically accessible formats
Geoenvironmental Education

- Synthesize different disciplinary skills into a *geoenvironmental* skill set
- Incorporate environmental policy and economics and how they affect technical decisions
- Unify terminology and teaching methods
Multidisciplinary Education

Provide students with skills necessary to:

- Integrate science and engineering concepts important to geoenvironmental problems;
- Deal with open-ended questions;
- Collaborate and effectively interact with professionals of different specialties; and
- Be versatile within geoenvironmental field.
Regulations & Economics

- Knowledge of environmental laws and regulations is critical.
- Encourage engineering involvement in policy decisions in order to help shape future technology trends.
- Students should learn and understand how economics drive policy decisions and technical advances.
- Learn how to weigh the importance of and make decisions based on public, regulatory, and environmental concerns.
Unification/Standardization

- Terminology
- Methods/Approaches
Geoenvironmental Research

- **Nanotechnology** (sensors & treatment)
- **Predictive Modeling**
- In situ *destruction* of contamination (allow for long term treatment)
- **Innovative** characterization & monitoring techniques
- **Effective** methods for remediating heterogeneous, low-permeability soils contaminated with mixed-waste
Nano________________

- Nanoparticles, nanosensors, etc.
- Extremely small circuits and mechanical devices built at the molecular level
- Nanoscale interactions at interfaces, such as between organics and inorganic surfaces, water and gas, etc.

- *Example: Nanoscale iron for contaminant remediation.*
Pragmatic Models

- Incorporate long-term processes in predictive models
- Develop models that are more field oriented
  - Based on common types of field data
  - Lumped parameters
  - More emphasis on regional scale with the integration of GIS for ease of information exchange
  - Incorporate economic considerations
- Verification and validation
- Emerging contaminants: endocrine disruptors, priones, pharmaceuticals, others?
- Heterogeneous ________________ (contaminant, geology, flow field, microbial ...)
Characterization

- Non-invasive technologies for characterization (geophysics)
- Subsurface imaging
- Develop/Improve miniature subsurface sensors for real-time monitoring
  - Integrate with GIS, web-based or other information technologies.
  - Improve accuracy and expansion of detection limits.
- Better means are needed to characterize heterogeneous, low-permeable systems
In Situ Destruction

- Advanced chemical oxidation
  - Both NAPLS and dissolved plumes
- Bioremediation
  - New microbes, substrate injection, etc.
- Bioreactor landfills
- Innovative delivery methods
- Permeable reactive barriers
  - Long-term performance
  - Reaction products
- Energy-induced reactions/enhancements, e.g.:  
  - Irradiation
  - Ultrasound
Sustainability

- Better understanding of mobility and fate of unusual potential contaminants (antibiotics).
- Reuse of manufacturing waste for roadway construction or remediation schemes.
- Early involvement in policy-making decisions.
Common Themes

- Integration of disciplines
- Large-scale spatial data (GIS)
- Modeling: account for everything but be simple
- Long-term
  - Problematic conditions: low-permeability, heterogeneity, contaminant mixtures, lack of control, widespread low concentrations
- Better awareness of regulatory and economic considerations
- Standardization
- Characterization and Imaging
Contaminated Sites