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Sandia National Laboratories

Soil Treatability Study

Energy Technology Engineering Center • U.S. Department of Energy

# Recommended Studies for the Soil Treatability Study

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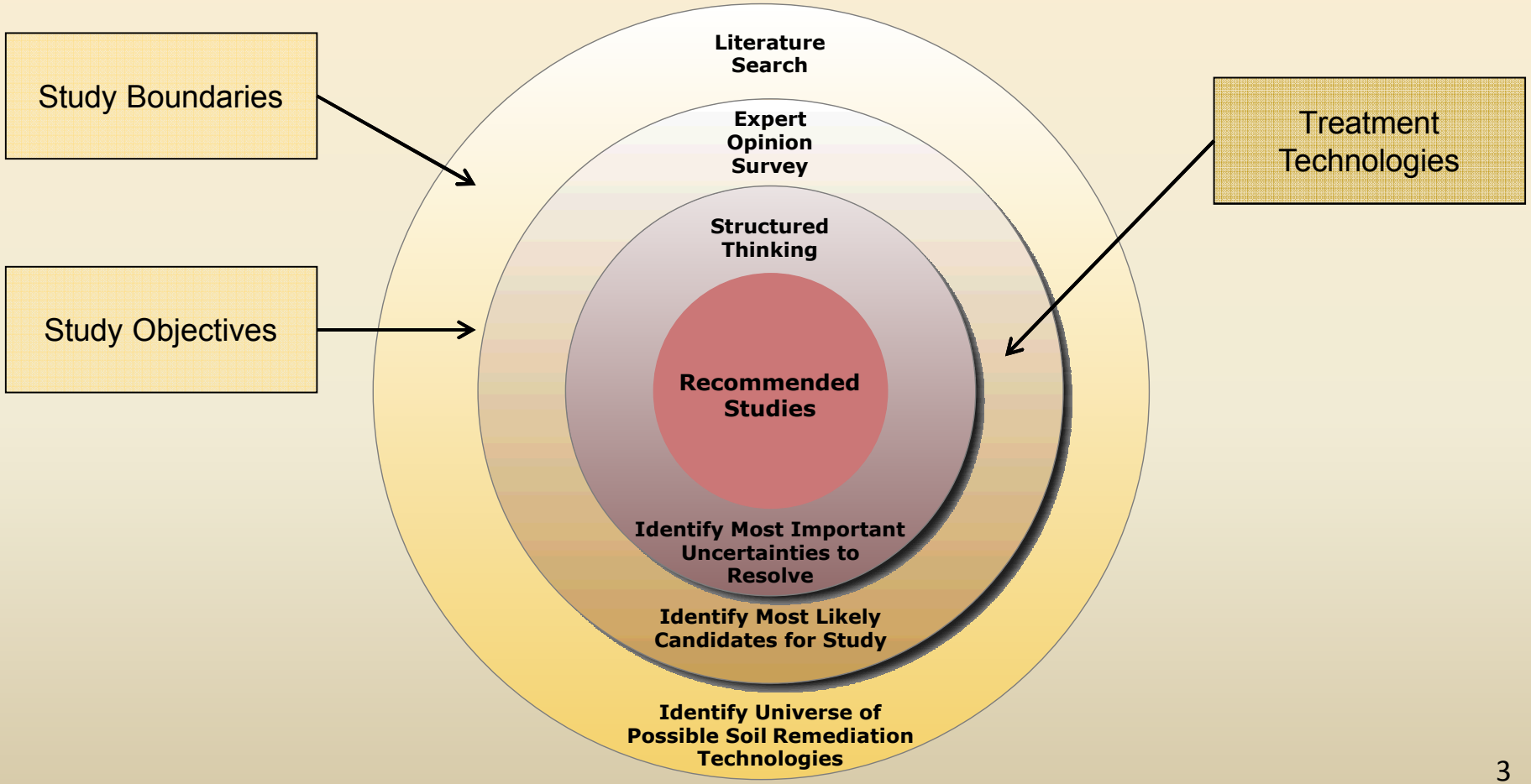
# Conclusion of Our Last Meeting

- DOE and Sandia will accept input from the STIG regarding
  - The uncertainties identified.
  - The studies suggested.
- DOE and Sandia will then work together to prioritize the recommended studies to resolve the most important uncertainties.

# Where we are now



# Concept of Uncertainty

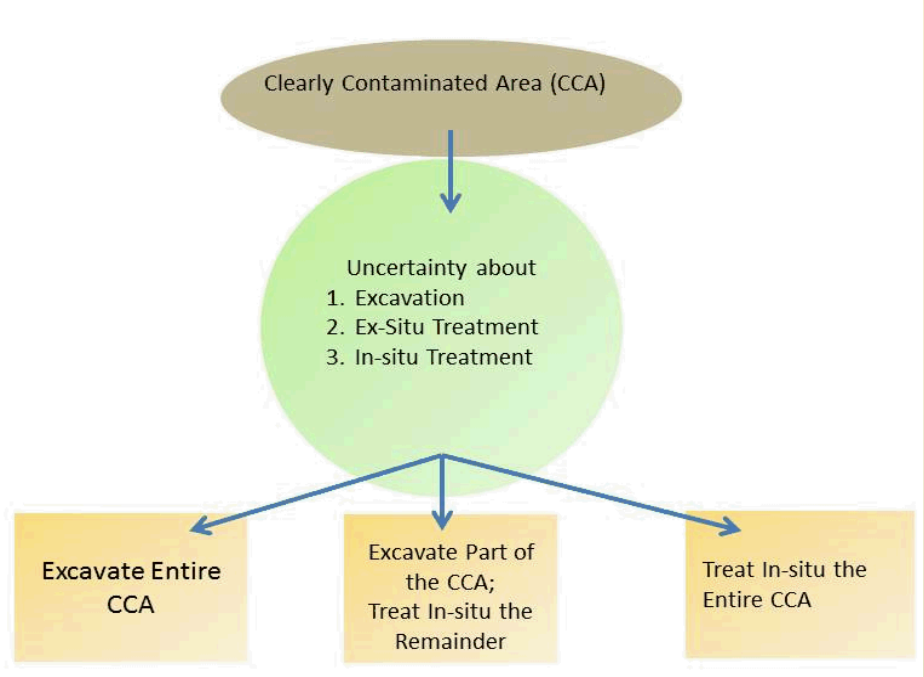
- Identifying Uncertainties
  - Where are there unanswered questions?
  - What are people uncertain about?
  - What will help the DOE make a decision?
- Resolving Uncertainty
  - Research resolves uncertainty.
  - Treatability studies – not necessarily full demonstrations.
  - Modeling, laboratory work, and field work can resolve uncertainties.

# Three Uncertainty Perspectives

- Uncertainty About Treatment Technologies
  - What is unknown about the technology for application at ETEC?
- Uncertainty About Specific Contaminants
  - Is there something unusual about this contaminant that makes the job harder?
- Uncertainty About Specific Clearly Contaminated Areas (CCA)
  - Is there something unusual about this CCA that makes the job harder?

# Structured Thinking Process

- Identifies uncertainties that impact choices to be made.
- Helps prioritize uncertainties.
- Allows the decision maker to choose between alternatives.



# Prioritizing Possible Studies

- What are the most important uncertainties to resolve?
  - Relative extent of contamination.
  - Difficult (recalcitrant) contaminants.
  - Multiple contaminants.

# What is a Treatability Study?

- Laboratory Testing
  - Conducted in a laboratory under very controlled conditions.
  - Used as a general “proof-of-principle” test.
  - Considered for technologies that have not been fielded or that are being considered for use in an application that is unproven.
- Field Testing
  - Will be conducted on the ETEC site.
  - Used as specific “proof-of-principle” test.
  - Considered for technologies that have been fielded in conditions similar (site characteristics and contaminants) to those at ETEC.

# What is a Treatability Study?

- On-Site "As-Is" Testing (Surveys/Sampling)
  - What is the chemical form of a contaminant?
  - How much contamination resides in plant material right now?
  - How much clay is there in the soil?
- Modeling Studies (Simulations)
  - Is there interaction (mass exchange) between the soil and the groundwater?
  - How long does the CCA stay "hot"?
- Literature and Historical Data Studies
  - Is there natural attenuation of contaminants?

# Questions and Answers

# Soil Partitioning/Separation Studies

- Why conduct soil partitioning/separation studies?
  - Can potentially reduce the volume of soil for off-site disposal, if excavated.
  - Supports a simple treatment technology – soil separation.
  - Addresses multiple contaminants.
  - Benefits other potential studies.
- What should be studied?
  - What are the particle size distributions for ETEC soils?
  - Do contaminants known to be present at ETEC reside preferentially with the soil fines or are they distributed throughout the soil with the various particle sizes?
  - Which contaminant groups associate themselves preferentially with the fines and which do not?
  - Can multiple contaminants be remediated at the same time utilizing this technique, and if so, which contaminant groups?

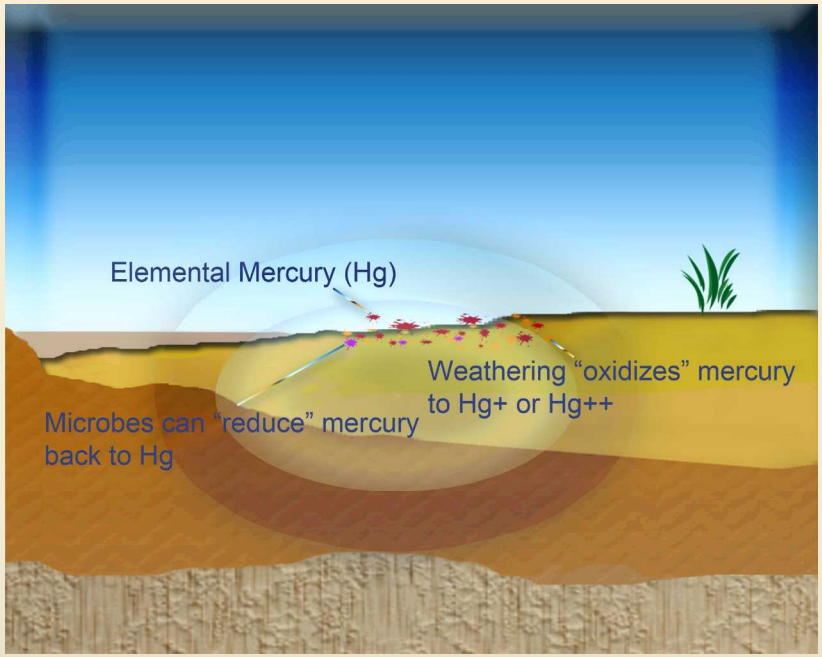
# Soil Partitioning/Separation Studies

- How should soil partitioning/separation be studied?
  - Small volume analyses (Collect both contaminated and uncontaminated soil; determine geotechnical properties, chemical properties, and thermal properties).
  - Large volume analyses (Excavate required volume, perform dry soil partitioning, perform contaminant analysis, develop a mass balance).
  - Enhanced separation analyses (Excavate required volume, perform wet soil partitioning, perform contaminant analysis, develop a mass balance).
  - Soil washing/thermal analyses (Excavate required volume, perform wet soil partitioning, add a soil washing/thermal step, perform contaminant analysis, develop a mass balance).
- Additional benefits
  - Small volume analyses will provide useful information to other studies (e.g. particle size distribution, soil thermal conductivity, chemical properties).
  - Large volume analyses may remediate the soils on which they are performed.

# Questions and Answers

# Mercury Studies

- Why conduct mercury studies?
  - A relatively large volume of soil at ETEC is contaminated with mercury.
  - In-situ treatment of mercury poses potential challenges.
- What should be studied?
  - Chemical form of mercury – elemental or weathered?



# Mercury Studies

- How should mercury be studied?
  - Small volume analyses (Collect soil samples and analyze the chemical form).
  - Biological conversion to elemental mercury (Collect soil samples, inventory biota, test biota in laboratory for reduction of mercury).
  - No large volume analyses recommended.
  - No thermal field test with mercury contaminated soils is recommended.
- Additional benefits
  - Identification of the biota in the site soils will benefit the bioremediation studies.

# Questions and Answers

# Phytoremediation Studies

- Why conduct phytoremediation studies?
  - Many of the soils at ETEC are contaminated with heavy metals.
  - Some of the soils at ETEC are contaminated with radionuclides.
  - Phytoremediation is the only in-situ technology (within the study boundaries) for potential remediation of soils contaminated with heavy metals/radionuclides.
  - Phytoremediation is seen by SNL as a possible secondary or passive in-situ treatment for all contaminants.
  - The STIG expressed a strong interest in phytoremediation.

# Phytoremediation Studies

- What should be studied?
  - What plant species currently growing at ETEC can remove contaminants from the soil?
  - Which contaminants specifically can be removed by these plants?
  - How efficient is this plant uptake? How clean will the soil be? How long will it take?
  - What is the mechanism by which plants remove specific contaminant? Is it hyperaccumulation, rhizosphere stimulation or phytotranspiration?
  - Can the uptake by plants be improved by composting, fertilization, irrigation, and/or the addition of microbes?

# Phytoremediation Studies

- How should phytoremediation be studied?
  - Site plant species inventory (Perform an inventory of plant species growing on the CCAs, develop a crosswalk of CCAs, contaminants, and plant species; identify plant species that are like the species shown to demonstrate remediation).
  - Site-wide plant species sampling (Collect plant species samples from a number of CCAs listed in the crosswalk. The highest priority sampling should be plants that may hyperaccumulate metals).
  - Laboratory phytoremediation studies (For plants that are shown under the site-wide plant species sampling study to have removed contaminants from the soil or plants thought to phytotranspire contaminants).
- Additional benefits
  - Phytoremediation allows for minimal destruction/disturbance of the environment.

# Questions and Answers

# Bioremediation Studies

- Why conduct bioremediation studies?
  - Bioremediation technologies act synergistically with other soil remediation technologies to aid in soil remediation.
  - Bioremediation may already be occurring (naturally) in the soils.
  - Effective for treatment of petroleum hydrocarbons and organics.
- What should be studied?
  - Natural biota in the ETEC soils.
  - Enhancing the performance of existing biota.
  - Possibility of introducing non-native biota.

# Bioremediation Studies

- How should bioremediation be studied?
  - Site biota inventory.
  - Laboratory analyses (The highest priority contaminant for this recommendation is TPH).
- Additional benefits
  - Biota can enhance phytoremediation and natural attenuation.

# Questions and Answers

# Thermal Treatment Studies

- Why conduct thermal studies?
  - Thermal treatment technologies can apply to many contaminants.
  - May be only in-situ treatment option for mercury, dioxins, and PCBs.
- What should be studied?
  - Achievable soil temperatures.
  - Thermal conductivity and heat capacity of the soil.
  - Condition of soil after in-situ thermal treatment.
  - Vapor containment.

# Thermal Treatment Studies

- How should thermal treatment be studied?
  - In-situ thermal remediation for shallow soils (Thermal blanket concept, less than 3 feet, contaminated only with PCBs).
  - In-situ thermal remediation for deeper soils (Heater probe concept, greater than 3 feet, contaminated only with PCBs).
- Additional benefits
  - Can treat several contaminants at once.
  - Field test on the CCAs containing PCBs may remediate the CCAs.

# Questions and Answers

# Natural Attenuation Studies

- Why conduct natural attenuation studies?
  - Non-invasive technology.
  - Likely to already be occurring at the site.
  - May be applied to a variety of contaminants.
- What should be studied?
  - Is natural attenuation occurring?  If so, at what rate?
  - Possible enhancement of natural attenuation.
  - Dioxins, PAHs, SVOCs, VOCs, TPHs, perchlorates, and NDMA.

# Natural Attenuation Studies

- How should natural attenuation be studied?
  - Examination of historical sampling data.
  - Field demonstration at ETEC site.
  - Laboratory demonstration of natural attenuation.
- Additional benefits
  - May be helpful for areas that must be protected and undisturbed.

# Questions and Answers

# Thank you