Ground-Water Monitoring Perspectives and Needs

Thomas J. Nicholson\textsuperscript{1}, James Shepherd\textsuperscript{2} and Jon Peckenpaugh\textsuperscript{2}

\textsuperscript{1}Office of Nuclear Regulatory Research
\textsuperscript{2}Office of Nuclear Material Safety and Safeguards
U.S. Nuclear Regulatory Commission

Presented to
Workshop on Long-Term Performance Monitoring of Metals and Radionuclides
Reston, Virginia
April 21, 2004
Outline

• Generic Ground-Water Monitoring Needs

• Technical Considerations

• Implementation

• Conclusions
Ranges of site conditions to be considered:

- Sites with no evidence of releases (e.g., baseline, pre-operational and operational monitoring)

- Sites with early indication of possible failures or potential releases (additional detection and remediation monitoring)

- Sites with releases and identifiable plumes (detection, remediation, and post-remediation monitoring)

- Monitoring is site-specific and supports acceptance criteria
Generic Ground-Water Monitoring Needs

• Design monitoring systems to establish current conditions and detect changes in system behavior that may affect contaminant transport

• For sites with ground-water plumes, identify contaminant source-term location, plume extent and behavior

• Develop and assess monitoring database to identify and quantify causative transport mechanisms (e.g., events and processes in the unsaturated and saturated zones)

• Identify preferential transport pathways (e.g., presence of heterogeneities and perched-water systems)
Generic Ground-Water Monitoring Needs

- Identify precursors to system failures and releases [i.e., Performance Indicators (PI)]

- Assess effectiveness of contaminant isolation systems (e.g., engineered barriers)

- Develop and assess remediation approaches
  - In-situ bioremediation
  - Monitored natural attenuation
Technical Considerations

• Couple monitoring to site characterization and facility Performance Assessments (PA)

• Analyze monitoring data to confirm system performance as input to decision making (e.g., Bayesian approach for updating PA with risk-significant data)

• Identify alternative conceptual flow and transport models (e.g., Equivalent Porous Media, Dual Porosity, Dual Permeability, Discrete Fracture and Hybrid Composite Models)
Conceptual Flow Models for Fractured Media (after Altman et al., 1996)
Conceptual Model of a Complex Site

from Ward et al. (1997) after Caggiano et al. (1996)
Implementation

• Develop and provide guidance on the technical bases useful for NRC staff evaluations of licensees’ ground-water monitoring programs

• Develop guidance for identifying risk-significant PI’s (e.g., Water Content, Pressure, Flux, Contaminant Concentrations) to be monitored

• Demonstrate connection between PI’s and PA

• For assessing long-term performance (e.g., out to 1,000 years), identify use of monitoring data as input to PA models (i.e, parameter estimation, model calibration and uncertainty analyses)
Conclusions

• Robust and integrated ground-water monitoring strategy (IGWMS) should fulfill generic needs and technical considerations

• IGWMS should be tested over a range of hydrogeologic features, events and processes using site-specific monitoring datasets
Conclusions

IGWMS will provide practical information for:

• Understanding monitoring needs to verify PA
• Identifying conceptual models related to causative transport mechanisms (e.g., source-term release, episodic recharge events)
• Supporting PA models of long-term performance (e.g., estimating parameter & boundary conditions and assessing uncertainties)
• Assessing effectiveness of engineered systems and remediation approaches
• Communicating PI’s thru data management, analysis and visualization to decision makers
Additional Information

• Young, M.H. and others, “Results of Field Studies at the Maricopa Environmental Monitoring Site, Arizona,” NUREG/CR-5694, US NRC, June 1999


➢ Download research reports at: http://www.nrc.gov/