SAND2007-4456P

Data Integration for LILW Repositories

KHNP Training Program
Module 4: Repository Siting and Characterization

July 9, 2007

Rick Beauheim
Carlsbad Programs Group
Sandia National Laboratories

SAND2007-XXXXP

Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

LILW Repositories

- Shallow (at or near land surface)
  - El Cabril—Spain
  - Centre de la Manche (closed)—France
  - Centre de l'Aube—France
  - SFR—Sweden
- Deep
  - WIPP (TRU and mixed waste)—USA
  - Bruce (planned) —Canada

Sandia National Laboratories

Shallow LILW Repositories

- Do not require the same degree of characterization as deep geologic repositories
- Time scale of concern (~300 yr) is typically shorter than for HLW repositories
- Scientific studies include:
  - Seismic
  - Geological
  - Geochemical
  - Hydrogeological
  - Geotechnical
  - Ecological
- More emphasis is placed on near-surface processes and events (e.g., floods)

Deep LILW Repositories

- Require a similar degree of characterization as deep geologic repositories for HLW
- May allow for longer period of operation or greater volumes of waste or different waste inventory than shallow LILW repositories

Sandia National Laboratories

Data Integration

Data must be integrated for a variety of purposes:

- **Environmental Impact Reports**
- **Safety Analysis Reports**
- **Technical baseline reports**
- **Compendium characterization reports**
- **Performance assessment/License applications**

and provide a basis for decision-making

Environmental Impact Reports

- Most countries require some form of Environmental Impact Statement or Assessment that summarizes the effects of creating and operating the disposal facility on the existing environment
- A major part of these documents is a comprehensive description of the existing environment at the proposed facility site

Safety Analysis Reports

- Safety Analysis Reports describe the safety aspects of repository operation
  - Waste handling
  - Transportation
  - Radiological exposures
  - Natural events (floods, hurricanes)
  - Seismicity
  - Plant and process design
  - Accidents
  - Excavation stability

Technical Baseline Reports

- The natural conditions existing at a site before repository construction begins must be defined and documented in technical baseline reports
- This baseline can then be used to evaluate changes that occur in the future
- Technical baseline reports are often organized or divided on the basis of subject matter, e.g., hydrology, geology, biota, meteorology

Compendium Characterization Reports

- Provides useful compendium of information for:
  - New staff
  - Scientific community
  - Regulators
  - Interested public
- May be where the conceptual model for a particular discipline is developed and articulated
- May be updated as additional data become available

License Applications

- Contents of license applications are typically specified by regulations
- High-level data summaries are usually one component

Sandia National Laboratories

Preparation of Data Integration Reports

- Author(s) must have broad understanding of topic and also understand the details of the investigations
- Not everyone with the required understanding can also write a good integration report
- Identifying capable authors, and then providing them with the necessary, undistracted time to write a report, can be a challenge
- All reports/authors need to draw from the same database to maintain consistency

WIPP Environmental Impact Statements

- Final EIS completed in 1980
- Final Supplement EIS (SEIS) completed in 1990
- WIPP Disposal Phase Final Supplemental EIS completed in 1997

Sandia National Laboratories

WIPP Safety Analysis Reports

- Safety Analysis Report (SAR) is required by a DOE order, and covers operational aspects of WIPP
- Original SAR completed in 1980—continually revised/updated through 1986
- Final SAR (FSAR) issued in 1990
- New version of FSAR published in 1995, with 4 revisions through 1999

Sandia National Laboratories

WIPP Technical Baseline Reports

- Ground-Water Flow Modeling of the Culebra Dolomite, Volume II: Data Base (SAND89-7068/2, 1990)—summarizes and establishes baseline values for data needed for groundwater modeling
- WIPP RCRA Background Groundwater Quality Baseline Report (DOE/WIPP 98-2285, 1998)—summarizes 5 rounds of groundwater sampling results obtained prior to first receipt of waste—updated in 2000 to include 5 more rounds of groundwater sampling conducted prior to first receipt of RCRA-regulated waste

WIPP Compendium Reports

- Topical reports usually written by Principal Investigator in that field
- Summarize studies performed over some period of time and overall conceptual understanding
- May be revised/redone as additional studies are completed

Sandia National Laboratories

WIPP Compendium
Site Characterization Reports

- Geologic Characterization Report (GCR)—summary of characterization activities completed by 1978 (SAND78-1596)
- Results of Site Validation Experiments (TME 3177, 1983)
- Summary of the Results of the Evaluation of the WIPP Site and Preliminary Design Validation Program (WIPP-DOE-161, 1983)
- Summary of Site-Characterization Studies Conducted from 1983 through 1987 (SAND88-0157)

Sandia National Laboratories

WIPP Compendium
Geologic Reports

- **Facies Variability and Post-Depositional Alteration within the Rustler Formation—summary report detailing conceptual geologic model of Rustler Formation (DOE/WIPP 88-004, 1988)**
- **Assessment of the Potential for Karst in the Rustler Formation at the WIPP Site (SAND2005-7303, 2006)**

Sandia National Laboratories

WIPP Compendium
Hydrogeochemical Reports

- Stable-Isotope Geochemistry of Groundwaters in the Delaware Basin of Southeastern New Mexico (SAND87-0138, 1987)
- Hydrogeochemical Studies of the Rustler Formation and Related Rocks in the WIPP Area, Southeastern New Mexico (SAND88-0196, 1991)
- Analysis of Solutes in Groundwaters from the Rustler Formation At and Near the WIPP Site (SAND86-0917, 1997)

WIPP Compendium
Hydraulic Testing Reports

- Interpretations of Single-Well Hydraulic Tests Conducted At and Near the WIPP Site, 1983-1987 (SAND87-0039)
- Analysis of Hydraulic Tests of the Culebra and Magenta Dolomites and Dewey Lake Redbeds Conducted at the WIPP Site (SAND98-0049, 1998)
- Hydraulic Testing of Salado Formation Evaporites at the WIPP Site: Final Report (SAND98-2537, 1999)

Sandia National Laboratories

WIPP Compendium
Tracer Testing Reports

- Integration of Interpretation Results of Tracer Tests Performed in the Culebra Dolomite at the WIPP Site (SAND92-1579, 1992)
- Interpretations of Tracer Tests Performed in the Culebra Dolomite at the WIPP Site (SAND97-3109, 2000)

Sandia National Laboratories

Other WIPP Compendium Reports

- Summary Report for the WIPP Technology Development Program for Isolation of Radioactive Waste (SAND88-0844, 1988)
- Systems Analysis, Long-Term Radionuclide Transport, and Dose Assessments (SAND89-0462, 1989)
- Compilation and Comparison of Test-Hole Location Surveys in the Vicinity of the WIPP Site (SAND88-1065, 1989)
- A Select Bibliography with Abstracts of Reports Related to WIPP Geotechnical Studies (1972-1990) (SAND92-7277, 1993)

WIPP Data Reports

- Hydrologic Data Reports—8 volumes covering hydraulic testing and monitoring from 1980-1990
- Salado Hydrology Program Data Reports—3 volumes covering Salado hydraulic testing from 1988-1995
- Annual Water Quality Data Reports—5 volumes covering 1986-1990
- Brine Sampling and Evaluation Program Reports—6 volumes covering Salado brine sampling from 1985-1991
- Quarterly/Annual Geotechnical Field Data Reports—continuous since 1982
- Annual Site Environmental Reports—continuous since 1991

WIPP License Applications

- No-Migration Variance Petition (1989)—revised in 1990
- RCRA Part B Permit Application—6 revisions from 1991 through 1997
- RCRA Part B Permit itself has now been modified a number of times
- Compliance Certification Application (1996)
- Compliance Recertification Application (2004)
- All of these applications included integrated descriptions of site conditions and expected future behavior

Data Integration for Bruce LILW Repository

- Bruce Geoscientific Site-Characterization Plan calls for development of:
  - Descriptive geologic site model
  - Descriptive hydrogeologic site model
  - Descriptive geomechanical site model
  - Overall site model geosynthesis

Sandia National Laboratories

Purpose of Bruce Descriptive Geologic Site Model

- Describe the 3D spatial distribution of all important geologic formations and the occurrence of all important structural features
- Provide a basis for geoscientific understanding of the current condition of the site, its past evolution, and likely future natural evolution over the period interest
- Provide the basic framework for the development of descriptive hydrogeologic and geochemical site models

Bruce Descriptive Geologic Site Model

- **Bruce descriptive geologic site model integrates:**
  - **Seismic data**
  - **Core descriptions**
  - **Geophysical logs**
  - **Stratigraphic information**
  - **Structural information**
  - **Laboratory petrologic and mineralogic data**

Purpose of Bruce Descriptive Hydrogeologic Site Model

- Describe the 3D spatial distribution of the groundwater flow and radionuclide transport and attenuation processes and properties of the bedrock units that will host and overlie/underlie the repository
- Provide the necessary information to define and describe the pathways and migration rates for any radionuclide releases from the repository
- Provide the information necessary to support Safety Assessment and repository engineering design

Bruce Descriptive Hydrogeologic Site Model

- Bruce descriptive hydrogeologic site model integrates:
  - Hydraulic testing data
  - Hydraulic head data
  - FEC logging
  - Hydrostratigraphy
  - Groundwater and pore water geochemistry
  - Laboratory diffusion, porosity, and sorption data

Purpose of Bruce Descriptive Geomechanical Site Model

- Describe the 3D spatial distribution of all relevant geomechanical parameters, such as *in situ* stresses, rock peak and residual strength parameters, elastic parameters, swell and creep parameters, joint orientations and characteristics, and rock mass classification ratings
- Provide the information necessary to support Safety Assessment and repository engineering design

Bruce Descriptive Geomechanical Site Model

- **Bruce descriptive geomechanical site model integrates:**
  - **Seismic data**
  - **Geophysical logs (acoustic, televiewer)**
  - **Geomechanical core logs**
  - ***In situ* stress measurements**
  - **Rock mass properties**
  - **Laboratory geomechanical data**

Sandia National Laboratories

Purpose of Bruce Overall Site Model Geosynthesis

- Develop an overall descriptive geosphere site model that provides consistency of geoscience understanding amongst individual descriptive geologic, hydrogeologic, and geomechanical site models and consistency with other complementary and supporting geoscience studies and projects undertaken to build confidence in site suitability and the safety case

Features of Bruce Overall Site Model Geosynthesis

- Characterization of the undisturbed system and behavior of the site
- Assessment of repository-induced disturbances
- Assessment of geological long-term evolution of the site
- Development of a realistic and defendable reference geoscientific data set for use in Performance Assessment and repository engineering work

Sandia National Laboratories

Major Elements of Bruce Site Model Geosynthesis

- Complementary geoscientific studies:
  - Regional geologic framework
  - Regional hydrogeologic modeling
  - Regional petroleum geology assessment
  - Regional hydrogeochemical assessment
  - Regional geomechanics assessment
  - Repository gas generation and migration
  - Long-term climate change
- Site-specific numerical analyses
  - Hydrogeologic modeling
  - Geochemical modeling
  - Geomechanical modeling
- Scientific data and model visualization

Sandia National Laboratories

Summary

- All information collected to characterize LILW disposal sites must be integrated to form a coherent, consistent understanding of the site
- Data integration occurs on a variety of scales, from summaries of activities within individual disciplines to overall syntheses of all site-related data
- Concise integration of data will be required for many types of reports, license applications, and environmental impact assessments
- All reports/authors need to draw from the same database to maintain consistency