

# CENTER FOR NUCLEAR WASTE REGULATORY ANALYSES

## TRIP REPORT

**SUBJECT:** Nuclear Waste Technical Review Board's Panel Meeting on the Natural System (20.06002.01.131)

**DATE/PLACE:** March 9–11, 2004  
Las Vegas, Nevada

**AUTHORS:** J. Winterle and P. Bertetti

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### PERSONS PRESENT:

Jim Winterle and Paul Bertetti attended from CNWRA. John Bradbury attended from NRC. Nuclear Waste Technical Review Board Natural System Panel members in attendance were Richard Parizek, Thure Cerling, Priscilla Nelson, and Dan Bullen. A complete list of meeting attendees will be available on the Nuclear Waste Technical Review Board Internet site ([www.nwrtb.gov](http://www.nwrtb.gov)) in the near future.

### BACKGROUND AND PURPOSE OF TRIP:

The stated purpose of the meeting was to examine aspects of the natural system that control transport of radionuclides from Yucca Mountain. The meeting was structured to consider the aspects of water flow and associated hydrogeologic phenomena that are important for estimating the amount of time required for the transport of radionuclides from the repository horizon to the regulatory boundary. The following questions were posed by the Panel Chair at the beginning of the meeting.

- What is the median travel time of a molecule of water from the repository horizon at Yucca Mountain to the regulatory boundary?
- How much might travel time change for a radionuclide in that water, considering all factors relevant to radionuclide transport? Are all of the factors equally likely?
- Are the DOE radionuclide transport estimates conservative, realistic, or optimistic?
- What is the technical basis for these estimates? What is the Board's assessment of the technical validity of the technical basis? What can be done to improve the technical basis of the DOE estimates?
- How much could the technical basis be improved by 2010 if the DOE pursues a rigorous scientific program?

### MEETING SUMMARY:

The meeting consisted of a series of invited presentations, each followed by time for questions by panel members. On Tuesday, March 9, the meeting focused on features and processes

relevant to water flow and radionuclide transport in the unsaturated zone and included presentations evaluating the influence of climate change in the repository. Features and processes relevant to water flow and radionuclide transport in the saturated zone were discussed on Wednesday, March 10. A roundtable discussion scheduled for Wednesday afternoon was modified to a general open discussion forum after the DOE decided not to participate in the roundtable discussion. Time was made available each day for public comments. A complete meeting agenda, listing the invited speakers and their presentation topics, is attached to this trip report.

The majority of the presentations scheduled were made by Bechtel SAIC Company, LLC staff or scientists from the U.S. Geological Survey and national laboratories supporting the DOE Yucca Mountain effort. Notable exceptions included invitations by the panel to W. Murphy (California State University, Chico), who spoke on studies related to the Pena Blanca natural analogue, and to J. Winterle (CNWRA), who presented results of recent CNWRA modeling studies of the Yucca Mountain flow system. J. Bredehoeft (Hydrodynamics Group) outlined studies of the regional saturated zone flow system as undertaken by Inyo County, California. R. Dyer (DOE) gave a short presentation each day prior to the start of DOE presentations to explain that groundwater travel time is not specifically considered as a Yucca Mountain performance criterion.

On Tuesday, March 9, J. Houseworth (Lawrence Berkeley National Laboratory), G. Moridis (Lawrence Berkeley National Laboratory), and B. Robinson (Los Alamos National Laboratory) gave a series of presentations on flow and transport in the unsaturated zone. Houseworth provided an overview of the unsaturated zone conceptual model and lines of evidence to support the model, while Moridis presented results of process level modeling studies of unsaturated zone transport. Robinson followed with a presentation of transport-related performance assessment sensitivity analyses for the unsaturated zone. In general, the presentations for the unsaturated zone re-emphasized the importance of fracture-matrix interaction. That is, transport times for radionuclides and diffusion in the unsaturated zone were sensitive to variations in the active-fracture parameter, and experimental results at Alcove 8-Niche 3 indicated that uncertainty in the factor is large. This uncertainty is represented stochastically in performance assessments. Moridis emphasized extensive use of conservative assumptions (e.g., neglect of engineered barriers) in the process-level modeling, but natural system features incorporated in the modeling were equivalent to those used in the performance assessment abstractions. In fact, some features of unsaturated zone conceptual model used in performance assessment, such as release of radionuclides into the matrix rather than fractures, were not presented in the process-level analyses even though sensitivity analyses indicated that initiation of transport in fractures versus matrix had a significant effect on predicted travel times. Matrix sorption processes in the Topopah Spring welded unit (Tsw) were most significant for unsaturated zone transport of neptunium, which is consistent with results previously reported at the Radionuclide Transport Technical Exchange in December 2000. A range of values from 0 to 6 ml/g for the partition coefficient of neptunium resulted in predicted unsaturated zone travel times for neptunium that varied by two orders of magnitude.

On Wednesday, March 10, K. Rehfeldt (Los Alamos national Laboratory), S. Kuzio (Sandia National Laboratory), and B. Arnold (Sandia National Laboratory) gave a series of presentations for the saturated zone conceptual model, process-level modeling, and the performance assessment abstractions for saturated zone flow and transport. The presentations paralleled those for the unsaturated zone given the previous day. The DOE results presented confirmed that the presence of saturated alluvium and sorption of neptunium in the alluvium is important in

delaying travel time of neptunium through the saturated zone. Results for process-level modeling of colloid transport indicated the kinetics of colloid attachment to and detachment from the rock matrix were significant (transport times and releases in the unsaturated zone were somewhat insensitive to kinetics and were more affected by colloid size). The attachment and detachment process is modeled as a retardation factor for irreversible colloids, and application of this factor produces a significant (1.5 orders of magnitude) delay in the transport of colloids through the saturated zone relative to unretarded aqueous species. Early breakthrough of a small fraction of colloids as observed in field studies is not reproduced by the DOE model. Given the large uncertainty and relative lack of corroborating experimental evidence for the values of the attachment-detachment factor, further review of the DOE approach is warranted.

On Thursday, March 11, Nuclear Waste Technical Review Board panel members and invited participants (mainly Nuclear Waste Technical Review Board staff, consultants, and invited speakers) attended a field trip to the Yucca Mountain area. This field trip was not part of the Panel Meeting on the Natural System. The trip focused on Yucca Mountain site geology and geomorphology, with stops at the Yucca Mountain Project Sample Management Facility, Busted Butte, Raven Canyon, and Nye County wells.

**CONCLUSIONS:**

Several presentations of relevance to unsaturated and saturated groundwater flow and radionuclide transport in the Yucca Mountain region were given. A full transcript of the panel meeting will be available at the Nuclear Waste Technical Review Board Internet site ([www.nwtrb.gov](http://www.nwtrb.gov)) in the near future.

**PROBLEMS ENCOUNTERED:**

None.

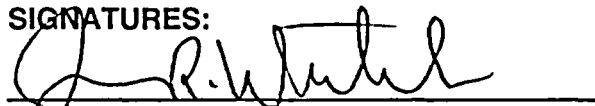
**PENDING ACTIONS:**

None.

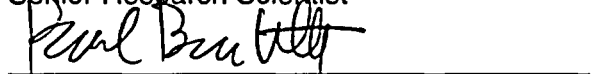
**RECOMMENDATIONS:**

None.

**SIGNATURES:**



James Winterle  
Senior Research Scientist

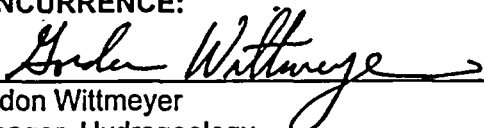


Paul Bertetti  
Senior Research Scientist

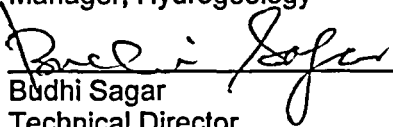
3-25-04  
Date

25 March 2004  
Date

CONCURRENCE:

  
Gordon Wittmeyer  
Manager, Hydrogeology

3/29/2004  
Date

  
Budhi Sagar  
Technical Director

3/30/2004  
Date

**ATTACHMENT**



UNITED STATES  
NUCLEAR WASTE TECHNICAL REVIEW BOARD  
2300 Clarendon Boulevard, Suite 1300  
Arlington, VA 22201

**Panel on the Natural System**  
**Crowne Plaza Hotel**  
**4255 South Paradise Road**  
**Las Vegas, NV 89109**  
Tel: (702) 369-4400  
Fax: (702) 369-3770

**Unsaturated Zone Fluid Flow and Radionuclide Transport**  
**Tuesday March 9, 2004**

- 8:00 a.m. **Call to order and introductory remarks**  
Richard R. Parizek, Chair, Panel on the Natural System,  
U.S. Nuclear Waste Technical Review Board
- 8:25 a.m. **Geological evidence of past climatic and hydrologic regimes of the Great Basin**  
Eric McDonald,  
Desert Research Institute
- 8:50 a.m. *Questions and discussion*
- 9:05 a.m. **Past, present, and future climate of Yucca Mountain**  
Saxon Sharpe,  
Desert Research Institute
- 9:35 a.m. *Questions and discussion*
- 9:55 a.m. **Break**
- 10:10 a.m. **Climate change and Yucca Mountain unsaturated zone hydrology**  
James Paces,  
U.S. Geological Survey/Yucca Mountain Project
- 10:40 a.m. *Questions and discussion*
- 11:00 a.m. **Conceptual models of Yucca Mountain unsaturated zone flow**  
Alan Flint,  
U.S. Geological Survey
- 11:30 a.m. *Questions and discussion*
- 11:50 a.m. **Public comments**
- 12:10 p.m. **Lunch**

- 1:10 p.m. Session introduction**  
Thure Cerling, member, Panel on the Natural System,  
U.S. Nuclear Waste Technical Review Board
- 1:20 p.m. Role of secondary minerals in unsaturated zone radionuclide transport at the Peña Blanca analog site**  
William Murphy,  
California State University, Chico
- 1:45 p.m. Questions and discussion*
- 2:00 p.m. Science and Technology program work at the Peña Blanca analog site**  
Ardyth Simmons,  
BSC/Los Alamos National Laboratory
- 2:15 p.m. Questions and discussion*
- 2:25 p.m. Conceptual models and independent lines of evidence for evaluating DOE unsaturated zone model calculations**  
James Houseworth,  
BSC/Lawrence Berkeley National Laboratory
- 3:05 p.m. Questions and discussion*
- 3:25 p.m. Break**
- 3:40 p.m. Sorption, matrix diffusion, and colloid-facilitated transport in unsaturated zone radionuclide transport models**  
George Moridis,  
BSC/Lawrence Berkeley National Laboratory
- 4:10 p.m. Questions and discussion*
- 4:30 p.m. Unsaturated zone radionuclide transport predictions and abstractions for Total System Performance Assessment**  
Bruce Robinson,  
BSC/Los Alamos National Laboratory
- 5:00 p.m. Questions and discussion*
- 5:20 p.m. Public comments**
- 5:50 p.m. Adjourn for the day**



## **Saturated Zone Fluid Flow and Radionuclide Transport Wednesday March 10, 2004**

- 8:00 a.m. Session introduction**  
Priscilla Nelson, Member, Panel on the Natural System,  
U.S. Nuclear Waste Technical Review Board
- 8:10 a.m. Ground-water flow system of the Death Valley region**  
Claudia Faunt,  
U.S. Geological Survey/Yucca Mountain Project
- 8:40 a.m. Questions and discussion*
- 9:00 a.m. Inyo County investigations of flow in fault zones south of Yucca Mountain**  
John Bredehoeft,  
The Hydrodynamics Group
- 9:30 a.m. Questions and discussion*
- 9:50 a.m. Break**
- 10:10 a.m. Ground-water flow system of the Yucca Mountain area**  
James Winterle,  
Center for Nuclear Waste Regulatory Analysis, Southwest Research Institute
- 10:40 a.m. Questions and discussion*
- 10:55 a.m. Conceptual model of saturated zone flow and transport and independent lines of evidence for evaluating DOE saturated zone model predictions**  
Ken Rehfeldt,  
BSC/Los Alamos National Laboratory
- 11:25 a.m. Questions and discussion*
- 11:40 a.m. Public Comments**
- 12:00 p.m. Lunch**
- 1:15 p.m. Session introduction**  
Daniel Bullen, Member, Panel on the Natural System,  
U.S. Nuclear Waste Technical Review Board
- 1:25 p.m. Geochemical mapping of the ground-water system**  
Gary Patterson,  
U.S. Geological Survey/Yucca Mountain Project
- 1:40 p.m. Questions and discussion*

- 1:50 p.m. **Sorption, matrix diffusion, and colloid-facilitated transport in saturated zone radionuclide transport models**  
Stephanie Kuzio,  
BSC/Sandia National Laboratory
- 2:10 p.m. *Questions and discussion*
- 2:20 p.m. **Saturated zone radionuclide transport predictions and abstractions for Total System Performance Assessment**  
Bill Arnold,  
BSC/Sandia National Laboratory
- 2:50 p.m. *Questions and discussion*
- 3:10 p.m. **Break**
- 3:30 p.m. **Roundtable discussion**
- 5:00 p.m. **Public comments**
- 5:30 p.m. **Adjourn**