U.S. DEPARTMENT OF ENERGY
OFFICE OF CIVILIAN RADIOACTIVE WASTE MANAGEMENT

# NUCLEAR WASTE TECHNICAL REVIEW BOARD

## SUBJECT: INTRODUCTION TO SZ FLOW AND UZ / SZ TRANSPORT STUDIES


**PRESENTER:** **Dennis R. Williams**

**PRESENTER'S TITLE AND ORGANIZATION:**
**Deputy Assistant Manager, Licensing**
**YMSCO**
**LAS VEGAS, NV**

**TELEPHONE NUMBER:** **(702) 794-1417**


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# INTRODUCTION TO SZ FLOW AND UZ / SZ TRANSPORT STUDIES

- HYDRAULIC AND CONSERVATIVE TRACER TESTING AT C-WELLS
by M.J. Umari (USGS)

- TRANSPORT AND REACTIVE TRACER TESTING AT C-WELLS
by H.J. Turin (LANL)

- UZ AND SZ FLOW AND TRANSPORT MODELING
by Bruce Robinson (LANL)

# SATURATED ZONE (SZ) FLOW AND TRANSPORT - Why study the SZ?

- Radionuclides released from the repository that reach the SZ and may be transported to the accessible environment
- SZ is not as significant a retardation barrier compared to the UZ - its' greatest importance is the potential for radionuclide dilution
- SZ flux affects the degree of mixing and dilution of radionuclides in the volcanic aquifer
- SZ flux affects travel-times and concentrations of radionuclides down-gradient from the site

# OBJECTIVES OF C-WELL TESTING
# - What do we hope to learn?

- Testing objectives include:
  - obtaining hydraulic properties of the volcanic aquifer through pumping tests
  - estimating flow and transport parameters from tracer tests
- These properties and parameters are essential input to the numerical flow and transport models and will be used in TSPA/VA transport calculations
- Results will aid in addressing probable time frames required for radionuclides to move from the repository horizon to the accessible environment via groundwater

# HYDRAULIC AND CONSERVATIVE TRACER TESTS AT THE C-WELLS

- Composite transmissivity was calculated
- Hydrogeologic units are highly heterogeneous
- Transmissivities range from 100 $ft^2/d$ 20,000 $ft^2/d$
- Storativity is poorly constrained at this time
- Tracer testing has been conducted in the Bullfrog - Upper Tram interval
- Results from tracer tests conducted in different ways in this interval seem to indicate similar transport properties
- We cannot transfer transport properties from the Bullfrog - Upper Tram to other units, because hydraulic properties are expected to differ considerably between units

# REACTIVE TRACER TESTS AT THE C-WELLS

- Reactive, conservative and colloidal tracer testing have been conducted concurrently in the Bullfrog - Upper Tram interval
- The system is a dual porosity flow and transport system
- Radionuclides travel in the fractures but also diffuse into the rock matrix, increasing travel time and sorption
- Estimated dispersivity (about 2 m at a flow distance of 30 m) indicates that at a 25 km scale, it should range from 50-500 m, allowing the use of large dispersivity values in transport simulations

# UNSATURATED ZONE FLOW AND TRANSPORT MODEL

- UZ chemistry modeling is consistent with estimates of flux values between 1 and 5 mm/yr with evidence of a past wetter climate
- Np-237 and Tc-99 are the most important radionuclides from a peak dose perspective Uranium and Pu are relatively minor contributors
- A small portion of the escaped radionuclides may reach the water table quickly (10 ky) through fast pathways
- At 100 ky, weakly sorbing radionuclides will reach the water table

# SATURATED ZONE TRANSPORT MODEL

- Model is being calibrated to hydraulic-head measurements and hydrochemical data
- SZ transport results in dilution of radionuclide concentrations without providing significant delay of arrival compared to the travel times in the UZ
- For that fraction of the inventory that rapidly reaches the water table, it will be significantly reduced in peak concentration by the time radionuclides reach the accessible environment, as well as delaying the arrival, perhaps to times greater than the 10 ky
- The SZ provides defense against perhaps the most uncertain aspect of unsaturated zone performance, namely rapid transport of a fraction of the inventory to the water table