FEB 15 1994

MEMORANDUM FOR: Margaret Federline, Chief
Hydrology and Systems Performance Branch, DHLWM

FROM: William H. Ford, Hydrogeologist
Hydrologic Transport Section
Hydrology and Systems Performance Branch, DHLWM

SUBJECT: TRIP REPORT, ACNW WORKING GROUP MEETING ON UNSATURATED FLOW AT THE POTENTIAL YUCCA MOUNTAIN HIGH-LEVEL WASTE REPOSITORY SITE, FROM DECEMBER 13 TO 15, 1993, AT LAS VEGAS, NEVADA

From December 13-15, 1993, I attended: (1) a meeting of the Advisory Committee on Nuclear Waste (ACNW) on December 13th, (2) an ACNW working group meeting on unsaturated flow on December 14th, and (3) an ACNW Yucca Mountain tour on December 16th. This report contains some technical highlights from these interactions.

On December 13, 1993, I attended the afternoon session of the 59th Meeting of the ACNW. Much of the discussion in this meeting revolved around a presentation by the State of Nevada. The State of Nevada is concerned the regulatory process is diminishing the importance of the geologic barriers. The State fears, as deficiencies in the geologic barriers are discovered, the regulatory process will place more reliance on engineered barriers. Therefore, the use of engineered barriers to correct deficiencies in geologic barriers would result in a site selection and licensing process, which is less influenced by the condition of the geologic barrier.

On December 14, 1993, I attended the "ACNW Working Group Meeting on Unsaturated Flow at the Potential Yucca Mountain High-Level Waste Repository Site" (final agenda attached). The purpose of this Working Group meeting was to explore the issues of ground water age dating, groundwater travel time, saturated zone hydrology, radionuclide transport, coupled processes, and performance assessment.

Alan Flint (U.S. Geological Survey) presented a talk on "Characterization of Unsaturated Zone Infiltration." In test areas with significant thicknesses of alluvial cover, it has been observed infiltrating water is lost to evapotranspiration before it can move into the bedrock. Deeper infiltration into bedrock is observed at those sites with little soil cover, such as ridge tops and side slopes, as opposed to terraces and channels. It has been proposed that water preferentially flows through Tiva Canyon unit fractures, even when the fractures are filled with material. This is because fracture fill material is more porous than the Tiva Canyon welded matrix. This implies that areas with many filled fractures and a thin soil cover may significantly contribute to infiltration at Yucca Mountain.

Joseph Rousseau (U.S.Geological Survey) provided a presentation on "DOE/YMPO Surface-Based Data Collection Studies in Unsaturated Zone Percolation."

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Preliminary findings from borehole UZ-16 indicates that the imbricate faults are almost vertical and fracture densities in the Topopah Spring are much greater than earlier estimates, ranging from 50 to 250 fractures/m^3. Water was encountered near the water table in fractures of the Prow Pass unit. Three theories to explain the occurrence of this water were mentioned:

(1) The water is residual water from higher piezometric and or standing water levels in the Prow Pass (the matrix may be locally saturated near interconnected fractures and/or near adjacent fault zones).

(2) Fracture flow in the unsaturated Prow Pass unit matrix is sustained by high pressure heads (artesian) and upward flow from the (water table).

(3) Fracture flow in the unsaturated Prow Pass unit matrix is sustained by downward fault flow derived from lateral inflow and near-surface infiltration (water draining from higher units).

Albert Yang (U.S. Geological Survey) presented a talk on "DOE/YMPO Hydrochemical Characterization of the Unsaturated Zone." Carbon dioxide gas sampling from borehole UZ-1 does not provide evidence of contributions of carbon dioxide from rock with depth. This indicates most of the carbon dioxide is not from the rock, but comes from vegetative roots or is atmospheric in origin (Yang, 1993). Interpretations of carbon-14 gas sampling data indicate gas compositions get older with depth, with older gas (9,400 years) occurring below the Paint Brush nonwelded unit. The NRC staff is currently considering the implication of slow gas movement at Yucca Mountain and that the Paint Brush nonwelded unit may be a barrier to gas movement. If carbon-14 ages indicate old (prebomb) gas, the NRC is also considering this could imply recent (post bomb) isotopes arrive at depth by either liquid flow or sample contamination and not through gaseous transport.

Pore water data from boreholes UZ-4, UZ-5, and UZ-16 contains evidence of recent tritium in all the bedded units, while the welded units contains prebomb tritium. Of these three holes, borehole UZ-16 is the only one to penetrate much below the top of the Topopah Springs unit. This hole has been drilled from the surface into the water table, which at this location occurs in the Prow Pass unit. In this hole, recent tritium was found in the Paint Brush nonwelded unit and the bottom of the Calico Hills nonwelded zeolitic unit. Recent Chlorine-36 was found in pore water samples from borehole UZ-16 in the Paint Brush nonwelded unit and the top of the Calico Hills nonwelded zeolitic unit. Explanations have previously been suggested to explain the occurrence of recent isotopes (post bomb) in bedded units above the Topopah Springs welded unit. Some of these explanations entertain the possibility of episodic fracture flow through the Tiva Canyon welded unit or lateral movement of water from outcrops of the PaintBrush bedded unit. However, no explanations were offered at the meeting for the deep occurrence of recent isotopes at the depth of the Calico Hills unit. At this time the U.S. Geological Survey is considering a range of interpretations and is investigating the possibility of sample contamination. The NRC staff is considering the concept that recent isotopes may be found in deep bedded

units, because vertical boreholes are more likely to encounter evidence of episodic fracture flow in these types of units. Bedded units have a much larger lateral matrix permeability than the matrix of welded units. If a few fractures flow from time to time, water in the fractures would be more quickly absorbed into the bedded units than the matrix of the welded units. In addition, the greater permeability of the bedded units would allow water from fractures to move a greater distance in a lateral direction. Therefore, even if there was occasional fracture flow through welded units, vertical boreholes would have a greater chance of encountering isotopic evidence of vertical fracture flow in the bedded units, than the welded units.

When borehole UZ-16 was drilled, water was found above the water table in a Prow Pass unit fracture. Oxygen-18, deuterium, calcium, sodium, bicarbonate, carbonate, chloride, and sulfate data indicate the water chemistry and isotopic ratios of the water in the fracture was much closer to the water in the water table than the water in the Calico Hills zeolitic unit above. This implies the water in the fracture came from the water table, as opposed to the Calico Hills unit above the Prow Pass unit.

Borehole UZ-16 pore water samples of oxygen-18 and deuterium also suggest the Calico Hills zeolitic unit is from an older, colder time, than the water found in the units above and below. This appears to be in disagreement with isotopic data indicating the presence of recent (post bomb) water in the Calico Hills zeolitic unit. Several theories are being entertained to explain this observation.

Edward M. Kwicklis (U.S. Geological Survey) talked on "Site Scale Unsaturated Zone Modeling." Models of groundwater water flow, which take into account fracture and matrix flow properties, have produced good correlations with moisture contents and isotopic data from boreholes UZ-4, UZ-5, UZ-7, and UZ-13 (all these holes were drilled from the surface into the top of the Topopah Springs unit). Statistical correlations between some of the important unsaturated zone hydrogeologic parameters have been identified. These correlations may enable easily measured parameters (such as porosity) to be used to calculate parameters, which are more difficult to obtain (such as hydraulic conductivity-saturation curves). If successful, this could provide more data for hydrologic model input. Flux profiles have been created which indicate large, relatively recent influxes of water into the Paintbrush bedded unit beneath the wash at UZ-4 and UZ-5. This is consistent with interpretations explaining tritium peaks at UZ-4 and UZ-5 as fracture flow through the Tiva Canyon member and lateral flow along the Paintbrush bedded unit. The near-static equilibrium water potential profile at UZ-7 suggests the vitric cap rock of the Topopah Spring Member may be an important capillary barrier.

On December 15, 1994, the ACNW held a tour of Yucca Mountain. This tour provided an opportunity to view the Exploratory Studies Facility starter tunnel, construction of the first test alcove, the laboratories of U.S. Geological Survey principal investigators, Joe Rousseau and Alan Flint, and attend a lecture on the Ghost Dance Fault and faulting at Yucca Mountain.

References Cited:

Yang, In. C., Peters, C.A., and Thorstenson, D.C., Carbon Isotopic Data From Test Hole USW UZ-1, Yucca Mountain, Nevada, High-Level Radioactive Waste Management Proceedings of the Fourth Annual International Conference, Las Vegas, Nevada, April 26-30, 1993.

/s/

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Enclosure:
Final Agenda

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ATTACHMENT 1

UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON NUCLEAR WASTE
WASHINGTON, D.C. 20555

FINAL AGENDA

ADVISORY COMMITTEE ON NUCLEAR WASTE
WORKING GROUP MEETING
DECEMBER 14, 1993

UNSATURATED ZONE FLOW AT THE POTENTIAL
YUCCA MOUNTAIN HLW REPOSITORY SITE

8:15 - 8:30 a.m.	Opening Remarks by Working Group Chairman and Consultants (ACNW)
8:30 - 9:15 a.m.	Overview of Apache Leap Research Program Ernie Hardin (UA)
9:15 - 9:30 a.m.	DOE Opening Remarks and Introductions J. Dlugosz (DOE)
9:30 - 9:45 a.m.	Regulatory Issues Being Addressed by DOE/YMPO Unsaturated Zone Studies A. Gil (DOE)
9:45 - 10:15 a.m.	Overview of DOE/YMPO Studies of the Unsaturated Zone M. Chornack (USGS)
10:15 - 10:30 a.m.	* * * B R E A K * * *
10:30 - 11:30 a.m.	DOE/YMPO Characterization of Unsaturated Zone Infiltration A. Flint (USGS)
11:30 - 12:00 a.m.	DOE/YMPO Site Scale Unsaturated Zone Modeling E. Kwicklis (USGS)
12:00 - 12:30 p.m.	DOE/YMPO Surface-Based Data Collection Studies on Unsaturated Zone Percolation J. Rousseau (USGS)
12:30 - 1:30 p.m.	* * * L U N C H * * *

1:30 - 2:00 p.m.	DOE/YMPO Hydrochemical Characterization of the Unsaturated Zone I. Yang (USGS)
2:00 - 2:30 p.m.	Exploratory Studies Facility Interface -Construction Phase Activities -Main Test Level Activities M. Chornack (USGS)
2:30 - 3:00 p.m.	Three-Dimensional Model of Unsaturated Zone Flow B. Bodvarsson (LBL)
3:00 - 3:30 p.m.	Integration of Unsaturated Zone Data Collection, Modeling Studies, and Performance Assessment C. Newberry (YMPO)
3:30 - 3:45 p.m.	* * * * BREAK * * * * *
3:45 - 4:00 p.m.	Review of DOE/YMPO response to ACNW concerns J. Dlugosz (DOE)
4:00 - 4:30 p.m.	Alternative Conceptual Models of Unsaturated Zone Flow at Yucca Mountain L. Lehman (Linda Lehman & Associates)
4:30 - 5:00 p.m.	Fracture and Matrix Flow in the Unsaturated Zone at Yucca Mountain M. Mifflin (Mifflin & Associates)
5:00 - 5:30 p.m.	ESSE Peer Review Comments on DOE's Hydrology Program D. Kreamer (UNLV)
5:30 - 5:45 p.m.	Wrap-Up/Round Table All