UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

DATE: April 10, 1996

TO: John H. Austin, Chief
Performance Assessment and HLW Integration Branch (PAHL), Division of Waste Management
Office of Nuclear Materials Safety and Safeguards

FROM: William Belke, Sr. On-Site Licensing Representative for Quality Assurance and Engineered Systems

Chad Glenn, Sr. On-Site Licensing Representative for Natural Systems and Total Systems Chad Glenn

SUBJECT: U. S. NUCLEAR REGULATORY COMMISSION ON-SITE LICENSING REPRESENTATIVES' REPORT ON YUCCA MOUNTAIN PROJECT FOR MARCH, 1996

INTRODUCTION

The principal purpose of the On-Site Representatives' (OR) reports is to alert NRC staff, managers and contractors to information of U. S. Department of Energy (DOE) programs for site characterization, repository design, performance assessment, and environmental studies that may be of use in fulfilling NRC's role during pre-licensing consultation. The principal focus of this and future OR reports will be on DOE's programs for the Exploratory Studies Facility (ESF), surface-based testing, performance assessment, data management systems and environmental studies. Relevant information includes new technical data, DOE's plans and schedules, and the status of activities to pursue site suitability and ESF development. In addition to communication of this information, any potential licensing concerns, or opinions raised in this report represent the views of the ORs and not that of NRC headquarters' staff.

QUALITY ASSURANCE, ENGINEERING, AND NRC KEY TECHNICAL ISSUES

1. Attended the March 27, 1996, NRC/DOE QA videoconference held in Washington, D.C., and Las Vegas, Nevada. The objective of this meeting was for the meeting to be a technical meeting leading toward issue resolution for items listed in the agenda. Enclosure 1 provides the agenda for this meeting. The minutes of this meeting will be documented in a subsequent letter separate from this OR report.

   One of the agenda items pertained to resolution status of NRC open issues. One of the NRC open issues was a result of the OR observation of two recent audits of the U.S. Geological

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Survey (USGS). The open issue pertained to the overall quality of the USGS technical reviews. Of the four reports audited during two audits, two of the four contained significant deficiencies. DOE recognized this as a problem and issued a September 27, 1995, letter to the M&O with 13 good practices to avoid lapses in the technical verification and technical work supporting technical reports. It is the OR's understanding that DOE has a special surveillance effort underway to verify a representative number of USGS technical reports to assure these lapses are not widespread. The NRC OR agrees with this effort and has requested to be kept informed.

The NRC OR however, as expressed at this meeting, cannot totally agree with the conclusion depicted for USGS in Chart 1, in the February 22, 1996, DOE Summary Report of the OCRWM QA Program Effectiveness for Fiscal Year 1995. On this chart, for USGS Supplement III, "Scientific Investigation," effectiveness for this area overall is considered "marginal." It would appear that in view of two of the four technical reports audited having significant deficiencies, this area would have been considered at least, "indeterminate" or possibly "unsatisfactory" pending the outcome and results of the final review.

2. Attended an Appendix 7 type meeting held in Las Vegas, Nevada, on March 13 and 14, 1996. The purpose of this meeting was for NRC to obtain clarification on the performance goal-based seismic design methodology proposed in DOE's Topical Report II. Representing the NRC staff were three members of the NRC Headquarters Engineering and Geoscience Branch, three members from the Center for Nuclear Waste Regulatory Analyses (CNWRA) staff, and the two ORs. The State of Nevada was invited but did not attend.

   The objective of the meeting was to discuss the details of the performance goal based seismic design methodology as proposed to be applied by DOE to a geologic repository design at Yucca Mountain. The DOE presentations and discussions that followed, provided answers to NRC staff questions on design details and clarified DOE's positions with respect to the implementation of design methodology. The information obtained by the NRC staff at this meeting will also be of assistance in resolving the NRC Key Technical Issue (KTI) associated with Repository Design and Thermal-Mechanical Effects.

   The NRC attendees provided significant feedback to the authors of DOE Topical Report II and insights on what portions of the report may need revisions. Technical discussions at this meeting were frank and open and considered beneficial by NRC and the DOE participants.

3. On March 19, 1996, DOE conducted a Safety Stand Down meeting for all Yucca Mountain Site Characterization employees. This meeting was conducted in Las Vegas, Nevada, and for all three shifts at the Yucca Mountain Field Operations Center at the Nevada Test Site. The ORs do not have the capability to receive notification of such meetings and consequently, did not attend. Hopefully, this situation will be rectified in the near future with OR access to the DOE computer system. (See last paragraph under "Other Activities" in this report). The purpose of this meeting was to remind employees of workplace safety being a priority for this project. According to the meeting notification, presentations were to be made by DOE and M&O Senior Management with the aim of improving communications with regard to safety issues. DOE was to present the results of their recent employee concerns review pertaining to safety and health issues. The Construction Contractor was to conduct toolbox safety sessions for ESF construction personnel.

   The OR discussed the subject matter with several DOE employees including DOE management. It is the OR's understanding that an ESF Safety Team consisting of four individuals, over several weeks, performed a review and interviewed a number of employees involved with work at the ESF. Apparently, many of these employees expressed safety and health issues which supposedly were documented in a ESF Safety Team Internal report. Several of these employee concerns were presented at the March 19, 1996, meeting to serve as examples for safety. A copy of the report was requested from DOE management to verify whether any of the expressed concerns involved potential licensing issues. DOE management indicated that the report and concerns had been turned over to the M&O for investigation and should be finalized in about three weeks. DOE explained that a number of the concerns were not fully substantiated or validated and therefore, it was requested that the OR wait until the final report is released.

   When the ESF Safety Team Report is finalized and more information is obtained, it will be reported on in a future OR report.

4. During the week of February 26 through March 1, 1996, the OR and a senior geologist from NRC Headquarters observed a performance-based QA audit of the DOE M&O conducted in Albuquerque, New Mexico, and Las Vegas, Nevada. The purpose of this audit was to evaluate effectiveness of the implementation of the QA program requirements for the work being performed at Sandia Laboratories in Albuquerque, New Mexico, under the direction of the M&O, and work being performed at the M&O offices in Las Vegas, Nevada.

The audit team primarily focused on the implementation of the QA program requirements associated with the generation of the "Three-Dimensional Rock Characteristics Models". This model is one of a series of models intended to integrate into the overall total system model. The audited areas included appropriate QA program criteria pertaining to: 1) Organization; 2) QA Program; 3) Implementing Documents; 4) Control of Documents; 5) Corrective Action; 6) QA Records; 7) Software; and 8) Scientific Investigation.

The KTI associated with the audit was in the area of Structural Deformation and Seismicity. This KTI seeks to ensure that significant conditions and hazards are identified, understood, fully considered, and used appropriately to evaluate repository performance. Initially, the KTI activities are focusing on the development of conceptual models and on whether or not DOE is obtaining necessary and sufficient data with which to develop the models, and is adequately integrating this information with its other activities. The subject of this audit provided insight into DOE's program that will facilitate resolution of this KTI. The complete details of the NRC's participation in observing this audit will be documented and be available in NRC Observation Audit Report QA-96-03.

EXPLORATORY STUDIES FACILITY (ESF)

As of March 29, 1996, the TBM advanced to station 46+63 meters (15,298 feet). Geologic mapping and sampling were completed to station 45+67 meters. The rate of excavation and testing slowed over the end of this reporting period due to: ventilation system repairs, conveyor belt adjustments to prepare for the start of excavation at the Northern Ghost Dance Fault Alcove, and Category 4 ground conditions. The location of alcoves and preliminary tunnel stratigraphy is summarized in Enclosure 2.

<u>ESF Testing</u>
Alcove 2 (Bow Ridge Fault Alcove):
The main purpose of testing in this alcove is to conduct hydrochemistry tests to determine the hydrologic properties of the Bow Ridge Fault. A second radial borehole (ESF-BRFA-HPF#2) was cored to a total depth of 85.7 feet. The borehole penetrated the Bow Ridge Fault at approximately 56 feet. Investigators ran a temperature and caliper log of this borehole.

Alcove 3 (Upper Paintbrush Tuff [non-welded] Contact Alcove):
The primary purpose of this alcove is to test the hydrologic properties of the contact between the Tiva Canyon welded units and the Paintbrush bedded units. Investigators set packers and conducted gas sampling in the two radial boreholes in this alcove.

Alcove 5 (Thermal Testing/Facility Access/Observation Drift):
This facility will be used for testing in-situ thermomechanical properties in the potential repository host rock. This alcove is being excavated with an Alpine Miner. The total design length of this facility is 130 meters. Excavation of the main drift of this alcove advanced to station 0+53 meters before being halted to initiate excavation of the Thermomechanical Alcove (TMA). Station 0+00 for the TMA is on the right rib of Thermal Test Alcove main drift at approximately station 0+40. Excavation of the TMA progressed approximately 18 of the 30 meters planned for this heater test shakedown area. The TMA will be the location of the Single Heater Test which will provide measurements to examine rock-mass thermal properties. The heater for this test is expected to be turned on in the August 1996 timeframe.

Alcove 6 (Northern Ghost Dance Fault Alcove):
The main purpose of this alcove is to conduct hydrochemistry test to determine the hydrologic properties of the Ghost Dance Fault. The planned breakout location for this alcove is station 37+37. Excavation (via drill and blast) is expected to start in May 1996.

SURFACE-BASED TESTING

Borehole Drilling and Testing:
The location of boreholes referenced in this section is provided in Enclosure 3.

C-Hole Testing
Series of tracer tests are planned at the C-Holes Complex to provide parameters for ground water flow and transport modeling. The first conservative or non-reactive tracer test (no chemical interaction between tracer and rock) was initiated February 13, 1996, and concluded March 29, 1996. As a result of this test, a tracer breakthrough curve was established to assist in determining hydrologic parameters for modeling. A preliminary plot of this breakthrough curve is attached (Enclosure 4). Further testing using both conservative and non-conservative tracers (chemical interaction between tracer and rock) is scheduled to begin in May 1996.

G-2 Pump Testing
The purpose of aquifer testing in this borehole is to investigate the large hydraulic gradient north of repository block. Investigators continue to monitor the fluid level recovery from the 55 hour pump test initiated on February 5, 1996. On March 29, 1996, the fluid level had recovered to within 0.2 feet of the original level measured prior to the short duration drawdown tests conducted before the 55 hour pump test. This initial test was inconclusive in determining whether the large hydraulic gradient is representative of the regional water table or a

perched water body. A longer pump test (approximately 10 days) is scheduled to start in early April 1996.

Borehole Pneumatic Testing
Investigators continue to collect pneumatic data in boreholes UZ-4, UZ-5, NRG-6, UZ-7a, SD-12, NRG 7a. Nye County is also recording pneumatic data from instrumentation installed on the TBM and in boreholes NRG-4 and ONC-1. A retrievable monitoring system is presently being installed in SD-7 for pneumatic testing prior to and during passage of the TBM through the southern half of the ESF.

OTHER ACTIVITIES

NRC Key Technical Issues
Container Life/Source Term:
The OR office worked with DOE staff in coordinating a NRC request for a rock sample from the potential repository horizon in the ESF. The sample was collected and shipped to NRC's contractor facility, Center for Nuclear Waste Regulatory Analyses (CNWRA) in San Antonio, Texas. The sample will be used for the investigation of the survival of microorganisms at different temperatures and the effect of these natural organisms on the critical potentials for the corrosion of container materials. DOE staff and contractors demonstrated excellent cooperation in satisfying this sample request.

Thermal Effects on Flow:
The OR office worked with DOE staff in identifying and obtaining specific records on a G-Tunnel thermal test conducted in the late 1980s. NRC and CNWRA staff are interested in using G-Tunnel field data to test NRC's thermohydrologic model. DOE staff were very cooperative in making this information available to NRC staff.

Igneous Activity:
The OR office coordinated with DOE and Nellis Air Force Range security officials in arranging access to the Nellis Range for two CNWRA geologists during the week of April 21, 1996. The purpose of this visit is to make field observations and collect samples of basalt rocks as part of NRC's ongoing studies of Yucca Mountain basaltic volcanoes.

Unsaturated/Saturated Flow Under Isothermal Conditions:
1. An ESF moisture study is underway to investigate the effect of ventilation in the ESF. Investigators will attempt to determine an ESF moisture mass balance based on the known quantity of water used in the ESF, and measurements of moisture content at various points in the ESF. Temperature, humidity and pressure probes have been installed in the ESF at various locations (TBM, ventilation lines, and wall rock) for this purpose. DOE investigators and Nye County are currently

monitoring temperature, humidity and pressure in the ESF. This ESF study will help to establish ambient moisture content in freshly excavated areas and the nature of any change in moisture content over time. The results of this study are expected to provide useful information for unsaturated zone site scale modelers and investigators conducting heater and other tests in the ESF.

2. DOE investigators are using a variety of techniques including Geographic Information System (GIS) to integrate various types of site characterization data. GIS was recently used to develop a flux map of the Yucca Mountain area. The flux map provides an estimate of the amount of water that enters the unsaturated zone. In this application, the Yucca Mountain study area was divided into over 5,000 geometric polygons. Parameters important to flux were used to characterize each polygon. These parameters include: soil type, depth to bedrock, annual precipitation, topographic position (crest, side slope, channel) and area of polygon. GIS was used to integrate data for each polygon such that this information could be presented in the form of a flux map over the entire study area. Arc/Info software was then used to calculate the flux and present this information graphically. The flux map is presently being used as input to the development of an unsaturated zone flow and transport model for Yucca Mountain.

Synthesis Reports
DOE is developing a series of synthesis reports in FY96 that integrate information on different aspects of site characterization. Draft outlines for three of the synthesis reports planned to be completed this year are attached (Enclosure 5). A fourth synthesis report "Stratigraphy, Structure, and Rock Properties of Yucca Mountain" has been cancelled. This information will instead be included in DOE's 1997 Program Integration and Safety Assessment.

Automated Technical Data Tracking System
The ORs are currently in the process of establishing a network account for access to DOE's Automated Technical Data Tracking (ATDT) system. The ATDT is a DOE computer-based information management system designed to maintain references to data resulting from Yucca Mountain Site Characterization Project data collection and development activities. ATDT catalogs data records submitted to the project, however the actual data does not reside in this system. ATDT users can query this system and conduct searches for specific information. Specific records may be requested separately using the data tracking number obtained from the ATDT system. Access to this system is available to project participants and affected units of government.

GENERAL

1. Meetings/Interactions Attended the regularly scheduled meeting with W. Barnes (Yucca Mountain Site Characterization Office (YMSCO) Project Manager), Deputy Project Manager, YMSCO Assistant Managers, and the YMSCO QA Manager. Topics discussed at this meeting included: 1) NRC observations from February 26 through March 1, 1996, DOE audit of the M&O and Sandia National Laboratories; 2) DOE modeling hierarchy; 3) schedule for publishing Strategy For Waste Isolation Containment Strategy and Advance Conceptual Design Documents For Yucca Mountain Site; 4) status of funding to State and Local Governments; 5) NRC KTI status; 6) ESF NRC sample requests; 7) update on the potential move of the NRC Office to the Summerlin facility; and 8) NRC March 1, 1996, site visit.

2. Appendix 7 Site Interactions

   Conducted a March 12, 1996, site visit with the NRC and CNWRA staff that were in attendance at the March 13-14, 1996, Appendix 7 meeting to discuss DOE Topical Report II. The purpose of this visit was for these members to gain familiarity with the current site characterization technical activities being conducted at Yucca Mountain. There were no outstanding issues raised on this visit.

3. Reports

   Over this reporting period, the following reports were received in the NRC Las Vegas office:

<u>DOE/OCRWM</u>

DOE/RW-0438, Rev. 1	THE NUCLEAR WASTE POLICY ACT, AS AMENDED, with Appropriations, Acts Appended, 2/95
<u>TRW/M&O (CRWMS)</u>	NEVADA POTENTIAL REPOSITORY PRELIMINARY TRANSPORTATION STRATEGY, STUDY 2, VOL. I & II

<u>LAWRENCE LIVERMORE</u>

UCRL-ID-121513	REPORT ON LABORATORY TESTS OF DRYING AND RE-WETTING OF INTACT ROCKS, J. J. ROBERTS, W. LIN, 3/96
	BIBLIOGRAPHY OF YUCCA MOUNTAIN PROJECT (YMP) PUBLICATIONS AT LAWRENCE LIVERMORE NATIONAL LABORATORY (9/77--3/96)

UCRL-ID-121791	THERMAL-HYDROLOGICAL ANALYSIS OF LARGE-SCALE THERMAL TESTS IN THE EXPLORATORY STUDIES FACILITY AT YUCCA MOUNTAIN, T. BUSCHECK, J. NITAO, 10/95
LOS ALAMOS	LANL MONTHLY MANAGEMENT ANALYSIS REPORT FOR FEBRUARY 1996
NWTRB, 3/96	DISPOSAL AND STORAGE OF SPENT NUCLEAR FUEL--FINDING THE RIGHT BALANCE, A Report to Congress & Secretary of Energy
USGS	
WRIR 94-4177	RESULTS AND INTERPRETATION OF PRELIMINARY AQUIFER TESTS IN BOREHOLES UE-25c #1, UE-25c #2, AND UE-25c #3, YUCCA MOUNTAIN, NYE COUNTY, NEVADA, A. L. GELDON
	YUCCA MOUNTAIN PROJECT BRANCH PROGRESS REPORT, February, 1996

cc w/encs.:
R. Milner, DOE-OCRWM
R. Loux, State of Nevada
J. Meder, Nevada Legislative Counsel Bureau
W. Barnes, YMSCO
D. Horton, YMSCO
N. Chappell, M&O
H. Haghi, M&O
M. Murphy, Nye County, NV
M. Baughman, Lincoln County, NV
D. Bechtel, Clark County, NV
D. Weigel, GAO
P. Niedzielski-Eichner, Nye County, NV
B. Mettam, Inyo County, CA
V. Poe, Inyo County, CA
W. Cameron, White Pine County, NV
R. Williams, Lander County, NV
L. Fiorenzi, Eureka County, NV
J. Hoffman, Esmeralda County, NV
C. Schank, Churchill County, NV
L. Bradshaw, Nye County, NV
W. Barnard, NWTRB
R. Holden, NCAI
A. Melendez, NIEC
R. Arnold, Pahrump, NV
N. Stellavato, Nye County, NV
J. Greeves, NRC WA (T7J-9)
J. Thoma, NRC WA (T7F-1)
M. Bell, NRC WA (T7C-6)
M. Federline, NRC WA (T7J-9)
J. Spraul, NRC WA (T7F-1)
A. Garcia, NRC WA (T7J-9
C. Paperiello, NRC WA (T8A-23)
M. Knapp, NRC WA (T8A-23)
R. Irish, NRC WA (T-5D28)
W. Reamer, NRC WA (O15B-18)
W. Patrick, CNWRA (Center

NRC-DOE VIDEO CONFERENCE AGENDA
HIGH-LEVEL WASTE QUALITY ASSURANCE

490 L'Enfant Plaza, Suite 7200
Washington, DC

Bank of America Building, Room 663
101 Convention Center Drive, Las Vegas, NV

March 27, 1996

OBJECTIVE* - *Technical meeting leading toward issue resolution for items listed below.

1:00 EST (10:00 PST)	Opening Remarks	DOE, NRC, NV, AULG
1:10 EST	NRC/DWM reorganization	NRC
1:20 EST	Resolution status of NRC open QA issues	DOE/NRC
2:00 EST	DOE (Brocoum) letter of January 31, 1995, to NRC (Holonich) - "U.S. Department of Energy (DOE) Position on Qualification of Existing Data."	NRC/DOE
2:15 EST	Draft NRC position on the use of existing data for issue resolution	NRC
2:30 EST	DOE (Milner) letter of February 7, 1996, to NRC (Travers) regarding QARD application to 10 CFR Part 72 - "Licensing Requirements for the Independent Storage of Spent Nuclear Fuel and High-Level Radioactive Waste"	DOE
2:50 EST	Changes to DOE audit schedule	DOE
3:00 EST	Closing Remarks and Discussion	DOE, NRC, NV, AULG
3:10 EST (12:10 PST)	Adjourn	

ENCLOSURE 1

ESF TUNNEL STRATIGRAPHY*

STATION	
0+00 to 0+99.5m	Tiva Canyon crystal poor upper lithophysal zone.
	Alcove #1 (centerline station intersection): 0+42.5
0+99.5 to 1+90m	Tiva Canyon crystal poor middle nonlithophysal zone
	Alcove #2 (centerline station intersection): 1+68.2
1+90 to 1+99.5m	Tiva Canyon crystal poor lower lithophysal zone.
1+99.5 to 2+02m	Bow Ridge fault zone (placing Pre-Ranier Mesa Tuff against Tiva Canyon Tuff)
2+02 to 2+20m	pre-Ranier Mesa Tuff
2+20	Fault (4.3m offset)***
2+20 to 2+63.5m	pre-Ranier Mesa Tuff
2+63.5 to 3+37m	Tuff "X"
3+37 to 3+49.5m	pre-Tuff "X"
3+49.5 to 3+59.5m	Tiva Canyon vitric zone
3+59.5 to 4+30m	Tiva Canyon crystal rich nonlithopysal zone
4+30m	Fault (~10m offset)***
4+30 to 4+34	Tiva Canyon crystal rich nonlithopysal zone
4+34 to 4+39m	Tiva Canyon crystal rich lithopysal zone
4+39 to 5+50m	Tiva Canyon crystal poor upper lithophysal zone
5+50m	Fault (~5m offset)***
5+50 to 5+53	Tiva Canyon crystal poor upper lithophysal zone
5+53 to 5+87m	Tiva Canyon crystal poor middle nonlithophysal zone

ESF TUNNEL STRATIGRAPHY CONTINUED*

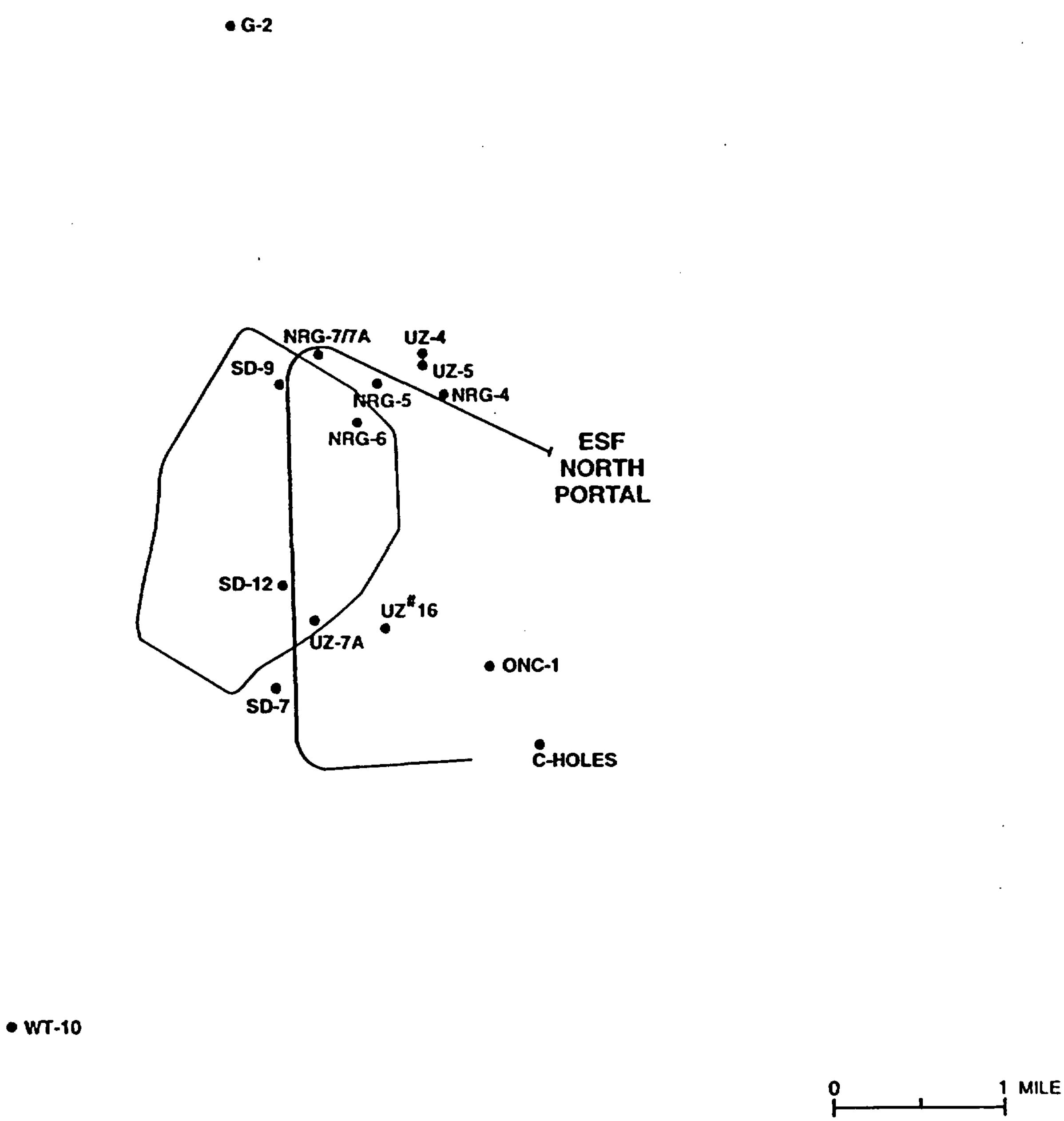
5+87 to 6+19m	Tiva Canyon crystal poor lower lithophysal zone
6+19 to 7+00m	Tiva Canyon crystal poor lower nonlithophysal zone
7+00m	Fault (~20m? offset)***
7+00 to 7+77m	Tiva Canyon crystal poor lower nonlithophysal zone.
	Alcove #3 (centerline station intersection): 7+54.
7+77 to 8+69m	Tiva Canyon crystal poor vitric zone
8+69 to 9+12m	Bedded tuffs (including thin Yucca Mountain member)
9+12 to 10+20m	Pah Canyon Member.
10+20 to 10+51.5m	Pre-Pah Canyon tuffs
	Alcove #4 (centerline station intersection): 10+27.8
10+51.5 to 11+93m	Topopah Spring crystal rich vitric zone
11+93 to 17+17m	Topopah Spring crystal rich nonlithophysal zone
17+17 to 17+97m	Topopah Spring crystal rich lithophysal zone
17+97 to 27+20m	Topopah Spring crystal poor upper lithophysal zone
27+20 to 35+93m	Topopah Spring crystal poor middle nonlithophysal zone
	Alcove #5 (centerline station intersection): 28+27
35+93m	Sundance fault (most prominent fault plane, minor fracturing reported between Stations 35+85 and 36+40)
35+93 to face	Topopah Spring crystal poor middle nonlithophysal zone

* All stations given are referenced to the right springline unless otherwise noted. Station 0+00 is located at coordinates N765352.7, E569814.4.

** Indicates that contact is preliminary and has not been verified.

*** Only faults with greater than 4 meters offset are noted on the table.

Selected Borehole Locations



OPTIONAL FORM 99 (7-90)

FAX TRANSMITTAL	# of pages ► 5
To ROGER HENNING	From M.J. UMARI
Dept./Agency M&O	Phone # (303) 236-5050, ext. 347
Fax # (702) 794 5378	Fax # (303) 236 5047
NSN 7540-01-317-7368 5099-101	GENERAL SERVICES ADMINISTRATION

PRELIMINARY DF INFORMATION

DATE: 3/14/96

TO: Roger Henning

FROM: M.J. Umari MJU and Mike Fahy MF

THROUGH: Dick Luckey Dick R. Luckey

SUBJECT: Ongoing Pilot Tracer TEST at the C-Holes Complex

We are sending you, in addition to the following text, 3 graphs that we will refer to as Figures 1, 2, and 3.

Figure 1 is the breakthrough curve, a plot of actual concentrations in ppb versus elapsed time in days from the time of tracer injection. Portions of the curve that have no or few data points represent periods of time for which UNLV has not yet analyzed the samples. Eventually the whole breakthrough curve would appear densely-packed with data points.

Figure 2 represents a portion of the breakthrough curve, up to an elapsed time of 29,000 min. (20.14 days). For this portion of the curve, a preliminary match, represented by figure 3, was obtained using a dual-porosity analytic model by Allen Moench (Moench, 1995).

Some parameters we specified as input prior to using the Moench model, whereas others, we obtain from fitting results of the model to the actual breakthrough curve.

The matrix porosity was specified to be 21%, based on previous information from core analyses and geophysical logs.

At this point we are prepared to present only two parameters that were obtained from this particular match, which in turn may not be a unique interpretation of the data. The first parameter obtained from this fit is a value of 19 feet for the longitudinal dispersivity (the ability of the dual-porosity medium to disperse the tracer beyond purely advective transport). This value is reasonable because the dispersivity value should not exceed the distance between pumped and injection wells of 95.5 feet.

The second parameter obtained from this match is an effective concentration of the injected slug of 69 ppm. The actual concentration of the injected slug was 10,000 ppm. By making the effective concentration of the slug a parameter to obtain from the fit, you avoid having to know how much mass was captured by the pumped well.

More analysis is needed before we can determine what the fracture porosity indicated by the fit is. Figures 2 and 3 demonstrate, though, that the Moench model can be used to match type curves to

ENCLOSURE 4

the breakthrough curve, and obtain physical parameters from the match. Because the matches are not unique, various sets of fitted parameters will result. We will, in time, seek to narrow this range by discarding some values as not physically realistic based on other lines of evidence.

Basically, this pilot tracer test has been very successful: a very-clearly-defined breakthrough curve is being defined, and the data can be interpreted, albeit non-uniquely at this point, but this is the inherent problem with all hydraulic and tracer tests.

Please call either of us for any further clarification.

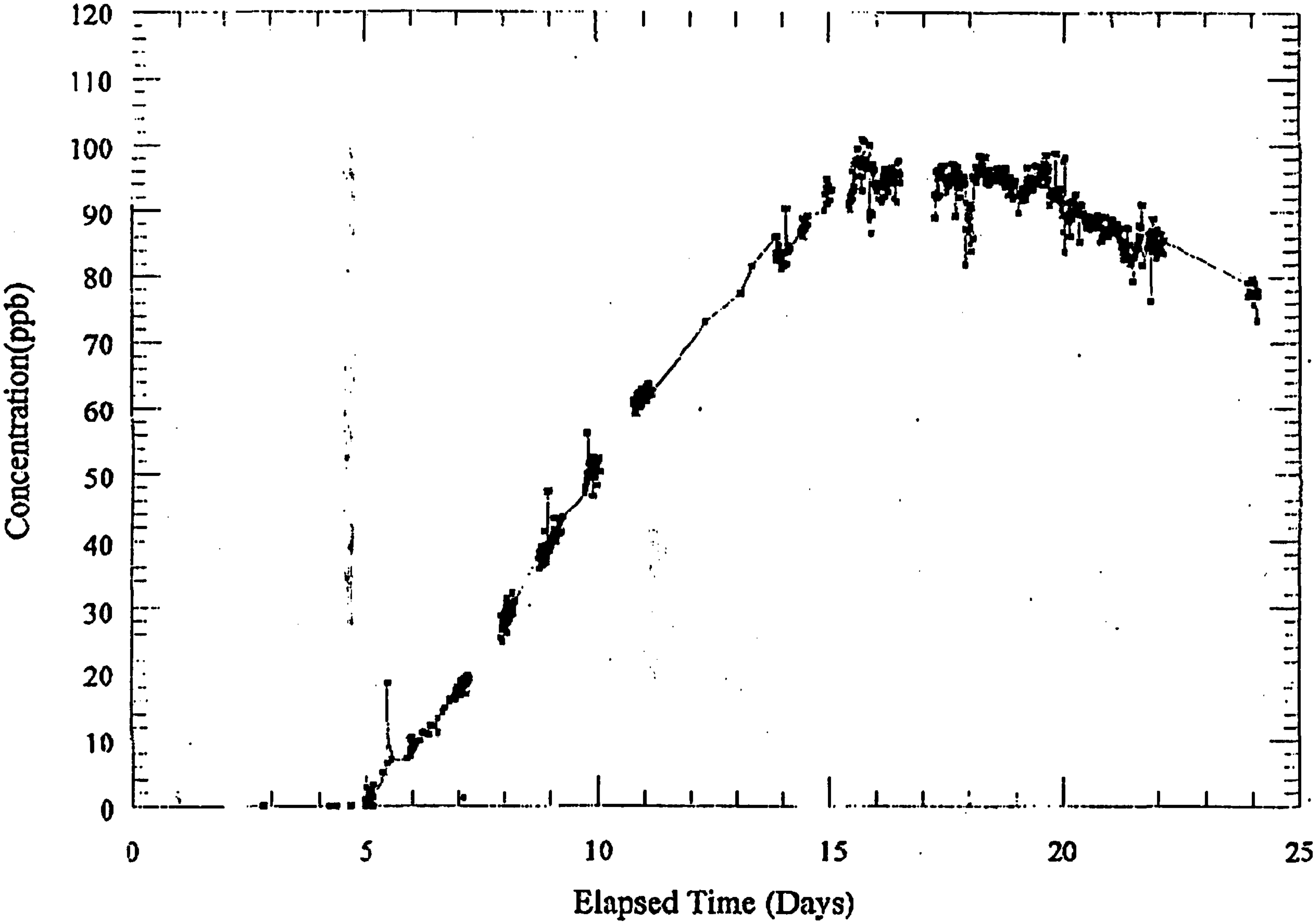
M.J. Umari (303) 236-5050, ext 247
Mike Fahy (303) 236-5050, ext. 245

REFERENCES:

Moench, A.F. 1995, Convergent radial dispersion in a double-porosity aquifer with fracture skin: Analytical solution and application to a field experiment in fractured chalk: American Geophysical Union, Water Resources Research, v. 31, no. 8, p. 1823 - 1835

FIGURE 1

Tracer Test at Cwells 02/13/96 NaI (10,000 ppm) Injectate



Time: 13:16:18, Date: Mar 13, 1996, Wed

PRELIMINARY DRAFT
INFORMATION ONLY

FIGURE 2

Tracer Test at Cwells 02/13/96 NaI (10,000 ppm) Injectate

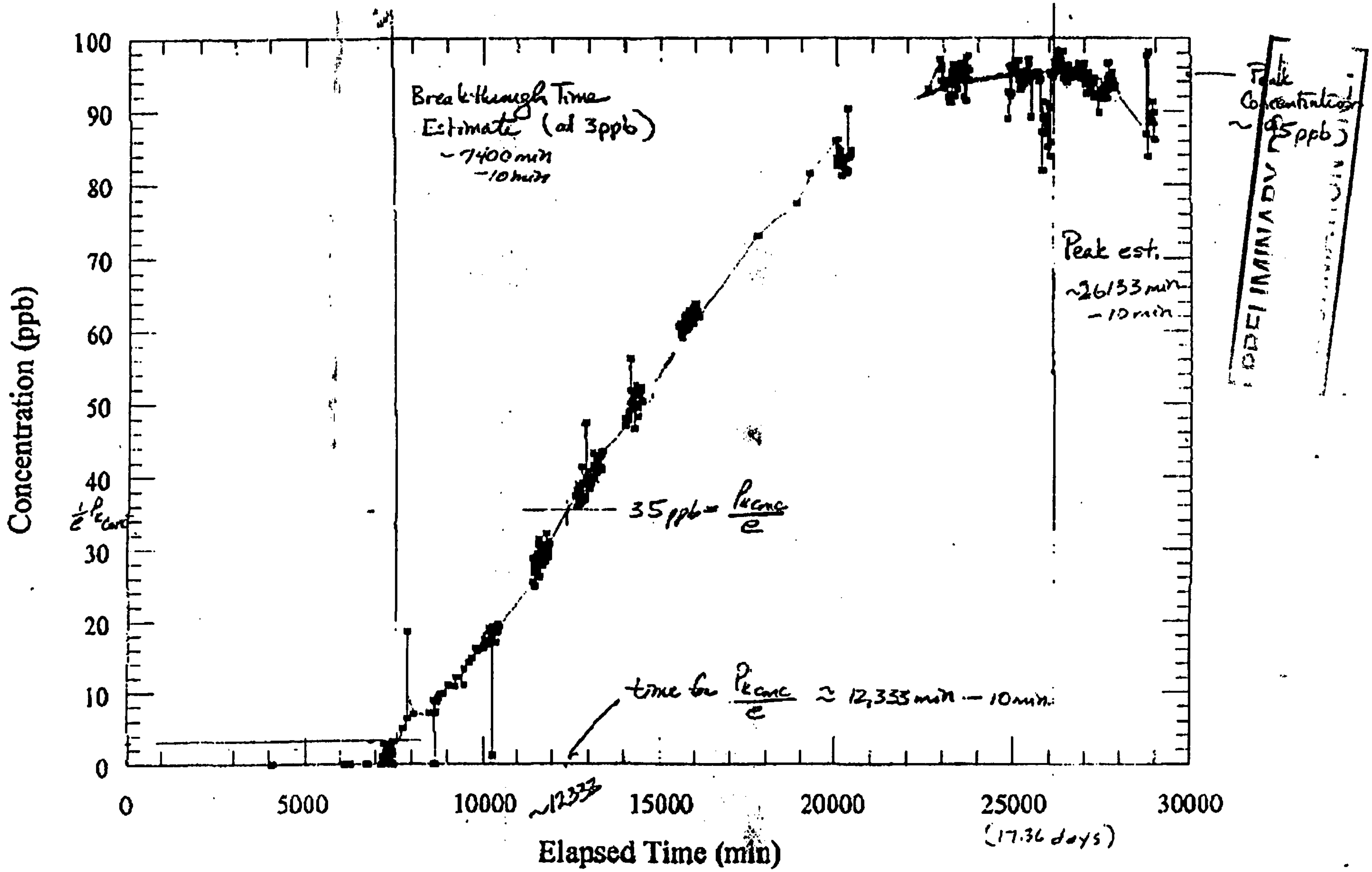
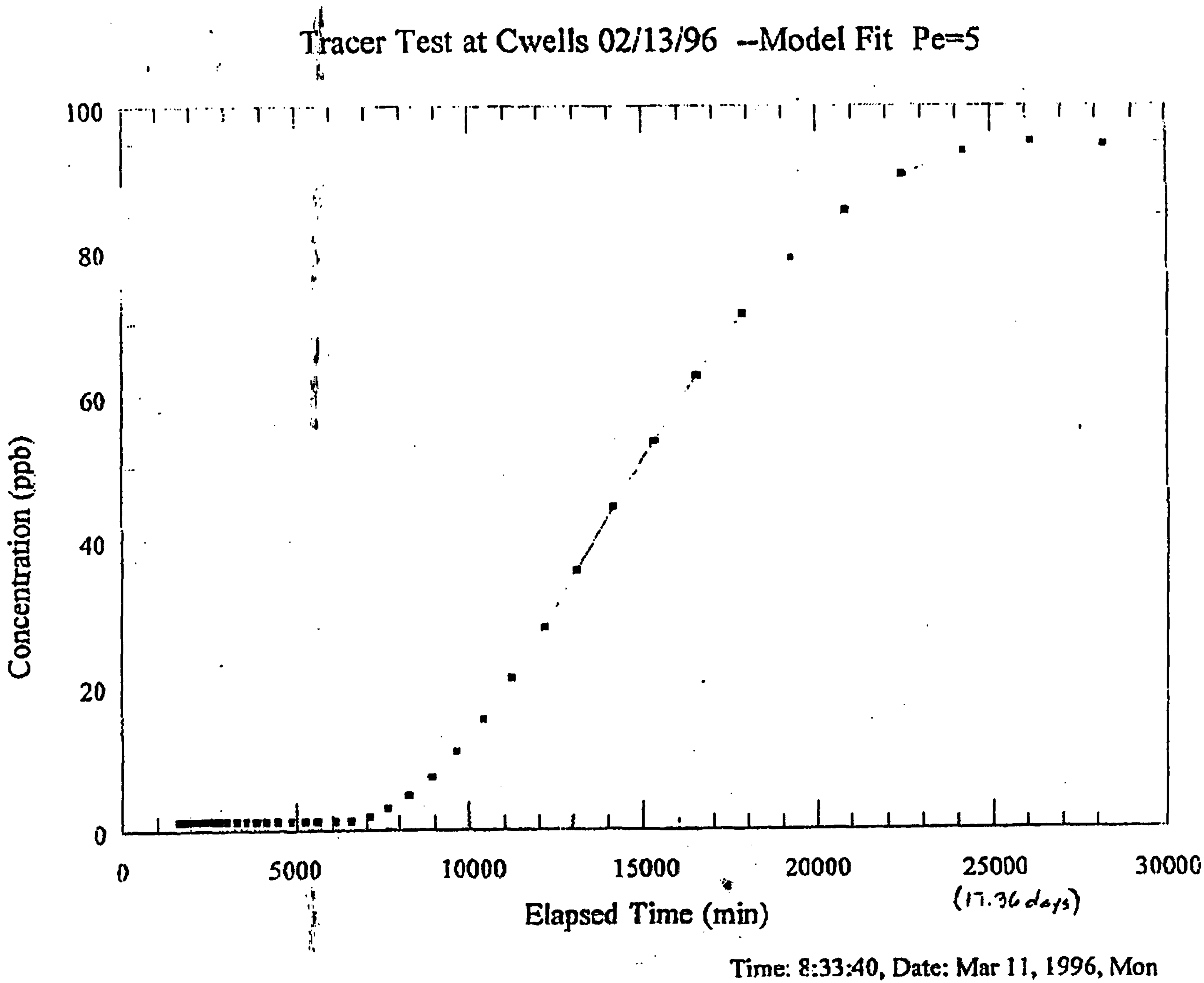


FIGURE 3


Tracer Test at Cwells 02/13/96 --Model Fit Pe=5
Concentration (ppb)
0
20
40
60
80
100
0
5000
10000
15000
20000
25000
30000
(17.36 days)
Elapsed Time (min)
Time: 8:33:40, Date: Mar 11, 1996, Mon

INFORMAL MEMORANDUM

TO: Tim Hawe, AMSL

FROM: Juliana Herrington, AMSP

DATE: March 29, 1996

SUBJECT: CORRESPONDENCE FOR THE NRC

Enclosed are copies of draft outlines for three of the synthesis reports we will produce this year. Please forward to Chad Glenn per our discussions earlier this week. The draft outlines, dated March 27, 1996, are for Geotechnical Characterization of the Proposed Repository Site at Yucca Mountain, Mineralogy/Petrology of Transport Pathways, and Near-Field Environment.

Please contact Juliana Herrington at 794-7203 if you have any questions.

for Susan B. Jones
Assistant Manager for Scientific Programs

Enclosures:
as stated

APPENDIX A

CONDENSED OUTLINE AND WRITING ASSIGNMENTS FOR THE GEOTECHNICAL CHARACTERIZATION OF THE PROPOSED REPOSITORY SITE AT YUCCA MOUNTAIN

1.0 Introduction -- **The M&O will be responsible for writing all of Chapter 1.**
- 1.1 Purpose
- 1.2 Background
- 1.3 Scope
- 1.4 Quality Assurance
- 1.5 Report Organization

2.0 Geotechnical Summary -- **The M&O will be responsible for writing Chapter 2. Summary sections identified below will be written by SNL personnel.**
- 2.1 Introduction
- 2.2 Geology and Major Structural Features of the Proposed Site
  - 2.2.1 Known Geologic Features of Engineering and Construction Significance
  - 2.2.2 Potential Geological Features with Engineering and Construction Significance
- 2.3 Thermal/Mechanical Stratigraphy
- 2.4 Orientations of Joints and Fractures
- 2.5 Hydrology
- 2.6 Rock Structure Data
- 2.7 Laboratory Rock Properties Data -- **Nancy Brodsky**
  - 2.7.1 Physical Properties
  - 2.7.2 Thermal Properties
  - 2.7.3 Mechanical Properties of Intact Rock
  - 2.7.4 Mechanical Properties of Fractures
- 2.8 Rock Mass Quality Indices: RMR and Q -- **Steve Sobolik**
- 2.9 Rock Mass Thermal and Mechanical Properties Estimates -- **Steve Sobolik**
- 2.10 Availability of Naturally Occurring Construction Materials
- 2.11 Underground Opening and Borehole Sealing
- 2.12 Geochemistry and Health Concerns
- 2.13 Summary of Implications of Geotechnical Information

3.0 Geology of the Site -- **The M&O will be responsible for writing this chapter; SNL staff may provide input where noted (by **).**
- 3.1 Introduction
- 3.2 Lithologic Logging of the Core
- 3.3 Stratigraphy
  - 3.3.1 General Overview
    - 3.3.1.1 Ash-Flow Tuffs
    - 3.3.1.2 Bedded Tuffs and Other Volcanic Deposits

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3.3.1.3 Alluvial Deposits
** 3.3.2 Geologic Cross Sections -- Chris Rautman
3.3.3 Thermal/Mechanical Stratigraphy
3.4 Major Structural Features
3.5 Hydrologic Features
** 3.6 In Situ Stress Measurements -- Mike Riggins

4.0 Rock Structure Data -- **The M&O will write this section, with SNL input where noted.**
4.1 Introduction
4.2 Rock Structural Logging
** 4.3 Borehole Rock Structure Data -- **Chris Rautman**
4.3.1 RQD Data
4.3.2 Rock Weathering and Hardness
4.3.3 Lithophysae Content
4.3.4 Fracture Data
4.3.5 Analysis of Rock Structural Character where Boreholes Intersect Faults
4.3.6 Correlation of Core Rock Structural Data with Downhole Video Logs
4.4 ESF Rock Structure Data
4.4.1 RQD Data
4.4.2 Fracture Data
4.4.x **Additional subheadings as appropriate for USBR, etc.**

5.0 Laboratory Rock Properties Data -- **Nancy Brodsky will write this chapter. She will get input from Mike Riggins, Bill Olsson, Steve Brown, NER, and Jim Connolly.**
5.1 Introduction
5.2 Physical Properties
5.2.1 Density and Porosity
** 5.2.2 Mineralogy -- **Jim Connolly will assist Nancy.**
** 5.3 Thermal Properties -- **Mike Riggins will assist Nancy.**
5.3.1 Thermal Conductivity
5.3.2 Thermal Expansion
5.3.3 Heat Capacity
5.3.4 Correlations of Thermal Properties
** 5.4 Mechanical Properties of Intact Rock -- **NER will assist Nancy.**
5.4.1 Static and Dynamic Elastic Properties
5.4.2 Strength
5.4.3 Creep Properties
** 5.5 Fracture Mechanical Properties -- **Bill Olsson, Steve Brown will assist Nancy.**
5.5.1 Fracture Stiffness
5.5.2 Fracture Strength

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6.0 Rock Mass Quality Data -- **Steve Sobolik will be responsible for this chapter except where noted (by **). For Sections 6.2 through 6.4, he will get input from Agapito personnel.**

- 6.1 Introduction
- 6.2 Rock Mass Quality Indices for the Rock Mass Rating System
  - 6.2.1 Data Analysis Procedures
  - 6.2.2 Strength Parameter
  - 6.2.3 Rock Quality Designation Rating
  - 6.2.4 Spacing of Discontinuities
  - 6.2.5 Condition of Joints
  - 6.2.6 Groundwater
  - 6.2.7 Distribution of Rock Mass Rating Values for the Thermomechanical Units
- 6.3 Rock Mass Quality Indices for the Q System
  - 6.3.1 Data Analysis Procedures
  - 6.3.2 Rock Quality Designation
  - 6.3.3 Joint Set Number
  - 6.3.4 Joint Roughness Number
  - 6.3.5 Joint Alteration
  - 6.3.6 Joint Water Reduction Factor
  - 6.3.7 Stress Reduction Factor
  - 6.3.8 Distribution of Q Values for the Thermomechanical Units
- 6.4 Evaluation of RMR and Q Results
  - 6.4.1 Correlation of RMR and Q Results
  - 6.4.2 Comparison of Q and RMR Determined in the ESF to SBT Core-Based Data
  - 6.4.3 Distributions of Q Values
- ** 6.5 Key Block Analysis -- **Mike Riggins of SNL is responsible for this section. He will receive assistance from Clinton Lum of SNL.**

7.0 Rock Mass Thermal and Mechanical Properties-- **Steve Sobolik will write this chapter except where noted (by **).**

- 7.1 Introduction
- 7.2 Data Analysis Procedures
- 7.3 Rock Mass Strength
  - 7.3.1 Yudhbir Criterion
  - 7.3.2 Hoek and Brown Criterion
  - 7.3.3 Design Rock Mass Strength
  - 7.3.4 Rock Mass Mohr-Coulomb Strength Parameters and Dilation Angles
- 7.4 Rock Mass Elastic Moduli
- 7.5 Rock Mass Poisson's Ratios
- 7.6 Rock Mass Thermal Conductivity and Heat Capacity
- 7.7 Rock Mass Thermal Expansion

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** 7.8 Instrumentation Results from ESF -- Mike Riggins will be responsible for this section.

8.0 Implications of Geotechnical Information -- The M&O will write this section with SNL input as stated in Section 2.0.

9.0 References -- All authors will give references to the M&O, who will collate them.

Appendices as needed; e.g.: -- TBD by authors of preceding sections.

Technical Procedures - by reference
Development of Rock Mass Quality Estimates from Core Data
Racked Frequency of Occurrence Tables for Q, RMR, and RQD by Thermomechanical Unit
Rock Mass Quality; Indices for the Lithophysae-Rich and Nonlithophysal Tuff Rock
Core logs
Lab Properties, organized by property
RMQ data by data type
etc.

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Outline for Mineralogy/Petrology Summary and Synthesis Report

Chapter I: Mineralogy/Petrology of Transport Pathways

I. Geochemical Stratigraphy of the Yucca Mountain Site
    A. The "Background" Bulk-Rock Chemistry of Yucca Mountain
        1: Primary chemistry of the silicic volcanic units
        2: Chemistry of altered tuffs
    B. Mineral Chemistry
        1: Abundances, distributions, and compositions of minerals at Yucca Mountain
            a. Primary minerals (phenocryst, devitrification, and vapor-phase)
            b. Secondary minerals

II. Geochemistry of the Potential Host Rock at Yucca Mountain
    A. Geochemical/Textural Stratigraphy of the Topopah Spring Tuff
    B. Bulk-Rock Chemistry in Reference to the Potential Repository Location
    C. Mineralogy in Reference to the Potential Repository Location

III. Applications of Geochemistry to Flow and Transport Models
    A. Mineralogy as a Factor in Sorption Experiments
    B. Microautoradiography
    C. Calcite as a Representative of Pleistocene(?) Deposits

IV. Fracture Mineralogy
    A. The Importance of Fracture Minerals
        1: Fractures as transport pathways (UZ)
        2: Fractures as transport pathways (SZ)
    B. Fracture Minerals of the UZ: chemistry, abundance, and paragenesis
        1: Silica minerals (tridymite, cristobalite, quartz, and opal)
        2: Zeolites (diversity)
        3: Mn-oxides
        4: Clays
        5: Calcite
    C. Fracture Minerals of the SZ: chemistry, abundance, and paragenesis
        1: Quartz
        2: Zeolites (equivalence to wall-rock)
        3: Mn-oxides
        4: Fe-oxides
        5: Clays
        6: Calcite
    D. Limitations and Needs in Applying Fracture Mineralogy to Site Transport Models

V. Minerals and Construction: Mineral Health Hazards

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A. The Nature of Mineral Inhalation Hazards
B. Inhalation Hazards Specific to Yucca Mountain
    1: Zeolites
        a. mordenite
        b. erionite
    2: Chain clays
        a. palygorskite
    3: Silica phases
        a. quartz, cristobalite, and tridymite
        b. opal
C. Hazard Rankings, Impacts, and Mitigation

V. Statistical Considerations
    A. Available Statistical Analyses
    B. Needed Analysis

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1: Long-term Clinoptilolite Dehydration (structural studies)
2: Dynamic Heating
3: Equilibrium and Calorimetric Studies of Clinoptilolite

C. Smectites

1: Long-term Dehydration
2: Dynamic Heating

D. Glasses

1: Long-term dehydration and rehydration of Topopah Spring lower vitrophyre glass
2: Dynamic heating

E. Contributions of hydrous minerals to repository heating effects and water budget

1: Water released by hydrous minerals as a function of repository thermal history
2: Thermal effects of hydrous mineral dehydration/rehydration as a function of repository thermal history

F. Remaining Uncertainites and Information Needs

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Chapter II: History of Mineralogic and Geochemical Alteration of Yucca Mountain

I. Natural Alteration History
A.Overview of Alteration History Studies
B. Syngenetic Alteration of Pyroclastic Rocks
1: General Description
2: Devitrification and vapor-phase crystallization
3: Moderate-temperature hydrothermal alteration
a. Alteration at the top of the Topopah Spring Tuff (Busted
Butte,
Yucca Mountain, ESF)
b. Alteration in the lower Topopah Spring devitrified-vitric transition zone
c. Alteration in the nonwelded Paintbrush Tuff
d. Alteration in the Tiva Canyon Tuff
e. Implications for Paleohydrology
C. Diagenetic Alteration
1: General Description
2: Occurrences of zeolitic rocks (emphasis on genetic aspects)
3: Geochronology
a. K/Ar Studies
b. Petrofabric Studies
4: Conceptual Model of Zeolitization at Yucca Mountain (including paleohydrology)
5. Chemical-Textural Studies of Zeolitization
a. Chemical Changes Associated with the Vitric-Zeolitic
Transition
b. Distribution Patterns of Clinoptilolite Composition
D. Regional Hydrothermal Alteration
1: General Description
2: Paleogeothermal studies
3: Geochronology
E. Surficial Alteration (trench studies)
F. Brecciation of the Topopah Spring and Tiva Canyon Tuffs (trench, outcrop,
and
ESF studies)
G. The Role of Colloids in Alteration and Transport
H. Present and Future Rates of Alteration Processes
I. Implications of Natural Alteration for Repository-Induced Processes
J. Remaining Uncertainties and Information Needs
K. Summary and Chronology of Alteration History of Yucca Mountain

II. Dehydration and Rehydration of Yucca Mountain Hydrous Phases
A. Overview of Dehydration/Rehydration Studies
B. Zeolites

Chapter III: Kinetics and Thermodynamics of Mineral Evolution

I. Thermodynamic Stability of Minerals and Glasses at Yucca Mountain: Synthesis of thermodynamic data, field observations, and geochemical modeling on mineral and glass stability

A. Description of present environmental conditions and possible extrapolation to repository conditions. From CMS paper.

1. Zeolites present at Yucca Mountain
    a. Clinoptilolite, Mordenite, Analcime, Stellerite, Erionite, Minor Zeolites
    b. Why are we worried about zeolites?
2. Ground water compositional trends
3. Thermal trends (past and possibly the Buscheck stuff)

B. Analysis of Zeolite Stability

1: Thermodynamic Data
    a. Description of estimation methods used to derive thermodynamic data.
    b. Comparison of estimated data with measured data for zeolites.

2: Listing and description of representative chemical data for YM zeolites.
    a. List the representative chemical data and their sources.
    b. Describe the known chemical trends for phases to determine the representative compositions to be used in modeling. From Zeolite'93.

3: Modeling of zeolite occurrences at Yucca Mountain.
    a. Observations of zeolite stability at Yucca Mountain
    b. Modeling of the conditions which result in stability of the primary zeolites (clinoptilolite, mordenite, analcime, and stellerite). From Zeolite '93, CMS paper.
    c. Modeling of the conditions which result in the stability of the rare zeolites (laumontite, chabazite, phillipsite, erionite). From Zeolite '93.
    d. Modeling specific to the formation of erionite at Yucca Mountain. From erionite letter report.
    e. Modeling addressing the clinoptilolite to analcime transition. From CMS paper
    f. Address the limited modeling on heulandite/stellerite stability.
    g. Compare and contrast field and modeling results on zeolite stability.

C. Analysis of illite/smectite stability

1: Transformation to illite

D. Silica Polymorphs

1. tridymite, opal-CT, or cristobalite to quartz transformation
   Knowing the kinetics of the transformation, cristobalite and quartz dissolution/precipitation kinetics, age of the formation, and the SiO2 abundance, can we calculate the temperature at various points in a drill hole (e.g., reproduce points on the geotherm of Bish and Aronson for the USW G-holes?). Estimate conversion of silica minerals under the thermal influence of a repository, effects on aqueous silica activity.
2. possible mobilization of silica in reflux zone, dissolution/precipitation affecting rock permeability.

E. Glass

F. Miscellaneous

Discussion of implications of mineral and glass transformation on the thermohydrologic history of Yucca Mountain

II. Kinetics of Mineral and Glass transformation at Yucca Mountain

Synthesis of experimental and field observations on kinetics of reactions.

A. Silica Polymorphs

1: Cristobalite to quartz transformation.
   a. Knowing the kinetics of the transformation, age of the formation, and the SiO_2 abundance, can we calculate the temperature at various points in a drill hole (e.g., reproduce points on the geotherm of Bish and Aronson for the USW G-holes?).
   b. Can we model the amount of silica conversion that YM may encounter?
2: Transformation of opal-CT and tridymite

B. Feldspar dissolution kinetics, effects on aqueous silica activity.

C. Clinoptilolite/Analcime

1: Dissolution-precipitation kinetics
2: Prediction of clinoptilolite to analcime reaction rates

D. Glass-discussion of implications for mineral and glass transformations.

III. Summary of results.

Implications for thermohydrology of Yucca Mountain, transport of radionuclides, integrity of the repository. Use of modeling to assess importance of thermal reactions.

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3.5 Equilibrium Chemical and Mineralogical Conditions

Under some scenarios, chemical equilibrium may be achieved. This is likely to be the case where heating rates are slow, fluid movement is minimal, and the duration of perturbed conditions is long. For this case, rock water interaction experiments, and EQ3/6 modeling, have been completed that provide preliminary bounds to the chemical and mineralogical state of the system. These results will be summarized, for studies completed since the Preliminary Near-Field Environment Report (PNFER).

3.5.1 Scenarios where equilibrium is likely

Identification of scenarios where chemical equilibrium may be achieved (heating rates are slow, fluid movement is minimal, and the duration of perturbed conditions is long).

3.5.2 Preliminary bounds on the chemical and mineralogical state of the system for these scenarios.

Information will be based on already completed rock water interaction experiments, and EQ3/6 modeling,. These results will be summarized for studies completed since the Preliminary Near-Field Environment Report (PNFER).

3.6 Kinetically Controlled Chemical and Mineralogical Conditions

Under conditions in which fluid velocities are high, or changes in temperature are relatively rapid, or perturbation of the system is short, chemical and mineralogical equilibrium may not be achieved. The chemical and mineralogical conditions achieved will, therefore, be a function of time, and the rate of reaction. Since the PNFER, we have completed several studies of reaction rates in laboratory and natural systems. The results of these studies will be summarized.

3.6.1 Scenarios where kinetics dominate

3.6.1 Identification of scenarios where kinetics rather than chemical and mineralogical equilibrium dominates. These will involve conditions in which fluid velocities are high, or changes in temperature are relatively rapid, or perturbation of the system is short.

3.6.2 Analyses of the chemical and mineralogical conditions as a function of time, and the rate of reaction (kinetics).

3.6.3 Laboratory and natural systems studies of reaction rates.

3.7 Testing Simulation Capabilities Using the New Zealand Process Natural Analogue

Extensive use has been made of the New Zealand geothermal site, where processes that will occur at Yucca Mountain, are occurring today under observable and measurable conditions. This work has focused on evaluating simulations strategies, and testing databases. This work will be summarized.

3.8 Coupled Geochemical and Hydrological Processes

Movement of water at elevated temperatures will result in chemical and mineralogical changes that will also modify hydrological parameters. Preliminary studies of these processes have been conducted through both laboratory and numerical simulation approaches. These preliminary results will be summarized.

3.9 Summary

The chemical and mineralogical conditions that may evolve in the NFE will be bounded, summarizing the results presented in the previous sections. An description of the work necessary to refine these bounds will be provided. This will be an update of and addtion to the material reported in the Preliminary Near Field Environment Report and where that material is appropriate it will not be repeated in Rev. 1.

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