UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

March 5, 2001

Mr. Ronald A. Milner, Chief Operating Officer
Office of Civilian Radioactive Waste Management
U. S. Department of Energy
1000 Independence Avenue, SW
Washington, DC 20585

SUBJECT: U.S. NUCLEAR REGULATORY COMMISSION'S OBSERVATION AUDIT REPORT NO. OAR-01-03, "OBSERVATION AUDIT OF THE OFFICE OF CIVILIAN RADIOACTIVE WASTE MANAGEMENT, QUALITY ASSURANCE DIVISION, AUDIT NO. M&O-ARP-01-02"

Dear Mr. Milner:

I am transmitting the U.S. Nuclear Regulatory Commission's (NRC's) Observation Audit Report (No. OAR-01-03), of the U.S. Department of Energy's (DOE's), Office of Civilian Radioactive Waste Management (OCRWM), Quality Assurance Division's,(OQA's), audit of activities regarding to the "Unsaturated Zone Flow and Transport Model Process Model Report" (UZ PMR). The UZ PMR was prepared by, and the supporting activities performed by, the OCRWM Management and Operating Contractor (M&O), and the U.S. Geological Survey. This audit was conducted on February 5 through 9, 2001, at the M&O facilities in Las Vegas, Nevada.

UZ PMR activities and selected Analysis Model Reports (AMRs) were previously audited on January 24 through 28, 2000, and at that time, several of the documents audited were in the process of being developed. The purpose of this performance-based audit was to evaluate the effectiveness of the implementation of the OCRWM Quality Assurance Program described in the Quality Assurance Requirements and Description document, and its implementing procedures for the UZ PMR and selected AMRs supporting the UZ PMR. Also, the audit evaluated action taken as a result of the findings and recommendations from the January 2000 UZ audit.

The NRC observers (observers) determined that this audit was effective in identifying potential deficiencies and recommending improvements for the PMR and AMRs reviewed. During the conduct of the audit, both the OQA audit team (audit team) and the observers independently reviewed applicable analysis reports and supporting data, models, and software.

Within the areas evaluated, the audit team identified four potential deficiencies, of which two were corrected during the conduct of the audit. Subsequent to the audit, one potential deficiency was resolved. The remaining potential deficiency identified procedure compliance problems with processing input transmittals for UZ PMR and AMR activities.

Although the UZ PMR appeared to satisfactorily compile the results of the supporting AMRs, the audit team made 20 recommendations regarding the content of AMR No. ANL-NBS-HS-000017 (U0085), "Analysis of Geochemistry Data," Revision 0, with Change Notice No. 1. Except for AMR No. U0085, there were very few audit team recommendations. Although not discussed during the audit nor the audit exit, the Division of Waste staff is concerned that the number of audit team recommendations for AMR No. U0085 may reflect some inattention to detail by the AMR preparers and reviewers.

As discussed in the attached report, the observers submitted four audit observer inquiries (AOIs) requesting clarification and information on audited documents. The AOIs addressed outstanding recommendations identified in the NRC observation report from the January 2000 UZ PMR audit activities.

Although the audit team identified some potential deficiencies, and four AOIs requesting clarification and information were generated, the observers believe that the AMRs and PMR reviewed during the audit were technically sound and that these products indicated an improving trend over several AMRs and PMRs audited during the past year. The observers agreed with the audit team's conclusions, findings, and recommendations presented at the audit exit.

During the audit, the observers met with the M&O personnel responsible for the qualification of data and software supporting the potential DOE site recommendation for a high-level waste repository. The observers were informed that as of January 30, 2001, 85 percent of the data and 97 percent of the software supporting site recommendation were fully qualified.

A written response to this letter and the enclosed report is not required; however, we do request that you respond to the four AOIs. The responses to the AOIs should be entered on the appropriate AOI form and forwarded either to the NRC Onsite Representatives or to Larry L. Campbell at NRC headquarters. If you have any questions, please contact Larry L. Campbell at (301) 415-5000.

Sincerely,
/RA/
C. William Reamer, Chief
High-Level Waste Branch
Division of Waste Management
Office of Nuclear Material Safety
and Safeguards

Enclosure: NRC Observation Audit Report
No. OAR-01-03, "Observation Audit
of the Office of Civilian Radioactive
Waste Management, Quality Assurance
Division, Audit No. M&O-ARP-01-02"

DISTRIBUTION:

File Center	PUBLIC ACNW	LSS	CNWRA	NMSS r/f	HLWB r/f	
SWastler	CGlenn	BMabrito	WBelke	RLatta	CWReamer	DWMr/f
JWinterle	TCarter	DBrooks	Tmatula	HArlt		

ADAMS Accession No. (later) **This document is Non-Sensitive**

DOCUMENT NAME: S/DWM/HLWB/llc/Unsaturated Zone Audit Observation Feb 2001.wpd ***See Previous concurrence**

OFC	HLWB		*Tech Editor		HLWB		HLWB			
NAME	LLCampbell	LLC	EKraus		NKStablein	NKS	CWReamer	CW		
DATE	02/23/01		02/22/01		03/02/01		03/5/01		01	

OFFICIAL COPY

ACNW: YES X NO ___ Delete file after distribution: Yes__ No __

1) This document should be made available to the PUBLIC. Yes - llc3

2) This document is related to the HLW program. It should be placed in the LSS. Yes - llc3

Although the UZ PMR appeared to satisfactorily compile the results of the supporting AMRs, the audit team made 20 recommendations regarding the content of AMR No. ANL-NBS-HS-000017 (U0085), "Analysis of Geochemistry Data," Revision 0, with Change Notice No. 1. Except for AMR No. U0085, there were very few audit team recommendations. Although not discussed during the audit nor the audit exit, the Division of Waste staff is concerned that the number of audit team recommendations for AMR No. U0085 may reflect some inattention to detail by the AMR preparers and reviewers.

As discussed in the attached report, the observers submitted four audit observer inquiries (AOIs) requesting clarification and information on audited documents. The AOIs addressed outstanding recommendations identified in the NRC observation report from the January 2000 UZ PMR audit activities.

Although the audit team identified some potential deficiencies, and four AOIs requesting clarification and information were generated, the observers believe that the AMRs and PMR reviewed during the audit were technically sound and that these products indicated an improving trend over several AMRs and PMRs audited during the past year. The observers agreed with the audit team's conclusions, findings, and recommendations presented at the audit exit.

During the audit, the observers met with the M&O personnel responsible for the qualification of data and software supporting the potential DOE site recommendation for a high-level waste repository. The observers were informed that as of January 30, 2001, 85 percent of the data and 97 percent of the software supporting site recommendation were fully qualified.

A written response to this letter and the enclosed report is not required; however, we do request that you respond to the four AOIs. The responses to the AOIs should be entered on the appropriate AOI form and forwarded either to the NRC Onsite Representatives or to Larry L. Campbell at NRC headquarters. If you have any questions, please contact Larry L. Campbell at (301) 415-5000.

Sincerely,

C. William Reamer, Chief
High-Level Waste Branch
Division of Waste Management
Office of Nuclear Material Safety
and Safeguards

Enclosure: NRC Observation Audit Report
No. OAR-01-03, "Observation Audit
of the Office of Civilian Radioactive
Waste Management, Quality Assurance
Division, Audit No. M&O-ARP-01-02"

Letter to R. Milner from C.W. Reamer dated: March 5, 2001

cc:

R. Loux, State of Nevada
S. Frishman, State of Nevada
L. Barrett, DOE/Washington, DC
A. Brownstein, DOE/Washington, DC
S. Hanauer, DOE/Washington, DC
C. Einberg, DOE/Washington, DC
J. Carlson, DOE/Washington, DC
N. Slater, DOE/Washington, DC
A. Gil, YMPO
R. Dyer, YMPO
S. Brocoum, YMPO
R. Clark, YMPO
S. Mellington, YMPO
C. Hanlon, YMPO
T. Gunter, YMPO
K. Hess, BSC
D. Krisha, BSC
S. Cereghino, BSC
M. Voegele, BSC/SAIC
S. Echols, Winston & Strawn
B. Price, Nevada Legislative Committee
J. Meder, Nevada Legislative Counsel Bureau
D. Bechtel, Clark County, NV
E. von Tiesenhausen, Clark County, NV
A. Kalt, Churchill County, NV
G. McCorkell, Esmeralda County, NV
L. Fiorenzi, Eureka County, NV
A. Johnson, Eureka County, NV
A. Remus, Inyo County, CA
M. Yarbro, Lander County, NV
R. Massey, Lander County, NV
J. Pitts, Lincoln County, NV
M. Baughman, Lincoln County, NV
A. Funk, Mineral County, NV
J. Shankle, Mineral County, NV
L. Bradshaw, Nye County, NV
M. Murphy, Nye County, NV
J. McKnight, Nye County, NV
D. Weigel, GAO
W. Barnard, NWTRB
R. Holden, NCAI
A. Collins, NIEC
R. Arnold, Pahrump County, NV
J. Larson, White Pine County
R. Clark, EPA
F. Marcinowski, EPA
R. Anderson, NEI
R. McCullum, NEI
S. Kraft, NEI
J. Kessler, EPRI
D. Duncan, USGS
R. Craig, USGS
W. Booth, Engineering Svcs, LTD
J. Curtiss, Winston & Strawn
N. Rice, NV Congressional Delegation
T. Story, NV Congressional Delegation
J. Reynoldson, NV Congressional Delegation
S. Joya, NV Congressional Delegation
J. Pegues, City of Las Vegas, NV
L. Lehman, T-Reg, Inc.

U.S. NUCLEAR REGULATORY COMMISSION

OBSERVATION AUDIT REPORT NO. OAR-01-03

"OBSERVATION AUDIT OF THE

OFFICE OF CIVILIAN RADIOACTIVE WASTE MANAGEMENT

OFFICE OF QUALITY ASSURANCE

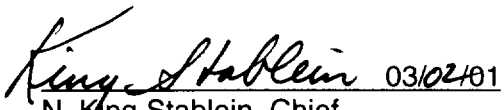
AUDIT NO. M&O-ARP-01-02"

/R/ 02/27/01
Robert Latta
Repository Site Section
High-Level Waste Branch
Division of Waste Management

/R/ 02/27/01
Hans Arlt
Repository Site Section
High-Level Waste Branch
Division of Waste Management

/R/ 02/26/01
James Winterle
Center for Nuclear Waste Regulatory
Analyses

Reviewed and Approved by:



03/02/01
N. King Stablein, Chief
Projects and Engineering Section
High-Level Waste Branch
Division of Waste Management

Enclosure

1.0 INTRODUCTION

Staff from the U.S. Nuclear Regulatory Commission (NRC) Division of Waste Management and contractors from the Center for Nuclear Waste Regulatory Analyses (CNWRA) observed the U.S. Department of Energy's (DOE's), Office of Civilian Radioactive Waste Management (OCRWM), Quality Assurance Division's (OQA's), audit of activities regarding to the "Unsaturated Zone Flow and Transport Model Process Model Report" (UZ PMR). The UZ PMR was prepared by and the supporting activities performed by the OCRWM Management & Operating Contractor (M&O) and the U.S. Geological Survey (USGS). This audit, M&O-ARP-01-02, was conducted on February 5-9, 2001, at the M&O facilities in Las Vegas, Nevada.

The UZ PMR activities and selected Analysis Model Reports (AMRs) were previously audited on January 24-28, 2000 (OQA Audit No. M&O-ARP-00-04), and at that time, several of the documents audited were still in the process of being developed. The purpose of this audit was to evaluate the implementation of the applicable provisions contained in the OCRWM Quality Assurance Requirements and Description (QARD), DOE/RW-0333P, Revision 10, by evaluating the UZ PMR and selected AMRs supporting the UZ PMR. Also, the audit evaluated action taken as a result of the findings and recommendations from the January 2000 UZ audit. During the audit, the PMR and four AMRs were subjected to a technical evaluation as well as evaluation to ensure that the applicable programmatic requirements contained in the QARD and implementing procedures were met.

The NRC observers' (observers') objective was to assess whether the M&O, USGS, and OQA are properly implementing the provisions contained in the QARD and the requirements contained in Subpart G, "Quality Assurance," to Part 60, of Title 10 of the U.S. Code of Federal Regulations (10 CFR Part 60). Because of the anticipated DOE submittal of the Site Recommendation (SR) for a high-level waste repository, the following observation activities were emphasized: 1) confirming that data, software, and models supporting SR are properly qualified; 2) evaluating the progress being made by DOE and its contractors in meeting the data and software qualification goals for SR; and 3) ensuring the technical adequacy of the PMR and AMRs within the scope of the OQA audit.

This report addresses the observers' determination of how effective the OQA audit was, and whether the M&O implemented adequate QARD controls in the audited areas of the UZ PMR and the adequacy of implementation of QARD controls by the M&O in the audited areas of UZ PMR and AMR development.

2.0 MANAGEMENT SUMMARY

The observers agreed with the audit team's (audit team's) conclusions, findings, and recommendations. The observers determined that OQA Audit M&O-ARP-01-02 was well-planned and effectively implemented. The audit team members were independent of the activities they audited and were knowledgeable in the quality assurance (QA) and technical disciplines within the scope of the audit. The audit team qualifications were reviewed and were found acceptable.

Within the areas evaluated, the audit team identified four potential deficiencies. Two deficiencies were corrected during the audit; one was determined, subsequent to the audit, not to be a deficiency; and the following potential deficiency remained open: input transmittals were not processed in accordance with procedure. The audit team made several recommendations about the content of the documents reviewed including: a) justification for selection of base-case models over alternative models; b) exemption of a software package from procedure requirements; and c) several recommendations, for the AMR, addressing the analysis of geochemistry data, including changes in text of the AMR to improve traceability, transparency, justification of assumptions, clarity of the AMR purpose, and the need for additional discussion of alternative models (see Section 4.5.3 of this report).

As discussed in the attached report, the observers submitted four audit observer inquiries (AOIs) requesting clarification and information on audited documents. The AOIs addressed outstanding recommendations identified in the NRC observation report from the January 2000 UZ audit.

Although the audit team identified some potential deficiencies, and four AOIs requesting clarification and information were generated, the observers believe that the AMRs and PMR reviewed during the audit were technically sound and that these products indicated an improving trend over several AMRs and PMRs audited during the past year.

Overall, the audit team concluded that the OCRWM QA program had been satisfactorily implemented in the areas evaluated. The observers generally agreed with the audit team's conclusion.

3.0 AUDIT PARTICIPANTS

3.1 Observers

Robert Latta	Team Leader	NRC
Hans Arlt	Technical Specialist	NRC
James Winterle	Technical Specialist	CNWRA

3.2 OQA Audit Team

Robert Hartstern	Audit Team Leader	OQA/Quality Assurance Technical Support Services (OQA/QATSS)
Samuel Archuleta	Auditor	OQA/QATSS
Robert Hasson	Auditor	OQA/QATSS
Richard Powe	Auditor	OQA/QATSS
Richard Weeks	Auditor	OQA/QATSS
Keith Kersch	Technical Specialist	SAIC
Thomas Doe	Technical Specialist	Management & Technical Services
Levy Kroitoru	Technical Specialist	Management & Technical Services

4.0 REVIEW OF THE AUDIT AND AUDITED ORGANIZATION

This OQA audit of the M&O was conducted in accordance with OCRWM Quality Assurance Procedure (QAP) 18.2, "Internal Audit Program," and QAP 16.1Q, "Performance/Deficiency Reporting." The NRC staff's observation of this audit was based on NRC Manual Chapter 2410, "Conduct of Observation Audits," dated July 12, 2000.

4.1 Scope of the Audit

The UZ PMR activities and selected AMRs were previously audited on January 24-28, 2000, and at that time, several of the documents audited were in the process of being developed. The audit team conducted a limited-scope, performance-based audit of activities and processes related to the development of the AMRs supporting the UZ PMR. Audit activities included evaluation of the UZ PMR, four AMRs, selected software, and associated data. The audit also included review of the programmatic controls governing the AMRs and technical requirements contained in the AMRs. Further, the audit evaluated action taken as a result of the findings and recommendations from the January 2000 UZ PMR audit.

The implementation of the following procedures for the audited activities, and the preparation of the following AMRs and the UZ PMR were evaluated by the audit team and the observers during the audit:

Procedures

a) AP-2.1Q, "Indoctrination and Training of Personnel," Revision 0, with Interim Change Notice (ICN) No. 0

b) AP-2.2Q "Establishment and Verification of Required Education and Experience of Personnel," Revision 0, with ICN No. 0

c) AP-2.13Q, "Technical Product Development Planning," Revision 0, with ICN No. 4

d) AP-2.14Q, "Review of Technical Products," Revision 1, with ICN No. 1

e) AP-2.15Q, "Work Package Planning Summaries," Revision 0, with ICN No. 1

f) AP-3.4Q, "Level 3 Change Control," Revision 2, with ICN No. 0

g) AP-3.10Q, "Analysis and Models," Revision 2, with ICN No. 3

h) AP-3.11Q, "Technical Reports," Revision 1, with ICN No. 1

i) AP-3.14Q, "Transmittal of Input," Revision 0, with ICN No. 2

j) AP-3.15Q, "Managing Technical Product Inputs," Revision 2, with ICN No. 0

k) AP-3.17Q, "Impact Reviews," Revision 1, with ICN No. 0

l) AP-SI.1Q, "Software Management," Revision 2, with ICN No. 4, ECN No. 1

m) AP-SIII-1Q, "Scientific Notebooks," Revision 1, with ICN No. 0

n) AP-SIII.2Q, "Qualification of Unqualified Data and the Documentation of Rationale for Accepted Data," Revision 0, with ICN No. 2

o) AP-SIII.3Q, "Submittal and Incorporation of Data to the TDMS," Revision 0, with ICN No. 3

p) AP-SV.1Q, "Control of the Electronic Management of Data," Revision 0, with ICN No. 2

q) QAP-2.0, "Conduct of Activities," Revision 0

r) QAP 16.1Q, "Management of Conditions Adverse to Quality," Revision 4, with ICN No. 1

s) QAP-18.1Q, "Auditor Qualification," Revision 6, with ICN No. 0

t) QAP-18.2Q, "Internal Audit Program," Revision 8, with ICN No. 0

u) AP-2.21, "Quality Determinations and Planning for Scientific, Engineering, and Regulatory Compliance Activities," Revision 0

PMR

a) TDR-NBS-HS-000002, "Unsaturated Zone Flow and Transport Process Model Report," Revision 00, with ICN No. 02

AMRs

a) U0010 (ANL-NBS-HS-00032), "Simulation of Net Infiltration for Modern and Potential Future Climates," Revision 00, with ICN No. 01

b) U0085 (ANL-NBS-HS-000017), "Analysis of Geochemistry Data," Revision 00, with ICN No. 01

c) U0110/N0120 (MDL-NBS-HS-000001), "Drift Scale Coupled Processes (DST and THC Seepage) Models," Revision 01

d) U0175 (MDL-NBS-GS-000011), "Future Climate Analysis - 10,000 Years To 1,000,000 Years After Present," Revision 00

4.2 Conduct and Timing of the Audit

The audit was performed effectively and the audit team demonstrated a sound knowledge of the applicable M&O and DOE programs and procedures. Audit team members conducted thorough interviews, they challenged responses, when appropriate, and they effectively employed their detailed audit checklists. The observers concluded that the timing of the audit was appropriate for the auditors to evaluate ongoing UZ PMR activities. The audit team and the observers caucused at the end of each day. Meetings between the audit team and M&O management (with the observers present) were also held to discuss the current audit status and preliminary findings.

4.3 Audit Team Qualification and Independence

The qualifications of the audit team leader and the audit team were reviewed for accuracy and completeness in accordance with the requirements of Procedure QAP 18.1, "Auditor Qualification." The observers' review included an examination of the training, education, and experience of the audit team members. The observers concluded that the audit team members, including the technical specialists, had the necessary expertise and were well-prepared to audit the subject matter in the PMR and AMRs.

4.4 Examination of QA Elements

The OQA programmatic and technical audit activities were conducted simultaneously using sub-audit teams generally consisting of at least one technical specialist and one QA auditor. Often during the audit, certain programmatic aspects of the documents audited were independently reviewed by a audit team member. The observers determined that the limited-scope audit focused on the QA elements closely associated with the development of the AMRs. The observers evaluated the audit team's review of the following QA elements.

4.4.1 AP-2.13Q, "Technical Product Development Planning"

The audit team reviewed technical development plans and work product planning sheets applicable to the subject AMRs. In addition, the audit team reviewed the methodology for the product development, including the tracking of unresolved issues such as inputs requiring qualification, to be verified (TBV). The observers agreed with the audit team's findings in this area and made no additional findings nor observations.

4.4.2 AP-SI.1Q, "Software Management"

Software controls associated with the UZ PMR and AMRs were discussed during each of the technical interviews. The audit team reviewed qualification documentation and determined that the requirements of the software management procedure had been met, with the exception of computer software package ARCINFO, Version 6.1.2, for AMR No. U0010, on infiltration. However, the audit team concluded, that use of the ARCINFO software was limited to visual display of data. Therefore, the audit team recommended that the use of the ARCINFO software be evaluated to determine if it is exempt from AP-SI.1Q because of its use in the AMR. Notwithstanding this recommendation, the audit team made a positive comment that software routines in the AMR No. U0010 were well-documented. The observers agreed with the audit team findings in this area and made no additional observations nor inquiries.

4.4.3 AP-3.15Q, "Managing Technical Product Inputs"

Each of the AMRs examined included document input reference sheets that list the inputs to and references cited in the AMR. The document input reference sheets also identify the status of the input (e.g., qualified, TBV). The audit team examined the TBV status and determined that it generally included the appropriate statements in accordance with the "Analysis/Model Documentation Outline." The observers agreed with the audit team findings in this area and made no additional findings nor observations.

4.4.4 AP-3.10Q, "Analysis and Models"

The audit team used Procedure No. Ap-3.10Q to evaluate the activities covered during the audit. By definition, this procedure applies to activities pertaining to the development, documentation, checking, review, approval, and revision of analyses or models, and the calibration, validation, or use of models to support scientific, engineering, or performance-assessment work activities.

The audit team generally concluded that the requirements of Procedure AP-3.10Q had been appropriately implemented for AMR Nos. U0010, U0085, U0175, and U0110/N0120. The observers agreed with the audit team findings in this area and made no additional findings nor observations.

4.4.5 AP-2.14Q, "Review of Technical Products"

The observers held discussions with cognizant individuals in the Data/Software Qualification Department and reviewed selected data tracking number (DTN) sets to gain insights into the verification methodology to resolve TBVs. As a result of reviews and discussions, the observers determined that significant progress was being made. The observers were informed that on January 31, 2001, approximately 85 percent of the data and 97 percent of the software supporting site recommendation were fully qualified.

4.4.6 Potential Deficiencies

The audit team identified the following potential deficiencies:

One potential deficiency identified that the Technical Data Management System (TDMS) database access list was not being submitted to the Records Processing System, as required by Procedure No. AP-S.III.3Q. Subsequent to the audit exit, the audit team determined that the TDMS access list was maintained electronically and that Procedure No. AP-S.III.3Q had been satisfied because the access list was being electronically submitted.

The second potential deficiency identified two examples where the responsible M&O manager failed to follow the provisions contained in Paragraph 5.4.3 of Procedure No. AP-3.14Q. Specifically, the responsible manager failed to sign a copy of the PMR and AMR input transmittal and forward the completed transmittal to the Input Tracking Coordinator. These two examples of this deficiency were corrected during the conduct of the audit. However, as a result of these two examples, the audit team performed additional reviews and identified additional examples of the apparent failure to follow procedure. As a result of the investigation of the input transmittals referenced in the UZ PMR, the audit team issued a potential deficiency to evaluate the extent of this condition.

4.5 Examination of Technical Activities

The technical specialists on the audit team performed detailed reviews of the technical adequacy of the UZ PMR and AMRs audited. The observers assessed the audit team's performance of these reviews and were given an opportunity to perform a review of the

technical adequacy of the documents. Also, the observers were given an opportunity to ask questions during the audit.

As discussed in the following paragraphs, the observers generally agreed with the audit team findings in this area; however, the observers identified and discussed a few areas of concern, as discussed in the following sections, with the audit team.

4.5.1 PMR No. TDR-NBS-HS-000002, "Unsaturated Zone Flow and Transport Model," Revision 00, ICN 02

The UZ PMR documents the integration of outputs from submodels for climate, infiltration, unsaturated flow, drift seepage, and radionuclide transport to develop a simplified, yet robust approach for considering these processes in total-system performance assessments.

The audit team technical specialist assigned to review the UZ PMR was well-prepared to conduct the audit. The PMR originator and cognizant PMR-development staff were available to answer the audit team's technical questions and provide information about software, data, and model documentation. The audit team technical specialist emphasized the importance of understanding how data outputs from the various submodels are treated to become input for the process model and other submodels. The audit team made two recommendations in this area: 1) justification should be provided for selecting the transport model with matrix diffusion over an alternative model with no matrix diffusion, because the use of matrix diffusion over no matrix diffusion in the transport models is not justified either in the PMR or in the supporting AMRs; and 2) review other alternative models in the PMR and add statements of justification for their exclusion, as necessary. The NRC observers agreed with the audit team recommendations.

Several questions were focused on understanding how the "active fracture" concept is used to scale the effective fracture-matrix interface area as a function of percolation flux. An observer noted that since fracture-matrix interface area is greatly reduced by the active-fracture model, it seemed surprising that sensitivity studies show the process of matrix diffusion significantly delays transport of radionuclides to the water table. The observers discussed that since matrix diffusion is emerging as an important process, there is a strong need to verify that the active-fracture and matrix-diffusion models are properly integrated. During ensuing discussions, the audit team technical specialist suggested that a study of the sensitivity of the transport model to the active fracture parameter would be a useful. Also, the observers suggested that a sensitivity study be carried out showing that the active-fracture and matrix-diffusion models are properly integrated. The PMR authors agreed that this sensitivity study would enhance confidence in the model.

4.5.2 AMR No. U0010 (ANL-NBS-HS-000032), "Simulation of Net Infiltration for Modern and Potential Future Climates," Revision 00, ICN 01

This AMR produces spatially heterogeneous infiltration maps of average, high, and low infiltration rates for modern, monsoonal, and glacial transition climates for Yucca Mountain. The estimates of net infiltration are used for defining the upper boundary condition for the site-scale 3-dimensional flow model for the unsaturated zone.

The audit team technical specialist assigned to review this AMR was well-prepared to conduct the audit. The AMR checker and cognizant AMR-development staff were available to answer the audit team's technical questions and provide information about software, data, and model documentation. The technical specialist's questions were focused on the editorial changes that had been made since the last revision, and on the method of tracking the changes. The audit team did not identify any technical deficiencies in this AMR. The observers agreed with the audit team's findings.

The observers evaluated whether recommendations made during a previous audit (NRC's Observation Audit Report No. OAR-00-04) were adequately addressed. The observer concluded that all but four of the previous recommendations were incorporated into the Infiltration AMR. The four exceptions are summarized as follows: 1) provide a technical basis for predicting how future climate might affect vegetation cover, and therefore infiltration, at Yucca Mountain; 2) validate assumptions stated in the distributed-parameter water-balance model to ensure that mean annual shallow infiltration estimates are not under-predicted; 3) provide a justification for not using time-steps smaller than 24 hours when performing surface-water flow routing and calculating daily net infiltration; and 4) describe how a previous infiltration model report (Flint et al., 1996, as identified in Section 6.0 of this report) was used in the Infiltration AMR. The audit team identified, as a concern, the unqualified nature of the Flint, et al. (1996) report during the previous audit of this particular AMR, in January 24-28, 2000. This concern was identified, as such, in the OCRWM QA Audit Report M&O APR-00-04. The AMR checker commented that the revised AMR supplants the Flint, et al. (1996) report entirely; however, the stated purpose in the AMR is that it "...describes enhancements made to the infiltration model documented in Flint, et al. (1996) and documents an analysis using the enhanced model." Further, it was discussed that Flint, et al. (1996) is also used as a reference for many assumptions asserted in the revised Infiltration AMR. The observers generated four AOIs to document these omitted recommendations. Section 5.1 of this report provides additional detailed discussion on these four AOIs.

At the time of the AMR revision, an analysis of model sensitivity to uncertainty in input parameters and of the impact of parameter accuracy on model results, for this AMR, was not complete. Considering the relatively high level of uncertainty associated with the infiltration model results, the observers emphasized that this analysis needs to be completed and documented as provided for on Page 77 of the AMR.

4.5.3 AMR No. U0085 (ANL-NBS-HS-000017), "Analysis of Geochemistry Data," Revision 00, ICN 01

This AMR provides a summary of geochemistry data for the UZ at Yucca Mountain that are derived from a variety of sources. None of the data in this AMR is used as direct input to other AMRs or the UZ PMR. Rather, the data are used for model validation or to support conceptual model development.

The audit team technical specialist assigned to review this AMR was well-prepared to conduct the audit. The AMR originator and cognizant AMR-development staff were available to answer the audit team's technical questions and provide information about software, data, and model documentation.

During the audit, the observers raised a concern regarding infiltration estimates, in the AMR, that are based on the chloride mass balance (CMB) method. Specifically, Assumption No. 19 in Table 2 of the AMR states that the CMB approach is assumed to be valid for flow in a fractured-rock system. This assumption was listed as TBV, but the observer questioned whether this assumption can be verified since the CMB approach is applicable to plug flow in a homogenous porous medium. In ensuing discussion it was agreed that this assumption results in a limitation that the CMB infiltration estimates in this AMR represent lower-bounds. This limitation was acknowledged in the text of the AMR. Also, the observer found that the CMB infiltration estimates in this AMR were not used for input to, or validation for, any other AMR or PMR. This was a discussion of whether it may be possible to close the TBV status of Assumption No. 19, because the resulting limitations are acknowledged and made clear to potential end users of the CMB analysis. The audit team technical specialist recommended that an approach should be developed to address the TBV status of assumptions in this AMR. The observer asked how the TBV status of this assumption is tracked; an M&O staff member demonstrated how assumptions are tracked through the DIRS system. The observer found that Assumption No. 19 from this AMR was listed in the DIRS system with the identifier TBV-4766, and appropriate points of contact were listed.

No deficiencies were identified in this AMR; however, the technical specialist made several formal recommendations for improving the traceability, transparency, defensibility, and reproducibility of the analyses in this AMR. Although the UZ PMR appeared to satisfactorily compile the results of the supporting AMRs, the audit team made 20 recommendations regarding the content of AMR No. U0085. Except for AMR No. U0085, there were very few audit team recommendations. Although not discussed during the audit nor the audit exit, the DWM staff is concerned that the number of audit team recommendations for AMR No. U0085 may reflect some inattention to detail by the AMR preparers and reviewers. The observers agree with the audit team findings and recommendations.

4.5.4 AMR No. U0110/N0120 (MDL-NBS-HS-000001), "Drift-Scale Coupled Processes (DST and THC Seepage) Models," Revision 01

The purpose of this AMR is to provide the framework to evaluate THC coupled processes at the drift scale, to predict flow and transport behavior for specified thermal loading conditions, and predict the chemistry of waters and gases entering potential waste-emplacement drifts.

The audit team technical specialist assigned to review this AMR was well-prepared to conduct the audit. The AMR originator and cognizant AMR-development staff were available to answer the audit team's technical questions and provide information about software, data, and model documentation.

For this AMR, the scope of the audit team review was limited to evaluating whether recommendations made during a previous audit (OCRWM Audit Report M&O-ARP-00-08) were adequately addressed. The technical specialist concluded that most of the previous recommendations have been incorporated into the current AMR and he complimented the originator on a much improved document. The technical specialist made some minor suggestions, such as incorporation of an additional reference and confirmation of an assumption regarding the percentage of heat removal for modeling the drift-scale heater test.

An observer asked if confirmation of this assumption is being tracked. The AMR originator was able to show the observer that the assumption in question is listed in the DIRS as TBV and will be closed on completion of an ongoing study.

The audit team did not identify any deficiencies in this AMR. The observers agree with the audit team's findings.

4.5.5 AMR No. U0175 (ANL-NBS-GS-000011), "Future Climate Analysis - 10,000 Years To 1,000,000 Years After Present," Revision 00

The purpose of this AMR is to provide input to the infiltration model of Yucca Mountain for the period from 10,000 to 1,000,000 years after closure of the proposed repository. Key inputs include calcite mineral data from Devil's Hole, south of Yucca Mountain, and fossil records from lake-bed sediments from Owen's Lake, CA. The technical approach taken for this AMR is patterned after a similar AMR developed for the postclosure period from zero to 10,000 years.

The technical specialist was well-prepared to conduct the audit. The AMR originator and cognizant AMR-development staff were available to answer the audit team's technical questions and provide information about software, data, and model documentation.

The AMR was in draft form at the time of the audit, undergoing the late stages of the technical review process. This gave the audit team an opportunity to evaluate the technical review and revision processes as specified in AP-3.10Q.

The technical specialist's questions were focused on the traceability, transparency, defensibility, and reproducibility of model inputs and outputs. One concern the audit team technical specialist raised was that the AMR did not address how future climate might affect vegetation cover at Yucca Mountain. The audit team questioned whether there is sufficient technical basis for the parameters in the infiltration model that are used to account for vegetation changes during future climates. The AMR originator answered that climate-induced changes in vegetation were beyond the scope of this AMR. The effects of climate on vegetation, and hence, infiltration, are addressed in the AMR on infiltration, which was also reviewed during the audit (see Section 4.5.2 of this report).

The audit team did not identify any deficiencies for this AMR that had not already been noted during the technical review process. The audit team commended the originators and checkers for compliance with the AP-3.10Q technical review process. Specifically, the auditors were impressed with the word-processing approach that provided color-coded reviewer comments, made it easy to see which portions of AMR text were affected, and also provided a convenient summary of all comments. The observers agree with the audit team's findings.

5.0 NRC STAFF FINDINGS

The observers determined that OQA Audit M&O-ARP-01-02 was effective in determining the level of compliance of M&O activities associated with the subject AMRs. The observers agreed with the audit team's conclusion that the OCRWM QA program had been satisfactorily implemented except for the identified potential deficiencies. The following sections address the observers' findings.

5.1 NRC Audit Observer Inquiries

The following AOIs were generated during the audit:

a) AOI No. M&O-APR-01-02-1, dated February 9, 2001, was written to identify an observer inquiry for ANL-NBS-HS-00032. The AOI states: "Arbitrary upper-bound vegetation cover percentages and bedrock root-zone thicknesses were assigned: 20% and 2.0 m for the modern climate; 40% and 2.5 m for the monsoon climate and 60% and 3.0 m for the glacial transition climate. A more detailed discussion of the assumed values is needed since the values may be excessive, thus leading to an over-prediction of ET and under-prediction of shallow infiltration. (Refer to U.S. NRC's Observation Audit Report No. OAR-00-04)."

b) AOI No. M&O-APR-01-02-2, dated February 9, 2001, was written to identify an observer inquiry for ANL-NBS-HS-00032. The AOI states: "The instantaneous flow routing (IFR) method assumes that the duration of surface-water flow at Yucca Mountain is less than 24 hours and episodic in nature. This assumption is the basis for not using time-steps smaller than 24 hours when performing surface-water flow routing and calculating daily net infiltration. Please provide the NRC with adequate justification. (Refer to U.S. NRC's Observation Audit Report No. OAR-00-04)."

c) AOI No. M&O-APR-01-02-3, dated February 9, 2001, was written to identify an observer inquiry for ANL-NBS-HS-00032. The AOI states: "An implicit assumption of the distribution-parameter water-balance model is that capillarity is not an important component of UZ flow processes for the objective of estimating annual average infiltration rates in the semi-arid climate of Yucca Mountain. The INFIL ver. 2.0 contains both the distribution-parameter water-balance module and the Richards module and could readily be used to confirm the basis for this assumption for a small scale region. The NRC recommends that the assumptions in the distribution-parameter water-balance model be validated by comparison against a numerical Richards equation-based code to assure that mean annual shallow infiltration estimates are not under-predicted. (Refer to U.S. NRC's Observation Audit Report No. OAR-00-04)."

d) AOI No. M&O-APR-01-02-4, dated February 9, 2001, was written to identify an observer inquiry for ANL-NBS-HS-00032. The AOI states: "The work upon which this model is based (Flint, et al., 1996, "Conceptual and Numerical Model of Infiltration at Yucca Mountain") is unqualified. (See OCRWM QA Audit Report M&O APR-00-04)(p. 9). Was information used to support conclusions made in the Infiltration AMR? If yes, describe

how the Flint, et al. (1996) data were qualified and assumptions verified. NRC requests additional information and details. (Refer to U.S. NRC's Observation Audit Report No. OAR-00-04)."

5.2 NRC Audit Exit Summary

During the audit exit, the observers expressed appreciation for the excellent cooperation and responsiveness provide to them during their observation activities. Also, the observers stated that they agreed with the audit team findings and recommendations, as presented at the audit exit. Also, the observers identified that they had provided the audit team four audit observer inquiries. Further, it was explained that these inquiries related to the subject of net infiltration as discussed in AMR No.U0010, and that these inquiries had been discussed with the audit team and cognizant technical leads.

Although not directly within the scope of the UZ PMR audit, the observers became aware of a project initiative that may roll up technical information related to the consideration of cool repository design referred to as an "Integrated AMR." The observers stated that DWM staff would appreciate a presentation to better understand the proposed Integrated AMR and proposed that this presentation be discussed at the next quarterly management meeting in March 2001.

Except for AMR No. U0085, there were very few audit team recommendations. Although not discussed during the audit nor the audit exit, the Division of Waste Management staff is concerned that the 20 audit team potential recommendations for AMR No. U0085, identified by the audit team and discussed in Section 4.5.3 of this report, may reflect some inattention to detail by the AMR preparers and reviewers.

6.0 References

Flint, A.L.; J.A. Hevesi, and L.E. Flint, *Conceptual and Numerical Model of Infiltration for the Yucca Mountain Area, Nevada*, Milestone 3GUI623M, 1996. Denver, Colorado: U.S. Geological Survey, ACC: MOL.19970409.0087

U.S. Nuclear Regulatory Commission's Observation Audit Report No. OAR-00-04, "Observation of the Office of the Civilian Radioactive Waste Management, Quality Assurance Division, Audit No. M&O-ARP-00-004," March 20, 2000