Scientific Analysis/Calculation Error Resolution Document

Complete only applicable items.

INITIATION

1. Originator:	2. Date:	3. ERD No.
Carl Axness/Peter Persoff	07/31/2008	ANL-NBS-GS-000008 ERD 01

4. Document Identifier:	5. Document Title:
ANL-NBS-GS-000008 REV 01	Future Climate Analysis

6. Description of and Justification for Change (Identify applicable CRs and TBVs):

I Background Information Summary

This ERD has been prepared to resolve CRs 9292 and 10226. The eight issues of CR 9292 were identified in the file "CR Issues from CR-6334 Evaluation of ANL-NBS-GS-000008.doc", which is attached to CR 9292. In Section III, each issue is repeated in italics, followed by an analysis of the issue and the change to be made in the AMR (ANL-NBS-GS-000008 REV 01). CR 10226 is addressed after CR 9292.

II. Inputs and Software

No new assumptions or software are used to support the analysis in this ERD. One input that is changed to direct input is qualified in accordance with SCI-PRO-001.

Three new references ~~is~~ are to be added to Section 8.1: 5/14/08

[DIRS 183041] SNL (Sandia National Laboratories) 2008. *Features, Events, and Processes for the Total System Performance Assessment: Analyses.* ANL-WIS-MD-000027 REV 00. Las Vegas, Nevada: Sandia National Laboratories. ACC: DOC.20080307.0003; DOC.20080407.0009.

This added reference is cited in the qualification of Thompson et al. 1999 [DIRS 109740].

(Continued on following pages)

CONCURRENCE

	Printed Name	Signature	Date
7. Checker	Charles Haukwa		08/04/08
8. QCS/QA Reviewer	Sounia Kassabian Darnell	Sounia K. Darnell	08/04/2008

APPROVAL

9. Originator	Carl Axness Peter Persoff	Carl Axness Peter Persoff	08/04/2008 08/01/2008
10. Responsible Manager	Robert MacKinnon	for RJM	8.12.08

(Continued from Block 6)

[DIRS 177081] SNL (Sandia National Laboratories) 2006. *Data Analysis for Infiltration Modeling: Extracted Weather Station Data Used to Represent Present-Day and Potential Future Climate Conditions in the Vicinity of Yucca Mountain.* ANL-MGR-MD-000015 REV 00. Las Vegas, Nevada: Sandia National Laboratories. ACC: DOC.20070109.0002.

[DIRS 176100] SN0512NOAADATA.003. NOAA Weather Station Data for Beowawe, NV (1982-2004), Delta, UT (1968-2004), Hobbs, NM (1947-2004), Nogales, AZ (1948-1983), Rosalia, WA (1949-2004), St. John WA, (1963-2004), and Spokane, WA, (1948-2004). Submittal date: 12/12/2005.

These references are added in Section 6.6.2.

III. Analysis and results

This section analyzes the issues in CRs 9292 and 10226, and presents changes to be made to the parent document, ANL-NBS-GS-000008 REV 01. The conclusions and output are unchanged.

CR 9292 Evaluation

Issue 1: *In DTN: GS000100001221.001, the values were not listed in the AMR or the Product Output DTNs, so there is no way to compare values.*

Analysis: The values referred to are the mean annual precipitation (MAP) and mean annual temperature (MAT) characterizing various locations discussed in the text of the AMR, including locations representing future climates. The MAP and MAT criteria for selecting these locations are discussed in Section 6.6.2. Table 6-2 is added to provide these values, taken from DTN: GS000100001221.001.

Change to the AMR:

Insert the following text between the first and second paragraphs of Section 6.6.2, on p. 6-46:

> Selection of locations to represent future climate states is based upon criteria of MAP and MAT and occurrence at the present time of indicator ostracode species, as discussed in this section. MAP and MAT data for meteorological stations, taken from DTN: GS000100001221.001 [DIRS 146816], are summarized in Table 6-2. Note that the MAP and MAT values in *Data Analysis for Infiltration Modeling: Extracted Weather Station Data Used to Represent Present-Day and Potential Future Climate Conditions in the Vicinity of Yucca Mountain*, ANL-MGR-MD-000015 REV 00 [DIRS 177081], Tables 7.1-1 through 7.1-3, are based on a different DTN: SN0512NOAADATA.003 [DIRS 176100] which has a longer period of record. However the difference between the two data sets does not affect the selection of future climate proxy sites.

Table 6-2. Meteorological data for stations discussed in text.

Station	Proxy for climate	MAP (in/yr)[a]	MAP (mm/yr)	Average daily maximum temperature (°F)[b]	Average daily minimum temperature (°F)[b]	MAT (°C)[c]
Lordsburg, NM	(not a proxy site)	11.20	284	78.4	43	16.0
Nogales, AZ	Monsoon Upper Bound	16.3	414	79	42	15.8
Hobbs, NM	Monsoon Upper Bound	16.44	418	76.5	47.8	16.8
Spokane, WA	Glacial Transition Upper Bound	17.79	452	60.3	39.5	9.9
Rosalia, WA	Glacial Transition Upper Bound	18.1	460	60.9	36.1	9.2
St. John, WA	Glacial Transition Upper Bound	17.06	433	60.9	35.8	9.1
Beowawe, NV	Glacial Transition Lower Bound	8.64	219	65.	30.8	8.8
Delta, UT	Glacial Transition Lower Bound	7.79	198	65.4	34.8	10.1

[a]Values in inches per year, as reported in source DTN

[b]Values in Fahrenheit, as reported in source DTN

[c]Mean of average daily maximum temperature and average daily minimum temperatures, converted to Celsius

SOURCE: DTN: GS000100001221.001 [DIRS 146816]

Issue 2: *For GS000200005121.001 the referencing for this source is unclear it is very difficult to make the comparison. This source needs to be better explained in the AMR to be traceable. The DTN directs the user to TIC 234261, the last page of the TIC item describes, "a disk at the end of this issue contains the orbital and isolation data referred to in this paper", however this disk is not with the TIC item.*

Analysis: This issue has been resolved. The data have been copied from the disk and a hard copy is in records with accession number LLR.20070314.0039. No change to the AMR is needed.

Changes to the AMR: No change to the AMR is needed.

Issue 3: *In DTN: GS030908315121.001, the values were not listed in the AMR or Product Output DTNs.*

Issue 4: *In DTN: GS031108315121.002 the values were not listed in the AMR or Product DTNs.*

Analysis: Both these inputs are diatom data which are actually indirect input to this report.

Changes to the AMR: Change the title of Table 4-1 to: Summary of Data Sets Used as ~~Data~~ Direct Inputs. Delete the first and fourth rows of Table 4-1, p. 4-1. Change citations to indirect input in DIRS. The corrected Table 4-1 is presented on page 6 of this ERD.

In Section 6.5.1, p. 6-26, the first three sentences in the first full paragraph read:

> The primary data source for this discussion is the Owens Lake micropaleontological record of diatoms and ostracodes (DTN: GS030908315121.001 [DIRS 171152]; GS031108315121.002 [DIRS 170227]; GS970708315121.002 [DIRS 106508]; GS031108315121.003 [DIRS 168533]), and this discussion will focus on the ostracodes, as their story is similar to the diatoms. Diatom data will be used when necessary to support the ostracode story.

Change these sentences to read:

> The primary data source for this discussion is the Owens Lake micropaleontological record of ostracodes (DTNs: GS031108315121.003 [DIRS 168533] and GS970708315121.002 [DIRS 106508]), and diatoms (DTNs: GS030908315121.001 [DIRS 171152] and GS031108315121.002 [DIRS 170227]). This discussion will focus on the ostracodes. Diatom data corroborate the ostracode story, as described in Forester et al. (1999 [DIRS 109425, pp. 15-16).

Issue 5: *(Litwin, R.J.; Smoot, J.P.; Durika, N.J.; and Smith, G.I. 1999, 109440) Section 4 of AMR needs to be more specific, because it is very difficult to identify what values were used a direct input. If 63 cm/kyr sedimentation rate estimate for the Lake Owens Lake is the only direct input used from this source identify the page it can be found.*

Analysis: The specific reference is provided.

Changes to the AMR: To clarify the statement, in the last paragraph on page 6-40, delete the reference after "… 63 cm/ka is used" and include the following text:

> This average sedimentation rate, 63 cm/kyr, is the average of the sedimentation rates during the Holocene (OIS 1), 60 cm/kyr, and the OIS 5, 66 cm/kyr, as given in Litwin et al., (1999 [DIRS 109440], Table 1).

Issue 6: On page 6-28 it states using "the reconstruction of the last glacial climate based on plant macrofossils recovered from packrat middens (Thompson, R.S.; 1999, DIRS: 109470)" to calibrate the relative climate reconstruction. Also on page 6-34, "The OIS 2 full-glacial climate estimates at Yucca Mountain for MAP is about 266 to 321 mm and for MAT is about 7.9°C to 8.5°C (Thompson et al. 1999 [DIRS 109470])." It seems that this reference was used as Direct Input.

Analysis: Thompson et al. 1999 [DIRS 109740] provides one specific value which is used as a criterion for selecting the analog climate sites. That is the MAT; the glacial-transition climate must be no lower and preferably warmer than 8°C. This value is qualified in accordance with SCI-PRO-001. The data qualification plan and data qualification report are attached to this ERD.

Changes to the AMR:

Add Thompson et al. 1999 [DIRS 109740] to Table 4-1. The corrected Table 4-1 is presented on page 6 of this ERD.

On p. 6-51, third paragraph, line 5, change "(Thompson et al. 1999 [DIRS 109470])" to "(Thompson et al. 1999 [DIRS 109470], Tables 2 and 4)"

Issue 7: *DTN GS970708315121.002 is listed in Section 4 and is identified as a direct input, however DIRS lists this as an Indirect Input.*

Analysis: This reference is actually used as indirect input. It will be deleted from Table 4-1 and the DIRS report will be corrected.

Changes to the AMR: Delete the second row of Table 4-1, p. 4-1. The corrected Table 4-1 is presented on page 6 of this ERD.

Issue 8: *Forester, R.M.; 1999 DIRS: 109425 and Landwehr, J.M.; 1997 DIRS: 109124, both are internally qualified in Appendix A, but are listed as Indirect Input in DIRS. Either they should be Direct Inputs or there was no reason to qualify them in Appendix A.*

Analysis: The Forester et al. reference is actually used as direct input to demonstrate the correspondence between ostracode species abundance and oxygen isotope state (OIS). It will be added to Table 4-1 and the DIRS report will be corrected.

The Landwehr et al. reference contains the actual data in DTN: GS000200005121.003. These data are actually used as direct input to demonstrate the correspondence between OIS and climate in the Yucca Mountain area. It will be added to Table 4-1 and the DIRS report will be corrected.

Changes to the AMR: Add both Landwehr, et al. 1997 [DIRS: 109124] and Forester, et al. 1999 DIRS: 109425] to Table 4-1 and correct the DIRS report.

The corrected Table 4-1, including corrections to address all issues of this CR, is shown below, with both additions and deletions shown:

Table 4-1. Summary of Data Sets Used as Direct ~~Data~~ Inputs

Data Inputs	Data Tracking Number and [DIRS]
~~Diatom Data from Owens Lake 1984-1992 Cores~~	~~GS030908315121.001 [DIRS 171152]~~
~~Ostracode Data from Owens Lake 1984-1992 Cores~~	~~GS970708315121.002 [DIRS 106508]~~
Supplementary Data to Ostracode Data From Owens Lake 1984 - 1992 Cores	GS031108315121.003 [DIRS 168533]
~~Supplementary Data to Diatom Data From Owens Lake 1984 - 1992 Cores~~	~~GS031108315121.002 [DIRS 170227]~~
Earthinfo, Inc. Western U.S. Meteorologic Station weather Data - NCDC Summary of Day (West 1) and NCDC Summary of Day (West 2)	GS000100001221.001 [DIRS 146816]
Earth-orbital Parameter Data for the Present to 100,000 years in the Future	GS000200005121.002 [DIRS 146817]
Earth-orbital Parameter Data for the Last 10 Million years	GS000200005121.001 [DIRS 146818]
Radiometric Dating and $\delta^{18}O$ Data from Devils Hole, Nevada	GS000200005121.003 [DIRS 146819]
Calibrating Late Quaternary Terrestrial Climate Signals: Radiometrically Dated Pollen Evidence from the Southern Sierra Nevada, USA (Litwin et al. 1999)	[DIRS 109440]
Data for Devils Hole Core DH-11 (Landwehr et al. 1997)	[DIRS 109124]
The Climatic and Hydrologic History of Southern Nevada During the Late Quaternary (Forester et al. 1999)	[DIRS 109425]
Quantitative Paleoclimatic Reconstructions from Late Pleistocene Plant Macrofossils of the Yucca Mountain Region (Thompson et al. 1999).	[DIRS 109470]

NCDC = National Climate Data Center

Forester et al. 1999 [DIRS 109425] is used as direct input in section 6.5.1. The following four citations are therefore changed to refer to specific pages or figures:

On p. 6-26, in the first full paragraph, line 8, change "Forester et al. 1999 [DIRS 109425]" to "Forester et al. 1999 [DIRS 109425], pp. 10-24"

On p. 6-27, Figure 6-12, change "Source: Forester et al. (1999 [DIRS 109425], Figure 7])." to "Source: Modified from Forester et al. (1999 [DIRS 109425], Figure 7])." and delete the last sentence of the note "This figure is used for corroborating purposes only."

On p. 6-28, in the last paragraph, line 4, change "Forester et al. 1999 [DIRS 109425]" to "Forester et al. 1999 [DIRS 109425], Figures 7, 8, and 9"

On p. 6-29, in the first full paragraph, line 4, change "Forester et al. 1999 [DIRS 109425]" to "Forester et al. 1999 [DIRS 109425], pp. 10-24".

CR 10226 Evaluation

This level D CR (opportunity for improvement) was closed without action. The following change to ANL-NBS-GS-000008 REV 01 is made to resolve the condition.

Changes to the AMR: On p. 6-47 of ANL-NBS-GS-000008 Rev 01, replace all instances of "MAP" with "annual precipitation" and replace all instances of "MAT" with "annual temperature". This change is made to p. 6-47 only.

Additional Editorial Changes to the AMR:

On p. v, Table of Contents, Section 6.5.2 is listed twice; delete the first row for Section 6.5.2.

On p. 6-10, second paragraph, line 1, change "Milonkovich forcing" to "Milankovich forcing".

On p. 6-40, second full paragraph, line 3, change "mass-accumulation" to "mass-accumulation rate".

On p. 6-42, line 4, change "Liwin" to "Litwin".

On p. A-1, last paragraph, line 4, change "Litwing" to "Litwin".

IV. Impact evaluation

There is no change to the output or conclusions of ANL-NBS-GS-000008 REV 01. That report has only one output DTN: GS000308315121.003, *Meteorological Stations Selected to Represent Future Climate States at Yucca Mountain, Nevada.* The output DTN is not affected by this ERD, and the future climate analog locations have not changed.

The following documents were evaluated for impacts. They are the only controlled documents that cite DTN: GS000308315121.003. There is no impact to any of them.

- ANL-WIS-MD-000027 Rev. 00, *Features, Events, and Processes for the Total System Performance Assessment: Analyses*
- MDL-NBS-HS-000023 Rev. 01, Addendum 01 *Simulation of Net Infiltration for Present-Day and Potential Future Climates*
- TDR-WIS-PA-000014 Rev. 00, *TSPA Information Package for the Draft SEIS.*

Also, there is no impact to the Safety Analysis Report.

Appendix A. Data qualification for MAT during Full-Glacial Climate.

Data set for qualification:
Thompson, R.S.; Anderson, K.H.; and Bartlein, P.J. 1999. *Quantitative Paleoclimatic Reconstructions from Late Pleistocene Plant Macrofossils of the Yucca Mountain Region.* Open-File Report 99-338. Denver, Colorado: U.S. Geological Survey.
ACC: MOL.19991015.0296. [DIRS 109470]
The data value to be qualified for the purpose of selecting analog climate stations is:

> During the last glacial maximum, the mean annual temperature (MAT) at Yucca Mountain was approximately 8°C (Thompson et al. 1999 [DIRS 109470], Tables 2 and 4).

Method of qualification and rationale:
The data are qualified by corroboration because corroborating data are available.

Evaluation criterion:
The MAT during full-glacial climate is used to establish the minimum mean average temperature for analog climate stations that represent the future glacial-transition climate (BSC 2004 [DIRS 170002], p. 6-51). This minimum MAT is 8°C as shown in Thompson et al. 1999 [DIRS 109470], Tables 2 and 4. Therefore the criterion for corroboration is that the corroborating value must fall between 6° and 8°C.

Attributes of the data relevant to qualification (SCI-PRO-001, Attachment 4)

Qualification of personnel and organization generating the data:
The data were generated by the USGS and published in a USGS open-file report. Created by an act of Congress in 1879, the USGS is currently the sole science agency for the Department of the Interior. The USGS serves as an independent fact-finding agency that collects, monitors, analyzes, and provides scientific understanding about natural resource conditions, issues, and problems. The USGS carries out studies on a national scale and sustains long-term monitoring and assessment of natural resources. Because it has no regulatory or management mandate, the USGS provides impartial science related to natural resources and hazards. The diversity of scientific expertise enables the USGS to carry out large-scale, multi-disciplinary investigations that build the base of knowledge about the environment.

The primary author of Open-File Report 99-338, Robert S. Thompson, has been a research geologist at the USGS for over twenty years. Dr. Thompson's research focuses on the interactions between environmental and climatic changes through time, from the Pliocene to the present day and into the future. He leads the Climate Change, Land Use, and Environmental Sensitivity (CLUES) Project, which investigates modern relations between plant distributions and climate, provides quantitative paleoclimatic reconstructions from paleobotanical data, and employs arrays of paleoenvironmental data to assess the ability of climate models to simulate climates different from that of today. He has served in several leadership positions within the USGS, including: Team Chief Scientist for the Global Change and Climate History Team, Team Chief Scientist for the Central Region Earth Surface Process Team, acting Coordinator for the Earth Surface Dynamics program, and acting Regional Geologist in the Central Region.

Extent to Which the Data Demonstrate the Properties of Interest. The MAT for the Yucca Mountain region for the last glacial maximum is used as one criterion to select analog climate stations to represent the glacial-transition climate state. These data are relevant with respect to the property of interest.

Prior Uses of the Data. These data were used in the screening analysis of FEPs (Features, events, and processes) 1.3.04.00.0A, Periglacial Effects and 1.3.05.00.0A, Glacial and Ice Sheet Effect (*Features, Events, and Processes for the Total System Performance Assessment: Analyses,* SNL 2008 [DIRS 183041]).

Demonstration of Corroboration. The data on temperature during the last full glacial period are corroborated by data presented in Spaulding et al. 1985 [DIRS 106883]. That reference indicates that during the last glacial maximum (18,000 years before present), the MAT in the region of the Nevada Test Site was 6 to 7 C° colder than at present (Spaulding et al. 1985 [DIRS 106883], page 1 and Table 10). The difference in MAT between the present day climate and the last glacial maximum is based upon the comparison between plant communities identified by analysis of packrat middens and the present-day plant communities occupying the same sites. The present day mean annual temperature at those sites averages 14°C (Spaulding et al. 1985 [DIRS 106883], Table 5). Thus the MAT during the last glacial maximum calculated from the data of Spaulding et al. 1985 [DIRS 106883] is 7 to 8°C. This is satisfactory corroboration of the value in Thompson et al. 1999 [DIRS 109470]. The value of MAT given in Thompson et al. (1999 [DIRS 109470], Tables 2 and 4) is therefore qualified for use to define the minimum average temperature for proxy climate stations representing the glacial-transition future climate state.

Data Qualification Plan

Complete only applicable items.

QA: QA

Page 1 of 1

Section I. Organizational Information

Qualification Title:

Mean average temperature at Yucca Mountain during the last full-glacial climate.

Requesting Organization

PA – Natural Systems

Section II. Process Planning Requirements

1. List of Unqualified Data to be Evaluated

Thompson et al. 1999 [DIRS 109470]: The mean average temperature (MAT) at Yucca Mountain during the last full-glacial climate was about 8°C.

2. Type of Data Qualification Method(s) [Including rationale for selection of method(s) (Attachment 3) and qualification attributes (Attachment 4)]

SCI-PRO-001, Attachment 3, Method 2: Corroborating Data.

3. Data Qualification Team and Additional Support Staff Required

Peter Persoff (chair)
Carl Axness

No additional support staff required.

4. Data Evaluation Criteria

The use of the data is to establish the minimum mean average temperature for analog climate stations that represent the future glacial-transition climate (BSC 2004 [DIRS 170002], p. 6-51). Therefore the criterion for evaluation is that the corroborating value must be between 6° and 8°C.

5. Identification of Procedures Used

SCI-PRO-001 for data qualification,
SCI-PRO-005 for documentation.

6. Plan coordinated with the following known organizations providing input to or using the results of the data qualification

Natural Systems Infiltration Model author.

Section III. Approval

Qualification Chairperson Printed Name	Qualification Chairperson Signature	Date
Peter Persoff	Peter Persoff	07/28/2008
Responsible Manager Printed Name	**Responsible Manager Signature**	**Date**
Robert MacKinnon	Robert MacKinnon	07/29/2008

SCI-PRO-001.1-R1