



Department of Energy

Washington, DC 20585

OCT 09 1991

Mr. John J. Linehan, Acting Director  
Repository Licensing and Quality  
Assurance Project Directorate  
Division of High-Level Waste Management  
Office of Nuclear Material Safety  
and Safeguards  
U.S. Nuclear Regulatory Commission  
Washington, DC 20555

Dear Mr. Linehan:

This letter is to provide the U.S. Nuclear Regulatory Commission with information regarding the U.S. Department of Energy (DOE) responses to ten comments by the State of Nevada on Revisions 0 and 1 of Study Plan 8.3.1.5.2.1, "Characterization of Quaternary Regional Hydrology."

Enclosed is the DOE Yucca Mountain Site Characterization Project Office (YMPO) transmittal letter to the State of Nevada (Gertz to Loux, dated September 19, 1991), which briefly addresses the four primary concerns the State of Nevada identified with the study plan. Enclosure 1 to the YMPO letter is enumerated comments by the State of Nevada. Enclosure 2 to the YMPO transmittal letter is prepared DOE responses to the State of Nevada comments.

Should you require additional information, please contact Sharon Skuchko of my office at (202) 586-4590.

Sincerely,

Dwight E. Shelor for  
Associate Director for  
Systems and Compliance  
Office of Civilian Radioactive  
Waste Management

Enclosure: as stated

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PDR WASTE  
WM-11 PDR

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NH03

cc w/Enclosure:

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WBS 1.2.5.2.2  
QA: N/A

SEP 19 1991

Robert R. Loux  
Executive Director  
Nuclear Waste Project Office  
State of Nevada  
Capitol Complex  
Carson City, NV 89710

**U.S. DEPARTMENT OF ENERGY (DOE) RESPONSES TO STATE OF NEVADA COMMENTS ON STUDY PLAN 8.3.1.5.2.1, "CHARACTERIZATION OF QUATERNARY REGIONAL HYDROLOGY"**

Enclosed are the DOE responses to ten comments by the State of Nevada on Revisions 0 and 1 of the subject Study Plan. For comments on DOE-approved Study Plans, the Yucca Mountain Site Characterization Project Office (YMPO) asks the responsible principal investigator to perform an assessment of their impact on the planned study. Such assessments include discussion of how comments should be addressed within the planned program (i.e., justify why changes to the program are or are not appropriate), and how concerns could be addressed at later stages in the characterization program, if appropriate. Enclosure 1 contains numbered comments from your letter, and Enclosure 2 contains DOE's responses.

Your cover letter identified four primary concerns (Comments 1-4) with the Study Plan. This letter will briefly respond to each. First, you noted that the Study Plan did not contain descriptions of all of the activities which will be conducted as part of the study, and that your comments were to be considered preliminary. We recognize that the plan is incomplete, and that your views could not, therefore, be considered final. The activities described in the Study Plan's current revision are ongoing, whereas the undescribed activities have not been initiated. We appreciate your early input, and will factor it into later versions of the plan.

Second, you commented that there was little discussion of the "practical aspects" of parameter estimation and the interaction of various models, and you noted that serious errors may result with respect to models of the distribution of flow paths and velocities if transmissive properties in fractured systems are not considered. We strongly concur that it is vital that we consider the transmissive properties of fractured rocks in our flow models. Further, we believe that an understanding of the relationship between estimates of hydrologic parameters (e.g., transmissive properties) and actual flow regimes is critical to the long term success of the program. In fact, these information needs may provide the strongest rationale we have

SEP 19 1991

Robert R. Loux

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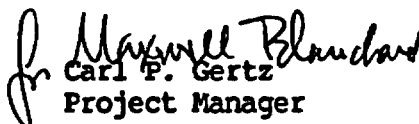
for conducting the paleohydrologic studies described in this Study Plan, which allow us to assess how past flow paths have been affected by the spatial distribution of hydraulic properties. This understanding (as evidenced by mineral deposits) is critical to our ability to predict the evolution of potential future flow paths and is, to some extent, independent of the flow model chosen for the site.

Third, your letter stated that the Study Plan did not completely represent the current state of knowledge regarding the paleohydrology of the Yucca Mountain region. As you are aware, consistent with U.S. Nuclear Regulatory Commission guidance on format and content, Study Plans are not intended to be comprehensive interpretive reports. The plan did briefly summarize the relevant information that existed as of its issuance, but we concur that there have been several important papers published regarding Quaternary hydrology in the Yucca Mountain area in the last two years. These papers include work by scientists sponsored by the State of Nevada, such as Quade and Cerling, that have significantly contributed to our understanding of unsaturated zone (UZ) hydrology (generally confirming our concept of UZ hydrologic processes). Future revisions of the Study Plan will, of course, reference important recent publications if they are relevant to any proposed changes. Technical support documentation will report the results of studies, interpretations of data, assumptions used, and relevance to site suitability or licensing issues. If the state is aware of any additional specific publications that we have not cited to date, we would appreciate notification, and the reports will be incorporated in our planning for future activities.

Finally, with respect to your fourth concern regarding environmental requirements, the work required for evaluating the environmental effects of site characterization is not included in the Site Characterization Plan and, consequently, is not dealt with in this or any other Study Plan. The YMPO Systems Engineering Management Plan (SEMP) requires that integration with the environmental program be done. The organization and management of environmental activities are described in the YMPO Environmental Management Plan.

If you have any further questions or need clarification, please contact Thomas W. Bjerstedt at (702) 794-7590.

RSED:TWB-3993

  
for Carl P. Gertz  
Project Manager

Enclosures:

1. Comments on Study Plan 8.3.1.5.2.1  
(Revisions 0 and 1)
2. Response Package

SEP 19 1991

Robert R. Loux

-3-

cc w/encls:

J. W. Bartlett, HQ (RW-1) FORS  
S. J. Brocoun, HQ (RW-22) FORS  
J. R. Stockey, HQ (RW-22) FORS  
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April 9, 1991

John W. Bartlett, Director  
Office of Civilian Radioactive  
Waste Management  
U.S. Department of Energy  
Washington, D.C. 20545

Dear Dr. Bartlett:

The State of Nevada has reviewed the DOE Study Plan "Characterization of the Yucca Mountain Quaternary Regional Hydrology" (Study Plan 8.3.1.5.2.1) and its cited references, and Revision 1 to the Study Plan (received March 21, 1991), and is providing its comments in this letter and attachment. The State's comments address the adequacy, completeness, and technical accuracy of the Study Plan to meet the purposes of site characterization.

The State's primary concerns regarding the subject Study Plan are summarized as follows:

COMMENT  
1

1. The Study Plan and Revision 1 do not contain a description of Activity 8.3.1.5.2.1.1 - Regional Paleoflood Evaluation, or Activity 8.3.1.5.2.1.2 - Zone Hydrochemical Analysis, and therefore a complete assessment of the Study Plan to adequately characterize the Quaternary regional hydrology cannot be accomplished. Until the State has received and reviewed the complete Study Plan, its comments must be considered preliminary.

COMMENT  
2

2. The description of model linkages and parameter estimates are developed on a conceptual basis, but little discussion is provided on the practical aspects of parameter estimation and the interaction of various models. For example, serious errors with respect to the distribution of flow paths and velocities can result if proper consideration is not applied to transmissive properties in fractured systems.

Enclosure #

COMMENT  
3

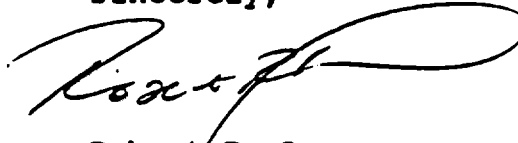
3. With respect to Activity 8.3.1.5.2.1.5 - Studies of Calcite and Opaline-Silica Vein Deposits, the Study Plan and Revision 1 do not represent a complete and current reference base of information on such vein deposits in the Yucca Mountain area and surrounding region.

COMMENT  
4

4. The scientific investigation interfaces between site characterization and environmental protection required by the DOE Systems Engineering Management Plan have not been documented in this Study Plan. This concern has been identified to the Department in State comments on other study plans, but has yet to be addressed in a substantive manner.

Should you have questions, this Office is available to meet with the Department and discuss the State's comments at any time.

Sincerely,



Robert R. Loux  
Executive Director

RRL:cs

Attachment

cc: \ Carl Gertz, YMPO  
Joe Youngblood, NRC  
Dade Moeller, NRC-ACNW  
Don Deere, NWTRB  
Dwayne Weigel, GAO  
Steve Kraft, EEI

ATTACHMENT

State of Nevada comments on DOE Study Plan 8.3.1.5.2.1  
"Characterization of the Yucca Mountain Quaternary Regional  
Hydrology."

1. Study Plan Objectives

COMMENT  
5

The use of hydrologic models to predict possible future water-table elevation changes is a reasonable objective. However, it will be an extremely difficult objective to accomplish since even with the completion of all SCP studies, the information base will be sufficient only to perhaps calibrate a model of the regional hydrologic system. There will be no independent data set upon which to verify the unique model; therefore, any perturbation of such a model will only provide a very general estimate of response of the water table. A sensitivity analysis will help identify key characteristics; however, identifying all relevant boundary conditions which, in the past, influenced recharge both on site and regionally, may be impossible.

2. Study Rationale

COMMENT 6

On page 2.1-3, the emphasis of the discussion is on predicting the saturation of the repository due to change in flow regime at the repository site itself. However, if the statement on



page 1.3-10, which declares a need for maintaining 70 meters vertical distance between the repository disturbed zone and the water table is a project requirement, then equal emphasis on page 2.1-3 should be given to increases in water-table evaluation due to increased recharge up-gradient in the flow system.

On page 2.1-4, the objective of the Analog Recharge Activity (8.3.1.5.2.1.4) is misstated. The analog recharge activity is really aimed at evaluating recharge versus precipitation not infiltration. The constant use of the term infiltration or potential infiltration is inconsistent with other study plans and its common usage. The terms used throughout other study plans relate to the flux or net flux through the unsaturated zone.

On pages 2.1-14 through 2.1-17, the Study Plan discusses the logic diagrams for developing models of the unsaturated zone, saturated zone and surface waters. These three models are shown to be linked, but no equations are provided to enable an assessment of how these linkages will operate.

3. **Schedule**

COMMENT

7

In Section 2.2.4 - Time Required Versus Time Available, the discussion indicates a minimum record of five-year's data is

needed at each analog - recharge study site. It is quite optimistic to believe that a reliable precipitation-runoff-recharge relationship can be developed for a particular watershed based upon a record length of even twice that time period. Given the levels of precision in obtaining the measures of the water balance components, the residual error and uncertainty may mask the real recharge component. Even in areas with significantly higher precipitation than expected in these analog sites, many investigators have been unable to truly quantify recharge.

With respect to time needed for the studies, two of the studies are not discussed in the Study Plan, therefore cannot be assessed (Regional Paleo-Flood Evaluation and Quaternary Unsaturated Zone Hydrochemical Analysis). The other two studies, Evaluation of Past-Discharge Areas and Analog-Recharge Studies, are of concern because of their importance in determining potential flux through the mountain. The Study Plan indicates these studies will be carried out during a minimum of five consecutive years at each site. However, there are numerous caveats in the text which indicate these studies may require longer periods of time, since they are involve new areas of scientific research. This recharge flux information is critical, especially the analog recharge information, since all estimates of health and environmental effects are directly tied to the quantity of water contacting

the waste. If the activities take five to seven years then they will seemingly meet the current schedule for input into the EIS and License Application. If however, field work encounters unexpected conditions or many delays, then this information may not be available in time to avoid delays in the issuance of the EIS and the License Application.

4. Specific Comments on Study Plan Activities

COMMENT

8

Activity 8.3.1.5.2.1.3 Evaluation of Past-Discharge Areas

On page 3.3-1, Objective 2 of the activity is to understand the past - and present - discharge areas of the regional-hydrologic system in order to predict the future saturated-zone hydrologic system at Yucca Mountain. Even after 30 years of study of the regional flow system, there still remain significant uncertainties about the NTS-Yucca Mountain flow system with respect to interconnection and boundaries. Also, it is only optimistic to expect that in five to seven years an adequate understanding of the past regional system will be achieved.

Page 3.3-1, Objective 3 indicates that past ground water levels will be determined in carbonate caverns such as Devil's Hole. What other caverns will be investigated?

On page 3.3-3, the second paragraph indicates that elevations of paleo-spring mounds are to be used as the control to define the paleo-water table elevation. Has there been a comparison of current discharge elevations and the current carbonate potentiometric elevation to check the validity of this approach? How does the study propose to account for changing elevations through time in southern Nevada due to tectonic activity?

Section 3.3.3.1 regarding Remote Sensing (page 3.3-4) indicates that the use of remote sensing (RS) is based on the concept that the spectral analysis will provide distinct spectral signatures which can be related to specific hydrologic characteristics. Several investigations have attempted this in the past and were unsuccessful i.e., known springs at NTS were not identifiable given the resolution available from LANDSAT MSS and TM data.

The entire section on use of RS, together with other data bases, to develop a model for infiltration, assumes that there is much more hard data available than really exists. For example, climate records are few and do not give the spatial or elevation coverage needed. The only long-term records are for precipitation and temperature. To estimate what would be the response under different climatic conditions, it is first necessary to understand what is occurring under the present

day climate regime. This is extremely difficult given that the spatial and temporal distribution of precipitation is not known for most of the region.

One of the objectives of the RS analysis is to provide support data for estimating values of potential infiltration. What would be the validity of such an estimate, given that even in the wetter analog areas, the amount of water entering the soil zone and potentially available for recharge in general, is, limited by the precipitation input, rather than the soil zone characteristics that would be interpreted from the RS analysis.

On page 3.3-8 the text states that LANDSAT Thematic Mapper (TM) data were chosen for the following reasons: 1) good spatial resolution; 2) good spectral resolution; and 3) the regional nature of the study. How will the spectral signal from TM data relate to the objective of estimating infiltration or recharge?

Table 3.3.1 (page 3.3-9) identifies the data to be utilized for remote-sensing methodology development. The text does not describe the quantity or quality of the MSS and TM data available for the Yucca Mountain area. The only data description is for the Death Valley methodology development task.

Given the selection of several past LANDSAT images to be analyzed for the Death Valley "training site", how is that analysis going to be related to ground truth? For any particular location there is most likely no hard data to compare to the image. The response range between "wet" and "dry" will show up; however, this tells us little about degrees of "wet" and "dry".

In the last paragraph on page 3.3-10, a definition of "regional infiltration/recharge" is needed to avoid confusion between the two. Is the discussion directed toward the climate controlled phenomena, the physical control due to soil and vegetation characteristics, or some combination of these parameters?

The last paragraph on page 3.3-10 states that the current method for estimating recharge is based on precipitation and elevation, i.e., the Maxey-Eakin method, which provides an excellent first approximation. This method may have some validity for gross approximation of recharge in regions wetter than southern Nevada. However, proposing its use for the southern Nevada area goes well beyond its original intent, and the method has no demonstrated validity in most areas of southern Nevada.

On page 3.3-11, reference is made to available climatic data for the areas to be assessed using remote sensing. There are few long-term climate data records, other than precipitation and temperature, for the region. Only the immediate area of Yucca Mountain has a more complete climate record, which will, of necessity, have to be extrapolated with considerable uncertainty to the region.

On page 3.3-12, given the limitations on the applicability of LANDSAT data for predicting hydrologic conditions, how will the "success" of the model of infiltration be judged?

Pages 3.3-28 and 3.3-29 indicate that the center of gravity (COG) method can be used to estimate the vertical distribution of aquifer properties estimated from lithologic logs. The COG method can be a useful method for estimating parameter distribution for a number of parameters and situations. However, its use in defining certain fractured rock properties is not always appropriate. An example, where it may not be appropriate is in calculating transmissive properties of a fracture system. This is because the fracture distributions and some fracture parameter distributions determined from lithologic logs do not necessarily control actual flow channels and velocities. For instance the highest density, or the center of gravity of the fracture occurrence or fracture aperture may not be an accurate representation of the

true occurrence of, or velocity of, flow.

#### Activity 8.3.1.5.2.1.4 Analog-Recharge Studies

COMMENT

9

On page 3.4-8, in the second paragraph, it is stated that soil-moisture content can be estimated using thermal and reflective responses. To properly evaluate the use of this technique, some indication of its precision and accuracy needs to be provided. The difference between wet and dry can be observed, but how well can the moisture content be quantified through use of this technique?

In the section on data collection (page 3.4-8), the potential infiltration is directly related to maximum recharge for each analog site. Again, the use of "potential infiltration" is confusing. Is it intended to denote the maximum amount of water that could infiltrate over a fixed time period given certain boundary conditions?

The last paragraph on page 3.4-8 discusses a proposed comparison of packrat middens from analog sites to Yucca Mountain to establish paleoclimatic conditions. Considerable packrat midden data is already available for Yucca Mountain and surrounding areas, much of which has been collected by the Desert Research Institute under sponsorship of this Office. Was this available information taken into account in preparing



the Study Plan?

**Activity 8.3.1.5.2.1.5 Studies of Calcite and Opaline-Silica Vein Deposits**

COMMENT

10

During February 6-7, 1990, a DOE/NRC Workshop on hydrogenic calcite/silica deposits was held in Las Vegas, Nevada. A preponderance of "pre-characterization" data presented at this workshop provided compelling evidence that the authigenic mineralization occurring in Trench 14 is of pedogenic (soil) origin. This activity plan has not been revised to account for these findings. The study plan needs to re-focus its attention to those data needs which remain to be addressed:

1. Comprehensive age dating of the carbonate and opaline authigenics and stable isotope analyses of concurrent samples.
2. Correlative age and isotope data on authigenics from other trenches with those from Trench 14.
3. Trace element geochemistry data collection to ascertain the concentrations of key ore elements such as: Hg, Pb, Au, Ag, etc.
4. Trace element geochemistry as well as age and isotopic

data should be collected on authigenic and host rock minerals to resolve genesis issues.

5. Additional observation of Trench 14 features at increased depth.

Section 3.5.3.2 (page 3.5-8) purports to summarize the current knowledge of hydrogenic deposits in the Yucca Mountain area, with its primary focus on Trench 14. However, the section fails to acknowledge State-sponsored research or current studies by DOE Yucca Mountain Project participants. This section should be revised to include discussions of the following studies:

- a. Quade and Cerling, University of Utah: This research has concluded that the Trench 14 K-horizon and vein filling carbonates were deposited as pedogenic deposits in isotopic equilibrium with C4 and C3 plant derived CO<sub>2</sub>. Isotopic signals suggest a paleoenvironment equating to a higher altitude and a colder weather climate. See J. Quade and T. Cerling, Science, December 14, 1990, page 1549.
- b. Muhs, U.S. Geological Survey: These studies of Trench 14 uranium-isotope data suggest a pedogenic formation of carbonate vein fillings. See D. Muhs, U-series

geochronology, DOE/NRC Workshop on Calcite/Silica Vein Deposits, February 6-7, 1990.

- c. Vaniman, Los Alamos National Laboratory: This research suggests that the mineralogy of the Trench 14 carbonates is similar to other pedogenic deposits rather than to spring deposits. See D. Vaniman, Chemical/Mineralogic Evidence from Trench 14 Vein Deposits and Analog Sites, DOE/NRC Workshop on Calcite/Silica Vein Deposits, February 6-7, 1990.
  
- d. Szabo and Kyser, U.S. Geological Survey. This work on drill cores from Yucca Mountain concludes that fracture- and cavity-filling calcite precipitated from downward-migrating meteoric water. See B. Szabo and T. Kyser, Geological Society of America Bulletin, Volume 102, December 1990, page 1714.

Page 3.5-14 is an index map for the State of Nevada, which shows the locations of hot springs to be sampled. It is not clear why all the hot springs to be sampled are located above 39 degrees North latitude, yet all the cold springs to be sampled are located within 36 degrees 30 minutes to 37 degrees North latitude. Hot springs exist down gradient of, and closer to Yucca Mountain than those selected. The rationale for the selection of hot springs to be sampled needs

explanation.

Section 3.5.3.10 describes the paleontological investigations proposed for this activity. Paleontological studies require comprehensive baseline data indicating environmental limitations of each species investigated. These data need to be presented in published formats for review by the scientific community. This appears to be a very ambitious study given the very limited relevant information base on aquatic and terrestrial organisms in southern Nevada.

RESPONSES TO STATE OF NEVADA COMMENTS ON  
STUDY PLAN 8.3.1.5.2.1, REVISION 0 and REVISION 1  
(CHARACTERIZATION OF QUATERNARY REGIONAL HYDROLOGY)

Response to Comment 1

Revision 2 for this Study Plan is in U.S. Department of Energy (DOE) review. It contains a description of Activity 8.3.1.5.2.1.1 (Regional Paleoflood Evaluation), and an interim change notice stating that the responsibility for Activity 8.3.1.5.2.1.2 (Quaternary Unsaturated-Zone Hydrochemistry) will be transferred to Study Plan 8.3.1.2.2.7 (Hydrochemical Characterization of the Unsaturated Zone). The Site Characterization Program Baseline will be altered to indicate this change.

Response to Comment 2

Modeling is an ancillary part of this study and, where used, will be only local in scale. For this reason, flow paths and velocities should be well constrained. The U.S. Geological Survey (USGS) intends to test these methods in both fractured and unfractured rocks. A full description of the modeling methods would be available in Study Plan 8.3.1.2.1.4 (Regional Hydrologic System Synthesis and Modeling).

Response to Comment 3

The reference base for Activity 8.3.1.5.2.1.5 was complete at the time the Study Plan was approved by DOE (6/8/89). New information is continually evaluated by the principal investigator, but planning documents like Study Plans are not expected to be kept current with the study results. Technical support documentation will report the results from site characterization studies.

Response to Comment 4

The work required for evaluating the environmental effects of site characterization is not included in the Site Characterization Plan (SCP) and, consequently, is not dealt with in this, or any other, Study Plan. The Systems Engineering Management Plan (SEMP) requires that integration with the environmental program be done. The SEMP does not prescribe that each Study Plan document the interfaces with environmental requirements. Organization and management of environmental activities are described in the Environmental Management Plan. Please also see the DOE's response to the State of Nevada's Comment 3 on Study Plan 8.3.1.16.1.1 and Comment 3 on Study Plan 8.3.1.17.4.2.

#### Response to Comment 5

A sensitivity analysis will be done. Note that Activities 8.3.1.5.2.1.3 and 8.3.1.5.2.1.4 are data-gathering activities. The details of modeling are provided in Study Plan 8.3.1.2.1.4 (Regional Hydrologic System Synthesis and Modeling). Applications of the models to future conditions are provided in Study Plan 8.3.1.5.2.2 (Characterization of the Future Regional Hydrology Due to Climate Changes).

#### Response to Comment 6

##### Paragraph 1

Note that on page 1.3-5 (second paragraph) of the Study Plan, it is emphasized that the contribution of the Quaternary regional hydrology study to performance issues is indirect, occurring mainly through the provision of paleohydrologic data to Study Plan 8.3.1.5.2.2 (Future Regional Hydrology Due to Climate Changes). This relationship is also true with respect to the contribution of Study Plan 8.3.1.5.2.1 to design issues. One of the objectives of the future saturated-zone modeling activity (Activity 8.3.1.5.2.2.3) is to synthesize the existing paleohydrologic data through the use of numerical simulation techniques to determine the effects that lesser or greater recharge would have on water-table altitude, groundwater flow paths, and hydraulic gradients in the Yucca Mountain region. This effort will include effects of increased recharge upgradient from the repository candidate site.

##### Paragraph 2

The investigators were working with the Claassen model when the Study Plan was written. They realized that recharge is not a realistic output of his model, but that effective moisture or potential infiltration (considered interchangeable terms) can be calculated. In the FRMS model, this is called excess soil-zone water, groundwater, and subsurface leakage. If the term flux is to be substituted for the terms effective moisture, recharge, or infiltration, it should be the result of discussions among the investigators in this study and those in the unsaturated-zone program. As of this writing, this action has not been taken.

##### Paragraph 3

Figure 2.1-2 (a through d) is a reproduction of SCP Figures 8.3.1.2-2 through 8.3.1.2-4 in the first part of SCP Section 8.3.1.2 (Overview of the Geohydrology Program). Its purpose in the Study Plan is explained on page 2.1-14 (third paragraph). For an introductory explanation of the three hydrologic models and their corresponding investigations, see SCP pages 8.3.1.2-3 through 8.3.1.2-92.

#### Response to Comment 7

With respect to the analog-recharge activity, the USGS acknowledge that it is optimistic to believe that a completely reliable precipitation-runoff-recharge relationship can be developed given the time available. However, they emphasize that their approach is defensible considering the time available and the imperfect conditions under which the activity will be conducted. The Claasen and Leavesley models are able to run on three to five years of data but, as in any scientific investigation, limitations imposed by the size of the data base must be considered in interpreting the model output.

The purpose of a performance confirmation program, required by 10 CFR Part 60, is to allow for long-term data gathering and monitoring of physical processes to establish needed confidence. The needs of a performance confirmation program will be established at a more appropriate time in the site characterization program.

With respect to the past-discharge activity, this effort does not require five years of study to develop the tools to identify and evaluate each past-discharge site to determine its geologic age and hydrologic and climatic history. At present, the investigators anticipate having preliminary answers at a few sites at the end of next year.

#### Comment 8

##### Paragraph 1

The time allotted for objective 2 of Activity 8.3.1.5.2.1.3 may be minimal, but the USGS believes that it is adequate. See also the response to Comment 7 with respect to the performance confirmation program.

##### Paragraph 2

Other carbonate caves are listed as an option in case any such caves are found in the course of regional mapping.

##### Paragraph 3

Estimates of any elevation changes during the Quaternary that have affected past-discharge points will come from work carried out as part of the tectonics program. It is not clear how comparisons between the current discharge elevations and the current carbonate potentiometric elevations can be used to test whether or not elevations of paleospring mounds can be used to determine paleowater table elevations.

#### Paragraphs 4 and 5

Past efforts to use remote sensing in the vicinity of the Nevada Test Site have not been totally successful. The methods and spectral data available have improved, however, and the failure of past efforts alone does not preclude a new attempt.

#### Paragraph 6

The hypothesis to be tested is that vegetation and surface salts may vary with infiltration and that, as such, remote sensing would be able to establish zones of similar character that would reflect zones of similar infiltration.

#### Paragraph 7

As stated above, in general much of what is hypothesized in this section is to be tested. Standard tools needed to answer the major questions do not exist and, therefore, the USGS is attempting to develop them.

#### Paragraph 8

Complete printouts for available data can be obtained from EROS and the lists are updated periodically. Thus, inclusion of such a list in the Study Plan is inappropriate.

#### Paragraph 9

Salt maps provide a measure of average moisture for a given area. Ultimately, field collecting of samples and chemical analysis provide ground truth.

#### Paragraph 10

The discussion relates to a combination of infiltration and recharge.

#### Paragraph 11

The Maxey-Eakin method is only a starting point. The investigators anticipate that the analog recharge activity and soils work will provide a major improvement.

#### Paragraph 12

The current records are only a starting point. The YMP will be collecting much more extensive data. The new records may not be for as long a time period as that currently available, but the areal coverage will be much better. Between the two sets of data, the USGS anticipates an acceptable limit of potential error.



Paragraph 13

Success will be judged by general calibration.

Paragraph 14

We agree that the center of gravity method has limitations and, therefore, do not plan to use that method in inappropriate areas.

Comment 9

Paragraph 1

The soil-moisture content is said to be estimated by this technique because the method is only qualitative and, therefore, precision and accuracy are not given.

Paragraph 2

See answer to Comment 6, Paragraph 2.

Paragraph 3

Available packrat-midden data form the basis of comparison. If the Desert Research Institute investigators have unpublished data that bear on the subject, the USGS would appreciate having access to it so that it can be assimilated into a more complete comparison.

Comment 10

Most of the requested information to be included was developed long after DOE approved the Study Plan (see also the response to Comment 3). If the knowledge obtained by DOE or other investigators requires changes to the study, future revisions of the Study Plan will describe them, and the evolving data and interpretations that lead to change. At present, we do not believe a revision is necessary. Data and conclusions will be presented in the technical support documentation (i.e., the scientific and regulatory reports that are published by the project) that results from the study.

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Paragraph 3

See answer to Comment 6, Paragraph 2.

Paragraph 2

The soil-moisture content is said to be estimated by this technique because the method is only qualitative and, therefore, precision and accuracy are not given.

Paragraph 1

Comment 9

We agree that the center of gravity method has limitations and, therefore, do not plan to use that method in inappropriate areas.

Paragraph 14

Success will be judged by general calibration.

Paragraph 13