



Department of Energy

Washington, DC 20585

October 1, 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 the State of Nevada comments on Study Plan 8.3.1.2.1.2, "Characterization of the Yucca Mountain Regional Surface-Water Runoff and Streamflow."

Enclosed is the DOE Yucca Mountain Site Characterization Project Office (YMPO) transmittal letter to the State of Nevada (Gertz to Loux, dated August 20, 1991). Enclosures to the YMPO letter are (1) enumerated comments by the State of Nevada (Enclosure 1 to the YMPO transmittal letter) and (2) prepared DOE responses to the State of Nevada comments (Enclosure 2 to the YMPO transmittal letter).

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

Sincerely,

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

3 Enclosures:

1. DOE transmittal letter to the State of Nevada dated August 20, 1991;
2. State of Nevada letter to DOE dated April 12, 1991; and
3. DOE Responses to State of Nevada Comments.

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cc w/Enclosures:

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WBS 1.2.5.2.2
QA: N/A

AUG 20 1991

Robert R. Loux
Executive Director
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U.S. DEPARTMENT OF ENERGY (DOE) RESPONSES TO STATE OF NEVADA COMMENTS ON STUDY PLAN 8.3.1.2.1.2, "CHARACTERIZATION OF THE YUCCA MOUNTAIN REGIONAL SURFACE-WATER RUNOFF AND STREAMFLOW"

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

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

Carl P. Gertz
Project Manager

RSED:TWB-4003

Enclosures:

1. Comments on Study Plan 8.3.1.2.1.2
2. Response Package

cc w/encls:

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S. J. Brocoum, HQ (RW-22) FORS
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April 12, 1991

John 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 Regional Surface-Water Runoff and Streamflow" (Study Plan 8.3.1.2.1.2) and its cited references 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 is overly optimistic in proposing that during the 5-year study duration sufficient data can be collected to characterize the watershed response to precipitation events. It is highly unlikely that adequate data will become available to calculate the frequency and magnitudes of site surface flooding with a reasonable assurance of accuracy required for licensing.

COMMENT

2

2. This Study Plan is premature given the acknowledgement that much of the data required for calculating surface flooding will be derived from the Meteorological Network Study Plan, which is yet to be written. This Study Plan further acknowledges its evolutionary status, and that revision may be necessary following completion of the Meteorological Network Plan.

Enclosure 1

COMMENT

3

3. The Study Plan proposes installing a number of streamgauge and precipitation stations in the Yucca Mountain area. The impact of construction of these stations on the environment must be considered. The scientific investigation interfaces between site characterization and environmental protection are required by the DOE Systems Engineering Management Plan, but 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 to 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
Dwayne Weigel, GAO
Steve Kraft, EEI
Don Deere, NWTRB

ATTACHMENT

State of Nevada comments on DOE Study Plan 8.3.1.2.1.2
"Characterization of the Yucca Mountain Regional Surface-Water
Runoff and Streamflow".

1. Study Plan Objectives

COMMENT

4

The first two objectives contain the basic assumption that "enough" events will occur during the period of data collection to provide an adequate data base upon which to characterize watershed response to precipitation events. If Figure 5.1-1 represents the period of data collection (5 years), it is doubtful that an adequate number of events and responses will be recorded to sufficiently characterize runoff and streamflow for Yucca Mountain. Based upon the number of observed runoff events during the approximately 10 years since the site was first considered, few runoff events are likely to be measured during the proposed 5-year study period.

In addressing Performance Issue 2.3 (page 1.3-4), the stated approach is to use site information from this study to calculate frequency and magnitudes of repository surface flooding. It is highly unlikely that flood data planned to be collected during such a short period of time will be adequate to perform the necessary analysis. In lieu of

relying on very limited site data, more conceptual approaches will likely be necessary, using a number of assumptions together with regional frequencies. The Study Plan should consider such alternate approaches.

2. Study Rationale

COMMENT

5

The statement on page 2.1-5 that "some degree of uncertainty is inevitable" is a gross understatement. Given the proposed short period of data collection, a high degree of uncertainty is sure to result. The discussion, in paragraph two on page 2.1-5 addresses the short data collection period and the resulting uncertainty, but the subject seems to have been set aside in the remainder of the Study Plan. Experience throughout the southwestern United States, where much longer data bases exist, suggests that application of many lines of investigation is necessary to obtain even broad estimates of flooding frequency and magnitudes.

The statement on page 2.1-1 that data "will not be scaled up or down to represent values from stream channels other than those in which the measurements are taken" suggests that every significant channel is to be monitored at every location which may affect the proposed repository. Although many streamflow gages are indicated in Figures 3.1-3 and 4, the implication above does not necessarily appear to be correct. The debris-

transport data will have to be scaled for the site due to the extremely limited data base and the size of the region over which the data may be collected.

The discussion in the first paragraph on page 2.2-2 is appropriate and serves to emphasize the point that it is not possible to gather sufficient data in the relatively short time period planned. The second part of this discussion, relating to continued data collection until repository closure is not relevant to addressing any of the design or performance issues which must be resolved during site characterization. Is this discussion meant to suggest that new data acquired after the repository is designed and constructed will somehow be incorporated if necessary in modifications to the facility? Since this Study Plan addresses site characterization activities, a discussion of post-construction activities has little significance.

3. Activity 8.3.1.2.1.2.1 Surface-Water Runoff Monitoring

COMMENT

6

The second objective of the surface-water runoff monitoring activity - to develop an "adequate" data base should be better defined. The temporal and spatial distribution of both precipitation and runoff in an arid area requires long periods of record to establish precipitation-runoff relationships, as pointed out in several places in the Study Plan. Therefore,

it is difficult to evaluate the proposed study program without a precise definition of the amount of data expected to be collected relative to the amount needed to address each of the related design and performance issues.

Objective Four of the monitoring activity is related to establishing water balance components for the areas examined, specifically the runoff component. Given the limited accuracy of streamgaging, the error component in runoff data may be much larger than other components of the water balance equation. The Study Plan needs to recognize the large uncertainty in quantifying the runoff component of the hydrologic cycle.

On page 3.1-1, the following statement is made: "Data thus obtained are necessary to (1) define a major element of the hydrologic budget; (2) calibrate precipitation-runoff models that may be developed for Yucca Mountain, Fortymile Wash, and the general region (Yucca Mountain, Fortymile Wash, the NTS, and areas peripheral to a composite of these three specific areas); and (3) provide data necessary for the assessment of flood potential throughout the region and within specific areas." The data planned to be collected under this Study Plan may provide qualitative data for each of the three areas described, however, quantitative cause and effect relationships and frequency-magnitude relationships will

require much longer periods of data collection than proposed for this activity.

Given the climatic conditions at the site, it is optimistic to believe that precipitation-runoff models can be calibrated for drainages at Yucca Mountain without long periods of observation of all the parameters which influence runoff. The antecedent conditions can and do vary considerably causing significant variation in runoff for a fixed precipitation input. For flood analysis, these uncertainties are usually compensated by making very conservative assumptions about precipitation abstractions and then estimating responses which would occur under those assumptions. Such analysis would at least give some conservative estimates for flooding potentials. It would not be of value in estimating current watershed responses to precipitation events. Only a long period of observation will provide the needed data for such estimates.

On page 3.1-6, the lack of existing long-term data is documented, but use of what little data are available is not placed in the context of meeting the study objectives. The intended use of data collected after the site-characterization period is not explained.

On page 3.1-7, it is suggested that peak flow measurements,

i.e., peak stage converted to flow, based on channel geometry, slope, etc., can be converted to streamflow records. This will be of value only where the stage is continuously monitored. The crest-stages will still only give a single value, and any attempt to extrapolate those values to an entire hydrograph would not be appropriate.

In the section on general approach, pages 3.1-7 and 8, problems related to streamflow monitoring are discussed. Although there are problems associated with automated streamflow samplers, they can be installed to begin sampling when flow begins, and then sample throughout a flow event. Manual sampling, in general, will miss the initial part of the hydrograph, thus providing an incomplete record of the chemical transport.

In the section on meteorological measurements, storage gages are proposed to be used, but no justification given. For most hydrologic analyses, intensity of a precipitation event is as significant as the total depth of precipitation. Therefore, it is suggested that storage gage data be used only to supplement the recording gage data.

On page 3.1-9, the statement is made that most precipitation gages will be located near the streamgages or at supplementary sites. The justification given is that data at or near the

streamgage sites are easy and economical to collect. This does not serve the purpose of these precipitation gages, which is to determine precipitation over the watershed. Would it not be better to integrate these gages with the "official meteorological network" from the outset?

Pages 3.1-9 and 10 discuss the collection of the air temperature data. The collection of temperature measurements is not adequately described. Are the temperature measurements only to be collected where snow accumulation and snowmelt are expected, or are they also planned for other locations so plant responses to precipitation can be estimated or empirical ET estimates made?

In the section which describes the streamflow measurements, there is no discussion of precipitation networks for each of the gaged drainages. The initial location of a recording gage near the streamgage will not provide an adequate measure of drainage precipitation, especially for convective storms. Each drainage will require several precipitation gages to give a reasonable areal coverage. Achieving such coverage should be the objective in establishing the location and number of precipitation gages.

On page 3.1-28, there is mention of performing statistical analyses of long-term data to establish estimates of runoff

frequencies. However, earlier statements indicated that no significant amount of long-term data exists for the southern Nevada region including Yucca Mountain. Therefore, the program described here can not provide any statistically significant long-term information during the site characterization period.

Two alternatives to the statistical analysis method of estimating runoff frequencies are described: (1) determine runoff frequencies empirically using precipitation and basin characteristics, or (2) determine runoff frequencies using regionalized runoff relations. These two alternatives are rejected on page 3.1-28, although, in reality they are the only choices available to determine runoff frequencies for the area, and they will, in all likelihood, have to be employed if necessary information is to be obtained by the time it is needed for repository decisions, and to be used as input to other studies, i.e., unsaturated zone studies. The site-specific data to be collected will be valuable and should be obtained, but will serve only to reduce the uncertainty associated with the other approaches.

The simplified approach described in the section on the relation of runoff to weather conditions, and the explanations provided, are not adequate to meet the rigorous needs of the high-level waste repository siting and design. Determining

the necessary precipitation versus runoff relationships requires a complete understanding of watershed conditions prior to the event, since small changes in antecedent conditions can result in large changes in watershed response to a given input of precipitation.

Page 3.1-29 describes application of an evolutionary approach to the streamflow and precipitation measurement networks. This has both positive and negative consequences. While the dynamic measurement networks described can yield more precise and representative data, changes in the measurement location introduces an additional variable which effectively increases the uncertainty in determining site-specific precipitation-runoff relationships.

4. Activity 8.3.1.2.2.2 Transport of Debris by Severe Runoff

COMMENT

7

In the rationale section (page 3.2-1), the key reason given for evaluating transport of debris by severe floods is to assess the hazard to surface facilities. A very conservative approach is required to satisfy the activity objectives. Since site and regional data will be limited, an approach such as enveloping regional data to estimate this hazard should be considered in the Study Plan.

RESPONSES TO STATE OF NEVADA COMMENTS ON
STUDY PLAN 8.3.1.2.1.2
(CHARACTERIZATION OF THE YUCCA MOUNTAIN REGIONAL RUNOFF AND STREAMFLOW)

Response to Comment 1

The Study Plan is not intended to be either optimistic or pessimistic with respect to the characterization of streamflow. It is intended to be both realistic regarding the need for streamflow data that were essentially nonexistent when monitoring began in 1983, and practical by launching a concerted effort to obtain and interpret as many of the needed data as possible. The success of this effort depends on available time, study resources, and the vagaries of nature during the study duration. Perfection is not expected or possible, nor is it a requirement. There are no known strategies that would be acceptable that do not include a vigorous streamflow-data collection component. Streamflow data are needed by many site characterization activities other than site surface flooding. Study Plan 8.3.1.16.1.1 (Characterization of Flood Potential of the Yucca Mountain Site) sets forth an array of flood analysis and prediction strategies that do not rest exclusively on this data-collection activity. The five-year study duration identified in the Study Plan has not yet begun, and over eight years of data have already been collected in this ongoing study. Therefore, true duration of the study and its potential for success are subject to continuing reevaluation by the principal investigator and the U.S. Department of Energy.

Response to Comment 2

This Study Plan is not premature with regard to the status of the meteorological Study Plan because the runoff and streamflow Study Plan describes a study strategy that was generally in progress years before Study Plans became a requirement of the program. Study Plan 8.3.1.2.1.2 merely formalizes and expands the activity to interface better with other new and evolving investigations. It includes an element of flexibility that allows it to evolve with the natural scientific development of the entire Yucca Mountain Site Characterization Project. It was written to evolve with the increase in knowledge and possible changes of emphasis that should be expected of a dynamic and complex scientific research program. Study Plan 8.3.1.2.1.2 will interface with Study Plan 8.3.1.12.2.1 (Meteorological Data Collection at the Yucca Mountain Site). Neither plan, however, is likely to be a single-step process.

Response to Comment 3

Streamgaging sites are being evaluated with regard to their impact of construction on the environment, and will be installed in full accordance with environmental regulatory requirements. We believe it is important to proceed, as soon as practical, with their installation and operation to allow the collection of necessary and irreplaceable data critical to the development of knowledge essential for predictions.

Response to Comment 4

Paragraph 1

The first two objectives do not assume that "enough" events will occur during the period of data collection to provide an adequate data base upon which to characterize watershed response to precipitation events. However, there should be enough events to substantially improve current understanding of these relationships. There are no other regional data available to substitute. Therefore, data collection is not only helpful, but mandatory, regardless of the analytical techniques to be used. Also, paleoflood data will be collected as part of another Site Characterization Plan (SCP) Activity (8.3.1.5.2.1.1, Regional Paleoflood Evaluation) to broaden the data base. Figure 5.1-1 shows the characterization schedule by years starting with fiscal year (FY) 1 and continuing through FY 9. The U.S. Geological Survey (USGS) has been monitoring streamflow and precipitation since 1983, but FY 1 (in the context of this study) has not yet begun. USGS is proceeding with the available equipment, and adding additional equipment as site access and funding allows. At the end of FY 5, the need arises to analyze, synthesize, or hypothesize, the best means to characterize surface-water runoff and streamflow. However, without data, there will be nothing to analyze, limited synthesis, and fewer hypotheses. Data collection is the only fruitful course of action in these early years. Periods of no flow also provide valid data of unchallengeable accuracy. Any available data will be an asset rather than a liability. The objectives, as stated, are considered to define a straightforward, rational, and necessary strategy to meet the needs of site characterization. These objectives do not rule out new analytical technology or any technology transfer. USGS is not aware of a better strategy to provide the needed information.

Paragraph 2

The data gathered through the conduct of this study will be combined with those collected through Activity 8.3.1.16.1.1.1 (Site Flood and Debris Hazards). The Study Plan for that companion activity describes the likely use of more conceptual approaches, regional frequencies, and alternate approaches.

Response to Comment 5

Paragraph 1

Whether the statement "some degree of uncertainty is inevitable" is a "gross understatement" or not, cannot be known until the study is complete. The USGS could agree or disagree with the comment if a fixed end for the study was stipulated, what runoff will occur, etc. The Study Plan clearly states that few data are available and that it is the investigator's intent to collect some. The criticism in this comment seems directed to the Study Plan for Activity 8.3.1.16.1.1.1 (Site Flood and Debris Hazards). Reference to that plan and to Activity 8.3.1.5.2.1.1 (Regional Paleoflood Evaluation) will show that different lines of investigation are being pursued to provide useful estimates of flooding frequency and magnitudes.

Paragraph 2

The quotation cited appears in Section 2.2.1. USGS intends to collect detailed data on streamflow from Yucca Mountain when it occurs. However, one of the main impediments to the complete and efficient collection of these critical data has been an environmental permitting impasse with the State of Nevada, which prevents the installation of needed stream gages at the Yucca Mountain site. As a result, some important data may not be collected. Data collected away from Yucca Mountain will be used to temper interpretations of precipitation-runoff responses in Yucca Mountain stream channels. Major scaling up or down may not be necessary. The regional nature of streamflow and debris transport characterization was in part designed to address the site-specific data deficiencies that have been pointed out. Site-specific data collection is of the highest order of priority.

Paragraph 3

Surface-water characterization to better understand and cope with groundwater recharge and flooding will probably remain an important consideration during the post-construction period, and we anticipate that some site characterization activities (particularly monitoring) will continue beyond construction. Additional data may be needed for continual model calibrations and verifications, and to monitor storage safety and integrity and modify the facility. The statement in the Study Plan regarding the probable need for long-term streamflow-data collection, at least up to the time of repository closure, is therefore believed to be realistic at this stage in site characterization planning.

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 precise definition of the performance confirmation program will be established at a more appropriate time in the site characterization program.

Response to Comment 6

Paragraph 1

A universally acceptable definition of an "adequate" data base would be difficult to achieve. However, we believe the studies described in the plan will provide sufficient data to meet the performance and design information needs of the program.

Paragraph 2

USGS agrees that streamflow documentation in this environment is assumed to be less accurate than in most other environments. However, true accuracy will not be known until data collection proceeds fully and results are evaluated. Nevertheless, we believe that the data developed in this study will provide a reasonable basis for modeling the hydraulic regime at Yucca Mountain.

Paragraph 3

As noted above, data collection will continue throughout site characterization and may continue beyond it. Data have already been collected at many sites for over eight years. We believe this baseline will provide an adequate basis for longer term modeling and, moreover, we believe the strategies proposed in this Study Plan are prudent. We are, likewise, pleased the state's comments do not appear to have identified significant alternative approaches.

Paragraph 4

We agree that long periods of data collection are desirable, and we also agree that uncertainties that result must be compensated by conservative assumptions in analyses. We anticipate that the data collected in this and related studies in the hydrology program (including data that address the "antecedent conditions" mentioned by the commentor) is adequate to support the needed precipitation-runoff analyses. Antecedent conditions are also being measured by other activities (unsaturated and saturated-zone groundwater studies). Early study results can be used to justify changing strategies, if warranted.

Paragraph 5

All available data and all data collected in this study will be used to help characterize runoff and meet a wide variety of hydrologic objectives and needs stated in various Study Plans, as summarized in Sections 2 and 4 of this plan. Paragraphs 3 and 4 of page 3.1-6 state that historic data will be used in site characterization when the available data are useful and representative. Streamflow data collected after site characterization can be used to decrease uncertainty in extrapolations based on a larger data base.

Paragraph 6

We concur that it would not be appropriate to construct flow hydrographs from peak-flow measurements, and we do not intend to attempt it. Nevertheless, crest-stage data are a useful, and cost effective, component of the overall program of flood studies.

Paragraph 7

If additional automated sampling is determined to be needed and cost effective, it will be employed.

Paragraph 8

Storage gages measure cumulative rainfall and are useful and very cost effective. Intensity data is also being collected as part of the meteorological program, as described in Study Plan 8.3.1.2.1.1 (Meteorology for Regional Hydrology). In general, we believe the commentor's suggestion is already a fundamental part of the strategy; storage data will supplement recording-gage data.

Paragraph 9

Data from precipitation gages operated as part of this activity is being integrated with data from the meteorological network described in Study Plan 8.3.1.2.1.1 (Meteorology for Regional Hydrology) and Study Plan 8.3.1.12.2.1 (Meteorologic Data Collection at the Yucca Mountain Site).

Paragraph 10

Air temperature data will be collected at meteorological stations, as described in Study Plans 8.3.1.2.1.1 and 8.3.1.12.2.1. Decisions with respect to location of stations will be made in conjunction with the strategies developed through Study 8.3.1.12.2.1 and the perception of data needs as streamflow and snow-measurement gages are activated. USGS will collect the data needed to help calibrate precipitation-runoff models, within the constraints of the study.

Paragraph 11

The main precipitation measurement network is being designed and operated under SCP Study 8.3.1.2.1.1 (Meteorology for Regional Hydrology) and is described in that Study Plan. The network is currently operational. USGS will reexamine the data needs and add supplementary gages where they are needed, as site characterization proceeds.

Paragraph 12

The length of the data record at any site depends on a number of intangible and unknown factors, as discussed earlier. Also, the definition of "long-term" may vary in different contexts. Statistical analyses of the monitored period will be utilized, together with observation of the geologic record, as a basis for future predictions. We believe this combination will provide an adequate understanding of likely future performance, and of the uncertainties associated with projections.

Paragraph 13

We agree with this comment, and we recognize that multiple alternative strategies may be required. As the commentor recognizes, we believe the site characterization program we have defined will support any of the likely alternatives. Paragraph 3, page 3.1-28, indicates alternative strategies that might be used if available data are inadequate.

Paragraph 14

This paragraph is generally answered by several of the earlier responses. It is important to recognize that this study was not designed to precisely track each water droplet through the hydrologic cycle. Instead, it is designed to first obtain a fundamental grasp on basic precipitation-runoff relations, general accounting of regional runoff, specific accounting of

Yucca Mountain runoff in key drainages, and general calibration data for precipitation-runoff modeling in Fortymile Wash. It is also designed to recognize debris hazards related to runoff and to provide knowledge to better understand processes of debris movement at Yucca Mountain and throughout the region. Other activities will also provide complementary data on antecedent conditions at and around Yucca Mountain. The Study Plan is intentionally general with respect to streamflow characterization in some instances. This allows flexibility to adjust investigative strategies to accommodate knowledge gained through early results.

Paragraph 15

The comment is generally correct and understood. We believe the creation of uncertainties resulting from an evolutionary strategy will be compensated by the ability to maintain scientific flexibility to adjust the strategy as knowledge becomes available.

Response to Comment 7

This Study Plan deals mainly with the collection of debris-transport data. The use of these data for flood-hazard prediction is described in Study Plan 8.3.1.16.1.1 (Flood Potential and Debris Hazards of the Yucca Mountain Site). Analytical strategies for the application of these data are described in that plan, and we believe that some of those strategies include the conservative philosophy proposed by the commentor.