To: Robert Browning

Department of Energy
Yucca Mountain Site Characterization
Project Office
P. O. Box 98608
Las Vegas, NV 89193-8608

WBS 1.2.5.2.2
QA: N/A

DEC 18 1990

Robert R. Loux, Jr.
Executive Director
Nuclear Waste Project Office
State of Nevada
Evergreen Center
Suite 252
1802 North Carson Street
Carson City, NV 89710

RESPONSES TO STATE OF NEVADA COMMENTS ON THE SITE CHARACTERIZATION PLAN (SCP) RELATED TO STUDY PLANS 8.3.1.5.2.1 (QUATERNARY REGIONAL HYDROLOGY) AND 8.3.1.17.4.2 (LOCATION AND RECENCY OF FAULTING NEAR PROSPECTIVE SURFACE FACILITIES)

Enclosed are U.S. Department of Energy (DOE) responses to comments on the SCP related to the Study Plans referenced above. Enclosure 1 contains responses to comments germane to Study Plan 8.3.1.5.2.1 and Enclosure 2 contains responses to comments germane to Study Plan 8.3.1.17.4.2. The comment considered from the state's September 1989 comment package precedes each DOE response.

DOE identified comments in the state's September 1989 comment package that appeared applicable to these two Study Plans so that responses could be provided by January 1991. DOE acknowledges these comments from the State of Nevada and is currently in the process of addressing the remainder of the September 1989 comment package. DOE also appreciates the opportunity to explain or clarify the SCP's study program with respect to those aspects commented upon. Responses identify any actions that already have been, or are being, taken to address the comments.

If you should have any further questions or need of clarification, please contact David C. Dobson at (702) 794-7940.

Carl P. Gertz, Project Manager
Yucca Mountain Site Characterization
Project Office

RSED:TWB-720

Enclosures:
1. Comments and Responses for Study Plan 8.3.1.5.2.1
2. Comments and Responses for Study Plan 8.3.1.17.4.2

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NUCLEAR WASTE PROJECT OFFICE

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DEC 18 1990

cc w/encls:
J. W. Bartlett, HQ (RW-1) FORS
S. J. Brocoum, HQ (RW-22) FORS
D. E. Shelor, HQ (RW-30) FORS
S. G. Van Camp, HQ (RW-20) FORS
Allen Benson, HQ (RW-20) FORS
G. P. King, HQ (RW-5) FORS
S. M. Volek, SAIC, Las Vegas, NV
T. A. Grant, SAIC, Las Vegas, NV
M. D. Voegele, SAIC, Las Vegas, NV
J. L. Younker, SAIC, Las Vegas, NV
A. V. Gil, SAIC, Las Vegas, NV
J. H. Peck, SAIC, Las Vegas, NV

U.S. DEPARTMENT OF ENERGY RESPONSES TO COMMENTS RECEIVED FROM THE STATE OF NEVADA ON THE SITE CHARACTERIZATION PLAN PERTAINING TO THREE ACTIVITIES IN STUDY PLAN 8.3.1.5.2.1 CHARACTERIZATION OF THE QUATERNARY REGIONAL HYDROLOGY

The State of Nevada submitted comments on the statutory draft of the Site Characterization Plan in September, 1989. In preparation for near-term field activities, comments were identified which were related to work proposed under Study Plan 8.3.1.5.2.1 and responses were prepared addressing the concerns raised in these comments.

The U.S. Department of Energy response package provides a copy of the State of Nevada comments related to the study plan; the comments have had identifying numbers prefixed with "SNS" added. The responses include a brief synopsis of the comment. Each comment was either furnished a response or cross-referenced to a related response.

ENCLOSURE 1

SNS-42

NEVADA NUCLEAR WASTE PROJECT OFFICE
TECHNICAL REVIEW COMMENT FORM

DOCUMENT TITLE: Site Characterization Plan

COMMENT NO.: 16; pg. 1 of 1

CHAPTER NO.: 3

SEC. NO. PAGE NO. DRWG. NO.	COMMENT
sec. 3.7.4.1 pg. 3-106	Subject: Lowering of ground-water levels during the Quaternary Period. Specific Information: Para. 3, "Winograd et al. (1985) describe a major and progressive depletion in the deuterium content of ground-water recharge in the Spring Mountains (Figure 3-19) during the Quaternary Period, and the most likely explanation for this is a decrease in Pacific moisture due to uplift of the Sierra Nevada and Transverse Ranges". Discussion: It is recognized that this section is dealing with a longer time period than the isotope section apparently does (the entire Quaternary rather than about the last 15,000 years). However, the logic set forth in this section contradicts the simple tenet of the isotope section that "older" groundwater will have a depleted, heavy isotope composition characteristic of high-altitude, cold continental precipitation. Winograd and others' hypothesis would work in the opposite direction: older precipitation would be less depleted in heavy isotopes than would precipitation after major uplift. The concept of these opposing hypotheses should be recognized in the isotope section, accompanied by some discussion of the choice of time scale under consideration.

REVIEWER: Jenny Chapman
Print

Signature

ORGANIZATION:
Desert Research Institute
University of Nevada System

DATE: 6-22-89

COMMENT SNS-428

Lowering of groundwater levels during Quaternary period.

RESPONSE:

Yes, it is agreed that the effect of a rising Sierra Nevada would work in the opposite direction to that of a change of climate from colder, about 15,000 years ago, to a warmer regime at present. It must be borne in mind, however, that the time frames are different by orders of magnitude. Winograd et al. (1985) did not sample groundwaters, but carbonates deposited by groundwaters that have long since been replaced by more recent water. There is no known groundwater of sufficient age to show the effect hypothesized by Winograd. Thus, the concern expressed by this comment is not germane to the investigation of groundwaters at Yucca Mountain. If in the future sufficiently ancient groundwaters are discovered, this issue would be addressed.

REFERENCE:

Winograd, I.J., Szabo, B.J., Coplan, T.B., Riggs, A.C., and Kolesar, P.T., 1985, Two million year record of deuterium depletion in Great Basin ground waters; Science, vol. 227, p. 519-522.

SNS- 437

NEVADA NUCLEAR WASTE PROJECT OFFICE
TECHNICAL REVIEW COMMENT FORM

DOCUMENT TITLE: Site Characterization Plan

COMMENT NO.: 25; pg. 1 of 1

CHAPTER NO.: 3

SEC. NO. PAGE NO. DRWG. NO.	COMMENT
sec. 3.10.1 pg. 3-234	Subject: Summary of significant results . Specific Information: "...there is no evidence that water levels were more than 100 m higher during the Quaternary Period." Discussion: The above statement is incorrect. Though not necessarily conclusive, the carbonate deposits exposed in Trench 14 can easily be interpreted as spring deposits reflecting a very high ground-water level.

REVIEWER: Jenny Chapman
Print

Signature

ORGANIZATION:
Desert Research Institute
University of Nevada System

DATE: 6-22-89

COMMENT SNS-437

Summary of significant results.

RESPONSE:

Material presented in the cited section is an interpretation of the published data available at the time the Site Characterization Plan was prepared. The passage cited from Section 3.10.1 is a summary of information discussed in Sections 3.9.8 and 3.7.4, and is not an assertion standing without supporting data. The data gathered to date are totally consistent with a pedogenic origin for the calcite-silica deposits in Trench-14, but do not necessarily exclude an origin by upwelling water. The data are inconsistent with an origin from hot waters of any type. The commentor appears to accept the arguments of Mr. Szymanski, who believes that the Trench-14 deposits represent evidence supporting an interpretation for upwelling waters from the saturated zone. These calcite-silica deposits are to be characterized as part of Study Plan 8.3.1.5.2.1 (Characterization of the Yucca Mountain Quaternary Regional Hydrology).

SNS

25

II-167

NEVADA NUCLEAR WASTE PROJECT OFFICE TECHNICAL REVIEW COMMENT	
DOCUMENT TITLE: Site Characterization Plan : Yucca Mountain Site, Nevada Research and Development Area, Nevada : Nuclear Waste Policy Act (Section 113).	
AUTHOR(S): U.S. Department of Energy/ Office of Civilian Radioactive Waste Management	REFERENCE: DOE/RW-0199 (December 1988).
COMMENT #: 103	CHAPTER/SECTION: 8.3.1.3.5.1.1 Activity: Solubility measurements
SUBSECTION, PAGE #, PARAGRAPH(S) # LINE(S) #, PLATE #, FIGURE #, TABLE #, GRAPH #, MAP#.	COMMENT:
Pages 8.3.1.3-88 to 91	This activity is unchanged from the CD-SCP. The first water to come in contact with the nuclear waste canisters and thus transport radionuclides is vadose-zone water. The chemistry of vadose-zone water is not known, yet three water compositions have already been chosen for experiments. Clearly, these solubility measurements apply to the saturated zone and not the vadose zone. In view of the fact that most of the credit for ground-water travel time is in the vadose zone, lack of consideration of vadose-zone water chemistry is a serious omission.
REVIEWER: D. L. Shettel, Jr. Signature	ORGANIZATION: Mifflin & Associates, Inc. DATE: 30 June 1989

MY890703a

COMMENT SNS-725

Vadose-zone water chemistry.

RESPONSE:

Contrary to the implication of this comment, the Site Characterization Plan (SCP) does describe plans to characterize vadose zone water chemistry. However, those plans do not appear in the section cited in this comment. For example, according to Section 3.2 of Study Plan 8.3.1.5.2.1 (DOE, 1989), study of the isotopic and chemical characteristics of unsaturated zone water would be used to evaluate past infiltration and percolation history of Yucca Mountain. This evaluation would be coordinated with those of the hydrochemical characterization of the unsaturated zone, described in Study Plan 8.3.1.2.2.7 (DOE, 1990) (Hydrochemical Characterization of the Unsaturated Zone). Study 8.3.1.2.2.7 is the primary effort designed to assess the range of composition for unsaturated zone ground water. The description of activity 2 of Study Plan 8.3.1.5.2.1 is not contained in Revision 1 of the Study Plan. Revision 1 contains the 3 activities that comprise ongoing work. The information from all of these studies would be used in predicting potential radionuclide transport at Yucca Mountain.

REFERENCE:

DOE (U.S. Department of Energy), 1989. Study Plan 8.3.1.5.2.1 Paleoclimate Study: Lake, Playa, Marsh Deposits, Yucca Mountain Project Office, Las Vegas, NV.

DOE (U.S. Department of Energy), 1990. Study Plan 8.3.1.2.2.7 Hydrochemical Characterization of the Unsaturated Zone, Yucca Mountain Project Office, Las Vegas, NV.

SNS 08

II-249

NEVADA NUCLEAR WASTE PROJECT OFFICE
TECHNICAL REVIEW COMMENT

DOCUMENT TITLE:	Site Characterization Plan : Yucca Mountain Site, Nevada Research and Development Area, Nevada : Nuclear Waste Policy Act (Section 113).
AUTHOR(S): U.S. Department of Energy/ Office of Civilian Radioactive Waste Management	REFERENCE: DOE/RW-0199 (December 1988).
COMMENT #: 170	CHAPTER/SECTION: 8.3.1.5.1.4.2 Activity: Surficial deposits mapping of Yucca Mountain area.

SUBSECTION, PAGE #, PARAGRAPH(S) # LINE(S) #, PLATE #, FIGURE #, TABLE #, GRAPH #, MAP#.	COMMENT:
Pages 8.3.1.5-66 to 72	In the CD-SCP, this activity number was devoted to soil moisture analog study. In the SCP, this study has been removed. In the CD-SCP, the surficial deposits mapping activity was listed as 8.3.1.5.1.4.3 and is now listed as 8.3.1.5.1.4.2. A new addition to the objectives of this activity (from the CD-SCP) is to determine the distribution of major concentrations of calcite-silica vein deposits, at or near the ground surface at Yucca Mountain. Insufficient information is presented concerning these data and the means of data collection for the calcite-silica vein deposits. It is understood that the primary purpose is to map these deposits and possibly to date them using uranium series techniques. The means used for locating these deposits needs clarification, as does the chemical, mineralogical, and possibly paleontological techniques that will also be used to assess their genesis. A statement of clarification is needed to support how these deposits relate to the climate-change problem relating to Yucca Mountain.

REVIEWER: M. E. Morgenstein Signature	ORGANIZATION: Mifflin & Associates, Inc. DATE: 04 April 1989

MY890703a

COMMENT SNS-808

Calcite-silica vein deposits.

RESPONSE:

The information identified in the comment is to be gathered primarily by Study Plan 8.3.1.5.1.4 (Analysis of the Paleoenvironmental History of the Yucca Mountain Region). Some of these parameters, especially those related to past discharge deposits, e.g. areal extent, chemistry, mineralogy, and paleontology would be gathered by Study Plan 8.3.1.5.2.1 (Characterization of the Yucca Mountain Quaternary Regional Hydrology). See also the response to Comment 1659.

REFERENCE:

DOE (U.S. Department of Energy), 1989. Study Plan 8.3.1.5.2.1 Paleoclimate Study: Lake, Playa, Marsh Deposits, Yucca Mountain Project Office, Las Vegas, NV.

SNS 319

II-260

NEVADA NUCLEAR WASTE PROJECT OFFICE
TECHNICAL REVIEW COMMENT

DOCUMENT TITLE:	Site Characterization Plan : Yucca Mountain Site, Nevada Research and Development Area, Nevada : Nuclear Waste Policy Act (Section 113).
AUTHOR(S): U.S. Department of Energy/ Office of Civilian Radioactive Waste Management	REFERENCE: DOE/RW-0199 (December 1988).
COMMENT #: 181	CHAPTER/SECTION: 8.3.1.5.2.1.5 Activity: Studies of calcite and opaline silica vein deposits.

SUBSECTION, PAGE #, PARAGRAPH(S) # LINE(S) #, PLATE #, FIGURE #, TABLE #, GRAPH #, MAP#.	COMMENT:
Pages 8.3.1.5-110 to 118	In order to fully utilize ostracod data, a published account of the ecological database for recent species would be desirable. These data may prove to be highly significant in obtaining an understanding of the genesis of the opaline-carbonate deposits and, as such, should be made public. A full study plan is required prior to commenting further on this activity, as insufficient information is offered in the SCP.

REVIEWER: M. E. Morgenstein Signature	ORGANIZATION: Mifflin & Associates, Inc. DATE: 05 May 1989

MY890703a

COMMENT SNS-819

Calcite and opaline studies.

RESPONSE:

A large non-project ostracode data base has been assembled and smaller data bases geographically associated with Yucca Mountain are being collated. Ostracode data from samples collected in Kansas, Colorado, and New Mexico are being organized as a prototype test activity within the paleohydrology investigation. A report would then be completed that contains all physical and chemical data, ostracode occurrences, plates, and site descriptions. This study would be referenced in a Site Characterization Progress Report, when complete. Regardless of whether a well defined paleoenvironmental interpretation is able to be made from a suite of samples, presence and absence data for taxa is important information. Additional plans for paleontologic data collection are described in the Study Plan 8.3.1.5.1.2 (Paleoclimate Study: Lake, Playa, Marsh Deposits).

REFERENCE:

DOE (U.S. Department of Energy), 1989. Study Plan 8.3.1.5.2.1 Paleoclimate Study: Lake, Playa, Marsh Deposits, Yucca Mountain Project Office, Las Vegas, NV.

STATE OF NEVADA
AGENCY FOR NUCLEAR PROJECTS
NUCLEAR WASTE PROJECT OFFICE
QUALITY ASSURANCE PROCEDURE

SNS-1055

QAP-3.4
REVISION 0
JANUARY 20, 1989

NEVADA NUCLEAR WASTE PROJECT OFFICE
TECHNICAL REVIEW COMMENT FORM

DOCUMENT TITLE: Site Characterization Plan

COMMENT NO.: 3-11 p. 1 of 1 | CHAPTER NO.: 3

SEC. NO. (PAGE NO.) [FIG. NO.]	COMMENT
3.7.4.2 (3-107)	Uranium-disequilibrium ages on calcitic material from southern Nevada and southeastern California commonly yield questionable results. Any ages provided by this method should be identified as being tentative or preliminary.

REVIEWER: Kerry Keen
Print

Signature

ORGANIZATION:
L. Lehman & Associates, Inc.

DATE: June 29, 1989

COMMENT SNS-1055

Uranium-disequilibrium ages on Calcitic material.

RESPONSE:

The age of 750,000 years cited in section 3.7.4.2 reported by Winograd and Szabo (1986) is based on a long extrapolation beyond the range in which the technique is ordinarily used. Except for special cases the uranium series age could be used only to about 350,000 or perhaps to 400,000 years. To determine a greater age the initial U-234/U-238 ratio (at time zero) must be known. Winograd and Szabo (1986) have compiled a substantial data base for ground water discharge deposits with ages less than 400,000 years for which the initial U-234/U-238 ratio in the region of interest has remained essentially constant. They then extrapolate on the assumption that this was also true for more ancient deposits. The assumptions and reliabilities of the 750,000 year age are discussed in the cited reference. Thus, neither the usual uranium series nor uranium trend ages are the same as that cited in Site Characterization Plan section 3.7.4.2.

The U.S. Department of Energy (DOE) agrees with the reviewer. Section 3.5.3.7 of Study Plan 8.3.1.5.2.1, (DOE, 1989), contains a description of the multiple dating techniques that would be used to date calcite and silica vein-filling depositors. DOE anticipates using uranium-series, uranium-trending and electron spin resonance methods for dating calcite and silica deposits, potassium-argon for dating volcanic ash, and fission-track methods for apatite separated from wallrock.

REFERENCES:

DOE (U.S. Department of Energy), 1989. Study Plan 8.3.1.5.2.1 Paleoclimate Study: Lake, Playa, Marsh Deposits, Yucca Mountain Project Office, Las Vegas, NV.

Winograd, I.J. and Szabo, B.J., 1986, Water-table decline in the south-central Great Basin during the Quaternary Period; U.S. Geological Survey Open-File Report 85-697, 18 p.

STATE OF NEVADA
AGENCY FOR NUCLEAR PROJECTS
NUCLEAR WASTE PROJECT OFFICE
QUALITY ASSURANCE PROCEDURE

SNS-1076

QAP-3.4
REVISION 0
JANUARY 20, 1989

NEVADA NUCLEAR WASTE PROJECT OFFICE
TECHNICAL REVIEW COMMENT FORM

DOCUMENT TITLE: Site Characterization Plan

COMMENT NO.: 3-32 p. 1 of 1 | CHAPTER NO.: 3

SEC. NO. (PAGE NO.) [FIG. NO.]	COMMENT
3.9 (3-146)	The current state of our knowledge regarding the hydrologic properties of faults as expressed by "...faults may act preferentially either as conduits for or as barriers against moisture flow." is quite amazing. The role of a key component of the hydrologic system of the proposed site is barely understood. The role of faults should probably have been determined before a site was proposed that has faults passing through the controlled area and the proposed repository itself.

REVIEWER: Kerry Keen
Print

Signature

ORGANIZATION:
L. Lehman & Associates, Inc.

DATE: June 29, 1989

COMMENT SNS-1076

Groundwater and the role of faults.

RESPONSE:

See response to the State of Nevada comment 1308.

SNS-1308

NEVADA NUCLEAR WASTE PROJECT OFFICE
TECHNICAL REVIEW COMMENT FORM

DOCUMENT TITLE: SCP
DOCUMENT NO.: DOE/RW-0199 AUTHOR: DOE

COMMENT NO.: 6 CHAPTER NO.: 1

SEC. NO.: 1.5 PAGE. NO.: 207 FIG./TABL:

COMMENT

The discussion comparing faulting with the unsaturated conditions of the respository concludes that the transport of radionuclides to the accessible environment is not likely in the pre-emplacement period and during the first 10,000 years. However, faulting which may occur in the post-emplacement period can change the hydrologic regime by blocking the present path of groundwater flow. The concern is not with springs appearing at the surface but with a local upwelling forming in the water table which may rise into the repository.

REVIEWER: Philip Murphy

Philip Murphy
Signature

ORGANIZATION: Dunn

DATE: 06-05-89

COMMENT SNS-1308

Faulting and the hydrologic regime.

RESPONSE:

Most faults are vertical or nearly vertical, and as such are not likely to block the path of unsaturated zone groundwater flow, which is thought to be predominantly vertical. Faults and fractures are known to be barriers in some cases and conduits for flow in other cases. This condition depends on many factors, including the degree of saturation, fracture coatings, capillary potential of the rock matrix, and other properties of the rock and fractures. One purpose of site characterization is to determine just how these properties affect the movement of fluids at Yucca Mountain.

The concern about local upwelling (along faults?) into the repository has been expressed by others. The U.S. Department of Energy would be examining this concern by assessing the possible mechanisms, estimating the probability of such an event, and by examining the consequences of such a hypothetical water table rise. Studies may show that the consequences are small, even in the unlikely case that a repository at Yucca Mountain is flooded by such a mechanism. For an unsaturated site, if such an event were to take place, a repository would only lose the geologic advantages for waste isolation currently believed to exist for disposal in the unsaturated zone (for example, the estimated very slow movement of water through the vadose zone).

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STATE OF NEVADA
AGENCY FOR NUCLEAR PROJECTS
NUCLEAR WASTE PROJECT OFFICE
QUALITY ASSURANCE PROCEDURE

QAP-3.4
REVISION 0
JANUARY 20, 1989

NEVADA NUCLEAR WASTE PROJECT OFFICE
TECHNICAL REVIEW COMMENT FORM

DOCUMENT TITLE: Site Characterization Plan

COMMENT NO.:	1-20	CHAPTER NO. 1
SEC. NO. PAGE NO. DRWG. NO.	COMMENT	
Sec. 1.2.2.2.10	<u>Age of calcite deposits</u> Section 1.2.2.2.10, p. 1-73; It is stated that "a correlation with even the younger ash is consistent with a relatively old age for the calcite deposits." This is not necessarily true, especially in light of recent evidence that Lathrop Wells Cone is younger than 20,000 yr old (Wells and others, 1988). Also, no evidence is presented that excludes the possibility of calcite formation postdating the ash.	

REVIEWER: Alan R. Ramelli
Print

Alan R. Ramelli
Signature

ORGANIZATION: University of Nevada-Reno

DATE: 6/29/89

Form 3.4.1

COMMENT SNS-1566

Age of calcite deposits.

RESPONSE:

If the Lathrop Wells cinder cone is as young as some have postulated, it is unlikely that the uncemented ash found in several faults near Yucca Mountain could be correlated with this most recent activity associated with the cone. The unlikely nature of the correlation is supported because there is a largely impermeable calcitic soil horizon developed atop the calcite and opaline silica deposits which is about 100,000 years old. It is therefore not likely that the ash infiltrated through the soil horizon.

SNS-1656

NEVADA NUCLEAR WASTE PROJECT OFFICE
TECHNICAL REVIEW COMMENT FORM

DOCUMENT TITLE: Site Characterization Plan

COMMENT NO.: 3-16; pg. 16 of 91	CHAPTER NO.: 8

SEC. NO. PAGE NO. DRWG. NO.	COMMENT
8.3.1.5.2.1.5 p. 8.3.1.5-110	Studies of calcite and opaline silica veins.

It would appear that this is yet another of the 'shotgun' approaches that exist throughout this draft SCP. DOE proposes almost all possible techniques to answer the question are these veins formed by ground waters going down or hydrothermal waters going up? What they do not appear to have done is to consider these possibilities in any sort of broader context (regional geologic significance??). Do the veins presently exposed in Trench 14 presage a broad-scale, post volcanic, hydrothermal event at or near Yucca?? Such are known elsewhere-witness the Golconda, Nv. deposits of manganese-tungsten and silver hosted in Quaternary valley alluvium and the slightly older but clearly post-volcanic Sulfur, Nv. gold deposits. What possibilities do these sorts of considerations open?

REVIEWER: L.T. Larson L. T. Larson J.R.	ORGANIZATION: Univ. Nevada-Reno DATE: June 9, 1989

COMMENT SNS-1656

Calcite and opaline silica veins.

RESPONSE:

A peer review report (Hanson et al. 1987) on the proposed program of studies of the calcite and opaline-silica deposits in the Yucca Mountain area recommended proceeding with multiple techniques for investigating these deposits. The report considered the variety of techniques that could be useful and recommended that the work be ranked, with the use of later techniques being dependent on the results of early work.

At least a low potential for geothermal resources at the Yucca Mountain site is indicated by the existence of warm springs in the region and late Tertiary volcanic activity in the Crater Flat area. To address this possibility, Study Plan 8.3.1.9.2.1 (Natural Resource Assessment of Yucca Mountain Region, Nye County, Nevada) would also provide a final qualitative assessment of geothermal resources at the repository site in terms of (1) the presence or absence of favorable conditions, (2) the present-day value and utility if located, and (3) the potential for future exploration. Information needed for this assessment would be obtained in large part from the evaluation and modeling of geothermal systems being conducted in Activity 8.3.1.9.2.1.3 (Assessment of the Potential for Geothermal Energy at Yucca Mountain). The response to Comment 1659 identifies data gathering activities related to calcite-silica deposits. If, in the course of these activities, data is gathered that indicates the potential for minerals of economic value, such information would be passed through to Study 8.3.1.9.2.1. The identification of mineral and energy deposits in the Yucca Mountain area is included in Study Plan 8.3.1.9.2.1. This Study Plan includes a geochemical assessment of mineralization based on a detailed sampling and analytical program, and an appraisal of the mineral resource potential based on geological and geophysical data.

On February 6-7, 1990, a technical exchange was held regarding the calcite-silica deposits between the U.S. Nuclear Regulatory Commission and the U.S. Department of Energy (DOE) with representatives from the State of Nevada in attendance. Information based on recent field and laboratory work was introduced by a scientist employed by the State of Nevada and scientists employed by DOE. None of the evidence presented indicated that the deposits were formed by high temperature water upwelling from depth. All of the evidence was consistent with the deposits being formed by the downward percolating waters of a pedogenic system. The information, however, was not inconsistent with other low temperature modes of origin. Additional studies are planned to further test these findings and to reduce uncertainty.

REFERENCE:

Hanson, G.N., Baker, V.R., Bethke, PM., Hudleston, P.J., and Roquemore, G.R., 1987, Report of the peer review panel on the proposed program of studies of the calcite and opaline silica deposits in the Yucca Mountain area, Nevada; Department of Earth and Space Sciences, State University of New York, Stony Brook, New York, pp 1-13.

SNS-1657

NEVADA NUCLEAR WASTE PROJECT OFFICE
TECHNICAL REVIEW COMMENT FORM

DOCUMENT TITLE: Site Characterization Plan

COMMENT NO.: 3-17; pg. 17 of 91	CHAPTER NO.: 8

SEC. NO. PAGE NO. DRWG. NO.	COMMENT
8.3.1.5.2.1.5 p. 8.3.1.5-110	Studies of calcite and opaline silica veins.

The nature and origin of the various calcite-silica veins and fracture fillings bear directly on questions concerning the extent and character of paleohydrothermal system(s) present beneath Yucca Mtn. It is critical that this group of activities be integrated with studies concerning past alteration (8.3.1.3.2.2) and potential for undiscovered mineral deposits. The geochemical, textural and petrographic information obtained in these studies should be part of the information base of the mineral resource studies, regardless of whether the information is of economic interest or not. It is disturbing to see this type of non-integrated approach so late in the DOE's program.

REVIEWER: S.I. Weiss Steven I. Weiss	ORGANIZATION: Univ. Nevada-Reno DATE: June 9, 1989

COMMENT SNS-1657

Nature and origin of veins.

RESPONSE:

The response to Comment 1659 identifies data gathering activities related to calcite-silica deposits. If, in the course of these activities, data is gathered that indicates the potential for minerals of economic value, such information would be passed through to Study 8.3.1.9.2.1 (Natural Resource Assessment of Yucca Mountain, Nevada).

The U.S. Department of Energy agrees with the reviewer about multiple uses of data and any linkage between these deposits with the potential for ore deposits would be considered during the assessment of mineral and energy resources in Study Plan 8.3.1.9.2.1. See also the responses to comments 1656 and 1659.

SPS-1658

NEVADA NUCLEAR WASTE PROJECT OFFICE
TECHNICAL REVIEW COMMENT FORM

DOCUMENT TITLE: Site Characterization Plan

COMMENT NO.: 3-18; pg. 18 of 91	CHAPTER NO.: 8

SEC. NO. PAGE NO. DRWG. NO.	COMMENT

8.3.1.5.2.1.5 Studies of calcite and opaline silica veins.
p. 8.3.1.5-110

The SCP outlines methods and technical procedures that utilize almost every conceivable laboratory - petrographic, chemical, isotopic, etc., procedure to characterize the vein deposits. The principal weakness in their approach is geological, and reflects an inadequate consideration of the importance of a thorough and quantitative understanding of the late Cenozoic paleohydrothermal history of the region within which the southwestern Nevada volcanic field is situated.

Specifically, the veins would be of much greater significance to the potential for disruption or flooding of the Repository if it could be shown that important hydrothermal activity had taken place in the region in latest Neogene (late Pliocene and/or Quaternary) time, than if this period, during which their was very little or no silicic igneous activity, was a time when no major hydrothermal/geothermal systems had developed in the region. This is particularly true if, as we suspect, it will not be possible to accurately date the veins by radiometric or other methods.

A *regional* understanding of the space-time distribution of hydrothermal activity is thus required. Moreover, it should be noted that there are several localities in Nevada (e.g., Sulfur, McGinniss) where there has been important hydrothermal activity, which in one case deposited economic precious-metal mineralization and in the other deposited Au and Ag, but in subeconomic amounts, well after the cessation of known Cenozoic volcanic activity!

REVIEWER: D.C. Noble D. C. Noble J.R.	ORGANIZATION: Univ. Nevada-Reno DATE: June 9, 1989

COMMENT SNS-1658

Methods and technical procedures.

RESPONSE:

The timing and amount of hydrothermal activity in the Yucca Mountain region and its importance to mineralization would be investigated in Study Plan 8.3.1.9.2.1 (Natural Resource Assessment of Yucca Mountain Region, Nye County, Nevada). Ore deposit models would be applied to Yucca Mountain to determine the association of mineralization with faults, fractures, and geothermal activity in the region.

Modern geothermal resources would also be evaluated under the auspices of Study Plan 8.3.1.9.2.1. These studies would include consideration of evidence for both regional and local paleohydrothermal activity in later Tertiary and Quaternary time, including the periods of both silicic and bimodal (basalt-rhyolite) volcanism.

It should also be noted that the conclusion drawn in the comment is based on two assumptions regarding the geology and an assumption regarding the importance of the calcite-silica veins in performance assessment. None of these assumptions have been proven and they may be invalid. The first geologic assumption stated "... it would not be possible to accurately date the veins by radiometric or other methods." Attempts are currently being made to date the veins by several different means. Should these prove successful, the conclusion is not valid.

The second geologic assumption is unstated and is that the calcite-silica veins were deposited by upwelling hydrothermal waters. This hypothesis is currently being tested and appears to be invalid. On February 6-7, 1990, a technical exchange was held between the U.S. Nuclear Regulatory Commission and the U.S. Department of Energy (DOE) regarding the calcite-silica deposits; representatives from the State of Nevada were also in attendance. Information based on recent field and laboratory work was introduced by a scientist employed by the State of Nevada and scientists employed by DOE. None of the evidence presented indicated that the deposits were formed by high-temperature water upwelling from depth. All of the evidence was consistent with the deposits being formed by the downward percolating waters of a pedogenic system. The information, however, was not necessarily inconsistent with low temperature spring deposits or deposition in a local recharge zone. Additional studies are planned to further test these findings and to add more certainty. This would appear to render the commentor's interpretation of these veins as hydrothermal indicators as invalid.

The section of the Site Characterization Plan (SCP) cited does not discuss the potential performance assessment impacts of the possible scenarios. It merely discusses the plans for site characterization. Performance assessment implications of the veins for potential repository disruption scenarios with regard to total-system performance are discussed in SCP Section 8.3.5.13.

SNS-1659

NEVADA NUCLEAR WASTE PROJECT OFFICE
TECHNICAL REVIEW COMMENT FORM

DOCUMENT TITLE: Site Characterization Plan

COMMENT NO.: 3-19; pg. 19 of 91	CHAPTER NO.: 8

SEC. NO. PAGE NO. DRWG. NO.	COMMENT
8.3.1.5.2.1.5 p. 8.3.1.5-111	Studies of calcite and opaline silica veins.

OBJECTION: Last paragraph states mapping from another activity will be used to determine the location and areal distribution of the calcite-opaline silica deposits, which will establish an important datum and critical point for modeling. The cited activity (8.3.1.5.1.4.2) appears to deal only with mapping of surficial deposits and thus the calcite-silica deposits within bedrock will apparently not be included. This is completely unacceptable; the datum will be meaningless without consideration of the deposits in bedrock as well.

REVIEWER: S.I. Weiss Steven I. Weiss	ORGANIZATION: Univ. Nevada-Reno DATE: June 9, 1989

COMMENT SNS-1659

Maps from other activities.

RESPONSE:

Study Plan 8.3.1.5.2.1, Section 3.5.3.3, p. 3.5-16, states, "A second objective of field investigations, which would be accomplished largely as part of allied studies (surficial deposits mapping of Study Plan 8.3.1.5.1.4 Paleoenvironmental History of Yucca Mountain Region), will be to construct a map of the proposed waste-disposal site, indicating the location and extent of all known spring deposits as well as all Quaternary surficial deposits containing calcite and silica. To the extent possible, the map would show these deposits subdivided by mode or origin."

Study Plan 8.3.1.4.2.2 (Characterization of the Structural Features Within the Site Area) contains the following bedrock mapping activities; 1) geologic mapping of zonal features in the Paintbrush Tuff, 2) surface-fracture network studies, 3) geologic mapping of the exploratory shaft and drifts, and 4) borehole evaluation of faults and fractures. These activities also include descriptions of fracture filling materials, degree of mineralization, and the mineralogy of the fracture-fillings. Drilling activities would obtain core at various depths across the site. Calcite-silica vein filling materials obtained from core samples would be made available for study by the appropriate investigators, including those responsible for Study 8.3.1.3.2.1 (Mineralogy, Petrology and Chemistry of Transport Pathways) and Study 8.3.1.3.2.2 (History of Mineralogic and Geochemical Altration of Yucca Mountain).

RFERENCE:

DOE (U.S. Department of Energy), 1989. Study Plan 8.3.1.5.2.1 Paleoclimate Study: Lake, Playa, Marsh Deposits, Yucca Mountain Project Office, Las Vegas, NV.

DOE (U.S. Department of Energy), 1990. Study Plan 8.3.1.3.2.1 Mineralogy, Petrology and Chemistry of Transport Pathways, Yucca Mountain Project Office, Las Vegas, NV.

DOE (U.S. Department of Energy), 1990. Study Plan 8.3.1.4.2.2 Characterization of the Structural Features Within the Site Area, Yucca Mountain Project Office, Las Vegas, NV.

U.S. DEPARTMENT OF ENERGY RESPONSES TO COMMENTS RECEIVED FROM THE STATE OF NEVADA ON THE SITE CHARACTERIZATION PLAN PERTAINING TO STUDY PLAN 8.3.1.17.4.2 LOCATION AND RECENCY OF FAULTING NEAR PROSPECTIVE SURFACE FACILITIES

The State of Nevada submitted comments on the statutory draft of the Site Characterization Plan in September, 1989. In preparation for near-term field activities, comments were identified which were related to work proposed under Study Plan 8.3.1.17.4.2 and responses were prepared addressing the concerns raised in these comments.

The U.S. Department of Energy response package provides a copy of the State of Nevada comments related to the study plan; the comments have had identifying numbers prefixed with "SNS" added. The responses include a brief synopsis of the comment. Each comment was either furnished a response or cross-referenced to a related response.

ENCLOSURE 2

At a minimum the DOE should use 1:5,000 scale maps (Wu, 1985) for compiling all data within the boundary of the accessible environment. Appropriate smaller scale maps should be used to compile and represent critical areas of detailed studies, e.g. pavement mapping; FITS; ESF surface site; etc.

SNS-210 Repository Block - The way that the repository block is represented on the various maps and cross-sections is misleading. With the exception of the Ghost Dance fault the repository block is invariably shown to be essentially void of other faults, joints, and fractures that appear to be pervasive to the east, south, and north. Although this may turn out to be the case, the DOE does not present data in the SCP to justify this representation. In addition a very honest and conservative interpretation of Scott & Bonk's 1984 map just does not support the DOE position.

SNS-211 Surface Facility Site - The DOE representation of the site area east of Exile Hill in Midway Valley chosen for the surface facilities is very misleading. Neal (1986) presents clear evidence to support his interpretation of a fault zone that is at least 1 km wide with a cumulative offset of several hundred meters that appears to cover the entire area beneath the proposed surface facilities site. DOE repeatedly tries to minimize the significance of these data. For example, DOE makes the statement (Page 8.3.1.17-93 and 94) attributed to Neal (1986) that "indicates that closely spaced faults (less than 50 meters) occur beneath the surficial deposits". Neal (1986) makes no statement regarding specific fault spacing but instead interprets a zone of faulting over 1 km wide. Another example can be found on Page 8.3.1.17-61 where DOE states that "surface facilities (FITS) will be cited where there is no evidence of Quaternary faulting". On Page 8.3.1.17-60/61 the DOE implies that it is acceptable to site FITS over Quaternary faults as long as the slip rate is less than 0.001 mm/yr or the faults don't measurably offset materials less than 100,000 years old. Since the DOE will probably not be able to demonstrate either of these conditions at the Midway Valley site unless they are willing to dig a 1 - 2 km long trench to a depth of 60 - 90 meters, they should give serious consideration to finding an alternate site for FITS. In the interim a candid representation of the existing geological data coupled with an honest statement of the difficulties that will be faced in demonstrating site suitability would be a welcome change from the present SCP descriptions.

SNS-212 Geophysics - The SCP discussion of geophysical activities is ambiguous and misleading throughout. The erroneous impression is continually given that useful geophysical techniques are available that will work at Yucca Mountain and have sufficient resolution such that the data can be used in supporting performance assessment and design. The implication is that geophysics will somehow be able to provide considerable information between, beneath, and/or outside of the limited

COMMENT SNS-211

Surface Facility Site.

RESPONSE:

The comment asserts that substantial faults of Quaternary-age underlie the prospective location for facilities important to safety (FITS), i.e. waste handling buildings. The Bow Ridge and Paintbrush Canyon faults are known to have Quaternary offset in the Midway Valley area. However, these faults are located so that offset on either would not pose a surface rupture hazard to prospective surface facilities. No other faults within Midway Valley are definitely known to exist, are known to be buried by alluvium at depth, or are known to be concealed by surficial alluvium, including the postulated Midway Valley fault of Lipman and McKay (1965). Neal's Midway Valley fault zone was postulated to be about 1 km wide and to consist of multiple normal faults with a cumulative slip of many 10s to 100s of meters. The significance of Neal's interpretation cannot be properly judged given current information. Neal (1986) did not find geomorphic evidence of faulting within the valley and clearly states (p. 25) that, "the investigations provided no indication as to whether the imbricate normal faults [his Midway Valley fault zone] penetrate the overlying alluvium" at the site of the prospective location for FITS. The U.S. Department of Energy does not minimize the significance of these data, since its significance at this time cannot be properly judged.

Neal's (1986) Figure 7, a diagrammatic cross-section, shows faults underlying Midway Valley that penetrate into the alluvium. This cross-section is an interpretation based on seismic reflection data. The discussion in Neal (1986) stated the limitations of this technique. He stated (p. 24) that, "seismic velocities in alluvium and fractured tuff are sufficiently similar so that velocity alone cannot be used to distinguish the two. Consequently, structural interpretations based on these data may also be suspect; the structural model generated from the velocity measurements varies considerably from both the conceptual geologic model based on surface mapping and the geologic model based on borehole observations and surface mapping." It is therefore not known if faults postulated within Neal's fault zone show displacement that post-dates Tiva Canyon tuff emplacement and deposition of the oldest valley-fill.

Neal (1986) recognized that the potential surface fault rupture remained an outstanding issue that had not been fully resolved. One of the main recommendations of Neal's (1986) report (p. 26) was that, "a program of trenching through the alluvium should be conducted to determine if faulting has extended into younger alluvium, overlying the intensely fractured and faulted Tiva Canyon tuff. Several locations need to be selected, in order to investigate the alluvium over a range of ages... trenching is essential to determine if faulting has penetrated the alluvium; seismic surveys are not apt to provide this information." Study Plan 8.3.1.17.4.2 (DOE, 1989)is basically designed to implement Neal's recommendation.

By its nature, the trenching activity for the Midway Valley study is site-specific; that is, a specific site must be assumed for prospective facilities before siting a trench to obtain site-specific information there. The original selection of Midway Valley as the location of the reference

conceptual site was made on the basis of an engineering evaluation related to the location of surface facilities with respect to access ramps to the underground facility, topography in the area, and transportation route considerations. These remain valid considerations for prospective FITS. Midway Valley would continue to be considered as the preferred location for prospective FITS until an adequate data base is generated to evaluate whether surface faulting potential is a significant factor there or not. Because the results of a site-specific trenching activity cannot be determined in advance, Study Plan 8.3.1.17.4.2 is sequential in its approach, in that the first activity of the study would select a site for trenching and the second activity would investigate that site. Study Plan 8.3.1.17.2.1 (Faulting Potential at the Repository) would evaluate the results of this study and determine if the site is suitable for prospective surface facilities. If Study 8.3.1.17.2.1 determines that faulting or, an apparent absence of significant faulting, could not be demonstrated with sufficient confidence, then Study 8.3.1.17.4.2 would be directed to gather more information about the site or repeat the study at another location.

The commentor is correct in noting that a near-surface exploratory investigation, such as Midway Valley trenching, may not obtain the information enabling determination of slip rates of less than 0.001 mm/year or indicate offset in alluvium less than 100,000 years old, because stratified valley-fill materials of the proper age are not encountered in trenches. Testing the adequacy and resiliency of existing stratigraphic framework(s) for age control is part of the work scope for the Study Plan (8.3.1.17.4.2). The point is thus well-illustrated that the only way to determine the nature of these alluvial materials, and thereby the extent and character of faulting in Midway Valley, is to carry out the site characterization study.

REFERENCES

Lipman, P. W., and E. J. McKay, 1965, Geologic Map of the Topopah Spring SW Quadrangle, Nye County, Nevada; Map GQ-439, U.S. Geological Survey, Washington D.C.

Neal, J. T., 1986, Preliminary Validation of Geology at Site for Repository Surface Facilities, Yucca Mountain, Nevada; SAND85-0815, Sandia National Laboratories, Albuquerque, NM.

DOE (U.S. Department of Energy), 1989. Study Plan 8.3.1.17.4.2, "Location and Recency of Faulting Near Prospective Surface Facilities." Yucca Mountain Project Office, Las Vegas, NV.

SNS-277

STATE OF NEVADA
AGENCY FOR NUCLEAR PROJECTS
NUCLEAR WASTE PROJECT OFFICE

QAP-3.4

NEVADA NUCLEAR WASTE PROJECT OFFICE
TECHNICAL REVIEW COMMENT FORM

DOCUMENT TITLE: Site Characterization Plan

COMMENT NO.: 61 pg. 1 of 1	CHAPTER NO.: 8

SEC. NO. 8.3.1.17
PAGE NO. 8.3.1.17-28
DRWG. NO.

It is stated that the Paintbrush Canyon, Bow Ridge, Solitario Canyon, and Windy Wash Faults show evidence of normal dip-slip movement along surfaces that dip steeply to the west. The text fails to mention the Midway Valley Fault System between the Paintbrush Canyon and Bow Ridge Faults which also underlies the proposed surface facilities. This fault zone is estimated to be over 1 km wide with several hundreds of meters offset. The fault zone is also reported to dip to the east rather than to the west (Neal, 1986). The Midway Valley Fault is estimated to be as long or longer than the Bow Ridge Fault (USGS, 1984). A conservative position required by present NRC practice is to assume that the entire fault length could be active if any one segment is active. The question then becomes one of the size of earthquake that such a fault could sustain and not which segment is active.

REVIEWER: David D. Tillson (Print)	ORGANIZATION: Consulting Geologist
David D. Tillson (Signature)	DATE: June 30, 1989

COMMENT SNS-277

Midway Valley fault system.

RESPONSE:

The degree of interconnectedness of major faults in the area would be addressed as part of studies 8.3.1.17.4.6 (Quaternary faulting within the Site Area) and 8.3.1.17.4.7 (Subsurface Geometry and Concealed Extensions of Quaternary Faults at Yucca Mountain). Furthermore, the U.S. Department of Energy (DOE) enters characterization with no a priori view whether major faults are connected or not, or that the results of previous studies would be borne out by further work. DOE is unaware of any NRC requirement, applicable to surface FITS for a mined geologic disposal system that, mandates the assumption, "that the entire fault length could be active if any segment is active."

DOE's current basis for evaluating seismic hazard is the 10,000-year cumulative slip earthquake for which the technical basis, and a hypothetical application, are fully explained in DOE's responses to the State of Nevada's comment 346H and NRC's comment 52 on the SCP/Consultation Draft. See also the response to State of Nevada comment 211.

REFERENCES

Lipman, P. W., and E. J. McKay, 1965. Geologic Map of the Topopah Spring SW Quadrangle, Nye County, Nevada; Map GQ-439, U.S. Geological Survey, Washington D.C.

Neal J.T., 1986. "Preliminary Validation of Geology at Site for Repository Surface facilities, Yucca Mountain, Nevada," SAND85-0815, Sandia National Laboratories, Albuquerque, NM.

DOE (U.S. Department of Energy), 1989. Study Plan 8.3.1.17.4.2, "Location and Recency of Faulting Near Prospective Surface Facilities." Yucca Mountain Project Office, Las Vegas, NV.

SNS-283

STATE OF NEVADA
AGENCY FOR NUCLEAR PROJECTS
NUCLEAR WASTE PROJECT OFFICE

QAP-3.4

NEVADA NUCLEAR WASTE PROJECT OFFICE
TECHNICAL REVIEW COMMENT FORM

DOCUMENT TITLE: Site Characterization Plan

COMMENT NO.: 67 pg. 1 of 1	CHAPTER NO.: 8

SEC. NO. 8.3.1.17
PAGE NO. 8.3.1.17-32
DRWG. NO.

It is stated that extensive field investigations will be conducted in the immediate site vicinity of facilities important to safety (FITS). The design parameter being used gives preliminary guidance on the distance (100 meters) detailed studies (continuous trenching) should extend from the location of FITS. The 100 meter trench distance is unlikely to meet NRC requirements for investigations of possible surface fault rupture at the FITS site in Midway Valley. Present NRC regulation requires mapping over a distance of at least 10 miles (16 km) in both directions along the fault trace to establish the control width. Based upon the results of the mapping, the control width (zone requiring detail study) is then established. Based upon the maps presently available from the DOE (USGS, 1984 and Neal, 1986) it is estimated that the control width will be closer to 1 km rather than the proposed 100 meters.

REVIEWER: David D. Tillson (Print)	ORGANIZATION: Consulting Geologist
David D. Tillson (Signature)	DATE: June 30, 1989

COMMENT SNS-283

Field investigations in the vicinity of FITS.

RESPONSE:

The distance of 100 m in Site Characterizatin Plan (SCP) Tables 8.3.1.17-3(a) and 8.3.1.17-3(b) is the distance from facilities important to safety (FITS) in which a detailed trenching program would attempt to identify faults with marginally significant slip rates (>0.001 mm/yr) or faults that measurably offset materials less than 100,000 years old. The 100 m distance is intended to be guidance on the minimum distance that trenches in SCP Activity 8.3.1.17.4.2.2 should extend from the locations of prospective FITS.

The use of a 100 meter distance past the limits of FITS in the SCP is not a standoff distance from any potential faults and it is not intended that standoff distances would be used as the primary basis for assessing surface rupture hazard. The principal concern is probability of surface faulting under the FITS themselves and not with the distance of the FITS from a fault. Therefore, the primary design parameter for this concern is the total probability of exceeding 5 cm of fault displacement at the locations proposed for FITS. This evaluation is to be made in Study Plan 8.3.1.17.2.1 (Faulting Potential at the Repository).

An important contributor to this evaluation would be evidence that differential offset (due to either primary, branch, or secondary faulting) has or has not occurred at the prospective locations for FITS in the Late Quaternary. A primary assumption is that the longer the time interval during which no faulting has occurred at the FITS location, the lower the probability of faulting during the next 100 years (the operational life of FITS). The SCP establishes a minimum duration for this time interval of no faulting as the last 100,000 years. Therefore, the objective of the trenching in Activity 2 of Study Plan 8.3.1.17.4.2 (DOE, 1989) is not to measure the distance to the nearest fault but to determine whether any offset has occurred at the prospective location for FITS during a time period longer than the last 100,000 years. Even if it can be shown that no offset occurred at the FITS location for a period greatly in excess of 100,000 years, there would still be some low probability of fault offset for the future. Study 8.3.1.17.2.1 would evaluate this probability by considering the results of Study 8.3.1.17.4.2 and combining these results with those of geophysical, drilling, and regional and local faulting studies to estimate the probability of faulting at the prospective location for FITS.

See the responses to the State of Nevada comment 316 on the statutory SCP for further discussion regarding applicability of 10 CFR 100 Appendix A to a mined geologic disposal system.

REFERENCES

DOE (U.S. Department of Energy), 1989. Study Plan 8.3.1.17.4.2, "Location and Recency of Faulting Near Prospective Surface Facilities." Yucca Mountain Project Office, Las Vegas, NV.

STATE OF NEVADA
AGENCY FOR NUCLEAR PROJECTS
NUCLEAR WASTE PROJECT OFFICE

SNS-292

QAP-3.4

NEVADA NUCLEAR WASTE PROJECT OFFICE
TECHNICAL REVIEW COMMENT FORM

DOCUMENT TITLE: Site Characterization Plan

COMMENT NO.: 76 pg. 1 of 1	CHAPTER NO.: 8

SEC. NO. 8.3.1.17.2.1.1
PAGE NO. 8.3.1.17-60 and 61
DRWG. NO.

The parameters required for the synthesis of data to assess the potential for surface faulting that FITS indicates that only faults within 100 meters of locations proposed for FITS that have apparent Quaternary slip rates g.t. 0.001 mm/yr or that measurably offset materials less than 100,000 year old will be investigated. It is reported (J. T. Neal, SAND85-0815, 1986) that the Midway VAlley Fault Zone is at least 1 km wide with a cumulative offset of "several hundred meters" beneath the site chosen for the surface facilities. If the proposed synthesis includes only data within 100 meters of FITS, it is quite probable in the case of Midway Valley that the NRC requirements for control width zone investigations will not be met.

REVIEWER: David D. Tillson (Print)	ORGANIZATION: Consulting Geologist
David D. Tillson (Signature)	DATE: June 30, 1989

COMMENT SNS-292

Potential for surface faulting.

RESPONSE:

See the responses to State of Nevada comments 283 and 316.

SNS-294

STATE OF NEVADA
AGENCY FOR NUCLEAR PROJECTS
NUCLEAR WASTE PROJECT OFFICE

QAP-3.4

NEVADA NUCLEAR WASTE PROJECT OFFICE
TECHNICAL REVIEW COMMENT FORM

DOCUMENT TITLE: Site Characterization Plan

COMMENT NO.: 78 pg. 1 of 1	CHAPTER NO.: 8

SEC. NO. 8.3.1.17.2.1.1
PAGE NO. 8.3.1.17-61
DRWG. NO.

The SCP states that surface FITS will be sited where there is no evidence of Quaternary faulting. It is not obvious why the DOE is so vague on this most important criteria. At the present proposed site for FITS, east of Exile Hill in Midway Valley, several hundred meters of fault offset has been identified (SAND85-0815, 1986). Positive demonstration that there is no evidence of Quaternary faulting (it is assumed that "several hundred meters" qualifies as substantial) when the Quaternary-Tertiary contact is over 60 feet below the surface will be an expensive and time consuming task.

REVIEWER: David D. Tillson (Print)	ORGANIZATION: Consulting Geologist
David D. Tillson (Signature)	DATE: June 30, 1989

COMMENT SNS-294

Surface FITS siting and Quaternary faulting.

RESPONSE:

Study Plan 8.3.1.17.4.2 (DOE, 1989), Activity 2, has as a parameter goal the demonstration of the absence of Quaternary faulting for facilities important to safety (FITS). This is a legitimate goal since the activity must provide such a demonstration, or the selected site and FITS must be designed to accommodate surface faulting potential. The setting of a goal for the activity to select a site and make such a demonstration (in this case a trench) does not presuppose success. Failure to achieve the goal would mean that a decision must be made that alternative sites should be investigated or surface facility designs altered.

The Bow Ridge and Paintbrush Canyon faults are known to have Quaternary offset in the Midway Valley area. However, these faults are located so that offset on either would not pose a surface rupture hazard to prospective surface facilities important to safety (FITS). No other faults in Midway Valley, either observed or buried, have well-documented (unequivocal with the state of present knowledge) Quaternary offset. Neal (1986) did not find geomorphic evidence for faults and clearly stated, "the investigations provided no indication as to whether the imbricate normal faults [his Midway Valley fault zone] penetrate the overlying alluvium", at the site of prospective FITS. Also see the response to State of Nevada comment 211.

REFERENCES

Neal, J. T., 1986, "Preliminary Validation of Geology at Site for Repository Surface Facilities, Yucca Mountain, Nevada", SAND85-0815, Sandia National Laboratories, Albuquerque, NM.

DOE (U.S. Department of Energy), 1989. Study Plan 8.3.1.17.4.2, "Location and Recency of Faulting Near Prospective Surface Facilities." Yucca Mountain Project Office, Las Vegas, NV.

SNS-314

STATE OF NEVADA
AGENCY FOR NUCLEAR PROJECTS
NUCLEAR WASTE PROJECT OFFICE

QAP-3.4

NEVADA NUCLEAR WASTE PROJECT OFFICE
TECHNICAL REVIEW COMMENT FORM

DOCUMENT TITLE: Site Characterization Plan

COMMENT NO.: 98 pg. 1 of 1 | CHAPTER NO.: 8

SEC. NO. 8.3.1.17.4.2.1.
PAGE NO. 8.3.1.17-93 and 94
DRWG. NO.

The statement attributed to Neal (1986) that "indicates that closely spaced faults (l.t. 50 meters) occur beneath the surficial deposits", is taken out of context and is misleading. Neal (1986) makes no statement regarding the specific spacing of the faults. The statement is "the individual offsets in the zone of close-spaced, normal faulting may be small and difficult to detect, but the zones may be as much as a kilometer in width with a cumulative vertical offset of several hundred meters." An additional important point raised by Neal (1986) is the existence of a down to the east high angle reverse fault between borehole RF-9 and RF-3. This interpretation is inconsistent with the structural profile proposed by Scott & Bonk (1984). It is possible that the Midway Valley Fault could represent the west side of a graben structure with the Paintbrush Fault representing the east side.

REVIEWER: David D. Tillson
Print.

David D. Tillson
Signature

ORGANIZATION:
Consulting Geologist

DATE: June 30, 1989

COMMENT SNS-314

Spacing of faults.

RESPONSE:

The statement regarding 50 m spacing for Neal's (1986) "imbricate fault zone" was an interpretation that was based on Figure 1 of Neal (1986). The commentor raises possible interpretations, which represent multiple working hypotheses given current information. The Midway Valley Study Plan (DOE, 1989), among others, is designed to gather data that can be used to test these various interpretations.

REFERENCES

Neal, J. T., 1986, "Preliminary Validation of Geology at Site for Repository Surface Facilities, Yucca Mountain, Nevada", SAND85-0815, Sandia National Laboratories, Albuquerque, NM.

DOE (U.S. Department of Energy), 1989. Study Plan 8.3.1.17.4.2, "Location and Recency of Faulting Near Prospective Surface Facilities." Yucca Mountain Project Office, Las Vegas, NV.

SNS-315

STATE OF NEVADA
AGENCY FOR NUCLEAR PROJECTS
NUCLEAR WASTE PROJECT OFFICE

QAP-3.4

NEVADA NUCLEAR WASTE PROJECT OFFICE
TECHNICAL REVIEW COMMENT FORM

DOCUMENT TITLE: Site Characterization Plan

COMMENT NO.: 99 pg. 1 of 1	CHAPTER NO.: 8

SEC. NO. 8.3.1.17.4.2.1
PAGE NO. 8.3.1.17-94
DRWG. NO.

The statement is made that faults (Midway Valley) are not believed to penetrate alluvial units; surface expression is not evident. This statement is misleading and appears to be an attempt to minimize the significance of the data on faulting in the area of FITS. The seismic data and available borehole data show that the fault zone extends for a distance of at least 1 km to the east of Exile Hill. There is no evidence, pro or con, to support the statement that alluvial units are not offset. In addition, Figure 3 from Neal (1986) implies that the faulting must continue across the valley to the Paintbrush Canyon Fault where it has been recognized that alluvial units are offset.

REVIEWER: David D. Tillson (Print)	ORGANIZATION: Consulting Geologist
David D. Tillson (Signature)	DATE: June 30, 1989

COMMENT SNS-315

Faults penetrating alluvial units.

RESPONSE:

The Bow Ridge and Paintbrush Canyon faults are known to have Quaternary offset in the Midway Valley area. However, these faults are located so that offset on either would not pose a surface rupture hazard to prospective surface facilities important to safety (FITS). No other faults in Midway Valley, either observed or buried, have well-documented (unequivocal with the state of present knowledge) Quaternary offset. Neal (1986) did not find geomorphic evidence of faulting and clearly stated, "the investigations provided no indication as to whether the imbricate normal faults [his Midway Valley fault zone] penetrate the overlying alluvium", at the site of prospective FITS. Also see the response to State of Nevada comment 211.

REFERENCES

Neal, J. T., 1986, "Preliminary Validation of Geology at Site for Repository Surface Facilities, Yucca Mountain, Nevada," SAND85-0815, Sandia National Laboratories, Albuquerque, NM.

SNS-316

STATE OF NEVADA
AGENCY FOR NUCLEAR PROJECTS
NUCLEAR WASTE PROJECT OFFICE

QAP-3.4

NEVADA NUCLEAR WASTE PROJECT OFFICE
TECHNICAL REVIEW COMMENT FORM

DOCUMENT TITLE: Site Characterization Plan

COMMENT NO.: 100 pg. 1 of 1	CHAPTER NO.: 8

SEC. NO. 8.3.1.17.4.2.2
PAGE NO. 8.3.1.17-95
DRWG. NO.

The impression is given in 8.3.1.17.4.2.1 and 8.3.1.17.4.2.2 that the surface fault investigations will be limited to the immediate vicinity of Midway Valley next to Exile Hill. Present NRC criteria for surface fault investigations requires that studies be conducted for 16 km (10 miles) in both directions along the fault trace and over a zone that is some multiplier times the control width. In the case of the Paintbrush Fault the multiplier would be 2 or 3 based on a magnitude 6.5 earthquake. Since the Midway Fault is known to be at least 1 km wide (Neal, 1986) the zone for requiring detailed fault investigation would be considerably wider than the proposed 100 meters on either side of FITS.

REVIEWER: David D. Tillson (Print)	ORGANIZATION: Consulting Geologist
David D. Tillson (Signature)	DATE: June 30, 1989

COMMENT SNS-316

Surface fault investigations.

RESPONSE:

The comment assumes that, in general, the seismic investigations planned for the Midway Valley study of the Yucca Mountain characterization program would not provide sufficient information to satisfy the seismic design and siting criteria of 10 CFR Part 100, Appendix A. Appendix A was written on the basis of the seismic risk assessment technology available in the late 1960s and early 1970s. It was also written for nuclear power plants, not high-level nuclear waste repositories. Power plants have an operational life of about 40-50 years; a relatively short lifetime compared to a geologic repository's operational and postclosure lifetime.

To ensure that a nuclear power plant can be safely shut down, Appendix A recommends designing facilities for a single "maximum credible event." Such a design basis would not take into account the cumulative effects of multiple events that could occur during 10,000 years. Over such long periods of time, a more probabilistic approach is needed. The U.S. Nuclear Regulatory Commission has had several opportunities to impose Appendix A on a repository but never has. Although the possibility of applying 10 CFR Part 100, Appendix A, has been discussed in NRC draft position papers, there is no explicit guidance or regulation as to whether it is applicable. The U.S. Department of Energy's position is that it is not applicable to a mined geologic disposal system. In addition, the Nuclear Waste Technical Review Board's "Second Report to Congress" (NWTRB, 1990) states that Appendix A, "should not be used to site and license the repository and its surface facilities" (p. 11).

REFERENCES

Nuclear Waste Technical Review Board, 1990, Second Report to the U.S. Congress and the U.S. Secretary of Energy, Arlington, Virginia (November, 1990), 34 p.

SNS-1541 continued

"An outline of our current perception of the effects from faulting is presented in DOE (1986) and summarized here. It appears unlikely that faulting would lead to radionuclide releases to the accessible environment during the first 10,000 yr following closure of the repository" (p. 1-207).

"Even if new fractures formed, they are not expected to significantly alter ground water flow conditions because the area already is strongly fractured" (p. 1-207).

"Because these faults (such as the Windy Wash and Paintbrush Canyon) have very low slip rates, it is anticipated that the demonstration can be made that the occurrence of 5 cm of displacement in 1,000 yr on even these longer, more significant faults is a very low probability event" (p. 8.3.1.8-27).

"During the Quaternary, tectonic and volcanic processes in the Yucca Mountain area have included . . . slow (less than 3 cm/1000 yr) relative vertical tectonic adjustment . . . The effect of these intermittent and localized constructional processes on the late Quaternary landscape of the Yucca Mountain area has been limited . . . Comparable tectonic and volcanic activity over the next 10,000 yr would likely induce a comparably limited effect on the (late Quaternary) landscape of the Yucca Mountain area" (p. 1-30).

"Quaternary deposits are offset or fractured by 32 faults in the 1,100 km^2 area . . . 23 of them moved 1.2 to 2 million yr ago, four of them about 1 million yr ago, and at least five of them during the past 270,000 yr" (p. 1-128)

"If the average offset per event (on the Windy Wash fault) was about 10 cm, each event had a magnitude (Ms) of about 6 to 6.5 . . . The rate of offset averaged over the past 270,000 yr has been about 0.0015 mm/yr which is "extremely low" in the classification scheme of Slemmons and dePolo (1986)" (p. 1-132 & 1-133).

"The (Solitario Canyon) fault shows no evidence of movement during the past 270,000 yr but does show evidence of movement about 1.2 million yr ago" (p. 1-133).

"Considering the length and nature of this (Paintbrush Canyon) fault, it could have been the source of moderate earthquakes (M 6.5) in the past, although such events would appear to be rare based on the low rate of movement" (p. 8.3.1.17-30).

". . . the annual probability for the controlling earthquake is expected to be low (less than about 10^{-4}, assuming the Paintbrush Canyon fault is controlling) . . . (p. 8.3.1.17-37).

This conflict arises because the impression is given that the position has already been adopted that significant faulting has a low probability of occurrence, as it was in the EA. One could easily speculate that this dichotomy is one based on the different approaches taken by the USGS and the DOE.

SNS-1542

Local Quaternary Tectonic Studies

For the most part, the program outlined in the SCP for evaluation of local tectonics is quite extensive and describes lofty goals. This program calls for collection of an enormous amount of information. As outlined in sections 8.3.1.17.4.6.1 Activity: "Evaluate Quaternary geology and potential Quaternary faults at Yucca Mountain" and 8.3.1.17.4.6.2 Activity: "Evaluate age and recurrence of movement on suspected and known Quaternary

SNS-1542 continued

faults", the "parameters" to be obtained in order to evaluate local tectonics include;

- Length, location, and spatial orientation of faults
- Segmentation within individual faults
- Width of faults
- Age and nature of Quaternary deposits and Quaternary surfaces displaced by or covering Quaternary faults within the site area
- Location, amount, and direction of displacement of Quaternary deposits and Quaternary surfaces
- Age, lateral extent, and height of fault scarps
- Age of soils overlapping or displaced by faults
- Age of volcanic ashes intercalated in surficial deposits that overlap or are displaced by faults, or that have filled fissures within the fault zones

This information is to be obtained primarily through Quaternary mapping, exploratory trenching, and associated dating of Quaternary materials. We consider this to be an appropriate approach, but feel that it is not made clear that these goals can be reasonably achieved. Several of these issues involve data that are not easy to obtain and that usually have fair to high levels of uncertainty (e.g., age estimates, strike-slip displacements, locations and orientations of buried faults, ages of compound fault scarps). In particular, given the complex, anastomosing nature of the Yucca Mountain fault system, we do not believe it will be possible to make an adequate interpretation of fault segmentation, at least with regard to discrete rupture segments. It is not made clear in the SCP that these problems are appreciated, nor how uncertainties will be incorporated.

SNS-1543

Regional Quaternary Tectonics Studies

We feel the SCP correctly assesses the need for and relative importance of regional Quaternary tectonics studies:

> "The first important object of the tectonic studies is to describe the location, nature, amount, and probability of potential fault movement at the proposed Yucca Mountain repository. Accomplishing this requires integrating results from regional and site-specific studies. Among the required data will be 1) slip rates and recurrence rates of movements on Quaternary faults, 2) probability of future faulting on different styles of faults, 3) character of the regional stress field, and 4) probabilities from the tectonic scenarios" (p. 1-349 & 1-350).

The proposed regional tectonics data collection program is described in the pre-closure tectonics section 8.3.1.17.4. Geological and geophysical evidence of large-scale

COMMENT SNS-1542

Local Quaternary tectonic studies.

RESPONSE:

The comment states concern over the potential uncertainty for several of the parameters to evaluate faulting potential, seismicity and tectonism. i.e. age-estimates, strike-slip displacement, locations and orientations of buried faults, ages of compound fault scarps, and fault segmentation.

AGE-ESTIMATES, RECURRENCE INTERVALS, SEGMENTATION

Studies that are part of the pre-closure tectonic program to assess the potential for fault rupture are designed to seek evidence for Quaternary movement or, conversely, its absence. Whether this evidence is provided by the principle of cross-cutting relationships or by radiometric dating of near-surficial materials depends on the preserved geologic record. Absence of evidence through lack of surficial materials, for example, diminishes the degree of certainty that could be attained if a variety of techniques could be brought to bear on the problem.

The only way to know whether or not near-surface materials possess the attributes to derive ages or show clear stratification characteristics amenable to age bracketing, in Midway Valley or elsewhere on the site, is to proceed with these studies. Once field work begins, the quality of the geologic record, and the methods used to characterize it, would ultimately determine the degree of age resolution attainable by these techniques. It is difficult to predict now whether the preserved record is such that would allow gathering the amount and quality of data to resolve multiple movements along single faults or segments, or slip events on more than one fault that are synchronous.

Several conventional dating techniques would be used. Experimental techniques such as thermoluminescence, uranium-trend, cation-ratio and possibly other surface-material dating techniques such as Cl-36, He-3, and Be-10 would be used in absence of materials datable by conventional or other experimental techniques that have had wider exposure. Because there are limitations and uncertainties associated with the use of experimental methods, more than one method would be used where possible.

STRIKE-SLIP RATES

Understanding fault slip-rates is important relative to meeting the stated goals of performance parameters, which would include an understanding of the relationship between strike-slip and dip-slip movement along faults. But knowing the magnitude of the uncertainty regarding slip-rates can only result from executing the relevant studies. The slip-rates calculated for some faults would be based on measured net slip in recognition of the possibility of a significant strike-slip component. The discussion in SCP Section 8.3.1.17.4.6.2 has been expanded from the SCP/Consultation Draft to emphasize the need for understanding the lateral component of slip on faults in the site area.

LOCATION AND ORIENTATIONS OF BURIED FAULTS

Preliminary evaluation of existing maps (Swadley et al., 1984) and of 1:12,000 aerial photographs indicates that the pattern and distribution of Quaternary faults, surficial deposits, and related geomorphic features, are substantially simpler than that for pre-Quaternary faults and fractures mapped at the 1:12,000 scale by Scott and Bonk (1984). Revisions were made to SCP Section 8.3.1.4.2.2 (Characteristics of Structural Features within the Site Area) from the SCP/Consultation Draft in approaches to understanding fracture systems and fault zones in the subsurface using non-invasive and down-hole geophysical methods. Methods such as borehole radar, cross-hole methods, borehole-to-surface methods would be used to identify and characterize faults if possible. The feasibility of vertical seismic profiling would be investigated for its potential to identify faults between surface boreholes. Once underground access is attained, conventional and photogrammetric geologic mapping in the Exploratory Shaft Facility would be performed to better understand fault characteristics.

REFERENCES

Scott, R.B., J. Bonk, 1984. Preliminary Geological Map of Yucca Mountain Nye County, Nevada with Geological Section, Open File Report USGS-OFR-84-494, U.S. Geological Survey.

Swadley, W. C., D.L. Hoover, and J. N. Rosholt, 1984. Preliminary Report on Late Cenezoic Faulting and Stratigraphy in the Vicinity of Yucca Mountain, Nye County, Nevada, USGS-OFR-84-788, Open-File Report, U.S. Geological Survey.

SNS-1769

NEVADA NUCLEAR WASTE PROJECT OFFICE
TECHNICAL REVIEW COMMENT FORM

DOCUMENT TITLE: Site Characterization Plan		
COMMENT NO.:	2 of 5	CHAPTER NO. 8
SEC. NO. PAGE NO. DRWG. NO.	COMMENT 1 of 2	
8.3.1.17.4.2	Identification of relevant earthquake sources Relevant earthquake sources will be identified through a synthesis of information including geophysical structural information. Important to this activity are the location and potential activity of burial faults. Model site effects using the wave properties of the local geology -Theoretical site-effect models will be developed based on measurements of the velocity, attenuation and density structure of the soil and bedrock to a depth of at least 1 km, particularly under Midway Valley. The data for these studies will primarily be supplied by the data-collection activities in Investigation 8.3.1.17.4 as outlined in Figure 8.3.1.17-5. Location and recency of faulting near the prospective surface facility includes two activities, the identification appropriate trench locations in Midway Valley and exploratory trenching in Midway Valley. The identification of appropriate trench locations will be made primarily using geologic mapping. Areas of supported Quarternery faulting may also be investigated using shallow seismic refraction and reflection profiling. To this	
REVIEWER: Keith Priestley Print Keith Priestley Signature	ORGANIZATION: University of Nevada Reno Seismological Laboratory DATE: June 27, 1989	

Form 3.4.1

SNS-1769
Continued

STATE OF NEVADA
AGENCY FOR NUCLEAR PROJECTS
NUCLEAR WASTE PROJECT OFFICE
QUALITY ASSURANCE PROCEDURE

QAP-3.4
REVISION 0
JANUARY 20, 1989

NEVADA NUCLEAR WASTE PROJECT OFFICE
TECHNICAL REVIEW COMMENT FORM

DOCUMENT TITLE: Site Characterization Plan		
COMMENT NO.:	2 of 5	CHAPTER NO. 8
SEC. NO. PAGE NO. DRWG. NO.	COMMENT 2 of 2	
	should be added shallow radar profiling. Studies have shown this to be a valuable and economic method for identifying appropriate locations for trenching and for mapping the subsurface continuation of structures between trenches.	
REVIEWER: Keith Priestley Print Keith Priestley Signature	ORGANIZATION: University of Nevada Reno Seismological Laboratory DATE: June 27, 1989	

Form 3.4.1

COMMENT SNS-1769

Identification of relevant earthquake sources.

RESPONSE:

As described in Section 8.3.1.17 of the SCP (Identification of Relevant Earthquake Sources), seismic hazard studies are divided into studies focusing on data collection and data analyses (pages 8.3.1.17-56 to 8.3.1.17-60 in the SCP). Study 8.3.1.17.4.2 (DOE, 1989) is only one of several data gathering studies that would be used to estimate the probability of surface fault rupture at the location of prospective facilities important to safety. Study 8.3.1.17.2.1 (Faulting Potential at the Repository) is the data assessment study for the concerns related to preclosure surface fault rupture and would draw on a number of studies (see SCP Figure 8.3.1.17-4) in order to evaluate the overall probability of surface fault rupture at the prospective site of surface facilities. The assessment in Study 8.3.1.17.2.1 would include the results of detailed site-specific studies (such as Study 8.3.1.17.4.2) that include geological, geophysical, and drilling studies of the structures present beneath the alluvium of Midway Valley and surrounding areas 14.2.1; Exploration Program: 14.2.3; Field Tests and Characterization Measurements: 4.2.1; Characterization of the Vertical and Lateral Distribution of Stratigraphic Units Within the Site Area: 4.2.2; Characterization of the Structural Features Within the Site Area: 4.2.3; Three-dimensional Geologic Model: 17.4.7; Subsurface Geometry and Concealed Extensions of Quaternary Faults at Yucca Mountain. 17.4.6 (Quaternary Faulting within the Site Area). 17.4.3. (Quaternary Faulting within 100 Km of Yucca Mountain, Including the Walker Lane). 17.4.12 (Tectonic Models and Synthesis. (8.3.1.14.2.1, 8.3.1.14.2.3, 8.3.1.4.2.1, 8.3.1.4.2.2, 8.3.1.4.2.3, and 8.3.1.17.4.7), studies of the nature of Quaternary-aged faulting in both the region and in Midway Valley (8.3.1.17.4.6 and 8.3.1.17.4.3), and studies of the regional tectonic setting (8.3.1.17.4.12).

Table 2-1 of Study Plan (8.3.1.17.4.2) identifies possible geophysical and remote sensing techniques for use in the Midway Valley study. Ground penetrating radar, seismic reflection, and seismic refraction are techniques identified for possible use.

REFERENCES:

DOE (U.S. Department of Energy), 1989. Study Plan 8.3.1.17.4.2, "Location and Recency of Faulting Near Prospective Surface Facilities." Yucca Mountain Project Office, Las Vegas, NV.