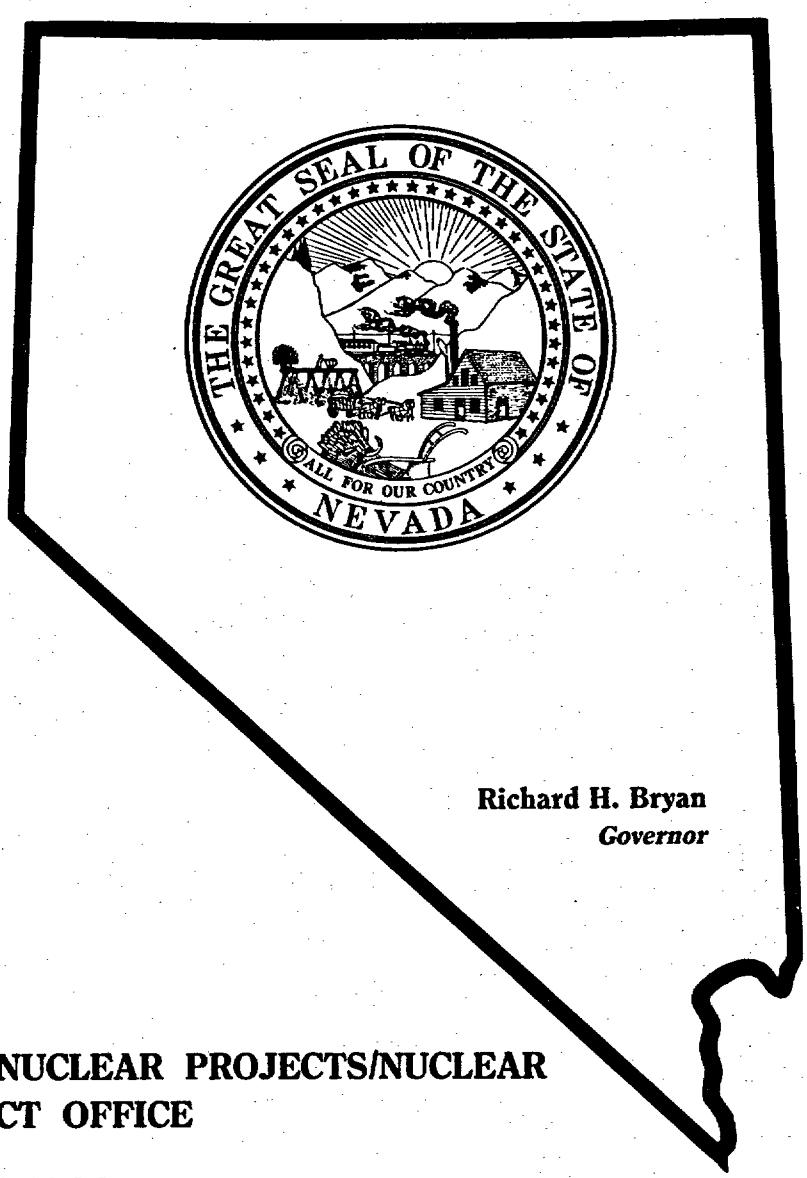
STATE OF NEVADA COMMENTS

ON THE

U.S. Department of Energy Consultation Draft Site Characterization Plan, Yucca Mountain Site, Nevada Research and Development Area, Nevada



Richard H. Bryan
Governor

COMPILED BY

AGENCY FOR NUCLEAR PROJECTS/NUCLEAR WASTE PROJECT OFFICE

SEPTEMBER, 1988

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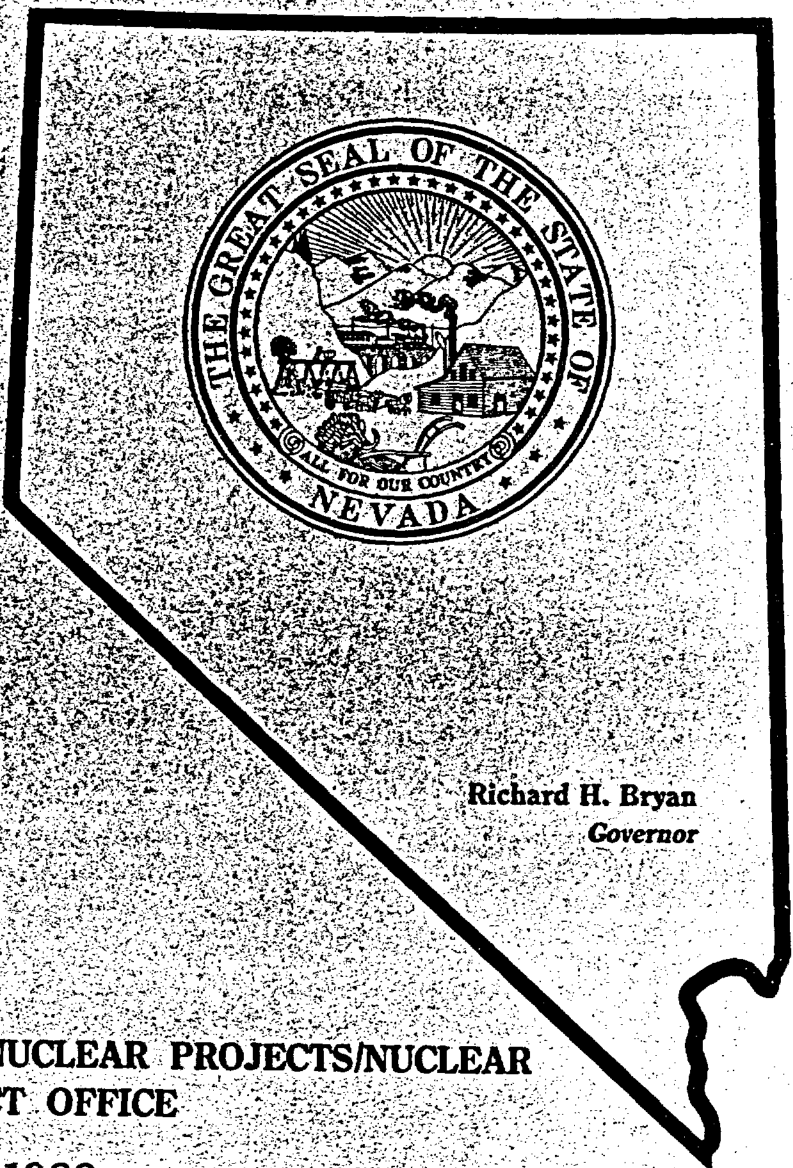

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U.S. DEPARTMENT OF ENERGY CONSULTATION DRAFT

SITE CHARACTERIZATION PLAN

YUCCA MOUNTAIN SITE

NEVADA RESEARCH AND DEVELOPMENT AREA

NEVADA

PREPARED BY

NEVADA AGENCY FOR NUCLEAR PROJECTS/
NUCLEAR WASTE PROJECT OFFICE

SEPTEMBER 1988

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CONSULTATION DRAFT

SITE CHARACTERIZATION PLAN

YUCCA MOUNTAIN SITE,
NEVADA RESEARCH & DEVELOPMENT AREA, NEVADA

By
Water Resources Center
Desert Research Institute
University of Nevada System

June 1988

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INTRODUCTION

The Yucca Mountain site has the potential of being a technically sound location for the long-term isolation of high-level nuclear waste. There are a number of favorable hydrogeologic features associated with Yucca Mountain such as the following:

1) A relatively thick unsaturated zone;
2) Low precipitation and high potential evaporation;
3) The presence of zeolitic clays;
4) Long ground-water travel paths to discharge areas; and
5) Limited ground-water development.

Most of these features have been measured and quantified with a fair degree of accuracy.

However, there are a number of hydrogeologic features which have not been adequately quantified. One of the main reasons for this lack of quantification is the extreme complexity of the hydrologic system. Ironically, some of this complexity is due in part to favorable hydrogeologic features listed above. The thick unsaturated zone makes it extremely difficult to collect hydrologic data with which to quantify the unsaturated and saturated zones. The low precipitation rate makes it difficult to quantify the recharge flux.

The SCPCD has identified a number of key issues that need to be addressed for characterization of the Yucca Mountain site. A variety of complex experiments have been proposed in an attempt to address these issues. Although a lot of time, money and effort has been spent on characterizing the Yucca Mountain area to date, there are still many unresolved technical issues.

Since many of the experiments proposed in the SCPCD have never been done in an unsaturated fractured media, it is impossible to tell if they will be successful. Results of these experiments may indicate that new test designs or data collection procedures are needed to address the issues.

Our approach to reviewing the SCPCD has been to first identify key technical issues which have not be resolved and to make specific comments associated with the hydrologic experiments proposed.

The SCPCD does not provide enough detail on these experiments in order to evaluate the technical aspects of their design, data collection, and analyses procedures. A detailed evaluation of the experiments will be needed when the Work Plans are released.

Specific comments have been made on virtually all studies and activities we believe to be relevant from a hydrologic standpoint. For the most part, comments have been made on the general conceptual design of experiments. In some cases additional data collection or design changes have been proposed.

KEY TECHNICAL ISSUES

There are a number of key technical issues which have not been adequately addressed for the Yucca Mountain site, partly because of the difficulty involved in measuring the parameters needed to quantify the process. Theoretical and practical techniques with which to quantify flow and transport in an unsaturated fractured medium are only now being developed. The following key technical issues need to be resolved before travel times and concentration to the accessible environment can be evaluated:

1) Mechanisms and rates of water flow in the unsaturated zone;
2) Rates and locations of recharge at Yucca Mountain
3) Rates of flow in the saturated zone;
4) The validity of models to be used in calculating repository performance;
5) The geochemical environmental, especially with regard to the redox environment.

These key technical issues are further elaborated on in more detail in the following section.

CONCEPTUAL MODEL FOR UNSATURATED FLOW

The current conceptual model for unsaturated flow developed by the U.S. Geological Survey (Montazer and Wilson, 1985) assumes that no significant flux of moisture occurs within fractures. All moisture that enters a fracture is quickly sucked into the matrix due to the hypothesized high tensions in the matrix.

This conceptual model has never been tested in field or laboratory experiments. Tensions have not adequately been measured in fractures and matrix materials. There is only one unsaturated borehole near Yucca Mountain (USW UZ-1) in which an attempt has been made to measure tensions. Tension measurement in this borehole are continuing to decline as the borehole equilibriates to the natural conditions. Therefore, it is still questionable, based on this limited data, if the proposed conceptual model is valid.

Only a limited number of measurements of moisture and even fewer of tension have been made to date in the tuffs. The reliability of these limited data is open to question. Even when no water is used, drilling may affect the moisture characteristics of rock through heating and contact with air at a different humidity than the pore air. There is, for example, a large apparent discrepancy between tension and moisture content measurements in the Topopah Springs Member in well H- 1, which was drilled with mist, and in well UZ-1, which was dry-drilled. With the observed air movement occurring in the mountain, it may also be difficult to obtain reliable measurements in the shaft. There is concern that no reliable determination is yet possible of the extent to which samples have been disturbed by drilling. This concern is particularly serious for tension measurements, because the addition or subtraction of a small amount of water in the most permeable pores or fractures could greatly change tensions while having very little effect on the total water content of a sample. The plan to observe moisture potential over long periods in packed-off intervals has promise for overcoming these difficulties, but its success is not certain and will require careful verification.

Other features which have not been addressed concerning this conceptual model are the potential effects of fracture coatings and entrapped air. Fracture coatings and entrapped air can effectively isolate the fracture from the matrix. Hence, significant fracture flow could occur. Fracture mapping in the exploratory shaft will help to define the extent of fracture coatings. The potential impacts of entrapped air limiting imbibition into the matrix need to be evaluated experimentally. There are no experiments currently planned to address the problem of entrapped air.

The anisotropy of both fracture and matrix material needs to be addressed. At present no one has attempted to define anisotropy in three dimensions. Flow directions and paths can be significantly influenced by the anisotropy of the fractures and matrix materials. It is not clear in the SCPCD how the anisotropy of the system will be determined.

Another key parameter that needs to be addressed is the effective porosity of the fractures and matrix. The effective porosity in the unsaturated zone is a function of the moisture content and will have to be defined for both gas and water. A few of the planned activities indicate that this issue will be addressed; however, there are some serious concerns about how successful this testing will be.

There is a need to define the preferred flow paths in the unsaturated zone. At present, the conceptual model predicts the flow paths to be within matrix material, which has not been experimentally demonstrated. In addition, there is a need to evaluate the potential impacts of faults on flow paths. Tests are planned for both the Solitario and the Ghost Dance Faults. The ultimate success of these experiments is unknown, since not enough details are provided for the experiments. The SCPCD does not present a specific test plan for Ghost Dance Fault; rather it states that they are considering a number of different types of tests.

The potential impacts that the natural flow of air through Yucca Mountain will have on experiments planned for the exploratory shaft will have to be evaluated. Tests are planned to quantify the potential impacts air flow has had on drying the rock surrounding USW UZ-6 and USW UZ-6s boreholes. These tests should be evaluated prior to shaft excavation, in order that the drying effect can be minimized and accounted for in the exploratory shaft.

The spatial variability of hydrologic properties has not been adequately addressed. Spatial variability needs to be addressed in order to accurately address the potential recharge flux through the repository. The planned installation and testing of additional unsaturated boreholes will help to quantify the degree of spatial variability; however, it cannot be determined at this time if the number of boreholes and tests planned will be sufficient.

The presence or absence of perched water needs to be evaluated for Yucca Mountain. The only test planned to look for perched water is in the exploratory shaft. This will consist of a visual inspection of the rocks after each mining shift. A careful evaluation of neutron hole logs can be used to help identify perched water, but because water saturation in the tuffs is high, very sensitive logging is required.

The potential success of the tests planned for the unsaturated zone is still unknown. Numerical models have been proposed to help in the design and analysis of tests planned for the unsaturated zone. However, many of the numerical models have not been identified or developed yet. Therefore, there is a serious concern if the data from the tests can be analyzed.

The conceptual model for the ground-water flow system underlying Yucca Mountain is discussed in Section 3.9.3. On p. 3-208 of that section, the following is stated:

> "...hydrologic data from the unsaturated zone at Yucca Mountain are to be obtained directly only from the exploratory shaft test facility and from a relatively small number of surface-based boreholes. Consequently, it will be necessary to rely on indirect methods, such as numerical flow and solute-transport modeling and geostatistical techniques, to infer the state of the presently existing natural hydrologic system by interpolating within and extrapolating from a somewhat incomplete set of field data."

Yet, later on p. 3-211, a somewhat contradictory statement is made:

> "one of the major tasks to be accomplished through the data-acquisition program at the site...is to collect sufficiently large sample sets to delimit the uncertainties associated with the quantitative predictions of the numerical model."

There are two issues that follow from the above statements: (1) will sufficient and representative data be collected to validate the conceptual model of ground-water flow within Yucca Mountain, and (2) will the models be appropriate and sufficient to analyze and interpret the data?

It is difficult to answer both questions, given the information in the SCPCD. For the latter question concerning models, it applies to both models for mountain-scale conceptualization, as well as models used to interpret various tests (e.g., pressure or tracer tests). The models discussed in Section 3.9.3.4

(Unsaturated-zone relationships) were simplified and did not consider all of the processes that are occurring at Yucca Mountain. The models discussed in Section 8.3.1.2.2.9 (Unsaturated-zone flow and transport modeling) are all TBD (to be determined). Therefore, how the data will be interpreted and what models will be used to test conceptualizations of Yucca Mountain are issues that are not clarified in the SCPCD.

RECHARGE ESTIMATES

One of the key technical issues that has not been adequately addressed is the estimation of past, present, and future recharge flux for the Yucca Mountain site. A number of investigators have developed empirical formulas and estimates of recharge and have been referenced in the SCPCD; however, no hard data have been collected to date to substantiate these estimates. The recharge flux for Yucca Mountain has been estimated by various investigators to range from 2.0 to 10 mm/yr (SCPCD, p. 3-202 to 3-204). This relatively large range of present day recharge estimates can significantly impact the performance of the repository and resultant travel time to the accessible environment. Current conceptual models proposed for Yucca Mountain assume that significant fracture flow will not occur (Montazer and Wilson, 1985). This is based in part on the assumption that the recharge flux for the site is less than 0.5 mm/yr and that tensions in the rock matrix are large. A preliminary analysis of travel times to the accessible environment by Sinnock and others (1987) indicates that significant fracture flow can occur if the recharge flux exceeds the saturated hydraulic conductivity of the rock matrix times the hydraulic gradient. Hence, recharge fluxes larger than 1 mm/yr can result in significant fracture flow. Therefore, the potential exists with the current range of recharge fluxes (0.2 to 10 mm/yr) for much higher travel times through fractures than have previously been calculated based on matrix flow. Depending on the actual recharge flux rate, the 1000 yr travel-time requirement may not be met for this site. Hence, a refinement of the recharge estimates are needed in order to more accurately evaluate the Yucca Mountain site.

The conceptual models presented by the DOE have been evolving away from steady uniform infiltration toward areal inhomogeneity and intermittence of recharge. Now it appears (p. 3-194) that "steady-state moisture flow is presumed to be established in all but a thin, near-surface interval of the unsaturated zone." It has not been established whether the system is in a steady state. Transient behavior might be due to major recharge events occurring as infrequently as once every 100 or 500 years. The few interpretations to date of tension vs. depth profiles have been based on steady-state concepts. If transient phenomena must be considered, interpretation of such profiles is more complex and very different conclusions may be reached.

It is generally agreed that estimation of past recharge rates from paleoclimate reconstructions remains a problem. The water balance modeling approach does not provide a credible way of making such estimates in the absence of directly applicable data. Measurement of present-day recharge in the areas with climate and vegetation similar to past conditions at Yucca Mountain would be more convincing.

Plans to model ground-water regimes under paleoclimatic conditions have focused on the question of whether the repository will flood. This certainly may be important with respect to waste package performance. However, a water table rise that comes nowhere near the repository could still adversely affect repository performance. In particular, if the water table below the repository were to rise into the densely welded Topopah Springs zone, a lateral pathway could be created for more rapid transport of radionuclides to the accessible environment. It appears likely that most of the ground water at Yucca Mountain represents underflow from recharge areas further north. Consequently, the position of the water table may depend more on recharge conditions to the north than on the amount of local recharge. If direct evidence cannot exclude a water table rise large enough to be of concern, then modeling studies would be needed to estimate pluvial water tables. These studies would require estimates of pluvial recharge in the recharge areas at Timber Mountain and further north.

Flow of perched water to local discharge areas might drastically shorten migration path lengths. There is some evidence of ancient springs on Yucca Mountain. More attention to perched water is needed in the paleohydrology program.

SATURATED FLOW SYSTEM

Several important, unresolved issues that pertain to the saturated zone near Yucca Mountain exist:

1. Rates of flow in the saturated zone can be estimated several different ways. One approach is to estimate an average hydraulic conductivity, an average hydraulic gradient, and an average effective porosity, and calculate a velocity

using Darcy's Law. The drawback to this approach is that the hydraulic conductivity varies greatly. Hence, many measurements are needed before a reliable average can be calculated. Because most of the water will travel along the most permeable pathways, the average flow velocity will be faster than calculated using this approach. A second approach is to use computer models to calculate average flow rates. In the models that have been developed in the past, the boundary conditions (which of necessity have been estimated) drive the model. Aquifer parameters are backed out of the model as the model is calibrated. The values of the aquifer parameters should be reasonable, reliable estimates, but are directly influenced by the boundary fluxes (recharge and discharge) used during development of the model. Unfortunately, recharge measurements are difficult to make, except perhaps in eastern Jackass Flats. The recharge estimates used in the models are based on empirical procedures that do not consider many of the factors that affect recharge, and on estimates or measurements of discharge. In the Amargosa Desert, discharge is primarily by evaporation and transpiration rather than from springs, and therefore the discharge estimates are probably not very good.

The repository block is generally bound by known and suspected faults or fracture zones. The relationship between faults and the observed discontinuities in hydraulic head is not known. It may be possible that on a repository-to-accessible-environment scale the effect of fractures on ground-water flow can be evaluated by applying "bulk properties" to the medium (which means that at a certain scale the medium will respond like a porous medium). But the distribution of head data suggests that at least some of the faults are affecting the flow field by acting as independent hydraulic features whose properties cannot be averaged out in a larger-scale conceptual model. The testing program should determine the hydraulic characteristics of the faults near the repository block. In order to assess adequately ground-water flow from the repository to the accessible environment, a testing program by which the hydraulic character and importance of these faults can be determined is necessary. Such a testing program needs to include sufficient measurements to delineate three-dimensional variations in hydraulic properties and/or parameters.

The areal pattern of hydraulic head measurements suggests the existence of narrow ground-water barriers across which large potential gradients occur, combined with larger regions of very small gradients. However, the complex pattern of vertical gradients indicates that a two-dimensional, plan-view conceptual model would not fully explain the flow system. In particular, variations from point to point in the location of the water table within each of the zones listed above probably depend on relationships with deeper aquifers as well as on horizontal flow. Consequently, additional water-table holes, by themselves, will add little to the understanding of the flow system. A better understanding of the flow regime will be aided only by more three-dimensional potentiometric information. Such information, along with additional chemical and heat-flow data, is essential to calibrate a model.

Closely associated with the problem of areal variation is the issue of scale dependence and definition of a representative elementary volume (REV). Any geologic medium is extremely variable on a very small scale; hydrogeologists define an REV as a volume over which small-scale random variation can be averaged. Ground-water systems are understood in terms of bulk properties, averaged over an REV, and large-scale variations which can be observed directly and treated as known trends or discrete features. The difficulty in a fracture-dominated environment like Yucca Mountain is finding a scale at which to define an REV so that bulk properties can be measured and used to interpret the flow system. One or two experiments with 300-ft spacings may not be adequate to establish an REV.

2. Controls on water levels near Yucca Mountain are not well known. North and west of the proposed repository, hydraulic gradients are uncharacteristically high. Beneath and east of the proposed repository, the gradient is very low. The causes of the high gradient are not known.

The new water-table wells have helped to clarify the potentiometric surface (and hence probable flow paths) within and surrounding the repository block. Preliminary analysis of new head data indicates that if wells penetrating beneath the Tuffs of Lithic Ridge are excluded, then the potentiometric levels fall into three closely grouped categories: (a) The two wells north of Drillhole Wash have heads of 1,020 m and 1,029 m, (b) Wells in Crater Flat and some wells on the crest of Yucca Mountain have heads between 769 m and 780 m, and (c) The remaining wells, within most of the repository block and to the east and south, have heads between 724 m and 732 m. The deeper wells H-1, P-1, and (perhaps) G-1, all located in area (c), show heads in the "older tuffs" and Paleozoic carbonates to be 20 to 50 meters higher in the younger tuffs.

3. Almost all the measurements of head made in the deeper parts of the saturated zone (below the upper 200 feet) are either short-term measurements made in packed-off intervals, or are long-term measurements made over long

intervals of open hole. Therefore, the hydraulic head in low-permeability parts of the boreholes (where a long period of time is required for water levels to equilibrate) is not known. Most of the measurements made in packed-off intervals were made in conjunction with hydrologic testing shortly after the well was drilled. The drilling subjected the rock to higher water pressures than it was naturally subjected to, which would tend to increase the pore pressure in the rock. However, pumping tests were generally performed after the hole was drilled but before the packer tests were performed. Therefore, the water levels measured during the packer tests could be either higher or lower than would occur naturally, especially in the lower permeability rocks. Hence, vertical gradients are not well known.

4. The hydrologic testing that has been performed clearly demonstrates the importance of fractures in the transmission of water in the saturated zone. Mapping of fracture orientations both on the surface and in drillholes indicates that there is a greater number of fractures with an approximate north-south orientation than with other orientations. The vast majority of the faults also strike approximately north-south. Therefore, the rock is not isotropic with respect to permeability. This fact has not been considered in the modeling that has been performed, or in estimations of flow directions. No aquifer tests have been analyzed to determine the effects of the fracturing on anisotropy, and few have been performed. The effect of the anisotropy will be to make the dominant flow direction much more to the south than has been previously assumed.

Permeable zones in different boreholes occur at different stratigraphic locations. These zones have not been successfully correlated areally. The degree of correlation between permeable zones can yield useful inferences about the nature and degree of large-scale permeability of the rocks; such interferences are of particular value when, as in this case, little information on the extent of and the hydraulic connection between permeable zones is available.

5. Another factor that might affect direction of flow is the presence of the tuffaceous beds of Calico Hills between the repository area and Fortymile Wash. Because of its zeolitized nature, the Calico Hills has been assumed to have a low permeability. Its permeability has only been tested in situ at UE-25b#1, where it was fairly permeable. However, it may be cut by faults in that drill hole. At the C-hole complex, the Calico Hills were not very permeable, and tests were not performed because water did not flow from the unit. If the Calico Hills is generally of low permeability, then it would tend to hinder the movement of water from Yucca Mountain toward the Fortymile Wash area.

6. The effective porosity is an important parameter in the calculation of flow velocities. This parameter is also difficult to measure, and to date, has not been. Estimates can be made based on estimates of the number of fractures contained in a certain volume of rock and their estimated apertures. Fracture network models of flow in fractures indicate that the details of the network are important in determining flow velocities, and that calculating flow estimates ignoring the network can be misleading. At present, there are no plans to measure the effective porosity except at the C-hole complex, the location of which was to be near a minor fault, and which may not be characteristic of either the majority of the saturated zone, or of rock near the larger faults.

The overall modeling strategy appears to be one of first modeling the regional flow and then modeling the subregional flow system as a segment of the regional system. This, in turn, would lead to modeling the repository block and environs to assess a repository's isolation capability. Insufficient data are available concerning Timber Mountain, northern Yucca Mountain, northern Crater Flat, and the boundary region between Crater Flat and the Amargosa Desert. Further refinement of the model seems unlikely to be useful without a large amount of new data from test wells throughout the extent of the subregional model area.

The regional model alone, for which transmissivities and fluid potentials are generalized, usually from sparse data, may not provide a sound basis on which to establish boundary conditions for the subregional or repository flow models. The boundaries of the current subregional model are mostly in areas for which little or no hydrogeologic data has been collected and in which the zonation of the regional model ignores geologic complexities. Although current data are insufficient to calibrate a three-dimensional flow model, existing data do indicate a three-dimensional nature to the NNWSI flow system. Use of a two-dimensional model alone may lead to inappropriate interpretations and predictions.

AQUIFER TESTS

Numerous aquifer tests were performed in the past in the saturated zone. With few exceptions, these have been analyzed using a porous media approach assuming homogeneity, isotropy, and radial flow. The data do not agree well with these assumptions. First, it is well known that the fractures control movement of water into and out of the boreholes. These fractures are steeply dipping, so that the radial flow assumptions may be inappropriate. Second, high flow rates in the fractures close to the well bore may result in nonDarcian flow, and errors may also result from ignoring the kinetic term in the calculation of hydraulic head. Third, because the fractures are steeply dipping, leakage around packers during the injection tests is more likely to occur than in layered, sedimentary rocks. If leakage occurs, then the well bores above and below the test interval may behave as constant-head boundaries, a condition not considered in the mathematical models used to interpret the test results. Fourth, the high pressures used in the injection testing may have increased fracture apertures, changing the hydraulic properties during the test.

Careful analysis of the testing results has not been performed. Even though poor matches to type curves have consistently been observed, there has been little effort to determine the causes, or to find other approaches to correctly interpret the data. The published interpretations of the tests should be viewed with skepticism.

An exception to the statement in the previous paragraph is the interpretive work performed at the C-hole complex. Research has been performed in the past, and additional work is planned, to understand the characteristics of the fractured tuffs, and correctly interpret the test results. When this work has successfully developed approaches to interpreting the testing data, these approaches should be used to reinterpret the testing data collected at other sites around Yucca Mountain. Until the reinterpretation is performed, the published results should be used as indicators, but not measures, of hydraulic properties.

GEOCHEMISTRY

Insufficient effort has been spent on interpreting the chemical analyses and integrating them with flow analyses. The recent water analyses have been very extensive - including a large number of trace elements and isotopes in addition to major element chemistry. Yet there appears to be no comprehensive synthesis of the information already available on ground-water chemistry. Further, the chemical analyses are reported virtually independently of the hydrologic and geologic information. Synthesis of all such data is necessary to make the greatest use of hydrochemical information. Just as rock properties are now being evaluated in their stratigraphic and structural framework, ground-water geochemistry must be considered in light of the geologic, lithologic, and hydrologic setting.

Most of the samples are simply pumped from wells and are considered to be composite samples. However, the water sampled is probably from the most permeable zone nearest the pump intake so they are not really composite samples from all the strata that the well penetrates. Even when samples are taken from intervals, often these intervals are very large (for example, an 1142 m interval in USW H-1). But even more problematic, it is still not clear how these intervals are related to hydrology or lithology. One of the most difficult and necessary tasks is to truly sample water from different tuff strata. Ideally, each individual stratum that may ultimately be part of the repository or part of the flow path should be sampled. Presently, there is no indication that waters from low permeability zones in the tuff have been sampled. This identification of individual water chemistries is necessary if they are to be subsequently used in hydrologic modeling of flow paths, mixing, etc. The possibility exists that the major element chemistry of individual waters may not be significantly different from each other. Trace element or isotopic signatures may still be useful in hydrologic modeling. Current information is inadequate to address the question of the distinction of individual water chemistries.

Some samples have been taken from different depths in water standing in the well bore by lowering remotely-opened bottles. These samples will not be any more specifically tied to the geologic setting than the composite samples will be. Further, standing water is much less representative of formation water than those samples obtained at the conclusion of pumping tests or from production wells. Chemical and biological reactions are likely to occur in the standing water which would alter its chemical characteristics. In laboratory studies on geochemical retardation, LANL (1982) has been using an "average" J-13 sample as a reference standard water. In experiments contacting this J-13 water for three weeks at ambient temperature with individual tuff samples, the resultant water chemistry was observed to change. Most elements changed somewhat compared to the starting composition. In contact with tuff from the J-13 well, the Mg content of the water decreased noticeably. With tuffs from another hole (USW G-1), the solution had especially increased Na and decreased Mg and Ca concentrations.

These results should be considered in light of the hydrochemistry of individual tuff layers. It may be that the J-13 composition chosen does not represent formation water of any one of the tuffs chosen for reaction. Then the subsequent chemical reactions are to be expected. However, it is possible that the water is not in chemical equilibrium with its host tuff. This condition would make reaction path modeling extremely complex. Simple mixing or mass balance models (for example, BALANCE) could not be readily used for help with hydrologic modeling. Temporal chemical variability of water from one tuff unit does not necessarily imply that kinetically-controlled reactions dominate water chemistry; it may in fact reflect flow-path conditions.

There is concern about some of the details of analytical methodology:

(1) Filter size. Several investigators have shown the effects of choice of filter size on the final chemical analysis of dissolved species (Jones and Kennedy, 1974; LANL, 1982). The species most affected are those likely to be present as fine colloidal material such as Si, Fe, Al, Ti, and Mn. LANL workers reported dramatic influence on chemical analyses and recommended use of 0.05 fm filters. The USGS and EPA standard methodology uses 0.45 fm filter but a number of recent studies have used 0.1 fm filters (Jones and Kennedy, 1974). Some standard methodology should be adopted and reported with the analysis. If comparison of analyses is to be attempted in detail, it is crucial that standardized sample collection, treatment, and storage routines be followed.

(2) Redox potential. Most of the more recent chemical analyses list Eh. Field emf measurements are notoriously difficult to make. If the aqueous system is not well poised (adequate amounts of each species of redox couple), then the emf measurement is probably meaningless. These are fairly dilute waters (TDS often near 200 mg/L) with low iron contents (often below 0.05 mgL). Reported Eh's have been -0.191 to +0.353V for water of pH 7 to 8. There is concern about the validity of these data. We suggest analytical measurements of Fe^{2+} and Fe^{3+} as well SO_4^{2-} and NO_3^- and NO_2^-. Also, a more careful consideration of possible redox couples might lead to a better understanding of the redox potentials of these waters. This information may be very useful when assessing recharge and the open or closed nature of the flow system. An interesting set of redox data exists for the month of daily samples taken from the Bullfrog layer by LANL. The samples show a dramatic systematic increase of dissolved oxygen, Eh, and NO_3^- with a decrease in the reduced species NO_2^-.

(3) Analytical quality. It would be helpful for the laboratories to routinely give some information about analytical methodologies and quality. Report of the charge balance for each analysis and duplicate analyses would give an idea about laboratory accuracy and precision. Also, detection limits for analytical procedures should be reported. The use of 0 for reported concentration can be misleading.

COMMENTS

The consultation draft of the Site Characterization Plan for Yucca Mountain is an extensive document providing a glimpse of investigations planned at Yucca Mountain. The hydrologic parts of the SCPCD were reviewed, and both general and specific comments are provided.

GENERAL COMMENTS

1) Insufficient information is provided to allow appropriate comments to be developed. Many of the tests are experimental, and may or may not be successful. Both test procedures and interpretive methods have yet to be developed.

2) The studies proposed for unsaturated zone characterization may be inadequate. It appears that insufficient effort is to be spent developing an adequate understanding of flow and transport properties in the fractured tuffs. The movement of waters in the fractures will largely be determined by the amount of water available, and the rate at which water will move from the fractures into the matrix. Too little effort is being directed toward this last question. Proper understanding of this process is critical for predicting travel time through the unsaturated zone.

3) There is a very strong reliance on the use of unvalidated models for the design of experiments in the exploratory shaft and the interpretation of the resulting data. The assumptions of these models should be thoroughly investigated.

4) The construction of the exploratory shaft and test facilities will alter the hydrologic environment, by drying the rock, unless the humidity of the ventilation air is carefully controlled. The drying process will bias the results of the experiments toward meeting the regulatory criteria for acceptance of the repository and may invalidate the characterization process.

5) Collection of water samples and characterization of water encountered in fractures in the unsaturated zone should receive high priority. This is a critical point. Adequate characterization will probably require temporary cessation of mining and other activities. These delays should be planned for, and technical personnel need to have the authority to immediately stop other activities in the instance

water is encountered.

6) There is too great a reliance on previous studies of the saturated zone. The models used for analysis of the hydrologic tests are not appropriate for use in interpreting most of the testing; there is poor agreement between the type curves and the data. These tests should be reevaluated in view of knowledge to be gained from the C-hole complex.

7) The SCP shows no work plans directly related to assessing the recharge potential of the many ephemeral streams which drain to the east off of Yucca Mountain. It is our opinion that these areas have significant potential to produce localized pulses of recharge into the subsurface. Such phenomena suggest that local fracture flow may dominate in these areas which must be addressed in the travel time and radionuclide migration analysis. The SCP indicates only extended studies of Fortymile Wash will be conducted. Although this feature is important to the overall ground-water hydrology of the site, it will not influence the recharge rate estimates through the repository environment.

Our recommendation is that detailed studies be conducted in several wash environments on Yucca Mountain to quantify this important recharge component.

8) The impacts of air and water vapor migration do not appear to be adequately addressed. These processes may lead to discharge of the radionuclides to the immediate surface environment. The SCP deals strictly with travel time from the repository to the saturated ground-water system while ignoring this process.

The possibility of upward vapor migration has been suggested in Montazer and Wilson (1984) but research does not appear to be proposed to study the impacts of such processes on gaseous radionuclide migration.

9) The process of dispersion in partially-saturated, fractured tuff has not yet been addressed in the scientific literature beyond the theoretical phase. The dispersion process, while reducing the maximum concentration will also decrease the time of first arrival at the accessible environment.

The impacts of dispersion will therefore reduce the travel time when compared with the bulk ground-water travel-time expressions suggested by the NRC. Studies should be conducted to study the dispersion process in the unsaturated fractured tuffs of Yucca Mountain to determine if theoretical studies completed to date agree with field results. Additional work will also be needed in code development of model transport in both saturated and partially-saturated, fractured tuff.

10) At this time, the study of water and solute movement in fractured rock is in its infancy and it therefore does not appear scientifically valid to choose one media approximation over another until further studies have been completed. An EPM approach may be valid for bulk fluid transport, however discrete fracture models may be necessary to handle the transport processes of radionuclides. This discrete approach is being taken by many other countries (Canada, Switzerland, etc.) and there is no data to suggest that Yucca Mountain will behave in an equivalent porous-media manner.

11) There appears to be little attention paid to the SCP to the study of fracture/matrix interactions, specifically studies aimed at understanding the hydraulic properties at the fracture/matric interface. There appears to be a feeling within the SCP that fluid will move into the matrices in response to capillary gradients and governed by matrix permeability. Yet we know from other field sites and core data that many of the fractures are lined with chemical precipitates or may have radically differing properties than the interstices of the matrix blocks. It is quite reasonable to assume that these fracture skins will significantly retard the uptake of fluid from the fractures into the matrices. Such behavior will tend to channelize fluid flow and will significantly alter any travel-time calculations.

12) The use of traditional soil physics mass balance equations (Richard's equation) for high-tension fractured -uff simulation appears tenuous at this time due to lack of validation. The conceptual model inherent in the Richard's equation has only been validated in the true sense of the term by 50 years of soil physics for shallow-soil studies in humid areas.

It has not been applied, however, to the scenarios of Yucca Mountain tuff, nor was it ever intended to be used for such conditions. As a result, the inherent assumption that the Richard's conceptual model of flow can be applied is invalid. Data must be collected to show that all of the processes of fluids moving in fractured rocks are inherent within Richard's model before it can be used indiscriminately.

Several factors, such as wetting front instability, potential non-wetting or hydrophobic surfaces, and vapor transport, are likely to be occurring at Yucca Mountain, however, Richard's equation does not have such processes as its basis. It is clear that much more basic research is needed in the study of partially-saturated fluid flow in fractured rocks before we can apply our traditional models.

13) The SCP states that the model-calibration phase will use either tension or water content as the calibration criteria. There is no problem with the use of tension (other than the data are hard to come by), however, the calibration by water content (or saturation) is erroneous due to the hysterisis problem. At this time, no data has been presented on the hysteritic behavior of the tuff-retention characteristics. Based upon traditional soil-physics data, we would expect to see significant hysterisis in the tuff. Such hysterisis leads to multivalued water content and therefore multivalued permeability data. Such behavior will significantly alter travel-time estimates.

14) The SCP (as well as the NRC) places emphasis on the disturbed zone as that zone where intrinsic permeability and effective porosity are altered. For an unsaturated-zone repository such factors are not relevant. Disturbed-zone criteria should be based upon alteration of the relative permeability curves (analogous to intrinsic permeability) and water retention (analogous to effective porosity). These data will control fluid, air, and radionuclide transport near the repository and will provide a much more coherent picture of the affects of disturbance.

The SCP also states that fluid flow and therefore performance will be within the matrix within the disturbed zone. There is no data to suggest that the non-isothermal conditions near the repository will lead to only matrix flow. On the contrary, we expect (but do not know) that fluid flow will be locally fracture-controlled due to the nonisothermal conditions. Until data is collected, it is imperative that both fracture and matrix flow be considered within the disturbed zone.

The fact that the SCP calls for ignorance of this condition appears to be a serious flaw in the planned analysis.

SPECIFIC COMMENTS

SPECIFIC COMMENTS

The following specific comments are presented to clarify the general concerns expressed previously. They are presented in the order encountered in the SCPCD with specifics relating to the description of the current state of knowledge, Chapters 3, 4, and 5 first. Following that are comments on the proposed tests and analyses as presented in Chapter 8. The final comments are related to the Performance Assessment sections of the SCPCD.

Citation: SCPCD
Chapter: 3.6.2
Page: 3-61 and 3-62
Subject: Relationship among hydrogeologic units

Specific Information:

This rather short section concludes that though vertical flow occurs, the primary regional component is lateral. Additionally, the section concludes that "detailed definition of localized vertical gradients over the entire hydrogeologic study area is unnecessary in a regional reconnaissance."

Discussion:

It may be true that lateral flow is the dominant regional flow direction (not enough back-up information is supplied to support this conclusion). However, this does not automatically translate that vertical fluxes are unimportant in understanding regional flow. Mapping the locations and determining the quantity of vertical water movement could be necessary for achieving mass balances and building realistic groundwater-flow models. Unless some other, unreferenced, information supports the conclusion of this section, we would say that the approach is flawed and could lead to overlooking the importance of vertical flow in regional hydrology. Arguments can be made over the degree of "detail", but investigations of vertical fluxes across the entire hydrogeologic study area should be made, not just focused at the Yucca Mountain site. A step in the right direction will be to construct separate potentiometric maps for the different hydrogeologic units (see comments for 3.6.3, pg. 3-62).

Citation: SCPCD
Chapter: 3.6.3
Page: 3-62
Subject: Potentiometric Levels

Specific Information:

The introductory paragraph states that the distribution of wells is adequate for the general definition of the regional potentiometric surface, shown on Figure 3-9.

Discussion:

In a basin containing several discrete hydrogeologic units, it is best to construct potentiometric level maps for each unit separately. It can be useful to compare depths to first saturation (water-table maps) that may combine measurements in different units. However, the significance of a map combining potentiometric levels from confined and unconfined units is unclear. This seems especially risky given that the previous section (3.6.2) states that upward and downward flow occurs. The steep gradients noted in the discussion may only be artifacts of mixing data from different units.

Another problem with a composite map such as this is that it can mask data gaps. The adequacy of data coverage will depend on how many wells are completed in each hydrogeologic unit. If many of the measurements used for Figure 3-9 are from the lower carbonate aquifer, then the distribution of wells may indeed be good. However, that means that the data density for the volcanic aquifers could be very poor. Regardless of the distribution of measurements among the units, the map in Figure 3-9 has some obvious data gaps, e.g., east of Nye County, which would be good to try and fill.

Citation: SCPCD
Chapter: 3
Page: 3-62 and 3-76
Subject: Potentiometric levels/hydraulic heads in the saturated zone

Specific Information:

Effects of subsurface temperatures on potentiometric levels/hydraulic heads in the saturated zone

Discussion:

On page 3-62, it is stated that in areas of steep hydraulic gradients, thermal conditions probably do not affect steep hydraulic gradients significantly. Allusion is made to "preliminary analyses," but no reference/analyses are actually provided. Thermal effects may or may not be important in areas of steep gradients, but their effects in areas of suspected vertical flow or "gentle" gradients could be significant. Our calculations have indicated that thermal effects on potentiometric levels/gradients can be non-negligible. For example, we recalculated the heads in well UE-25p#1 and found that when the effects of temperature on heads (via the change in water density) are included, the static water level in the Tertiary rocks is 14.30 meters lower and that in the Paleozoic rocks is 18.15 meters lower. These hardly represent "small effects," especially when one is concerned with calculating gradients in areas where the potentiometric surface is nearly flat, such as beneath Yucca Mountain itself. In the case of UE-25p#1, the direction of the gradient is unchanged, but the corrected head difference is 16.55 meters versus an uncorrected difference of 20.41 meters. As an aside, on another project we corrected heads in Areas 19 and 20 (Pahute Mesa) of the Nevada Test Site and found changes of up to 15.1 meters in some cases, which indicates that UE-25p#1 is not an isolated instance.

The implications of this issue are far-reaching: ground-water travel times, which are a function of head gradients, may be incorrect; the various modeling results may be incorrect because the models used the hydraulic head (uncorrected) as the dependent variable instead of the pressure. In addition, the temperature effects on the hydraulic conductivity/transmissivity values may be significant. Depth-averaging would not remove the temperature effects, since temperatures can vary areally and the precentage change in head will not be the same at each locale. Regional ground-water flow models probably should have used pressures and permeabilities (or permeability x thickness) instead of heads and hydraulic conductivities (or transmissivity).

We suspect that regional flow will not be dramatically changed by including the temperature effects on hydraulic head; however, the changes could become more significant as one goes from the regional to the local scale. In addition, we feel the effort should have been made to calculate these effects instead of making statements that temperature effects probably are not significant without providing any justification.

Citation: SCPCD
Chapter: 3.6.4
Page: 3-64
Subject: Hydraulic characteristics of principal hydrogeologic units

Specific Information:

This section does not comment on the adequacy (quantity or quality) of data, nor does it refer to a section of Chapter 8 that describes planned work in this area.

Discussion:

Though not referenced in this section, the corresponding part of Chapter 8 seems to be 8.3.1.2.1.3.1 This section recommends performing a sensitivity analysis to determine what additional measurements of permeability, transmissivity, storage, porosity, recharge, and discharge are needed. Section 3.6.4 clearly identifies some data gaps, e.g., no data from the upper carbonate aquifer and upper clastic aquitard and data from only one borehole for the lower clastic aquitard. This section (3.6.4) should comment on the adequacy of these data and should reference a section of Chapter 8 that describes a work plan for filling gaps (not just an "assessment of data needs").

Citation: SCPCD
Chapter: 3.7.1.2
Page: 3-71
Subject: Model of recharge and discharge

Specific Information:

"Although some uncertainty remains on the quantities and distributions of recharge over the region, the level of uncertainty does not appear significant in terms of affecting site-specific analyses and interpretations for Yucca Mountain."

Discussion:

The above statement is gratuitous and does not really make any sense. How did the author reach this conclusion? What analyses and interpretations are unaffected? The discussion preceding this conclusion suggests a high degree of uncertainty that correspondingly reflects great uncertainty in the regional hydrologic model. This is further supported in the first paragraph, pg. 3-72, where the author states "Modeling studies...have shown recharge to be a highly sensitive element of regional flow models...." The offending statement should be struck and the additional work planned given the respect it deserves.

Citation: SCPCD
Chapter: 3.7.1.3
Page: 3-71
Subject: Residence times of the ground water

Specific Information:

Item #2 on the page gives one age for the valley-fill aquifer, then speculates on the age of water in the tuff aquitard.

Discussion:

This seems to be a highly speculative way of determining the age of water in the tuffs, and probably too general, as well. Section 3.6.4 describes the tuffs as highly variable in hydrologic properties. The age of water sampled in the tuffs will depend on how much of its flow path was through fractured, transmissive parts and how much was through tight matrix blocks. Though ages of several hundred thousand years are not beyond possibility, much younger ages are also possible, especially given the uncertainties in rock-property data and recharge estimates (cited as supporting slow vertical flow).

Citation: SCPCD
Chapter: 3
Page: 72-74, 96-102, 111-113, 164-168, 221-223
Subject: Residence times of ground water; regional isotope hydrology; ground-water recharge during Late Wisconsin time: carbon-14 evidence; hydrogeochemistry; hydrochemical confirmation of ground-water behavior (saturated zone)

Specific Information:

Effects of mixing on ground-water ages (carbon-14 dating of ground water) and relationship between decay ages and actual

Discussion:

Carbon-14 decay ages of ground water, whether "raw" or "adjusted/corrected" are not necessarily equal to the actual ground-water ages. In order to relate the two ages, a specific mixing model must be specified. Only in the case of pure piston flow, i.e., no mixing, are the two ages equivalent. Unless mixing has been accounted for, interpretations based on decay ages can be erroneous. The SCPCD seems to recognize that mixing is a factor in converting decay ages to ground-water ages (page 74), but there are apparently no plans to develop mixing models for carbon-14 decay ages.

Citation: SCPCD
Chapter: 3.7.2.2
Page: 3-78
Subject: Ash Meadows subbasin

Specific Information:

"It may be desirable to confirm the interpretations with one or more additional wells with multidepth head measurements. Plans for collecting additional data (of) this type are discussed in Section 8.3.1.2."

Discussion:

We heartily support the recommendation for multidepth head measurements. Unfortunately, we cannot identify any activities in 8.3.1.2 designed to achieve this.

Citation: SCPCD
Chapter: 3.7.3.1.1
Page: 3-82
Subject: Chemical composition of ground water

Specific Information:

Paragraph 1 says "...with sulfate, chloride, and fluoride present in concentrations of 0 to 217 mg/l, 14 to 3 mg/l, and 0 to 10 mg/l, respectively.

Discussion:

Given that the convention used throughout this section is to report values as low to high, we suspect that the chloride range is incorrect.

Citation: SCPCD
Chapter: 3.7.3.1.2
Page: 3-91
Subject: Discharge from the tuff aquifer

Specific Information:

Based on the linearity of HCO3 vs. Na and Cl vs. Na, White (1979) concluded that water in alluvium could evolve from tuffaceous compositions by concentration increases due to evapotranspiration.

Discussion:

It will take more than just evaporation to derive the alluvium concentration from the tuffs. On the lower plot, it shows Na increasing at about twice the rate of Cl. If simple evaporation is the only process, they should increase mole for mole. Evaporation may certainly be going on, but it must be accomplished by either a Na-enriching or Cl-depleting process, or both. Cl-depletion is difficult to postulate, thus it is more likely that Na is buidling up in solution faster than Cl due to incongruent dissolution of Na from volcanic glass. White (1979) also argues that CaCO3 dissolution occurs (increasing Ca in solution) and that SO4 from hydrothermal sources is added.

Citation: SCPCD
Chapter: 3.7.3.2.1
Page: 3-79
Subject: Regional isotope hydrology--tuff aquifer

Specific Information:

Paragraph 2 discusses the stable isotopic composition of Yucca Mountain versus Wash samples and states "This is consistent with rainstorm runoff, rather than snow melt recharge."

Discussion:

As no data are presented on stable isotope compositions of either of these types of precipitation events, the above-quoted statement is highly speculative. In fact, as every description of the Yucca Mountain samples is prefaced with the phrase "...older high altitude, cold continental recharge...", it appears that the interpretation was made before any precipitation data were examined.

Citation: SCPCD
Chapter: 3.7.3.2.1
Page: 3-96
Subject: Regional isotope hydrology–tuff aquifer

Specific Information:

The del D/del O-18 data of groundwater beneath Fortymile Canyon is "consistent in isotopic composition with warmer, mid-continental intense rainstorm runoff that could cause Fortymile Wash to flow. Rare, high-intensity rainfall events therefore probably currently recharge the shallow tuff aquifer at this location."

Discussion:

This hypothesis of the recharge mechanism in Fortymile Canyon seems perfectly reasonable, but the stable isotopic data presented do not necessarily support it. The most obvious gap is the absence of stable isotopic data from precipitation in the area. How can a determination that the Fortymile Wash data are consistent with present-day, heavy summer rainstorms be made when no data on present-day rainfall is given? The assumption that observed differences in the isotopic content of recharging precipitation could be inaccurate. Slight differences in geomorphology and sediment type can have a large impact on the isotopic characteristics of recharge (Allison et al., 1985). The relative enrichment in heavy isotopes noted in Fortymile Wash is also not characteristic of high-intensity rainfall events. Rainfall events with high total precipitation volumes are characterized by lighter isotopic compositions relative to normal area rainfall (Gat and Gonfiantini, 1981: Vogel et al., 1963). Indeed, the study by Vogel and others (1963) found that ground water in the Kalahari Desert replenished by occasional heavy downpours contained considerably less deuterium than either area rain or river water.

Central to all of the stable isotope interpretations in the SCP is the concept that modern water is enriched in heavy isotopes and older ground water is depleted. This hypothesis is virtually useless without some idea of what the isotopic composition of modern recharge actually is. Even if the concept proves valid, it cannot be applied blindly to all ground-water samples without taking into account all of the processes which may have affected the water's isotopic composition, e.g., type of precipitation event, mode of infiltration.

Citation: SCPCD
Chapter: 3.7.3.2.1 and 3.7.4.5
Page: 3-99 and 3-11
Subject: Carbon-14 dating of water in tuff aquifer and paleohydrology interpretations

Specific Information:

These discussions assume that water from the Cenozoic aquifers does not need correction of apparent C-14 ages.

Discussion:

The assumption that no correction for "dead" carbon is needed could be seriously in error. Certainly these sections should consider other hypotheses in addition to Claassen's (1985). Three possible carbon reservoirs exist, in addition to atmospheric CO2: 1) caliche and calcium carbonate cements and coatings; 2) carbonate within the Cenozoic section, including limestone beds and calcite deposits along fractures and faults; and 3) the regional Paleozoic carbonate aquifer.

While Claassen (1985) assumes that recharging water has an initial radiocarbon content equal to 100 pmc, other workers in arid to semi-arid lands have found values of 85-87 pmc (Vogel, 1970; Wallick, 1973). Claassen (1985) argues that dissolution of caliche is at best a minor factor in development of the chemical and isotopic characteristics of groundwater in the tuffs. However, Claassen's evidence is not conclusive. For instance, a reported lack of caliche within the floor of Fortymile Draw presupposes this as the dominate recharge pathway. The descriptions of surficial deposits in section 1.2.2.3 indicate the pervasiveness of calcium carbonate in the Yucca Mountain area soils, and thus its availability to go into solution. Claassen's del C-13 argument is also equivocal: he assumes that caliche would have a del C-13 of ~0 per mil, similar to marine limestone. Wallick (1973) reports a mean value of -3.4 +/- 1.3 per mil for the del C-13 of soil carbonates in the Tucson Basin. Combining the caliche observations with a larger role for vegetation's effect on soil could easily have a soil carbonate component. The role of vegetation, both present-day and during a pluvial period, should be carefully evaluated.

The other two dead carbon sources should also be considered. Though carbonates do not comprise a large proportion of the Cenozoic section, they do occur (Sec. 1.2.1.2) and could affect a sensitive measurement like C-14. Similarly, the addition of carbon originating in the Paleozoic carbonates should also be considered. Potentiometric levels indicate possible upward fluxes of water from the carbonate aquifer to the tuffs.

Another source of possible error in Claassen's analysis is the assumption that the C-14 composition of the soil gas is 100 pmc. A good discussion of this problem is given in Section 3.9.5.2 (Hydrochemical Confirmation of Ground-Water Behavior) where it is pointed out that Yang et al. (1985) found the C-14 concentration in soil gas CO2 to be as low as 34 pmc in samples from 368 m below the surface in the Yucca Mountain area.

In summary, Claassen's C-14 evaluation represents one interpretation (at the oldest age endpoint). Other interpretations are possible and should be evaluated. The range in interpreted ages can then be compared with hydrologic flow models and paleohydrologic interpretations.

Citation: SCPCD
Chapter: 3.7.3.2.2
Page: 3-102
Subject: Regional isotope hydrology--carbonate aquifer

Specific Information:

"The waters show no hydrothermal fractionation and do not resemble expected modern precipitation."

Discussion:

Just what is the expected modern precipitation? Even if data are lacking at the site, the "expected" value should be stated and justification given for the choice, e.g., values from nearby areas. Obviously, someone has a guess as to what they think it should be since the entire isotope section is riddled with references to a present, warmer precipitation signature versus an older, pluvial one. This guess should be spelled out instead of implied so that it can be critically evaluated.

Citation: SCPCD
Chapter: 3.7.4.1
Page: 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" ground water 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.

Citation: SCPCD
Chapter: 3.9.1
Page: 3-148
Subject: Baseline monitoring

Specific Information:

Figure 3-28 is a potentiometric-level map constructed with "composite" values. The method of selection of these values is unclear.

Discussion:

The choice of values for this map clearly favored "water table" measurements. For instance, in well UE-25p#1, the value from the Paleozoic carbonates was not used while the measurement from the tuffs was. However, this method of selection is not spelled out and is certainly not obvious since the title of the map is "preliminary composite potentiometric-surface map", not "water-table map" or "depth-to-first-water map."

Beyond this, the method of data selection is still unclear. The map uses the "composite" measurement for well USW H-1, while it uses the measurement for the uppermost isolated interval for well USW H-6. The differences between these measurements are not great, but Sec. 3.9.1.1.2 states that due to the small range in water-level altitudes, "measurement precision is important for determination of fluctuations, gradients, and probably flow paths" (p. 3-153). Therefore, small differences in water levels are considered important. Surely the map's author had a system for choosing between several values for one well. It should be spelled out here.

Citation: SCPCD
Chapter: 3.9.1.1.1
Page: Page 3-148, para. 3
Subject: Unsaturated zone

Specific Information:

Unsaturated zone measurements

Discussion:

Paragraph 3 indicates that the silica flour used for heat dissipation probes was dry. It is our understanding that the flour added was at a suction of -1.0 bars, which is fairly wet. See Montazer et al., 1985.

Citation: SCPCD
Chapter: 3.9.1.2.1
Page: 3-157 through 3-159
Subject: Unsaturated zone

Specific Information:

Unsaturated zone measurements

Discussion:

Based upon the data supplied in the SCP, the height above perched water in UZ-1 of instrument station 15 is 16 meters. If saturated conditions existed at this depth (387 meters), then it is expected that the psychrometers and HDP's should register approximately -1.6 bars. Based upon Figures 3-30 and 3-31, matric potential values ranged from -1 to -5 bars. We believe these data show an expression of the experimental variability in measuring potentials and the point should be addressed.

Citation: SCPCD
Chapter: 3.9.1.2.1
Page: 3-160, para. 1
Subject: Unsaturated zone

Specific Information:

Equilibrium of instrumentation

Discussion:

The SCP states "...instruments have stabilized sufficiently to yield matric potential profile...," indicative of ambient conditions within the host rock. Montazer (1986) states that the addition of dry sand to borehole UZ-1 may have caused significant drying of the rock matrix surrounding the borehole thereby disrupting the natural conditions. The low conductivity of the rock mass will prevent reëstablishment of equilibrium conditions for a long period. The psychrometer readings therefore may be significantly biased toward the dry range and true ambient conditions may be much wetter.

Citation: SCPCD
Chapter: 3.9.3.2.2.
Page: 3-200
Subject: Saturated zone

Specific Information:

"Significant vertical hydraulic gradients have been observed in only a few drillholes..."

Discussion:

While the above statement is true, it is also true that efforts have not been made to observe vertical gradients in many drillholes. Table 3-24 lists water-level measurements from 31 wells. Only seven of these wells provide measurements from individual zones in addition to composite measurements. Of these seven, three wells exhibited significant gradients (19 to 54 m) between zones and two others had differences between 1 and 2 meters. UE-25p#1 is apparently the only measurement of head in the regional carbonate aquifer in the Yucca Mountain area.

The last paragraph in this section expresses great uncertainty about whether water movement is upward or downward ("Yucca Mountain is an area where local vertical flow may be either up or down"). Given this uncertainty and the fact that significant vertical gradients were observed in almost half of the wells where vertical gradients were examined, a specific work plan to investigate the magnitude and direction of vertical fluxes is called for. The work plan outlined in 8.3.1.2.3.1.2 (Site potentiometric level evaluation) should include this sort of study.

Citation: SCPCD

Chapter: 3.9.3.3, 3.7.3.2.1, 3.7.3.2.2, 3.7.4.5, 3.9.5.2

Page: --

Subject: Residence times of the ground water; regional isotope hydrology (tuff aquifer & carbonate aquifer); ground-water recharge during Late Wisconsin time: carbon-14 evidence; hydro-chemical confirmation of ground-water behavior (saturated zone)

Specific Information:

Effects of mixing on ground-water ages (carbon-14 dating of ground water)

Discussion:

Carbon-14 decay ages of ground water, whether "raw" or "adjusted and/or corrected," are not necessarily equal to the actual ground-water ages. In order to relate the two ages, a specific mixing model must be specified. Only in the case of pure piston flow, i.e., no mixing, are the two ages equivalent. Unless mixing has been accounted for, interpretations based on decay ages can be erroneous. The SCP seems to recognize that mixing is a factor in converting decay ages to ground-water ages (last paragraph of page 3-228), but there are apparently no plans to develop mixing models for carbon-14 decay ages. Reference is made to "...planned use of initial carbon-14 modeling and relative dating along flow paths to resolve apparent difficulties of interpretation...", to be described in Chapter 8, Section 8.3.1.2.3. This approach does not imply the use of mixing models to obtain ground-water ages.

Citation: SCPCD
Chapter: 3.9.4
Page: 3-213
Subject: Ground-water velocity and travel time

Specific Information:

This section focuses on determining travel times for "expected" fluxes from the repository disturbed zone.

Discussion:

This orientation is understandable because of the need to show compliance with the NRC performance objective (10 CFR 60.113(a) (2)). However, velocities and travel times are also needed for the analysis of release scenarios to determine compliance with 40 CFR 191. Section 3.9.4 should recognize this additional need and consider flow times in units that could be involved in unexpected flow paths, e.g., those induced by human intrusion. These should include, at a minimum, flow times in the lower carbonate aquifer, and flow in the upper saturated tuffs in the flow field was perturbed by a borehole connection with a higher potentiometric level in the carbonates or older tuffs.

Citation: SCPCD
Chapter: 3.10.1
Page: 3-233
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.

Citation: SCPCD
Chapter: 3.10.1
Page: 3-233
Subject: Summary of significant results

Specific Information:

"The results...indicate that the climatic regime is unlikely to produce water-table rises over the next 10,000 years that could inundate the repository. This unlikely scenario is to be examined further."

Discussion:

The modeling by Czarnecki (1985) reported in 3.9.8 does suggest (with many qualifications) the conclusion stated above. However, Section 3.9.3.4 (Unsaturated-Zone Relationships) reports modeling by Rulon et al. (1986) and Peters et al. (1984) that predicted "steady net infiltration rates (or percolation fluxes) exceeding values in the range from 0.5 to 1.0 mm/yr would produce complete matrix saturation in the TSw and TCw units after the mountain equilibrates to the change in flux. These conditions could lead to liquid-water flow within the fractures of these units" (p. 3-211). Czarnecki's model assumes an infiltration rate of 8 mm/yr. The models being used to simulate water-table rises do not seem to be consistent enough to warrant confidence in which model is correct. It would be best to hold open the possibility of large water-table rises until future studies narrow the range of possibilities.

Citation: SCPCD

Chapter: 3.6.3, 3.9.1.1.2, 3.9.1.2.2, 3.9.3.2.2, 3.9.4.2

Page: –

Subject: Hydrology/potentiometric levels, site hydrogeologic system--baseline monitoirng-saturated zone; potentiometric levels-saturated zone; ground-water travel times

Specific Information:

Effects of temperatures on hydraulic heads and related matters

Discussion:

On page 3-159, paragraph 3, the following is stated:

"However, effects on water levels caused by water-density differences due to differences in ground-water temperatures among wells probably are small."

Our calculations indicate that this is untrue. For example, we recalculated the heads in well UE-25p#1 and found that when the effects of temperature on heads (via the change in water density) are included, the static water level in the Tertiary rocks is 14.30 meters lower and that in the Paleozoic rocks it is 18.15 meters lower. These hardly represent "small effects," especially when one is concerned with calculating gradients in areas where the potentiometric surface is nearly flat, such as beneath Yucca Mountain intself. In the case of UE-25p#1, the direction of the gradient is unchanged, but the corrected head difference is 16.55 meters versus an uncorrected difference of 20.41 meters. As an aside, on another project, we corrected heads in Areas 19 and 20 (Pahute Mesa) of the Nevada Test Site and found changes of up to 15.1 meters in some cases, which indicates that UE-25p#1 is not an isolated instance.

The implications of this issue are far-reaching; ground-water travel times, which are a function of head gradients, may be incorrect; the various modeling efforts ,e.g., Waddell, 1982; Czarnecki and Waddell, 1984, may also have produced incorrect results; and the various potentiometric surface maps may be wrong. The modeling results may be incorrect because the models used the hydraulic head (uncorrected) as the dependent variable instead of the pressure. In addition, the temperature effects on the hydraulic conductivity/transmissivity values may be significant. Depth-averaging would not remove the temperature effects, since temperatures can vary by area and the percentage change in head will not be the same at each locale. Regional ground-water flow models probably should have used pressures and permeabilities (or permeability x thickness) instead of heads and hydraulic conductivities (or transmissivity).

We suspect that regional flow will not be dramatically changed by including the temperature effects on hydraulic head; however, the changes could become more significant as one goes from the regional to the local scale. In addition, we feel the effort should have been made to calculate these effects instead of making a blanket statement that temperature effects "probably are small." This statement should be justified.

Citation: SCPCD
Chapter: 3.9.3.3
Page: –
Subject: Recharge-discharge and leakage

Specific Information:

Temporal variability of fluid flux

Discussion:

The SCP states that high frequency recharge events will quickly be damped out as they proceed into the unsaturated zone. Inherent in this statement is that the matrix and fractures quickly come into thermodynamic equilibrium. As judged by the recent AGU session and interest in macropores, field data does not support this assumption. In addition, the SCP makes no mention in the sections concerning measurement technologies and data as to the "expected" response of TCP's or HDP's to rapid non-equilibrium fracture flow. Significant laboratory work must be done to estimate the behavior of these traditional instruments to these flow phenomena.

Citation: SCPCD

Chapter: 3.9.3.3, 3.7.3.2.1, 3.7.3.2.2, 3.7.4.5, 3.9.5.2

Page: –

Subject: Residence times of the ground water; regional isotope hydrology (tuff aquifer & carbonate aquifer); ground-water recharge during Late Wisconsin time: carbon-14 evidence; hydro-chemical confirmation of ground-water behavior (saturated zone)

Specific Information:

Effects of mixing on ground-water ages (carbon-14 dating of ground water)

Discussion:

Carbon-14 decay ages of ground water, whether "raw" or "adjusted/corrected," are not necessarily equal to the actual ground-water ages. In order to relate the two ages, a specific mixing model must be specified. Only in the case of pure piston flow, i.e., no mixing, are the two ages equivalent. Unless mixing has been accounted for, interpretations based on decay ages can be erroneous. The SCP seems to recognize that mixing is a factor in converting decay ages to ground-water ages (last paragraph of page 3-228), but there are apparently no plans to develop mixing models for carbon-14 decay ages. Reference is made to "...planned use of initial carbon-14 modeling and relative dating along flow paths to resolve apparent difficulties of interpretation...", to be described in Chapter 8, Section 8.3.1.2.3. This approach does not imply the use of mixing models to obtain ground-water ages.

Citation: SCPCD
Chapter: 3.7.1.2
Page: --
Subject: Model of recharge and discharge

Specific Information:

Regional potentiometric surface

Discussion:

A potentiometric gradient is described, Figure 3-10, from the Sheep Range toward Yucca Flat. Our data from the area suggest that there may be a ground-water divide between the Sheep Range and the east Desert Range. Therefore, little or no water from the Sheep Range flows toward the west as described in Figure 3-10.

Citation: SCPCD
Chapter: 4.1.2.5
Page: Page 4-45, para. 1
Subject: Dissolved gas

Specific Information:

Dissolved carbon dioxide

Discussion:

All increases in pH from 7.0 to 8.5 can be accounted for by CO2 degassing; the second sentence implies this, but the third sentence shows a change of 10^{-5} to 10^{-5}. This is clearly a typing error. However, what are the units for these values (pCO2, CO2(mg/l), % by weight, etc.)? Ground water having an initial pCO2 = $10^{-1.5}$ would equilibrate to atmospheric levels (pCO2 = $10^{-3.5}$) when left in an open container.

Citation: SCPCD
Chapter: 4.1.2.6, 8.3.1.2.3.5, 8.3.1.2.3.2.2
Page: 4-46,47; 8.3.1.2-96; 8.3.1.2-335
Subject: Regional radioisotope activity

Specific Information:

On page 4-46 of the SCPCD, the statements "Plans for obtaining additional data of the concentration of naturally-occurring radionuclides in Yucca Mountain ground water are outlined in Section 8.3.1.2. These data will provide baseline values for future reference in monitoring the ground water at Yucca Mountain." are made. However, within the relevant sections (8.3.1.2.1.3.5 and 8.3.1.2.3.2.2) the only plans for further studies are the collection of ground-water samples that "will be analyzed for standard ionic composition; carbon-14 and tritium, stable isotopes of carbon, hydrogen, oxygen, and sulfur; and other inorganic constituents, as needed. The usefulness and applicability of uranium-series disequilibrium analyses will be evaluated; if determined to be appropriate, these analyses will also be done."

Nowhere within the SCPCD or within the USGS technical procedure manuals is a process defined for the baseline monitoring of radionuclides susceptible to transport from the proposed repository.

Discussion:

A geochronology procedure outlined in technical procedure manual GCP-04 allows for the determination of uranium-234, uranium-238, and thorium-234. This, in conjunction with procedures outlined in Chapter 8.3.1.2 and technical procedures manual HP-11, allows for the determination of tritium, carbon-14, total uranium concentration, as well as the isotopes listed above. However, an attempt should be made to analyze for various radionuclides on a periodic basis in order to establish a baseline monitoring program for future reference. Kerrisk (1985) is a good treatise on radionuclides that will be present within the repository in quantities greater than their respective EPA release rates.

Citation: SCPCD
Chapter: 5
Page: 5-2, para. 2
Subject: Key meteorological data

Specific Information:

"Meteorological data have been collected from monitoring stations operated by the National Weather Service, and at stations on the Nevada Test Site (NTS) and Yucca Mountain. Key meteorological data that indicate local climate are temperature, precipitation, and atmospheric moisture, and to a lesser extent, wind speed and wind direction."

Discussion:

The relative importance of meteorologic data to climatic considerations depends, in part, upon the scale of climatic interest. From a regional perspective, wind direction may be of greater interest because it reflects both aerosol and moisture sources which ultimately determine precipitation growth mechanisms as well as temporal and spatial distributions of precipitation. On a local scale, wind directions are altered by topographic features. Local wind directions influence meso- to microscale climatic norms (precipitation, temperature) in terms of exposure and drainage.

Citation: SCPCD
Chapter: 5
Page: 5-11, para. 2
Subject: Synoptic scale processes

Specific Information:

"The link between synoptic-scale processes and their effect on site-specific meteorology is not known at this time because the data are not yet available. The multi-tower monitoring program implemented at Yucca Mountain (Section 8.3.1.12) is designed specifically to collect data that can be used to characterize the relationships between site conditions and regional weather systems."

Discussion:

Synoptic-scale influences on local climate and meteorology have been studied by Houghton (1969), but this work seems to have been neglected throughout the SCP document in discussions of climate. Houghton studied synoptic patterns in terms of the amount and distribution (temporal and spatial) of Great Basin precipitation.

Citation: SCPCD
Chapter: 5
Page: 5-11, para. 5
Subject: Dominant winds

Specific Information:

"Predominantly northerly winds prevail because of synoptic influences in the fall and winter months, but south to southwesterly winds become dominant during the spring and summer."

Discussion:

Dominant wind directions as measured at ground stations (800 to 850 mb level) are strongly influenced by local topography and do not necessarily correspond to synoptic winds measured at the 700 to 650 mb level (mountaintop). Houghton's (1969) analysis of dominant synoptic wind patterns suggest that the climatically important winds in winter come out of the west to southwest, not the north. In summer, the climatically-important winds are suggested to come out of the south to southeast, not the southwest. Sources of precipitable moisture are significant to understanding modern climate as well as paleoclimate.

Citation: SCPCD
Chapter: 5
Page: 5-16, para. 3
Subject: Precipitation and atmospheric circulation patterns

Specific Information:

"Precipitation in the Yucca Mountain area is associated with two distinct atmospheric circulation patterns. The first of these patterns creates winter frontal passages that are associated with Pacific air masses moving toward the area from the west. Approximately 50 percent of the precipitation in the vicinity of Yucca Mountain occurs as a result of these systems during the months of November through April, even though the entire area lies in the rain shadow of the Sierra Nevada. The second type of circulation pattern than occurs in the area creates a secondary peak in precipitation in the late summer (July and August) and is a result of thunderstorm acitivities."

Discussion:

Houghton (1969) characterized Great Basin precipitation as being derived from three triggering mechanisms (Pacific, Continental, and Gulf), which he associated with six statistically-distinct, synoptic-circulation patterns. In the southern Great Basin, the summer Gulf component is the dominant seasonal mechanism, representing in excess of 25 percent of annual precipitation. The Pacific component represents only approximately 40 percent of annual precipitation and 50 percent of winter precipitation. The balance of the annual precipitation results from the Continental component.

Distinctions regarding the origin of air masses (sources of aerosol and moisture) are important to characterization of both modern and paleoclimate because they determine development of precipitation and subsequent spatial and temporal patterns.

Citation: SCPCD
Chapter: 5
Page: 5-20, para. 3
Subject: Thunderstorm infiltration

Specific Information:

"Because the repository would be located in the unsaturated zone beneath Yucca Mountain, evaluation of the long-term ability of the site to contain stored waste must include a determination of how much of the precipitation falling at the surface infiltrates as potential recharge to the ground water. While thunderstorms are significant events and potentially damaging, they occur in the summer months when soil moisture is low and potential evapotranspiration is high and thus are not likely to result in significant ground-water recharge (Nichols, 1986). The most likely events leading to infiltration that exceed soil moisture deficit and evapotranspiration and could thus lead to percolation through the repository horizon would occur during the winter months."

Discussion:

The contention that summer thunderstorms do not result in significant recharge is not universally accepted. These events do lead to significant flows in wash areas which tend to be filled with alluvial materials that have reasonably high hydraulic conductivity thus permitting significant infiltration during both the precipitation and runoff events. While summer evaporation rates are high, there is evidence that suggests that summer transpiration rates for some dominant plant species in the Yucca Mountain environment may be low. These data suggest that the plants may enter a summer senescent period and do not respond during that period to changes in soil moisture. Thus, if moisture infiltrated in the wash environments reaches below the zone of effective evaporation, then it may have the opportunity to move through the root zone without being transpired.

Infiltration of winter and spring precipitation may reach the root zone during periods of maximum plant transpiration and thus be consumed before it has the opportunity to ever reach the zone of saturation (recharge).

Citation: SCPCD
Chapter: 5
Page: 5-21, para. 5
Subject: Tower-recorded wind directions

Specific Information:

"Data from the towers indicate that wind direction is influenced primarily by two general types of atmospheric activity. First, large-scale pressure systems govern seasonal variations in wind direction and produce predominantly northerly winter winds and predominantly southerly summer winds. Secondary to overall patterns are terrain-induced wind flow patterns and the effects of ground-surface heating and cooling."

Discussion:

Terrain exercises the dominant influence on tower-measured wind directions. Mountain-top winds, 650 to 700 mb level, (10,000-12,000 ft msl) reflect the "large-scale pressure systems." These winds, particularly the climatically-important ones, are dominantly out of the west during winter months. The measured northerly and southerly tower-wind directions are the result of terrain effects. Comparison of the winds, both at upper levels and at the surface, during periods of precipitation occurs with the overall wind data set would provide a better understanding of the air flow patterns important to the precipitation process.

Citation: SCPCD
Chapter: 5
Page: 5-25, para. 5.1.1.5
Subject: Upper air data

Specific Information:

Wind measurements in Yucca Flat at 5,000 and 6,000 ft msl are characterized as "upper air data" and are compared with NTS tower measurements.

Discussion:

It is not surprising that these wind data are similar to the "ground level" tower measurements since these elevations are within the zone of terrain influence. While these data are significant and important to transport of ground-released radionuclides, they are of lesser significance from a climate point of view. From a synoptic weather perspective these data would be considered "boundary layer" air rather than "upper" air. The Las Vegas NWS rawinsonde measurements are the most long-term source of "upper" air data.

Citation: SCPCD
Chapter: 5
Page: 5-88 and 5-105
Subject: Vegetation data and climate

Specific Information:

Page 5-88: "1. Comparisons of maps of species distributions with maps of climatic parameters. Past changes in the species distribution are assumed to reflect changes in the subjectively- correlated climatic variable. "Modern plant distributions are poorly mapped in the West, limiting the applicability of this method." Additionally, without means of assessing whether there is a mechanism linking the distribution of a given species with a certain parameter, these mapped comparisons may be misleaading." (emphasis added)

Page 5-105: "Climatic, steam-flow and vegetational data for the region during the past 50 yr are of fair quality and are probably sufficient for modeling applications..."

Discussion:

There is an apparent conflict regarding the adequacy of data on vegetation distribution. A vegetation-climate "transfer function" may provide important insight and data on past and potential, future climate regimes. If the vegetation data base is inadequate to accomplish that analysis, then a mapping program should be included in the Chapter 8 description of investigations. Such a program, however, does not appear in the study plan.

Citation: SCPCD
Chapter: 5
Page: Page 5-105, para. 3
Subject: Meteorological data network--evaporation

Specific Information:

"...a comprehensive, site-specific base of meteorological data. The data should include hourly averages of wind speed, wind direction temperature, and parameters for the determination of atmospheric stability. Ideally, the data should cover as long a time period as possible and should include parameters for comparison with less site-specific but longer-term climatological records (precipitation and relative humidity). The Meterological Monitoring Plan (SAIC, 1985) (Section 8.3.1.12) provides a means by which this information need can be satisfied."

Discussion:

Chapter 5 discusses several parallel approaches to defining both modern and paleoclimatic regimes and thus the potential impact of a future climatic change on the hydrologic performance of the repository. Within the Great Basin, the ultimate "sink" for all precipitation is evaporation. Past pluvial regimes can be explained through either the precipitation or evaporation process or some combination of changes in both. The importance of the evaporation parameter is stressed in discussion in pages 5-42 to 5-54 (Section 5.2.1.2.1). Measured (pan) and calculated evaporation rates are strongly correlated with latitude because of solar energy availability, but show wide year-to-year variability that reflects meteorological conditions.

While pan evaporation is not a true measure of natural evaporation from lakes, streams, or soil, it is a direct measure that can be related to the natural processes. Given the importance of evaporation, it is curious that such direct measurement has not been included in the meteorological-data network.

Citation: SCPCD
Chapter: 8.3.1.2
Page: 8.3.1.2-58 to 8.3.1.2-67, 8.3.1.2-82 to 8.3.1.2-106
Subject: Ground-water flow system conceptual model; ground-water flow system; regional and sub-regional ground-water flow models

Specific Information:

Description of regional ground-water flow system; numerical modeling of same

Discussion:

An understanding of the regional hydrologic-flow system is quite important. As stated on page 8.3.1.2-58, this system must be understood to define present and expected boundary conditions for site unsaturated and saturated ground-water models and the hydrogeologic setting in which the site occurs. In turn, the above must be understood to develop travel-time estimates, flow paths and fluxes in the vicinity of the repository, and the effects of present and future conditions. In addition (page 8.3.1.2-60), regional ground-water flow models will also provide the direction for future data collection.

The SCPCD obviously recognizes the importance of the regional subsurface flow system. Pages 8.3.1.2-58 to 67 and 8.3.1.2-82 to 106 provide background material, rationale, and activities and investigations designed to improve knowledge of the regional flow system. Recognition is made of the uncertainties inherent in boundary conditions and other items and some studies, e.g., ET study, are proposed to mitigate some of these uncertainites. Efforts will be made to update the regional model of Waddell (1982) and the subregional model of Czarnecki and Waddell (1984) and to construct a two-dimensional, vertical cross-sectional model and a quasi-three-dimensional, regional ground-water flow model. General comments will be made on these efforts and some of the apparent inconsistencies.

With regard to improvement of the existing regional/subregional models, it is implied that the basic conceptual model of Winograd and Thordarson (1975) will be utilized as a paradigm. One of the problems with the entire modeling program is that there does not appear to be sufficient latitude to explore different conceptual models. Although one of the investigations (8.3.1.2.1) has as its objective to develop a conceptual model of the regional hydrologic system, it remains to be seen how much latitude will be utilized. The Waddell model, used as the basis for the Czarnecki-Waddell model (and so on down the line), is based on the Winograd-Thordarson conceptual model. One wonders what results numerical models would produce if some alternative to the Winograd-Thordarson conceptual model were used.

As mentioned previously (page 8.3.1.2-60), regional ground-water flow models will provide a direction for future data collection. However, on page 8.3.1.2-64, it is implied that no new program of data collection is expected to be needed.

On page 8.3.1.2-101, the document suggests that the vertical component of flow is minor, as suggested by potentiometric data. However, on page 8.3.1.2-104, it is implied that a quasi-three-dimensional model is needed because of the suspected vertical flow in the Yucca Mountain region due to potentiometric differences.

One activity of interest is the regional three-dimensional hydrologic modeling (8.3.1.2.1.4.4). With regard to this effort, a number of comments can be made. Initial recharge and boundary conditions for this model will be taken from the existing Waddell and Czarnecki and Waddell models. Will the "revised" versions of these models alluded to earlier be used to provide this information? The implication is that the original models will be used. The quasi-three-dimensional model will be calibrated in the steady-state mode but will be used in part to simulate conditions suggesting transcience (climatic change, tectonism, future ground-water development). Will there be any effort to calibrate against transient conditions? Virtually no information exists on the vertical hydraulic-conductivity distribution in the region (page 8.3.1.2-105), yet values of this parameter will probably prove to be important especially in assessing the effects of increased recharge. No extensive program is planned to evaluate vertical conductivities; each unit in the three-dimensional model will be assumed isotropic. Although the sensitivity of the model to the isotropy assumption will be evaluated, it is difficult to see why this important parameter is not given more attention. Although the "quasi" approach circumvents the lack of vertical hydraulic-conductivity information to some degree, this information would seem to be very critical to the proper assessment of certain effects.

The technical procedures for a number of activities (subregional, two-dimensional, areal hydrologic modeling; subregional, two-dimensional, cross-sectional hydrologic modeling; regional, hydrologic-system synthesis and modeling; regional, three-dimensional, hydrologic modeling; conceptualization of regional hydrologic models) are not specified.

Citation: SCPCD
Chapter: 8.3.1.2.1.1
Page: 8.3.1.2-67
Subject: Characterization of the meteorology for regional hydrology

Specific Information:

The objectives of this study are (1) to characterize the area surrounding Yucca mountain in terms of precipitation and its relationship to surface runoff, with particular emphasis on the Fortymile Wash drainage basin, and (2) to provide input into the rainfall-runoff model development effort. One activity is planned to collect the data required to satisfy these objectives.

Discussion:

To meet the rather bold objectives of this study component, a much denser continuous rain gage network may be required than what is general proposed in the SCPCD. There is much variability in the spatial distribution of summer storm events in this region due primarily to the complex regional topography and high relative relief. This complexity requires much more spatial coverage. Non-recording rain gauges are limited in function because they do not measure rainfall intensity or duration (hyetographs), and thus should be avoided. Rainfall intensity-duration will be the key measurement in developing rainfall-runoff relationships or models. Relevant research in determining the optimum rainfall gaging network has been conducted and should be reviewed prior to network design (Osborne, et al, 1968; Osborne et al, 1971).

Citation: SCPCD
Chapter: 8.3.1.2.1
Page: 8.3.1.2-66
Subject: Studies to provide a description of the regional

Specific Information:

"Additional precipitation gages will be established to support infiltration studies (Section 8.3.1.2.2.2) and rainfall runoff modeling (Section 8.3.1.2.1.4.3)."

Discussion:

The SCPCD does not address objectives or activities associated with rainfall-runoff model development. Referenced Section 8.3.1.2.1.4.3 is not in the SCPCD. Since much of the data collection programs prescribed in the SCPCD are to provide specific data for the development of the rainfall-runoff model, it is crucial to present for review the specific activities and parameters.

Citation: SCPCD
Chapter: 8.3.1.2.1.1.1
Page: 8.3.1.2-67
Subject: Precipitation and meteorological monitoring

Specific Information:

The objective of this study is to provide site-specific information on storm precipitation at, and near, the network streamflow-measurement sites.

Discussion:

It is unclear why the SCPCD emphasizes the objective of measuring storm precipitation at and near streamflow-measurement sites. A storm hyetograph measured at a streamflow measurement site most often is not representative of the upgradient watershed's hyetograph that will yield streamflow. The rainfall network must be designed to provide a spatially averaged hyetograph for a given watershed subunit. The stream flow gage station then is coincidentally located at the outlet of this watershed unit. In this way the rainfall/runoff relationship of that particular watershed subunit can be developed. Hydrographs of specific watershed subunits can then be added and compared to the hydrograph recorded at the basin outlet to further characterize the watershed response to the storm event.

Citation: SCPCD
Chapter: 8.3.1.2.1.2.1
Page: 8.3.1.2-72
Subject: Surface-water runoff monitoring

Specific Information:

Figure: 8.3.1.2-7 (p. 8.3.1.2-76) Site precipitation, streamflow, and proposed weather stations

Discussion:

Proposed locations for additional precipitation, streamflow, and weather stations are presented in the SCPCD-Figure 8.3.1.2-7. The SCPCD does not present a rationale for the design of the instrument networks or the selection of specific measurement sites. The design of such networks can only be done after a detailed study of the Yucca Mountain watershed. Specifically, the investigations to select rain- gage locations should include: 1) Identification of data gaps in the present rain gage network; 2) field survey of the local physiography to determine rain shadows and higher precipitation areas; 3) general review of seasonal storm paths; 4) optimization exercise relating rain gage density and location to the centroid of watershed subunits and location of stream gages (outlet of the watershed subunits). The selection of streamflow gages should be coincidental, focusing on coverage of major tributaries (watershed subunits) of the Fortymile Wash.

Citation: SCPCD
Chapter: 8.3.1.2.1.3.1
Page: 8.3.1.2-82
Subject: Assessment of the regional hydrogeologic data needs in the saturated zone

Specific Information:

It is unclear how this activity will be performed.

Discussion:

The model by Czarnecki and Waddell (1984) can be used to evaluate the effect of uncertainty of some parameters on the possible performance of the repository. The measurement parameter of sensitivity should be flow velocities in the ground-water system near Yucca Mountain; the SCPCD does not indicate what specific parameter will be used. The model is not accurate enough to address information needs in the vicinity of Yucca Mountain; a detailed, three-dimensional model which incorporates the dip of the units and their offset across the larger faults will probably be needed for that task. Preliminary assessments could be made close to Yucca Mountain, but the results should be considered to be only tentative.

Citation: SCPCD
Chapter: 8.3.1.2.1.3.2
Page: 8.3.1.2-83
Subject: Regional potentiometric level studies

Specific Information:

This activity plan seems to be the focus for regional potentiometric level studies (the other regional studies seem to be modeling exercises) and does not address concerns raised for Chapter 3.6.3.

Discussion:

This activity plan lacks any evaluation of potentiometric levels in various hydrogeologic units and resulting vertical head gradients. Though determining the location of the water table is an admirable goal, it should not be the sole focus of the potentiometric studies. There should be explicit plans for obtaining potentiometric level data for all of the identified hydrogeologic units. A first step must be to construct potentiometric level maps for each unit to identify where new data would be most helpful. Areas where vertical communication between units is indicated should receive special attention.

An additional concern is that the area of the map presented in Figure 8.3.1.2-8 is much smaller than that shown as the "regional hydrologic study area" and planned model area (as shown in Figure 8.3.1.2-11). It may be that the field reconnaissance of existing wells will cover the larger area; if so, the study area map should be presented. Apparently, only two new regional water-level holes are currently planned. As there appear to be larger data gaps on Figure 3-9 than where the two new wells are located, some justification of the well location should be provided.

Citation: SCPCD
Chapter: 8.3.1.2.1.3.2
Page: 8.3.1.2-83 through -87
Subject: Regional potentiometric level studies

Specific Information:

Adequacy of the database

Discussion:

From a Yucca Mountain perspective, there are some deficiencies in the regional potentiometric database. Very little is known about the change in head in the vertical direction. Hydraulic heads in northern Yucca Wash and north of Yucca Wash are not known. It is known that a relatively steep gradient exists between northern Jackass Flat and the confluence of Pah Canyon with Fortymile Canyon, but details are not known. In the NTS area, steep gradients are associated with low-permeability rocks, such as the Eleana. Additional head information would be useful in identifying the cause of the high gradients observed north of the repository block (the high gradient between USW G-2 and USW H-1 is a different issue). Similarly, little is known about hydraulic-head changes in Crater Flat; measurements are available from VH-1 and VH-2 only. South of Yucca Mountain, additional data would be helpful. A gravity high is present southwest of the intersection of US 95 and Nevada highway 29, which may be caused by shallow Paleozoic rocks; a well in this location may provide more information on the hydraulic relationship between the Tertiary and Paleozoic rocks. Certainly, data should be collected out of any wells in the vicinity of Yucca Mountain, provided that the data provide further insight. It may not be beneficial to obtain geophysical logs or material-property data out of all the holes provided by the mining company. Performing permeability measurements on cuttings is questionable. The usefulness of these data should be evaluated before much effort is expended.

Vertical gradient data should be collected by drilling and completing holes to different depths, especially close to Yucca Mountain and downgradient from the proposed repository. Long-term vertical gradient data are lacking, except at USW H-1. These holes could be sampled for chemical stratification data, and the deeper holes (with a short screened interval, approximately 50 ft) could provide useful information on heat flow and rates of water movement.

A string of shallow holes down Fortymile Canyon between UE-29a#2 and UE-25WT#15 would be useful in mapping the change in head down the canyon. (The canyon is mistakenly labeled "Fortymile Wash" on Fig. 8.3.1.2-8; the wash begins where the stream enters Jackass Flat.) These data would help understand the cause of the high gradient.

Temperature logs are useful in interpreting vertical flow directions. However, caution is urged in interpreting these logs in open holes, because of the transmissive character of the borehole. Zones of upward and downward flow commonly occur together in the same hole; the locations of these zones may be determined more by the locations of permeable fractures encountered by the borehole than by the head distribution in the hole.

Use of a permeability value from a single test can yield misleading conclusions on flow rates. Careful tests and analytical procedures will be needed.

Citation: SCPCD
Chapter: 8.3.1.2.1.3.3
Page: 8.3.1.2-88
Subject: Fortymile Wash recharge study

Specific Information:

Quantification of recharge on a regional scale is needed to eliminate some of the uncertainty associated with the regional ground-water flow model. However, we question the ability to measure accurately short term, high intensity floods resulting from periodic storm events.

Discussion:

The significant volume of suspended sediment and boulders contained within flash floods on the NTS indicates that a fair amount of channel scouring and subsequent redeposition is occurring. With changes in stream channel geometries after each storm event it will be difficult to establish a calibrated stage-discharge relation from which channel losses can be calculated.

Neutron holes will also be installed across the channel to track moisture fronts resulting from these events (SCP, p. 8.3.1.2-89). Controlled experiments should be conduct to the established the frequency of logging needed to track the fronts and the sensitivity of the tool. Ponding experiments are also planned in this activity (SCP, p. 8.3.1.2-89). It is our recommendation that the ponding experiments be conducted first to help guide in the collection and analyses of data from the neutron holes traversing the Fortymile Wash channel.

Citation: SCPCD
Chapter: 8.3.1.2.1.3.4
Page: 8.3.1.2-93
Subject: Evapotranspiration Studies - Franklin Lake playa

Specific Information:

The evapotranspiration studies planned for Franklin Lake playa may be useful in quantify evapotranspiration in this area. However, the investigator proposes to develop an empirical relation between evapotranspiration and depth to water (SCP, p. 8.3.1.2-93). It is questionable whether a meaningful empirical relation can be developed based on these two parameters and applied to other discharge areas.

Discussion:

This activity involves obtaining measurements of evapotranspiration using eddy-correlation and Bowen ratio techniques, for correlation with depth to water in the Amargosa Desert. It is unclear from the SCPCD when these measurements will be made, or how frequently. This information is critical in assessing the approach. Multiple measurements are necessary because of the strong probability that unsteady-state conditions exist, resulting in changes in the amount of water stored in the unsaturated zone between the water table and the land surface. Data collected by Czarnecki (1987) from the Franklin Lake playa indicate that the moisture content in the unsaturated zone changes with time. He calculated that the ET rate changes by as much as a factor of 6 over time at some sites on the playa. Therefore, multiple measurements will be necessary.

A third approach that should be investigated for evaporation measurements is the use of a cuvette, which provides a "direct" measurement of evaporation, by measuring the increase in humidity inside a closed container placed temporarily on the ground.

Although used to estimate depth to water, geophysical approaches alone may lack the accuracy needed for this type of study. They should not be relied upon without confirmatory measurements in boreholes.

The investigators acknowledge that other factors will influence evapotranspiration rates such as soil texture, plant type and density, and that these will be considered in the analysis (SCP, p. 8.3.1.2-93). Accurate estimate of evapotranspiration will also be dependent on meteorological parameters such as wind speed, humidity, solar radiation, etc., which will need to be factored into the environmental settings. Hence, based on the stated approach to this study, we feel the empirical relation developed from this activity will only be applicable at this location and cannot be apply in other areas.

Citation: SCPCD
Chapter: 8.3.1.2.1.3.5
Page: 8.3.1.2-96
Subject: Regional hydrochemical tests and analyses

Specific Information:

This plan lacks any reference to analyzing the ground water for radionuclides.

Discussion:

There is no mention is this section of analyzing the samples for naturally-occurring radionuclides (other than for ground water dating purposes). The regional and site hydrochemistry programs should include as a task the characterization of groundwater with regard to both natural and anthropogenic radionuclides. The data generated by this task can fulfill several objectives: establishing levels of radionuclides in the ground-water environment prior to the arrival of waste, aiding in identifying differing hydrochemical facies and ground-water chemical reactions, and applying the data as analogs (or perhaps in some cases as direct comparisons) for the transport of waste nuclides by area ground water.

The above comment also applies to Sec. 8.3.1.2.3.2.2 "Hydrochemical Characterization of Water in the Upper Part of the Saturated Zone at the Site."

Citation: SCPCD
Chapter: 8.3.1.2.1.3.5
Page: 8.3.1.2-96
Subject: Regional hydrochemical tests and analyses

Specific Information:

There are apparently no plans to collect data on the stable isotopic composition of precipitation.

Discussion:

Neither this section nor the precipitation-data sections (8.3.1.2.1.1.1 and 8.3.1.12) mention the collection of precipitation samples for chemical and isotopic analysis. The maximum amount of information and certainty in interpretations cannot be acheived from the stable isotope analyses planned in this activity and in 8.3.1.2.3.2 (Site Saturated Zone Hydrochemistry) and 8.3.1.2.2.8 (Unsaturated Zone Hydrochemistry) without also gathering stable isotope data from precipitation. As noted in Sec. 3.7.3.2.1 (Regional Isotope Hydrology), the collection and stable isotopic analysis of rainfall and snow samples "will contribute significantly to an improved interpretation of this system" (p.3-99). In addition, unsaturated-zone techniques such as chloride profiling would benefit from major ion analyses of precipitation.

Citation: SCPCD

Chapter: 8.3.1.2.1.3.5 (also applies to 8.3.1.2.3.2, 8.3.1.5.2.1.2, and perhaps others)

Page: 8.3.1.2-96

Subject: Carbon-14 dating of ground water

Specific Information:

The discussion of isotope hydrology in Chapter 3, as well as the plans in the above-referenced sections, considers the carbon-isotope systematics of only the ground-water system, neglecting the need for data from soil gas and carbonates.

Discussion:

The appropriate analyses seem to all be included in the SCP, but they are located in several different programs. For instance, 8.3.1.2.2.8.1 (Gaseous-Phase Chemical Investigations) contains plans to sample soil gas for radiocarbon and stable carbon isotope ratios. Section 8.3.1.5.1.4.3 (Surficial Deposits Mapping of the Yucca Mountain Area) includes plans for carbon and oxygen isotopic analysis of secondary carbonates. However, the sections dealing with ground-water radiocarbon studies neglect to discuss the soil gas and carbonate work as being necessary to the proper interpretation of the ground-water data. Some cross-referencing between these plans would be prudent to ensure that the required data are available to all those who need it.

Citation: SCPCD
Chapter: 8.3.1.2.1.3.5
Page: 8.3.1.2-95 through -97
Subject: Regional hydrochemical tests and analyses

Specific Information:

Completeness of analyses and use of data

Discussion:

The description lists parameters that will be determined and methods for interpreting the data. The methods for collection of the samples are not mentioned, nor are the locations to be sampled. Information on dissolved oxygen or redox indicators apparently is not being collected, and should be. Samples should be collected in a manner to preserve the redox state. Information on vertical changes in chemistry needs to be collected.

Flow rates are commonly calculated based on C-14 data. It will be important to determine flow paths independently. Perhaps more important is investigating whether diffusion of C-14 into the rock matrix from the fractures occurs. If so, flow rates will be greater than would be calculated on the basis of the data themselves (without accounting for matrix diffusion).

There is no discussion about collection of field duplicates, splits, or other standard QC approaches. Technical Procedure NWM-USGS-HP-23, R1 may include this discussion, but probably does not. Sending samples to more than one lab for laboratory comparison should also be done periodically.

Citation: SCPCD

Chapter: 8.3.1.2.1.4

Page: 8.3.1.2-97 through -98

Subject: Conceptualization of regional hydrologic flow models

Specific Information:

Applicability of model

Discussion:

The regional ground-water flow model by Waddell certainly requires an update. New data in the vicinity of Yucca Mountain clearly point out some inadequacies in the model, developed in 1980 and 1981. The model should be updated, but should not be overextended. However, the model is two-dimensional and may be inadequate for accurately describing flow in the Amargosa Desert area and to Death Valley. It will be important to look at vertical flow, especially into or out of the Paleozoic rocks found at fairly shallow depth near Yucca Mountain. The possibility of underflow from the Ash Meadows area, beneath the Amargosa Desert, into the Furnace Creek Wash area should be investigated, at least as far as determining if it could be important in terms of modeling radionuclide transport near Yucca Mountain. The model of Waddell should be used to integrate the currently existing data, but its assumptions should be revisited.

Citation: SCPCD
Chapter: 8.3.1.2.1.4
Page: Begins on page 8.3.1.2-97
Subject: Regional hydrologic system synthesis

Specific Information:

Activity: Conceptualization

Discussion:

As in section 8.3.1.2.2.10.1, this section implies that no conceptual model exists for the saturated or unsaturated zone. This is absurd since a conceptual model is described in detail in Sec. 3.9.3, titled "Ground-Water Flow Systems Conceptual Model." Although Sec. 3.9.3 carefully points out that conceptual models must be continually tested and revised, Chapter 8 indicates that a single model will be formulated and adopted. No clear provision is made for flexibility of the model, or careful consideration of alternative models. It is suggested that the SCPCD take its own advice and specifically include a plan for updating the conceptual model, and for exploring alternatives. The apparent rigidity of the SCP is a serious problem.

Citation: SCPCD
Chapter: 8.3.1.2.1.4
Page: 8.3.1.2-99
Subject: Regional hydrologic system synthesis

Specific Information:

Activity: Sub-Regional 2-D Model

Discussion:

This is an important and necessary step in the characterization process, but the SCP does not recognize the probable degree of uncertainty in the results of this activity. Mention is made of the new results of Czarnecki (1987) in the Amargosa Desert, and these results illustrate an important point. A few "holes of opportunity" demonstrated that our understanding of the regional hydrologic system is extremely poor. Czarnecki now believes that discharge from the Yucca Mountain system is one-third to one-half the value used in his original model (Czarnecki and Waddell, 1984). Incorporation of this reduced discharge in the Sub-Regional Areal model will lead to profoundly different results than previous models. None of the parameters of this activity are well-known today, nor are they likely to be well-known; therefore, the results of this activity must be clearly acknowledged.

An assumption inherent in this type of model is that flow is strictly horizontal, and the thickness of the flow zone is constant. Since no accurate cross section of the area has been constructed, the validity of this assumption is unknown. It is clearly an oversimplification, and the influence of vertical flow, changes in aquifer thickness, and thermal buoyancy effects may be significant. The potential influence of these processes must be evaluated before the model results can be considered realistic.

An unfortunate fact in regions of limited data is that flow modeling might be calibrated, i.e., models can match the current known data, but generally cannot be validated (tested with a data set not used for calibration). The work proposed in this activity is justified, as long as the results are recognized to be strictly qualitative, and highly uncertain.

Citation: SCPCD
Chapter: 8.3.1.2.1.4.2
Page: 8.3.1.2-99 through -100
Subject: Subregional two-dimensional areal hydrologic modeling

Specific Information:

Incorporation of anisotropy

Discussion:

Previous models have not adequately addressed the effects of anisotropy of hydraulic conductivity. Czarnecki and Waddell (1984) investigated the effect of anisotropy on model calibration assuming that the model was correct in all aspects except the degree of anisotropy, but did not attempt to change model zonation or boundary conditions. They did not investigate the effect on direction of flow. Fracture orientation data suggest that the rocks are anisotropic, although no field tests have been performed and analyzed to measure permeability in different directions. Anisotropy can have a large effect on flow directions, and hence calculations of transport directions and interpretations of geochemical data.

Citation: SCPCD
Chapter: 8.3.1.2.1.4
Page: 8.3.1.2-101
Subject: Regional hydrologic system synthesis

Specific Information:

Activity: 2-D Cross-Sectional Model

Discussion:

Many of the comments made for 8.3.1.2.1.4.2 apply to this activity as well. First and foremost, an accurate geologic cross section must be made for this activity to produce meaningful results. A basic assumption of this type of model is that no flow occurs into or out of the cross section; for this reason the section is oriented along stream-lines predicted by the areal model. As discussed above, the areal model, and therefore the predicted geometry of streamlines, is highly uncertain. In fact, the streamline illustrated in Fig. 8.3.1.2-11 is probably invalid in view of Czarnecki's Amargosa Desert results. Once again, this is a necessary activity, and the uncertainty is unavoidable, but it must be acknowledged. The uncertainty is clearly pointed out in this particular section. Why isn't it emphasized in any of the other modeling sections?

Citation: SCPCD
Chapter: 8.3.1.2.1.4.3
Page: 8.3.1.2-101 through -103
Subject: Subregional two-dimensional cross-sectional hydrologic modeling

Specific Information:

Selected cross section, and assumption of isotropy

Discussion:

Development of a cross-sectional model is needed. However, development of such a model on this scale may not provide much useful information because of the lack of three-dimensional head data and a poor understanding of the distribution of Paleozoic rocks and other deposits beneath the Amargosa Desert. A less intensive approach, and one that may be appropriate in view of the gaps in data, would be to prepare detailed geologic sections along the chosen line, incorporating known head data.

The line of the section should be reevaluated after performing calculations on the effects of anisotropy. The flow path from Yucca Mountain will probably be more southerly, rather than southeasterly toward Fortymile Wash.

This section could then be used to guide development of cross-sectional models in more detail, concentrating on Yucca Mountain and the nearby areas. Several such models should be developed. Particle-tracking approaches might be used in both the plan-view and cross-sectional models.

Citation: SCPCD
Chapter: 8.3.1.2.1.4.4
Page: 8.3.1.2-103
Subject: Regional three-dimensional hydrologic modeling

Specific Information:

Area of model, conflict between the models, and sensitivity analyses

Discussion:

The area to be modeled is not discussed, but presumably is about the same as the subregional models discussed in other sections of the SCPCD. The amount of detail planned for the model is unspecified. The relationship of this 3-D model with the 2-D areal and cross-sectional models is unclear. Which model will control decisions concerning the site?

Vertical discritization is needed not only for including layers of different lithology, but for numerical accuracy. Sensitivity of the model to the number of layers, even if of the same properties, should be performed. Because of the great deal of uncertainty about the properties of the underlying layer, the vertical conductivities of the layers, and the hydrologic heads present in the lower layer, careful sensitivity analyses should be performed, with perhaps several different models developed to test different hypotheses. It is well known that calibration of a model to available data does not ensure that the model is correct. When data are not available, many different interpretations are possible, and the consequences of these interpretations should be investigated.

Citation: SCPCD
Chapter: 8.3.1.2.1.4
Page: 8.3.1.2-103
Subject: Regional hydrologic system synthesis

Specific Information:

Activity: 3-D Saturated-Zone Models

Discussion:

Since this activity will be based on the 2-D model results, it will suffer from all of the problems discussed previously. Objective 2 of the activity (to estimate hydrologic properties where they are unknown) is extremely risky with this kind of model, and is in reality a trial-and-error aproach to parameter estimation. Apparently, reasonable values may be obtained, but their validity is unknown. As above, this model may be calibrated, but validation using a separate data set is very unlikely.

(p.105, para. 2) Assumption of isotropic hydraulic conductivity is unrealistic in fractured rocks (see Rulon et al. (1986) for more reasonable treatment).

Citation: SCPCD
Chapter: 8.3.1.2.2.1.2
Page: 8.3.1.2-125
Subject: Natural infiltration analyses

Specific Information:

The second activity, analyses of natural infiltration, will primarily depend on the use of neutron access holes to measure the unsaturated zone moisture content and to track moisture fronts.

Discussion:

Neutron logging may not be able to detect water moving in fractures. First, the neutron access holes would have to penetrate preferential flow paths that may be present within the fracture planes. Second, the neutron tool will have difficulty detecting a relatively thin layer of water in a fracture, especially if the saturation of the matrix is high. Finally, the rate of movement is likely to be rapid, so that frequent logging will be necessary. Hence, data from the neutron access holes will have to be evaluated with these potential problems in mind and the limitations they place on the conclusion drawn from them.

Citation: SCPCD
Chapter: 8.3.1.2.2.1.2
Page: 8.3.1.2-125
Subject: Tritium Profiling

Specific Information:

"Tritium profiling studies will determine flow velocities averaged over approximately the last 30 years by analyzing bomb-produced tritium concentrations in core obtained from representative neutron access holes."

Discussion:

The water collected from core for tritium profile analyses will be almost exclusively from the rock matrix. The absence of post-bomb water will not be proof that recent recharge and water movement along the fractures has not occurred. Conversely, the rapid movement of gas in the fractures provides a mechanism for contamination of the matrix water with post-bomb tritium.

Citation: SCPCD
Chapter: 8.3.1.2.2.1.3
Page: 8.3.1.2-134
Subject: Double ring infiltrometry measurements and ponding tests.

Specific Information:

"Ponding tests that measure infiltration rates over approximately the upper 15 ft of unconsolidated surficial materials will be conducted at the same locations as double-ring infiltrometry measurements."

Discussion:

The use of these methods to establish maximum infiltration rates in surficial materials is appropriate, as long as air entrapment is accounted for; however, these tests will not address infiltration in areas with limited surficial material. Precipitation directly on fractured rocks can result in rapid infiltration.

Another objective of the ponding tests is to ascertain the relative importance of fracture versus matrix flow. The use of neutron access holes to track moisture fronts in the fractured bedrock will be doubtful for reasons discussed previously (Chapter 8.3.1.2.2.1.2). Hence, the potential for successfully tracking moisture fronts through the fractured bedrock is doubtful. A dye will be added to the ponded water, such that preferential flow paths can be visually identified at the completion of the study. The mining of the fractured rock below the ponding sites may provide the data to quantify the accuracy with which moisture fronts were actually identified through the neutron holes.

Citation: SCPCD
Chapter: 8.3.1.2.2.1.3
Pages: 8.3.1.2-134 to 135
Subject: Small- and Large-Plot Rainfall Simulations

Specific Information:

None

Discussion:

These simulations will be useful in establishing the potential recharge flux given different rainfall intensities. Limited details are provided on the test design and instrumentation therefore, it is difficult to comment on the planned tests. One good aspect of this study is that an attempt will be made to quantify natural infiltration in control plots adjacent to the artificial plots. This will be the first time that real data have been collected on natural infiltration adjacent to Yucca Mountain. However, there is concern about the plan to locate these sites adjacent to the ponding sites and the potential for interference from lateral spreading of water.

Citation: SCPCD
Chapter: 8.3.1.2.2.3.1
Page: 8.3.1.2-140
Subject: Matrix hydrologic properties testing

Specific Information:

"Matrix hydrologic property measurements will be conducted on consolidated geologic rock samples only."

Discussion:

The laboratory hydrologic property measurement activity has been designed to collect unsaturated and saturated hydrologic property data on the porous matrix material, while no attempt has been made to collect unsaturated hydrologic property data on fractures. Determination of unsaturated hydrologic properties for fractures has been ignored, in part because of the difficulty in making these measurements and in obtaining good fracture samples.

There is a proposed activity in the exploratory shaft study to collect four or five fracture samples for hydrologic and solute transport property analyses. The collection of fracture property data from the shaft is important; however, fracture property measurements are needed prior to the collection of fracture samples from the exploratory shaft, in order to test the USGS/DOE proposed conceptual model for flow in the unsaturated zone. Most of the activities planned for the exploratory shaft are designed based on the USGS/DOE conceptual model. Prototype testing of this conceptual model prior to the mining of the shaft may identify the need for additional studies and data collection in the shaft.

Therefore, samples of fractures should be collected from either shallow excavations or rock outcrops for prototype hydrologic testing. Fracture samples from core will tend to be unsuitable for hydrologic testing because of their limited size. Data from these fracture samples should then be used to evaluate the USGS/DOE conceptual model for the unsaturated zone and hydrologic tests planned for the exploratory shaft.

Citation: SCPCD
Chapter: 83.1.2.2.3.2
Page: 8.3.1.2-149
Subject: Site vertical borehole studies

Specific Information:

Approximately 17 additional boreholes are planned for unsaturated testing in this activity. Tests planned for this activity include:

1) Single-hole gas permeability tests;
2) Cross-hole pneumatic tests;
3) Gas-tracer diffusion tests;
4) Long-term monitoring, similar to UZ-1;
5) Vertical seismic profiling (VSP); and
6) Fluid-injection tests.

Discussion:

Unsaturated zone testing and data collection, such as was proposed in this activity, are needed near the proposed repository location. However, a major concern for hydrologic testing in this area is the in- situ condition of the fracture and matrix material as a result of gas and moisture discharges from UZ-6 and UZ-6S. Work by Weeks (1987) indicate that a significant drying out of the rock around UZ-6 and UZ- 6S has occurred since they were drilled in September 1984. An evaluation should be made concerning the potential impacts this drying will have on the proposed hydrologic tests. In addition, the potential for open boreholes to act as pathways for gas and moisture flow needs to be minimized in the design and implementation of these proposed tests.

The gas tracer diffusion tests will be influenced by the flow of air and moisture to open boreholes. Therefore, test intervals will have to be isolated from barometric and elevation effects to reduce the potential for air flow.

Citation: SCPCD
Chapter: 8.3.1.2.2.3.3
Page: 8.3.1.2-169
Subject: Solitario Canyon Horizontal Borehole Study.

Specific Information:

"It is recognized that the hydraulic properties of the fault zone may vary from unit to unit, but the principal investigation effort will be focused on the Topopah Spring unit because it is the proposed repository host rock".

Discussion:

It is difficult to evaluate the specific test and analyses to be performed on this fault zone, because of the limited information provided. The difficulty of drilling and instrumenting a 300 m horizontal borehole will be much greater than previously encountered at the site. Therefore, new techniques may have to be developed for instrumenting and testing this hole from those previously used. We question the feasibility of installing a horizontal borehole across the Solitario Fault zone. It may be better to install vertical boreholes on both sides of the fault to perform crosshole testing.

Citation: SCPCD
Chapter: 8.3.1.2.2.4.1
Page: 8.3.1.2-182
Subject: Intact-fracture tests in the exploratory shaft facility

Specific Information:

The first activity proposed under the exploratory shaft program is the collection and hydrologic testing of fractured rock samples. This will be the first attempt at measuring fracture flow properties for the tuffs.

Laboratory tests planned for the intact-fracture samples include standard unsaturated property measurements for the matrix material; the fractures will have injection tests for two-phase flow properties, tracer column tests, flow channelization tests and stress permeability measurements.

Discussion:

"The design of the ESP hydrologic tests is principally based on the initial conceptual unsaturated-zone hydrologic model for the site..." (SCPCD, p. 8.3.1.2-177)

A quantification of fracture hydrologic properties is an integral part of characterizing unsaturated and saturated flow for Yucca Mountain. A conceptual model has been proposed by the USGS (Montazer and Wilson, 1984) for unsaturated flow; however, this conceptual model has never been verified. Yet, the design of tests proposed for the exploratory shaft are based on this conceptual model. Hence, there is a need to collect fractured tuff samples and obtain data on hydrologic properties of the fractures to test this conceptual model prior to the tests proposed for the shaft. Depending on the results of these tests, there may be a need to modify the test design or add new tests to the exploratory shaft program.

Limited information is provided on the actual tests planned for the fractured tuff samples. Therefore, we are unable to comment on this aspect of the activity.

Citation: SCPCD
Chapter: 8.3.1.2.2.4.2
Page: 8.3.1.2-193
Subject: Infiltration in the exploratory shaft facility

Specific Information:

"The objective of this activity is to determine the hydrologic conditions that control the occurrence of fracture and matrix flow."

Discussion:

Infiltration tests in the exploratory shaft facility have the potential of providing valuable in-situ data on fracture and matrix flow within the Topopah Spring unit. However, it is not clear from the information provided in the SCPCD how the experiment will be run, how the hydrologic properties will be measured, or exactly how the analysis will be performed.

The current design plans calls for the installation of nine horizontal and four vertical boreholes. The nine boreholes will be drilled in three different horizontal layers with boreholes on one side instrumented for long-term monitoring and the boreholes on the other side will be used for logging and tracer detection. It is not clear from the information provided how the central set of boreholes will be instrumented for data collection. The infiltration tests will be conducted at different flow rates; a tracer will also be added to the sand and the concentration breakthrough monitored in the boreholes. The data analysis will be performed with the use of three-dimensional, variability saturated transport computer codes.

It is not clear from the information provided how the stated objective for this activity will be met. In order to determine the conditions that control the occurrence of fracture and matrix flow, tensions in both the matrix and fractures have to be measured. The SCPCD states, "Fracture flow will be assumed to have occurred when discrete fractures in the middle row of boreholes show significant difference in water potential from that in the matrix." (SCPCD, P. 8.3.1.2-197). Yet, the techniques for measuring the water potential of a fracture have not been developed or presented. A determination of when fracture flow occurs and under what conditions is the most critical part of this experiment. The success or failure of this experiment will depend on making these measurements.

The use of three horizontal boreholes per layer appears to be insufficient for detecting fracture flow. The high potential for channelization within the fracture planes may result in boreholes missing the preferential flow path. Therefore, an increase in the number of boreholes will increase the potential of detecting fracture flow.

Also, it appears that only one side will be instrumented for long- term monitoring, where as the other side will be used for logging. We recommend that additional boreholes be instrumented for measuring matric potential across the infiltration site, rather than relying on data from just one side since the system has a high potential of being both anisotropic and heterogeneous over this test volume. The heterogeneity and anisotropy needs to be measured and incorporated into the analysis of the data.

Citation: SCPCD
Chapter: 8.3.1.2.2.4.3
Page: 8.3.1.2-209
Subject: Bulk-permeability test in the exploratory shaft facility

Specific Information:

Data collected from the bulk-permeability tests "will be used in a mathematical model (TOUGH) that simulates two-dimensional gas flow in nondeformable porus media" (SCPCD, p. 8.3.1.2-215).

Discussion:

The tests being proposed under this activity will be testing individual fractures and fracture sets within the immediate vicinity of the test room. It is not anticipated that fracture sets within this volume will respond as an equivalent two-dimensional porous media; yet a two-dimensional porous media model has been proposed to analyze the results. We recommend that a three-dimensional fracture flow models be considered for the analysis of the test data.

Citation: SCPCD
Chapter: 8.3.1.2.2.4.3
Page: 8.3.1.2-210
Subject: Bulk-permeability test in the exploratory shaft facility

Specific Information:

"Modeling and prototype testing will be used to approximate the minimum distance that will be required to avoid interference with adjacent activities."

Discussion:

The use of models and prototype tests to predict the minimum distance to avoid interference is appropriate; however, instrumentation of key fracture and fracture sets in adjacent working areas should be considered as an additional check to verify the model and prototype results. If the fracture system is well connected to adjacent workings, appropriate boundary conditions will have to be included in the data analysis or the test conditions will have to be modified. It would be a mistake to assume that interference effects are not present in the data, strictly based on the results of modeling and prototype testing with no additional data for verification.

In addition, the double-bulk head proposed for the access drift may not be sufficient for isolating it from the bulk-permeability tests. It may be necessary to seal the wall surfaces of the entire access drift with an impermeable membrane, similar to that proposed in the infiltration room.

Citation: SCPCD
Chapter: 8.3.1.2.2.4.3
Page: 8.3.1.2-213
Subject: Bulk-permeability test in the exploratory shaft facility

Specific Information:

"A gaseous tracer will be injected into some of the packed-off intervals, and its arrival time will be measured at the outflow point to determine the effective porosity of the system."

Discussion:

The proposal to use a gas tracer in conjunction with the bulk- permeability tests to determine the effective porosity of the system is good in concept; however, the collection and analysis of data from this test will be extremely difficult and may be of little practical use. First, it will be necessary to identify all potential discharge points for the tracer in order to measure a concentration breakthrough curve. Second, if the data could be collected and analyzed, the effective porosity value would only be applicable to gas and will be highly dependent upon the moisture contents of the matrix and fracture material. Small changes in moisture content can result in large changes in effective porosity. Hence, the applicability of a gas effective porosity value for unknown moisture conditions is questionable.

Citation: SCPCD
Chapter: 8.3.1.2.2.4.3
Page: 8.3.1.2-213
Subject: Bulk-permeability test in the exploratory shaft facility

Specific Information:

"These tests may be repeated to determine the reliability of the procedure and the permeability changes caused by the variability of the moisture content in the rock."

Discussion:

It is not clear with the information provided how the initial moisture content of the rock will be determined and how the moisture content will be quantified for subsequent permeability tests. In order to quantify the reliability of the procedure, it will be necessary to know if changes in permeability are a result of changes in moisture content or hysteresis in the test procedure.

Citation: SCPCD
Chapter: 8.3.1.2.2.4.4
Page: 8.3.1.2-225
Subject: Radial borehole tests in the exploratory shaft facility

Specific Information:

There are two primary objectives for this activity.

"1) To detect vertical movement of water in both the vapor and liquid forms and to evaluate the potential for lateral movement of water along the hydrogeologic contacts."

"2) To evaluate the radial extent of shaft excavation effects on the hydrologic properties of unsaturated hydrogeologic units."

Discussion:

It is highly questionable if the second objective stated for this activity can be accomplished. It will be difficult to analyze the tests to determine changes in permeability and moisture content as a result of mining. First, the air-injection tests will tend to dry the rock units, increasing the permeability as a result of changes in moisture content. Second, the presence of the shaft will affect the boundary conditions associated with the air injection tests. Sections of the shaft that are grouted will tend to act as a no-flow boundary while the ungrouted portion will act as a time-dependent constant head. Hence, the permeability of the fractured rock will change as new fractures are exposed to the shaft and others are sealed. Therefore, changes in the permeability of the rock units as a result of mining have the potential of being overwhelmed by changes in moisture and boundary conditions. It will be very difficult to separate the changes in permeability as a result of mining from changes in the test conditions.

Not enough information is provided to evaluate the first objective. It is not clear how the potential for the lateral movement of air and water along hydrologic contacts will be detected in the cross-hole tests. The SCPCD (p. 8.3.1.2-228) indicates that these tests will be conducted after long-term monitoring is completed. Data from USW UZ-1 indicates that years may be required for the hydrologic system to equilibrate. Perhaps it might be better to conduct the cross-hole tests before long-term monitoring.

Citation: SCPCD
Chapter: 8.3.1.2.2.4.5
Page: 8.3.1.2-236
Subject: Excavation effects test in the exploratory shaft facility

Specific Information:

The objective of this activity is to measure stress and permeability changes as a result of excavation and lining of the shaft.

Discussion:

As was stated in the radial borehole test activity, it may be difficult to detect changes in permeability of the rock adjacent to the shaft because of changes in moisture contact and boundary conditions.

Citation: SCPCD
Chapter: 8.3.1.2.2.4.6
Page: 8.3.1.2-241
Subject: Calico Hills test in the exploratory shaft facility

Specific Information:

None

Discussion:

The Calico Hills tests have not been carefully thought out pending a decision on whether to penetrate the unit. Basically, the tests planned for this activity consist of single borehole packer air- injection tests and limited cross-hole testing with air and water. There is a brief discussion of injecting water into the Ghost Dance fault and monitoring the breakthrough in deeper boreholes. However, the SCPCD, (p. 8.3.1.2-244) states that the results of this test may be inconclusive.

The movement of water through the Calico Hills is very important to characterize. Unless fracture flow can be conclusively proven to not occur, credit for long travel times and retardation should not be allowed. A careful examination of the Calico Hills is needed.

Citation: SCPCD
Chapter: 8.3.1.2.2.4.7
Page: 8.3.1.2-246
Subject: Perched water tests in the exploratory shaft facility

Specific Information:

"Aquifer tests will be conducted from the exploratory shaft to determine the extent, yield and hydraulic coefficients of the perched water zone."

Discussion:

The most important data to collect if perched water is encountered is a water sampleter sample for chemical analysis and age dating. Performing an aquifer test by inserting a small diameter screen into the shaft wall will provide little useful data if the test could be performed. The most likely scenario is that perched water will be flowing into the shaft from a number of intersecting fractures planes, such that the insertion of a well screen will do little to concentrate the flow. It will be important to isolate the zones of discharge, such that changes in water pressure and water quality can be monitored with time (several years). If longer term monitoring indicates the perched zone is extensive, specific aquifer tests might be designed to investigate the zone. However, drying up the zone by draining or pumping it may decrease the moisture content at greater depths, which would bias the investigations toward acceptance of the site.

Citation:	SCPCD
Chapter:	8.3.1.2.2.4.8
Page:	8.3.1.2-248
Subject:	Hydrochemistry tests in the exploratory shaft facility

Specific Information:

One objective of this activity is to "determine the flow direction, flux and travel time of water in the unsaturated zone by isotope geochemistry techniques".

Discussion:

In the objectives of this activity it is stated that the flow direction will be determined from isotope geochemistry techniques. The description of the activity (SCPCD, p. 8.3.1.2-249) goes even farther and states that flow paths can be determined from isotope ratios.

Because of the complex nature of ground-water flow in unsaturated, fractured rock, it will be difficult to interpret the data (assuming the data can be collected). The use of isotope data to determine the age of recharge water will have to account for the potential for isotope exchange as a result of natural air flow through the mountain (Weeks, 1987). In addition, it is not clear how the data will be corrected for contamination resulting from the shaft ventilation. All drilling gases will have a SF6 tracer added to it; however, it does not appear that the shaft ventilation will have a tracer gas added to it. Variable flow rates (fracture vs. matrix, different fracture apertures, etc.) may make interpretation difficult.

Citation: SCPCD
Chapter: 8.3.1.2.2.5.1
Page: 8.3.1.2-252
Subject: Diffusion tests in the exploratory shaft facility

Specific Information:

"The objective of this activity is to determine in situ the extent to which monitoring tracers diffuse into the water-filled pores of two of the tuffs (Topopah Spring welded unit and Calico Hills nonwelded unit) that the exploratory shaft will penetrate."

Discussion:

The diffusion test proposed under this activity has both theoretical and practical problems associated with it. The Topopah Spring and Calico Hill tuffs are unsaturated in the exploratory shaft; this is contrary to the stated objective of testing water-filled pores. As a result of the pores being unsaturated, there will be two forces acting on the aqueous tracer solution: 1) a gravity head which will drive the aqueous tracer solution vertically, and 2) a suction head present in the unsaturated matrix. The combined effect of these two forces will overwhelm the diffusivity coefficient that they are attempting to measure.

A second theoretical problem with the test is that a diffusivity coefficient for the unsaturated zone cannot be measured by the introduction of an aqueous tracer. The diffusivity coefficient is a function of both the molecular diffusion of the solute and the tortuosity of the porous medium. In the unsaturated zone the tortuosity is a function of both the matrix material and moisture content. Hence, the diffusivity coefficient in the unsaturated zone changes as the moisture content changes. In the saturated zone the diffusivity coefficient is a constant, since it is not a function of the moisture content.

A practical problem associated with the test is the identification of nonfractured section of the borehole through the use of a television log. It will be difficult to identify micro-fractures with a television camera log. It would be better to obtain continuous care for visual inspection.

Citation: SCPCD
Chapter: 8.3.1.2.2.6
Page: 8.3.1.2-254
Subject: Characterization of flux within the Paintbrush nonwelded unit in the vicinity of the Ghost Dance fault

Specific Information:

A detailed plan has not been developed to test the Ghost Dance fault; however, ideas are being presented to test this fracture.

Discussion:

We agree that the fault zone should be investigated. At a minimum a series of neutron holes should be installed through the fault, such that higher moisture contents can be detected. The potential for success of installing an infiltration experiment would be highly dependent upon the design of the test. Hence, this activity will have to be evaluated once more detailed plans are developed.

Citation: SCPCD
Chapter: 8.3.1.2.2.7
Page: 8.3.1.2-257
Subject: Characterization of gaseous-phase movement in the unsaturated zone

Specific Information:

None

Discussion:

The gaseous-phase movement activity is one of the more important studies to be conducted. The study is ambitious with the type of experiments to be conducted. It is not clear how the analysis will be performed for some of the experiments. As is the case for most of the experiments in fractured rock, it is usually easier to conduct the experiment than it is to analyze the results.

The SCPCD states that gas phase modeling will be used to help interpret the results. The use of the USGS HST code to model the water vapor and gaseous radionuclide transport from Yucca Mountain is proposed. This code may be a good first approach at looking at the data; however, it has not been demonstrated that the fractured tuff can be represented as a porous media at this scale.

One important assumption that needs to be evaluated in this work is whether a porous media model is appropriate at the Yucca Mountain scale. The SCPCD (p. 8.3.1.2-117) indicates that a 3-dimensional, two- phase flow, heat and transport model will be developed for Yucca Mountain. However, it is not clear if this will be a fracture flow or porous media model. Other tests in the exploratory shaft will use a fracture flow model to analyze the results.

Another concern with the development of a two-dimensional cross- sectional model is the design and parameter values that will ultimately be used in it. Kipp (1987) performed some preliminary modeling of gas flow through Yucca Mountain. The model design for this work was over simplified and used some questionable parameter values. The complex stratigraphy of Yucca Mountain was represented by two hydrostratigraphic units: one for the fractured tuff and one for the soil. An accurate model of Yucca Mountain will have to incorporate the welded and nonwelded stratigraphy as well as zonations for highly fractured zones.

An example of one questionable parameter values used in Kipp's model was a porosity of 10-percent for the fractured tuff. Work by Erickson and Waddell (1985) estimates the fracture porosity at 0.1 to 0.01 percent. The final porosity value used in the model will have a significant impact on calculated travel times for gas and moisture transport; travel times will decrease as the porosity values decrease. Therefore, the final design of the model for this study and other studies on Yucca Mountain will have major impacts on the data analysis and interpretation.

Citation: SCPCD
Chapter: 8.3.1.2.2.8
Page: 8.3.1.2-267 through -269
Subject: Gaseous-phase chemical investigations

Specific Information:

Interpretation of information

Discussion:

In order to interpret the isotopic information, either the isotopic composition of the water in the unsaturated zone, or the fractionation and exchange relationships between the water and the gas, should be known. The gas composition is proposed to be used to develop information about the water, so that the latter information on relationships will be required. Because of temperature changes with depth, the effects of temperature may be important, both in terms of the relationships in situ, and in terms of fractionation during sampling. As the water vapor cools as it is pumped to the surface, it may condense, changing the composition of the gas. Nonequilibrium effects may also be important. Details on how these effects will be considered should be presented.

A typographical error exists in the text. "Oxygen-13" should be "oxygen-18".

Citation: SCPCD
Chapter: 8.3.1.2.2.8.2
Page: 8.3.1.2-269 through -272
Subject: Aqueous-phase chemical investigations

Specific Information:

Sampling procedure, isotope and gas exchange, interpretation of ages

Discussion:

Collection and preservation methods are not discussed. It will be important to prevent contamination by exchange with modern gases and liquids, especially with the radioactive isotopes. Extraction of the water should occur under an inert atmosphere. It may be possible to extract water using elevated gas pressures, rather than a triaxial press. This may reduce changes in water chemistry caused by breakage of grains exposing new surfaces for reaction, although the effect of the gas pressure increase should be investigated.

If significant quantities of gas are moving through the unsaturated zone as suggested by Weeks (1987), the water samples may not be representative of recharge environments at all. Exchange of gases between the water and gas needs to be considered.

Interpretation of radioactive "age" data will probably not be straight-forward because of the gaseous exchange, and because of the possibility of diffusion of dissolved gases and ions from fracture surfaces into the rock matrix. For example, in the saturated zone, diffusion of C-14 from the fracture into the matrix can make the flow rate in the fracture appear to be much slower than it actually is. Diffusion into the matrix makes the C-14 content of the water a function of the distance from the fracture. Interpretation of these data will be difficult.

Citation: SCPCD
Chapter: 8.3.1.2.2.9
Page: 8.3.1.2-273
Subject: Unsaturated-zone flow and transport modeling

Specific Information:

Activity: Preliminary Numerical Modeling

Discussion:

This description begins with the statement that the model will be constructed by "formulating the controlling hydrologic and transport processes mathematically." There is no specific discussion of what steps will be taken to ensure that these processes are correctly identified and formulated. For example, moisture characteristic curves for fractured rock at Yucca Mountain are based on a formulation for soils. Is this adaptation valid? Are evaporation/condensation relationships adequately formulated in existing models? This section does not acknowledge the limited nature of our understanding of the physics of unsaturated flow in fractured rocks. Instead, the section implies that modeling can be used to indicate the validity of the underlying physical theories and mathematical formulations. This would be a dangerous approach, and too much reliance on modeling to answer fundamental questions of process should not be permitted.

Citation: SCPCD
Chapter: 8.3.1.2.2.9.2
Page: 8.3.1.2-275
Subject: Simulation of the natural hydrogeologic system

Specific Information:

"The objective of this activity is to construct a three- dimensional, two-phase, coupled heat- and moisture-flow model for the natural site hydrogeologic system to (1) simulate and investigate the present existing state of the system and (2) predict probable future and past states of the system under changing environmental conditions."

Discussion:

This activity does not explicitly state if the model to be used will be a porous media or a coupled porous media-fracture flow model. It appears from the brief description of this activity that a porous media model will be used. One important assumption that needs to be evaluated is whether a porous media model is appropriate at this scale. The major assumption in the conceptual model for the unsaturated zone is that significant fracture flow does not occur at Yucca Mountain. This assumption has never been proven through field or laboratory experiments.

The unsaturated zone model will be used to predict future and past states of the system under changing environmental conditions. Significant fracture flow can occur with higher recharge rates. A porous media model will not be able to simulate the increased flux and travel times resulting from fracture flow.

If hydrologic barriers and ponded conditions are to be accurately simulated with a model, it will be necessary to incorporate fractures into the model. A porous media model will predict significantly different results than a coupled porous media/fracture flow model when saturated conditions are approached. Therefore, the use of a porous media model will not be appropriate to address the objective of this activity.

Citation: SCPCD
Chapter: 8.3.1.2.2.9
Page: 8.3.1.2-275
Subject: Unsaturated-zone flow and transport modeling

Specific Information:

Activity: Simulation of Natural Hydrogeologic System

Discussion:

As written, e.g., "the purpose of this model remains largely heuristic," p.275, this activity is valid and necessary. The description is quite vague, and fails to address the feasibility of a natural simulation. Recent experience in modeling unsaturated soils (Abadou, 1988) indicates that realistic models of volumes on the order of hundreds of cubic meters can exceed the capacity of a Cray-2. A repository-scale simulation may be impossible. Updegraff (1988) indicates that no existing code is adequate to model the unsaturated zone, and therefore considerable code development will be required in this activity.

Citation: SCPCD

Chapter: 8.3.1.2.2.9.3

Page: 8.3.1.2-278

Subject: Unsaturated-zone flow and transport modeling

Specific Information:

Activity: Stochastic Modeling and Uncertainty Analysis

Discussion:

The intent of this activity is to quantify the uncertainty present in model results. The basic premise is that uncertainty distribution functions can and will be accurately known. This kind of characterization is nearly impossible to achieve, and therefore estimates of the degree of uncertainty will themselves be highly uncertain. As in the rest of the reviewed sections, this activity fails to take into account practical limitations, and is unlikely to deliver what is promised.

Citation: SCPCD
Chapter: 8.3.1.2.2.10.1
Page: 8.3.1.2-279
Subject: Study: Unsaturated zone system analysis and integration

Specific Information:

Activity: Conceptualization, Unsaturated Zone

Discussion:

(See the comments on Saturated Conceptual Model). Such a model already exists, and the description of this activity should instead specify a formal means by which alternatives will be sought out and tested. This section states that "proposed alternative models will be considered and tested," but experience has so far shown that DOE is unlikely to propose such alternatives. Strictly technical forums or informal meetings would produce such alternatives, but these apparently have no place in the characterization process. In short, this section adequately summarizes the conceptual modeling process, but does not accurately represent the approach DOE is taking.

Citation: SCPCD

Chapter: 8.3.1.2.2.10

Page: 8.3.1.2-279

Subject: Study: Unsaturated-zone system analysis and integration

Specific Information:

None

Discussion:

It will be important to have a plan which coordinates all of the unsaturated zone activities. However, it is not clear how this study will be separate from the flux and transport modeling (8.3.1.2.2.9). The SCPCD indicates that numerical simulations will be performed, and fluxes, flow paths, and velocities will be determined. These will also be determined in the flow and transport modeling study. Are different models to be used for this study than in the flux and transport modeling? Are these the same activities?

Citation: SCPCD
Chapter: 8.3.1.2.2.9
Page: 8.3.1.2-281
Subject: Unsaturated-zone flow and transport modeling

Specific Information:

Activity: Numerical Simulation of Concepts

Discussion:

(See comments for previous activities in this study (8.3.1.2.2.9)). Principal concerns are feasibility of the modeling and adequacy of the numerical formulations. This section also fails to acknowledge existing models and preliminary results, e.g., Rulon et al., 1986, and the significance of lateral flow toward fault zones.

Citation: SCPCD
Chapter: 8.3.1.2.3
Page: 8.3.1.2-290 through -297
Subject: Investigation: Studies to provide a description of the saturated zone hydrologic system at the site

Specific Information:

General comments

Discussion:

Within the more permeable tuffs, hydraulic heads are likely to be similar. In order to obtain reliable data, the SCPCD indicates that very frequent measurements will probably be required. This statement is probably true for measuring both horizontal and vertical gradients. To date, relative few reliable measurements of vertical gradients have been obtained. More piezometer nests should be installed for long-term monitoring.

The SCPCD indicates (p. 8.3.1.2-296) that comprehensive interpretation of data will be restricted to data from the C-hole complex. Unfortunately, a careful reinterpretation of previously collected data from other hydrologic test holes should also occur. In the majority of instances, the analytical models used to interpret the tests did not agree with the testing data. Before these data are used in the characterization of the site, careful reevaluation is required.

While the high gradient measured across Solitario Canyon suggests that the fault may act as a barrier to ground-water flow, the Solitario Canyon fault is only one of many faults at Yucca Mountain. Information on the hydrologic characteristics of other faults should also be collected. In addition, the gradient is much steeper between USW H-1 and USW G-2 than it is across Solitario Canyon. The cause of this steep gradient should be determined as well.

Citation: SCPCD

Chapter: 8.3.1.2.3.1.1

Page: 8.3.1.2-298 through -301

Subject: Solitario Canyon fault study in the saturated zone

Specific Information:

Data collection, analysis of data

Discussion:

According to Figure 8.3.1.2-23, there is no evidence to suggest that the Solitario Canyon fault acts as a barrier to flow in the area where the testing is proposed. The high gradient occurs between USW WT-7 and USW H-3, and further to the south. Head data are simply not available for much of the proposed repository area. For example, there is no evidence that the water table has an elevation of less than 740 meters in the central part of the block. Prior to drilling USW H-7 to perform a pumping test that may not be beneficial, the configuration of the water table should be better defined. Although there may be some questions about drilling through the unsaturated zone in the middle of the block, this is probably the best place to collect additional water-level data.

The proposed testing program will probably not provide information on all of the stated parameters. For example, there appears to be no intention of drilling through the fault zone, so that, geologically speaking, it will probably not be any better characterized than has already been done by surface mapping. The nature and extent of the fault zone is already pretty well known. It has been known for a long time that the displacement decreases to the north. Whether a low-permeability fault gouge has developed along the faults will probably not be determined without collecting samples of the material along the fault. If the character of the fault is of prime interest, slant core holes through the fault might provide better data.

If pumping tests are performed, analysis of the data may be difficult. It may be difficult to distinguish between barrier effects caused by the fault, and anisotropic effects caused by fractures with the same orientation as the fault. Detailed numerical modeling should probably be performed prior to drilling the test hole to determine if the fault can be detected. The test should be interpreted assuming different scenarios. Fracture apertures are unlikely to be determined through this type of testing.

This effort, with the exception of the collection of additional water-level data, should be reconsidered.

Citation: SCPCD
Chapter: 8.3.1.2.3.1.2
Page: 8.3.1.2-301
Subject: Site potentiometric-level evaluation

Specific Information:

"2. Refine the potentiometric surface."

Discussion:

This section, like the regional section, ignores the possibility of differing potentiometric surfaces in differing hydrogeologic units. This work plan should acknowledge the possibility of vertical gradients and how to investigate them, or justify not examining them.

Citation: SCPCD
Chapter: 8.3.1.2.3.1.2
Page: 8.3.1.2-301 through -306
Subject: Site potentiometric-level evaluation

Specific Information:

Drilling locations, calibration

Discussion:

Most of the drilling into the saturated zone has been performed outside of the perimeter drift. USW G-4, the pilot hole for the exploratory shaft, is the lone exception, and it lies in the zone of higher fault density east of Ghost Dance fault. The location of the 740 meter potentiometric contour (Figure 8.3.1.2-23) is not well known; it may actually be in error by half a mile. Bending the contour toward the east would alter directions of flow, and may affect travel time calculations.

The 30-day pumping test of one of the C-hole complex wells may not provide much additional data unless additional observation wells are drilled. These should be located in a manner to best measure effects of anisotropy, for comparison with the fracture network models to be developed. The existing holes are probably too far away to detect drawdown because of barometric, earth tide, and instrumental noise. The typical WT well which only penetrates one or two hundred feet into the water table may not be deep enough to be useful for this purpose.

The water table wells to be drilled north of Drill Hole Wash should be drilled in a manner to allow some testing, either in conjunction with sampling, or separate packer tests. Pressure data can be collected using downhole digital recorders. Fracture mapping in the drill hole through television or televiewer logs is useful, but does not provide permeability information. Many of the fractures identified in drill holes are not capable of providing appreciable water.

Proper calibration and maintenance of the monitoring network is essential. If pressure transducers are used for long-term monitoring, their calibration should be frequently confirmed. The small differences in head present in the wells east of Yucca Mountain will require accurate measurements to differentiate. Transducer or power supply drift can easily make the measurements virtually useless.

Citation:	SCPCD
Chapter:	8.3.1.2.3.1.3
Page:	8.3.1.2-306 through -317
Subject:	Analysis of previously completed hydraulic-stress tests

Specific Information:

Reanalysis of tests performed in other holes

Discussion:

A great number of hydrologic tests have been performed in holes at and near the site. The agreement between the testing data and the analytical models used to interpret the tests has been poor in many or most cases. These data should not be accepted until a reanalysis is performed, based on fracture flow models. The emphasis in the past has been on obtaining a value for transmissivity, rather than understanding the flow system in the vicinity of the well. It is essential that the flow system be better understood before aquifer parameter values are calculated. Careful work at the C-hole complex should be extended to other test wells.

The methods used to collect the data, and instrument calibration procedures, need to be carefully documented, or the data and their interpretations may not be acceptable for licensing.

The lack of vertical gradients is not an indicator that unconfined conditions exist, but only that vertical flow rates are low or that vertical permeabilities are high.

Transient, fracture network flow models may eventually be required to interpret test results. These may need to be deterministic in the immediate vicinity of the well, but random away from the well.

Citation: SCPCD

Chapter: 8.3.1.2.3.1.4

Page: 8.3.1.2-316 through -319

Subject: Multiple-well interference testing

Specific Information:

Adequacy of observation well network

Discussion:

Prior to performance of the 30-day pumping test, calculations of expected results (based on previously collected data) should be performed. These calculations should incorporate possible effects of anisotropy caused by the dominant approximately N-S strike of the fractures in the area around the C-hole complex. Additional monitoring wells (probably deeper than the WT wells) may be needed, and should be drilled early enough to allow them to stabilize prior to the pumping test.

Citation: SCPCD

Chapter: 8.3.1.2.3.1.5

Page: 8.3.1.2-320

Subject: Testing of the C-hole sites with conservative tracers

Specific Information:

Tracer selection, interpretation of data

Discussion:

One tracer, 3-trifluoromethylbenzoate, is proposed for use in the three single well tests, and the two recirculating tests. One of the big advantages of the benzoic acid tracers is their low detection limits, coupled with their anthropogenic origin. Use of the tracer will increase its ambient concentration at the site. It may be unwise to plan to use the same tracer for all tests.

The drift-pumpback tests, especially the early part of the drift phase, will be most sensitive to the characteristics of fractures intercepted by the well. Because observations will only be available from the well, the drift test may not be an accurate measure of velocity outside the immediate vicinity of the well bore. Simulations should be performed testing the sensitivity of the experiment to transport properties several meters away from the well. How will information on the concentration of the tracer during the drift phase be obtained? There was no mention of use of radioactive tracers, so that downhole gamma counters will presumably not be used. Collection of samples may disrupt the experiment. A puff-drift-pump technique may be more informative.

Interpretation of the tests will be a challenge. It may turn out that the porous media approach will be sufficient to explain the test data. The approach of Grove and Beetem was pretty successful at the Amargosa Tracer Site, but the geometry of the transmissive zone there was appropriate. If the approach works, the results should not be overextended. For example, the dispersivity that results should be considered to be a function of the experiment (both scale and sampling approaches) rather than of the fractured medium.

A recirculating test may not be able to separate matrix diffusion effects from the tail caused by recirculation. Because diffusion looks like kinetic, rather than equilibrium sorption, running multiple tests at different pumping rates may indicate whether diffusion is occurring. This would best be done in a laboratory, using natural fractures.

The dual-porosity model of Huyakorn, et al. is for the case of advective movement in the fractures (assuming porous medium equivalency), with diffusion into the matrix. Advective movement in the matrix is not considered.

Prior to beginning any tests, simulations should be performed in order to estimate tracer concentrations needed for the tests. These concentrations should be high enough to overcome detection limit and analytical noise constraints. The work plans should include these calculations.

Citation: SCPCD
Chapter: 8.3.1.2.3.1.6
Page: 8.3.1.2-324 through -328
Subject: Well testing with conservative tracers throughout the site

Specific Information:

Choice of wells

Discussion:

Some of the proposed wells for additional testing may not be suitable. For example, UE-25a#1 was not constructed for hydrologic testing. It is a small diameter well containing a string of tubing which may not be removable without great effort. The tubing is not cemented. Similarly, USW G-3 may be too small for testing, although its tubing string is probably removable.

USW H-3 is a well with a generally low permeability. Its head (approximately 730 m) suggests that it may however be near a high permeability area. Results from it may not be useful in terms of characterizing the area. It may be a good well to test for matrix diffusion, although the effects of fracture coatings will be absent.

USW H-4 is a well that is not proposed for these tests, even though it is immediately downgradient from the proposed repository area, and has been generally well-characterized, through previous static I-131 logging. Why is it not proposed for further work?

Citation: SCPCD
Chapter: 8.3.1.2.3.1.7
Page: 8.3.1.2-328 through -332
Subject: Testing of the C-hole sites with reactive tracers

Specific Information:

Use of computer codes

Discussion:

The descriptions of the modeling work to be performed for interpreting the results of the conservative tracer experiments at the C-hole complex indicated that several different modeling approaches would be used, including a fracture network model. No mention was made of TRACR3D or FEHM. The use of different codes should be explained.

Citation: SCPCD
Chapter: 8.3.1.2.3.2.1
Page: 8.3.1.2-334
Subject: Assessment of site hydrochemical data availability and needs

Specific Information:

Depth-integrated sampling

Discussion:

The majority of water samples collected from the Yucca Mountain area have been collected without regard to the depth from which the sample is collected. For example, most of the samples were collected during pumping tests of the entire saturated thickness encountered by the hole, less 50 to 100 feet of cased-off rock at the top of the saturated zone. Hence, the resulting sample is a mixture of all water that was entering the hole at the time of sampling. The depths at which the water entered the hole was predominantly determined by the depth of permeable, connected fractures. Although data were collected on the distribution of these fractures, it will be quite difficult, if not impossible, to assemble a database that is meaningful and convincing.

Exceptions to the above statements include samples collected from the WT holes, the long-term pumping of USW H-3 (where the depth of the few permeable fractures is known), samples taken from the piezometer tubes in USW H-1, and possibly samples taken during the month-long pumping of UE-25b#1, when a bridge plug was used in an attempt to isolate the pumped interval from the lower part of the hole.

Interpretations of flow directions should incorporate the possible anisotropy of permeability.

Citation: SCPCD

Chapter: 8.3.1.2.3.2.2

Page: 8.3.1.2-234 through -337

Subject: Hydrochemical characterization of water in upper part of the saturated zone at the site

Specific Information:

Chemical parameters

Discussion:

Chlorine-36 and redox indicators might be useful. The redox indicators should probably be measured twice: at the end of pumping, and immediately after removal of the pump, using a wireline sampler.

Citation: SCPCD
Chapter: 8.3.1.2.3.2.2
Page: 8.3.1.2-336
Subject: Hydrochemical characterization of water
upper part of the unsaturated zone at the site

Specific Information:

Hydrochemical data will be interpreted using the models of either Wolery (1983) or Plummer et al. (1976).

Discussion:

How were the equilibrium models of Wolery (1983) and Plummer et al. (1976) chosen from all of the ones available? How will the choice between the two referenced models be made?

Citation: SCPCD
Chapter: 8.3.1.2.3.3
Page: 8.3.1.2-338
Subject: Saturated-zone modeling and synthesis

Specific Information:

Activity: Conceptualization, Accessible Environment

Discussion:

This section opens with the statement that "all reliable data and reasonable interpretations of it will be assimilated..." The SCPCD and the DOE program in general are not structured to support alternative concepts, and the above statement is meaningless in such an environment. The only way to carry out this assimilation is in settings such as specialized technical symposia, where free exchange of ideas is possible. This kind of exchange is not currently supported by DOE, but must be included if any of the planned conceptualization activities are to be carried out successfully.

Citation: SCPCD
Chapter: 8.3.1.2.3.3.1
Page: 8.3.1.2-338 through -339
Subject: Conceptualization of saturated zone flow models within the boundaries of the accessible environment

Specific Information:

None

Discussion:

Insufficient information for comment. How will conflicting interpretations be resolved? What are criteria for acceptance of previously collected data?

Citation: SCPCD
Chapter: 8.3.1.2.3.3
Page: 8.3.1.2-339
Subject: Saturated-zone modeling and synthesis

Specific Information:

Activity: Fracture Network Model

Discussion:

A fracture network model will be useful for studies of near-field effects. The more general applications alluded to in the plans, e.g., p.340, "evaluate the general hydrologic behavior of the saturated zone", are probably not feasible. Fracture network models of relatively small volumes should be successful; for large volumes they are probably not feasible.

Citation: SCPCD

Chapter: 8.3.1.2.3.3.2

Page: 8.3.1.2-339 through -342

Subject: Development of fracture network model

Specific Information:

None

Discussion:

A similar approach may be needed for interpretation of tests in the exploratory shaft.

Citation: SCPCD
Chapter: 8.3.1.2.3.3
Page: 8.3.1.2-342
Subject: Saturated-zone modeling and synthesis

Specific Information:

Activity: Calculation of Flow Paths

Discussion:

Although it is an ambitious proposal, the description of this activity is well written. It begins with criteria for evaluating the applicability of field tests to this effort. It discusses the limitations or assumptions inherent in each proposed technique. While not as thorough as it might be, this section at least admits that realistic results may not be possible. The author(s) should be applauded.

Citation: SCPCD

Chapter: 8.3.1.2.3.3.3

Page: 8.3.1.2-342 through -345

Subject: Calculation of flow paths, fluxes, and velocities within the saturated zone to the accessible environment

Specific Information:

Use of Winter et al., or Schwartz and Smith

Discussion:

As theories and techniques for modeling dispersive processes and flow and transport in fractures are still developing, limiting approaches to the two listed is inappropriate at this time.

Citation:	SCPCD
Chapter:	8.3.1.5
Page:	8.3.1.5-4 and 8.3.1.5-5
Subject:	Table 8.3.1.5-1 "Climatic Program Goals"

Specific Information:

Table 8.3.1.5-1 lists as "tentative goals" for the climate program to: "Show expected flux change will be <5 mm/yr."

Discussion:

There is a philosophical problem here with the objectivity of a program of study whose goals are to develop a predetermined result. The uncertainty ranges of climate variability and hydrologic response result in nonunique solutions, some of which may satisfy the stated goals. The statement of goals provides the appearance that the program will seek out those particular solutions, at the expense of other reasonable solutions that do not satisfy the program goals.

Citation: SCPCD

Chapter: 8.3.5.12

Page: 8.3.5.12-1 to 8.3.5.12-69

Subject: Issue Resolution Strategy for Issue 1.1: Will the mined geologic disposal system meet the system performance objective for limiting radionuclide releases to the accessible environment as required by 10 CFR 60.112 and 40 CFR 191.13?

Specific Information:

Table 8.3.5.13-2: Categories of sequences affecting barrier performance

Discussion:

The 17 categories presented in this table cover the primary hydrologic barrier concerns which may be affected and must be examined. However, the table does not include the gaseous transport process as pointed out. This oversight should be corrected since the gas phase release scenario may be as important as groundwater release. The current level of understanding is insufficient to allow DOE to minimize gas/vapor- transport considerations.

Citation:	SCPCD
Chapter:	8.3.5.12
Page:	8.3.5.12-1 to 8.3.5.12-69
Subject:	Issue Resolution Strategy for Issue 1.6: Will the site meet the performance objective for pre-waste-emplacement ground-water travel time as required by 10 CFR 60.113?

Specific Information:

The performance objective is stated in 10 CFR 60.113(a)(2) as

> The geologic repository shall be located so that pre-waste-emplacement ground-water travel time along the fastest path of likely radionuclide travel from the disturbed zone to the accessible environment shall be at least 1,000 years or such other time as may be approved or specified by the Commission.

The disturbed zone has been defined qualitatively in 10 CFR 60.2 as

> That portion of the controlled area the physical or chemical properties of which have changed as a result of underground facility construction or as result of heat generated by the emplaced radioactive wastes such that the resultant change of properties may have a significant effect on the performance of the geologic repository.

The accessible environment has been defined in 10 CFR 60.2 to mean (1) the atmosphere, (2) the land surface, (3) surface water, (4) oceans, and (5) the portion of the lithosphere that is outside the controlled area.

The controlled area, defined in 40 CFR 191.12(g), means

> (1) a surface location, to be identified by passive institutional controls, that encompasses no more than 100 square kilometers and extends horizontally no more than five kilometers in any direction from the outer boundary of the original location of the radioactive wastes in a disposal system, and (2) the subsurface underlying such a surface location.

In order to resolve this issue, DOE proposes to define, characterize, and assess the multiple barriers to ground-water flow. These are further defined in a five-part process as

1. Identifying all hydrogeologic units along potential flow paths to the accessible environment and identifying all potentially operating processes

within each of these units.

2. Classifying hydrogeologic units and flow processes as primary, secondary, and auxiliary "barriers" to establish a defense-in-depth basis for reasonable assurance that flow time to the accessible environment is at least 1,000 yr.

3. Establishing measures of performance, i.e., travel time, and assigning goals in terms of the measures that allow comparisons of the flow behavior in each unit to the 1,000 yr flow time requirement.

4. Identifying relevant flow processes within each unit.

5. Identifying relevant parameters and associated levels of confidence that will be used to predict the travel time and associated uncertainty through each unit.

with the next step to construct and apply numerical models to make travel-time predictions. The primary reliance in this process is noted in Table 8.3.5.12-1 as being the Calico Hills nonwelded vitric and zeolitic tuffs. Other components are characterized as being of either secondary or auxiliary importance.

Discussion:

In order to place primary importance on the two Calico Hills units and to have a high level of confidence on these predictions, it is required that the physical characteristics of these units be well-defined throughout the repository area in order that the "fastest path" be defined. Given the current confidence level and the desired confidence (high) as shown in Table 8.3.5.12-2 "Performance parameters for resolving Issue 1.6", there appears to be the need for an intense program to obtain additional information concerning these units. The program outlined for the field efforts does not show that the level of information will be collected which will yield the desired level of confidence.

Table 8.3.5.12-3 gives a thorough listing of each of the performance parameters needed and its level of confidence for each as well as for each of three statistical measures: the mean, standard deviation, and spatial correlation.

The minimal new data to be collected are described under activity 8.3.1.2.2.3.2 "Site vertical borehole studies" and activity 8.3.1.2.2.4.6 "Calico Hills Test in the Exploratory Shaft." This first activity proposes to dry drill six new surface-based holes which will be completed in the Calico Hills units; however, only UZ-2 and UZ-3 will be within the repository boundary. The remaining holes will be either east of the UZ-9 complex or south of the repository UZ-10. The second activity has as its purposes:

1. To determine the hydrogeologic properties and conditions of layers and fractures within the Calico Hills nonwelded unit.
2. To determine if perched water exists at or near the contact between the Topopah Spring welded unit and the Calico Hills nonwelded unit.
3. To investigate the permeability and flow conditions of the Ghost Dance fault where it transects the Calico Hills nonwelded unit.

to be accomplished by drifting and radially drilling from the Calico Hills breakout room.

These activities will provide some additional information about the Calico Hills units; however, it is difficult to have a great deal of confidence in the Calico Hills unit characterization based upon the two new holes primarily in the nonwelded vitric tuff at the southern end of the repository and the drift and 9-meter horizontal holes in the nonwelded zeolitic tuff at the northern end of the repository. These two activities will not provide satisfactory information to evaluate the spatial variability likely to be encountered beneath the repository.

In order to have a high confidence in the understanding of these units, a much-enhanced drilling and testing program would be necessary. However, as pointed out in 8.3.1.2-242 "exterior penetration or excavation of the unit for testing purposes may jeopardize the integrity of the unit as a barrier." Given this concern, it is doubtful that it will be possible to characterize the Calico Hills unit to the extent necessary and therefore it is likely that great uncertainty will surround the resolution of Issue 1.6.

Citation: SCPCD
Chapter: 8.3.5.13
Page: 8.3.5.13-17 through 8.3.5.13-36
Subject: Total system performance

Specific Information:

Technical Discussions of the Release Scenario Classes: Nominal case (E): Water-release pathways (pg. 8.3.5.13-17 through 8.3.5.13-36, as well as cases (C) and (D).

Discussion:

Key to being able to evaluate either the nominal case or the disruption scenarios and independent of the specific model to be used is the ability to determine the key characteristics of the unsaturated zone units beneath the repository level. It is not apparent that the limited amount of data collected from the surface-based drilling (new UZ holes) and the ES drift into the Calico Hills will provide an adequate data base upon which to base the models. The spatial variability cannot be determined from this limited amount of testing. In Table 8.3.5.13-8, the Calico Hills are the primary barrier which needs to be characterized to a high level of confidence if it is to be treated as an equivalent porous media, flow-transport process.

A second question arises when considering the magnitude of potential computational power required to analyze problems of this magnitude. Given the current "state-of-the-art" of being able to model unsaturated-zone flow, can DOE realistically expect to model these coupled processes or will the simplifications have to be such that any modeling efforts are essentially meaningless?

Citation: SCPCD

Chapter: 8.3.5.13

Page: 8.3.5.13-17 through 8.3.5.13-36

Subject: Total system performance

Specific Information:

Table 8.3.5.13-3

Table title page 8.3.5.13-15

Discussion:

The failure modes delineated under (C) and (D) relate to ground-water travel and the performance of that barrier. Under (E), the undisturbed barrier will be evaluated with some indication of concern for gas/vapor flow, yet there should be concern related to possible disruption which would increase the likelihood of gaseous transport.

Citation: SCPCD
Chapter: 8.3.5.13
Page: 8.3.5.13-91
Subject: Water-pathway models

Discussion:

Given the experience of using the one-dimensional model TOSPAC as exercised by Sandia, the description on page 8.3.5.13-92 indicates that there is little concern in moving to a two-dimensional model which is stated as being necessary. Recent reported modeling activities given at the "International Conference and Workshop on the Validation of Flow and Transport Models for the Unsaturated Zone" would bring this into question. A number of presentations expressed concern at being able to actually simulate flow in naturally-heterogeneous, porous media for any large-scale field problems. In order to handle realistic problems, tremendous computing power must be made available simply to obtain solutions. Validation of the more complex models brings in further complications.

The entire discussion here and under the subactivities related to model development and use under 8.3.5.13.4 assumes that "simplified, computationally efficient" models can be constructed and exercised which represent the essential events and processes. These models are to be used to make predictions over very long time frames. The ability to make even short-term predictions based on the best data available, making as few simplifying assumptions as possible, has not yet been reliably demonstrated. Therefore, this entire concept is suspect.

Citation: SCPCD
Chapter: 8.3.5.19
Page: –
Subject: Substantially completed analytic techniques

Specific Information:

The definition of these techniques is "those that already exist and could be used, with little additional work or only minor modifications, to conduct performance assessment analyses." It further lists these techniques in Table 8.3.5.19-1 and codes in Table 8.3.5.19-2, while stating that most have not been fully verified and validated for application to Yucca Mountain.

Discussion:

This section expresses little information concerning verification and validation of each proposed "substantially complete" code. It is our position that one should not consider these codes complete until they have been verified and validated, which is no trivial task. The amount of effort required to verify and then validate these codes could be quite substantial as indicated by the past activities of various DOE contractors. These codes, as listed, fall for the most part into the same category as those in Section 8.3.5.20, i.e., those requiring significant development.

The descriptions of plans for verification and validation under 8.3.5.20.2 should apply to all codes for use in performance assessment. Each must be examined to determine the model needs for validation which may change or add substantially to the data gathering and testing program.

Considering this last concept, it may be that the preferred conceptual models are driving the site characterization and determining the data acquired to justify the modeling.

Citation:	SCPCD
Chapter:	8.3.5.16
Page:	8.3.5.16-1 and 8.3.5.16-2
Subject:	Design of a long-term performance monitoring program

Specific Information:

The specific area of concern is the lack of planning for long-term monitoring of containment of radionuclides within the proposed repository.

Discussion:

In light of recent political developments that have designated the Yucca Mountain site as the only location to be characterized for the proposed repository and the associated implication that this site will be the location for the repository, it is important that serious thought be given to the idea of long-term monitoring of site performance. Long-term monitoring will require development of pre-construction baseline data; this will be accomplished during the site characterization effort, if the described efforts are carefully planned and conducted (see SCP sections 8.3.5.16 and 8.2.2.1.1.7). The long-term monitoring effort will also require continuing observation of repository performance using observation systems intended to detect releases at various points within the multiple barrier containment system. Such detection systems are not discussed in the Site Characterization Plan.

Citation: SCPCD
Chapter: 8.3.5.20
Page: –
Subject: Analytical techniques requiring significant development

Specific Information:

Verification and validation

Discussion:

The concept of a validation process moving from small-scale analyses to large-scale analyses for hydrologic and transport codes is oversimplified. A model may appear to be validated to each of two different scales; however, input parameters from proposed ES tests and other data gathering, such as surface-based boreholes, may not be transferrable to the large scale required for repository performance assessment.

Citation: SCPCD
Chapter: 8.3.5.20
Page: --
Subject: Analytical techniques requiring significant development

Specific Information:

Validation of models for performance assessment

Discussion:

The list of activities which are needed to test modeling assumptions, guide model development, and calibrate and validate the models read at first glance as a comprehensive list; however, there are no citations relating back to the planned tests, analyses, and studies.

There is no way to readily compare the goals of validation with the information gathering activities to determine whether there is any hope of validating the models.

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COMMENTS OF

MIFFLIN AND ASSOCIATES

Review of:

Consultation Draft of the Site Characterization Plan
Yucca Mountain Site, Nevada Research and Development Area, Nevada
DOE/RW-0160, January 1988.

for

State of Nevada
Nuclear Waste Project Office
Agency for Nuclear Projects
Carson City, Nevada

by

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July 1988

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July 1988

TABLE OF CONTENTS

SUMMARY STATEMENT

We found, early in our review efforts of the CD-SCP, that the massive document has been organized and written in such a manner as to obfuscate its stated purpose, that is, to describe the scientific and technical program of site characterization in detail so that the NRC, affected States and the public could make comments on its thoroughness and content. In reality, it has been written to show how the issues and licensing criteria are being approached, but it does not easily yield up a comprehensive and detailed picture of scientific and technical activities. It does, however, reluctantly yield a picture of a research and data gathering plan that we judge to be unlikely to resolve most site selection and site performance issues with confident data, and scientifically valid analyses. Frankly, the CD-SCP is a masterful sophism.

INTRODUCTION

The Nuclear Waste Policy Act of 1982 and 10 CFR 60 require from the U.S. Department of Energy (DOE) the submittal of the Site Characterization Plan (SCP) to the U. S. Nuclear Regulatory Commission (NRC), affected States and Indian Tribes, and the general public for review and comments prior to the construction of the test shaft at Yucca Mountain. Early in 1988, the DOE provided to the NRC and Nevada a Consultation Draft of the Site Characterization Plan (CD-SCP). Mifflin & Associates, Inc. (MAI) is providing a review of the CD-SCP from the hydrogeologic and closely related perspectives for the Nuclear Waste Project Office of the State of Nevada.

> "As defined in 10 CFR Part 60 site characterization means the program of exploration and research, both in the laboratory and in the field, undertaken to establish the geologic conditions and the ranges of those parameters of a particular site relevant to the procedures under Part 60. Site characterization includes borings, surface excavations, excavation of exploratory shafts, limited subsurface lateral excavations and borings and in-site testing at depth needed to determine the suitability of the site for a geologic repository. It does not include preliminary borings and geophysical testing needed to decide whether site characterization will be undertaken." (DOE, OGR/B-5, 1987).

The CD-SCP is a massive document. Part A, consisting of Chapters 1 through 7, describes the mined geologic-disposal system in terms of what is known at the present time:

Chapter 1 - Geology
Chapter 2 - Geoengineering
Chapter 3 - Hydrology
Chapter 4 - Geochemistry
Chapter 5 - Climatology and Meteorology
Chapter 6 - Conceptual Design of a Repository
Chapter 7 - Waste Package

Part B is the site-characterization program. The majority of the massive Part B document has been devoted to discussions of issue, issue-resolution strategies, informational needs, etc., and based on such considerations, the planned programs and investigations to accomplish the site characterization and licensing preparation steps.

The working elements of the CD-SCP are structured as follows: program, investigation, study, activity, and subactivity, listed in descending hierarchy. Specific reviews were established at the activity level, occasionally at the subactivity or study level when appropriate. Each hydrogeologically related activity in the CD-SCP was reviewed in terms of: 1) conceptual completeness and focus; 2) appropriateness of methodology to accomplish stated objectives; 3) availability of supportive technology; and 4) probability of success and/or feasibility. The following elements of the CD-SCP were reviewed:

8.3.1.2	Geohydrology Program
8.3.1.3	Geochemistry Program
8.3.1.4	Rock Characteristics Program
8.3.1.5	Climate Program
8.3.1.15	Thermal and Mechanical Rock Properties Program
8.3.4	Waste Package Program
8.3.5	Performance Assessment Program.

We have structured this review into three basic parts:

Overview Comments, where we deal with general impressions;

Issue Resolution Comments, where we deal specifically with several of the most important hydrogeologic issues; and

Activity Reviews (Appendix I) where we have, as individuals, reviewed the technical activities.

Review Authorship

This review has been established by the following individuals with expertise and experience as indicated:

A. Elzeftawy	Soils Physics/Hydrogeology
C. L. Johnson	Hydrogeology/Hydrogeochemistry
M. D. Mifflin	Climate Change/Hydrogeology
M. E. Morgenstein	Mineralogy/Geochemistry
D. L. Shettel, Jr.	Geochemistry/Isotope Geology

Specific reviews of the CD-SCP activities have individual authorship indicated. Lead responsibility for editing and general content of the review is taken by M. D. Mifflin. The above take responsibility for the comments.

OVERVIEW COMMENTS

GENERAL COMMENTS

The following objectives of the CD-SCP are stated in the Annotated Outline for Site Characterization Plans (DOE, February 1987, pp. xii to xiv):

"The purpose of the SCP is to provide a document in which the DOE:

- Describes the site, design of a repository and engineered barriers appropriate to the site, waste packages, emplacement environment, and performance analysis in sufficient detail so that the planned site characterization program may be understood.

- Identifies the uncertainties and limitations on site- and design-related information developed during site screening, including issues that need further investigation or for which additional assurance is needed.

- Describes the detailed programs for additional work, including performance confirmation, to (1) resolve outstanding issues, (2) reduce uncertainties in the data, and (3) make site suitability findings relative to DOE siting guidelines, 10 CFR 960.

The SCP will provide a vehicle for early NRC, State, Indian tribal, and public input on the DOE's data-gathering and development work so as to avoid postponing issues to the point where modifications would involve major delays or disruptions in the program. Early review of the DOE's site characterization plans as presented in the SCP will provide an opportunity for the NRC to evaluate whether the DOE's proposed program is likely to generate data suitable to support a license application." (OGR/B-5, p. xiii).

We find that the CD-SCP substantially, but not completely, meets the above first objective. We find that it does not consistently meet the second and third objectives. It does not consistently describe the detailed programs to: 1) resolve outstanding issues; 2) reduce uncertainties in the data; and 3) make site suitability findings relative to the DOE siting guidelines, 10 CFR 960.

We find that the CD-SCP does not entirely establish what is known about the Yucca Mountain from site-exploration activities to date. Many if not most aspects and findings are freely and fully discussed, but key findings, such as evidence of perched water within the vadose zone, and important observations of gas-circulation gradients within the vadose zone, are omitted. These omitted observations could prove to be the most fundamental findings to date with respect to the site's ability to isolate waste.

We find also, with respect to the above point two objective, that a major issue of fracture flow in the vadose zone has been deemed so unimportant that the resolution activity is to be primarily laboratory experiments. Therefore, we judge the CD-SCP fundamentally deficient with respect to resolving the issue by reducing or eliminating the uncertainties about fracture flow in the vadose zone.

We find that, with respect to the above, the CD-SCP often fails to provide enough details in the activity plans to confidently judge the plans.

The following questions are intended to be addressed by the SCP (DOE, OGR/B-5, February 1987):

- Have the important information needs and unresolved issues been identified?

- Does the SCP specifically address these information needs and present program plans to obtain the needed information?

- Are the methods of testing and analysis proposed for the planned site characterization program appropriate?

- Have alternative methods of testing and analysis been identified and evaluated, and has an adequate basis been provided for the selection of the methods to be used?

- Will the data to be collected and the reliability of the collection methods and analysis be of adequate quality to support site selection and a future license application?

- Have the testing plans been based on the performance requirements of the Mined Geologic Disposal System (MGDS) components, and are the tests adequate to enable evaluation of whether or not the MGDS components will perform as required?

We recognize aspects where the CD-SCP is seriously deficient in all of the above points of question. We think that important negative answers can be given for the first five questions when aspects of vadose-zone hydrology are considered. Point six, discussion of whether tests are adequate to enable evaluation of the expected performance of the MGDS, is not recognized in the CD-SCP. We assume that such testing call upon characterizing a combination of dynamic thermal loading and unloading, multiphase water transport, and dissolution processes based on in-situ geochemistry, all acting upon the engineered barriers.

We find the CD-SCP, when judged by the data development/analyses activities, unlikely to create a technical program that will establish viable databases to resolve or answer several of the important issues. The basis for this statement can be further examined in Appendix I reviews. Many activities are poorly designed and/or focused with respect to available technology. Many others are not feasible with respect to combinations of time, financial resources, and human and laboratory resources. Idealistic approaches, with much modeling in the face of little or no data and marked uncertainties with respect to processes operating, characterize the planned technical program. The CD-SCP is very consistent in calling upon numerical models (using existing, or newly developed, and/or to be developed codes) for the resolution of the characterization issues created by the complexity of the site and the very limited databases.

Our opinion is that the CD-SCP activities need to be carefully screened, focused, and modified into feasible, well-coordinated activity programs that could be completed in five or six years. Each program (investigation, study, and activity) needs the benefit of peer review by experts experienced in both theory and field investigation.

Further, an appropriate SCP would clearly identify and rank the most likely fatal flaws (issues) of the geologic-barrier system of the site to prioritize and coordinate site characterization studies. This has not been done; the CD-SCP generally fails to establish a vadose-zone fracture flow/travel time-issue resolution program that will work, and totally ignores the need for a research program to establish the impacts of the thermal envelope, and the associated extent of the disturbed zone with the induced hydrothermal system. Such a disturbed system has major potential to impact waste isolation.

DISCLAIMER

We find the disclaimer printed on the back cover of each volume to be inappropriate to the work presented. It says that the report was prepared as an account of work sponsored by the United States

Government, but neither the U.S. Government nor the U.S. Department of Energy, nor employees make any warranty, nor assumes legal liability or responsibility, etc. It also states that the views and opinions of authors expressed herein do not necessarily state or reflect those of the United State Government nor an agency thereof.

The DOE is clearly the author of the CD-SCP, as no authorship is shown other than the U.S. DOE. If the above disclaimer were to be used in an appropriate manner, the majority of the CD-SCP should be backed by specific authorships. Specific authors would be appropriate for the expert opinion and judgment desirable in the planned activities of exploration and research. We find by omitting the specific technical authorship, the DOE may have, perhaps inadvertently, diminished the technical quality of the CD-SCP. We suggest the DOE to recognize the scientific and technical challenge of characterizing Yucca Mountain, and appropriately indicate specific authorship on scientific and technical activities in the SCP.

DOE GOALS

A very disquieting presentation characteristic of the CD-SCP is the apparent perception that the given site,Yucca Mountain, in terms of geologic-barrier performance, can be made better or worse, just as an engineered system can be made better or worse by design changes. This conceptual approach has flavored the DOE selection process (Draft Environmental Assessment and Environmental Assessment documents) and continues in the CD-SCP. Explicit examples occur throughout the CD-SCP discussions and in tables, such as Table 8.3.1.5-1 on pages 8.3.1.5-4 and 5. This table, dealing with site performance during a climate change, shows a column of initiating events or processes, and another correlating column entitled "tentative goal", which gives the currently perceived extreme values that would be acceptable. Such a title "tentative goal" would be appropriate for an engineered barrier where engineered design determines performance. **A natural system, the geologic barrier, can not be altered once the site has been selected.** There is no goal, therefore; there is only performance characterization. Geologic and hydrogeologic aspects can only be characterized to varying degrees of accuracy as to how they will perform in waste isolation. Therefore, if the DOE correctly perceived that its mission is to characterize the site to establish if the repository should be built, the many "tentative goal" columns would be better named "performance requirement" or "tentative performance requirement." The term "goal" is widely used in the CD-SCP, and should not be used for the SCP for uncontrollable geologic and hydrologic aspects of the specific site. Performance goals are fine for engineered aspects.

CD-SCP CONTENTS AND TECHNICAL REVIEW

The CD-SCP is so massive and complex in terms of topical scope and objectives that the reader is easily diverted from the true intent of the document. The SCP is the **program of exploration and research, both in the laboratory and in the field.** Therefore, we have focused our review efforts not on the very extensive organizational discussions and rationalizations, but on the descriptions of the programs of exploration and research.

We believe that success or failure in reaching **confident** site characterization will depend heavily on the SCP adopted by the DOE. We base this belief on the following: 1) the choice of a repository-horizon environment that is totally unknown from a hydrogeologic perspective; 2) the ten years of effort already expended on Nevada Test Site (NTS) and the Yucca Mountain characterization; and 3) the continuing high degree of uncertainty with respect to many critical performance aspects of the site. Therefore, the CD-SCP has been reviewed in anticipation of discovering the technical program the DOE would mount to resolve the many issues and performance questions.

Activities are the technical and/or scientific efforts planned for site characterization. The CD-SCP links activities, where there is a usually brief discussion of the planned objectives, methods, and associated elements, to studies, generally composed of one or more activities, to investigations, which are composed of studies, to programs. All have been organized and rationalized with respect to characterization issues from the perspective of licensing requirements. The CD-SCP provides reasonable planning discussions at these levels. However, the **activities are a better measure of the** planned site characterization, and we give, in general, very low marks for the activities.

We have reviewed each activity (Appendix I) in our topical areas of responsibility because we recognize them as the only fundamental investigative activities in the CD-SCP. These activities, when executed, must provide the information to deal definitively with all issues and have the power to characterize the site. **Unfortunately, we have found that many activities are only at the conceptual stage at best, and would be better judged when work plans and technical procedures become available.** In response to this very real problem, we were forced to review the activities from an expert opinion mode, generally reading between the lines and judging the activity from several perspectives.

Technical Review Criteria: The four criteria adopted in the activity reviews: 1) conceptual completeness and focus; 2) appropriateness of methodology to accomplish stated objectives; 3) availability of supportive technology; and 4) probability of success and/or feasibility, warrant brief discussion. There are, however, no detailed **work plans** or **technical procedures** for each activity upon which we can base an in-depth review. Our ability to review conceptual aspects of a given activity is, therefore, better than our ability to review methodology, since the details of methodology are often not complete. **Any activity, if it fails in any of the four categories, fails to establish what is required for site characterization and/or issue resolution.** For example, one might find in a review that conceptual completeness or focus is rated low, and the other three aspects much higher. This would indicate that in our opinion, the activity can be performed in terms of methodology, available technology, and that there are the necessary resources for feasible execution, but it will not likely answer the correct questions. Conversely, we also find many of the activities more or less conceptually appropriate and focused, but unlikely to be successful because of deficiencies in methodology, available technology, or the likely availability of resources (including time).

In the reviews of the activities we find that, out of a total of 190 individual activities, we judge that 163 (about 86%) will not be successful in terms of the site characterization objectives (Table 1). When analyzed by program, we find only in one program (Climate) where there can be some important progress towards site characterization.

Table 1. Summary of MAI Reviews of CD-SCP Activities

CD-SCP PROGRAM	YES	NO	TOTAL REVIEWED
Geohydrology (8.3.1.2)	6(4)	51(47)	57(51)
Geochemistry (8.3.1.3)	4	33(29)	37(33)
Rock Characteristics (8.3.1.4)	1	5	6
Climate (8.3.1.5)	14(12)	15(14)	29(26)
Thermal and Mechanical Rock Properties (8.3.1.15)	2	2	4
Waste Package (8.3.4)	1	14(13)	15(14)
Performance Assessment (8.3.5)			
a. Engineered Barrier System (8.3.5.10)	3	23	26
b. Total System (8.3.5.13)	0	30	30
Total (without duplication)	31(27)	173(163)	204(190)

The DOE has, or could have, at its disposal, the best scientific facilities and cadre of scientists in the nation. Such resources have not been effectively tapped in the development of the CD-SCP. We think it productive to offer the probable reasons for our review findings:

I. The site-selection and licensing criteria demand knowledge about natural systems that is not normally established at the scales of consideration and the levels of confidence required.

II. The DOE has selected an entirely undocumented and little studied hydrogeologic environment for the repository at Yucca Mountain. There are few if any useful databases from similar environments in the world, and there are no proven techniques of study with respect to several key issues.

III. Fractured, and somewhat porous rock imposes a well-known but analytically intractable degree of complexity to fluid-flow systems, as does the vadose-zone position of the repository horizon. **It is known that conventional mathematical models and established field-test procedures will not perform adequately in both the saturated and vadose zones of the Yucca Mountain environment.**

IV. The host-rock stability is uncertain due to its origin and composition when subjected to the heat of the thermal envelope.

V. **The primary (and possibly only) waste-isolation attribute of the Yucca Mountain site is its location in an arid climate.** The mechanics and site-specific conditions of recharge are unknown in these arid climates for most classes of terrane, including that represented by Yucca Mountain.

The above factors relate to the thoroughness of the technical questions being asked, the very limited preexisting knowledge, and the complexity of the site. The following, however, relate to the DOE program:

VI. There is little evidence that the DOE has followed the expert advice offered by early peer-review groups. The characterization program continues to be weak in the same areas as the site-selection program (useful field studies lacking, useless models dominating).

VII. There is little evidence of peer review in the development of the majority of the CD-SCP activities. Only one program, climate change, seems to have had the benefit of independent peer review, and we judge half of the activities may succeed, which is a major improvement over all other programs.

VIII. There is ample evidence that many activities have been conceived and written, or perhaps rewritten, by authors with limited experience and training in the topical areas, and that these activities have not been reviewed by experts.

Points six through eight disappoint us. They indicate one or a combination of the following: 1) the DOE management has failed to recognize the complexity of the site (has not taken or used expert advice appropriately); 2) the DOE management has made a determination that careful characterization is not necessary, nor perhaps desirable; and/or 3) the DOE has failed to effectively develop and manage the required scientific program to confidently select and characterize the site.

PERFORMANCE ISSUES

The following sections are discussions and specific comments focused on selected performance issues:

PERFORMANCE ISSUE 1.1

The ability of a mined repository to limit radionuclide releases to the accessible environment is fundamentally dependent on geologic and hydrologic conditions at the site which, combined, establish the degree of the geologic barrier a specific site offers. Intrinsic properties such as permeability provide one general measure of site quality, while the chemistry of the rock-water system determines the mobility of radionuclides as well as the necessary desirable designs for the waste packages. Key Issue I in the Office of Geologic Repositories issues hierarchy relates to whether the mined geologic-disposal system at Yucca Mountain will isolate the radioactive waste from the accessible environment after closure in accordance with the requirements set forth in 40 CFR Part 191, 10 CFR Part 60, and 10 CFR Part 960 (CD-SCP, p. 8.2-2). Performance Issue 1.1, "Will the mined geologic disposal system meet the system performance objective for limiting radionuclide releases to the accessible environment as required by 10 CFR 60.112 and 40 CFR 191.13?" (CD-SCP, p. 8.2-3), dictates information needs 1.1.1 through 1.1.5 of section 8.3.5.13 of the CD-SCP, "Total System Performance":

Information Need (CD-SCP)

1.1.1	Site information needed to calculate releases to the accessible environment.
1.1.2	A set of potentially significant release scenario classes that address all events and processes that may affect the geologic repository.
1.1.3	Calculational models for predicting releases to the accessible environment attending realizations of the potentially significant release scenario classes.
1.1.4	Determination of the radionuclide releases to the accessible environment associated with realizations of potentially significant release scenario classes.
1.1.5	Probabilistic estimates for the radionuclide releases to the accessible environment considering all significant release scenarios.

Geochemistry

8.3.1.7 Overview of Rock Dissolution.....
8.3.1.7.1 Investigation: Rates of dissolution of crystalline and noncrystalline components in tuff.

Comments:

1. The use of the word "investigation" in the title/header is misleading; no investigation is planned.

2. Previous comments (Mifflin & Associates, Inc.) regarding the dissolution section of the EA have been ignored.

3. Specifically, considering the listed conclusions (p. 8.3.1.7-1) regarding dissolution in the EA, restated in the CD-SCP: the second conclusion regarding mineral insolubility is decidedly incorrect and not based on any factual information of which we are aware.

The first part of the fourth conclusion, insolubility of minerals comprising the host rock in and around Yucca Mountain, is incorrect as well; therefore the second part of the fourth conclusion, "significant subsurface rock dissolution is not a credible process leading to radionuclide releases greater than those allowable..." is incorrect information and contradicts current experiments (J. D. Rimstidt, personal communication, 1988) that suggest important mass transport occurs under nonequilibrium conditions (i.e., thermal gradients expected under repository conditions).

8.3.1.7.1.1 Application of Results

In general, there are no results when no investigations were specifically conducted to consider dissolution. The CD-SCP is illogical when it applies speculative conclusions from the EA to this important site-characterization issue. There are no results, only speculative and totally unsupported conclusions, to address higher-level findings concerning dissolution.

The dissolution question affects favorable conditions 3, 4, and 7 (Table 8.3.5.17-1) and potentially-adverse conditions (Table 8.3.5.17-2) 5, 7, 8, 10, and especially 23 (potential for future perched water bodies that may saturate portions of the underground facility).

Scenarios to characterize potentially-adverse condition [PAC] 5 do not address changes in the hydrologic conditions caused by the heat envelope generated by the repository after a few hundred years.

Scenarios regarding PAC 7 (ground-water geochemistry conditions that could increase solubility or chemical reactivity of the engineered-barrier system) do not address the thermal regime imposed by the waste repository, particularly the hydrochemical and mineralogical reactions that will accompany vaporization and condensation in fractures.

No scenarios concerning PAC 10 (dissolutioning) will be characterized further by DOE because their available information appears adequate to them. This is a serious flaw in the CD-SCP, since the assumption that dissolution will not occur has no basis in fact.

Scenarios regarding PAC 23, the potential for existing or future perched-water bodies that might saturate portions of the repository, do not include any that may result from actual storage of waste canisters in the repository over the several hundred years of perturbing thermal influences. Only the potential for perched-water bodies that may form under present [preclosure] conditions will be considered by the DOE. **This is a serious shortcoming in DOE's site-characterization plans considering the amount of water vapor that will be driven from the rock matrix in the greater than 95°C portion of the thermal envelope.**

If the DOE continues to assume that host rock and minerals are insoluble, then many other CD-SCP activities are inappropriate, such as 8.3.1.3.2.2.1 (History of mineralogic and geochemical alteration...); 8.3.1.3.2.2.2 (Smectite, zeolite, manganese minerals, glass dehydration and transformation); 8.3.1.3.3.2 (Kinetics and thermodynamics of mineral evolution); 8.3.4.2.4.1.1 (Rock-water interactions at elevated temperatures); 8.3.4.2.4.1.7 (Numerical analysis and modeling of rock-water interaction); and 8.3.4.2.4.4.2 (Repository horizon rock-water interaction). The CD-SCP dissolution program is totally deficient. The aforementioned studies and activities need to be integrated into a dissolution program.

General Comments: Geochemistry Section

The following items represent our major concerns regarding the geochemistry program in the CD-SCP. For specific comments, see the activity review sheets and the specific comment section of this review.

1. The continued use of water from well J-13 as a reference water for all experimental work is not justified. Most of the credit taken by DOE for ground-water travel time is postulated to occur in the vadose zone and therefore most of the retardation should also occur in the vadose zone. Thus, obtaining chemical analyses of a vadose-zone water should be of the highest priority in the CD-SCP. The range of vadose-waters compositions should be determined as quickly as possible. As experiments and modeling employing J-13 water may have to be redone, it would be judicious of DOE to suspend those activities utilizing J-13 water until the vadose-water chemistry is characterized.

2. Another serious problem involves extrapolating laboratory sorption data (determination of K_d's and retardation factors) to actual field conditions. Not enough importance is being attached to this subject. It is extremely difficult to envisage how data from experiments employing crushed tuff could be correlated to the field with any scientifically valid confidence. Crushing tuff generates new surfaces with attendant high-surface energies and nonrepresentative sorption characteristics. Furthermore, the mineralogy of the new rock surfaces from a modal standpoint is not known and should not be assumed from modal mineralogy of a whole rock sample. This may partially account for the unexplained scatter in previous experimental work and the differences between crushed tuff and solid core experiments. Highest priority should be assigned to validating the proposed experimental approach through field tests of sorption/retardation before additional resources are wasted in this extensively practiced but totally unproven methodology.

3. A major concern is the undue emphasis placed on modeling before experimental methodology is proven and meaningful field data are collected. Vast resources will apparently be directed to modeling efforts before sufficient information is collected to justify modeling.

4. Samples to be utilized in activities/studies are not clearly identified, nor are sample collection and preservation techniques. Very little is known about the site to date because of sampling difficulties.

5. Analytical methodology is not always indicated.

6. Technical procedures are not determined.

7. There are major inconsistencies in planned activities from one section to another.

8. Incomplete or wrong methodologies are used in many cases to obtain the desired information (See Appendix I Specific comments).

General Comments: Issue 1.1 Resolution Strategy

1. DOE continues to assume that matrix flow predominates over fracture flow in the vadose zone and that the matrix must be saturated for fracture flow to occur. No data exists to support these assumptions; in fact, based on suction-head data for the various rock units, these tuff units are most likely effectively saturated and therefore fracture flow should predominate.

2. DOE continues to assume that the percolation flux is uniformly distributed in space and time. This is highly speculative, not realistic nor conservative, and not supported by any data.

3. The dissolution scenarios (among others) have been ruled "not sufficiently credible to warrant further consideration" (DOE, 1986) by a "panel of experts". The same ruling was incredulously rendered for the bedded and domed salt sites. This ruling was not made by an independent panel of scientifically and/or technically recognized geochemists; but rather it was a DOE panel with, apparently, very limited expertise in the main subject area.

4. The DOE should convene a panel of recognized practicing geochemists and charge these experts with the tasks of evaluation of the rock-dissolution questions, particularly in light of the thermal envelope and the water content of the repository-rock horizon. Then it needs to follow the panel recommendations on appropriate rock-dissolution studies and add these to the SCP, if appropriate.

5. Under "Performance Parameters for Scenario Class C-3 [Table 8.3.5.13-14., p. 8.3.5.13-63]

(changes in unsaturated zone rock hydrologic and geochemical properties)", no consideration is given to the effect of waste emplacement in the repository. Specifically, those changes in rock-water geochemistry and hydrologic properties surrounding the repository level that may result in the formation of a perched-water body in the vadose zone above and below the repository, such as permeability and porosity changes brought about by refluxing of vadose-zone waters due to the thermal pulse of decaying waste.

6. Individual evaluation of topical scenarios for the purpose of eliminating scenarios with insignificant consequences may overlook the coupling that may occur between two or more processes/events that could produce significant consequences for the release of radionuclides to the accessible environment. We think this has occurred: **the DOE has omitted the most obvious scenario of water vapor driven from the thermal envelope condensing in the cooler fractures that surround the repository horizon** and returning to the boiling zone by gravitational forces.

Summary Comments: Issue 1.1 Resolution Strategy

Probabilistic estimates of radionuclide releases to the accessible environment must be based on sound, statistically valid, data and not on unproven DOE assumptions such as:

1. Matrix flow predominates in vadose zone;
2. percolation flux is areally and temporarily uniformly distributed; and
3. batch sorption experiments employing crushed tuff are representative of field conditions;
4. nor on statistically biased data such as were used by Sinnock, et al. (1986).

Until the aforementioned assumptions are proven by site characterization or changed to conservative assumptions, and sound statistical and geostatistical techniques are employed to evaluate data, the resolution of issues will continue to be flawed.

PERFORMANCE ISSUE 1.3:

Important "special" sources of ground water that are in close proximity to a repository should be well-characterized. Key Issue I in the Office of Geologic Repositories issues hierarchy relates to whether the mined geologic-disposal system at Yucca Mountain will isolate the radioactive waste from the accessible environment after closure in accordance with the requirements set forth in 40 CFR Part 191, 10 CFR Part 60, and 10 CFR Part 960 (CD-SCP, p. 8.2-2). Performance Issue 1.3, "Will the mined geologic disposal system meet the requirements for the protection of special sources of ground water as required by 40 CFR 191.16?" (CD-SCP, p. 8.2-3), dictates information needs 1.3.1 and 1.3.2 of section 8.3.5.15 of the CD-SCP, "Ground-water Protection".

Information Need (CD-SCP)

1.3.1 Determination whether any Class 1 or special sources of ground water exist at Yucca Mountain, within the controlled area, or within 5 km of the controlled area boundary

1.3.2 Determine for all special sources whether concentrations of waste products in the ground water during the first 1,000 years after disposal could exceed the limits established in 40 CFR 191.16.

Section 191.16 of 40 CFR Part 191 was added to the final EPA rule to provide protection for those individuals in the vicinity of a disposal system (FR 38072, September 19, 1985). The CD-SCP (p. 8.3.5.15-1) provides the following explanation of EPA water-source designations:

> "An aquifer must meet several criteria to be designated as a special source. The first step in the evaluation is to establish whether the aquifer is a Class I source as defined by the EPA Ground Water Protection Strategy of 1984 (EPA, 1984). The conditions that must be met for designation as a Class I source are (1) that the source is highly vulnerable to contamination because of the hydrologic characteristics and (2) that the source is irreplaceable in that no reasonable alternative is available to substantial populations or that the source is ecologically vital in that it provides baseflow to a sensitive ecological system.
>
> If an aquifer meets the criteria for a Class I source, the next step is to determine whether it qualifies as a special source of ground water. 40 CFR 191.12 defines a special source of groundwater as "those Class I ground waters identified in accordance with the agency's Ground-Water Protection Strategy . . . that: (1) are within the controlled area encompassing a disposal system or less than 5 km beyond the controlled area [the controlled area is the actual area chosen according to the 40 CFR 191.12 definition of the controlled area]; (2) are supplying drinking water for thousands of persons as of the date that the [DOE] chooses a location within that area for detailed characterization as a potential site for a disposal system (e.g., in accordance with Section 112(b) (1)(B) of the Nuclear Waste Policy Act); and (3) are irreplaceable in that no reasonable alternative source of drinking water is available to that population."

A valley-fill aquifer, a tuff aquifer, and a carbonate aquifer are present at Yucca Mountain. DOE states that only the valley-fill aquifer was serving a population of thousands of persons at the time that the site was chosen for characterization (CD-SCP, Section 3.8). DOE also offers a preliminary determination that no potential special sources of ground water are present at the site, below the site, within the boundaries of the controlled area, or within 5 km of the controlled area boundary (CD-SCP, p. 8.3.5.15-6). The hydrologic feasibility of developing the lower carbonate aquifer must consider the possibility of interbasin diversion of baseflow to the Ash Meadows Springs (Section 8.3.1.9.2.). DOE also considers that the Ash Meadows area is part of a different ground-water subbasin (Ash Meadows) from the Alkali

Flat-Furnace Creek Ranch ground-water subbasin, which contains Yucca Mountain (Section 3.6).

The content of Section 8.3.1.9.2 (Investigation: Studies to provide the information required on present and future value of energy, mineral, land, and ground-water resources) suggests that the CD-SCP does not intend to refine the very poor understanding of the western margin of the Ash Meadows flow system between Yucca Mountain and Ash Meadows. The projection of this boundary north of Lathrop Wells is entirely speculative. DOE plans an analysis 1.3.1.1. (p. 8.3.5.15-7) to determine whether any aquifers near the site meet the Class I or special-source criteria. This analysis consists of two activities (1.3.1.1.1 and 1.3.1.1.2). These pull hydrologic data from other activities and demographic information into an assessment.

Comments and Discussion

DOE prefers to ignore that the western extent of the Ash Meadows' ground-water flow system is highly uncertain, as well as the carbonate aquifer's uncertain relations with the tuff aquifers of Yucca Mountain and the valley-fill aquifer in Amargosa Valley.

Yucca Mountain overlies the fragmented western extent of a regional-carbonate aquifer (Winograd and Thordarson, 1975), which discharges on the order of 17,000 acre-feet per year of good-quality ground water near Ash Meadows. Structural relationships probably control the extent of the carbonate aquifer in this area. Four major Mesozoic thrust faults that involve the subvolcanic rocks are projected through the Yucca Mountain-Jackass Flats area by Wernicke (1988). From southeast to northwest, these are the Clery-Spector Range Thrust, the Schwaub Peak-Mine Mountain (?) Thrust, an equivalent of the back-facing Panama Thrust, and the Last Chance Thrust. These thrust sheets involve a nearly complete Paleozoic section that is known to include major aquifers in the region. If, as Carr and Monsen (1988) suggest, the breakaway zone for the Fluorspar Canyon Fault is west of Yucca Mountain and faults at Yucca Mountain are genetically related to the Crater Flat graben system, then Paleozoic carbonates could underlie the entire Yucca Mountain-Jackass Flats area. In the absence of large-magnitude Cenozoic extension, the Tertiary section would be expected to be underlain by an allochthonous wedge corresponding to rocks between the Marble Canyon and White Top Thrusts, and equivalents. The Cottonwood Mountains, southern Funeral Mountains, southern Bare Mountain, and Mine Mountain (NTS) offer the best exposures of tectonic elements that could be structurally analogous to those beneath Yucca Mountain. In the Grapevine Mountains, the same structural level of the fold and thrust belt is exposed, but Cenozoic rotation and extensional overprinting have confused relations among pre-Tertiary units there somewhat more than in the other listed areas.

The Mesozoic fold and thrust belt that may underlie Yucca Mountain consists of several discrete thrust sheets with stratigraphic throws of up to 5 km and the full spectrum of brittle through ductile behavior. A key question is whether extensional crustal thinning has removed Paleozoic carbonates from beneath Yucca Mountain, and if the Silurian dolomite in UE25-p#1 is part of the laterally continuous carbonate aquifers which discharges at Ash Meadows. The northwest strike of prethrust normal faults in the Spring Mountains region indicates that hydraulic relations in and beneath the thrust sheets between Yucca Mountain and the northern Specter Range-Ash Meadows area should be explored. Because of the water-resource potential of the regional-carbonate aquifer, an understanding of flow paths within it is needed to resolve performance issue 1.3. The carbonate aquifer serves as a water supply for NTS activities and supports the unique and endangered ecology of the Ash Meadows area, including the Devil's Hole part of Death Valley National Monument. In addition, the major spring areas in Death Valley National Monument are the principal water supply for the Furnace Creek area and may be part of the carbonate-aquifer system.

The available evidence indicates that:

1. The alluvial aquifer is Class 1.
2. The tuff aquifer is Class 1 because it is a prime recharge source to the alluvial aquifer.

3. The carbonate aquifers that discharge at Ash Meadows and at Death Valley are Class 1.

We see that the "special source" designation can only be confidently resolved by determining the flow-system relationships and boundary conditions between the three aquifers known to exist in the vicinity of the controlled area. The CD-SCP has no data collection activities that will produce a definitive database and it therefore offers no useful plan to resolve the ground-water protection "special source" issues.

PERFORMANCE ISSUE 1.6

The statutory requirement for evaluation of ground-water travel time (GWTT) presupposes a need for understanding the geometry and geologic controls on ground-water flow. Key Issue I in the Office of Geologic Repositories issues hierarchy relates to whether the mined geologic-disposal system at Yucca Mountain will isolate the radioactive waste from the accessible environment after closure in accordance with the requirements set forth in 40 CFR Part 191, 10 CFR Part 60, and 10 CFR Part 960 (CD-SCP, p. 8.2-2.). Performance Issue 1.6, "Will the site meet the performance objective for prewaste-emplacement ground-water travel time as required by 10 CFR 60.113" (CD-SCP, p. 8.2-5), dictates information needs 1.6.1 through 1.6.5 of section 8.3.5.12 of the CD-SCP, "Ground-water Travel Time":

Information Need (CD-SCP)

1.6.1	Site information and design concepts needed to identify the fastest path of likely radionuclide travel and to calculate the ground-water travel time along that path.
1.6.2	Calculational models to predict ground-water travel times between the disturbed zone and the accessible environment.
1.6.3	Identification of the paths of likely radionuclide travel from the disturbed zone to the accessible environment and identification of the fastest path.
1.6.4	Determination of the prewaste-emplacement ground-water travel time along the fastest path of likely radionuclide travel from the disturbed zone to the accessible environment.
1.6.5	Boundary of the disturbed zone.

The success of several investigations in the geochemistry program will depend on recognition of ground-water flow paths:

CD-SCP Section

8.3.1.3.1	Investigation: studies to provide information on water chemistry within the potential emplacement horizon and along potential flow paths;
8.3.1.3.2	Investigation: Studies to provide information on mineralogy, petrology, and rock chemistry within the potential emplacement horizon and along potential flow paths;
8.3.1.3.4	Investigation: Studies to provide the information required on radionuclide retardation by sorption processes along flow paths to the accessible environment;
8.3.1.3.5	Investigation: Studies to provide the information required on radionuclide retardation by precipitation processes along flow paths to the accessible environment;
8.3.1.3.6	Investigation: Studies to provide the information required on radionuclide retardation by dispersive, diffusive, and advective transport processes along flow paths to the accessible environment;
8.3.1.3.7	Investigation: Studies to provide the information required on radionuclide retardation by all processes along flow paths to the accessible environment; and
8.3.1.3.8	Investigation: Studies to provide the information required on retardation of gaseous radionuclides along flow paths to the accessible environment.

The conceptual framework for calculating ground-water travel time requires identification of "likely" flow paths to the accessible environment, along which travel times are calculated, and a disturbed-zone boundary from which calculations are begun. The original disturbed-zone concept was based on a near-field region of difficult-to-model flow processes (46 FR 35280, 35281, July 8, 1981). Later, the NRC (Gordon, et al., 1986) proposed to restrict the disturbed-zone definition to include only a region of intrinsic-property changes. However, this later proposal has not been formally adopted by the NRC probably because of the large region of hydrothermal (heat-pipe) effects that may develop around emplaced waste, including non-Darcian fracture flow as condensate accumulates. Intrinsic-property changes will probably accompany boiling and condensation of pore fluids, so even if the restricted definition of the disturbed-zone boundary, such as proposed by Gordon, et al. (1986) were adopted by the NRC, the boundary may extend a considerable distance above and below the repository.

Ground-Water Flow Path

It appears that the DOE is approaching the problem of ground-water flow paths from the following perspectives:

1. Calculate flow paths using two-dimensional porous-medium model.
2. Map the intersection of land surface with a composite regional potentiometric surface that rises and falls over geologic time.
3. Determine physical-property conditions that govern fracture versus matrix flow.
4. Investigate apparently steep and apparently flat regions in the composite potentiometric surface by drilling additional WT-holes and by conducting tracer tests.
5. Prepare a plan to investigate the hydrologic significance of the Ghost Dance Fault.

Perspective	CD-SCP Section	Methodology
Calculation based on fluid potentials	8.3.5.12.3.1.2	Numerical Model
Intersection of composite regional potentiometric surface with land surface	8.3.1.2	Reexamine and redate paludal deposits
Determine physical-property conditions that govern fracture vs. matrix flow	8.3.1.2.3	Develop empirical relations from laboratory tests
Investigate steep and flat regions in composite potentiometric surface	8.3.1.2.3.1	Drill WT-holes, hydrology hole, and possibly southern tracer test complex
Investigate steep and flat regions in composite potentiometric surface	8.3.1.2.2.3.3	Solitario Canyon horizontal borehole
Investigate hydrologic significance of Ghost Dance Fault	8.3.1.2.2.6	Develop plan only

Disturbed Zone

DOE proposes to develop a disturbed-zone definition (8.3.5.12.5.2, activity 1.6.5.2), and reevaluate that definition based on saturated and unsaturated-zone system investigations (8.3.1.2.2 and 8.3.1.2.3). We strongly suggest that it would be fundamental for the SCP to include activities that delineate the extent and character of the disturbed zone as now defined.

The disturbed zone is an important focus of State of Nevada review activities. We find that the zone of difficult-to-understand (and characterize) processes (46 FR 35280, 35281, July 8, 1981) has been equated conceptually by the DOE to the zone of intrinsic-property changes. The central concept of a zone of intrinsic-property changes appears in most, if not all, DOE-sponsored literature that requires a disturbed-zone definition (Langkopf, 1987 and CD-SCP, Section 8.3.5.12.5, for example). However, even if there were no intrinsic property changes whatsoever, heat-driven changes in the hydrologic system at Yucca Mountain can reasonably be expected to be profound (and extraordinarily complex from a modeling perspective). These hydrothermal processes can be reasonably expected to occur within 100 years of repository loading based on simple calculations using DOE's physical-property values.

The CD-SCP assumes that the NRC draft generic technical position (Gordon, et al., 1986) will be adopted formally by the NRC. The State of Nevada has pointed out to the NRC that that draft position fails to consider the hydrothermal effects of the waste, causing multiphase fluid flow. It is obvious that the more restricted (in space) the disturbed-zone definition, the longer the flow paths in the vadose zone along which travel times are calculated, and the longer the travel times in any flow scenario.

The potential hydrothermal effects in the vadose zone of Yucca Mountain due to waste-generated temperatures which exceed the boiling temperature of water is generally unrecognized[1] in the CD-SCP. Our analysis indicates marked increases in both vapor and liquid-phase flow are expected due to the strong thermal envelope generated by the waste. In the fractured-rock environment, the complexity of heat and mass-transfer processes and associated solution-mineral reactions will be greatly increased by the multiphase liquid and vapor-flow environment. We estimate that about 10,000 acre-feet of water are present within the volume of rock that is expected to reach boiling temperature within 100 years.

The CD-SCP definition of the disturbed zone ignores the importance of multiphase fluid transport. The CD-SCP definition is not as defined and intended in 10 CFR 60.2 (46 FR 35280, 35281, July 8, 1981). Instead of a mechanically disturbed zone of the current DOE definition (measured as extending several meters from the repository horizon) hydrothermal effects have the potential to extend downward and upward tens to hundreds of meters from the repository horizon.

Based on our findings of: a) a high probability of field-scale hydrothermal multiphase (heat-pipe) effects occurring during repository loading, and b) the resultant zone of vaporization and condensation that could extend upward and downward significant distances from the repository horizon, we believe that a zone of intrinsic property changes is not conservative as a basis for defining the disturbed zone. Physical and chemical changes within the zone of vaporization and condensation would be difficult to characterize by direct observation, and will be impossible to predict accurately based on initial conditions only. The DOE needs to address and establish a research program to resolve both the thermal and hydrothermal effects in the repository performance in the SCP.

CD-SCP Ground-Water Travel Time Strategy

The DOE recognizes the "reasonable assurance" licensing requirement (10 CFR 60.101(a)(2)) that the ground-water travel time at Yucca Mountain is at least 1,000 years leaves this issue ambiguous as to what constitutes data of sufficient quantity and quality (p. 8.3.5.12-10).

CD-SCP states (p. 8.0-9):

1. Langkopf (1987) refers to unpublished modeling studies by J. Gauthier and R. R. Peters in a 1986 internal memorandum (SANDIA) where water redistribution was considered from the repository midline to below the repository.. Their reported findings support our scenario of total water expulsion as vapor in a 100-year period. However, their model assumes the matrix would absorb the moisture.

"The top-level strategy focuses strongly on the investigations of the characteristics of the flow in the unsaturated zone, relying heavily on the current view that the percolation is low and that the water in the unsaturated zone is tightly confined within the rock matrix. If these concepts can be confirmed, then the general objective for the system and for the post closure performance of the engineered and natural barriers are very likely to be met. As part of these investigations, the program will address alternative concepts including flow in fractures, lateral movement of water at rock interfaces in the unsaturated zone, and the effect on the flow of structural features such as faults. The ability of the unsaturated rock to hold water and limit contact of water with the waste packages will also be investigated."

We find that the CD-SCP approach indicated by the above warrants both applause and criticism. The correct issues have been identified, including ground-water travel times, but the characterization approach **is to prove conditions and processes favorable to waste isolation**. This would make good sense if there were established technologies, in-depth understanding of the processes, simple natural systems, and well understood analog environments. This is not the case for the vadose zone at Yucca Mountain. The SCP therefore needs to be structured to **test for the unacceptable conditions**, and for the most part, it fails in terms of the vadose-zone issues.

Vadose-Zone Conceptual Model Comments

The CD-SCP investigation 8.3.1.2.2 entitled "Studies to provide a description of the unsaturated zone hydrologic system at the site" presents the DOE's purpose and objective as "to develop a model of the unsaturated-zone hydrologic system at Yucca Mountain that will assist in assessing the suitability of the site to contain and isolate waste." It is also stated that in developing the model the needed information will be provided through ten studies to characterize the flow and transport through the Yucca Mountain unsaturated zone. The major studies planned to be conducted by DOE during site characterization address the areas of unsaturated-zone infiltration, percolation, gaseous-phase circulation, and hydrochemistry. Appendix I indicates our opinion of the general failure of these investigations to adequately establish site characterization objectives.

The CD-SCP conceptual model of water flow through the vadose zone is generally based on the assumption of steady-state downward flow. A second assumption is that the water flux through the vadose zone is so small that most water flow is through the matrix of the rock and not through fractures. A third assumption is that matrix flow will predominate through the repository horizon (Topopah Spring). This assumption largely depends upon the hypothesis that excess recharge is both diverted away from the repository horizon and retarded by capillary and permeability barriers at the contacts between the Tiva Canyon welded unit and the underlying Paintbrush Tuff nonwelded unit; and between the Topopah Spring welded unit and the overlying Paintbrush Tuff nonwelded unit.

The CD-SCP vadose-zone conceptual model is articulated on p. 3-207 to 3-213. In reviewing the CD-SCP, we have become aware of two important facts. First, the CD-SCP does not seriously consider conservative conceptual models that fit the limited site-specific data and the open-literature data. Second, the CD-SCP conceptual model, amazingly, perfectly satisfies all of the following conditions:

"(i) Low moisture flux in the host rock and in the overlying and underlying hydrogeologic units;
(ii) A water table sufficiently below the underground facility such that fully saturated voids contiguous with the water table do not encounter the underground facility;
(iii) A laterally extensive, low-permeability, hydrogeologic unit above the host rock that would inhibit the downward movement of water or divert downward-moving

water to a location beyond the limits of the underground facility;
(iv) A host rock that provides for free drainage; or
(v) A climatic regime in which the average annual historic precipitation is a small percentage of the average annual potential evapotranspiration." (10 CFR 60.122(b)(8)).

The above, of course, are the NRC favorable conditions for a repository in a vadose-zone environment.

We think the CD-SCP conceptual model of flow of water through the vadose zone is not based on nor supported by the available technical data. The estimated downward ground-water flux may be low in the light of published data. Estimates of the downward vertical matrix flux (no fracture flow) through the repository-horizon host rock range from a low value of 0.003 mm/year (based on laboratory determinations on core, Weeks and Wilson, 1984) to a high of 10 mm/yr (Sass and Lachenbruch, 1982) based on the geothermal-gradient analyses. Montazer and Wilson (1984) data from borehole UZ-1 show negative (upward) flux of approximately 1 to 2 mm/yr in the Topopah Spring unit. They also estimated that a downward flux through the same unit to be 1 mm/yr based on geometric mean of the saturated hydraulic-conductivity measurements on core samples assuming a hydraulic gradient of one. However, Montazer and Wilson (1985) reported that the measured hydraulic conductivity of two saturated samples was two-orders-of-magnitude greater than the geometric mean. For the Paintbrush Tuff nonwelded unit, they estimated that a vertical flux of 0.1 to about 100 mm/yr may be occurring. Additional uncertainty on the estimated flux under present conditions is introduced by recharge estimates of 4.5 mm/yr (Rush, 1970) to 5 mm/yr (Waddell, et al., 1984). These estimates of recharge are inconsistent with the postulated 1 mm/yr by the CD-SCP. If the saturated-matrix conductivity of the Topopah Spring unit is limited to a maximum of 1 mm/yr as DOE indicates, then the vadose flux could pass through the repository-horizon host rock (Topopah Spring) as fracture flow.

The CD-SCP conceptual model also assumes by implication that the recharge throughout the proposed repository boundary area is uniformly distributed. In desert terrane such as the Yucca Mountain site, the recharge may be low and variable. However, much of the recharge is certainly concentrated and focused beneath washes, in and through open and exposed fractures, and through faults in the rock matrix of the repository block. It is very likely that most of the recharge occurs through the fractures and in turn gives rise to the flux values that shorten dramatically the ground-water travel times through the vadose zone toward the accessible environment.

The CD-SCP assumption that a capillary barrier exists at the contacts between the Tiva Canyon welded unit and the underlying Paintbrush Tuff nonwelded unit, and between the Topopah Spring welded unit and the overlying Paintbrush Tuff nonwelded unit is unlikely based on the available information provided by DOE. There is no data or evidence that recharge moves laterally down dip at the contact between the fractures networks of the Tiva Canyon welded unit and the matrix of the Paintbrush Tuff nonwelded unit. To date, no field or laboratory data have been published by DOE which indicate that saturated conditions have been observed at or near the contact. It is unlikely that water will move laterally over any significant distance until the tuff is almost saturated.

In addition to the above, the CD-SCP postulates the existence of a capillary barrier between the Paintbrush Tuff nonwelded and the Topopah Spring units. There is no evidence that water is present across this contact or as a general condition across the site. Therefore, there is no basis to assume that "excess recharge" has been stored or that significant lateral flow is occurring within this unit.

The CD-SCP discusses (on pages 8.3.1.2-248 to 250) the use of the geochemical approach to evaluate and determine the flow direction, water flux, and ground-water travel time in the unsaturated zone by isotopic techniques. It also states:

"Pore fluids from the matrix and near fractures will be extracted from exploratory shaft rubble core for chemical and isotope analyses.", "Fracture fluids are expected to permeate the surrounding matrix.", and "Fluids from samples with moisture contents less than 11 percent (including samples that have been squeezed and centrifuged) will be extracted using the vacuum distillation method."

This technique may be useful in estimating and evaluating the ground-water travel times of water in the matrix. However, it is not clear from the CD-SCP how water in the fractures, especially the Topopah Spring unit, will be sampled for the geochemical isotopic technique. Nowhere under any activity is it explained how fracture waters will be sampled and analyzed when encountered. There are no activities that address field determination of saturated fractures, or ephemeral fracture flow. Other problems that are not addressed by the CD-SCP are the distributed nature of recharge over the repository block, the scale at which data is developed, the three-dimensional distribution in space of data collection, and the manner in which interpretations of these data will be made. Based on surface mapping and the core data, there are several million fractures within the repository block and every one of these is a possible conduit for both liquid and vapor flow. In addition, there are very significant lithologic units and associated facies that can markedly impact matrix-hydraulic conductivities. We find no activities that recognize and deal effectively with these problems.

Vadose Zone Boreholes: The CD-SCP activity 8.3.1.2.3.2 (p. 8.3.1.2-14) entitled "Site vertical borehole studies" describes the DOE investigation which involves dry drilling and coring of nine planned boreholes that will range in depth from 122 to 460 meters below the land surface. We are surprised by the apparent strategy of the vadose-zone drilling program. Based on the existing data on moisture in the vadose zone, it could be interpreted that the drilling plan has been designed to avoid developing additional data on perched water, or resolving already developed ambiguous data. Specifically UZ-14, near UZ-1, has a design depth of 120 m. Thus, it will avoid encountering known saturation at 387 m, which stopped UZ-1 drilling. Also, it will not provide any data to resolve the ambiguous potential records of UZ-1 in the Topopah Spring.

In addition, all the deep boreholes (UZ-9, UZ-9a, UZ-9b, UZ-2, UZ-3, UZ-10) are useless with respect to evaluating the occurrence and extent of perched water at or below the repository horizon in the repository block. UZ-2 and UZ-3 are shallower than UZ-6 and located very close to UZ-6, hence no new data on the distribution of perched water is likely to be established. UZ-9, UZ-9a, UZ-9b, and UZ-10 are too far from the repository block to be representative of the block conditions. All the rest of the boreholes are too shallow to develop data at or below the repository horizon. Such a plan is unlikely to establish new information on perched water and it can not resolve existing questions about already encountered perched water.

We find that the same two drilling techniques previously used in site-selection studies are planned for all future surface based vadose-zone studies. Both of these drilling methods have serious weaknesses that are well known to DOE from experience, and these weaknesses seriously impact the ability of the DOE to characterize the vadose zone. The ODEX method is slow and has produced a depth maximum of around 400 feet. The reverse-air vacuum produces a large diameter borehole, can not drill through perched water, produces unstable boreholes in fractured tuff, and is unnecessarily costly. The moisture data from UZ-1 and UZ-6 are compromised by the large diameter of the borehole and the prolonged drilling time.

Vadose Zone Siting Criteria: The NRC siting criteria set forth in 10 CFR 60.122 consist of two sets of conditions namely, the first set (10 CFR 60.122(b)) encompasses favorable conditions and the second set (10 CFR 60.122(c)) encompasses the potentially adverse conditions. The NRC siting criteria include the requirement that DOE must demonstrate and show by analysis that the potentially adverse conditions, if present at the site, do not affect significantly the ability of the geologic repository to meet the performance objective related to isolation of the waste. The CD-SCP sets out a plan to prove a conceptual model of favorable conditions. In doing so, it fails to provide a plan of activities that test for unfavorable conditions in the vadose zone.

Concluding Vadose Zone Comments

The confident characterization of the vadose-moisture regime of Yucca Mountain fractured tuff is the most important hydrogeological site-characterization objective. Based on our technical review of the CD-SCP, the following observations are warranted:

1. The methodologies proposed by DOE for obtaining in-situ physical measurements of moisture conditions in vadose-zone fractured tuff are based on porous media models which are inappropriate for fractured tuff; therefore, the proposed methodologies are highly experimental and have questionable probability of success.

2. Within fractured rocks, such as in the vadose zone of Yucca Mountain, the unresolved problem of an appropriate scale of data collection is not being addressed. The CD-SCP is not clear on how this scale problem is going to be resolved.

3. There is no new approach in the CD-SCP for establishing confident travel times in the saturated zone. We suggest that the SCP should contain field-oriented research activities that attempt to establish the scale(s) at which the tuff aquifers can be treated as equivalent porous media between the repository block and the accessible environment.

4. The heavy reliance on computer and numerical codes developed for characterizing the liquid, vapor, heat, and radionuclide transport within the fractured rocks is disturbing because of the general absence of a reliable validation methodology and the continuing unavailability of reliable field data at various scales (laboratory versus repository scale).

Saturated Zone and Regional Hydrogeology

A key component of hydrogeologic characterization is establishment of relations between geologic elements of the system and fluid flow. Boundary conditions for any region of interest are primarily due to geologic controls either directly, as in the case of an impermeable barrier to flow, or intrinsically, as in the case of a natural conduit.

In the summary of significant results from Chapter 1 (Geology) of the CD-SCP, the following statements are made:

> "Planned studies will identify and characterize the subvolcanic rocks and delineate their contact with overlying volcanic rocks (Section 8.3.1.17) to allow for refinement of hydrologic and tectonic models." (CD-SCP, p. 1-323).

Also,

> "Inactive faults and fractures, in their role as hydrologic barriers and conduits, may also influence the hydrology in the repository area for the postclosure period (Chapter 3)." (CD-SCP, p. 1-328).

Chapter 3 of the CD-SCP summarizes the present state of knowledge concerning the hydrology of the Yucca Mountain site. Two sections, 3.7.4.2, "Ground-Water Flow Paths During the Quaternary Period," and 3.9.3.1, "Accessible Environment and Credible Pathways," relate to flow-path and travel-time issues.

The CD-SCP states on p. 3-198:

"Tests are planned to evaluate the conditions under which flow in fractures and faults may occur (Section 8.3.1.2.3), thus aiding in the definition of flow paths in the unsaturated zone."

Also,

"...because of the nearly flat potentiometric surface under parts of Yucca Mountain, specific flowpath directions are currently difficult to define. Furthermore, the degree of anisotropy has not been evaluated. Additional water-table holes and extensive multiple-well and single-well tracer tests may help define anisotropy, hydraulic connections, and probable flow paths in the saturated zone (refer to Section 8.3.1.2.3.1)."

According to a statement on p. 3-105, Section 8.3.1.2 includes studies to reexamine and redate spring and marsh deposits from the south end of Crater Flat and south of Yucca Mountain.

Regarding ground-water flow paths during the Quatemary period, the CD-SCP states on p. 3-107:

"...the occurrence of calcitic veins, tuffs, and marsh deposits kilometers to tens of kilometers upgradient from areas of modern ground-water discharge indicates that flow to points of ground-water discharge were shorter in the past."

Evidence of possible megascale channeling in carbonate rocks of the southern Great Basin has been available in the open literature for over a decade. The CD-SCP reiterates the results of Winograd and Pearson (1976):

"[Winograd and Pearson] have shown a radiocarbon anomaly in Crystal Pool to probably be caused by megascale channeling, with water moving to this discharge point at velocities appreciably greater than those to adjacent springs." (CD-SCP, p. 3-102).

Structural Control on Flow Paths: As stated on p. 8.3.1.17-186, the tectonic synthesis will be applied to information need 1.6.1 (Section 8.3.5.12.1), "site information and design concepts needed to identify the fastest path of likely radionuclide travel and to calculate the ground-water travel time along that path." This is one component of the ground-water travel time issue, as outlined on p. 8.3.5.12-23 in a discussion of interrelationships of information needs. DOE indicates that tectonic synthesis will also be applied to investigations 8.3.1.2.1 (regional hydrologic system) and 8.3.1.4.2 (geologic framework).

We have reviewed the CD-SCP for investigation activities planned to assess the hydrologic significance of geologic structure in the Yucca Mountain region. We looked for evidence that hydrologic test drilling is effectively integrated with geologic-characterization activities. The basis for our review comments is Table 8.3.1.4-2, "Site Characterization Plan Proposed Drilling Requirements," which lists proposed boreholes and associated CD-SCP activities.

Only one activity of the CD-SCP is squarely aimed at characterizing the hydrogeologic significance of a discrete repository-scale geologic structure. **Activity 8.3.1.2.3.1.1, "Solitario Canyon Fault Study in the Saturated Zone,"** will attempt to determine whether the Solitario Canyon Fault is a barrier to eastward movement of ground water through the repository block. Two new WT-holes will be drilled near the Solitario Canyon Fault, plus a new hydrologic test hole (production well) east of the fault on the ridge crest of Yucca Mountain, designated H-7. A long-term pumping test intended to observe pumping response across the Solitario Canyon Fault is planned. We commend this effort but question why similar studies are not planned to evaluate other known structures, such as the Ghost Dance Fault.

Steep hydraulic gradients immediately upgradient of the repository appear to have focused

DOE's attention with respect to mission objectives. **Activity 8.3.1.2.3.1.2, "Site Potentiometric-Level Evaluation,"** calls for two water-table drillholes near Drill Hole Wash to obtain additional data on the steep hydraulic gradient in this area, and another two water-table drillholes south and east of the repository site. It is evident from the discussion on p. 8.3.1.2-302 that data from geologic drillhole USW G-5 will be used to help determine the probable cause and nature of the steep hydraulic gradient north of Drill Hole Wash. Conversely, the region inferred to be down the hydraulic gradient receives virtually no attention in terms of possible structural controls and hydraulic connection with underlying and overlying aquifer lithologies.

No plans are given for assessment of preferred flow paths in carbonate rock between Yucca Mountain and Ash Meadows, or refinement of the inferred western boundary of the Ash Meadows ground-water flow system. **Activity 8.3.1.2.3.1.6, "Well Testing with Conservative Tracers Throughout the Site,"** calls for a possible second multiple-well tracer test complex in a location "where the physical rock properties are significantly different from those of the C-hole location" (CD-SCP, p. 8.3.1.2-327). There is no discussion of the many distinct geologic controls on fluid flow that might be investigated with tracers, nor is there any elaboration of the role of tracers in developing a hydrologic characterization of structural discontinuities. Most importantly, the building of a statistically meaningful sampling rationale from available data is not evident in the geohydrology program.

Hydrologic Effects of Regional Strain Features: Calcite veins in Pliocene and younger rocks at Ash Meadows strike N40° ± 10°E (Winograd and Szabo, 1986; CD-SCP, 1988). This is approximately at right angles to the direction of regional Cenozoic extension. Although major northeast-trending structures exist in the Yucca Mountain region, the CD-SCP does not appear to address the possibility that they might represent conduits to ground-water flow because of their fundamentally dilational character.

The CD-SCP alludes to the possible, but unknown hydrologic significance of detachment faults in the following statement:

> "If detachment faults exist at depth below the site, their relevance to repository design and performance as potential sources of ground motion, rupture, or hydrologic conduits or barriers hinges on their age, depth, and nature of the intersection of the detachment faults with the steeply-dipping Quaternary normal faults within the site area" (DOE CD-SCP, p. 8.3.1.17-132).

The possible hydrogeologic significance of detachment faults is therefore recognized in the CD-SCP, but no studies are presented for hydrogeologic assessment of detachment faults. The structural studies that focus on particular groups of faults near Yucca Mountain are disjointed from a hydrogeologic perspective, with the exception of Solitario Canyon Fault studies, since they do not include hydrogeologic objectives. One of the stated objectives of activity 8.3.1.17.4.12.1 (Evaluate Tectonic Processes and Tectonic Stability at the Site) is to "...evaluate the regional extent of detachment faults...and evaluate regional extent of Paleozoic rocks known to be aquifers, aquitards, or to provide favored surfaces of detachment or thrusting" (DOE CD-SCP, p. 8.3.1.17-181). The description of this activity given on p. 8.3.1.17-182 of the CD-SCP provides for topical reports on "Quaternary wrench faulting, detachment faulting, normal faulting, and left-lateral strike-slip faulting." Gravity and magnetic maps will be compiled, and "geologic cross sections showing inferred subsurface structural and stratigraphic geometry will be prepared." Nowhere, however, do we find a statement of any clear hydrogeologic objective accompanied by a testing methodology, in these tectonic studies.

We have been unable to judge the merits of DOE's proposed borehole locations since locations given in the CD-SCP are inconsistent and generally unjustified. For example, we note major discrepancies between proposed borehole locations given in Section 8.3.1.2.3.1.2 "Activity: Site Potentiometric Level Evaluation," and Section 8.3.1.4.1 "Investigation: Development of an Integrated Drilling Program." If, as stated on p. 8.3.1.4-18 of the CD-SCP, each proposed drillhole represents a source of data intended to answer a particular requirement of design or performance assessment, then all proposed holes should be precisely located and comprehensively justified. Furthermore, if Figure 8.3.1.4-2 contains a mixture of randomly-located and judiciously-sited holes, they should be clearly distinguished.

The difficulty in defining flow paths in the saturated zone for travel-time calculations is due, as stated on p. 8.3.1.2-295 of the CD-SCP, to the fact that hydraulic tests at Yucca Mountain have failed to identify definitive hydrostratigraphic units:

> "If pervasive fracturing crosses stratigraphic boundaries and accounts for orders of magnitude greater hydraulic conductivity than does the matrix, it may not be appropriate to simulate ground-water flow within a framework of hydrostratigraphic units."

As indicated earlier, only one activity, 8.3.1.2.3.1.1, "Solitario Canyon Fault Study in the Saturated Zone," is focused directly on determining the hydrologic role of a discrete geologic structure. While it is recognized that "...flow down the Ghost Dance Fault could result in concentrated flow in a part of the repository horizon" (CD-SCP, p. 8.3.1.2-255), a plan to characterize flux in the Ghost Dance Fault has not been presented in the CD-SCP.

There is no provision in the CD-SCP for hydrogeologic assessment of (discrete) geologic discontinuities in a geostatistically robust (rigorous) fashion. Plans have been made for a limited analysis of the hydrogeologic significance of the Solitario Canyon Fault, and as yet no plan exists for analysis of the Ghost Dance Fault. Activities proposed in the CD-SCP to provide flow-path characterization offer little hope of resolving performance issue 1.6 with respect to flow in the saturated zone. A comprehensive drilling and testing program that includes an assessment of the hydrogeologic character of representative geologic structures (or areas) is absent from the CD-SCP. The CD-SCP fails to focus site-characterization activities on real (as opposed to simulated) flow paths.

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APPENDIX I

TECHNICAL REVIEWS OF CD-SCP ACTIVITIES

APPENDIX I

This appendix contains specific review comments for activities, subactivities, and studies of CD-SCP under seven programs. These programs are:

1. Geohydrology Program (8.3.1.2),
2. Geochemistry Program (8.3.1.3),
3. Rock Characteristics Program (8.3.1.4),
4. Climate Program (8.3.1.5),
5. Thermal and Mechanical Rock Properties (8.3.1.15),
6. Waste Package Program (8.3.4), and
7. Performance Assessment Program (8.3.5).

Work plans and technical procedures for each activity were not included in the CD-SCP (nor have they been established in many cases) and only these more detailed elements of an activity may provide sufficient information for full evaluation of the technical merits of some activities of the CD-SCP.

The review comments were developed for these diverse programs as they relate to the technical hydrogeologic issues of Yucca Mountain site. Each activity was reviewed in terms of the following four criteria: 1) conceptual completeness and focus; 2) appropriateness of methodology to accomplish stated objective by DOE; 3) probability of success using the existing technology; and 4) feasibility in terms of time, funding, and human resources. Under each criteria, a unified score system was developed that can be applied to all four criteria. The scoring system range from the lowest grade, 0, to the highest grade of 4. The five grades scoring system covers the following;

0) insufficient information to judge;
1) incomplete/unfeasible/unlikely to succeed/will not establish objectives;
2) generally incomplete, probably will not establish objectives/probably will not succeed/probably unfeasible;
3) generally complete/probably will establish objectives/probably will succeed/probably feasible; and
4) complete/will establish objectives/success likely/feasible.

The manner in which we believe the review score should be used is as follows:

A. If any of the four aspects considered has a numerical score equal to or below 2, we have judged that the activity will fail to meet the site-characterization objective (indicated by a NO in the following score summaries). This includes scores of zero, which are given to indicate there is insufficient information for the reviewer to judge the aspect of the activity.

B. If all of the four aspects of the activity are scored 3 or above, we have judged that the addressed site-characterization objective may be established in the time frame available (indicated by a Yes in the following score summaries). We are assuming that highly qualified investigators and well-designed and appropriate technical procedures will be used to accomplish the activity objectives.

C. When duplicate MAI activity reviews disagreed, we have favored the results of our most experienced reviewer of the topic of the activity. These are indicated in the summary tables of Appendix I.

No review or reviewer is completely unbiased. In recognition of this and the very limited information given in the activities, our approach to the investigative activities of CD-SCP were impression reviews, where the most experienced expert with respect to topic within our group reviewed the activities quickly, by reading them rapidly in context with each other. We provide brief notes as to the why of the scores on the review sheets.

Several activities were purposely reviewed by more than one MAI reviewer. Several aspects are worth noting:

I. When the reviewers were both well trained and experienced in the reviewed topic, reviews were quite similar in results.

II. When the reviewers (all of the reviewers are geoscientists, hold Ph.Ds and have at least ten years of experience in their respective specialties) reviewed outside of their respective specialties, the scores were significantly higher than scores given by the experienced expert in the topic. In the few conflicting double reviews, we favor the results of the more expert reviewer.

We think some of our double review observations may hint at one reason for the overall low scores given the technical program of the CD-SCP. Activities which may "sound" good to the inexperienced generalist may, in truth, be very poorly designed and/or conceived when viewed by an experienced researcher in the specialized area of effort. Most of us (the reviewers) have rapidly picked up the jargon and concepts in the areas of expertise of our colleagues with respect to the Yucca Mountain studies, but our judgment may remain relatively poor on complex research objectives. Only years of experience allows one to accurately judge what is likely to be feasible, as well as what is correctly focused and designed, in efforts to establish viable data and analyses to resolve highly complex issues. Therefore, we conclude that:

a. The majority of activities as presented were not developed by seasoned researchers in the specialties that are required.

b. The majority of activities as presented were not peer reviewed by highly experienced experts.

CD-SCP ACTIVITY REVIEW SUMMARY SHEETS

Climate Change Program (8.3.1.5)

SECTION	CONCEPTUAL	METHODOLOGY	TECHNOLOGY	FEASIBILITY	SCP OBJECTIVES
8.3.1.5.1.1.1	4	3	4	3	YES
8.3.1.5.1.2	4	4	3	3	YES
8.3.1.5.1.2.1	3	3	3	2	NO
8.3.1.5.1.2.2	2	1	2	3	NO
8.3.1.5.1.2.3	2	1	3	3	NO*
8.3.1.5.1.2.3	3	3	3	4	YES
8.3.1.5.1.2.4	4	3	3	3	YES
8.3.1.5.1.3.1	4	4	3	4	YES
8.3.1.5.1.3.2	4	2	2	4	NO
8.3.1.5.1.3.3	4	2	1	3	NO
8.3.1.5.1.4.1	3	3	3	3	YES
8.3.1.5.1.4.1	3	3	3	3	YES
8.3.1.5.1.4.2	2	2	3	3	NO
8.3.1.5.1.4.2	2	2	3	3	NO
8.3.1.5.1.4.3	4	4	4	4	YES
8.3.1.5.1.4.4	4	4	4	4	YES
8.3.1.5.1.5.1	3	0	2	2	NO
8.3.1.5.1.6.1	1	2	2	1	NO
8.3.1.5.1.6.2	3	3	0	4	NO
8.3.1.5.1.6.3	1	3	1	1	NO
8.3.1.5.2.1.1	4	3	3	4	YES
8.3.1.5.2.1.2	4	4	2	4	NO
8.3.1.5.2.1.3	4	4	3	3	YES
8.3.1.5.2.1.4	4	3	3	3	YES
8.3.1.5.2.1.5	4	3	3	3	YES
8.3.1.5.2.2.1	2	2	2	2	NO
8.3.1.5.2.2.2	1	1	1	1	NO
8.3.1.5.2.2.2	1	1	1	1	NO
8.3.1.5.2.2.3	3	3	3	4	YES

* Review favored by MAI based on relative experience/expertise of the two reviewers in the activity topic.

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: 8.3.1.5.1.1.1 **page no.:** 8.3.1.5-24
ACTIVITY NO. (if applicable):
ACTIVITY TITLE: Synoptic characterization of regional climate.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 4

Comments:

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 3

Comments:
Model of C cycle during recharge not part of the objectives.

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 4

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 3

Comments:

REVIEWER: M. Mifflin. **DATE:** 09 June 1988.

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: 8.3.1.5.1.2 **page no.:** 8.3.1.5-26
ACTIVITY NO. (If applicable):
ACTIVITY TITLE: Paleoclimate study: lake, playa, marsh deposits. [Study]

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 4

Comments:

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 4

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 3

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 3

Comments:

REVIEWER: M. Mifflin. **DATE:** 09 June 1988.

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: 8.3.1.5.1.2.1 **page no.:** 8.3.1.5-28
ACTIVITY NO. (if applicable):
ACTIVITY TITLE: Paleontologic analyses.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 3

Comments:
Lacks the way that time will be established, and does not clearly indicate how or if integrated in to all stratigraphic studies that are necessary for age control.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 3

Comments:
Some problem with respect to published database for environments.

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 3

Comments:
Very little published work for comparing paleo with modern environments may prove to be a problem.

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 2

Comments:
Human resources and/or time as compared to the magnitude of the effort seems to be an important limitation.

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: 8.3.1.5.1.2.2 **page no.:** 8.3.1.5-31

ACTIVITY NO. (If applicable):

ACTIVITY TITLE: Analysis of the stratigraphy-sedimentology of marsh, lacustrine, and playa deposits.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 2

Comments:
Reliance on seismic techniques suggests that there is little understanding of Great Basin depositional environments and the difficulty of differentiating depositional environments from lithologies.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 1

Comments:
Only core/outcrops will allow characterization of lithologies in terms of depositional environments.

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 2

Comments:
Would work only if all seismic work heavily controlled by coring.

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 3

Comments:

REVIEWER: M. Mifflin. **DATE:** 09 June 1988.

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: 8.3.1.5.1 **page no.:** 8.3.1.5-33
ACTIVITY NO. (if applicable): 8.3.1.5.1.2.3
ACTIVITY TITLE: Geochemical analyses of lake, marsh, and playa deposits.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 2

Comments:
The overall objective is good, but the study activity proposed will not yield results due to poor focus. Study activity should be retitled to provide correct focus.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 1

Comments:
Should be looking at fluid inclusions and micropaleontology techniques. This section is very poorly developed. Specific deposits need to be identified along with good age controls.

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 3

Comments:
Micropaleo techniques with fluid inclusion work and authigenic mineralogy geochemistry could provide the information desired.

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 3

Comments:
The quantity of samples will be the only limiting factor in obtaining desired information and results.

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: 8.3.1.5.1.2.3 **page no.:** 8.3.1.5-33
ACTIVITY NO. (If applicable):
ACTIVITY TITLE: Geochemical analyses of lake, marsh, and playa deposits.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 3

Comments:
Will only work if closely tied to field mapping and associated sedimentological and stratigraphic analyses.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 3

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 3

Comments:
Potential problems of secondary changes due to the complex hydrologic histories and arid conditions.

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 4

Comments:

REVIEWER: M. Mifflin. **DATE:** 09 June 1988.

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: 8.3.1.5.1.2.4 **page no.:** 8.3.1.5-35
ACTIVITY NO. (if applicable):
ACTIVITY TITLE: Chronologic analyses of lake, playa, and marsh deposits.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 4

Comments:
Objective and focus sound.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 3

Comments:
Some dating methods listed need better tests when applied to the regional problems.

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 3

Comments:
Analytical techniques have some problems with respect to confident dating.

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 3

Comments:

REVIEWER: M. Mifflin. **DATE:** 09 June 1988.

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: 8.3.1.5.1.3.1 **page no.:** 8.3.1.5-38
ACTIVITY NO. (if applicable):
ACTIVITY TITLE: Analysis of pack rat middens.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 4

Comments:

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 4

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 3

Comments:
Still no agreement on how to best analyze and interpret pack rat middens.

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 4

Comments:

REVIEWER: M. Mifflin. **DATE:** 09 June 1988.

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: 8.3.1.5.1.3.2 **page no.:** 8.3.1.5-39
ACTIVITY NO. (If applicable):
ACTIVITY TITLE: Analysis of pollen samples.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 4

Comments:

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 2

Comments:
Pollen preservation is too limited to provide the type of record needed in both time and space for past vegetation.

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 2

Comments:
Problems exist in the interpretations of pollen counts; preservation in arid (oxidized) sediments a serious problem.

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 4

Comments:

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: 8.3.1.5.1.3.3 **page no.:** 8.3.1.5-41
ACTIVITY NO. (If applicable):
ACTIVITY TITLE: Determination of vegetation-climate relationships.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 4

Comments:

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 2

Comments:
Methodology undemonstrated on the plant communities and climates of the arid southwest.

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 1

Comments:
Plant/climatic controls information may not be well enough developed to use the transfer function and response function approach.

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 3

Comments:
If approach worked, it is feasible to execute.

REVIEWER: M. Mifflin. **DATE:** 09 June 1988.

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: 8.3.1.5.1.4.1 **page no.:** 8.3.1.5-44
ACTIVITY NO. (if applicable):
ACTIVITY TITLE: Modeling of soil properties in the Yucca Mountain region.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 3

Comments:

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 3

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 3

Comments:
This will only succeed if dating of soils and associated landforms is confident. There is enough promise in a variety of approaches to anticipate some success.

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 3

Comments:

REVIEWER: M. Mifflin. **DATE:** 09 June 1988.

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: Climate **page no.:** 8.3.1.5-44
ACTIVITY NO. (If applicable): 8.3.1.5.1.4.1
ACTIVITY TITLE: Modeling of soil properties in the Yucca Mountain region.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 3

Comments:

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 3

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 3

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 3

Comments:

REVIEWER: A. Elzeftawy. **DATE:** 13 June 1988.

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: 8.3.1.5.1.4.2 **page no.:** 8.3.1.5-48
ACTIVITY NO. (If applicable):
ACTIVITY TITLE: Soil moisture analog study.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 2

Comments:
Unfortunately, this study assumes that the soils in the two areas of study forming now are in analog pluvial climates.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 2

Comments:
Need to expand the range of wetter climates and use soils on the same parent terrane.

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 3

Comments:
The characteristics of the soils, including water chemistry, will likely succeed.

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 3

Comments:

REVIEWER: M. Mifflin. **DATE:** 09 June 1988.

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: Climate **page no.:** 8.3.1.5-48
ACTIVITY NO. (if applicable): 8.3.1.5.1.4.2
ACTIVITY TITLE: Soil moisture analog study.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 2

Comments:
Assume soils are forming under the same weather of pluvial climates?

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 2

Comments:
Need to expand the range of climates.

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 3

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 3

Comments:

REVIEWER: A. Elzeftawy. **DATE:** 13 June 1988.

MY880715mm

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: 8.3.1.5.1.4.3 **page no.:** 8.3.1.5-50
ACTIVITY NO. (if applicable):
ACTIVITY TITLE: Surficial deposits mapping of the Yucca Mountain area.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 4

Comments:

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 4

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 4

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 4

Comments:

REVIEWER: M. Mifflin. **DATE:** 09 June 1988.

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: 8.3.1.5.1.4.4 **page no.:** 8.3.1.5-56
ACTIVITY NO. (If applicable):
ACTIVITY TITLE: Eolian history of the Yucca Mountain region.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 4

Comments:

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 4

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 4

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 4

Comments:

REVIEWER: M. Mifflin. **DATE:** 09 June 1988.

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: 8.3.1.5.1.5.1 **page no.:** 8.3.1.5-61
ACTIVITY NO. (If applicable):
ACTIVITY TITLE: Paleoclimate-paleoenvironment synthesis.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 3

Comments:

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 0

Comments:
Not clear or stated as to how to obtain quantitative data from terrestrial paleocology and paleoenvironmental investigations.

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 2

Comments:
Modern climate models validated by paleoclimatic data suggest the need for much more quantitative data than can be developed.

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 2

Comments:
The independent variables of climate--temperature and precipitation--are needed for paleoclimates through time and space. This continues to be a serious challenge to paleoclimate analysis.

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: 8.3.1.5.1.6.1 **page no.:** 8.3.1.5-63

ACTIVITY NO. (If applicable):

ACTIVITY TITLE: Global climate modeling.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 1

Comments:
The sensitivity of a new global model will not better the information available for a regional model. Poorly focused, conceptually incorrect.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 2

Comments:
Appropriate for the first two objectives, but the global model of general circulation probably is not sensitive enough to provide meaningful boundary conditions (precipitation, temperature, ET, etc.) in the Great Basin.

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 2

Comments:
Global models are not sensitive in a complex region like the Great Basin and therefore it would not likely establish useful information.

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 1

Comments:
A global model sensitive enough to reach the objectives is not likely to be feasible in terms of all the resources required.

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: 8.3.1.5.1.6.2 **page no.:** 8.3.1.5-68
ACTIVITY NO. (if applicable):
ACTIVITY TITLE: Regional climate modeling.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 3

Comments:
Does not recognize the opportunity to calibrate the regional model with closed basin lake hydrology of the Great Basin.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 3

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 0

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 4

Comments:

REVIEWER: M. Mifflin. **DATE:** 09 June 1988.

This approach is of perhaps greater value than the global model in that Yucca Mountain climates are being attempted based on regional data.

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: 8.3.1.5.1.6.3 **page no.:** 8.3.1.5-70
ACTIVITY NO. (If applicable):
ACTIVITY TITLE: Linked global-regional climate modeling.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 1

Comments:
The global model is not likely to be sensitive enough to judge erosion rates, etc. Only regionally derived paleoclimate evidence is necessary for this analysis.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 3

Comments:
Last paragraph of 8.3.1.5-72, 73 does not make sense with respect to confirmation of climatic episodes by statistics, if orbital parameters are being used to predict climate change.

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 1

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 1

Comments:

REVIEWER: M. Mifflin. **DATE:** 09 June 1988.

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: 8.3.1.5.2.1.1 **page no.:** 8.3.1.5-82
ACTIVITY NO. (if applicable):
ACTIVITY TITLE: Regional paleo flood evaluation..

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 4

Comments:

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 3

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 3

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 4

Comments:

REVIEWER: M. Mifflin. **DATE:** 11 June 1988.

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: 8.3.1.5.2.1.2 **page no.:** 8.3.1.5-84
ACTIVITY NO. (If applicable):
ACTIVITY TITLE: Quaternary unsaturated zone hydrochemical analysis.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 4

Comments:

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 4

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 2

Comments:
The DOE program has not developed or used a drilling technique that allows for the sampling of fracture water at and below the repository horizon.

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 4

Comments:

REVIEWER: M. Mifflin. **DATE:** 12 June 1988.

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: 8.3.1.5.2.1.3 **page no.:** 8.3.1.5-86
ACTIVITY NO. (if applicable):
ACTIVITY TITLE: Evaluation of past discharge areas.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 4

Comments:
This is conceptually similar to investigations now underway by the State in other discharge areas.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 4

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 3

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 3

Comments:

REVIEWER: M. Mifflin. **DATE:** 12 June 1988.

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: 8.3.1.5.2.1.4 **page no.:** 8.3.1.5-93
ACTIVITY NO. (If applicable):
ACTIVITY TITLE: Analog recharge studies.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 4

Comments:
This is almost identical in conceptual approach to the analog recharge studies proporsed by the State (DRI) in 1984.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 3

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 3

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 3

Comments:

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: 8.3.1.5.2.1.5 **page no.:** 8.3.1.5-96
ACTIVITY NO. (if applicable):
ACTIVITY TITLE: Studies of calcite and opaline silica vein deposits.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 4

Comments:

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 3

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 3

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 3

Comments:

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: 8.3.1.5.2.2.1 **page no.:** 8.3.1.5-102
ACTIVITY NO. (If applicable):
ACTIVITY TITLE: Analysis of future surface hydrology due to climate changes.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 2

Comments:
It is not clear that there is enough data to model modern runoff.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 2

Comments:
Don't understand the technique to be used to validate the model.

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 2

Comments:
No demonstrated models of arid/semi-arid stream flow regimens in the region--no technology.

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 2

Comments:
A few years of data collections in the Yucca Mountain area are not likely to be enough to model even the present surface-water regimen.

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: 8.3.1.5.2.2.2 **page no.:** 8.3.1.5-103
ACTIVITY NO. (if applicable):
ACTIVITY TITLE: Analysis of future unsaturated zone hydrology due to climate changes.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 1

Comments:
The activity is flawed by the assumption that a calibrated vadose zone model will be established.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 1

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 1

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 1

Comments:

REVIEWER: M. Mifflin. **DATE:** 12 June 1988.

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: Climate **page no.:** 8.3.1.5-103
ACTIVITY NO. (If applicable): 8.3.1.5.2.2.2
ACTIVITY TITLE: Analysis of future unsaturated zone hydrology due to climate changes.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 1

Comments:
It is flawed because of the complete reliance on mathematical, theoretical, and unproven models.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 1

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 1

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 1

Comments:

REVIEWER: A. Elzeftawy. **DATE:** 13 June 1988.

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: 8.3.1.5.2.2.3 **page no.:** 8.3.1.5-105
ACTIVITY NO. (If applicable):
ACTIVITY TITLE: Synthesis of effects of possible future recharge due to climate changes on hydrologic characteristics of the Yucca Mountain saturated zone.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 3

Comments:
The approach is good, but compromised by the probable lack of model sensitivity in the areas of discharge where the changes of WL are established.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 3

Comments:
The two noted problems or weaknesses--ie. the sensitivity of the modeling in the discharge areas and the type of terrain which produces important recharge.

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 3

Comments:
A weakness is the lack of knowledge of the importance of recharge in terrain such as Yucca Mountain.

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 4

Comments:

REVIEWER: M. Mifflin. **DATE:** 12 June 1988.

Engineered Barrier System Release Rates Program (8.3.5.10)

SECTION	CONCEPTUAL	METHODOLOGY	TECHNOLOGY	FEASIBILITY	SCP OBJECTIVES
8.3.5.10.1.1.1	2	0	0	0	NO
8.3.5.10.1.1.2	2	0	0	0	NO
8.3.5.10.1.1.3	1	0	0	0	NO
8.3.5.10.2.1.1	2	2	3	3	NO
8.3.5.10.2.1.2	3	3	3	3	YES
8.3.5.10.2.1.3	3	3	3	3	YES
8.3.5.10.2.1.4	3	0	0	0	NO
8.3.5.10.2.1.5	3	3	0	0	NO
8.3.5.10.2.1.6	2	0	0	0	NO
8.3.5.10.2.2.1	3	3	3	3	YES
8.3.5.10.2.2.2	3	3	3	0	NO
8.3.5.10.2.2.3	3	3	0	0	NO
8.3.5.10.3.1	2	0	0	0	NO
8.3.5.10.3.2	3	3	0	0	NO
8.3.5.10.3.2.2	4	3	3	0	NO
8.3.5.10.3.3	3	3	0	0	NO
8.3.5.10.3.4	3	3	3	0	NO
8.3.5.10.3.5.1	2	0	0	0	NO
8.3.5.10.3.5.2	2	0	0	0	NO
8.3.5.10.3.5.3	3	3	3	0	NO
8.3.5.10.4.1	2	0	0	0	NO
8.3.5.10.4.2	2	0	0	0	NO
8.3.5.10.5.1.1	2	2	0	0	NO
8.3.5.10.5.1.2	3	3	0	0	NO
8.3.5.10.5.2.1	2	0	0	0	NO
8.3.5.10.5.2.2	2	0	0	0	NO

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SCP SECTION: 8.3.5.10 EBS Release Rates **page no.:** 8.3.5.10-36
ACTIVITY NO. (If applicable): 1.5.1.1 (8.3.5.10.1.1) (sub-activity)

ACTIVITY TITLE: 8.3.5.10.1.1.1 Sub-activity 1.5.1.1.1 Integrate spent fuel information.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 2

Comments:
Vague, no specifics.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 0

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 0

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 0

Comments:

REVIEWER: D. Shettel. **DATE:** 27 June 1988.

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SCP SECTION: EBS Release Rates **page no.:** 8.3.5.10-36
ACTIVITY NO. (If applicable): 1.5.1.1
ACTIVITY TITLE: 8.3.5.10.1.1.2 Sub-activity 1.5.1.1 Integrate glass waste form information.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 2

Comments:

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 0

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 0

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 0

Comments:

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SCP SECTION: EBS Release Rates **page no.:** 8.3.5.10-36
ACTIVITY NO. (if applicable): 1.5.1.1
ACTIVITY TITLE: 8.3.5.10.1.1.3 Sub-activity 1.5.1.1.3 Integrate waste package and repository design information.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 1

Comments:

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 0

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 0

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 0

Comments:

REVIEWER: D. Shettel. **DATE:** 27 June 1988.

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: EBS Release Rates **page no.:** 8.3.5.10-39
ACTIVITY NO. (If applicable): 1.5.2.1 (8.3.5.10.2.1)

ACTIVITY TITLE: 8.3.5.10.2.1.1 Sub-activity 1.5.2.1.1 Dissolution and leaching of spent fuel.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 2

Comments:
Use of J13 water not justified.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 2

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 3

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 3

Comments:

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: EBS Release Rates **page no.:** 8.3.5.10-40
ACTIVITY NO. (if applicable): (8.3.5.10.2.1) 1.5.2.1

ACTIVITY TITLE: 8.3.5.10.2.1.2 Sub-activity 1.5.2.1.2 Oxidation of spent fuel.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 3

Comments:

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 3

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 3

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 3

Comments:

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: EBS Release Rates **page no.:** 8.3.5.10-41
ACTIVITY NO. (if applicable): 1.5.2.1 (8.3.5.10.2.1.3)

ACTIVITY TITLE: 8.3.5.10.2.1.3 Sub-activity 1.5.2.1.3 Corrosion of zircaloy.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 3

Comments:
Again, J13 water is being used exclusively. Should consider vadose water compositions when available.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 3

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 3

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 3

Comments:

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SCP SECTION: EBS Release Rates **page no.:** 8.3.5.10-42
ACTIVITY NO. (if applicable): 1.5.2.1.1 [Dissolution and leaching of spent fuel]

ACTIVITY TITLE: 8.3.5.10.2.1.4 Sub-activity 1.5.2.1.4 Corrosion of and radionuclide release from other materials in the spent fuel waste form.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 3

Comments:

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 0

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 0

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 0

Comments:

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SCP SECTION: EBS Release Rates **page no.:** 8.3.5.10-43
ACTIVITY NO. (If applicable): 1.5.2.1.1 [Dissolution and leaching of spent fuel]

ACTIVITY TITLE: 8.3.5.10.2.1.5 Sub-activity 1.5.2.1.5 Evaluation of the inventory and release of C-14 from zircaloy cladding.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 3

Comments:

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 3

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 0

Comments:
No technical procedures given.

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 0

Comments:

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SCP SECTION: EBS Release Rates **page no.:** 8.3.5.10-44
ACTIVITY NO. (if applicable): 1.5.2.1.1 [Dissolution and leaching of spent fuel]

ACTIVITY TITLE: 8.3.5.10.2.1.6 Sub-activity 1.5.2.1.6 Other experiments on the spent fuel waste form.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 2

Comments:

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 0

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 0

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 0

Comments:

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SCP SECTION: EBS Release Rates **page no.:** 8.3.5.10-45
ACTIVITY NO. (If applicable): 1.5.2.2 [Characterization of glass waste form]

ACTIVITY TITLE: 8.3.5.10.2.2.1 Sub-activity 1.5.2.2.1 Leach testing of glass.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 3

Comments:

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 3

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 3

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 3

Comments:

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SCP SECTION: EBS Release Rates **page no.:** 8.3.5.10-46
ACTIVITY NO. (if applicable): 1.5.2.2 [Characterization of glass waste form]

ACTIVITY TITLE: 8.3.5.10.2.2.2 Sub-activity 1.5.2.2.2 Materials interactions affecting glass leaching.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 3

Comments:
Perhaps DOE should delay these experiments until vadose water chemistry is determined, as well as pour canister materiall

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 3

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 3

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 0

Comments:

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SCP SECTION: EBS Release Rates **page no.:** 8.3.5.10-47
ACTIVITY NO. (If applicable): 1.5.2.2 [Characterization of glass waste form]

ACTIVITY TITLE: 8.3.5.10.2.2.3 Sub-activity 1.5.2.2.3 Cooperative testing with waste producers.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 3

Comments:

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 3

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 0

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 0

Comments:

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: EBS Release Rates **page no.:** 8.3.5.10-54
ACTIVITY NO. (If applicable): (8.3.5.10.3.1) Activity 1.5.3.1

ACTIVITY TITLE: Integrate scenarios for release from waste package.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 2

Comments:
If there is only one subactivity, this level of breakdown is not needed.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 0

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 0

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 0

Comments:

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SCP SECTION: EBS Release Rates **page no.:** 8.3.5.10-55
ACTIVITY NO. (If applicable): 1.5.3.2
ACTIVITY TITLE: (8.3.5.10.3.2) Sub-activity 1.5.3.2.1 Develop data base for geochemical modeling.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 3

Comments:

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 3

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 0

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 0

Comments:

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SCP SECTION: EBS Release Rates — **page no.:** 8.3.5.10-56
ACTIVITY NO. (if applicable): 1.5.3.2
ACTIVITY TITLE: (8.3.5.10.3.2.2) Sub-activity 1.5.3.2.2 Develop geochemical modeling code.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 4

Comments:
One must be careful with use of "equilibrium sorption models" because they may not apply under all conditions.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 3

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 3

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 0

Comments:

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: EBS Release Rates **page no.:** 8.3.5.10-58
ACTIVITY NO. (If applicable): 1.5.3.3 (8.3.5.10.3.3)

ACTIVITY TITLE: Generate models for release from spent fuel.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 3

Comments:
Subactivity designation not needed if there is only one!

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 3

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 0

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 0

Comments:

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SCP SECTION: EBS Release Rates **page no.:** 8.3.5.10-60
ACTIVITY NO. (if applicable): 1.5.3.4 (8.3.5.10.3.4)

ACTIVITY TITLE: Generate models for release from glass waste forms.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 3

Comments:
Subactivity designation not needed if there is only one!

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 3

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 3

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 0

Comments:

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SCP SECTION: EBS Release Rates **page no.:** 8.3.5.10-62
ACTIVITY NO. (If applicable): 1.5.3.5.1 (8.3.5.10.3.5.1)

ACTIVITY TITLE: Development of system model.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 2

Comments:
Does not address appropriateness of anticipated/unanticipated scenarios. Peer review = validation??? Justification for simpler models?

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 0

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 0

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 0

Comments:

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SCP SECTION: EBS Release Rates **page no.:** 8.3.5.10-64
ACTIVITY NO. (if applicable): 1.5.3.5.2 (8.3.5.10.3.5.2)

ACTIVITY TITLE: Development of uncertainty methodology.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 2

Comments:
Validation by peer review???

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 0

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 0

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 0

Comments:

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SCP SECTION: EBS Release Rates **page no.:** 8.3.5.10-66
ACTIVITY NO. (If applicable): 1.5.3.5.3 (8.3.5.10.3.5.3)

ACTIVITY TITLE: Water flow into and out of a breached container.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 3

Comments:
Capillary barrier unproven. What about fracture orientation, dominance of fracture over matrix flow, etc.?

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 3

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 3

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 0

Comments:

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SCP SECTION: EBS Release Rates **page no.:** 8.3.5.10-71
ACTIVITY NO. (If applicable): 1.5.4.1 (8.3.5.10.4.1)

ACTIVITY TITLE: Deterministic calculation of releases from the waste package.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 2

Comments:

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 0

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 0

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 0

Comments:

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: EBS Release Rates **page no.:** 8.3.5.10-71
ACTIVITY NO. (If applicable): 1.5.4.2 (8.3.5.10.4.2)

ACTIVITY TITLE: Probabilistic calculations of releases from the waste package.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 2
Comments:

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 0
Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 0
Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 0
Comments:

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: EBS Release Rates **page no.:** 8.3.5.10-76
ACTIVITY NO. (if applicable): 1.5.5.1.1 (8.3.5.10.5.1.1)

ACTIVITY TITLE: Radionuclide distribution in tuff water.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 2

Comments:
Must be able to relate these experiments to field conditions.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 2

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 0

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 0

Comments:

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: EBS Release Rates **page no.:** 8.3.5.10-76
ACTIVITY NO. (If applicable): 1.5.5.1.2 (8.3.5.10.5.1.2)

ACTIVITY TITLE: Sub-activity 1.5.5.1.2 Radionuclide distribution in tuff cores.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 3

Comments:

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 3

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 0

Comments:
No technical procedures.

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 0

Comments:

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: EBS Release Rates **page no.:** 8.3.5.10-77
ACTIVITY NO. (if applicable): 1.5.5.2.1 (8.3.5.10.5.2.1)

ACTIVITY TITLE: Validation of near-field transport model using laboratory and field experimental data.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 2

Comments:
Poor discussion of validation. Validation should be based primarily on field tests.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 0

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 0

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 0

Comments:

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: EBS Release Rates **page no.:** 8.3.5.10-77

ACTIVITY NO. (If applicable): 1.5.5.2.2 (8.3.5.10.5.2.2)

ACTIVITY TITLE: Application of near-field transport model to waste package releases.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 2

Comments:

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 0

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 0

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 0

Comments:

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Geochemistry Program (8.3.1.3)

SECTION	CONCEPTUAL	METHODOLOGY	TECHNOLOGY	FEASIBILITY	SCP OBJECTIVES
8.3.1.3.2.1.1	3	3	0	4	NO
8.3.1.3.2.1.2	2	1	1	1	NO
8.3.1.3.2.1.3	3	3	3	4	YES
8.3.1.3.2.2.1	4	3	3	4	YES
8.3.1.3.2.2.2	3	3	3	4	YES
8.3.1.3.3.1	2	1	1	4	NO
8.3.1.3.3.2.1	3	1	1	4	NO
8.3.1.3.3.2.2	3	3	3	0	NO
8.3.1.3.3.2.3	3	3	3	0	NO
8.3.1.3.4.1.1	2	2	1	1	NO
8.3.1.3.4.1.2	2	2	2	1	NO
8.3.1.3.4.1.3	2	2	2	2	NO
8.3.1.3.4.1.4	3	0	0	0	NO
8.3.1.3.4.1.5	1	3	3	0	NO
8.3.1.3.5.1.1	3	3	3	3	YES
8.3.1.3.5.1.2	4	3	3	0	NO
8.3.1.3.5.1.3	2	3	3	3	NO
8.3.1.3.5.2.1	2	3	3	0	NO
8.3.1.3.5.2.2	2	0	0	0	NO
8.3.1.3.6.1.1	1	3	3	0	NO
8.3.1.3.6.1.2	2	2	2	0	NO
8.3.1.3.6.1.2	1	0	0	0	NO
8.3.1.3.6.1.3	2	0	1	0	NO
8.3.1.3.6.1.3	1	1	1	1	NO
8.3.1.3.6.1.4	3	0	0	3	NO
8.3.1.3.6.1.4	1	0	0	0	NO
8.3.1.3.6.1.5	3	0	1	0	NO
8.3.1.3.6.2.1	3	3	0	0	NO
8.3.1.3.6.2.2	2	0	3	0	NO
8.3.1.3.6.2.3	2	3	3	0	NO
8.3.1.3.6.2.3	1	0	3	3	NO
8.3.1.3.7.1.1	1	1	1	0	NO
8.3.1.3.7.1.2	1	1	1	0	NO
8.3.1.3.7.1.3	2	0	0	0	NO
8.3.1.3.8.1.1	2	0	0	0	NO
8.3.1.3.8.1.2	2	0	0	0	NO
8.3.1.3.8.1.2	1	0	3	3	NO

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: 8.3.1.3.2.1 **page no.:** 8.3.1.3-32
ACTIVITY NO. (If applicable): 8.3.1.3.2.1.1
ACTIVITY TITLE: Petrologic stratigraphy of the Topopah Spring Member.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 3

Comments:
Density of samples taken will in part determine if the activity is focused.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 3

Comments:
Limited on the basis of core-hole density.
No SEM work.
Coring fluids may affect mineralogy.

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 0

Comments:
No data is offered on sampling locations.

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 4

Comments:

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: 8.3.1.3.2 **page no.:** 8.3.1.3-34
ACTIVITY NO. (if applicable): 8.3.1.3.2.1.2
ACTIVITY TITLE: Mineral distributions between the host rock and the accessible environment.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 2

Comments:
Flow path data needed to support this study will be difficult to obtain.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 1

Comments:
Use of XRD only for identification of minerals is questionable. Small camera work not stated. Fracture/matrix mineralogy difference are very important.

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 1

Comments:
Flow path data requires technology beyond that which is existing.

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 1

Comments:
Flow paths are most likely not determinable.

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: 8.3.1.3.2 **page no.:** 8.3.1.3-36
ACTIVITY NO. (If applicable): 8.3.1.3.2.1.3
ACTIVITY TITLE: Fracture mineralogy.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 3
Comments:

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 3
Comments:
TWS-ESS-DP-16, R2 may not adequately provide for identification of transition metal oxyhydroxide minerals.

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 3
Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 4
Comments:

REVIEWER: M. E. Morgenstein. **DATE:** 09 June 1988.

NOTE: TWS-ESS-DP-16, R2 conflicts with terminology given in 8.3.1.3.2.1.1 page 8.3.1.3-34.

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: 8.3.1.3.2.2 **page no.:** 8.3.1.3-38
ACTIVITY NO. (if applicable): 8.3.1.3.2.2.1
ACTIVITY TITLE: History of mineralogic and geochemical alteration of Yucca Mountain.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 4

Comments:

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 3

Comments:
Should have vadose water chemistry, especially sodium data to constrain temperature of zeolite phases.

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 3

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 4

Comments:

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: 8.3.1.3.2.2 **page no.:** 8.3.1.3-40
ACTIVITY NO. (If applicable): 8.3.1.3.2.2.2
ACTIVITY TITLE: Smectite, zeolite, manganese minerals, glass dehydration, and transformation.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 3

Comments:

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 3

Comments:
Should have EM chemistry of the minerals as this will effect hydration-dehydration properties.

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 3

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 4

Comments:

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: 8.3.1.3.3 **page no.:** 8.3.1.3-47
ACTIVITY NO. (if applicable): Study - 8.3.1.3.3.1

ACTIVITY TITLE: Study - Natural analog of hydrothermal systems in tuff.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 2

Comments:
Input is insufficient to provide meaningful and usable results.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 1

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 1

Comments:
Vadose water chemistry is required and, presently, poorly characterized. Future characterization at the level required is questionable.

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 4

Comments:

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: Geochemistry **page no.:** 8.3.1.3-51
ACTIVITY NO. (If applicable): 8.3.1.3.3.2.1
ACTIVITY TITLE: Kinetic studies of zeolite and related framework silicates.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 3

Comments:
Title out of sync with text. Authors are discussing silica dissolution/precipitation kinetics in text.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 1

Comments:
No alternatives given if literature survey fails to provide needed information, as it will regarding zeolites.

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 1

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 4

Comments:
Feasible to do what is proposed, but it could have and should have been done in the time it took to write SCP.

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: Geochemistry **page no.:** 8.3.1.3-52
ACTIVITY NO. (If applicable): 8.3.1.3.3.2.2
ACTIVITY TITLE: Determination of end-member free energies for clinoptilolite-heulandite, albite, and analcime.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 3

Comments:

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 3

Comments:
To avoid solubility measurements at many temperatures, calorimeter (or DSC) measurements could have been performed to obtain ΔS°_f, ΔH°_f, which are needed for temperature extrapolations/interpolations.

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 3

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 0

Comments:

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: Geochemistry **page no.:** 8.3.1.3-54
ACTIVITY NO. (If applicable): 8.3.1.3.3.2.3
ACTIVITY TITLE: Solid solution descriptions of clinoptilolite/heulandite and analcime.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 3

Comments:
Might need to gather crystallographic information first.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 3

Comments:
OK if the theoretical entropy calculations work out, but these should be tested by some actual measurements by calorimetry.

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 3

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 0

Comments:

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: Geochemistry **page no.:** 8.3.1.3-63
ACTIVITY NO. (if applicable): 8.3.1.3.4.1.1
ACTIVITY TITLE: Batch sorption measurements as a function of solid phase composition.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 2

Comments:
Only uses J13 water. Applicability to reality (field) seriously questionable! Needs vadose water chemistry.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 2

Comments:
If speciation can't be worked out, results uninterpretable.

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 1

Comments:
Results would have "unknown" relationship to the field.

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 1

Comments:
Total sum of batch sorption data to date is difficult to use/interpret.

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SCP SECTION: Geochemistry **page no.:** 8.3.1.3-67
ACTIVITY NO. (If applicable): 8.3.1.3.4.1.2
ACTIVITY TITLE: Sorption as a function of sorbing element concentrations (isotherms).

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 2

Comments:
Needs vadose water chemistry, should not be using crushed tuff. Applicability to field unknown

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 2

Comments:
Use of crushed tuff is inappropriate at this time. Applicability to reality should be demonstrated before conducting experiments.

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 2

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 1

Comments:

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SCP SECTION: Geochemistry **page no.:** 8.3.1.3-68
ACTIVITY NO. (if applicable): 8.3.1.3.4.1.3
ACTIVITY TITLE: Sorption as a function of ground-water composition.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 2

Comments:
Vadose water chemistry needed. As most travel time credit is in vadose zone, more emphasis should be placed on vadose zone. Vadose zone is ignored. Assumes vadose zone waters have higher TDS than J13--this is unproven!

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 2

Comments:
Batch experiments (crushed tuff) not proven applicable to field.

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 2

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 2

Comments:
One should not perform experiments (waste ratepayers' money) before applicability is proven!

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: Geochemistry **page no.:** 8.3.1.3-70
ACTIVITY NO. (If applicable): 8.3.1.3.4.1.4
ACTIVITY TITLE: Sorption on particulates and colloids.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 3

Comments:

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 0

Comments:
Nothing on how particulates/colloids at Yucca Mountain will be collected, sampling locations, etc.

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 0

Comments:
Batch methods unproven.

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 0

Comments:

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: Geochemistry **page no.:** 8.3.1.3-71
ACTIVITY NO. (if applicable): 8.3.1.3.4.1.5
ACTIVITY TITLE: Statistical analysis of sorption data.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 1

Comments:
If the applicability of the sorption measurements to the field is unknown, statistical analyses are meaningless.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 3

Comments:
If the utility of the sorption data is unknown, what difference does methodology make?

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 3

Comments:
As above.

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 0

Comments:

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: Geochemistry **page no.:** 8.3.1.3-83
ACTIVITY NO. (If applicable): 8.3.1.3.5.1.1
ACTIVITY TITLE: Solubility measurements [of waste elements].

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 3

Comments:
This activity should precede all sorption experiments. Need vadose water chemistry.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 3

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 3

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 3

Comments:

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: Geochemistry **page no.:** 8.3.1.3-85
ACTIVITY NO. (if applicable): 8.3.1.3.5.1.2
ACTIVITY TITLE: Speciation measurements.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 4

Comments:

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 3

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 3

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 0

Comments:

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: Geochemistry **page no.:** 8.3.1.3-86
ACTIVITY NO. (If applicable): 8.3.1.3.5.1.3
ACTIVITY TITLE: Solubility modeling [of waste elements].

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 2

Comments:
Data needed. Section does not specify where information concerning range of conditions is derived.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 3

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 3

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 3

Comments:

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SCP SECTION: Geochemistry **page no.:** 8.3.1.3-87
ACTIVITY NO. (If applicable): 8.3.1.3.5.2.1
ACTIVITY TITLE: Colloid formation characterization and stability.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 2

Comments:
No attempt to determine what, if any, natural colloids exist at or near Yucca Mountain.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 3

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 3

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 0

Comments:

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: Geochemistry **page no.:** 8.3.1.3-88
ACTIVITY NO. (If applicable): 8.3.1.3.5.2.2
ACTIVITY TITLE: Colloid modeling.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 2

Comments:
Natural colloid concentrations should be known before modeling.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 0

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 0

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 0

Comments:

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: Geochemistry **page no.:** 8.3.1.3-98
ACTIVITY NO. (If applicable): 8.3.1.3.6.1.1
ACTIVITY TITLE: Crushed tuff column experiments.

<u>Conceptual Completeness and Focus</u>

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

<u>SCORE:</u> 1

Comments:
Fail to see relevance of crushed tuff to field situations. Crushing alters mineral surfaces and changes surface area. Sample selection implies knowledge of flow paths--where is this information? Need to know vadose water chemistry!

<u>Appropriateness of Methodology to Establish Stated Objective:</u>

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

<u>SCORE:</u> 3

Comments:

<u>Probability of Success Using Existing Technology:</u>

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

<u>SCORE:</u> 3

Comments:
Sample selection vague, not specific. Sample characterization?

<u>Feasibility in Terms of Time, Funding, and Human Resources:</u>

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

<u>SCORE:</u> 0

Comments:

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: Geochemistry **page no.:** 8.3.1.3-102
ACTIVITY NO. (If applicable): 8.3.1.3.6.1.2
ACTIVITY TITLE: Mass transfer kinetics.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 2

Comments:
Fail to see relevance of crushed rock columns to field situations. No experiments with fractures or under vadose zone conditions.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 2

Comments:
Methodology is unproven.

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 2

Comments:
Depends on technology to be developed.

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 0

Comments:

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SCP SECTION: Geochemistry **page no.:** 8.3.1.3-99
ACTIVITY NO. (if applicable): 8.3.1.3.6.1.2
ACTIVITY TITLE: Mass transfer kinetics.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 1

Comments:
What range of water velocity?
What is the water velocity function in the unsaturated zone?

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 0

Comments:
What is the new technique?

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 0

Comments:
What, where is the new technique?

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 0

Comments:

REVIEWER: Atef Elzeftawy. **DATE:** 11 June 1988.

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SCP SECTION: Geochemistry **page no.:** 8.3.1.3-104
ACTIVITY NO. (If applicable): 8.3.1.3.6.1.3
ACTIVITY TITLE: Unsaturated tuff column.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 2

Comments:
Columns are crushed rock or solid rock?

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 0

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 1

Comments:
Technology to be developed.

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 0

Comments:

REVIEWER: D. Shettel. **DATE:** 09 June 1988.

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SCP SECTION: Geochemistry **page no.:** 8.3.1.3-101
ACTIVITY NO. (if applicable): 8.3.1.3.6.1.3
ACTIVITY TITLE: Unsaturated tuff columns.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 1

Comments:
Modifying the effective porosity would not do it? What does the effective porosity mean, physically?

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 1

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 1

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 1

Comments:

REVIEWER: A. Elzeftawy. **DATE:** 11 June 1988.

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: Geochemistry **page no.:** 8.3.1.3-106
ACTIVITY NO. (If applicable): 8.3.1.3.6.1.4
ACTIVITY TITLE: Fractured tuff column studies.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 3

Comments:
Yes, but what about vadose zone fractured tuff column studies?

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 0

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 0

Comments:
Technology to be developed.

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 3

Comments:

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SCP SECTION: Geochemistry **page no.:** 8.3.1.3-103
ACTIVITY NO. (If applicable): 8.3.1.3.6.1.4
ACTIVITY TITLE: Fractured tuff column studies.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 1

Comments:
Curve fitting will mean NOTHING to the repository scale problems?

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 0

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 0

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 0

Comments:

REVIEWER: A. Elzeftawy. **DATE:** 11 June 1988.

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: Geochemistry **page no.:** 8.3.1.3-107
ACTIVITY NO. (If applicable): 8.3.1.3.6.1.5
ACTIVITY TITLE: Filtration [of particulates and colloids].

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 3

Comments:
Reuse of samples from other experiments is questionable. High pressures for experiments--what are effects, utility thereof!

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 0

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 1

Comments:
Technology to be developed.

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 0

Comments:

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SCP SECTION: Geochemistry **page no.:** 8.3.1.3-109
ACTIVITY NO. (if applicable): 8.3.1.3.6.2.1
ACTIVITY TITLE: Uptake of radionuclides on rock beakers in a saturated system.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 3

Comments:

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 3

Comments:
No information on sample locations other than Topopah Spring Member.

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 0

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 0

Comments:

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SCP SECTION: Geochemistry **page no.:** 8.3.1.3-110
ACTIVITY NO. (If applicable): 8.3.1.3.6.2.2
ACTIVITY TITLE: Diffusion through a saturated tuff slab.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 2

Comments:
Sample locations lacking. List of cations and radionuclides to be analyzed lacking.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 0

Comments:
No information on measurement of porosity, pore tortuosity, and pore constrictivity.

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 3

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 0

Comments:

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SCP SECTION: Geochemistry **page no.:** 8.3.1.3-111
ACTIVITY NO. (If applicable): 8.3.1.3.6.2.3
ACTIVITY TITLE: Diffusion in an unsaturated tuff block.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 2

Comments:
Description of samples to be used is too vague. No information on which elements/cations are to be used.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 3

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 3

Comments:
Additional computer codes to be developed!

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 0

Comments:

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SCP SECTION: Geochemistry **page no.:** 8.3.1.3-108
ACTIVITY NO. (If applicable): 8.3.1.3.6.2.3
ACTIVITY TITLE: Diffusion in an unsaturated tuff block.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 1

Comments:
Injection of fluid will not establish the needed unsaturated conditions.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 0

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 3

Comments:
It could be done.

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 3

Comments:

REVIEWER: A. Elzeftawy. **DATE:** 13 June 1988.

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: Geochemistry **page no.:** 8.3.1.3-118
ACTIVITY NO. (if applicable): 8.3.1.3.7.1.1
ACTIVITY TITLE: Analysis of physical/chemical processes affecting transport.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 1

Comments:
Validation process is wrong. Field experiments define applicability of laboratory-measured values, not transport calculations. They are going to "verify" applicability of laboratory experiments of saturated zone to vadose zone by modeling.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 1

Comments:
Computer codes need to be validated by field-laboratory work, not vice versa. TOUGH omitted!

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 1

Comments:
Computer codes not validated.

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 0

Comments:

REVIEWER: D. Shettel. **DATE:** 10 June 1988.

MY880719o

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: Geochemistry **page no.:** 8.3.1.3-122
ACTIVITY NO. (If applicable): 8.3.1.3.7.1.2
ACTIVITY TITLE: Geochemical/geophysical model of Yucca Mountain and integrated geochemical transport calculations.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 1

Comments:
How does one use a conceptual model to perform calculations [transport]?

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 1

Comments:
Calculations based on conceptual model will "validate" assumptions made by performance assessment?

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 1

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 0

Comments:

REVIEWER: D. Shettel. **DATE:** 10 June 1988.

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: Geochemistry **page no.:** 8.3.1.3-124
ACTIVITY NO. (if applicable): 8.3.1.3.7.1.3
ACTIVITY TITLE: Transport models and related support.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 2

Comments:
Computer models are used to "predict" not investigate...processes.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 0

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 0

Comments:
None of DOE's computer codes are validated yet.

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 0

Comments:

REVIEWER: D. Shettel. **DATE:** 10 June 1988.

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: Geochemistry **page no.:** 8.3.1.3-134
ACTIVITY NO. (If applicable): 8.3.1.3.8.1.1
ACTIVITY TITLE: Physical transport mechanisms and rates-retardation mechanisms and transport with retardation.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 2

Comments:
What if models do not exist?

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 0

Comments:
DOE does not even know if the models exist. Models should be known by now from literature survey.

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 0

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 0

Comments:

REVIEWER: D. Shettel. **DATE:** 10 June 1988.

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: Geochemistry **page no.:** 8.3.1.3-135

ACTIVITY NO. (if applicable): 8.3.1.3.8.1.2

ACTIVITY TITLE: Gas transport measurements.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 2

Comments:
Writers should learn difference between verify and validate.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 0

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 0

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 0

Comments:

REVIEWER: D. Shettel. **DATE:** 10 June 1988.

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: Geochemistry **page no.:** 8.3.1.3-130
ACTIVITY NO. (If applicable): 8.3.1.3.8.1.2
ACTIVITY TITLE: Gas transport measurements.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 1

Comments:
Poor focus, and do they know what they are talking about?

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 0

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 3

Comments:
It could be done.

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 3

Comments:

REVIEWER: A. Elzeftawy. **DATE:** 13 June 1988.

MY880715hh

Geohydrology Program (8.3.1.2)

SECTION	CONCEPTUAL	METHODOLOGY	TECHNOLOGY	FEASIBILITY	SCP OBJECTIVES
8.3.1.2.1.1.1	1	3	3	3	NO
8.3.1.2.1.2.1	3	3	3	3	YES
8.3.1.2.1.3.1	1	1	1	4	NO
8.3.1.2.1.3.2	3	3	3	3	YES
8.3.1.2.1.3.3	4	4	4	4	YES
8.3.1.2.1.3.3	2	3	3	3	NO*
8.3.1.2.1.3.4	2	3	3	3	NO*
8.3.1.2.1.3.4	4	4	4	4	YES
8.3.1.2.1.3.5	2	3	4	4	NO
8.3.1.2.1.4.1	1	0	0	0	NO
8.3.1.2.1.4.2	2	2	2	2	NO
8.3.1.2.1.4.3	1	1	2	2	NO
8.3.1.2.1.4.4	1	2	2	4	NO
8.3.1.2.2.1	2	1	1	1	NO
8.3.1.2.2.1.2	1	1	0	1	NO
8.3.1.2.2.1.3	2	1	2	3	NO
8.3.1.2.2.2.1	1	0	0	0	NO
8.3.1.2.2.2.1	2	3	3	3	NO
8.3.1.2.2.3.1	2	2	1	1	NO
8.3.1.2.2.3.2	2	2	2	2	NO
8.3.1.2.2.3.3	2	2	1	1	NO
8.3.1.2.2.4.1	1	2	3	2	NO
8.3.1.2.2.4.2	3	3	3	3	YES
8.3.1.2.2.4.3	1	3	3	3	NO
8.3.1.2.2.4.4	1	0	3	3	NO
8.3.1.2.2.4.5	2	3	3	3	NO
8.3.1.2.2.4.6	2	2	3	2	NO
8.3.1.2.2.4.7	3	3	3	3	YES
8.3.1.2.2.4.8	1	1	1	1	NO
8.3.1.2.2.4.8	3	2	2	0	NO
8.3.1.2.2.5.1	2	3	3	3	NO
8.3.1.2.2.6.1	1	0	0	0	NO
8.3.1.2.2.7.1	2	0	0	0	NO
8.3.1.2.2.8.1	2	2	2	0	NO
8.3.1.2.2.8.1	2	0	3	0	NO
8.3.1.2.2.8.2	2	2	2	0	NO
8.3.1.2.2.8.2	2	0	0	0	NO
8.3.1.2.2.9.1	2	0	0	0	NO
8.3.1.2.2.9.2	1	0	0	2	NO
8.3.1.2.2.9.3	1	1	1	1	NO
8.3.1.2.2.10.1	2	0	0	0	NO
8.3.1.2.2.10.2	1	0	0	0	NO
8.3.1.2.2.10.3	0	0	0	0	NO
8.3.1.2.2.10.3	0	0	0	0	NO
8.3.1.2.3.1.1	3	2	2	4	NO
8.3.1.2.3.1.2	2	2	2	4	NO
8.3.1.2.3.1.3	2	2	2	2	NO
8.3.1.2.3.1.4	2	4	2	3	NO
8.3.1.2.3.1.5	2	2	2	3	NO

8.3.1.2.3.1.6	1	2	1	3	NO
8.3.1.2.3.1.7	2	2	2	3	NO
8.3.1.2.3.1.8	1	2	1	3	NO
8.3.1.2.3.2.1	2	3	3	4	NO
8.3.1.2.3.2.2	2	1	4	4	NO
8.3.1.2.3.3.1	0	0	0	0	NO
8.3.1.2.3.3.2	2	3	3	2	NO
8.3.1.2.3.3.3	1	1	1	1	NO

* Review favored by MAI based on relative experience/expertise of the two reviewers in the activity topic.

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: Geohydrology (Regional) **page no.:** 8.3.1.2-67
ACTIVITY NO. (if applicable): 8.3.1.2.1.1.1
ACTIVITY TITLE: Precipitation and meteorological monitoring.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 1

Comments:
Rain gauges are needed on the top of Yucca Mountain and in closer proximity to the repository surface boundary.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 3

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 3

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 3

Comments:

REVIEWER: Atef Elzeftawy. **DATE:** 10 June 1988.

MY880718ee

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: Geohydrology **page no.:** 8.3.1.2-72
ACTIVITY NO. (If applicable): 8.3.1.2.1.2.1
ACTIVITY TITLE: Surface-water runoff monitoring.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 3

Comments:
Rain gauges are needed on the top of Yucca Mountain and in closer proximity to the repository surface boundary..

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 3

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 3

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 3

Comments:

REVIEWER: Atef Elzeftawy. **DATE:** 10 June 1988.

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: 8.3.1.2.1.3.1 **page no.:** 8.3.1.2-82
ACTIVITY NO. (If applicable):
ACTIVITY TITLE: Assessment of regional hydrogeologic data needs in the saturated zone.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 1

Comments:
2-D modeling is not the way to assess data needs.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 1

Comments:
A drilling program based on clear hydrogeologic objectives, not 2-D modeling, is needed.

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 1

Comments:
Model results from this study will be unreliable.

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 4

Comments:

REVIEWER: C. Johnson. **DATE:** 14 June 1988.

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: 8.3.1.2.1.3.2 **page no.:** 8.3.1.2-83
ACTIVITY NO. (if applicable):
ACTIVITY TITLE: Regional potentiometric level studies.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 3

Comments:
Incomplete with respect to carbonate aquifer.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 3

Comments:
Scope too limited with respect to number of boreholes.

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 3

Comments:
Jackass Flats area neglected.

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 3

Comments:

REVIEWER: C. Johnson. **DATE:** 14 June 1988.

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: 8.3.1.2.1.3.3 **page no.:** 8.3.1.2-88
ACTIVITY NO. (if applicable):
ACTIVITY TITLE: Fortymile Wash recharge study.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 4

Comments:

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 4

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 4

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 4

Comments:

REVIEWER: C. Johnson. **DATE:** 14 June 1988.

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: Geohydrology **page no.:** 8.3.1.2-88
ACTIVITY NO. (If applicable): 8.3.1.2.1.3.3
ACTIVITY TITLE: Fortymile Wash recharge study.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 2

Comments:
More holes are needed along the Wash. Three are not enough.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 3

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 3

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 3

Comments:

REVIEWER: Atef Elzeftawy. **DATE:** 10 June 1988.

MY880718cc

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: Geohydrology **page no.:** 8.3.1.2-92
ACTIVITY NO. (if applicable): 8.3.1.2.1.3.4
ACTIVITY TITLE: Evapotranspiration studies.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 2

Comments:
Need to monitor the unsaturated zone of each location (in-situ).

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 3

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 3

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 3

Comments:

REVIEWER: Atef Elzeftawy. **DATE:** 10 June 1988.

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: 8.3.1.2.1.3.4 **page no.:** 8.3.1.2-92
ACTIVITY NO. (If applicable):
ACTIVITY TITLE: Evapotranspiration studies.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 4

Comments:

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 4

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 4

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 4

Comments:

REVIEWER: C Johnson. **DATE:** 14 June 1988.

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: 8.3.1.2.1.3.5 **page no.:** 8.3.1.2-95

ACTIVITY NO. (If applicable):

ACTIVITY TITLE: Regional hydrochemical tests and analyses.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 2

Comments:
Hasn't this all been done? What's new?

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 3

Comments:
White, Claassen, and Benson have published good hydrochemical models.

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 4

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 4

Comments:

REVIEWER: C Johnson. **DATE:** 14 June 1988.

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: 8.3.1.2.1.4.1 **page no.:** 8.3.1.2-97
ACTIVITY NO. (If applicable):
ACTIVITY TITLE: Conceptualization of regional hydrologic flow models.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 1

Comments:
Hogwash. This should be incorporated in the "integrated" drilling program.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 0

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 0

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 0

Comments:

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: 8.3.1.2.1.4.2 **page no.:** 8.3.1.2-99
ACTIVITY NO. (If applicable):
ACTIVITY TITLE: Subregional two-dimensional areal hydrologic modeling.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 2

Comments:
2-D inappropriate, no consideration of anisotropy or fractures.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 2

Comments:
Desired parameters will be non-representative since equivalent porous medium is assumed.

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 2

Comments:
2-D, equivalent porous medium inappropriate.

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 2

Comments:
Validation not feasible.

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: 8.3.1.2.1.4.3 **page no.:** 8.3.1.2-101
ACTIVITY NO. (If applicable):
ACTIVITY TITLE: Subregional two-dimensional cross-section hydrologic modeling.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 1

Comments:
No hope of realism in these simulations.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 1

Comments:
Setting up this model will be just guess-work.

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 2

Comments:
Could succeed if accompanied by comprehensive deep drilling program.

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 2

Comments:
Much additional drilling would be required to characterize geometry, heterogeneity, anisotropy.

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: 8.3.1.2.1.4.4 **page no.:** 8.3.1.2-103
ACTIVITY NO. (If applicable):
ACTIVITY TITLE: Regional three-dimensional hydrologic modeling.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 1

Comments:
For example, how will remote sensing studies provide information on ground-water flow paths?

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 2

Comments:
Very unlikely that our understanding of regional ground-water flow will be improved by this model.

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 2

Comments:
Success should be measurable, but it is not.

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 4

Comments:
The objectives are feasible given competent geologic input and a substantial investment in drilling and testing.

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: Geohydrology **page no.:** 8.3.1.2-119
ACTIVITY NO. (If applicable): 8.3.1.2.2.1
ACTIVITY TITLE: Characterization of hydrologic properties of surficial materials.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 2

Comments:
The location of each experiment is critical in evaluating the usefulness of the results.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 1

Comments:
Listed methods are not the correct ones to use.

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 1
Comments:
The technology of the listed methods is not appropriate.

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 1
Comments:
Feasible if the correct methodologies are used.

REVIEWER: A. Elzeftawy. **DATE:** 09 June 1988.

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: Geohydrology   page no.: 8.3.1.2-125
ACTIVITY NO. (if applicable): 8.3.1.2.2.1.2
ACTIVITY TITLE: Evaluation of natural infiltration.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 1

Comments:
The locations of boreholes are not addressing the Yucca Mountain repository.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 1

Comments:
Water budget studies and methodologies are not appropriate for low flux.

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 0

Comments:
The tech. procedures are not explained or referenced.

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 1

Comments:
Feasible within the correct locations on the mountain.

REVIEWER: Atef Elzeftawy.   **DATE:** 09 June 1988.

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: Geohydrology **page no.:** 8.3.1.2-132
ACTIVITY NO. (If applicable): 8.3.1.2.2.1.3.
ACTIVITY TITLE: Evaluation of artificial infiltration.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 2

Comments:
The focus should be on fractured tuff areas and not alluvium.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 1

Comments:
Listed methods are suitable for porous media and not for fractured rock, such as tuffs.

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 2

Comments:
Modified technology may be useful and successful.

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 3

Comments:
Feasible if done using modified technology and methods.

REVIEWER: A. Elzeftawy. **DATE:** 09 June 1988.

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: Geohydrology **page no.:** 8.3.1.2-137
ACTIVITY NO. (if applicable): 8.3.1.2.2.2.1
ACTIVITY TITLE: Chloride and chlorine-36 measurements of percolation at Yucca Mountain.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 1

Comments:
Fragmented information; where, how, what, when are not addressed.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 0

Comments:
No methods listed or discussed.

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 0

Comments:
The discusseion is not clear and does not address the technology.

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 0

Comments:

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: Geohydrology **page no.:** 8.3.1.2-137
ACTIVITY NO. (If applicable): 8.3.1.2.2.2.1
ACTIVITY TITLE: Chloride and chlorine-36 measurements of percolation at Yucca Mountain.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 2

Comments:
What activities/studies/investigations are concerned with gathering the data needed?

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 3

Comments:
There are no references to methodology.

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 3

Comments:
If data have already been collected, what are the technical procedures? Sample localities not mentioned, nor techniques for obtaining samples.

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 3

Comments:
If data have been gathered, what is reference?

REVIEWER: D. Shettel. **DATE:** 10 June 1988.

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: Geohydrology **page no.:** 8.3.1.2-140
ACTIVITY NO. (If applicable): 8.3.1.2.2.3.1
ACTIVITY TITLE: Matrix hydrologic properties testing.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 2

Comments:
Stochastic models are not appropriate to define hydrogeologic units.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 2

Comments:
Methodologies are not appropriate for unsaturated fractured tuff formations.

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 1

Comments:
The technology may be useful if used properly.

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 1

Comments:
Does not address the unsaturated zone work.

REVIEWER: A. Elzeftawy. **DATE:** 09 June 1988.

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: Geohydrology **page no.:** 8.3.1.2-149
ACTIVITY NO. (If applicable): 8.3.1.2.2.3.2
ACTIVITY TITLE: Site vertical borehole studies.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 2

Comments:
Rationale for locations and depths of of boreholes is not clear or stated.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 2

Comments:
Methods of drilling may not be useful in getting needed data.

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 2

Comments:
The proposed technique for drilling is highly questionable for the required depths (600 m).

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 2

Comments:
The cost and time, based on UZ-1 and UZ-6 boreholes, could be very high to finish SCP for the site (5 to 6 years).

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: Geohydrology **page no.:** 8.3.1.2-168
ACTIVITY NO. (If applicable): 8.3.1.2.2.3.3
ACTIVITY TITLE: Solitario Canyon horizontal borehole study.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 2

Comments:
If successful, one hole only is not enough? Water may be injected?

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 2

Comments:
The method has not been demonstrated through fractured tuff formation.

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 1

Comments:
The drilling technology may be proble-matical for horizontal drilling to 300 meters.

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 1

Comments:
Based on the discussion, it is doubtful that any evaluation of parameters could be attained.

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: Geohydrology **page no.:** 8.3.1.2-182
ACTIVITY NO. (If applicable): 8.3.1.2.2.4.1
ACTIVITY TITLE: Intact-fracture test in the exploratory shaft facility.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 1

Comments:
The laboratory work does not address the in-situ shaft work (data applied).

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 2

Comments:
The methodology does not apply to in-situ conditions.

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 3

Comments:
The proposed technology is appropriate only for laboratory work.

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 2

Comments:

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: Geohydrology **page no.:** 8.3.1.2-193
ACTIVITY NO. (If applicable): 8.3.1.2.2.4.2
ACTIVITY TITLE: Infiltration tests in the exploratory shaft facility.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 3

Comments:
The sand layer on top of tuff may be problematical. Assumption of steady state may not be valid.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 3

Comments:
Some concern with regard to fracture.

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 3

Comments:
With great caution for flow through fractures.

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 3

Comments:
It should be observed for a continuous period of 4 to 5 weeks, at least.

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SCP SECTION: Geohydrology **page no.:** 8.3.1.2-209
ACTIVITY NO. (If applicable): 8.3.1.2.2.4.3
ACTIVITY TITLE: Bulk-permeability test in the exploratory shaft facility.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 1

Comments:
The description to address the evaulation of the listed parameters is not clear or related to the objectives.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 3

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 3

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 3

Comments:

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SCP SECTION: Geohydrology **page no.:** 8.3.1.2-225
ACTIVITY NO. (If applicable): 8.3.1.2.2.4.4
ACTIVITY TITLE: Radial borehole tests in the exploratory shaft facility.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 1

Comments:
Why, when, where, and how are not clearly stated.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 0

Comments:
All methods are to be delivered?

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 3

Comments:
The technology exists for evaluating the listed objectives.

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 3

Comments:
It could be done in time.

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SCP SECTION: Geohydrology **page no.:** 8.3.1.2-235
ACTIVITY NO. (If applicable): 8.3.1.2.2.4.5
ACTIVITY TITLE: Excavation effects test in the exploratory shaft facility.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 2

Comments:
It is not clearly explained with respect to how stress is related to the unsaturated zone hydrology.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 3

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 3

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 3

Comments:

REVIEWER: A. Elzeftawy. **DATE:** 09 June 1988.

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SCP SECTION: Geohydrology **page no.:** 8.3.1.2-241
ACTIVITY NO. (if applicable): 8.3.1.2.2.4.6
ACTIVITY TITLE: Calico Hills test in the exploratory shaft facility.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 2

Comments:
No discussion relative to unsaturated work.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 2

Comments:
Methodologies do not address the unsaturated zone characterization problem.

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 3

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 2

Comments:

REVIEWER: Atef Elzeftawy. **DATE:** 09 June 1988.

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: Geohydrology **page no.:** 8.3.1.2-246
ACTIVITY NO. (If applicable): 8.3.1.2.2.4.7
ACTIVITY TITLE: Perched water test in the exploratory shaft facility.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 3

Comments:
Some concern with regard to large volumes of water, if found.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 3

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 3

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 3

Comments:

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SCP SECTION: Geohydrology **page no.:** 8.3.1.2-248
ACTIVITY NO. (if applicable): 8.3.1.2.2.4.8
ACTIVITY TITLE: Hydrochemistry tests in the exploratory shaft facility.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 1

Comments:
Very fragmented and incomplete.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 1

Comments:
Does not state how water would be obtained from unsaturated zone.

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 1

Comments:
Technology proposed is not appropriate to obtain water of unsaturated zone.

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 1

Comments:

REVIEWER: Atef Elzeftawy. **DATE:** 09 June 1988.

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SCP SECTION: Geohydrology **page no.:** 8.3.1.2-248
ACTIVITY NO. (If applicable): 8.3.1.2.2.4.8
ACTIVITY TITLE: Hydrochemistry tests in the exploratory shaft facility.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 3

Comments:
There is no provision for perched water or saturated fractures, if they are encountered.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 2

Comments:
It is difficult to determine flux and flow directions with isotopic techniques unless there is a good 3D spatial distribution of samples. ESF is 1D.

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 2

Comments:
Data can probably be obtained with existing analytical technology, but interpretation of the data to satisfy all objectives is unlikely.

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 0

Comments:

REVIEWER: D. Shettel. **DATE:** 08 June 1988.

MY880722b

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: Geohydrology **page no.:** 8.3.1.2-252
ACTIVITY NO. (if applicable): 8.3.1.2.2.5.1
ACTIVITY TITLE: Diffusion tests in the exploratory shaft facility.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 2

Comments:
Poorly written and not clear how they are going to address flow through matrix/ fractures.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 3

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 3

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 3

Comments:

REVIEWER: A. Elzeftawy. **DATE:** 09 June 1988.

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: Geohydrology **page no.:** 8.3.1.2-255
ACTIVITY NO. (If applicable): 8.3.1.2.2.6.1
ACTIVITY TITLE: Plan to characterize the flux within the Paintbrush nonwelded unit in the vicinity of the Ghost Dance Fault.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 1

Comments:
Plan has not yet been developed.
When (year 2001?).

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 0

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 0
Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 0
Comments:

REVIEWER: A. Elzeftawy. **DATE:** 09 June 1988.

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SCP SECTION: Geohydrology **page no.:** 8.3.1.2-258
ACTIVITY NO. (if applicable): 8.3.1.2.2.7.1
ACTIVITY TITLE: Gaseous phase circulation study.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 2

Comments:
Too many words but no clear understanding of what is needed and why?

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 0

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 0

Comments:

-

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 0

Comments:

REVIEWER: A. Elzeftawy. **DATE:** 09 June 1988.

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: Geohydrology **page no.:** 8.3.1.2-267
ACTIVITY NO. (if applicable): 8.3.1.2.2.8.1
ACTIVITY TITLE: Gaseous-phase chemical investigations.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 2

Comments:
Flux should be measured directly. Could have multiple packed-off horizons in boreholes with flow meters.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 2

Comments:
Flux and flow direction are difficult to determine isotopically, unless there is extensive 3D sampling available. ESF is essentially 1D.

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 2

Comments:
Data can be obtained, but interpretation to achieve objectives is unlikely.

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 0

Comments:

REVIEWER: D. Shettel. **DATE:** 08 June 1988.

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SCP SECTION: Geohydrology **page no.:** 8.3.1.2-267
ACTIVITY NO. (if applicable): 8.3.1.2.2.8.1
ACTIVITY TITLE: Gaseous-phase chemical investigations.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 2

Comments:
Not very clear objectives.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 0

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 3

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 0

Comments:

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SCP SECTION: Geohydrology **page no.:** 8.3.1.2-269
ACTIVITY NO. (If applicable): 8.3.1.2.2.8.2
ACTIVITY TITLE: Aqueous-phase chemical investigations.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 2

Comments:
No provision for handling perched water zones or saturated fractures. Determining flux and flow direction from stable isotopes is pushing it.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 2

Comments:
Flux should be measured directly. Flow direction could be measured by geophysical methods.

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 2

Comments:
Data can probably be obtained, but interpretation to achieve objectives is unlikely. Are Al and Si going to be measured? These are essential for modeling rock-water interactions.

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 0

Comments:

REVIEWER: D. Shettel. **DATE:** 09 June 1988.

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SCP SECTION: Geohydrology **page no.:** 8.3.1.2-269
ACTIVITY NO. (if applicable): 8.3.1.2.2.8.2
ACTIVITY TITLE: Aqueous-phase chemical investigations.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 2

Comments:
It is not clear if they know the sources of liquid (fractures/matrix) and how they could be separated or identified.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 0

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 0

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 0

Comments:

REVIEWER: A. Elzeftawy. **DATE:** 09 June 1988.

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: Geohydrology **page no.:** 8.3.1.2-273
ACTIVITY NO. (If applicable): 8.3.1.2.2.9.1
ACTIVITY TITLE: Preliminary numerical modeling of the site hydrogeologic system.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 2

Comments:
Specific plans have not yet been developed or coordinated.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 0

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 0

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 0

Comments:

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SCP SECTION: Geohydrology **page no.:** 8.3.1.2-275
ACTIVITY NO. (if applicable): 8.3.1.2.2.9.2
ACTIVITY TITLE: Simulation of the natural hydrogeologic system.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 1

Comments:
The physics of the system is not well understood (not the normal porous media we know in soil physics).

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 0

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 0

Comments:
Use large computers like Crye or others?

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 2

Comments:

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SCP SECTION: Geohydrology **page no.:** 8.3.1.2-278
ACTIVITY NO. (If applicable): 8.3.1.2.2.9.3
ACTIVITY TITLE: Stochastic modeling and uncertainty analysis.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 1

Comments:
The needed data and site information are not available and may not be attainable to forumate this modeling work.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 1

Comments:
You can simulate data from a hat?

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 1

Comments:
Maybe use Cray computers in vain.

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 1

Comments:
Site characterization should be done within 5 to 6 years?

REVIEWER: A. Elzeftawy. **DATE:** 09 June 1988.

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SCP SECTION: Geohydrology **page no.:** 8.3.1.2-279
ACTIVITY NO. (if applicable): 8.3.1.2.2.10.1
ACTIVITY TITLE: Conceptualization of the unsaturated-zone hydrologic flow system.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 2

Comments:
How will the fractured unsaturated flow and transport problem be solved with respect to the understanding of its physics?

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 0

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 0

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 0

Comments:

REVIEWER: A. Elzeftawy. **DATE:** 10 June 1988.

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SCP SECTION: Geohydrology **page no.:** 8.3.1.2-281
ACTIVITY NO. (If applicable): 8.3.1.2.2.10.2
ACTIVITY TITLE: Numerical simulation of the concepts.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 1

Comments:
Unsaturated, three-dimensional moisture-flow model for Yucca Mountain block is unproven scientifically.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 0

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 0

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 0

Comments:

REVIEWER: A. Elzeftawy. **DATE:** 10 June 1988.

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SCP SECTION: Geohydrology **page no.:** 8.3.1.2-283
ACTIVITY NO. (If applicable): 8.3.1.2.2.10.3
ACTIVITY TITLE: System integration: Definition of flow paths and calculation of fluxes and velocities within the unsaturated zone.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 0

Comments:

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 0

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 0

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 0

Comments:

REVIEWER: A. Elzeftawy. **DATE:** 10 June 1988.

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SCP SECTION: 8.3.1.2.2.10.3 **page no.:** 8.3.1.2-283
ACTIVITY NO. (If applicable):
ACTIVITY TITLE: System integration: Definition of flow paths and calculation of fluxes and velocities within the unsaturated zone.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 0

Comments:
Very vague. How can relative importance of paths be analyzed if no methodology for defining paths exists?

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 0

Comments:
No methodology given.

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 0

Comments:
No hope offered.

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 0

Comments:

REVIEWER: C. Johnson. **DATE:** 10 June 1988.

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: 8.3.1.2.3.1.1 **page no.:** 8.3.1.2-298
ACTIVITY NO. (if applicable):
ACTIVITY TITLE: Solitario Canyon fault study in the saturated zone.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 3

Comments:
There should be an attempt to complete a well within the fault zone.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 2

Comments:
It is unlikely that the Solitario Canyon fault is uniform in its hydraulic properties.

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 2

Comments:
Drilling and testing effort is too limited, and well spacings are too great.

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 4

Comments:
Assessment of the hydrologic significance of such a well-defined structure is feasible.

REVIEWER: C. Johnson. **DATE:** 09 June 1988.

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SCP SECTION: 8.3.1.2.3.1.2 **page no.:** 8.3.1.2-300
ACTIVITY NO. (If applicable):
ACTIVITY TITLE: Site potentiometric-level evaluation.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 2

Comments:
Assessment of vertical components of fluid potential gradients are neglected, as are perched-water zones as in UZ-1.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE:

Comments:
2-D representation of 3-D system.

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 2

Comments:
Saturation in vadose zone may not be recognizable, and vertical gradients are generally ignored.

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 4

Comments:
Precise fluid-potential measurement is feasible.

REVIEWER: C. Johnson. **DATE:** 09 June 1988.

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: 8.3.1.2.3.1.3 **page no.:** 8.3.1.2-306
ACTIVITY NO. (if applicable):
ACTIVITY TITLE: Analysis of previously completed hydraulic-stress tests.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 2

Comments:
This is the accepted approach to data analysis, but nothing new is offered.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 2

Comments:
All this has been attempted already; methodology was correct but yielded poor results due to complexities of natural system.

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 2

Comments:
Convincing analytical solutions have not been presented despite much effort.

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 2

Comments:
Some pump test and slug test data do not fit any idealized response. The proposed analysis has already been attempted.

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: 8.3.1.2.3.1.4 **page no.:** 8.3.1.2-316
ACTIVITY NO. (if applicable):
ACTIVITY TITLE: Multiple-well interference testing.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 2

Comments:
Approach is conventional and acceptable, but scope of work is much too limited with respect to number of test wells and very uncertain with respect to interpretation.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 4

Comments:
There is no known alternative to this type of test for obtaining field hydraulic response data.

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 2

Comments:
Porous-media equivalency is not evident, and discrete-fracture geometry is not known and very complex. Success depends on network model from CD-SCP activity 8.3.1.2.3.3.2.

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 3

Comments:
Any sample volume may be non-representative, although the tests are feasible to the extent meaningful intervals in wells can be recognized and isolated.

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: 8.3.1.2.3.1.5 **page no.:** 8.3.1.2-320
ACTIVITY NO. (if applicable):
ACTIVITY TITLE: Testing of the C-hole sites with conservative tracers.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 2

Comments:
Tracer tests should be focused on exploring fracture geometry in a geologic context rather than on obtaining estimates for model-related parameters that may be non-representative.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 2

Comments:
Discrete fractures cause major difficulties, but at the C-well test scale their role is analyzable.

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 2

Comments:
Results may be impossible to interpret in fractured terrain, but the extensive experience base and small size of the C-well site may allow success.

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 3

Comments:
The tests are feasible but not much use in poorly-characterized fracture systems. Tests feasible at this scale, though.

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: 8.3.1.2.3.1.6 **page no.:** 8.3.1.2-324
ACTIVITY NO. (If applicable):
ACTIVITY TITLE: Well testing with conservative tracers throughout the site.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 1

Comments:
Geologic considerations are not evident; ie. role of discrete structures. Scope of study should emphasize fracture geometry rather than numerical model-related parameters.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 2

Comments:
Representative discrete fractures are not evaluated, and most wells are not constructed to allow definitive tracer tests.

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 1

Comments:
Tests can only succeed to the extent porous media approximation apply or fracture geometry is known.

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 3

Comments:
Single-well and multiple-well tests are probably feasible.

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: 8.3.1.2.3.1.7 **page no.:** 8.3.1.2-328
ACTIVITY NO. (if applicable):
ACTIVITY TITLE: Testing of the C-hole sites with reactive tracers.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 2

Comments:
Tracer tests should be focused on exploring fracture geometry in a geologic context rather than on obtaining estimates for model-related parameters.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 2

Comments:
Objective may be met at C-well test scale.

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 2

Comments:
Fatal flaw is unknown fracture geometry; Success depends on fracture network model from activity 8.3.1.2.3.3.2.

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 3

Comments:
Test feasible but expectations too great; C-hole results cannot be extrapolated to site in general.

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: 8.3.1.2.3.1.8 **page no.:** 8.3.1.2-332
ACTIVITY NO. (if applicable):
ACTIVITY TITLE: Well testing with reactive tracers throughout the site.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 1

Comments:
Fracture geometry rather than parameter estimation should be emphasized.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 2

Comments:
Most existing wells were not constructed to allow definitive tracer tests.

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 1

Comments:
Fatal flaw is unknown fracture geometry.

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 3

Comments:
Tests feasible but expectation too great.

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: Geohydrology **page no.:** 8.3.1.2-334
ACTIVITY NO. (If applicable): 8.3.1.2.3.2.1
ACTIVITY TITLE: Assessment of site hydrochemical data availability and needs.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 2

Comments:
Where do they think they are going to sample that hasn't already been sampled? Which isotopes? What does assembling sampling materials have to do with SCP activity?

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 3

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 3

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 4

Comments:

REVIEWER: D. Shettel. **DATE:** 14 June 1988.

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: Geohydrology **page no.:** 8.3.1.2-334
ACTIVITY NO. (If applicable): 8.3.1.2.3.2.2
ACTIVITY TITLE: Hydrochemical characterization of water in the upper part of the unsaturated zone at the site.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 2

Comments:
They should sample zones <1 m, <10 m, <20 m, <50 m, <100 m., etc. Are Si and Al going to be analyzed for? Why is geophysics mixed in here? If it pertains to another activity, what is reference?

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 1

Comments:
It's too late to perform this type of sampling now; it should have been done when well was initially drilled. Initially, wells were drilled with the wrong technology.

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 4

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 4

Comments:

REVIEWER: D. Shettel. **DATE:** 14 June 1988.

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: 8.3.1.2.3.3.1 **page no.:** 8.3.1.2-338
ACTIVITY NO. (If applicable):
ACTIVITY TITLE: Conceptualization of saturated zone flow models within the boundaries of the accessible environment.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 0

Comments:
Very weak presentation.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 0

Comments:
No methodology described.

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 0

Comments:
No measure of success is available.

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 0

Comments:
Feasibility can only be considered in the context of defined goals.

REVIEWER: C. Johnson **DATE:** 09 June 1988

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: 8.3.1.2.3.3.2 **page no.:** 8.3.1.2-339
ACTIVITY NO. (If applicable):
ACTIVITY TITLE: Development of fracture network model.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 2

Comments:
There is nothing new here, and results at a given multiple-well site cannot be extrapolated to the site in general. Assumes existence of an R.E.V.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 3

Comments:
Todd Rasmussen of the University of Arizona has already developed such a model.

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 3

Comments:
Since such a model already exists, DOE will probably succeed.

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 2

Comments:
Development of such a model is feasible; successful application may not be. Verification and validation may never be attained

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: 8.3.1.2.3.3.3 **page no.:** 8.3.1.2-342
ACTIVITY NO. (if applicable):
ACTIVITY TITLE: Calculation of flow paths, fluxes, and velocities within the saturated zone to the accessible environment.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 1

Comments:
There is no viable alternative to porous-medium approximation given; geologic controls are inadequately explored; limitations of technology not recognized.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 1

Comments:
Direct observation in the field must be more thorough before this modeling is justified. How about discrete fracture mapping?

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 1

Comments:
No hope at proposed level of drilling and testing effort.

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 1

Comments:
Would require much more drilling and much less statistical manipulation to succeed.

REVIEWER: C. Johnson. **DATE:** 10 June 1988.

Rock Characteristics Program (8.3.1.4)

SECTION	CONCEPTUAL	METHODOLOGY	TECHNOLOGY	FEASIBILITY	SCP OBJECTIVES
8.3.1.4.1.1.1	0	0	0	0	NO
8.3.1.4.1.1.2.	1	0	0	0	NO
8.3.1.4.1.1.3	1	0	0	0	NO
8.3.1.4.2.1.1	4	3	3	4	YES
8.3.1.4.3.1.1	2	2	2	3	NO
8.3.1.4.3.2.1	1	1	1	2	NO

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: Rock Characteristics **page no.:** 8.3.1.4-24
ACTIVITY NO. (If applicable): 8.3.1.4.1.1.1
ACTIVITY TITLE: Develop a position on drilling within the boundaries of the repository perimeter drift.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 0

Comments:

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 0

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 0

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 0

Comments:

REVIEWER: Atef Elzeftawy. **DATE:** 13 June 1988.

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SCP SECTION: Rock Characteristics **page no.:** 8.3.1.4-25

ACTIVITY NO. (If applicable): 8.3.1.4.1.1.2 (sub - .1 to .4)

ACTIVITY TITLE: The effects of drilling boreholes on the unsaturated zone using water, mud, or air foam as a drilling circulation medium (4 sub-activities).

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 1

Comments:
The 4 sub-activities are vague and position papers would not do it. Need technical work?

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 0

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 0

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 0

Comments:

REVIEWER: Atef Elzeftawy. **DATE:** 13 June 1988.

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: Rock Characteristics **page no.:** 8.3.1.4-27
ACTIVITY NO. (if applicable): 8.3.1.4.1.1.3
ACTIVITY TITLE: Evaluation of drillhole and other subsurface data for the purpose of siting additional drillholes..

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 1

Comments:
The statistical evaluation will not work!

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 0

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 0

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 0

Comments:

REVIEWER: Atef Elzeftawy. **DATE:** 13 June 1988.

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: 8.3.1.4.2.1 **page no.:** 8.3.1.4-37

ACTIVITY NO. (If applicable): 8.3.1.4.2.1.1

ACTIVITY TITLE: Surface and subsurface stratigraphic studies of the host rocks and surrounding units.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 4

Comments:

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 3

Comments:
Paleomagnetic sampling should be tightly spaced--spacing is unknown here. Sampling interval for mineralogy not clear. Fracture vs matrix mineralogy data? Drilling liquids contamination problem!

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 3

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 4

Comments:

REVIEWER: M. Morgenstein. **DATE:** 09 June 1988.

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SCP SECTION: 8.3.1.4.3.1.1 **page no.:** 8.3.1.4-89
ACTIVITY NO. (If applicable):
ACTIVITY TITLE: Systematic drilling program.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 2

Comments:
Holes will be drilled only to 200 feet below the static water table.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 2

Comments:
Too great an emphasis is placed on core and on the expected success of geo-statistical methods.

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 2

Comments:
Correlation distances are expected to be much less than nominal borehole spacing.

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 3

Comments:
Systematic core drilling is of course feasible, but adequate characterization is not.

REVIEWER: C. Johnson. **DATE:** 10 June 1988.

NOTE: "Determination of adequate characterization of spatial variability will depend heavily upon geostatistical techniques and will be identified in close cooperation with the modeling efforts of study 8.3.1.4.3.2" (3-D rock characteristics model).

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: 8.3.1.4.3.2.1 **page no.:** 8.3.1.4-95
ACTIVITY NO. (If applicable):
ACTIVITY TITLE: Development of three-dimensional models of rock characteristics at the repository site.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 1

Comments:
Material-property characterization is approached as if discrete structures and material domains are not yet recognized.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 1

Comments:
Despite the great expenditure, little in the way of new data can be expected from drilling on a 3500 to 4200-foot grid in the repository block.

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 1

Comments:
Depends on a much-too-limited and incomplete systematic drilling program, activity 8.3.1.4.3.1.1.

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 2

Comments:
Probably not feasible without compromising site integrity. The proposed grid is much too coarse for fracture characterization.

REVIEWER: C. Johnson. **DATE:** 10 June 1988.

MY880715w

Thermal and Mechanical Rock Properties Program (8.3.1.15)

SECTION	CONCEPTUAL	METHODOLOGY	TECHNOLOGY	FEASIBILITY	SCP OBJECTIVES
8.3.1.15.1.1.2	2	3	3	3	NO
8.3.1.15.1.1.3	3	3	3	3	YES
8.3.1.15.1.1.1	3	3	3	3	YES
8.3.1.8.5.2.3	1	0	3	3	NO

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: Thermal and Mechanical Properties **page no.:** 8.3.1.15-29
ACTIVITY NO. (If applicable): 8.3.1.15.1.1.2
ACTIVITY TITLE: Volumetric heat capacity characterization.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 2

Comments:
Core samples may not reflect the true in-situ heat properties of the rocks.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 3

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 3

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 3

Comments:

REVIEWER: Atef Elzeftawy. **DATE:** 13 June 1988.

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: Thermal and Mechanical Properties **page no.:** 8.3.1.15-31
ACTIVITY NO. (If applicable): 8.3.1.15.1.1.3
ACTIVITY TITLE: Thermal conductivity characterization.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 1

Comments:
Cores may not be representative of in-situ.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 3

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 3

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 3

Comments:

REVIEWER: Atef Elzeftawy. **DATE:** 13 June 1988.

MY880718jj

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: Thermal and Mechanical Properties **page no.:** 8.3.1.15-26
ACTIVITY NO. (If applicable): 8.3.1.15.1.1.1
ACTIVITY TITLE: Density and porosity characterization.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 3

Comments:
Cores may not be representative of the repository block.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 3

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 3

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 3

Comments:

REVIEWER: Atef Elzeftawy. **DATE:** 13 June 1988.

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: Postclosure Tectonics **page no.:** 8.3.1.8-119
ACTIVITY NO. (If applicable): 8.3.1.8.5.2.3
ACTIVITY TITLE: Heat flow at Yucca Mountain and evaluation of regional ambient heat flow and local heat flow anomalies.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 1

Comments:
Data are needed; however, nothing is stated with regard to acquiring the data.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 0

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 3

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 3

Comments:

REVIEWER: Atef Elzeftawy. **DATE:** 13 June 1988.

Total Performance Assessment Program (8.3.5)

SECTION	CONCEPTUAL	METHODOLOGY	TECHNOLOGY	FEASIBILITY	SCP OBJECTIVES
8.3.5.12.2.1	0	0	0	0	NO
8.3.5.12.2.1.1	0	0	0	0	NO
8.3.5.12.2.1.2	0	0	0	0	NO
8.3.5.12.2.2	0	0	0	0	NO
8.3.5.12.2.2.1	0	0	0	0	NO
8.3.5.12.2.2.2	1	1	3	3	NO
8.3.5.12.3.1.1	0	0	0	0	NO
8.3.5.12.3.1.2	1	1	1	1	NO
8.3.5.12.4.1	0	0	0	0	NO
8.3.5.12.4.1.3	1	1	1	1	NO
8.3.5.12.5.1	1	1	1	1	NO
8.3.5.12.5.2	1	1	1	1	NO
8.3.5.12.5.2	1	1	1	1	NO
8.3.5.13.2.1	0	2	3	0	NO
8.3.5.13.2.1.2	1	2	0	4	NO
8.3.5.13.2.2	3	2	0	0	NO
8.3.5.13.3.1.1	3	1	1	0	NO
8.3.5.13.3.1.2	2	0	0	0	NO
8.3.5.13.3.1.3	1	0	0	0	NO
8.3.5.13.3.1.4	1	0	0	0	NO
8.3.5.13.4.1.1	0	0	0	0	NO
8.3.5.13.4.1.2	1	0	0	0	NO
8.3.5.13.4.2.1	1	0	0	0	NO
8.3.5.13.4.2.2	1	0	0	0	NO
8.3.5.13.5.1.1	1	0	0	0	NO
8.3.5.13.5.1.2	1	0	0	0	NO
8.3.5.13.5.1.3	2	0	0	0	NO
8.3.5.15.1.1.1	1	3	3	3	NO
8.3.5.15.1.1.2	2	3	3	3	NO
8.3.5.15.2.2	1	1	1	1	NO

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: Ground-Water Travel Time **page no.:** 8.3.5.12-44
ACTIVITY NO. (If applicable): 8.3.5.12.2.1 (and sub-activities)

ACTIVITY TITLE: Model development.

"Covers pages 8.3.5.12-1 to 8.3.5.12-44)."

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 0

Comments:
Unsaturated zone matrix flow/fractures flow problem has not been recognized by D.O.E.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 0

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 0

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 0

Comments:

REVIEWER: Atef Elzeftawy. **DATE:** 10 June 1988.

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: Ground-Water Travel Time **page no.:** 8.3.5.12-45

ACTIVITY NO. (If applicable): 8.3.5.12.2.1.1 (Sub-activity 1.6.2.1.1)

ACTIVITY TITLE: Development of a theoretical framework for calculational models. (Sub-activity).

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 0

Comments:
Based on this section alone.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 0

Comments:
Based on this section alone.

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 0

Comments:
Based on this section alone.

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 0

Comments:
Based on this section alone.

REVIEWER: C. Johnson. **DATE:** 09 June 1988.

NOTE: Will work in conjunction with 8.3.1.2.2.

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: Ground-Water Travel Time **page no.:** 8.3.5.12-46

ACTIVITY NO. (if applicable): 8.3.5.12.2.1.2 (Sub-activity 1.6.2.1.2)

ACTIVITY TITLE: Development of calculational models. (Sub-activity)

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 0

Comments:
Based on this section alone.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 0

Comments:
Based on this section alone.

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 0

Comments:
Based on this section alone.

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 0

Comments:
Based on this section alone.

REVIEWER: C. Johnson. **DATE:** 09 June 1988.

NOTE: "Calculational models will be developed in cooperation with plans in 8.3.1.2.2."

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SCP SECTION: Ground-Water Travel Time **page no.:** 8.3.5.12-45
ACTIVITY NO. (If applicable): 8.3.5.12.2.2 (and two sub-activities)

ACTIVITY TITLE: Verification and validation.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 0

Comments:
They cannot make up their mind--validation or no validation?

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 0

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 0

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 0

Comments:

REVIEWER: Atef Elzeftawy. **DATE:** 10 June 1988.

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: 8.3.5.12.2.2.1 **page no.:** 8.3.5.12-45
ACTIVITY NO. (if applicable): 1.6.2.2.1 (Sub-Activity)

ACTIVITY TITLE: Verification of codes. (Sub-activity)

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 0

Comments:
Based on this section alone.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 0

Comments:
Based on this section alone.

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 0

Comments:
Based on this section alone.

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 0

Comments:
Based on this section alone.

REVIEWER: C. Johnson. **DATE:** 09 June 1988.

NOTE: "Details in Sections 8.3.5.19 and 8.3.5.20."

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: 8.3.5.12.2.2.2 **page no.:** 8.3.5.12-46
ACTIVITY NO. (If applicable): 1.6.2.2.2 (Sub-activity)

ACTIVITY TITLE: Validation of models. (Sub-activity)

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 1

Comments:
There is no emphasis on the role of field-scale discrete fractures or vaporization/condensation in strong thermal gradients.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 1

Comments:
Additional determinations of matrix characteristics do not constitute meaningful model validation to support information need 1.6.2.

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 3

Comments:
These experiments have been shown to succeed, but do not constitute meaningful model validation.

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 3

Comments:
Validation of models that include strong thermal gradients cannot be accomplished by these experiments but the experiments themselves are quite feasible.

REVIEWER: C. Johnson. **DATE:** 09 June 1988.

NOTE: Details in Section 8.3.5.19, "substantially completed analytical techniques" (?).

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: 8.3.5.12.3.1.1 **page no.:** 8.3.5.12-52
ACTIVITY NO. (if applicable): 1.6.3.1.1 (Sub-activity)

ACTIVITY TITLE: Unsaturated zone flow analysis. (Sub-activity)

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 0

Comments:
Based on this section alone.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 0

Comments:
Based on this section alone.

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 0

Comments:
Based on this section alone.

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 0

Comments:
Based on this section alone.

REVIEWER: C. Johnson. **DATE:** 09 June 1988.

NOTE: "Description of flow paths will be performed in conjunction with 8.3.1.2.2.10.3."
"Concepts....will be used in conjunction with 8.3.1.2.2.6.3."

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: 8.3.5.12.3.1.2 **page no.:** 8.3.5.12-52

ACTIVITY NO. (If applicable): 1.6.3.1.2 (Sub-activity)

ACTIVITY TITLE: Saturated zone flow analysis. (Sub-activity)

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 1

Comments:
Two-dimensional model in a region of such complex and uncertain geologic structure is decidedly not focused on determining flow paths.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 1

Comments:
Modeling activities proposed to resolve information need 1.6.3 do not adequately represent structural controls on ground-water flow.

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 1

Comments:
No hope of success in this geologic environment.

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 1

Comments:
Characterization of all likely flow paths in the saturated zone at Yucca Mountain is not feasible.

REVIEWER: C. Johnson. **DATE:** 09 June 1988.

NOTE: "Will be coordinated with saturated zone modeling in 8.3.1.2.3.3.3."

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: Ground-Water Travel Time **page no.:** 8.3.5.12-56
ACTIVITY NO. (if applicable): 8.3.5.12.4.1 (and three sub-activities)

ACTIVITY TITLE: Calculation of pre-waste-emplacement ground-water travel time.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 0

Comments:

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 0

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 0

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 0

Comments:

REVIEWER: Atef Elzeftawy. **DATE:** 10 June 1988.

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: 8.3.5.12.4.1.3 **page no.:** 8.3.5.12-57

ACTIVITY NO. (If applicable): 1.6.4.1.3 (Sub-activity)

ACTIVITY TITLE: Determination of the pre-waste-emplacement ground-water travel time. (Sub-activity)

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 1

Comments:
There is little hope of overcoming problems with the ill-defined Disturbed Zone boundary and flow paths.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 1

Comments:
The probabilistic approach is not justifiable in absence of knowledge of spatial correlation of parameters; does not resolve information need 1.6.4.

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 1

Comments:
The validity of this approach cannot be assessed with the existing or expected data bases.

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 1

Comments:
Spatial correlations will not be known from proposed drilling effort, nor will properties of major discrete fractures.

REVIEWER: C. Johnson. **DATE:** 09 June 1988.

MY880715x

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: Ground-Water Travel Time **page no.:** 8.3.5.12-67
ACTIVITY NO. (if applicable): 8.3.5.12.5.1
ACTIVITY TITLE: Ground-water travel time after repository construction and waste emplacement.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 1

Comments:

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 1

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 1

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 1

Comments:

REVIEWER: Atef Elzeftawy. **DATE:** 10 June 1988.

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: 8.3.5.12.5.2 **page no.:** 8.3.5.12-68
ACTIVITY NO. (If applicable): 1.6.5.2
ACTIVITY TITLE: Definition of the Disturbed Zone.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 1

Comments:
Awareness of heat pipe effect and complexities of vaporization and condensation on Disturbed Zone definition is not evident. Matrix flow is assumed.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 1

Comments:
The only real methodology that is evident is the prolonged effort to restrict rather than conservatively extend the estimated boundary. Does not resolve information need 1.6.5.

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 1

Comments:
We cannot predict the future thermo-hydrologic environment with existing technology.

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 1

Comments:
Not feasible because of observational, monitoring and computer-related limitations.

REVIEWER: C. Johnson. **DATE:** 09 June 1988.

NOTE: Disturbed Zone definition will be reevaluated based on results of Sections 8.3.1.2.2 (unsaturated zone hydrologic system investigation) and 8.3.1.2.3 (saturated zone hydrologic system investigation).

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: Ground-Water Travel Time **page no.:** 8.3.5.12-68
ACTIVITY NO. (if applicable): 8.3.5.12.5.2
ACTIVITY TITLE: Definition of the Disturbed Zone.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 1

Comments:

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 1

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 1

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 1

Comments:

REVIEWER: Atef Elzeftawy. **DATE:** 10 June 1988.

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: Total System Performance (8.3.5.13.2.1) (8.3.5.13.2.1.1) **page no.:** 8.3.5.13-87

ACTIVITY NO. (If applicable): 1.1.2.1

ACTIVITY TITLE: Preliminary identification of potentially significant sequences of events and processes at the Yucca Mountain repository site. (Sub-activity).

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 0

Comments:
Most information is scattered throughout this section, but is not in this sub-activity.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 2

Comments:
Method for identifying probable events/processes is flawed [from EA, panel of "experts"]. Experts were not independent of DOE, nor particularly qualified.

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 3

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 0

Comments:

REVIEWER: D. Shettel. **DATE:** 22 June 1988.

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: Total System Performance (8.3.5.13.2.1.2) **page no.:** 8.3.5.13-88

ACTIVITY NO. (if applicable): 1.1.2.1.2 (Sub-activity)

ACTIVITY TITLE: Preliminary identification of potentially significant release scenario classes..

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 1

Comments:
Use of EA as a reference is inappropriate; similar to inbreeding, but in this case of pseudo-scientific ideas.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 2

Comments:
See previous comments.

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 0

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 4

Comments:

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: Total Systems Performance (8.3.5.13.2.2) **page no.:** 8.3.5.13-88

ACTIVITY NO. (If applicable): 1.1.2.2
ACTIVITY TITLE: Final selection of significant release scenario classes to be used in licensing assessments..

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 3

Comments:

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 2

Comments:
Assumes site characterization plan and activities will be sufficient.

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 0

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 0

Comments:

REVIEWER: D. Shettel. **DATE:** 22 June 1988.

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: Total System Performance (8.3.5.13.3.1.1) **page no.:** 8.3.5.13-93

ACTIVITY NO. (If applicable): 1.1.3.1
ACTIVITY TITLE: Development of models for releases along water pathways.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 3

Comments:

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 1

Comments:
Use of less than 3D models must be justified. Use of preexisting models that are based on unproven assumptions (Sinnock, etc.) are biased (not statistically valid), and do not take into account site characterization findings is unwarranted and unjustified.

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 1

Comments:
See previous comments.

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 0

Comments:

REVIEWER: D. Shettel. **DATE:** 22 June 1988.

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: Total Systems Performance (8.3.5.13.3.1.2) **page no.:** 8.3.5.13-94

ACTIVITY NO. (If applicable): 1.1.3.1.2
ACTIVITY TITLE: Development of a model for gas-phase releases.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 2

Comments:

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 0

Comments:
It is not clear if site characterization data will be incorporated into model.

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 0

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 0

Comments:

REVIEWER: D. Shettel. **DATE:** 22 June 1988.

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SCP SECTION: Total Systems Performance **page no.:** 8.3.5.13-95

ACTIVITY NO. (If applicable): 1.1.3.1.3 (8.3.5.13.3.1.3)

ACTIVITY TITLE: Development of a model of releases through basaltic volcanism.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 1

Comments:

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 0

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 0

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 0

Comments:

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: Total Systems Performance (8.3.5.13.3.1.4) **page no.:** 8.3.5.13-95

ACTIVITY NO. (If applicable): 1.1.3.1.4
ACTIVITY TITLE: Development of a model of releases through human intrusion.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 1

Comments:
More complicated mathematical models do not necessarily form bases for simplified models. All models need to be validated.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 0

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 0

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 0

Comments:

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: Total Systems Performance (8.3.5.13.4.1.1) **page no.:** 8.3.5.13-98

ACTIVITY NO. (If applicable): 1.1.4.1.1
ACTIVITY TITLE: The screening of the preliminary scenario classes..

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 0

Comments:
Use of a DOE panel of self-proclaimed experts is biased. Reference by CDSCP to other DOE (non-independently peer reviewed) documents is questionable and misleading. Similar to building a house of cards!

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 0

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 0

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 0

Comments:

REVIEWER: D. Shettel. **DATE:** 22 June 1988.

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SCP SECTION: Total Systems Performance (8.3.5.13.4.1.2) **page no.:** 8.3.5.13-98

ACTIVITY NO. (If applicable): 1.1.4.1.2
ACTIVITY TITLE: A final screening of scenario classes.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 1

Comments:
Models should be developed after data are in hand.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 0

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 0

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 0

Comments:

REVIEWER: D. Shettel. **DATE:** 22 June 1988.

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SCP SECTION: Total Systems Performance (8.3.5.13.4.2.1) **page no.:** 8.3.5.13-99

ACTIVITY NO. (if applicable): 1.1.4.2.1
ACTIVITY TITLE: Preliminary development of simplified, computationally efficient scenario-class models.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 1

Comments:
Models are being simplified (apparently) in order to obtain the desired results? Scientifically, there is no justification to simplify models.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 0

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 0

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 0

Comments:

REVIEWER: D. Shettel. **DATE:** 22 June 1988.

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SCP SECTION: Total Systems Performance (8.3.5.13.4.2.2) **page no.:** 8.3.5.13-99

ACTIVITY NO. (If applicable): 1.1.4.2.2

ACTIVITY TITLE: Development of the final, computationally efficient models of the scenario classes that will be used to represent all significant processes and events in the simulation of the total system.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 1

Comments:
See comments on "Preliminary development of simplified computationally efficient..." [8.3.5.13.4.2.1].

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 0

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 0

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 0

Comments:

REVIEWER: D. Shettel. **DATE:** 22 June 1988.

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SCP SECTION: Total Systems Performance (8.3.5.13.5.1.1) **page no.:** 8.3.5.13-101

ACTIVITY NO. (If applicable): 1.1.5.1.1 (Sub-activity)

ACTIVITY TITLE: Construction of the total system simulator. (Sub-activity)

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 1

Comments:
See previous comments on preceding subactivities.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 0

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 0

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 0

Comments:

REVIEWER: D. Shettel. **DATE:** 22 June 1988.

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: Total Systems Performance (8.3.5.13.5.1.2) **page no.:** 8.3.5.13-102

ACTIVITY NO. (If applicable): 1.1.5.1.2 (Sub-activity)

ACTIVITY TITLE: Construction of the joint probability distribution to be used in the licensing assessment calculations. (Sub-activity)

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 1

Comments:
Garbage (biased) information in (based on assumptions or invalid statistics), garbage out!

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 0

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 0

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 0

Comments:

REVIEWER: D. Shettel. **DATE:** 22 June 1988.

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SCP SECTION: Total Systems Performance (8.3.5.13.5.1.3) **page no.:** 8.3.5.13-102

ACTIVITY NO. (if applicable): 1.1.5.1.3 (Sub-activity)

ACTIVITY TITLE: Construction of an empirical complementary cumulative distribution function for licensing action.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 2

Comments:
GIGO (garbage in, garbage out).

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 0

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 0

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 0

Comments:

REVIEWER: D. Shettel. **DATE:** 22 June 1988.

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: Groundwater Protection **page no.:** 8.3.5.15-7
ACTIVITY NO. (If applicable): 8.3.5.15.1.1.1
ACTIVITY TITLE: Synthesis and evaluation of hydrologic and environmental information needed to determine whether aquifers at the site meet the special source criteria.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 1

Comments:
By using more boreholes, data are needed for the alluvium, tuff, and carbonate aquifers to resolve this issue.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 3

Comments:
Methods are available to use.

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 3

Comments:
Could be done.

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 4

Comments:

REVIEWER: Atef Elzeftawy. **DATE:** 15 June 1988.

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: Ground-Water Protection **page no.:** 8.3.5.15-8
ACTIVITY NO. (if applicable): 8.3.5.15.1.1.2
ACTIVITY TITLE: Synthesis and evaluation of demographic and economic data needed to determine whether Class I or special sources of groundwater exist.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 2

Comments:
Vague, unclear, badly written and not focused.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 3

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 3

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 3

Comments:

REVIEWER: Atef Elzeftawy. **DATE:** 15 June 1988.

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: Groundwater Protection **page no.:** 8.3.5.15-10
ACTIVITY NO. (If applicable): 8.3.5.15.2.2
ACTIVITY TITLE: Synthesis and evaluation of releases of waste products to special sources of groundwater during the first 1000 years after disposal.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 1

Comments:
Modeling the total performance will not accomplish the task. Real data are badly needed.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 1

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 1

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 1

Comments:

REVIEWER: Atef Elzeftawy. **DATE:** 15 June 1988.

Waste Package Program (8.3.4)

SECTION	CONCEPTUAL	METHODOLOGY	TECHNOLOGY	FEASIBILITY	SCP OBJECTIVES
8.3.4.2.4.1.1	1	0	0	0	NO
8.3.4.2.4.1.1	1	2	1	0	NO
8.3.4.2.4.1.2	1	0	0	0	NO
8.3.4.2.4.1.3	1	1	3	3	NO
8.3.4.2.4.1.3	1	3	0	0	NO
8.3.4.2.4.1.4	3	3	3	3	YES
8.3.4.2.4.1.5	2	3	3	0	NO
8.3.4.2.4.1.6	2	3	3	0	NO
8.3.4.2.4.1.7	2	3	3	0	NO
8.3.4.2.4.2.1	1	0	0	0	NO
8.3.4.2.4.2.2	1	0	0	0	NO
8.3.4.2.4.2.3	1	0	0	0	NO
8.3.4.2.4.4.1	1	0	0	0	NO
8.3.4.2.4.4.2	1	0	0	0	NO
8.3.4.2.4.4.3	1	0	0	0	NO

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: Waste Package **page no.:** 8.3.4.2-45
ACTIVITY NO. (if applicable): 8.3.4.2.4.1.1
ACTIVITY TITLE: Rock-water interactions at elevated temperatures.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 1

Comments:
It is believed that vadose waters are chemically different than saturated waters. Also, saturated water chemistry will not bound the vadose zone waters.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 0

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 0

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 0

Comments:

REVIEWER: Atef Elzeftawy. **DATE:** 13 June 1988.

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: Waste Package **page no.:** 8.3.4.2-45
ACTIVITY NO. (If applicable): 8.3.4.2.4.1.1
ACTIVITY TITLE: Rock-water interactions at elevated temperatures.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 1

Comments:
Uses reference water only (J13). No consideration of thermal gradients.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 2

Comments:
Using isothermal experimental techniques.

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 1

Comments:
Experiment does not allow for boiling off of liquid water and consequent changes in fluid chemistry.

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 0

Comments:

REVIEWER: D. Shettel. **DATE:** 11 June 1988.

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: Waste Package **page no.:** 8.3.4.2-46
ACTIVITY NO. (if applicable): 8.3.4.2.4.1.2
ACTIVITY TITLE: Effect of grout, concrete, and other repository materials on water composition.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 1

Comments:
The whole activity is only a paragraph. This is a nice conceptual beginning.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 0

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 0

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 0

Comments:

REVIEWER: D. Shettel. **DATE:** 11 June 1988.

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: Waste Package **page no.:** 8.3.4.2-46
ACTIVITY NO. (if applicable): 8.3.4.2.4.1.3
ACTIVITY TITLE: Composition of vadose zone water from the waste package environment.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 1

Comments:
Theoretical models will not do it. We need to understand the physics of the system first.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 1

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 3

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 3

Comments:

REVIEWER: Atef Elzeftawy. **DATE:** 14 June 1988.

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: Waste Package **page no.:** 8.3.4.2-46
ACTIVITY NO. (If applicable): 8.3.4.2.4.1.3
ACTIVITY TITLE: Composition of vadose water from the waste package environment.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 1

Comments:
Comparison of actual vadose water with equilibrium models to determine contamination is backwards. Water should be checked for tracers and polymers from drilling fluids.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 3

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 0

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 0

Comments:

REVIEWER: D. Shettel. **DATE:** 13 June 1988.

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: Waste Package **page no.:** 8.3.4.2-47
ACTIVITY NO. (if applicable): 8.3.4.2.4.1.4
ACTIVITY TITLE: Dissolution of phases in the waste package environment.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 3

Comments:

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 3

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 3

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 3

Comments:

REVIEWER: D. Shettel. **DATE:** 13 June 1988.

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: Waste Package **page no.:** 8.3.4.2-48
ACTIVITY NO. (If applicable): 8.3.4.2.4.1.5
ACTIVITY TITLE: Effects of radiation on water chemistry.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 2

Comments:
Need vadose water composition!

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 3

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 3

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 0

Comments:

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: Waste Package **page no.:** 8.3.4.2-49
ACTIVITY NO. (if applicable): 8.3.4.2.4.1.6
ACTIVITY TITLE: Effects of container and borehole liner corrosion products on water chemistry.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 2

Comments:
Needs vadose water composition.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 3

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 3

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 0

Comments:

REVIEWER: D. Shettel. **DATE:** 13 June 1988.

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: Waste Package **page no.:** 8.3.4.2-50
ACTIVITY NO. (If applicable): 8.3.4.2.4.1.7
ACTIVITY TITLE: Numerical analysis and modeling of rock-water interaction.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 2

Comments:
Assumes equilibrium generally (locally) in the sense of constant temperature (isothermal condition). EQ3/6 or any other known code can't handle thermal gradients.

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 3

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 3

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 0

Comments:

REVIEWER: D. Shettel. **DATE:** 13 June 1988.

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: Waste Package **page no.:** 8.3.4.2-51
ACTIVITY NO. (if applicable): 8.3.4.2.4.2.1
ACTIVITY TITLE: Single-phase fluid system properties.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 1

Comments:

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 0

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 0

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 0

Comments:

REVIEWER: Atef Elzeftawy. **DATE:** 13 June 1988.

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: Waste Package **page no.:** 8.3.4.2-52
ACTIVITY NO. (If applicable): 8.3.4.2.4.2.2
ACTIVITY TITLE: Two-phase fluid system properties.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 1

Comments:
How could you separate the gas phase from the liquid phase of water in the rock?

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 0

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 0

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 0

Comments:

REVIEWER: Atef Elzeftawy. **DATE:** 14 June 1988.

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: Waste Package **page no.:** 8.3.4.2-53
ACTIVITY NO. (If applicable): 8.3.4.2.4.2.3
ACTIVITY TITLE: Numerical analysis of flow and transport in laboratory systems.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 1

Comments:
Laboratory tests will not validate flow and transport models of repository scale!

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 0

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 0

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 0

Comments:

REVIEWER: Atef Elzeftawy. **DATE:** 14 June 1988.

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CD-SCP ACTIVITY REVIEW FORM

SCP SECTION: Waste Package **page no.:** 8.3.4.2-56
ACTIVITY NO. (If applicable): 8.3.4.2.4.4.1
ACTIVITY TITLE: Repository horizon near-field hydrologic properties.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 1

Comments:

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 0

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 0

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 0

Comments:

REVIEWER: Atef Elzeftawy. **DATE:** 14 June 1988.

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SCP SECTION: Waste Package **page no.:** 8.3.4.2-57
ACTIVITY NO. (if applicable): 8.3.4.2.4.4.2
ACTIVITY TITLE: Repository horizon rock-water interaction.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 1

Comments:

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 0

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 0

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 0

Comments:

REVIEWER: Atef Elzeftawy. **DATE:** 14 June 1988.

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SCP SECTION: Waste Package **page no.:** 8.3.4.2-57
ACTIVITY NO. (If applicable): 8.3.4.2.4.4.3
ACTIVITY TITLE: Numerical analysis of fluid flow and transport in the repository horizon near-field environment.

Conceptual Completeness and Focus

4 Complete and/or focused.
3 Generally complete and/or focused.
2 Generally incomplete and/or poorly focused.
1 Incomplete and/or not focused.
0 Insufficient information to judge.

SCORE: 1

Comments:

Appropriateness of Methodology to Establish Stated Objective:

4 Methodology will establish objective.
3 Methodology probably will establish objective.
2 Methodology probably will not establish objective.
1 Methodology will not establish objective.
0 Insufficient information to judge.

SCORE: 0

Comments:

Probability of Success Using Existing Technology:

4 Success likely.
3 Probably will succeed.
2 Probably will not succeed.
1 Success unlikely.
0 Insufficient information to judge.

SCORE: 0

Comments:

Feasibility in Terms of Time, Funding, and Human Resources:

4 Feasible.
3 Probably feasible.
2 Probably not feasible.
1 Unfeasible.
0 Insufficient information to judge.

SCORE: 0

Comments:

REVIEWER: Atef Elzeftawy. **DATE:** 14 June 1988.