NRC COMMENTS

ON

DOE DRAFT ENVIRONMENTAL ASSESSMENT

FOR THE

DAVIS CANYON SITE

March 20, 1985

DAVIS CANYON
DRAFT EA REVIEW CONTRIBUTORS

Robert Johnson	Project Manager
Clayton Pittiglio	Site Manager
John Bradbury	Geochemistry
Pauline Brooks	Performance Assessment
Lou Bykoski	Arch./Cultural/Historic Resources
Don Cleary	Aesthetic Resources, Natural Resources and Socioeconomics
Barbara Cooke	Groundwater Hydrology
John Cook	Radiological Transportation
Clarence Hickey	Aquatic Ecology
Ted Johnson	Surface Water Hydrology
Walt Kelly	Geochemistry
Gerry LaRoche	Terrestrial Ecology
William Lake	Radiological Impact
Bill Lilley	Environment/Socioeconomics
Earl Markee	Meteorology and Air Quality
Jerry Pearring	Design/Rock Mechanics
Charles Peterson	Waste Package
Bob Samworth	Water Quality and Noise
Steve Smykowski	Design/Rock Mechanics
Mike Tokar	Waste Package
John Trapp	Geology/Geophysics
Tilak Verma	On Site Representative
John Voglewede	Waste Package
Mike Wangler	Radiological Impact

INTRODUCTION

Background

On December 20, 1984, the DOE issued draft environmental assessments (EAs) for nine potentially acceptable sites for the nation's first nuclear high-level waste repository. Issuance of final EAs will be in accordance with the Nuclear Waste Policy Act of 1982 (NWPA) which directs the U.S. Department of Energy (DOE) to issue an EA for each site that the Secretary nominates as being suitable for site characterization. Public review and comment were solicited on draft EAs for a period ending on March 20, 1985. From among the nine potentially acceptable sites, five sites are being proposed for nomination as being suitable for site characterization. Following the issuance of the final environmental assessments, DOE will formally nominate at least five sites as suitable for site characterization and recommend at least three of the nominated sites to the President for site characterization as candidates for the first repository.

Each draft environmental assessment contains: (a) a description of the decision process by which the site was selected; (b) information on the site and its surroundings; (c) an evaluation of the effects of site characterization activities; (d) an assessment of the regional and local impacts of locating a repository at the site; (e) an evaluation as to whether the site is suitable for site characterization and for development as a repository; and (f) a comparative evaluation of the site with other sites that have been considered.

The NWPA and NRC regulations governing licensing of the geologic repository provide for consultation between DOE and NRC staffs prior to formal licensing to assure that licensing information needs and requirements are identified at an early time. In accordance with the NRC/DOE Procedural Agreement on repository prelicensing interactions, NRC and DOE staffs have been conducting such consultations. According to NWPA, the environmental assessments are to provide a summary and analysis of data and information collected to date on sites which the DOE intends to nominate for site characterization. Therefore, they present an important opportunity for NRC and DOE staffs to consult on the issues that exist at each site which must be addressed for site characterization. They also afford an opportunity for the NRC staff to point out at an early stage in DOE's repository program potential licensing problems with a site if they were found to exist on the basis of available information.

NRC Staff Review

The staff conducted its review of the EAs according to the NRC Division of Waste Management's "Standard Review Plan for Draft Environmental Assessments

(Dec 12, 1984)." Because of the limited time available for review and the vast amount of data and information existing for the nine sites, the staff had prepared for the draft EA reviews well before their receipt. Preparation included: 1) broad familiarization with the overall existing data/information base for each site; 2) selected detailed reviews of data; 3) development of a clear understanding of the guidelines; and 4) development of preliminary views and issues through reviews of existing data and scoping reviews of preliminary EA drafts. This early preparation and familiarization with the existing data base has allowed the staff to determine if the conclusions and findings in the EAs are consistent with the available data.

In its review, the staff has sought to identify potential safety issues through a review of DOE's application of the siting guidelines. The staff has focused on the analyses and technical evaluations that are made on individual guidelines which constitute the factual basis upon which the site comparisons are made by DOE. The staff reviewed the available data, interpretations, assumptions and performance assessments in the EA and its references that DOE used to substantiate its evaluation of a site against the guidelines. In commenting on the EAs, the staff has recognized that the level of information which exists on each site is not equivalent to what will be necessary to make findings about the suitability of the one site that is proposed for development as a repository. The staff has reviewed the evaluations and conclusions which are called for at the EA stage by the siting guidelines. These guidelines recognize the inherent uncertainties that will face any site before detailed site characterization.

The staff's review and comment on the evaluations and conclusions on the siting guidelines effectively identified issues which are relevant to potential safety issues. In its concurrence action on the siting guidelines, the Commission found that the guidelines are consistent with the requirements of its own regulations on geologic repositories (10 CFR Part 60). Therefore, while the staff has not identified in each case how its comments relate to the specific requirements of 10 CFR Part 60, we feel that they serve to identify those issues which are relevant to potential licensing of each site based on information currently available and which will need to be resolved during site characterization.

The staff also commented on the analyses of environmental impacts of site characterization activities and repository operation with the intent of assisting DOE's preparation of the final EAs. However, the staff has not performed a detailed review with regard to the site characterization plans in Chapter 4 or the repository descriptions in Chapter 5 of the EAs. The staff only commented on those aspects of site characterization plans, such as the need for characterizing the geohydrological regime beneath Canyonlands Park, which need to be considered to evaluate the site against the siting guidelines, at this time. Site characterization plans will be reviewed upon receipt of such plans in accordance with the NWPA and in other consultations with the DOE under the interagency agreement governing repository prelicensing matters (48 FR 38701); the staff's review and positions will be documented in site characterization analyses at that time.

NRC Staff Comment-Summary

In no case did the staff conclude that a disqualifying condition was clearly present or a qualifying condition clearly absent at the sites being investigated. To a large extent the EAs recognize that uncertainties exist at each site. However, in some instances, the full range of uncertainty that exists about certain factors affecting site suitability is not recognized in the discussion supporting the EA findings. The staff noted that in a number of instances the EAs make conclusions and findings which are not supported by existing data or which existing data indicate are not conservative. In these instances, the staff points out specific data and other information which indicate that EA conclusions are not realistically conservative as required by 10 CFR Part 960 (10 CFR Part 960.3 requires that assumptions made in EA evaluations be... "realistic but conservative enough to underestimate the potential for a site to meet the qualifying condition of a guideline..."). For example, we point out information on hydrologic conditions at several sites which is not fully documented in the EAs and which could realistically support less optimistic conclusions about groundwater travel time than those presented in the EA.

In each comment, the staff has attempted to describe the significance of the comment and to recommend what DOE might do to resolve the comment. Ultimately, it may be found unnecessary to completely eliminate all of the uncertainties about site features that are identified in the comments. It is expected that through further investigation it can be shown that some of these uncertainties are compensated for by other site features which assure overall system guidelines are met. (For example, some questions about geochemical properties may be mooted or lessened in importance by development of information indicating that there are very favorable and compensating groundwater conditions.) Nevertheless, it is essential that all potential problems and uncertainties about sites be explicitly identified at this stage so that site-screening decisions are based on complete assessment of the facts and that future site characterization work is complete.

In pointing out deficiencies in DOE's evaluations of individual sites, the staff has commented on DOE's evaluations and findings with respect to the various individual factors which are important to site suitability (i.e., 10 CFR Part 960 guidelines on geohydrology, geochemistry, rock characteristics, etc.). We expect that the DOE analyses in Chapter 1 through 6 will be revised in light of our comments. The staff therefore recommends that DOE reconsider its ratings and ranking analyses of sites in Chapter 7 so that the overall comparison of sites and resulting decisions are consistent with supporting evaluations and findings on individual factors.

It is the staff's view that by recognizing uncertainties identified in our comments and reexamining its assessments in light of the other technical concerns that we raise, the environmental assessments and related decisions will be strengthened.

Presentation of EA Comments

The staff presents its comments in two parts. First, it presents major comments. The order in which these comments are presented has no special significance; the order is governed by the fact that some comments, which help the reader understand others, come first. Second, detailed comments are presented on each of the chapters of the EA. The major comments are those comments which the staff considers may potentially lead DOE to a change in EA findings with respect to specific guideline or may affect the relative ratings of sites. In some of the detailed comments, the staff identifies areas where the discussions supporting the EA findings are more certain than we believe the data supports. If such supporting discussions were considered in the comparison and ratings of sites, these detailed comments could be as significant as those labeled major comments.

Many of the staff's comments appear identical for different sites because the information presented by DOE in the EAs was often identical and therefore would result in the same comment, particularly when sites are in the same geohydrologic basin. Similar comments do, however, take into consideration differences resulting from site specific information.

MAJOR COMMENTS

Comment 1

Tectonics and Structural Discontinuities

Guidelines on Tectonics 10 CFR 960.4-2-7(a), (b), (c)(3), (d) and 960.5-2-11(a), (c)(2), (c)(3), (d).

The draft EA appears to describe many structural features of the site area separately and in an unrelated fashion. The information that is in the draft EA, as well as information from the literature, suggests that the site region is in an active tectonic regime. In addition there are many structures and features within the site region that have not been addressed in the draft EA, and there are geologic data that do not appear to have been utilized in the analysis of the tectonic framework and associated structures. In addition to the tectonic concerns, the effect of these features and processes do not appear to have been adequately considered in analysis of the geohydrologic and rock characteristics guidelines (see major comments 3 and 7).

Several pieces of geologic information suggest that the site region is located in an active tectonic region, and that an active stress field is present. To the northwest of the site, the Colorado River generally follows the trend of the Colorado lineament, a zone of inferred right lateral basement faulting (Warner, 1978, Case and Joesting, 1972). This Precambrian structural zone is seismogenic along certain portions (Warner, 1978, Brill and Nuttli, 1983), including the zone from approximately the confluence of the Colorado and Green Rivers, northeast to Moab (ONWI-492, Figure 2.1). Fault-plane solutions presented within ONWI-492, suggest ongoing right-lateral displacement along this zone. In addition, the Shay/Bridger Jack/Salt Creek Graben complex is located south of the site. This zone is described in section 3.2.5.1. as an en echelon series of grabens which may have formed in response to left-lateral displacement at depth. This section further states that the south fault of the Shay graben displaces Quaternary sediments, and Figure 2-17 of ONWI-492 shows that microearthquake activity has been recorded in this area. The available data therefore suggest that this structural zone is active. The indications of the tectonic activity both northwest and south of the site do not appear to have been adequately considered during the analysis of the tectonic guidelines qualifying and disqualifying conditions.

ONWI-400 presents the results of in situ stress measurements conducted in borehole GD-1 which indicate a maximum horizontal stress direction of approximately east-northeast and suggests a ratio of maximum to minimum stress of 1.6:1. As is stated within the draft EA, the appearance of the valley anticlines is suggestive of excess horizontal stress in the site region (draft EA, p. 3-53). The microearthquake activity described above along the Colorado River and in the area of Shay/Bridger Jack/Salt Creek Grabens is indicative of stress release. While interpretations on the state of stress in the site vicinity are highly speculative, the draft EA appears to have considered the possibility of an active compressive stress field in the site vicinity, but has not adequately substantiated its conclusion.

The present data base is limited regarding known subsurface structures in the site vicinity. There are many known features that have not been discussed in the draft EA, such as the Imperial Fault zone or the structures in the area of Chesler Canyon. In addition, the data that are available do not appear to have been fully utilized. The stratigraphic and structural information in McCleary, 1984 (DOE investigator) has not been integrated with the geophysical data in Kitcho, 1983. Comparison of these two reports shows that DOE is presenting two different interpretations as to the expected conditions along fault zones and this inconsistency has not yet been resolved. In addition, during the NRC geophysics data review with DOE on October 18, 1984, the NRC noted that several aeromagnetic anomalies existed which appeared to coincide with anomalies noted on Landsat imagery and orthophotos. Information presented in the draft EA suggests that this information has not been fully analyzed.

A large data base exists that indicates that structural discontinuities exist at depth within evaporite sequences. In borehole GD-1 for example, while there were no fractures reported within Unit 6, fractures were reported in most other units such as the dolomite and anhydrite interbeds both above and below Unit 6, and within the Honaker Trail and Leadville Formations (ONWI-388, vol. III, pages 569-570, 591-592, 628, 629, 648, 775-776, and 785-787). This information was not discussed in the draft EA and it does not appear that it was factored into any of the analyses.

The data on subsurface structures that are available and have been analyzed suggest a high degree of uncertainty that allows for several possible interpretations of subsurface structures and tectonic regime. Interpretations of seismic lines in the vicinity of the Shay Graben (Kitcho, 1983, DOE investigator) suggest that subsurface structure may not be accurately reflected by the surface exposures (see detailed comment 6-12). Due to the plastic nature of salt, the NRC is unsure how basement faulting would propagate through salt and how basement faulting would be recognized at the surface (see detailed comment 3-11). In the area of the Lockhart Basin, DOE has interpreted the surface expression of faulting to be reflective of dissolution. With this interpretation the causative faults are not apparent in surface exposures (see detailed comment 3-20). These pieces of information suggest that the surface structural expression may not be indicative of the subsurface structural/tectonic regime. The majority of structural interpretations in the site vicinity are based on surface mapping, and without knowledge of the relationship between surface exposures and the location and nature of subsurface structures, there is extreme uncertainty in trying to evaluate how the site will respond to tectonic activity and therefore how suitable the site is for waste isolation.

Because of the concerns raised above, the NRC considers that the findings in the draft EA that potentially adverse conditions on increases in earthquake activity (960.4-2-7(c)(3)) and 960.5-2-11(c)(3)) are not present or that the favorable condition on future tectonic processes (960.4-2-7(b)) is present, are not supported. In the analysis of the tectonics qualifying and disqualifying conditions (960.4-2-7(a), 960.4-2-7(d), 960.5-2-11(a) and 960.5-2-11(d) the draft EA has not adequately presented the existing data base or adequately considered uncertainties. In addition to the direct tectonic concerns, the uncertainty in the structural and tectonic setting may have an effect on the geohydrologic (960.4-2-1) and rock characteristics findings (960.4-2-3, and 960.5-2-9) (see major comments 3 and 7).

DOE should consider synthesizing data relevant to tectonics and structural discontinuities of the site and geologic setting which considers the associated uncertainties. In addition to the concerns discussed above, this synthesis should account for at least: the Meander anticline, the Needles Fault zone, north-northwest trending salt anticlines and smaller parallel structures including Gibson dome and Rustler dome and Indian Creek Syncline, the valley anticlines, the northwest trending faults that run parallel to, or in some cases, within the core of the salt anticlines, and the northeast trending faults. The results of this synthesis should provide the basis for re-evaluating the tectonic guidelines and other technical guidelines as appropriate.

Comment 2

Dissolution

Guideline on Dissolution 10 CFR 960.4-2-6(a), (b), (d).

The analysis presented in the draft EA in support of the dissolution findings does not discuss important available data and associated uncertainties inherent in the data base. Because of the following concerns the NRC considers that the analysis and findings for dissolution guidelines, 960.4-2-6(a), 960.4-2-6(b) and 960.4-2-6(d), do not reflect the inherent uncertainties of the data base.

During the NRC geophysics data review with DOE on October 18, 1984, seismic lines were examined which are the basis for the DOE statement "...within the site and its vicinity... . No discontinuities in the salt reflector are observed in these data." (draft EA, page 6-105). During this data review it was concluded that the salt reflectors could not be continually traced. The lines were not shot specifically to obtain detailed information on the site, but rather to obtain a regional overview. The discontinuous reflectors may be the result of many factors including 1) data gathering and processing techniques, 2) depositional variations within the salt sequence, or 3) dissolution features. The methods utilized, namely shooting and recording techniques, and the possibility of poor surface coupling of the shots, combined with the limited coverage, results in a data set that has a high degree of uncertainty that cannot be used as definite evidence for the non-existence of dissolution as the draft EA implies.

Based on observations within the area of the Lockhart basin and in the salt anticline region, the DOE has stated that they only expect dissolution to occur when faulting has disrupted the evaporite sequence bringing the water-bearing Mississippian strata in contact with the salt sequence. The known amount of throw on fault R, (figure 3-19 of the draft EA), which is only slightly more than a mile from the site, appears sufficient to meet this condition, yet there is no analysis within the draft EA that indicates that the DOE has considered this possibility.

Kitcho, 1983, (DOE investigator) presents aeromagnetic and gravity data which indicates several anomalies, one of which is located in the area of fault R. During the NRC data review, it was noted that this anomaly, as well as several others within the region, including one at the head of Lavender Canyon, coincided with circular anomalous areas on orthophotos and Landsat imagery. The DOE does not appear to have included these data and the related uncertainties in their analysis of dissolution potential.

The DOE has not presented information on joints and fractures which could provide pathways for fluid migration. Joints and fractures have been reported in other evaporite sequences, were reported in borehole GD-1 and can be a major factor in the dissolution process if they can provide pathways for fluid migration. Until the potential of fracture flow is integrated into the assessment, the NRC is concerned that potential pathways for fluid migration that could lead to dissolution and associated features has not been adequately assessed.

As described in the draft EA, the Leadville limestone contains many karst features. This formation, as well as the limestones within the Honaker Trail and Pinkerton Trail formations, that are water soluble rocks could, instead of inhibiting dissolution, as is inferred in the draft EA section 3.2.5.6., provide a focus for salt dissolution, if solution cavities, fractures or collapse features are present that would allow ground water to come in contact with the salt.

The DOE has examined the available well logs in the area, and report that they have observed no evidence of dissolution. Not only are the number of logs limited, but based on NRC review of the same logs, the resolution provided by the logs, at best, would be such that only major dissolution features could be observed. Uncertainty exists in that smaller, active features could easily have gone undetected. The draft EA does not address this uncertainty. In addition, the NRC does not know if the drilling records of wells in the site vicinity were examined for evidence of fluid loss or gain. If this had been accomplished, the DOE should report this information.

McCulley, et al., (1984), shows that the chemistry of the Leadville waters collected from borehole GD-1 are probably indicative of rapid dissolution. The DOE has presented no analysis to support the contention that this is thought to have come from dissolution outside the site vicinity.

Since the DOE has no site-specific estimates on rates of dissolution, rates obtained at WIPP and the Texas Panhandle were used in the analysis. Not only does the NRC question the validity of transferring these rates to a different geohydrologic setting, but the rates cited do not represent the full range of values reported in the literature (see detailed comment 6-41). If DOE wishes to use these non-site-specific rates, Gustavson, et al., 1980, (DOE investigator from TBEG) presented rates approximately an order of magnitude greater that those used by DOE for the analysis. No discussion is presented which justifies the applicability or inapplicability of transferring these none-site-specific rates to this hydrogeologic setting or of the associated uncertainty that utilization of the full range of rates would have on the findings.

The NRC agrees with the statement on page 6-106, paragraph 5, that there is insufficient information to conclude that hydraulic interconnection leading to loss of waste isolation could not occur. As DOE has not utilized all available information, has not fully addressed the uncertainty in the data base and has used questionable data in the analysis, the NRC considers that the evaluations supporting the dissolution guidelines are adequate. In addition to the direct concerns related to dissolution, the uncertainties related to the features and process of dissolution may have an effect on the geohydrologic findings (960.4-2-1) (see major comment 3).

The DOE should consider integrating the available structural data described above with available hydrological and geochemical information so that alternate interpretations of potential flow paths, dissolution zones and dissolution potential can be identified and the uncertainties evaluated. The DOE should consider factoring the above information and concerns into the various technical findings, as appropriate.

Comment 3

Groundwater Travel Time

Guideline on Geohydrology 10 CFR 960.4-2-1(b).

The draft EA concludes that the favorable condition of a 10,000 year travel time (960.4-2-1 (b)) is present because their calculated travel time ranges between 137,000 and 239,000 years. However, many of the assumptions and approaches used in the evaluation and supporting analyses do not properly represent the full range of values, and therefore, the lower bound of the calculated travel time range is inappropriately long. Specifically, the assumptions and approaches used in the evaluation of this favorable condition are not conservative with respect to flow paths, hydraulic gradients, porosities, and conceptual and numerical modeling.

A single conceptual model is considered for evaluation of groundwater travel time in the draft EA. It consists of downward matrix flow through several thousand feet of halite interbedded with dolomite, anhydrite and mudstone, to the Leadville Limestone brine aquifer, where it flows westward horizontally. Within the context of this conceptual model, many quantifiable uncertainties are not incorporated into the travel time range. In addition, the draft EA does not consider or does not adequately substantiate rejection of alternative flow scenarios such as horizontal matrix- or fracture-flow through the interbeds, vertical flow through structural discontinuities, or the potential for localized upward flow in the Paradox Formation, as discussed below.

Potentially faster flow paths, such as through interbeds and along structural discontinuities, may exist as compared with the single pathway used in the evaluation (see detailed comments 6-4, 6-5 and 6-8 and major comment 1). The occurrence of fracture flow is recognized but not used to bound the travel time estimate (see detailed comment 6-7). The lateral gradient provided in the draft EA for the Leadville Limestone is not conservative based on available potentiometric head data (see detailed comment 3-30). The presence of a downward gradient in the host rock and immediately surrounding units is not adequately demonstrated by the available data (see detailed comments 3-31 and 6-10 and major comment 4). Porosity data used in the evaluation are not conservative with respect to the available data (see detailed comment 3-29 and 6-7). Conceptual and numerical models used to support the travel time estimates contain uncertainties which have not been carried through to bound the travel time estimate (see detailed comments 3-32, 6-7 and 6-9). The travel time calculation does not consider that size of the disturbed zone and size of the controlled area determine distance to the accessible environment (see detailed comment 6-7 and 6-110). In addition, flow rates calculated for the Leadville Limestone as used in the travel time calculation may contain an arithmetic error (see detailed comment 6-7).

The NRC concludes that consideration of the above-mentioned concerns may substantially reduce the confidence that the favorable condition is present. Therefore, DOE should consider the concerns mentioned above in its groundwater travel time analyses. The DOE should also consider revising the draft EA to more accurately convey the uncertainty associated with its conclusion on this favorable condition and the large uncertainty associated with travel time estimates.

Comment 4

Hydraulic Gradient

Guideline on Geohydrology 10 CFR 960.4-2-1(b)(4).

The draft EA concludes that the favorable condition of a downward or predominantly horizontal hydraulic gradient in the host rock and in the immediately surrounding geohydrologic units (960.4-2-1(b)(4)(ii)) is present. This finding results from their conclusion that a downward hydraulic gradient exists across the host rock. The NRC concludes that the draft EA has not demonstrated the uniqueness of this gradient, and that scenarios identifying upward gradients are reasonable alternative interpretations of the available potentiometric data, as discussed below.

The NRC notes that in support of this finding the draft EA has selectively presented data which demonstrate the presence of a downward gradient within the host rock units. The borehole GD-1 data set from which the draft EA references a downward gradient between long-term test numbers 2 and 3 also shows an upward gradient between test numbers 3 and 5. The widely variable head data from borehole GD-1 support a broad range of interpretations, including minimal vertical interconnection with the potential for localized upward gradients as well as the potential for localized downward gradients (see detailed comments 3-31 and 6-10). The draft EA also concludes that on a larger hydrogeologic system scale, comparison of regional potentiometric levels in the aquifers above and below the host rock units also indicates a downward gradient. Although NRC agrees that the regional data indicate a downward gradient, the NRC notes that this regional gradient does not preclude the possibility for localized upward vertical flow (see detailed comment 3-31 and 6-10). Hydrochemical data may further substantiate the potential for a localized upward gradients between the middle and upper hydrostratigraphic units (see detailed comment 3-29).

The above-mentioned concerns indicate that the favorable condition may not be present. Because of these problems the DOE should consider reevaluating the available information considering the points noted above. The DOE should also consider either revising the draft EA to include any additional existing evidence for the presence of a downward gradient with consideration of the above concerns or consider revising the finding to reflect the existing uncertainties.

Comment 5

Host Rock Carnallite Content and Dehydration/Melting

Guidelines on Geochemistry 10 CFR 960.4-2-2(b)(3), (c)(1), (c)(2), and Rock Characteristics 960.4-2-3(c)(2).

The draft EA does not consider the amount of carnallite present and associated uncertainties, the potential thermal alteration of the hydrated phases, and the significance of alteration on rock strength and water content. Hydrated minerals such as carnallite in the proximity of the underground facility may undergo melting and/or dehydration at elevated temperatures anticipated in and near the repository as a result of waste emplacement.

In the draft EA, estimates of amounts and natures of the mineral assemblages of the host rock at the repository horizon are based on stratigraphic information from GD-1, the only well in which the entire evaporite sequence of the Paradox Member has been cored. Extrapolating stratigraphic information from GD-1 to the repository location, the draft EA assumes that potash (carnallite) contents decrease in the repository horizon. However, this assumption is based on data on salt cycle 18 (Hite, 1982), not salt cycle 6, the repository host rock. Thus, there is little justification in assuming that potash contents in the host rock will be less than those in GD-1.

As described in the draft EA salt cycle 6 is 238 feet thick and contains 134 feet of carnallite marker and bed overlying the potential repository horizon. This marker bed in GD-1 3 miles north of the site, is made up of thin layers of carnallite within the massive halite and contains an average of 2.39 weight percent carnallite ($KMgCl_3 \cdot 6H_2O$) (see detailed comments 3-4 and 3-26). Some layers (up to 1" thick) contain <u>at least</u> 50 percent carnallite. The carnallite marker bed may be approximately 50 feet above the repository horizon and may experience temperatures of 120°C (see detailed comment 6-19). Only melting of pure NaCl (800°C) and pure $CaSO_4$ (1450°C) are considered in the draft EA (page 6-88, 960.4-2-2(b)(3)). This section also states that there will be no resulting adverse effects because the anticipated maximum repository temperature is 250°C, even though the melting point of pure carnallite ranges from 130 to 165°C (see detailed comments 3-4 and 6-19). Furthermore, in the multicomponent system representing the phases in the carnallite marker bed, melting could occur at temperatures lower than those of the pure end members, as in the case of eutectic, peritectic, and azeotropic systems (see detailed comment 6-19). When coupled with the relatively high thermal conductivity of halite, partial melting may even occur in the carnallite marker bed overlying the repository horizon. Such a process might affect rock strength, but has not been evaluated in the draft EA (see detailed comment 6-19).

Besides affecting the rock strength, melting and decomposition of hydrated minerals releases H_2O that is bound in the crystalline phases. The melting of carnallite which contains 38.9 wt.% H_2O can release six times more H_2O to the fluid phase than is released from dehydration reactions considered in the draft EA (see detailed comment 6-25). This water will dissolve salts producing a high Mg brine which is more corrosive to the waste canisters than low Mg brine. Furthermore, in the case of an intrusive brine, the high solubility of carnallite could potentially cause a brine rich in magnesium to form (see detailed comments 6-14 and 6-80).

In light of the possibility of melting of hydrated phases in the proximity of the underground facility, there is insufficient evidence to support the finding that geochemical conditions will not degrade the rock strength (960.4-2-2(c)(2). Furthermore, the generation of high Mg brines produced by the melting of carnallite does not lend support to the findings that groundwater conditions in the host rock could not affect the chemical reactivity of the engineered-barrier system to the extent of compromising the expected repository performance (960.4-2-2(c)(1)) and physical and chemical phenomena could not be expected to affect waste containment or isolation (960.4-2-3(c)(2)).

With the carnallite marker bed containing thermally unstable minerals close to the repository horizon, the DOE should consider re-evaluating the amount and potential effects of carnallite on repository performance. The effects of carnallite dehydration and melting on rock strength, brine formation and movement, and waste package corrosion should be re-estimated. The DOE should revise the findings for the guidelines discussed above and the relevant performance assessments as appropriate.

Comment 6

Radionuclide Mobility

Guideline on Geochemistry 10 CFR 960.4-2-2(b)(2), (b)(4), (c)(1), (c)(2), and (c)(3).

Evidence presented in the draft EA regarding processes that affect radionuclide migration, such as precipitation, sorption, radiocolloid formation, and organo-radionuclide complexation, is limited and, in some cases, evaluations are incomplete. Despite the ambiguous nature of the data, optimistic estimates of the above parameters are used which may lead to underestimations of radionuclide mobility.

The DOE contractor document cited in the draft EA (Levy and Kierstead, 1982) in support of the position that the effects of geochemical processes on sorption of radionuclides will be insignificant only marginally discusses sorption (see detailed comment 6-22) and by its title is only a "Very Rough Preliminary Estimate...". The draft EA analysis of precipitation and sorption does not consider the potential for migration of radionuclides through flow paths other than the deep basin brine aquifers.

The existence of chemically reducing conditions is beneficial to waste isolation in that certain radionuclides are less soluble and more readily sorbed in their reduced state. The data and the evaluations used in the draft EA do not adequately support the statement that reducing conditions are expected (see detailed comments 3-25 and 6-16). The reduced constituents cited in the draft EA to support the contention that reducing conditions are expected (i.e., CH_4, , H_2) can persist metastably in oxidizing groundwater. Certain processes which may influence the redox conditions are ignored, such as radiolysis, waste package corrosion reactions, and the presence of atmospheric O_2 (see detailed comment 6-21). Regardless, the conclusion that effective reduction of nuclides occurs because reducing conditions are expected is not well-founded because slow kinetics inhibit the establishment of equilibrium conditions, allowing redox sensitive elements such as uranium and neptunium to remain in their oxidized state where their solubilities are maximum and they do not readily sorb on the host rock minerals (see detailed comments 3-25 and 6-16).

The discussion of radiocolloid formation and organo-radionuclide complexation uses data that are not applicable to the expected site conditions (see detailed comments 6-17 and 6-18). Without site-specific data, it is premature to conclude that radiocolloids and organo-radionuclide complexes will not form under repository conditions.

By not employing the range of values implied by the uncertainties in the above mentioned parameters used to estimate retardation of radionuclides, the draft EA may be underestimating the potential for radionuclide migration. While information is presented regarding precipitation and sorption of radionuclides, only unsupported optimistic estimates of the expected redox conditions, radiocolloid formation, and organo-radionuclide complexation as they affect radionuclide mobility are used in the evaluation of guideline 960.4-2-2(b)(2). Therefore, the finding made in the draft EA that this favorable condition is present is not strongly supported (see detailed comments 6-16, 6-17 and 6-18). The uncertainties in the redox conditions and the amount of brine resulting from carnallite do not appear to be used in waste package corrosion and solubility performance assessment calculations, thus limiting the applicability of their results (see major comments 5 and 10 and detailed comment 6-16). Since the draft EA assumes a very limited amount of brine in the calculations for expected conditions, any additional sources of brine are important to consider. These performance calculations are used to make favorable findings for guidelines 960.4-2-2(b)(4) and 960.4-2-2(c)(1), concerning radionuclide solubility and the effects of groundwater conditions on the stability or chemical reactivity of the engineered barrier system, respectively. The favorable findings are not strongly supported due to the limited applicability of the performance assessment calculations. For guideline 960.4-2-2(c)(2), concerning geochemical processes that could reduce sorption, the data do not support the finding for this guideline and the document referenced in the draft EA is inappropriate to the sorption discussion (see detailed comment 6-22). For guideline 960.4-2-2(c)(3), concerning redox conditions, the data presented are too ambiguous to support a finding that the potentially adverse condition of chemically oxidizing conditions will not be present (see detailed comment 6-16).

The DOE should consider the uncertainties in the available data in re-evaluating processes and conditions that affect radionuclide migration. The DOE should revise, as appropriate, the findings for the guidelines discussed above and the relevant performance assessments.

Comment 7

Effects of Host Rock Mass Heterogeneity

Guidelines on Rock Characteristics 10 CFR 960.4-2-3(b)(1),(b)(2), (c)(1), (c)(3), and 960.5-2-9(b)(1), (b)(2), (c)(2).

Evaluations of Rock Characteristic guidelines presented in the draft EA contain statements that suggest a homogeneous in-situ rock mass throughout the site. Data from the site vicinity described in the draft EA indicate that heterogeneities such as carnallite zones and joints and fractures might exist in the salt host rock (see major comments 1 and 5). Mining experience such as at the Waste Isolation Pilot Plant (WIPP) also indicates that in the absence of site data, unforeseen heterogeneities should not be discounted at this time. The presence of such heterogeneities could adversely impact construction of the repository and significantly impact maintenance and potential retrieval operations that would be performed under adverse thermomechanical conditions after waste emplacement. An assumption of homogeneity tends to underestimate these impacts. In addition, the presence of heterogeneities tends to increase the level of uncertainty regarding the draft EA assumption that rock property data derived from core samples of fairly pure bedded salt may be considered representative of the mechanical properties of the in-situ rock mass (see detailed comments 3-21, 6-29 and 6-33). This source of uncertainty has not been discussed. Therefore, uncertainties related to the heterogeneous nature of the host rock would be significant for evaluating the Rock Characteristics guidelines and may not have been adequately evaluated in arriving at the findings.

Section 3.2.6.1 states "Paradox salt is relatively pure" and Section 6.3.1.3.3 states "... the salt fabric in the repository host rock is expected to be relatively competent and homogeneous over the total area to be mined." The draft EA presents estimated values of physical, thermal, and engineering properties of the host rock from limited laboratory testing of samples of salt rock taken from a single borehole (GD-1) located 3 miles from the site (see detailed comments 3-21, 6-29, and 6-33). These estimates are presented in the draft EA as representative of the in-situ host rock mass at the site. It also appears that uncertainties related to the adverse effects of heterogeneities were not factored into the evaluation. Since the engineering behavior of a salt rock mass can be dominated by heterogeneities, especially under waste induced thermomechanical loading, estimates of the physical, thermal, and engineering properties of the intact samples from borehole GD-1 may not be representative of the host rock at the site. An assumption of host rock homogeneity underestimates several rock mechanics related concerns such as the adverse effects of heterogeneities on the estimated strength, creep, thermal conductivity, porosity of the host rock as well as dehydration and melting of carnallite which reduces rock strength (see major comment 5 and detailed comments 6-29, 6-30, 6-32, 6-50, 6-52, 6-53, and 6-57). These in turn may limit design flexibility, roof and opening stability, and requirements for rock support and reinforcement. Uncertainties regarding the impact of these adverse effects on the requirement for unique engineering practices beyond current reasonably available technology for constructing and maintaining repository openings, sealing shafts, and for potential retrieval operations have not been addressed.

The evaluations for post-closure Rock Characteristics guidelines 10 CFR 960.4-2-3(b)(1) and pre-closure Rock Characteristics guideline 10 CFR

960.5-2-9(b)(1) do not consider the effects of heterogeneities that may limit the available lateral extent of host rock needed for locating the underground facility. In addition, the lateral extent would be particularly limited due to the stresses created by the mesa's in the area if the Two Phase Repository Design is used. As a consequence, the findings that a favorable condition is present have not been adequately supported. In addition, the evaluation for post-closure Rock Characteristic guideline 10 CFR 960.4-2-3(c)(1) does not consider the effects of heterogeneities that may increase the expected engineering difficulties and the degree of complexity required to construct, operate, and close a repository. Therefore the finding is not adequately supported.

The evaluations for Rock Characteristics guidelines 10 CFR 960.4-2-3(b)(2), and (c)(3) and 10 CFR 960.5-2-9(b)(2) and (c)(2) do not discuss uncertainties regarding the impact of heterogeneities on artificial support requirements and requirements for engineering measures beyond reasonably available technology necessary for repository construction and operation. As a result, the evaluations presented for these guidelines may be inadequate.

The DOE should consider expanding the evaluations presented for the guidelines noted above to address the potential influence of heterogeneities on repository construction, operations, and waste isolation, and if appropriate, modify the findings based upon the results of the reevaluations.

Comment 8

Retrievability

Guidelines on Ease and Cost 10 CFR 960.5-1(a)(3); and Rock Characteristics 960.5-2-9(b)(2), (c)(3), (c)(4).

Evaluations presented in the draft EA tend to underestimate the technical difficulty and do not adequately discuss the uncertainties associated with the rock mechanics aspects of retrieval. Retrieving waste canisters in salt under repository induced thermomechanical loading conditions is unique (i.e., a new concept) to current mining technology. Retrieval operations could be significantly impacted by adverse conditions created by elevated temperatures particularly in a heterogeneous host rock. The evaluations for several rock characteristic guidelines indicate that the draft EA has not adequately discussed the uniqueness of retrieval technology and the effects of adverse conditions on retrieving the waste canisters.

Section 6.3.3.2.3 states, "If retrieval of the waste form after emplacement is required, the creep closure of salt against the canister will require overcoring of the canister, or removal of the waste form from the in-place overpack, both of which will pose some difficulty.". However, no discussion is presented which addresses the response of a potentially heterogeneous host rock mass to variations in areal heat loading density and the associated uncertainties related to drift opening maintenance and room stability during retrieval. In addition, the discussions on retrievability in Section 5.1.3.3 and Section 6.3.3.2.3 do not completely consider the potentially adverse effects associated with elevated temperatures such as reduced rock strength, accelerated creep, pressurized gases surrounding the waste canisters and hot brine flow (see detailed comments 5-9, 5-28, and 6-54). These adverse effects could create technical problems with maintaining room stability as well as locating and removing the waste canisters. As pointed out by Kendorski, et al., (1984), retrieval related areas where technology has not been proven include ground support systems, canister location systems, and canister over-coring systems. In addition, the potentially adverse effects may be unfavorable for the health and safety of the mining personnel retrieving the waste particularily if the waste canisters are breached (see detailed comments 6-51 and 6-54).

The evaluation for Rock Characteristics guideline 10 CFR 960.5-2-9(b)(2) (which requires minimal or no artificial support for underground openings to ensure operations including retrieval), does not address potential problems related to remining in a thermally weakened heterogeneous rock mass and lacks consideration of anticipated changes in the rock characteristics due to heating over long periods of time. As a result, the draft EA finding may be inadequately supported (see detailed comments 6-32 and 6-53). In addition, the evaluations for the findings presented for guidelines 10 CFR 960.5-1(a)(3) (addressing ease and cost of construction), 10 CFR 960.5-2-9(c)(3) (addressing maintenance of underground openings), and 10 CFR 960.5-2-9(c)(4) (addressing the difficulties associated with retrieval), may be incomplete and overestimate the potential suitability of the site for retrieval operations (see detailed comments 6-56 and 6-57).

It is recommended that the discussions and evaluations be expanded to include consideration of the uncertainties associated with repository induced thermomechanical loading on a potentially heterogeneous rock mass, mining problems, radiological safety issues, and adverse rock characteristics expected to be encountered during retrieval. It is also recommended that where appropriate, the results of the reevaluations be factored into the conclusions and findings presented.

Comment 9

Shaft Sealing

Guidelines on Rock Characteristics 10 CFR 960.4-2-3(c)(3), and 960.5-2-9(c)(2)

Evaluations presented in the draft EA do not adequately discuss the many uncertainties associated with constructing, sealing, and decommissioning shaft systems to assure containment and isolation of the waste. Given the history of salt mine flooding caused by shaft failures and the impact of flooding on safety, operations, and retrievability, shaft sealing is a major repository concern. Uncertainties associated with shaft sealing include risks associated with: 1) contemplated shaft construction methods including blindhole drilling and drilling and blasting; 2) the design of sealing materials for long-term compatibility with engineering and chemical properties of shaft wall rock; 3) the response of shaft seals/shaft wall to potential seismic motion; and 4) the uncertainties associated with potential waste emplacement thermal effects on the integrity of the seals. The draft EA provides a very general description of shaft seal requirements (Section 5.1.1.3, page 5-12) and does not adequately address the above mentioned uncertainties. As a consequence, available evidence significant for evaluating several rock characteristics guidelines may not have been evaluated in support of the findings.

The analyses presented places considerable reliance on existing construction, lining, and sealing technologies (Section 6.3.3.2.3) and does not address the uncertainties associated with extrapolating current technology related to typical mining operations to meet the unique long-term requirements of seals associated with repository performance in salt (see detailed comments 6-56). Uncertainties also arise due to the limited ability to obtain rock characteristics data needed for locating and placing seals when using the blindhole drilling method. The discussion presented in Section 5.1.1.3 does not address the potential for differential ground movements caused by initial expansion and subsequent contraction due to the thermal pulse which may extend to the shaft areas and produce deleterious strains in shaft linings and seals. The discussion also does not address the potential for significant damage to shaft seals due to potential dynamic earthquake loads (see detailed comments 5-2, 6-6 and 6-47).

The evaluation presented for Rock Characteristic guideline 10 CFR 960.5-2-9(c)(2) (which addresses potentially adverse conditions that would necessitate use of engineering measures beyond reasonably available technology) does not address appropriate uncertainties associated with shaft sealing (see detailed comments 6-56). The evaluation is, therefore, inadequate.

The evaluation presented for Rock Characteristic guideline 10 CFR 960-4-2-3(c)(3) (which addresses the potential of waste generated heat decreasing the isolation provided by the host rock as compared with pre-waste emplacement conditions), does not present an indepth evaluation of uncertainties associated with long-term seal performance in geohydrologic and thermal environments that could adversely impact on strength and bonding characteristics of yet undeveloped and untested long-term seals (see detailed comments 5-2 and 6-36). As a result the evaluation may be inadequate. From a technical standpoint, the shaft seal system is a significant repository component whose objective is to prevent flooding that would preclude the use of the repository for waste emplacement during the preclosure period and in postclosure would prevent or delay ground water contact with the waste form or limit the rate of radionuclide release into the ground water after contact has occurred.

When revising the draft EA it is recommended that the evaluations presented for the guidelines noted above be expanded to address the uncertainties associated with shaft sealing and, if appropriate, the findings be modified to reflect the results of the reevaluation.

Comment 10

Waste Package Performance Predictions

The waste package performance assessment is based upon a multi-factored, but simplistic approach that leads to a potentially incorrect perception that the reference waste package will last a very long time (at least 10,000 years under expected conditions) (e.g., ch. 6, sections 6.3.2.1 and 6.4.2.4.1). Based on limited evidence and analysis, it is indicated that if the package were to fail (due to some unexpected condition or scenario), the low solubilities of the radionuclides in the expected total volume of brine contacting the waste package would limit the releases, for most elements, to within small fractions of EPA limits (e.g., Ch. 6, sections 6.3.2.1 and 6.4.2.4.1). These conclusions are based on performance assessments which are very preliminary and based on limited data. In some sections of the draft EA, statements on waste package performance properly acknowledge that uncertainties exist at the present time (e.g., ch. 6 sections 6.3.2.2 and 6.4.2.1, paragraph 2, and ch. 7, section 7.7.2, paragraph 4). However, a potentially incorrect overall impression is created that there is considerable margin available for compliance with NRC performance objectives for the waste package and engineered barrier system (e.g., ch. 6, sections 6.3.2.1, 6.4.2.3.4, 6.4.2.4.1, and 6.4.2.5).

The concerns mentioned below cast considerable doubt on the conclusions regarding waste package performance in the draft EA. For example, the waste package lifetime may be as much as two orders of magnitude less than that calculated with the expected conditions. The waste package performance assessment is conducted by first selecting reference (expected and unexpected) conditions for the near-field chemical and physical environment and expected modes of failure of the waste package. The lifetimes, or times-to-failure, of the waste package are then calculated through a series of computational steps involving principally the calculation of thermal conditions, rates of brine migration, and rates and amounts of corrosion of the waste package overpack. The reference conditions are, in many cases, selected either in lieu of data (e.g., regarding brine composition) or after rather optimistic interpretation and application of sparse existing data (e.g., the rate of uniform corrosion as a function of brine composition and rate of migration) (see detailed comment 6-88). In some instances, relevant waste package degradation and failure scenarios, such as pitting corrosion, are apparently either not taken into consideration (see detailed comments 6-72, 6-89 and 6-108) or are not adequately addressed (see detailed comments 6-92 and 6-93). There are also potentially large (but unquantified) uncertainties associated with the calculation of radiation field and thermal conditions (see detailed comments 6-76, 6-90 and 6-91) and with the solubility of radionuclides in brine (see detailed comments 6-96 and 6-97).

In lieu of applicable long-term data, the waste package performance assessment has relied heavily upon analytical models to make predictions over the expected lifetime of the repository. However, the analytical approach, as well as the models themselves, appear to have a number of limitations, which are summarized below. Because the information presented in support of the analytical models is limited, it is not possible to ascertain the precise nature of the modeling limitations in the performance assessment. From what evidence is available, it appears that significant problems may exist that could have a major effect on the results of the performance assessment.

The limitations in the modeling approach include the following: (1) conceptual limitations, such as the use of a wastage allowance (thickness of the container allocated) for overpack corrosion, which is valid only for uniform corrosion; (2) analytical oversimplifications, such as the use of one-dimensional analysis where multi-dimensional effects are expected (see detailed comment 6-9); (3) lack of consideration of alternative scenarios such as premature failure due to manufacturing defects; (4) the need for a prior knowledge of the results in order to run the analysis; (5) lack of consideration of synergistic effects (e.g., more than one corrosion process active at one time); and (6) lack of consideration of the effects of uncertainties in the models and input parameters (see detailed comment 6-14).

The significance of these remarks pertain to (1) the statements made in the draft EA (sections 6.4.2.4.1 and 6.4.2.5) that the 10 CFR 60 and 40 CFR 191 requirements are met by the proposed waste package design under reference expected conditions, and (2) the fact that the sense of large available margin may obscure the need for creation of appropriate models for waste package failure and radionuclide release. Regarding the former point, the draft EA has provided insufficient information to adequately support these conclusions. Regarding the latter point, the use of inappropriate or inaccurate modeling assumptions could lead to incorrect decisions regarding waste package data requirements.

Therefore, the effects of the input parameter and model uncertainties on the waste package performance assessment should be considered in revising the draft EA conclusions. The DOE should also consider appropriate qualifying statements where overly optimistic conclusions are given (e.g., ch. 6, sections 6.3.2.1, 6.4.2.3.4, 6.4.2.5, and 6.4.2.5).

Comment 11

Controlled Area

Guidelines on Environmental Quality 10 CFR 960.5-2-5 and Site Ownership and Control 10 CFR 960.4-2-8 and 960.5-2-2.

No basis or supporting calculations or assumptions for the preliminary controlled area are given in the draft EA. It appears that the size of the preliminary controlled area did not consider factors discussed below which might enlarge the size. This in turn may lead to underestimating site ownership and control and environmental quality problems and may not provide adequate protection of the site from activities such as non-DOE drilling that could adversely affect the containment and isolation capability of the site.

The size of the proposed controlled area identified on page 5-4 of the draft EA is approximately 9 sq. mi. or 5760 acres. This amounts to the edge of the controlled area (accessible environment) being less than 1 km from the edge of the underground facility. Page 6-6 of the draft EA states that this preliminary area is based on "preliminary data related to radionuclide release time" and Figure 3 of the draft EA states that it is based on preliminary estimates of the site of the Geologic Repository Operations Area (GROA) and performance assessment analysis. Because no additional basis is given or referenced it appears that the following factors were not accounted for: (1) possible adjustments to size and orientation of the underground facility design; (2) size of the underground facility assuming the two-phase design; and (3) uncertainties associated with assumptions and estimates regarding groundwater travel time and radionuclide transport.

The draft EA states in Chapter 5 that the design information presented is based on a feasibility study and no site specific data. Given the uncertainties related to hetergeneities stress and thermal effects which might affect the design (see major comment 7,) it is possible that the underground facility as shown in Figure 3-2 might be enlarged or reoriented to account for thermal effects and site heterogeneities identified during site characterization or construction. The preliminary controlled area presented does not seem to account for such flexibility of design.

The preliminary controlled area is based on the single-phase design described in Chapter 5. However, p. 5-130 states that DOE is proceeding further with the two-phase concept. The area needed for the underground facility for the two phase design is 3,359 acres or almost double the area of the one-phase design. Assuming the same distance beyond the edge of the underground facility the controlled area for the two-phase design would result in a significantly larger preliminary controlled area.

The NRC assumes that the preliminary controlled area size was based on preliminary calculations of groundwater travel times and radionuclide transport which are based upon various geologic, hydrogrologic and geochemical assumptions presented in the draft EA. Many of these draft EA assumptions have uncertainties related to them (see major comments 1, 3, and 5). It does not appear that the size of the controlled area has accounted for these uncertainties in such a way that it would adequately account for the range of conditions that might be expected at this time to be encountered during site characterization.

The size of the preliminary controlled area is important to the environmental quality (960.5-2-5) and site ownership and control guidelines (960.4-2-8 and 960.5-2-2). If the controlled area may have to extend into Canyonlands National Park, documenting in the draft EA how jurisdiction and control of this land can be acquired can be necessary to support the findings for the potentially adverse conditions and the qualifying conditions for 960.4-2-8 and 960.5-2-2. Should testing be needed in the Park as a result of an enlarged controlled area, evaluations and findings for the environmental quality guideline would be affected.

Finally, the preliminary controlled area size is important to adequate protection during site characterization against activities such as non-DOE drilling, which could adversely affect the containment and isolation capability of the site.

DOE should consider re-evaluating the size of the preliminary controlled area and provide a basis for its identifications which takes into account the concerns mentioned above. The result of these revisions should be factored into the findings as appropriate. If the controlled area may have to extend into Canyonlands National Park, then DOE should consider further analysis of 1) effects on Canyonlands National Park and 2) acquiring jurisdiction and control of this land and giving the basis for such an acquisition in the final EA quality and site ownership and control guidelines.

Comment 12

Potential Field Studies in Canyonlands National Park

Guidelines on Environmental Quality 10 CFR 960.5-2-5(a), (c)(3), (d)(2), and (d)(3).

The program of field investigations proposed in Chapter 4 of the draft EA does not address many of the geologic and hydrologic features and conditions in and in close proximity to Canyonlands National Park which might be important to repository performance. Also, consideration has not been given to the possibility that a larger control area might be needed than is presented in the draft EA (see major comment 11). The apparent incompleteness of the field program outlined would result in an under-estimation of the environmental impacts the field program will have on Canyonlands National Park.

Tectonic features, such as the Imperial fault zone, and salt dissolution features, such as the Grabens and Needles fault zones are present in the park. The relationship of such features to subsurface stratigraphy, dissolutioning and ground water flow is presently not well understood. The draft EA does not present a program that would resolve the NRCs concerns regarding tectonic features and dissolution (see major comments 1 and 2).

The Shay Graben appears to be part of a tectonic system that also includes the Bridger Jack and Salt Creek grabens (see detailed comment 3-10). This system is a potential active fault zone, a potential source of earthquakes, and a potential area of dissolution. It does not appear that a sufficiently detailed field program has been planned to fully evaluate this complex structural zone. The need for more borings, seismic lines and trenches has not been considered in the draft EA. This system lies within and in close proximity to Canyonlands National Park.

The DOE has identified several geophysical anomalies which do not appear to have been sufficiently analysed (see major comments 1 and 2). Until these anomalies are understood with respect to structure and dissolution, it is impossible to predict the effect they will have on waste isolation. These features appear to overlap the eastern boundary of the park, therefore, investigations of these anomalies may have an effect on the park. The proposed field program in the draft EA does not include evaluations of these features.

The hydrologic testing scheme proposed for site characterization in chapter 4 does not describe any data collection between approximately 2 km and 22 km down gradient from the edge of the Geologic Repository Operations Area. The draft EA includes no technical justification for limiting intensive characterization to within 2 km of this area. The testing scheme may appear to be defensible on the basis of the hydrogeologic setting description presented in the draft EA which indicates that all radionuclide transport requirements can be met within an area of limited horizontal extent. However, the NRC concludes that this testing scheme may not be consistent with the present level of uncertainty regarding the possibility of certain hydrogeologic conditions such as localized upward gradients, flow thru interbeds and vertical structurally controlled flow (see detailed comment 4-2).

If a larger controlled area is needed (see major comment 11) which might overlap the park boundary, then evaluations are needed in the final EA to determine if additional site characterization activities are needed in this area.

The field program proposed in the draft EA does not appear sufficient in scope to resolve many of the potential technical concerns. The NRC, therefore, considers the above concern has not been adequately factored into the analysis in support of the Environmental Quality Guidelines 960.5-2-5(a), 960.5-2-5(c)(3), 960.5-2-5(d)(2) and 960.5-2-5(d)(3).

In revising the draft EA, the DOE should consider re-evaluating the field investigation program to determine if it will provide the information necessary to address the concerns raised above. The DOE should also consider revising those portions of the draft EA dealing with effects on Canyonlands National Park to reflect any revisions to the field program.

Comment 13

Comparative Evaluation of Sites Against Guidelines on Surface Flooding

Guidelines on Surface Characteristics 10 CFR 960.5-2-8(c) and Hydrology 10 CFR 960.5-2-10(b)(2).

In assessing the guidelines relating to surface water flooding (960.5-2-8(c) and 960.5-2-10(b)(2)), DOE appears to be inconsistent among the nine sites. DOE correctly concludes that at two sites (Deaf Smith and Swisher) the repository facilities are not subject to surface water flooding while at the other seven sites they are. The sites that are subject to flooding would have to be flood-protected in varying degrees through the use of engineering measures. At four of those sites (Davis Canyon, Lavender, Cypress Creek, and Vacherie) DOE concludes that because flood protection would have to be provided the adverse condition (960.5-2-8(c)) is present and the favorable condition (960.5-2-10(b)(2)) is not. At the remaining three sites (Hanford, Yucca Mountain, and Richton) DOE concludes that since flood protection could be provided, through engineering measures, the adverse condition is not present and the favorable condition is. The seven sites susceptible to surface flooding have not been treated equitably.

We suggest that DOE decide whether credit for flood protection through engineering measures be considered in applying guidelines 960.5-2-8(c) and 960.5-2-10(b)(2) and then implement the decision consistently. We note that engineering measures, if properly designed and implemented, can be used to protect almost any site from almost any flood. Thus, a decision to allow credit for such flood protection may amount to eliminating the differentiation between sites with respect to these guidelines.

Comment 14

Comparative Evaluation of Sites

The draft EA's describe in Chapter 7 and Appendix B the relative weights given to post-closure and pre-closure guidelines. As required by the guidelines, DOE gave greater weight to post-closure guidelines (i.e., from 51% to 85% in applying the so-called utility estimation method). However, the staff notes that the spread of site ratings on individual guidelines (see, for example, Tables B-2 and B-3) is distinctly different between the post-closure and pre-closure analyses. The spread of ratings on pre-closure guidelines is much greater than it is for post-closure guidelines. The result of this wider spread is to have pre-closure guidelines dominate the overall ranking, notwithstanding the greater weight given to post-closure guidelines. It appears as if the ratings might be relative in nature as opposed to being an assessment of sites on an absolute scale. If ratings are indeed relative in nature, then inconsistent treatment of post-closure and pre-closure ratings may be interpreted as effectively going counter to the requirement that post-closure guidelines be assigned greater weight in site comparison.

The staff recommends that the description of the rating methods in the final EA be expanded to explain the reason for the wider spread on pre-closure ratings and, in general, to describe more specifically, the method of assigning ratings on individual factors.

Major Comments References

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DETAILED COMMENTS

EXECUTIVE SUMMARY COMMENTS

Comment E-1

Executive Summary, Subsection 2.2.6, Preliminary Decision on Nomination, Page 7, Paragraph 2

This paragraph appears to belong to another draft EA, presumably that of the Deaf Smith County Site, TX. The appropriate paragraphs for Davis Canyon should be inserted.

Comment E-2

Executive Summary, Section 3, the Site, Page 9, Paragraph 4

In the summary paragraph on hydrostratigraphic units in the Western Paradox Basin, the draft EA presents a comparison between the transmissivity of the upper and lower hydrostratigraphic units which is not supported by the available data presented in the draft EA and in referenced DOE literature.

The draft EA states that the "transmissivity of the lower hydrostratigraphic unit is generally lower than that of the upper [hydrostratigraphic] unit." This statement is not supported by the transmissibility [sic] data presented in Table 3-12 (pages 3-133 to 3-134) of the draft Lavender Canyon EA for borehole GD-1. Table 3-12 lists transmissibilities [sic] on the 8.89×10^{-2} to 1.2 m^2/d in the Leadville Limestone (the lower hydrostratigraphic unit) and ranging from 1.0×10^{-5} to 3.3×10^{-1} m^2/d in the upper hydrostratigraphic unit. Regional data also refute the conclusion that the upper units have higher transmissivities than the lower units (Woodward Clyde Consultants, 1982, Appendix A, Table A-5).

Comment E-3

Executive Summary, Section 3, The Site, Page 9, Paragraph 4

In the summary paragraph on the groundwater system in the Western Paradox Basin, the conclusion in the draft EA about interconnectedness of units and vertical flow between the upper and lower units is not conclusively supported by the available head data for the Paradox Formation at borehole GD-1.

The draft EA states that "there is a vertical downward hydraulic gradient from the upper to the lower aquifer." The data available pertaining to the heads in the middle hydrostratigraphic unit do not necessarily support the uniqueness of a gradient caused by a potential difference between the upper and lower aquifers, but are subject to a range of interpretations (see detailed comment 6-10).

Comment E-4

Executive Summary, Section 4, Effects of Site Characterization, Page 13, Paragraph 2

It is stated that "wildlife associated with the site would be displaced." This is a misconception for in most cases the species populations will eventually be reduced by the number of individuals the lost habitat supported (Kroodsma, 1985). The statement should be that wildlife habitat will be reduced by 240 acres which will need to be cleared for site characterization.

Comment E-5

Executive Summary, Section 5, Regional and Local Effects of Repository Development, Page 16, Last Paragraph

This paragraph provides an explanation of the types of transportation effects from increased commuter traffic and the hauling of supplies and radioactive waste. The second sentence states that radiological risks result from routine waste shipments; there is no mention of radiological risk from transportation accidents. It is suggested that DOE consider including an assessment of both routine and transportation accident effects in the summary.

CHAPTER 2 COMMENTS

Comment 2-1

Chapter 2 Site Selection Process

The NRC recognizes that there are no legal requirements for a formal quality assurance program to be applied to site screening information unless it is to be subsequently utilized in a license application. Nevertheless, assurance of the quality of data, analyses, and evaluations used in site screening decisions is an important factor. DOE should consider discussing the overall approach used in assuring that the quality of site screening data and associated analyses and evaluations are adequate for their intended use. Although this comment is being presented under Chapter 2, it applies to all of the draft EA chapters.

CHAPTER 3 COMMENTS

Comment 3-1A

Section 3.2.2.2, Erosion Processes, page 3-8 to 3-11

The rates of erosion presented in this EA are representative of the average but not the full range of values expected in the region. A more detailed discussion of the relationship of rates of erosion and scarp retreat should be presented in the final EA to justify the rates utilized in the analysis. In addition, as the operations area may be subject to rock falls or slides as a result of normal mechanical weathering processes and/or seismic loading, mass wasting and slope stability need to be addressed.

Comment 3-1B

Section 3.2.3, Stratigraphy, page 3-12 to 3-27 and Section 3.2.5, Structure and Tectonics, page 3-28 to 3-53

These two sections rely to a great extent on both McCleary, 1984, and Kitcho 1983 which are still in draft form. At the present time these two documents have many inconsistencies, the most noticeable being the interpretation presented for features such as the Imperial fault zone and the Shay/Bridger Jack/Salt Creek fault zone. (See McCleary figures A-28 and A-34 and Kitcho figures 4-10 and 4-11). In addition, the gravity and aeromagnetic anomalies and the relationship of these anomalies to structural features do not appear to have been analyzed. These two major data sets need to be reconciled.

Comment 3-2

Section 3.2.3.1, Regional Stratigraphic History of the Paradox Basin, page 3-14, paragraph 6

This section states that by the end of the Permian the formation of salt anticlines was well advanced but not complete, but does not state when or if this process was completed. As state of stress and salt flowage are important considerations for this site, a more detailed discussion of the timing and development of salt anticlines and associated structures is warranted.

Comment 3-3

Section 3.2.3.2, Subsection 3.2.3.2.11, Paradox Formation, page 3-25 paragraph 10

In the Gibson Dome borehole, the thickness of the Paradox Formation was determined to be 2889 feet; the thickness of the Paradox Formation beneath the Davis Canyon site is stated to be about 2500 feet; while at the Lavender site, it is estimated to be 1800 feet thick (Lavender Canyon draft EA).

The final EA should include a discussion of the cause of the thinning and an evaluation of its effect on selecting the configuration and location of the underground facility.

Comment 3-4

3.2.3.3, Thickness, Lateral Extent, and Characteristics of the Host Rock, Page 3-27, Paragraph 5

The draft EA underestimates the thickness of the carnallite marker bed in salt cycle 6 by approximately one-half, based on available data. The draft EA states that carnallite contents between 3200 and 3265 feet below Kelly bushing vary from 1.63 to 7.81 weight percent. This statement implies the carnallite bed is 65 feet thick in the GD-1 drill hole. In Figure 3-16 the interval from 3130 feet to 3270 feet is described as a zone containing dissolution features indicative of "high-solubility grains (potash?)". The relationship of these figures to the Table presented on page 3-110 is not clear. From the reference cited in the draft EA (Hite, 1983) Figure 3, the carnallite marker bed is considered to be 136' thick.

The thickness of this bed can be an important parameter in performance assessment calculations, because the repository horizon should not lie within the marker bed which contains elevated concentrations of H_2O and Mg. These components can lead to accelerated corrosion of the waste packages and increase the potential for radionuclide migration. Furthermore, the melting point of carnallite ranges from 130 to 165°C (Roedder and Bassett, 1981). Placing hot canisters in beds containing carnallite may produce partial melting of those beds. It is suggested this concern be addressed in the final EA.

Comment 3-5

Section 3.2.3.3 Thickness, Lateral Extent, and Characteristics of the Host Rock, page 3-27, Figure 3-13

The North trending fault overlaying the Gibson Dome area on Figure 3-13 does not appear on either Figure 3-17, Mapped Faults, or Figure 3-19, Reflection Time Contours Top of Mississippian. The DOE should consider expanding the discussion to include the origin, nature, and significance of this feature

Comment 3-6

Section 3.2.5, Structure and Tectonics, pages 3-28 to 3-53

The northwest trending structures in the area of Chesler Canyon appear to mark an area where the nature of deformation within the Graben fault system changes (McGill & Stromquist, 1979); therefore, it is an important feature in evaluating the tectonic processes operating in Grabens area. DOE should consider discussing these features in the final EA.

Comment 3-7

Section 3.2.5.1, Faulting, page 3-40, paragraph 2

The only fault mentioned to occur in the Davis Canyon area is a fault in the Precambrian inferred from seismic reflection data. Lack of data on type of fault, amount of offset, and orientation make it difficult to assess this fault with regard to the Geological Repository Operations Area and the current regional stress field. DOE should consider providing an explanation for how this fault is related, if at all, to Fault R shown crossing north of the Davis Canyon site in Figure 3-19.

Comment 3-8

Section 3.2.5.1, Faulting, pages 3-36, paragraph 1

This section proposes that the Lockhart fault may be a tensional feature resulting from collapse of the Lockhart Basin. If dissolution and subsequent collapse is proposed as the mechanism for the formation of this entire zone of faulting, the model developed for this feature should account for the fact that there are only northeast trending surface faults mapped near the Lockhart Basin.

The last sentence of this paragraph states that alluvial deposits have been ponded on the basin side of the Lockhart fault but do not appear to be displaced by the fault. The locations of observations made and descriptions of the observations need to be provided so that an independent evaluation of the conclusions can be made.

Comment 3-9

Section 3.2.5.1, Faulting, page 3-36, paragraph 2

Decrease of block rotations away from the Colorado River in the Needles fault zone is used as evidence that the dominant mechanism of faulting changes from salt flowage to down-dip sliding. The discussion does not address the likelihood that faulting initiated near the river and migrated to the east, or the possibility of collapse due to dissolution as an additional mechanism of deformation.

Evaluation of fault mechanisms (i.e. flowage, down-dip sliding, and collapse) is necessary to assess the potential for extension of the Needles fault zone into the site area. The extent to which each mechanism is operating and the conditions required for continuation of each mechansim should be discussed.

Comment 3-10

Section 3.2.5.1, Faulting, page 3-36, paragraph 6 and 7, and page 3-40, paragraph 1

This section states that the Shay/Bridger Jack/Salt Creek grabens may be an echelon series of grabens which may have formed in response to left lateral strike slip displacement at depth. This does appear plausible; however, the Sweet Alice and Dark Canyon faults may also be part of this system. As the Shay is reported to have displaced Quaternary deposits, because of their location and similarities, the Bridger Jack and Salt Creek are also potentially active. This series alone would require a large master fault. If, however, the Sweet Alice and Dark Canyon are also added to this system, an even larger, more significant seismotectonic zone is present in the site area which could require re-evaluation of the maximum credible earthquake for this zone.

Vertical displacement on the Shay graben is described, but no mention is made of lateral displacement. The interpretation of this fault forming in response to left-lateral movement at depth indicates the likelihood of lateral displacement at the surface. Sharply faceted spurs would seem to indicate recent movement. Although reactivation of an older fault is probable, no mention is made of the magnitudes of each period of movement. The amount of offset indicated by the faceted spurs and how much of the total offset occurred in this latest period of movement should be discussed. Adequate characterization of a fault system requries description of the entire history of faulting. Assigning an initial age of formation does not sufficiently describe its evolution.

DOE assumes at least two periods of movement; therefore, the sense of motion of each period should be discussed as they relate to each other.

There is no discussion of either the microearthquakes in the vicinity of the Shay graben (ONWI-492, Figure 2-7) or the four recent earthquakes east of those described in ONWI 492.

From orientations of the Shay/Bridger Jack/Salt Creek fault zone and its relationship to the Verdure-Glade graben systems, it is possible that these may be conjugate systems, with the former system having left-lateral displacement and the latter having right-lateral. If this is the case, it should be discussed. This may suggest that the graben systems have similar ages, but some variation is possible. If other information is available suggesting similar ages, it should be presented.

Characterization of fault parameters such as type, displacements, fault lengths, timing, ages, and sense of movement are important for the determination of past and possible future fault behavior. DOE should consider providing a more extensive discussion of these parameters in the final EA.

Comment 3-11

Section 3.2.5.1, Faulting, page 3-40, paragraph 2

The statement that most of these faults "die out in the lower part of the Paradox Formation" leaves open the possibility that plastic deformation of salt takes up displacement on faults in the basement rocks. Post-Pennsylvanian activity is not ruled out. No surface expression would be expected with this situation and this possibility should be discussed in the final EA..

The potential for fault movement in basement rocks underlying the site would have significant implications for repository performance, both with respect to ground motion and to deformation of the host rock. If displacement is taken up in the salt containing a repository, there may be greater potential for adverse effects than would be indicated by investigations of the surface exposures.

Comment 3-12

Section 3.2.5.2, Seismicity, page 3-45, paragraph 4

The seismicity implied to be associated with the Colorado lineament indicates a narrow zone along the Colorado River, as is shown in Figure 3-21. The text indicates a somewhat wider zone, and an average width of the lineament zone is given as 160 km on page 3-40, paragraph 3. Brill and Nuttli (1983) indicate the possibility of seismic activity within this zone where stress conditions are favorable. Ascribing seismicity to this feature suggests that stress is being released and DOE should consider evaluating and discussing the effects in the final EA in relation to the overall tectonic framework (see major comment No. 1).

Comment 3-13

Section 3.2.5.2, Seismicity, page 3-45, paragraph 4

The microearthquake swarm described in this paragraph and shown in Figure 3-21 defines a seismic zone at least 50 km long. Based upon an empirical fault length-magnitude relationship developed by Slemmons et al. (1982), a fault of this length could generate an earthquake of about Ms=6.3. Using the distance attenuation relationship developed by Joyner and Boore (1981) an event of this size, potentially as near as about 20 km to the Davis Canyon site, would be expected to cause horizontal ground accelerations of about 0.15g at the 50th percentile or 0.27g at the 84th percentile. Additional data concerning this seismic zone is needed to allow the reader to determine the adequacy of the conclusions reached in the draft EA text.

Comment 3-14

Section 3.2.5.2, Seismicity, page 3-45, paragraph 4

Available data concerning locations, magnitudes and sense of motion for earthquakes detected in the Shay Graben area and in the areas south and southwest of Davis Canyon need to be presented so that the reader can independently evaluate the draft EA conclusions.

Comment 3-15

Section 3.2.5.2, Seismicity, page 3-46, Figure 3-21

A map should be presented that shows the relationship of tectonic structures to seismicity so that the reader can determine if the conclusions in the draft EA are supported by the data.

Comment 3-16

Section 3.2.5.4, Uplift, Subsidence and Folding, page 3-49, paragraph 2

In view of the general aridity of the Paradox Basin during the Holocene, the lack of significant stream incision does not constitute definitive data in support of the conclusion that limited vertical crustal movement has occurred during this time, as this paragraph implies.

Comment 3-17

Section 3.2.5.4, Uplift, Subsidence and Folding, page 3-49, paragraph 6

Indian Creek Syncline is the closest known structure to the proposed site, yet the draft EA presents no discussion of its nature, origin and significance. In the final EA, DOE should consider discussing the relationship for this feature to the site and the regional tectonic framework.

Comment 3-18

Section 3.2.5.6, Dissolution, pages 3-50 to 3-53

Dissolution potential is a major concern at this site (see major comment No. 2), yet this section contains no discussion of potential dissolution in the Needles fault zone and the Shay/Bridger Jack/Salt Creek graben area. DOE should consider presenting this information in the final EA so that the dissolution guidelines will be better assessed.

Comment 3-19

Section 3.2.5.6, Dissolution, page 3-50, paragraph 4

On page 3-50, it is stated that relatively little dissolution is expected because the salt is overlain and underlain by relatively impervious carbonate strata. As these carbonates have been subject to dissolution, Karst topography had developed on the Leadville prior to deposition of the Pennyslvanian (ONWI-290, Vol. 1, p. 4-4) and the Leadville shows extensive dolomitization, fracturing and leaching (draft EA, p. 3-131), it is not clear why carbonate strata are expected to inhibit dissolution of the salt.

As an alternative to the suggestion that the carbonates will inhibit dissolution, DOE should consider the possibility that collapse into solution-created voids within the underlying limestone could create breccia pipes into the salt.

In addition, if it is assummed that dissolution is only possible when faults disrupt the Mississippian strata beneath the evaporite section, Fault R, Figure 3-19, should be considered as a potential focus for dissolution.

Comment 3-20

Section 3.2.5.6, Dissolution, page 3-50, paragraph 5

In this paragraph, dissolution in the Lockhart Basin is attributed to disruption of the salt sequence by a horst which allowed the water bearing Mississippian Leadville Limestone to come in contact with the salt-bearing formations. In Section 3.2.5.1, pp. 3-36, first paragraph, the Lockhart Fault is interpreted to have formed as a result of dissolution and subsequent collapse. In the Lockhart Basin, the general northwest trending faults are, therefore, the faults considered to control dissolution. If this theory is correct, the surface expression of structures is not indicative of the potential for dissolution to occur, but rather a reflection of areas where major dissolution has occurred. Considering the general lack of subsurface control near the site, it may be safe to assume the lack of surface expression may indicate that dissolution of the magnitude of the Lockhart Basin is not present at the site. How confident can DOE be that dissolution of a lesser magnitude is not expected at the site, especially if fault movement can be taken up by plastic deformation within the salt? Do northeast trending faults, of which the Lockhart fault is one, suggest that dissolution is more extensive in the area of the Lockhart Basin than the surface expression suggests? The final EA needs to present a more detailed discussion of the Lockhart Basin with emphasis on the implications this feature and its genesis has on the dissolution potential at the Davis Canyon site.

Comment 3-21

Section 3.2.6.1, Geomechanical Properties, Pages 3-53

A discussion has not been presented regarding the representativeness of the values for the geomechanical properties of Davis Canyon salt presented in Table 3-1 relative to the in-situ rock mass properties. Lacking this correlation, it is difficult to make judgments regarding the engineering properties of the in-situ rock. DOE should consider expanding this section to include a discussion on the representativeness of the samples tested relative to the in-situ rock mass. In additon, an estimate of sampling bias and core quality, and a discussion on problems associated with test sample selection and preparation should be included.

Comment 3-22

Section 3.2.7.1, Host Rock Chemical Properties, page 3-70, paragraph 3, and Section 3.2.8.8.2., Potash, page 3-109, paragraph 6

With present data base, there is little justification to assume potash mineralization does not occur at the site. The boundaries for both the potentially economic potash deposits and the zero potash deposits shown in Figure 3-25 are poorly constrained by the available data and the zero potash line includes portions of the Davis Canyon site. Conflicting evidence is presented in the table on 3-110, Figure 3-16 and Section 3.2.3.3 as to reported potash in the core of GD-1. The potash content is of concern for geochemistry, rock properties, dissolution and economic mineral deposits and, therefore, is a considerable concern for waste isolation.

Comment 3-23

Section 3.2.7.2, Hydrochemistry, Page 3-71, Paragraph 2&5

This section comments on the presence of brines within the clastic units of the Paradox formation, at the interface of the Paradox and overlying Honaker Trial formation, and at the bottom of the Paradox. To adequately determine waste package performance, it will be necessary to quantify the occurrence of brine pockets in the Paradox formation, particularily in salt cycle 6. Table 6-29, page 6-200, shows a condition by which unlimited brine could breach the canisters in 336 years for CHLW and 220 years for SFPWR. Large pockets near emplaced waste could supply unlimited brine to portions of the package. The DOE should consider including a more precise discussion on brine occurrence within the middle hydrostratigraphic unit and include discussion on the ramifications of large brine pockets on waste package stability.

Comment 3-24

3.2.7.2, Hydrochemistry Page 3-71, Paragraph 6

The possibility of dissolution at the proposed repository area is discounted by the DOE, despite evidence to the contrary. The statement is made that Cl^-/Br^- and Na^+/Cl^- ratios in water from the lower unit at GD-1 suggest that the high salinities of the water is related to salt dissolution. The next sentence says that much of the dissolution is interpreted to occur in the folded and faulted area of the Paradox Basin. However, GD-1 does not occur in the folded and faulted area of the basin. Possible explanations for this observation are that dissolution is occurring at or very close to GD-1 or that dissolution is occurring in the folded/faulted area and the high TDS brines are flowing to GD-1. There does not appear to be enough evidence to choose one explanation over the other.

Comment 3-25

3.2.7.2 Hydrochemistry, Page 3-71, Paragraph 7

The assertion that water in the Leadville Limestone is reducing is too strongly stated. The draft EA states that the Eh of water in the lower hydrostratigraphic unit, the Leadville Limestone, is between -140 and -240 millivolts based on platinum electrode measurements and calculations of the SO_4/H_2S redox couple. However, Eh measurements using a platinum electrode immersed in natural waters (complex systems) have been shown to be suspect possibly due to mixed potentials, non-equilibrium conditions, or electrode poisoning (Stumm, 1966). Furthermore, from the reference cited in the EA (McCulley et al., 1984, pp. 59-68) redox couples other than SO_4/H_2S were measured and found to give contradictory results, indicating the low degree of confidence which can be given these determinations. Thus, it is suggested that the assertion of low Eh be less strongly stated. In support of this statement, Lindberg and Runnells (1984) show that different sets of redox-sensitive species in the same groundwater often give different calculated Eh values indicating nonequilibrium conditions in low temperature groundwaters.

Comment 3-26

3.2.8.2.2, Potash, Page 3-110, Table (Unnumbered)

The discussion of the vertical extent of the carnallite bed conflicts with available data. The draft EA states that the carnallite bed is 14 feet thick and averages 1.0 wt % K_2O. However, from the cited reference (Hite 1982a, pp. 4-7) the thickness of the carnallite bed in salt cycle 6 is 120 feet. The spatial relationship of the repository to the carnallite bed may affect the ability of the repository to retain the radionuclides (see comments 3-4 and 6-15). Although as stated in the draft EA, 14 feet of salt cycle 6 does contain 1.0 wt. % K_2O, over 120 feet of salt contains approximately 0.25 wt % K_2O. It is suggested that a more complete discussion of the vertical extent of the carnallite bed be included in the final EA.

Comment 3-27

Section 3.3.2.1, Hydrology and Modeling, Page 3-127, Paragraph 6

Table 3-11 reportedly lists ranges of permeability and transmissibility values based on 230 drill-stem-test records. Transmissivity values are not presented in this table. The only transmissivity data provided in the draft EA are those from borehole GD-1. Regional transmissivity data are not cited though they are available in ONWI-290, Vol. V, Appendix A, Table A-5; nor is the method of analysis of these data in reaching draft EA conclusions presented. The problem can be resolved by correcting this citation of regional transmissivity data.

Comment 3-28

Section 3.3.2.1 Hydrology and Modeling, Page 3-132, Continuing Paragraph

The draft EA statements about hydraulic conductivity and effective porosity values for the Elephant Canyon at borehole GD-1 are not supported by the data from borehole GD-1. Furthermore, the term effective porosity is misapplied to the data from laboratory tests described in Thackston et al., 1984 (pp. 61-62).

The draft EA states that "the Elephant Canyon Formation at GD-1 yields laboratory conductivity values significantly higher than field values where individual strata have high effective porosity." The test data for borehole GD-1 (Thackston, et al., 1984, ONWI-491, Table 4-1 and Table 4-2) do not support this statement. Three intervals have been tested in the Elephant Canyon Formation. For each interval, the field and laboratory core values are within one order of magnitude. Considering the uncertainty inherent in conductivity values extrapolated from drill stem data, compounded by the uncertainty of using laboratory data to determine field properties, these values are not significantly different. For the case with the highest (so-called) effective porosity (Sample #7) the laboratory and field hydraulic conductivity values are particularly close with laboratory K_V varying from $2.3x10^{-5}$ to $3.4x10^{-5}$ cm/sec, K_H varying from $4.7x10^{-5}$ to $8.3x10^{-5}$ cm/sec, and the field K given as $2.4x10^{-5}$ cm/sec. Thus, the relevance of the phrase "where individual strata have high effective porosity" is unclear.

The term effective porosity as defined for advective flow velocity is misapplied to the laboratory test explained in Thackston et al. 1984 (pp. 61-62). The laboratory core analysis for effective porosity measures the volume of interconnected voids in the core sample divided by the bulk volume of core sample, which has been termed the "apparent porosity" (Loo, et al., p. 11). The effective porosity is given by the volume of interconnected voids actually contributing to flow divided by the bulk volume of rock. This distinction is important because the effective porosity is less than or equal to the apparent porosity; therefore, advective flow velocities, calculated with true effective porosities will be greater than or equal to flow velocities calculated using apparent porosities. Because effective porosity is defined with respect to advective flow (c.f. Bear, 1979, p. 63), the only sure method of measuring effective porosity is with tracer tests. The apparent porosity can be considered to be an upper bound on the effective porosity; the difference between apparent and effective porosity will depend upon the hydrogeologic system.

Comment 3-29

Section 3.3.2.1, Hydrology and Modeling, page 3-132, Paragraph 1

The description of the upper hydrostratigraphic unit does not appear to be supported by alternate interpretations of the available hydrochemical data presented in Section 3.2.7.2 of the draft EA.

In Section 3.3.2.1 (Hydrology and Modeling), the Elephant Canyon and upper two-thirds of the Honaker Trail are considered as one hydrostratigraphic unit. However, anomalous variations in the TDS data from borehole GD-1 are interpreted to suggest that (a) what is considered to be the upper hydrostratigraphic unit may be taken to be two separate hydrostratigraphic units (draft EA page 3-71, paragraph 1) or, (b) the high TDS values indicate the presence of dissolution (draft EA page 3-71, paragraph 2).

These variations in water chemistry may be the result of nearby salt dissolution which is occurring up gradient from the borehole. Also, high-TDS water in the Elephant Canyon and Honaker Trail Formations may have originated in the Paradox Formation. Though DOE has ruled out the possibility of upward flow between these units (draft EA, p. 6-81 paragraph 2), interpretation of data from borehole GD-1 can support the potential for localized upward gradients from the Paradox Formation as a source of high-TDS water (see detailed comments 3-31 and 6-10).

Determining the nature and characteristics of groundwater flow within the stratigraphic sequence above the proposed repository horizon is important to developing a valid conceptual flow model and assessing repository performance. Therefore, DOE should consider all alternatives until sufficient data are available to determine the best conceptualization.

Comment 3-30

Section 3.3.2.1, Hydrology and Modeling, page 3-141, Figure 3-40

DOE presents a map (Figure 3-40) of the potentiometric surface of the lower hydrostratigraphic unit which includes incorrect values and inconsistencies when compared with the referenced data source (Woodward-Clyde, 1982, Vol. V, Appendix A). A revised potentiometric map based upon consideration of the concerns discussed below would alter flow direction to a northwest direction.

Figure 3-40 may include an incorrect head value. A well located immediately west of borehole GD-1 is labeled with a head value of 4,195 feet on Figure 3-40, but is listed at 3,612 feet in Appendix A (Woodward-Clyde, 1982, Vol. V). A change of the plotted value to 3,612 feet alters the shape of the potentiometric surface significantly by creating a major reentrant for the 4,000 to 3,600 foot contour lines. Given a revised potentiometric map based on this change, the flow path direction under the Davis Canyon site changes to a strong northwest trend; flow goes more directly toward the Colorado River.

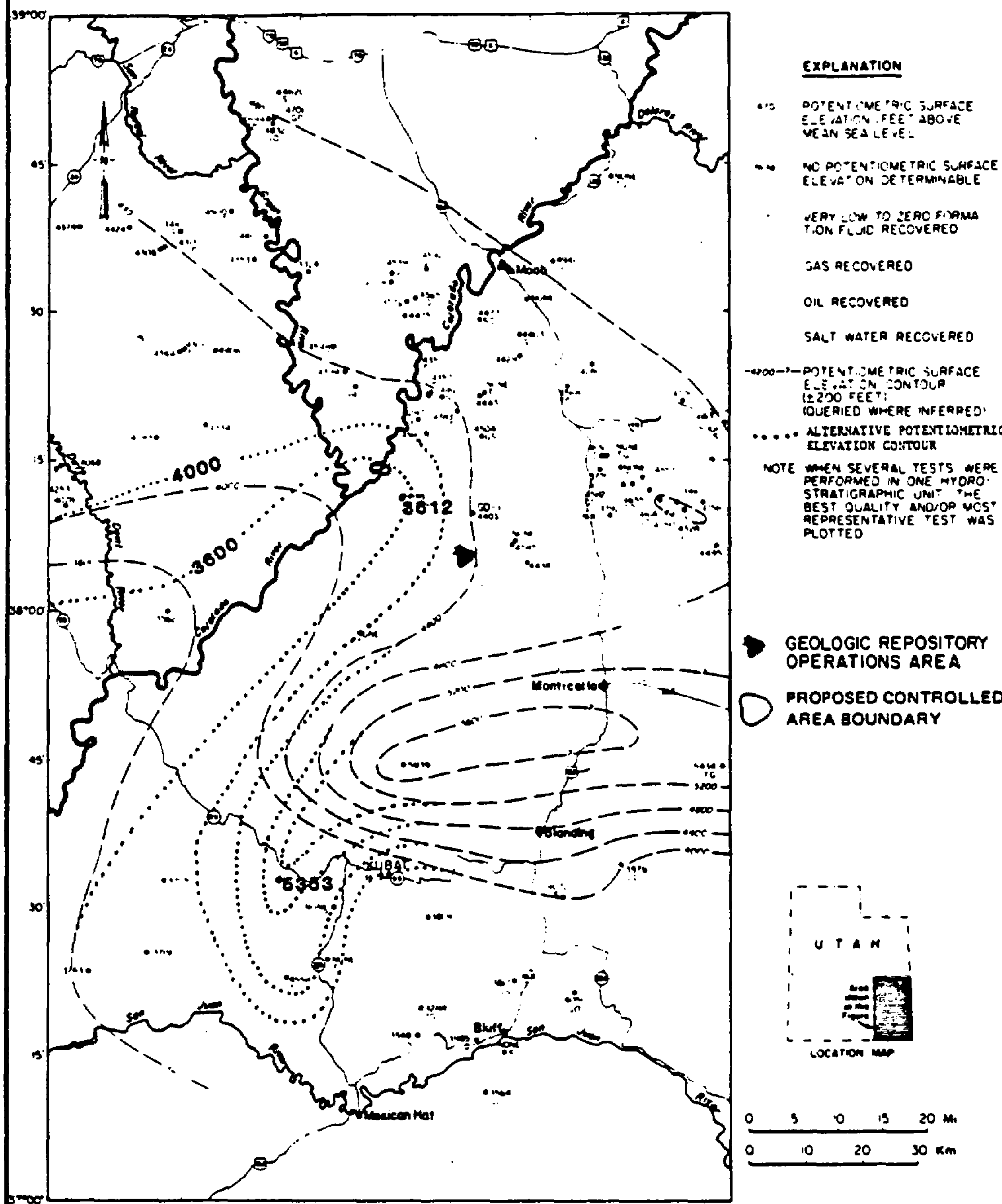
There are additional discrepancies between Figure 3-40 and Appendix A. Some wells plotted in Figure 3-40 are not listed at all in Appendix A. For example, a well located near the northwest corner of the map area, with a head value of 4,379 feet, is not listed in the appendix. Conversely, some wells listed in the appendix are not plotted on Figure 3-40 or its earlier versions. For example, a well listed in Section 27 of T.37 S., R.17 E., apparently has not been plotted in the figure. If this well is plotted and the correct value is plotted for the well near borehole GD-1, the shape of the potentiometric surface is altered significantly. In addition, many of the wells listed in Appendix A (Woodward-Clyde, 1982), have head values obtained from testing more than one interval. A note on Figure 3-40 indicates that a selection process was used to determine which one of the values was to be plotted; however, no discussion is presented in Woodward-Clyde (1982) or the draft EA to explain the basis of the selection process. Selection of values other than those used could also significantly alter the potentiometric surface map.

Replotting of Figure 3-40 after the alterations described above can produce an alternative potentiometric surface for the Leadville Formation. The configuration of the alternative potentiometric surface map is presented below (see Figure 3-A). This alternative potentiometric map indicates the Colorado River may be a much stronger hydraulic sink northwest of the geologic repository operations area than was the case for the original map. The gradient between the repository and the river is steepened.

The higher gradient parallel to the Colorado River northwest of the repository site suggests that a permeability change may exist in the Leadville Formation in the vicinity of the junction of the Colorado and Green Rivers. Groundwater gradients frequently reflect permeability changes caused by structural features that control surface drainage.

Comparison of the alternative potentiometric surface map presented herein with the map shown in Figure 2 of Hanshaw and Hill (1968) reveals a similar magnitude and direction of gradient on both maps. Unfortunately, however, Hanshaw and Hill do not show data points on their map. Another difference between the draft EA potentiometric map and the Hanshaw and Hill map which will require further clarification as site characterization proceeds is the nature of recharge to the lower hydrostratigraphic unit in the vicinity of the Abajo Mountains.

Flow rates and direction should be re-evaluated once possible discrepancies in the head map are resolved because flow rates in the Leadville Formation are used in the evaluation of Guideline 960.4-2-1(b)(1).



Potentiometric Surface, Lower Hydrostratigraphic Unit

NRC FIGURE 3-A AFTER DOE FIGURE 3-40

Comment 3-31

Section 3.3.2.1, Hydrology and Modeling, Page 3-133 to Page 3-135, Table 3-12

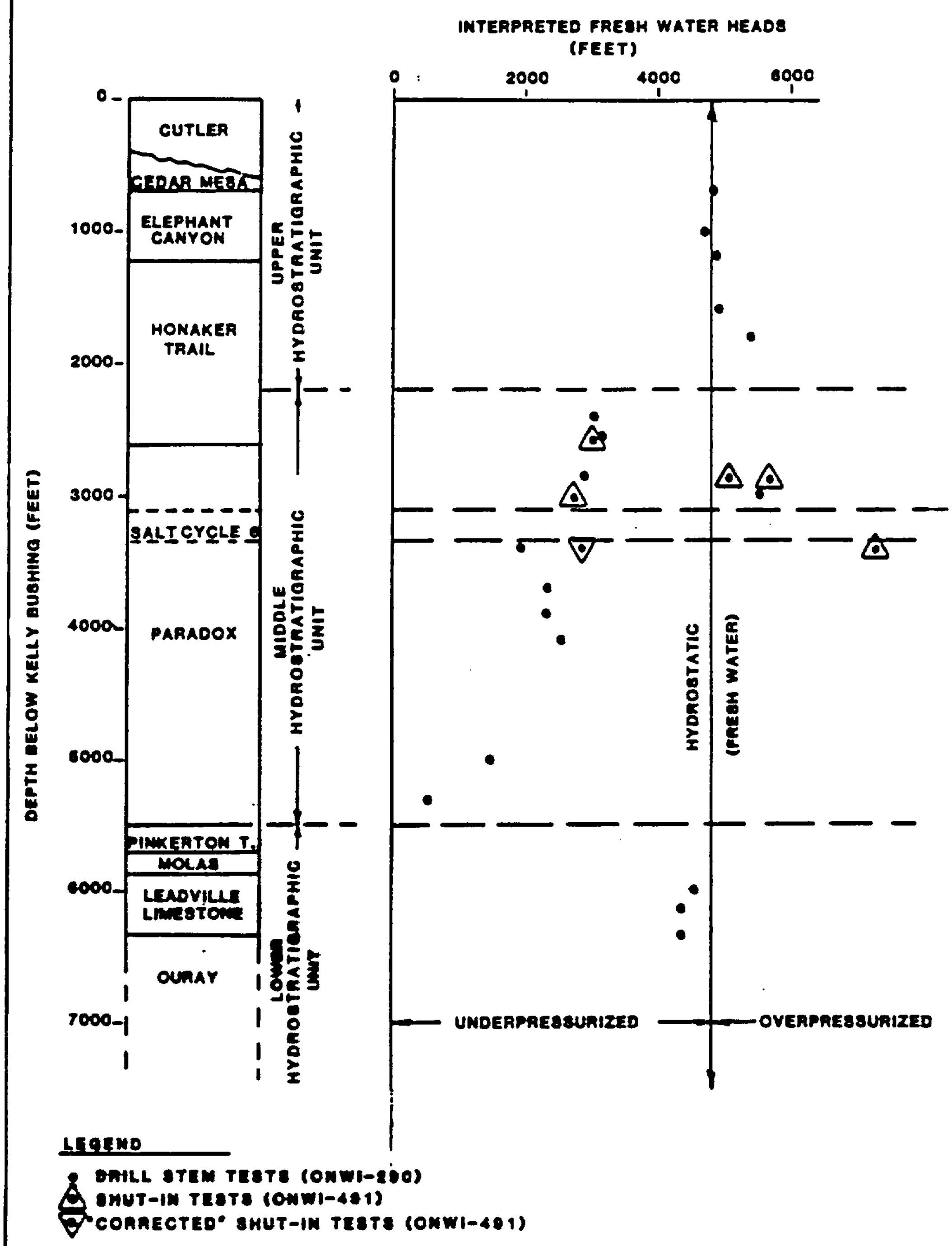
This Table does not show all potentiometric head data collected by DOE at borehole GD-1 which are used to support conclusions in the draft EA. If the potentiometric and estimated static reservoir data collected in the second series of tests (August-September, 1982) at borehole GD-1 were added to this table, complete consideration of the range of possible interpretations of gradient and flow direction for the middle hydrostratigraphic unit would be facilitated.

Head data from borehole GD-1 are variable. Figure 3-B (on previous page) depicts the short-term drill stem test head data (data points shown as circles) presented on Table 3-12 of the draft EA which were collected at borehole GD-1 from March 1980 to January 1981. The figure also shows the long-term shut-in test data (shown as triangles) collected at borehole GD-1 during August-September 1982 (Thackston, et al., 1984, Table 4-2). The Figure indicates that the potentiometric head profiles within each of the upper and lower hydrostratigraphic units each separately conform to a hydrostatic profile 0.4333 psi/ft (Thackston et al., 1984, p.11). In contrast, head within the Paradox Formation varies considerably with depth. The NRC concludes that consideration of the long-term test data increases the variability of measurements significantly. The long-term test data can be interpreted to indicate several alternative hydraulic conditions at borehole GD-1, including overpressurized and underpressurized conditions, as well as the possibility of localized upward and downward gradients. If there is localized vertical interconnection in these units, these head data suggest that there may be localized downward and upward flow. Hydrochemical data from borehole GD-1 may further substantiate the potential for localized upward gradients between the middle and upper hydrostratigraphic units (see detailed comment 3-29).

The NRC recognizes the difficulties encountered in data collection and interpretation of tests performed within low permeability units such as borehole GD-1. DOE has identified uncertainties related to the need for extended monitoring of pressure when testing tight formations, as well as the effect of salt squeeze on test results (Thackston et al., 1984, p.73 and p. 81). Other uncertainties related to extrapolating potentiometric head data from drill stem test records are recognized in various sections of the draft EA (e.g. p.6-80, paragraph 5).

These considerations indicate clearly the degree of uncertainty that should be recognized and considered when interpreting the head data taken within the host rock and surrounding units. Given the level of uncertainty, and the limited data available at this time, all available data should be presented for consideration.

NRC FIG. 3-B. FRESH WATER HEADS FROM TESTS IN GD-1



NOTE: POINTS LOCATED IN CENTER OF TEST INTERVALS

Comment 3-32

Section 3.3.2.1, Hydrology and Modeling, page 3-142, paragraph 3

The draft EA states that a basic conclusion from a study by Dunbar and Thackston (1984) is that "the conceptual ground-water flow system model is realistic." The NRC concludes that the conceptual model presented by DOE is not conservative in many respects (see major comment 3) and may not be realistic with respect to horizontal and vertical flow in the Paradox Formation (see detailed comments 3-31, 6-4, and 6-10), and the regional flow system (see detailed comment 6-9).

Comment 3-33

Section 3.3.2.1 Hydrology and Modeling, Page 3-142, Paragraph 4

In support of the statement that "little or no influx of external groundwater has occurred since early diagenesis of this salt deposit," the statement is made that "based on geophysical logs of petroleum exploration holes and the GD-1 borehole, the Paradox evaporite sequence is laterally extensive in the candidate area (McCleary et al., 1983, ONWI-485, Figure A-12; McCleary, 1984, Figures 4-6 through 4-9) and shows no dissolution of the salt in the site vicinity."

The NRC has commented (major comment 2) upon the treatment in the draft EA of likely present and potential dissolution in the site vicinity, and has identified uncertainties not presented by DOE. Specifically, the lithologic definition of the cited geophysical logs is considered by NRC to be adequate for identification of major dissolution features, such as missing units; but not adequate for identification of signs of lesser amounts of dissolution. In addition, the lack of localized dissolution based upon interpretation of geophysical logs may not be defensible given the regional sparsity of available data. Groundwater flow associated with dissolution along structural features could exist within a laterally extensive evaporite sequence which has otherwise sustained no influx of external groundwater.

Given these uncertainties, the NRC considers that minor dissolution, and groundwater flow associated with dissolution along structural features cannot be discounted based upon the available data.

Comment 3-34

Section 3.3.2.1, Hydrology and Modeling, Page 3-143, Paragraph 2

The draft EA presents a two-point interpretation of the potentiometric data available for the middle hydrostratigraphic unit, which includes the Paradox Formation. The NRC considers that additional interpretations of these data which infer potential vertical and horizontal flow paths and gradients within the middle hydrostratigraphic unit are equally defensible and should be included (see detailed comments 3-31, 6-4, and 6-10).

Comment 3-35

Section 3.4.2.2 Aquatic Ecosystems, Page 3-158 and 3-159

A brief discussion is presented on the fishery biota of upper Indian Creek, which is outside the project area of potential impact. Data on biotic populations are not presented for that portion of Indian Creek near the site, and downstream of the site. It is stated that Cottonwood Creek, most intermittent drainages into Indian Creek, and "other portions" of Indian Creek do not support fish populations. No information in support of these conclusions are cited. Field studies conducted in these creeks should be cited to support the statements. Section 3.4.2.3 (page 3-159) states that fish collections were made in Indian Creek. A discussion of those studies should be provided. The confirmed status of the biota are important to the analyses of impacts. No data are presented on the non-fish biota of the streams -- aquatic invertebrates, amphibians, etc.

Comment 3-36

Section 3.4.2.2 Threatened and Endangered Species, Page 3-159

Information on the biology and life history of the fishes razorback sucker and Colorado squawfish in the Colorado River, in relation to the potential impacts associated with the project are not provided. It is suggested that DOE assess the impact potential of water withdrawal on these protected species and that information is included on their life history near the proposed intake location.

Comment 3-37

Section 3.4.3, Air Quality and Meteorology, pages 3-159 to 3-169

No discussion of small scale atmospheric dispersion conditions is presented. In Section 3.4.3.1, Existing Air Quality, a discussion of large scale dispersion conditions is presented. Since the proposed site is located in a mountain valley, small scale dispersion conditions are important in the assessment of dispersions of pollutants within the first few kilometers from the site. Therefore, it is suggested that an assessment of the frequency of occurrence of various small scale dispersion conditions (atmospheric stability) be considered.

Comment 3-38

Section 3.4.3.6, Severe Weather, page 3-169

Assessments of the occurrence and magnitude of severe weather phenomena are not provided. In order to determine the significance of potential hazards due to severe weather as compared to other sites, quantitative assessments of the occurrence and magnitude of these phenomena should be considered. For example, it is suggested that the discussion of tornado occurrence include an estimate of strike probability for the site. Also, it is desirable to provide the duration of heavy fog.

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CHAPTER 4 COMMENTS

Comment 4-1

Section 4.1.1, Geophysical Studies, pages 4-18 to 4-19

This comment was incorporated elsewhere in the comment package.

Comment 4-2

Section 4.1.1.1, Geologic and Hydrologic Studies, Page 4-14, Figure 4-3, and Page 4-16 to 4-16a, Figure 4-4

The hydrologic testing layout for site characterization presented in the draft EA does not describe any data collection between approximately 2 km and 22 km down-gradient of the site. DOE has provided no technical support for this testing scheme. The NRC concludes that this scheme may not be consistent with the present level of uncertainty regarding data needs for site characterization, on the basis of the concerns discussed below.

All six hydrologic test wells (DC-1, DC-2, BB-1, BB-2 and 3 upper unit test wells) and the only stratigraphic confirmation borehole (SC-1) down-gradient of the site are less than 2 km, or more than 22 km from the site (measured from the edge of the geologic operations area). The down-gradient direction is derived from Figures 3-39 and 3-40. Consequently, at least 18 km of unexplored terrain lie between distances of 2 km and 22 km from the site in the west and southwest directions from the site. No data collection is planned beyond 2 km in the west-northwest direction of the site.

This testing scheme may appear to be defensible on the basis of the description of the hydrogeologic setting now accepted by DOE. Briefly summarized, the draft EA DOE proposes downward matrix flow through the host rock and underlying layers to the Leadville Limestone, through which it flows westward. The travel time to the Leadville Limestone is calculated by DOE to be 125,000 years (Section 6.3.1.1.1). Thus it would appear that all radionuclide transport requirements would be met within an area of small horizontal extent; and might also appear that verification or fine-tuning of such a conceptual flow model could be accomplished with testing over relatively short distances from the site.

The NRC considers, however, that this testing scheme may not provide adequate data to characterize the groundwater flow system. DOE should consider incorporating many concerns and uncertainties into its conceptual flow model which the NRC considers crucial to waste isolation. The NRC concludes that if certain conditions are found to be present near the site as a result of additional testing, such as localized upward gradients, flow through interbeds, and vertical structurally controlled flow, then the units above and below the

Paradox Formation would have to supply some of the waste isolation capability which at this time DOE considers to be supplied by the host rock (in the Paradox Formation). The potential imcompleteness of the field program may result in an underestimation of the environmental impacts the field program will have on Canyonlands National Park.

In revising the draft EA, DOE should consider the need for hydrologic testing west of the site and either revise the test plans or provide an explanation for why testing is not necessary which takes into consideration the concerns mentioned above.

Comment 4-3

Section 4.1.1.1.5 Lower Hydrostratigraphic Unit Test Wells - Activity Requirements, Page 4-15, Paragraphs 7 through 9

There is no discussion in this section of what will be done with the water pumped from the tests of the lower hydrostratigraphic unit. In the three-well interference tests the pumping well will be operated continuously for approximately one week and five such tests are planned over a period of two years (Figure 4-1). Depending on the pumping rate, these tests may produce a significant amount of water.

Two potential problems might occur depending on how or where the water from the lower tigra hydrostraphic units is discharged. The first is the possible adverse environmental effects of disposal of high-TDS water. Secondly, if water is ponded or is allowed to flow overland such that it recharges the upper hydrostratigraphic units, it might affect the local baseline (head and water quality) data being collected to characterize the upper units.

To resolve these two matters, disposal of pumped brines should be discussed in §4.2.1.4 Water Quality Effects. Possible effects on baseline hydrogeologic data should be included in §4.2.1.5 Effects on Soils, Geology and Paleotology, or §4.2.1.4.2 Ground Water.

Comment 4-4

Section 4.1.1.1.5, Lower Hydrostratigraphic Unit Test Wells, page 4-15, paragraph 1

The fate of the abandoned wells is not discussed. This information is needed to allow the reader to assess potential environmental impacts.

Comment 4-5

Section 4.1.1.1.8, Trench at Shay Graben, pages 4-17 to 4-18

The trench and seismic surveys (Section 4.1.1.2.) will provide information on the Shay Graben; however, there appears to be little effort planned to investigate the other graben structures. There are many questions, especially with regard to their tectonic and seismic characteristics, dissolution potential and fault interrelationships which need to be answered. Their echelon nature suggest they could be the surface expression of a very large east-west trending fault system. It is suggested that additional geophysical and geological studies should be considered including concentrated studies on the Salt Creek and Bridger Jack structures, and possibly the Sweet Alice and Dark Canyon features, to determine their regional significance. Such studies could impact both the Park and the Wilderness Study Area.

Comment 4-6

4.1.1.2 Geophysical Studies

The seismic survey methods described in Chapter 4 of the draft EA might be supplemented by techniques which we less disruptive to the environment. The methods given use standard oil field methods which use an energy source consisting of several large vibrator trucks. DOE should consider the possibility of modifying or supplementing the planned surveys with both high-solution shallow reflection and seismic refraction surveys which utilize a high frequency energy source. The techniques are especially suited for obtaining information in the upper 2000 feet of the stratigraphic section. They also do not require large truck mounted energy sources and therefore are much less disruptive of the surface in environmentally sensitive areas.

Comment 4-7

Section 4.1.2, Exploratory Shaft Facility, Page 4-21, Paragraph 7

It is stated that 4,000 linear feet of drift will be needed to connect the two shafts and to support site suitability and at-depth testing. However, no drifting is planned to characterize the actual repository storage area where the HLW is to be emplaced. It is important to gain reasonable assurance that the "host rock is sufficiently thick and laterally extensive" as stated in 10 CFR 960.4-2-3, Rock Characteristics.

Knowing the types and locations of anomalies thay may be expected in the repository area is important for brine migration, stability of openings and retrievability assessments. DOE should consider expanding the section to address the above conerns.

Comment 4-8

Section 4.1.2.4, Final Disposition, Page 4-57, Paragraph: All

If the site is found suitable and is selected for the first repository, the Exploratory Shaft facility may be incorporated into the repository design (Page 4-7, paragraph 1). It is unclear how such a decision will be reached and what the environmental impacts would be if the ESF does not become a part of a repository. This information is critical to an assessment of the performance of the shaft pillar area or the shaft seal system, or to identify/evaluate further environmental impacts. The DOE should consider expanding the discussion presented to address and provide clarification of the above point in the final EA.

Comment 4-9

Section 4.1.2.4.2, Shaft Backfill, Page 4-59, Paragraph 1

This comment was incorporated elsewhere in the comment package.

Comment 4-10

Section 4.1.2.4.7, Final Grading, Topsoil Replacement, and Revegetation, pages 4-60 to 4-61

The cumulative erosion risk could be significant, but is not discussed in the draft EA, nor is a time for effective revegetation stated.

Comment 4-11

Section 4.2.1, Expected Effects on the Natural Environment, page 4-77, Paragraph 4

It has been determined that proposed field activities appear not to conflict with the BLM Indian Creek-Dry Valley Management Framework Plan and the San Juan County Master Plan, but may conflict with the Canyonlands General Management Plan and the statement for management of the National Park Service. Adverse impacts on the Canyonlands National Park are important in the assessment of the Davis Canyon site; therefore, it is desirable to identify specifically what is or may be in conflict with the Canyonlands General Management Plan.

Comment 4-12

Section 4.2.1.2.1, Terrestrial Biota, Page 4-79, Paragraph 1

It is stated that "secondary impacts" to wildlife may occur. However, there is no indication of what or how severe these impacts are. It is suggested that DOE discuss what or how severe secondary impacts are.

Comment 4-13

Section 4.2.1.2.1, Terrestrial Biota, Page 4-79, Paragraph 3

It is stated that after decommissioning, disturbed areas will be restored to pre-existing contours. It is possible that it would be an environmentally desirable option not to restore the site to its pre-existing contours. For example, a depression might function as a temporary water retention area valuable for wildlife. Therefore, it is suggested that the final determination of the site restoration be left open until near the time it will be performed, in order to restore the site in a manner compatible with its future use. The same statement is made on page 4-80, paragraph 1.

Comment 4-14

Section 4.2.1.2.2, Aquatic Biota, Page 4-80

DOE states in the draft EA that measurable changes in the salinity of Indian Creek and Colorado River are unlikely to occur from site activities. Conversely, in the last sentence of the paragraph, it is stated that "Runoff from soils contaminated by windblown salt may increase salinity in receiving streams." It is suggested that these inconsistencies be resolved. If the excavated salt is not contained properly in the onsite facilities, impacts may occur to aquatic habitat downstream of Davis Canyon, including Indian Creek, and perhaps a portion of the Colorado River.

Comment 4-15

Section 4.2.1.2.2, Aquatic Biota, Page 4-80

It is stated that 0.4 km (0.25 mile) of the 12 miles of available trout habitat in Indian Creek may experience increases in turbidity and/or siltation, presumably from drill pad-associated activities nearby. Further, it is stated that no significant impacts to trout are expected. The basis for the conclusion is not provided. This 12-mile section of stream is classified as a Class 2, high priority, fishery resource (draft EA Section 3.4.2.2), one that may experience increased recreational fishing pressure, and is one of the few coldwater streams of the area (draft EA Section 5.2.4.2.1). In view of these facts, an impact to any portion of this small, yet significant, stream has the potential to impact its fishery. It is suggested that DOE provide support in the final EA for the conclusion that turbidity and/or siltation will have no significant impact on the trout.

Comment 4-16

Section 4.2.1.3, Air Quality Effects, pages 4-86 and 4-87

The effect of background air quality is not addressed in a complete manner. The assessment of air quality requires consideration of background, as well as local emissions. It is suggested that, in order to be consistent in providing a "worst case" assessment, consideration be given to including a background value between the annual average and the maximum 24-hour values in the assessment.

Comment 4-17

Section 4.2.1.3.1, Activities and Emission (Mitigation), page 4-85

Clarification of the effects of mitigation on air quality assessments is needed. Mitigation of air pollutant emissions during site characterization activities is discussed. However, it is not clear whether the mitigating factors are included in the emission rates given in Tables 4-20 and 4-21 on page 4-84. It is suggested that these factors and their bases be provided in the final EA.

Comment 4-18

Section 4.2.1.3.2, Air Quality Consequences, pages 4-88 to 4-92

Figures 4-15 through 4-17 show isopleths of predicted concentrations with higher values at greater distances in the southeasterly directions. Wind direction frequencies and airflow patterns are not included in the discussion of local meteorological conditions in Section 3.4.3. Without this information, the adequacy of the air quality assessments cannot be determined. It is suggested that the basis for showing these elongated isopleths in the southeasterly directions be presented in the final EA.

Comment 4-19

Section 4.2.1.3.2, Air Quality Consequences, page 4-89, paragraph 1

The calculated maximum 24-hour TSP offsite incremental concentration is 298 micrograms per cubic meter, which exceeds both the primary and secondary EPA-NAAQS (Table 4-19, page 4-82). Also, it is stated that this concentration should be reduced by a factor of two for the first 3 months of ESF construction and by a factor of five during the remainder of the construction period (17 months). It is suggested that the basis for these reduction factors be provided in the final EA.

Comment 4-20

Section 4.2.1.4, Water Quality Effects, Page 4-95

The exploratory shaft facility area plan (Figure 4-6) and the following discussion (Section 4.2.1.4) indicate that the exploratory shaft will be located in a flood plain, but above the 100-year flood level. Because of the value and usefulness of the in-situ test data that will be collected it does not seem prudent to design a shaft of such unprecendented size and depth for only a 100-year flood.

Based on the preliminary site location, it appears that the exploratory shaft will be located in a area that will experience high flood velocities that may present design difficulties; the steepness of the natural and man-made channels appears to be such that very high flow velocities could be produced by routine flood events.

NRC staff experience with floods during the construction of important structures, such as nuclear power plants, has indicated that the benefits of designing for a larger flood normally outweigh the costs of providing the necessary flood protection. In addition, if the shafts become a part of the surface facility design during repository operations, a larger design basis flood will likely be selected for the operational period. Therefore, it is strongly suggested that a larger flood, such as the probable maximum flood (PMF), be used for the design and location of the exploratory shaft and its appurtenant facilities.

Comment 4-21

Section 4.2.1.4.1, Surface Water, Page 4-95, paragraph 7
Section 4.2.1.4.2, Ground Water, Page 4-97, paragraph 1

In the discussion of surface water quality effects from site characterization, the draft EA states that water "would be obtained locally from wells or purchased from nearby municipalities..." and that "local surface water would not be used." In the subsequent section, the draft EA states that because "water requirements would probably be met from surface water supplies trucked to the site, no effects on the local groundwater flow regime are expected...". These quotes reflect an inconsistency regarding the source of water and the potential impact of water use on site surface and groundwater quality at the site. Clarification of the water source and its impact as well as definition of the term "locally" is needed.

Comment 4-22

Section 4.2.1.4.2 Ground Water, Page 4-97, Paragraphs 1-4

This section does not address the impact upon the groundwater flow regime of exploratory shaft construction.

Though the water needs for the shaft construction will be satisfied by water trucked in from outside the site, excavation itself will perturb the hydrogeologic system(s) at the site. Furthermore, it is not clear in the draft EA when the exploratory shaft construction (Figure 4-1, page 4-6) will take place with respect to the field studies (Figure 4-8, page 4-27). If construction of the exploratory shaft begins concurrently or soon after the various phases of field study, any baseline hydrogeologic data may be perturbed by the excavation.

DOE should consider discussing the possible effects of the exploratory shafts on the local baseline hydrogeologic data in this section (4.2.1.4.2) or in §4.2.1.5 Effects onSoils, Geology and Paleontology.

Comment 4-23

Section 4.2.1.4.2 Groundwater, Page 4-97, Paragraph 1

This section addresses the possible effects on the groundwater system of intensive water uses, and concludes that such problems will be avoided "because water requirements would probably be met from surface water supplies trucked to the site." However, no consideration is made of the possible local effects on the (upper hydrostratigraphic unit) groundwater flow regime from additional sources of recharge at the site from such sources as (unlined) sedimentation ponds, or the water pumped from long-term pump tests of the lower hydrostratigraphic units.

DOE should consider including a discussion on the possible effects of imported water and pump test water on the local baseline hydrogeologic data in this section or in section 4.2.1.5 Effects on Soils, Geology and Paleontology.

Comment 4-24

Section 4.2.1.6, Page 4-100, Onsite Activities

Temperature inversions can increase the travel distance of noise; however, they are not discussed in this section. It is suggested that the significance of temperature inversions over the canyon site be thoroughly explained (e.g., frequency of occurrence, time of year of occurrence, durations) to put the noise related phenomena into useful perspective.

Comment 4-25

Section 4.2.1.12, Summary of Impacts to Canyonlands National Park, page 4-124, paragraph 4

It is stated, "also, careful scheduling of activities, such as blasting or heavy equipment movement during the off season, could reduce impacts on tourists and help smooth out the seasonal economic decline normally associated with tourism." The term "smooth out the seasonal economic decline" is unclear. It is suggested that DOE clarify how scheduling characterization activities off season would not lead to an even greater decline in tourism during that period.

Comment 4-26

Section 4.3.2, Exploratory Shaft Alternative, Page 4-132, Paragraph 1

This section discusses alternatives in exploratory shaft facility design. No discussion, however, is given of the shaft construction method. Two shafts are planned at the site, one constructed by large-hole drilling and the other by the drill blast method. Large-hole drilling will make it difficult to characterize the subsurface stratigraphy. Lacking this characterization may affect accurate shaft seal placement which could result in decreased isolation performance of the repository. The rationale for choosing two different approaches is unclear. The draft EA for the Yucca Mountain site gives a strong argument in favor of the drill and blast method. The DOE should consider providing the rationale for the construction methods chosen and how the construction methods will affect seal placement.

Comment 4-27

Section 4.4, Summary of Site Characterization Impacts, page 4-136

Table 4-31 summarizes the site characterization impacts. In item 3 of the table, a statement is made that the air quality impacts will be minimal. It is suggested that minimal impacts be defined with respect to National Ambient Air Quality Standards and PSD Class I (National Park) areas.

Comment 4-28

Section 4.4 Summary of Site Characterization Impacts at Davis Canyon Site, Table 4-31, page 4-137, point 5; and Section 4.2.1.4.2 Ground Water, page 4-97, paragraph 4

Section 4.2.1.4.2 states that "infiltration of rain water through soils contaminated by windblown salt is not likely to affect significantly ground-water quality. As discussed in Section 4.2.1.2, salt deposition due to wind is expected to be small." In the summarization table, p. 4-137, it is stated that "infiltration of rain water through soils contaminated by windblown salt may impact ground-water quality, data are not yet available to evaluate ground-water contamination from this source."

The summarization in the table is inconsistent with the earlier text which it summarizes. If a demonstration is available to show that wind-blown salt is not likely to affect groundwater quality, it should be included in Section 4.2.1.4.2 and p. 4-137 should be changed. If such demonstration is not yet available, section 4.2.1.4.2 should be changed to show a lower degree of confidence.

CHAPTER 5 COMMENTS

Comment 5-1

Section 5.1.1.1, Repository Site Layout, Page 5-4

The rationale for selecting a Surface Area Land Control Rights area of 5760 acres, as presented in Table 5.1 for use in evaluating environmental impacts and comparing sites has not been addressed in the draft EA. The size of the controlled area significantly affects the environmental impacts associated with land ownership and the technical guideline related to available flow path distance between the edge of a repository and the accessible environment. As the selected area provides for a controlled zone extending beyond the subsurface repository area of less than one kilometer, it also impacts post closure technical guideline 960.4-2-1(b)(1) related to groundwater travel time. DOE should consider providing a detailed discussion of the parameters affecting the selection of the distance used and an analysis containing the rational used in arriving at the distance selected.

Comment 5-2

Section 5.1.1.3, Repository Shafts, Page 5-12, Paragraph 4

It is stated that shaft liner designs and installations will consider the site-specific stratigraphy and major underlying aquifers, taking into account decommissioning of the repository and the refilling and sealing of the shafts. If the thermal pulse from the waste reaches the shafts before the end of the retrievability period, the shafts must be able to withstand the differential displacements and strains between rock, grout, shaft liner, and shaft equipment resulting from the waste emplacement effects. DOE should consider presenting a discussion addressing thermal effects on the shafts and the repositories ability to isolate waste.

Comment 5-3

Section 5.1.1.4, Repository Subsurface Facilities, Page 5-14, Table 5-3

Table 5-3, Approximate Waste Storage Room Quantities, p. 5-14, shows that the Davis Canyon site is projected to receive 55,456 TRU packages, 7899 spent fuel packages and 3673 CHLW packages out of a total of 74,048 packages. Many analyses in the draft EA are in terms of spent fuel and CHLW. However, nearly 75% of waste packages will be TRU packages. No TRU package design information is presented in the draft EA.

DOE should consider presenting an analysis of waste package performance based on emplacement of TRU packages, or show that the conclusions from the analyses presented are not invalidated by emplacement of TRU packages.

Comment 5-4

Section 5.1.2.2, Offsite Development, Page 5-21

The second paragraph on page 5-21 describes the water supply pump station and intake on the Colorado River near Potash, Utah. The operation of a water intake on the Colorado River has the potential to impact aquatic biota. Of special interest in this regard is the impact potential to endangered river fish. DOE should consider examining the potential aquatic impacts resulting from water withdrawls.

Comment 5-5

Section 5.1.2.3, Onsite Development, Page 5-22

Certain buildings will be designed to withstand design basis earthquakes and tornados. The fate of the 50-acre salt stockpile during and after either of these events, however, is not addressed. Seepage, runoff, and wind effects to the stockpile are considered in the draft EA, however earthquakes and tornados may damage the integrity of the pile and result in salt escape to the biotic environment. DOE should consider addressing these impacts in the final EA.

Comment 5-6

Section 5.1.2.4, Shafts and Facilities Development, Page 5-23, Paragraph 1

It is stated that all of the repository shafts will be excavated using conventional blasting methods. Considering the decision of DOE to blind drill the exploratory shaft, the decision to drill and blast the repository shafts introduces shaft sealing uncertainties that may impact on repository performance assessment. These uncertainties include:

a) The possibility that damage to the main shaft walls induced by blasting will be of a different type than the damage to exploratory shaft walls due to boring. This would introduce uncertainty in extrapolating sealing data obtained during exploratory shaft construction to stability and sealing of the main shafts.

b) More certain overburden and rock data can be obtained in the main shafts than in the exploratory shaft. This assures better control of seal locations and seal installation in the main shafts when compared to the exploratory shaft.

DOE should consider expanding this section to include an analysis of the impact of using different shaft construction techniques on shaft sealing and thereby on repository operations and closure.

Comment 5-7

Section 5.1.2.4, Shafts and Facilities Development, Page 5-23, Paragraph 1-4

It is stated in Section 4.1.2.4 that if the site is found suitable and is selected for the first repository, the exploratory shaft facility in full or in part may be incorporated into the repository design. Further, it is stated in Section 5.5 that the alternate (two phase) design will use the exploratory shafts. Based on these statements, the exploratory shaft design should meet all relevant conditions for a permanent repository shaft including the ability to be backfilled/abandoned effectively. DOE should consider addressing the integration of the exploratory shaft facility into the repository program

Comment 5-8

Section 5.1.3, Repository Operation Activities, Page 5-25

This comment was incorporated elsewhere in the comment package.

Comment 5-9

Section 5.1.3.3, Retrievability, Page 5-31, Paragraph 1, 2

In this section a commitment is made to maintain the ability to retrieve previously emplaced waste packages. According to the discussion, the only decision that appears to be influenced by the retrievability requirement is whether or not to backfill the waste package storage rooms. Other decisions related to thermal load limits, access drift support designs, maintenance, personal radiological safety, etc., will also be impacted by retrievability considerations and have not been addressed. The greater creep tendency for cycle 6 salt at elevated temperatures may necessitate a lower thermal loading, in part, to maintain the retrieval option. DOE should consider expanding the discussion to include all pertinent retrievability considerations.

Comment 5-10

Section 5.2.1, Geologic Conditions, page 5-36, paragraphs 1,2,3, and 4

The discussion of potential subsidence/uplift presented in these paragraphs is inadequate. It appears to be based upon two uncoupled models, one for subsidence, the other for thermally-induced uplift. The discussion does not consider time factors. Subsidence will follow mining activities and will directly impact repository facilities during the operational phase. Thermal uplift will come into play as waste is entombed.

Comment 5-11

Section 5.2.1., Geologic Conditions, Page 5-36, Paragraph 4

The NRC is in the process of preparing a generic technical position on seismotectonic evaluation methods. This paper will cover the types of sesimotectonic investigation and evaluation methods which will need to be conducted for a repository. In addition, the NRC will need to separately review the types of structures to be constructed, their functions and the consequences of potential accidents before the actual design requirements can be determined. At the present time, it is premature to state that the design requirements for nuclear power plants are the same as those required for a waste repository. It can only be stated at this time that the design requirements of structures important to safety will comply with 10 CFR 60 and appropriate EPA regulations.

Comment 5-12

Section 5.2.1.1.1, Construction, Page 5-37, Paragraph 4

It is stated that possible impacts from salt handling during construction are discussed in Section 5.1.1.2. Section 5.1.1.2 is entitled Waste Receiving/Handling/Packaging Facilities and does not discuss salt impacts. This paragraph also states that "an additional salt dust source is the repository ventilation shaft; this source will be controlled with fabric filters (Section 5.2.5)." Section 5.2.5 is entitled Air Quality and does not discuss fabric filters. It is suggested that DOE clarify these two sections.

Comment 5-13

Section 5.2.1.1.1, Operation, Page 5-38, Paragraph 5

It is stated that "the second factor which will limit the extent on soils is relatively high precipitation in the region..." "Consequently, soils are expected to be leached of salt shortly after the salt is deposited and long-term buildup of salt is unlikely to occur." Section 3.4.3.3, page 3-168, states that annual average precipitations are low, 20.8 cm (8.2 inches) at Moab and 35.1 cm (13.8 inches) at Monticello for a 30 year basis.

It is evident that 8.2 to 13.8 inches of precipitation is not "relatively high." DOE should clarify this statement in the final EA.

Comment 5-14

Section 5.2.1.1.3, Decommisioning and Closure, page 5-39, paragraph 3

What types of contamination are being referred to in this paragraph? Does this contamination refer to materials escaping from the repository or to surficial contamination from repository operations? Where would such materials be removed to and in what way? How much material might exit? Estimates concerning these matters based upon the best present estimates are needed so that potential environmental impacts can be evaluated.

Comment 5-15

Section 5.2.2.2.1 Construction (Effects on Groundwater), p. 5-42, paragraph 7

The shaft seals, liners and concreting are described briefly. The draft EA then states that "as a result, hydraulic connection of aquifers and potential dissolving of the salt in the lower levels of the shaft will be avoided."

It is not possible to support the statement that potential dissolving of the salt along the shafts will be avoided. DOE should consider presenting drilling or mining statistics that demonstrate the likelihood of such occurrences, as well as the ways of detecting and resolving such leakage should the engineering precautions fall short.

Comment 5-16

Section 5.2.5, Air Quality, pages 5-53 to 5-62, figures 5-12 to 5-20

Figures 5-12 through 5-20 show irregularly shaped isopleths of predicted concentrations. Wind direction frequencies and airflow patterns are not included in the discussion of local meteorological conditions in Section 3.4.3. It is suggested that the basis for showing irregularly shaped isopleths be provided.

Also, the shape and magnitude of the isopleths in the referenced figures cannot be scaled to the isopleths given in Figures 4-15 through 4-17. It is suggested that the basis for these differences be provided.

Comment 5-17

Section 5.2.5.6.2, Visibility Exterior to the National Park, page 5-66, paragraph 3

Estimates of sky-terrain contrasts are made. It is suggested that the model and appropriate references for making these estimates be provided.

Comment 5-18

Section 5.3, Expected Effects of Transportation and Utilities, Page 5-90

The impacts from transportation accidents, including the estimated dose to the maximally exposed individual and the estimated number of latent cancer fatalities, are not discussed. DOE should consider including in the final EA either an explanation of the use of existing analyses and studies to substantiate the assertion that transportation accident impacts are small or analyses of consequences, probabilities, clean-up costs, and risks for a severe transportation accident en route to the site.

Comment 5-19

Section 5.3.1.1.2, Waste Transportation Cost, Page 5-92

Certain transportation corridors along the routes to the sites, for example those with high accident frequency or high waste traffic volume, or adverse weather conditions are a potentially important issue. Although the radiological risks along these special corridors are estimated to be small, such corridors may be subject to increased state and local emergency response actions. This response may be costly and could be disruptive to communities. It is suggested that this type of cost consideration be included in the assessment of transportation impacts.

Comment 5-20

Section 5.3.1.2 Radiological and Nonradiological Effects Associated with Nuclear Waste Transport Page 5-77, Fourth Paragraph

It is stated in this paragraph that potential risk associated with accidents severe enough to release some of the radioactive material being transported to the repository is less than one fatality in 26 years. It is suggested that the final EA contain a supporting analysis of the effects and probability of a severe accident involving transportation to the site.

Comment 5-21

Section 5.3.1.2, Radiological and Nonradiological Effects Associated with Nuclear Waste Transport,Page 5-94, Second Paragraph

The paragraph implies that under accident free operating circumstances, no radioactive material would be released from the shipping containers during transport. While this may be true for the contents of the package, there have been cases of contamination being released from the package surface during transport. It is suggested that the potential radiation doses to radiation workers involved in close proximity decontamination efforts be addressed in the final EA.

Comment 5-22

Section 5.3.1.3.1, Regional Highway Routing, Page 5-97, Paragraph 1

This section states that access to southeast Utah by Interstate Highway is available only from the east or west via I-70. Although the region under consideration is defined as a circle with a 125 mile radius, other Interstate roads in the area should not be overlooked. For instance, I-40 appears to be within about 50 miles south of the designated region. Unless there is some restrictions against using I-40, it is suggested that this route be considered along with I-70 since it is the most logical route to be used by trucks hauling waste from reactors located in the southeastern U.S.

Comment 5-23

Section 5.3.1.3.3, Additional Regional Concerns, Page 5-100, Fifth Paragraph

This paragraph provides average annual radiation doses to a maximally exposed individual (member of the general public) resulting from routine transportation to the repository. It is suggested the text include maximum exposure that would occur in a transportation accident.

Comment 5-24

Section 5.3.2.1 Radiological effects on nuclear waste transportation
Page 5-99, Table 5-15 and Page 5-101, Table 5-16

These tables provide estimated latent cancer fatalities associated with the 30-year operating lifetime of a repository. It is suggested that the tables list the exposures for the occupational and non-occupational population subgroups.

Comment 5-25

Section 5.3.2.2, Railroads, page 5-103, paragraph 2

Key geotechnical issues include the anticipated stability of proposed tunnels beneath the Canyonlands and Needles overlooks, stability of slopes elsewhere along the alignment to the repository, and potential environmental hazards arising from accidents caused by tunnel or slope failures. It is suggested that more information be presented to evaluate potential impacts or to assess the conclusions.

Comment 5-26

Section 5.4, Expected Effects on Socioeconomic Conditions, pages 5-107 and 5-108 (Figure 5-29)

No indication is given of the uncertainties of the labor force estimates used in the socioeconomic analyses. The size of the labor force during construction, operation, and closure is a major determinant of socioeconomic impacts. Therefore, labor force size and uncertainty would be reflected in the magnitudes and uncertainties of estimates of socioeconomic impacts. It is suggested that the uncertainty in labor force estimates be assessed and if they are sufficiently large the implications for the estimates of socioeconomic impacts be discussed.

Comment 5-27

Section 5.4.5.1.1, Construction, pages 5-128 and 5-129

The discussion in this section on technical and financial assistance for planning and mitigation needs to consider how assistance will be provided to assure timely planning. Early planning is necessary to prevent impacts that can be mitigated. Many of the tax benefits cited in this section are during construction when it will be too late to mitigate the impacts of construction. More emphasis needs to be placed on preplanning potential of financial and technical assistance. Specifically, the DOE grants may be available during site characterization to assist in planning for economic, social, and public health and safety impacts of a repository. This planning would identify potential impacts and requirements well in advance of the beginning of construction and allow timely mitigation. A detailed approach to impact mitigation is suggested, and plans for the timely implementation of studies should be considered. Mitigation planning is a lengthly process which should take place as early in the repository siting as possible. It is suggested that there be a full discussion of the timing of pre-impact planning assistance available and for mitigation planning.

Comment 5-28

Section 5.5, Implications of the Two-Phase Repository Design Concept, Page 5-130 thru 5-144, Paragraph all

The draft EA states that DOE has decided to proceed with further consideration of the two-phase concept, to meet the NWPA Mission Plan objective of having the first repository in operation by 1998. The draft EA states (page 5-130, paragraph 3) that somewhat different impacts than described in Chapter 5 would result. Possible significant differences that could result have been identified as:

1. Total excavated salt will increase and salt handling operations will increase. Increased salt volume and handling may require a larger surface area and result in larger on-site salt pile(s) with larger salt runoff and infiltration.

2. The two-phase concept specifies that gassy mine conditions shall be assumed [30 CFR Part 57 and 30 CFR Part 58 (draft)]. In addition, more stringent ventilation requirements must be met for gassy-mine conditions.

3. More extensive surface facilities will be required for waste handling, salt storage and rehandling, and numerous other areas.

4. An additional shaft will be required.

5. The construction schedule will be compressed.

These and other differences are far important in the contexts of all environmental impacts, safety, long-term and short-term performance of shafts and other major repository components, assurance probabilities, and site characterization requirements.

The environmental impact of the alternative repository design concept addressed in this section is not discussed in detail, because the design concept is evolving. Nevertheless, uncertainty regarding technical aspects of the design concept that impact environmental considerations, construction, shaft sealing, and retrieval operations appear important enough to warrent early consideration. These uncertainties are related to the following.

1. The two-phase concept may increase the opportunity for potential impacts on the geologic host rock conditions. The increased extraction could result in additional subsidence, larger pillar dilation and potentially more rapid creep under thermal conditions. No disucssion has been presented.

2. Information has not been presented to demonstrate that the HEPA filter system can handle the increased ventilation requirement of a two phase concept.

3. It does not appear that the subject of salt rehandling at the surface has been adequately considered in all aspects of its environmental impact.

4. There is no apprent difference between the phased and reference repository concept that would result in one being regarded as gassy and not the other. It appears that they both should be regarded as potentially gassy.

5. The incorporation of the exploratory shafts into the repository design should be addressed in sufficient detail to permit an adequate evaluation of shaft seal systems and repository performance.

6. Changes in the requirements for site characterization activities including the relocation of boreholes to accommodate the larger restricted zone and larger subsurface areas should be considered with due consideration to the uncertainty imposed by the resultant decrease in density of exploration data.

7. The retrieval requirement will be impacted by the effect of increased extraction percentage, waste emplacement schedules as affects thermal buildup, changes in extent of retrieval that may be required, canister transport distances, and other applicable factors. These impacts should be considered.

8. The simultaneous activities of both underground construction and waste emplacement operations may impact personal radiological safety and long term repository performance. Risks associated with the simultaneous performance of operations related to shaft construction and sealing, ventilation system modifications and waste emplacement that may adversely affect performance of the repository should be considered.

DOE should consider expanding the discussion presented in this section to address the above items.

CHAPTER 6 COMMENTS

Comment 6-1

Section 6.2 Suitability of the Site for Development as a Repository Under Guidelines not requiring Site Characterization, Page 6-65, Table 6-7, Item 6

As stated, guideline 960.5-2-5 includes the site and "its support facilities". Therefore, the column Assessment Results should include information pertinent to the access corridors. Specifically, it is known that endangered species occur along the proposed railroad route (Section 5.3.2.2, page 5-103, paragraph 4). This comment also applies under item Biota, in the same column.

Comment 6-2

Section 6.2.1.1 Site, Ownership and Control, Guideline 10 CFR 960.4-2-8-2, pages 6-6 to 6-7

The draft EA states that DOE has authority under Federal law to condemn State and privately owned land. It would be desirable to document this statement by reference to applicable law.

Comment 6-3

Section 6.3.1.1, Geohydrology, Page 6-80, Paragraph 1 and Page 6-81, Paragraph 3

In the discussion of relevant data, the draft EA cites Figures 3-15, 3-16, and 3-17 and reports that borehole data from borehole GD-1 and other boreholes in the area "indicate that thick, extensive halite beds are present at the site". The draft EA also states that no salt dissolution "has been detected within 10 kilometers of the site," and that the logs "from the GD-1 core and other boreholes in the site vicinity indicate no evidence of dissolution in the site vicinity."

Borehole data from which isopachs of salt cycle 6 and related units have been constructed are very sparse in the vicinity of the Davis Canyon Site. Only three boreholes are within a 10 kilometer radius of the site and each of these is located on the northeast side of the site. On all other sides of the site no borehole data points are present within a 10 kilometer radius, and in most directions the distance to the nearest control point is 20 kilometers or greater. No borehole has been drilled at the Davis Canyon Site. Due to the sparsity of boreholes near the Davis Canyon, site, the potential for dissolution should not be rejected at this time.

Comment 6-4

Section 6.3.1.1, Statement of Qualifying Conditions, page 6-81, Paragraph 1

The DOE limits its consideration of flow through secondary openings (fractures, joints solution channels) to the bedrock above and below the host rock, and the interbeds within the evaporite section. The DOE neglects to consider the possibility that fractures, joints, and solution channels may also exist in the halite, with the potential for providing vertical interconnection to interbeds or to the bedrock above and below the host rock. The NRC notes (see major comments 1 and 2) that tectonic stability and the potential for joints and fractures in the halite which may permit fluid migration and dissolution have not been adequately addressed in the draft EA.

Comment 6-5

Section 6.3.1.1.1, Analysis, Page 6-81, Paragraphs 4 to 5

The DOE addresses and rejects the possibility of horizontal flow through the interbed beneath salt cycle 6 as a potential flow path. The NRC concludes that the DOE does not provide a defensible case for rejecting this possibility, and further concludes that it should be considered on the basis of the available data.

The DOE presents two reasons for rejecting the possibility of horizontal flow through the interbed beneath cycle 6. The first, that such flow is not expected because of "likely near-zero horizontal gradients" is not defensible. Regional head data for the Paradox Basin are sparse and highly variable. On a local scale, the limited data available from borehole GD-1 are also extremely variable and can support a broad range of interpretations including many not considered in the draft EA. The NRC notes that data from one borehole cannot adequately support statements regarding horizontal flow, but that the data from borehole GD-1 do not preclude such scenarios as the potential for horizontal flow through the interbeds, either locally between vertical discontinuities which connect an interbed to points of differing heads, or regionally. The possibility of regional flow in the interbeds cannot be rejected on the basis of the limited data now available (see detailed comments 3-31, 6-10, and major comments 1 and 2).

The second justification which the DOE provides to discount expected horizontal gradients is that "likely discharge points, e.g., in the Colorado River, are up-gradient from repository and lower levels." In the conceptual model chosen by DOE as the basis for the groundwater travel time calculation, it would be impossible for the Colorado River to be up-gradient of the Paradox Formation. This conceptual model assumes downward flow through the Paradox Formation based upon the head drop between the overlying and underlying hydrostratigraphic units, and the Colorado River is downgradient of the underlying hydrostratigraphic unit. The DOE apparently uses the term up-gradient because the Colorado River has a higher head than several of the head values measured in the Paradox Formation (extrapolated from the drill stem test data taken at borehole GD-1). Differences between elevations at two remote points do not specify a gradient between those points unless there is an interconnecting flowpath. No data exist to support the conclusion that the Colorado River recharges the Paradox Formation at the site. Also, many of the head values measured at GD-1 are higher than the Colorado River (see comments 3-31 and 6-10).

The DOE should consider flow through interbeds, and in particular, flow through the interbed beneath salt cycle 6, as potential flow paths until such time as data are available to reject these alternatives.

Comment 6-6

6.3.1.1.1, Relevant Data, Page 6-80, Continuing Paragraph

The DOE states that no salt dissolution has been detected within 10 kilometers of the site. This conflicts with possible interpretations of the available data. In the draft EA (page 3-71, paragraph 2) dissolution is considered as an alternative reason for the presence of sodium chloride-dominated high TDS water at borehole GD-1 in the Elephant Canyon and Honaker Trail Formations. High TDS waters in the lower hydrostratigraphic unit also support the possibility of localized dissolution (see detailed comment 3-29). Furthermore, considering the sparsity of boreholes in this portion of the Western Paradox Basin, the possibility of dissolution cannot be ruled out simply because none has yet been detected. Since the TDS data can be interpreted to support the presence of dissolution within 10 km of the site (e.g. at borehole GD-1) the DOE may be permature in making the positive assertion that none has been detected within 10 km.

Comment 6-7

Section 6.3.1.1.2, Evaluation Process, 960.4-2-1, Page 6-81, Paragraph-6

The DOE concludes that the favorable condition of a 10,000 year travel time (960.4-2-1 (b)) is present because their calculated travel time ranges between 137,000 and 239,000 years (with about 125,000 years in the evaporite section). However, the assumptions and approaches used in the DOE evaluations and supporting analyses do not represent properly the full range of values; in particular, the lower bound of the calculated travel time range is indefensibly long. The assumptions and approaches used in the evaluation of this favorable condition are not conservative with respect to flow paths, hydraulic gradient, porosity, and conceptual and numerical modeling, as discussed below.

Potentially faster travel times along flow paths, such as through interbeds and along discontinuities may exist in addition to the single pathway assumed in the evaluation (see detailed comments 3-31, 6-4, 6-5, 6-10 and major comment 2). Consideration of alternatives such as flow through the interbed below salt cycle 6 or vertical flow to the upper hydrostratigraphic unit were rejected on the basis of assumptions which the NRC considers are not defensible (see detailed comments 6-5 and 6-8).

The possibility of fracture flow is recognized as a source of uncertainty by the DOE, but not incorporated into the travel time estimate. This omission is particularly non-conservative in the case of flow through the Leadville Limestone. Flow in the Leadville Limestone is known to be influenced by secondary permeability. The draft EA (p. 6-81, paragraph 1) states that "it appears probable that groundwater flow rates through the fractures or other secondary openings in the bedrock could be one or more orders of magnitude greater than the groundwater flow rates shown for the primary porosity portion of the bedrock." However, the analysis of horizontal flow provided for the draft EA travel time is based on use of primary porosity hydraulic parameters. Therefore, a defensible preliminary estimate of flow rate through the Leadville would be to expand by one or more orders of magnitude the upper (faster) bound of the range provided by the DOE. This would reduce the lower (shorter) bound on the travel time range through the Leadville by one or more orders of magnitude.

The lateral gradient provided in the draft EA for the Leadville Limestone is not conservative based on available potentiometric head data. The NRC has concluded (see detailed comment 3-30) that an alternative interpretation of the potentiometric surface for the Leadville Limestone approximately doubles the gradient below the site.

The uniqueness of a downward gradient in the host rock and immediately surrounding units is not demonstrated adequately by the available data (see detailed comments 3-31 and 6-10). The head data from the Paradox Formation are variable and support a broad range of interpretations including the potential for localized upward and downward gradients.

Porosity data used in the evaluation are not conservative with respect to the available data. The flow rate through the salt units was based upon a porosity value of 1%. "Apparent" effective porosity data for salt vary from 0.2 to 0.8% (Thackston et al., 1984, Table 4-1). However, because these laboratory measurements of "apparent" porosity provide an upper bound upon the true effective porosity, flow rates calculated based upon use of these data would not necessarily be conservative. The true effective porosity of salt may be lower. Thus, within the conceptual model for porous media flow through salt used for this analysis, the DOE did not bound the flow rates based upon the existing "apparent" porosity data.

The numerical models used to derive the travel time estimates contain uncertainties which have not been utilized to bound the travel time estimates (see detailed comment 6-9).

The DOE travel time calculation does not consider that the size of the disturbed zone determines flow path length and distance to the accessible environment. The size of the disturbed zone in salt has not yet been defensibly established. If if were determined to be more than 10m, the flow path through the salt would be shortened. The uncertainty associated with size of the disturbed zone is compounded by the proximity of the interbeds above and below salt cycle 6. These interbeds could possibly transmit flow horizontally (see detailed comment 6-5). This interpretation is an alternative flow model to the one provided by DOE. This approach might substantially reduce the travel time in the salt units.

The DOE does not consider that size of the controlled area determines distance to the accessible environment. Based upon the size of the controlled area provided in the draft EA, distance to the accessible environment is approximately 1 km. The DOE calculated flow through the Leadville Limestone over the "maximum 10 km allowance." Consequently, the Leadville Limestone travel time lower bound should be decreased by an additional order of magnitude.

Finally, the travel time range presented for the Leadville Limestone contains an arithmetic error. Flow rates of 0.986 to 9.49 feet/year over 10 km (32,808 feet) gives a travel time range of 3,460 to 33,300 years, not 12,000 to 114,000 years. This correction appears to be substantiated by the range of 3,000 to 33,000 years provided elsewhere in the draft EA (p. 6-211, Paragraph 6).

In summary, the range of groundwater travel times presented by the DOE is 137,000 to 239,000 years (with about 125,000 years through the evaporite section). Based upon consideration of the apparent arithmetic error, the NRC assumes that the range presented by the DOE should actually have been 128,000 to 158,000 years (with no change in the estimate of about 125,000 years through the evaporite section). Within the context of the conceptual flow model proposed by the DOE, the NRC concludes that on the basis of the quantifiable uncertainties, this range should be broadened. For example, the combined effects of fracture flow and the 1 km distance to the accessible environment could reduce the lower bound of the Leadville Limestone travel time by at least two orders of magnitude, to about 30 years. Conservative use of the available "apparent" effective porosity data might shorten the travel time through the halite as much as one order of magnitude, depending upon the numerical formulation used to generate these flow rates. Based upon these quantifiable uncertainties, a more defensible travel time range would be 12,530 to 158,000 years (about 12,500 to 125,000 years through the evaporite section, and 30 to 33,000 years in the Leadville Formation). The DOE should then consider qualifying the confidence in the range which they elect to present on the basis of such uncertainties as alternative flow paths through the interbeds, the possibility of localized upward flow in the Paradox Formation, steeper gradients in the Leadville Formation, and size of the disturbed zone. Each of these alternatives represents an alternative conceptual model which would result in different, perhaps faster, groundwater travel times.

The NRC concludes that the above issues may reduce substantially the confidence in the presence of this faovrable condition. Consequently, the results of the comparison of the hydrogeologic conditions of this site with other sites may be altered. The NRC recommends that the DOE should consider reevaluating its groundwater travel time analyses on the basis of the concerns discussed above. The reevaluation should convey a more realistic appraisal of the uncertainty associated with this favorable condition.

Comment 6-8

Section 6.3.1.1.2, Analysis of Favorable Conditions, Page 6-82, Paragraph 1

The DOE states that "it is not possible that the Elephant Canyon would be contaminated with radioactivity from the repository" because "an unrealistic assumption that future conditions are altered to permit upward flow to the Elephant Canyon would be required." The NRC concludes that rejection of this alternative flowpath is neither defensible nor conservative.

The head data from borehole GD-1 can be interpreted to indicate several alternative hydraulic conditions at Borehole GD-1, including the possibility of localized upward and downward gradients (see detailed comments 3-31 and 6-10). Hydrochemical data from borehole GD-1 may further substantiate the possibility of localized upward flow between the middle and upper hydrostratigraphic units (see detailed comment 3-29).

Comment 6-9

Section 6.3.1.1.2, Analysis of Favorable Condition, Page 6-83, Paragraph 4

The draft EA states that characterization and numerical modeling of the groundwater system appears to be relatively straightforward because of the "relative simplicity of stratigraphic, structural and hydrologic features in the site vicinity." The draft EA also states that preliminary numerical models "have been successfully applied to the region surrounding the site." The NRC concludes that these positive appraisals may not be defensible because of (1) uncertainties regarding the regional and local water input and output balances among the three hydrostratigraphic units, (2) uncertainties related to alternative conceptualizations of vertical flow in the Paradox Formation, and (3) uncertainties about numerical model calibrations and input parameters.

The modeled fluid potential distribution of the hydrostratigraphic units beneath the Paradox Formation is derived from potentiometric data for the lower hydrostratigraphic unit as presented in Woodward-Clyde (1982). As discussed previously (see detailed comment 3-30), the variability and reliability of the head data for the lower hydrostratigraphic unit influences the validity of the conceptual and numerical models that are based upon these data. The validity of the calibration of the model is measured by how closely it can approximate the measured potentiometric data. If the potentiometric surface as shown in Figure 3-40 of the draft EA does not reflect the true potentiometric distribution for the lower hydrostratigraphic unit, then a model calibrated to this figure cannot characterize groundwater flow in the lower hydrostratigraphic unit accurately. Two aspects of these fluid potential data and models calibrated to them warrant discussion. First, a large elongate potentiometric high is shown near Monticello, Utah, in Figure 3-40 of the draft EA. This prominent feature is based on only two widely separated data points; consequently, it may not necessarily be a continuous potentiometric high as the figure suggests. Second, sensitivity analyses presented by INTERA (1984a) indicate that this potentiometric high along with a potentiometric low near the western edge of the figure influences significantly the model output of the potentiometric surface of the Leadville Formation. If the correct head value of 3612 feet (see detailed comment 3-30) had been used for the well immediately northwest of borehole GD-1, this data point also would be important to model sensitivity and also would exert major control over the potential surface in the vicinity of Davis and Lavender Canyons. Incorporation of the correct data point probably would alter the results of the sensitivity analysis.

The NRC has additional concerns regarding the appropriateness of draft EA and supporting documents (INTERA 1984a and 1984b) assumptions regarding vertical flow into the units below the Paradox Formation. Vertical leakage into the units below the evaporite sequence of Paradox Formation was modeled as occurring in two locations. One location is the Lockhart Basin where dissolution has removed the salt sequence, and the other is at the junction of the Abajo Laccolith and the Verdure Graben. No explanation is presented for: 1) why this intersection point was chosen as a location of vertical flow, 2) why vertical flow is limited to one location along the Verdure Graben, 3) why vertical flow was not assumed around the perimeter of the Abajo intrusive complex, and 4) why no other vertical connection was considered.

Calibration procedures of the models used by the DOE are not presented in either of the pertinent supporting documents (INTERA 1984b, 1984b). Furthermore, discussion presented in INTERA, 1984b implies that the model surprisingly is insensitive to changes in input values of hydraulic parameters. For example, changes in vertical hydraulic conductivity through the Paradox Formation along the Colorado lineament produces "negligible" differences between Runs I and J. The data base used for calibration and the details of the calibration procedure presented in the draft EA and in the supporting documents are not sufficient to facilitate an understanding of this result.

Input values of horizontal and vertical hydraulic conductivity for all hydrostratigraphic units simulated are based on data from tests performed in borehole GD-1. These input values are not altered relative to test data except where geologic structures are known to be present and thought to affect groundwater flow. The basinwide application of data obtained from borehole GD-1 probably is a defensible procedure considering the limited availability of hydraulic property data on a regional scale; however, the risk of assuming regionally uniform hydraulic properties based upon values obtained from a single test hole should be recognized. Consequent to this approach, modeling efforts have treated the Leadville, Ouray and Elbert formations as a single hydrostratigraphic unit with assumed single values of vertical and horizontal hydraulic conductivity. The use of single values for these parameters over the entire thickness of the three formations reduces the hydraulic significance (and relevance to travel time) of high conductivity zones that may exist as a consequence of solution- and fracture-related features in the Leadville Formation. The apparent confusion in the use of total porosity versus effective porosity further limits the usefulness these model results have to ground water travel time calculations. Travel time calculations based on values of "apparent effective porosity" (see comment 3-29 and 6-7) or total porosity that are higher than effective porosity values presented by Thackston et al. (1984) will produce travel time estimates that are too long.

Finally, the modeling results presented in INTERA (1984a, 1984b) interpret the similarity of the potential distribution produced by the simulation to the potential distribution believed to exist in the vicinity of borehole GD-1 to constitute evidence of success of the modeling effort. However, in order to produce model output potentiometric values compatible with those measured in borehole GD-1, it was necessary to alter the potentiometric distribution input near the eastern boundary. This alteration treats this boundary as a discharge boundary. Discharge at this location appears to be contrary to the direction of the gradient derived from the potential distribution shown in Figure 3-40 of the draft EA.

The discussion presented herein and in related comments underscores the fact that current characterization and conclusions based on numerical modeling of the regional groundwater system are preliminary at best. The structural features which influence goundwater flow appear to be complex; these features remain untested with respect to hydraulic property data. Attempts at numerical modeling to date have been based upon incomplete analysis of a limited data base. Consequently the results must be qualified accordingly.

Comment 6-10

<u>Section 6.3.1.1.2, Analysis of Favorable Condition: Evaluation, Page 6-84, Paragraph 1</u>

The DOE concludes that the favorable condition of a downward or predominantly horizontal hydraulic gradient in the host rock and in the immediately surrounding geohydrologic units (960.4-2-1(b)(4)(ii) is present. They conclude that a downward hydraulic gradient exists across the host rock. The NRC concludes that the DOE has not demonstrated the uniqueness of this gradient, and that scenarios identifying upward gradients can be defended on the basis of the available potentiometric data.

Head data from borehole GD-1 are variable. By electing to present only the data for long-term test numbers 2 and 3 in borehole GD-1, the DOE supports the finding that a downward hydraulic gradient exists across host rock. The data may also indicate an upward hydraulic gradient within the Paradox Formation (host rock), based on potentiometric levels estimated from long-term test numbers 3 and 5. This upward gradient is indicated using both the corrected and uncorrected head value for test #5 (Thackstón, et al., 1984 Table 4-2). Furthermore, long-term test intervals #3 and #5, respectively, are roughly below and above Salt Cycle 6, presently taken as the repository horizon, whereas the intervals tested for long-term tests #2 and #3 are roughly above and below salt cycle 5, respectively.

The NRC presents a revision of Table 3-12 (see detailed comment 3-31 and noted (see detailed comment 3-31) that based upon these data, Figure 3-B) showing all the head data collected at borehole GD-1. The NRC has variably overpressurized and underpressurized conditions may occur at different depths in the host rock and surrounding units, and that if localized vertical interconnection exists among these units, there may also be localized downward and upward flow. The DOE also concludes that on a regional scale, differences in potentiometric levels in the aquifers above and below the host rock units also indicate a downward gradient. Although the NRC agrees that the regional data indicate a downward gradient, this regional gradient does not preclude the possibility of localized upward gradients. Hydrochemical data may substantiate further the potential for localized upward gradients between the middle and upper hydrostratigraphic units (see detailed comment 3-29).

These considerations indicate clearly the degree of uncertainty that should be recognized and considered regarding the presence and direction of hydraulic gradient within the host rock and immediately surrounding geohydrologic units. The NRC concludes that the favorable condition may not be present as supported. The DOE should revise the draft EA to include additional supporting evidence for the presence of a downward gradient with consideration of the above-mentioned concerns, or consider reversing the finding to reflect the existing uncertainties.

Comment 6-11

Section 6.3.1.1.2, Analysis of Favorable Condition: Evaluation, Page 6-84, Paragraph 1

The DOE concludes that the favorable condition of "a host rock and immediately surrounding geohydrologic units with low hydraulic conductivities" (960.4-2-1(b)(4)i) is present. The NRC concludes that this finding may not be defensible as presented because in the absence of large-scale field tests the possibility of fracture flow is not considered with respect to its effect on hydraulic conductivity.

The NRC recognizes that the evaporites in the Paradox Formation have low matrix hydraulic conductivities. However, the extent to which fracture flow may exist in the interbeds (see detailed comment 6-7), or vertically across units in the

Paradox Formation will dictate whether or not this favorable condition should be addressed in terms of the matrix or secondary properties of the host rock and surrounding units.

Comment 6-12

Section 6.3.1.1.3, Analysis of Potentially Adverse Condition, Page 6-84, Paragraph 1

In this section it is stated that changes in the pre-waste-emplacement geohydrologic conditions as a result of natural phenomena are not expected. The reference of Section 6.3.1.1.3, which was used to support this assertion, does not address all potential natural phenomena damage modes. Specifically, it does not address the possibility of increased permeability within the rock mass due to a) the effects of a seismic event, and b) strain concentrations along joints resulting from the thermal uplift which could compromise the geologic isolation of nuclear waste by accelerating the transport of radionuclides to the accessible environment. DOE should consider expanding their evaluation to include a discussion of additional damage modes resulting from naturally occurring and repository induced mechanical, thermal, and thermomechanical processes that may compromise the isolation of waste.

Comment 6-13

6.3.1.2.1 Analysis Page 6-86, Paragraph 5

The statement is made that "water content was measured to be as much as 2.148 weight percent (Hite, 1983). It was assumed for performance assessment calculations that the salt contains 5.0 volume percent brine (Section 6.4.2.1.3). This value is approximately 2.5 times the greatest measured brine content." This statement is neither accurate nor conservative. Possibly the confusion has arisen from an interchanging of water and brine physical parameters. However, if one assumes the parameters have not been interchanged, then the maximum weight percent water in the salt presented in the draft EA (p. 6-86) is equivalent to 5 vol % brine. Consequently, 2.5 times the greatest measured brine content would yield a brine volume percent of 12.5. The calculation should be corrected.

Comment 6-14

6.3.1.2.1, Analysis, Page 6-86, Paragraph 5

The statement that brine, which comes from outside the salt beds, will contain relatively low concentrations of magnesium when it contacts the waste packages, is not necessarily accurate. If this water passes through the carnallite marker bed, the possibility exists that magnesium concentration in the brine could increase significantly. For example, the solubility of carnallite is 64.5 grams per 100cc of cold water. Kieserite, $MgSO_4H_2O$, which also occurs in the carnallite marker bed has a solubility of 68.4 gram/100 cc of cold water (CRC Handbook of Chemistry and Physics, 1984). The solution in equilibrium with these phases will contain over 50,000 mg/L magnesium. It is suggested that a scenario involving high magnesium intrusive brines be considered in the final EA analysis.

Comment 6-15

6.3.1.2.1, Analysis, Page 6-86, Paragraph 6

The statement that containment characteristics of the host salt could be compromised only by dissolution of the host rock ignores other scenarios which could also compromise the containment characteristics of the rock. For example, the thermal load of the repository could partially melt the carnallite in the marker bed, producing a possible path for radionuclide release. It is suggested that alternative scenarios be addressed or a less definite statement be made.

Comment 6-16

Section 6.3.1.2.2 Precipitation of Radionuclides Outside the Host Rock Salt, Page 6-87, Paragraph 5

The assertion made by the DOE that groundwater in the deep basin brine aquifers is chemically reducing is based on inadequate data. The draft EA states that because the groundwater in the deep brine aquifers below the Paradox salt contains $S^=$ (reduced sulfur), it is chemically reducing. The presence of $S^=$ does not necessarily ensure reducing conditions. Under the nonequilibrium conditions common to low temperature natural waters , it is possible that $S^=$ could exist metastably in an oxidized groundwater for extended periods of time (Ohmoto and Lasaga, 1982). Lindberg and Runnells (1984) show that different sets of redox-sensitive species in the same groundwater often give different calculated Eh values indicating nonequilibrium conditions in low temperature ground waters.

The mineralogic data from the cited reference (McCulley et al., 1984, p. 25) are used to support the conclusion that reducing conditions are present in the interbeds. The reference describes framboidal pyrite in the interbeds between the salt cycles and states that its existence is direct evidence of the reducing conditions present in the middle hydrostratigraphic unit. This assertion is not necessarily true. For example, framboidal pyrite has been synthesized in the laboratory in the presence of oxygen (Sweeney and Kaplan, 1973). Furthermore, the conditions present when the pyrite formed may be different from those now. Reactions involving pyrite are often much slower than those involving other sulfides (Barton and Skinner, 1967, Fig. 7.1).

Thus, not enough evidence exists to determine the redox conditions of the interbed.

It is stated in the draft EA that migration of uranium and neptunium is greatly decreased under reducing conditions because they form compounds having much lower solubilities than those formed under oxidizing conditions. This is not always true. For example, Garrels and Christ (1965) show that even under extremely reducing conditions uranium can exist in solution in significant concentrations (figure 7.32b, e.g., as $UO_2(CO_3)_3^{4-}$ in equilibrium with UO_2). Furthermore, reducing conditions do not ensure that the redox sensitive ion will be in the reduced state. For example, $UO_2(CO_3)_3^{4-}$ contains uranium in its most oxidized state under reduced conditions (Eh=-0.4V,p pH = 9). It is suggested that the assertion equating decreased solubilities with reduced redox conditions be less strongly stated.

Comment 6-17

Section 6.3.1.2.2 Formation of Organic Complexes and Colloids, Page 6-87, Paragraph 6

The evaluation of the condition pertaining to the effect of colloids on radionuclide migration does not conclusively support a favorable finding. The statement that "brines will inhibit the formation of some types of colloids" does not address site-specific conditions or define what types of colloids may be inhibited from forming. The draft EA states that brines also inhibit the agglomeration of colloidal material into particulate size ranges. Thus, for colloid formation, it would appear that high concentrations of salt in water can be both favorable and unfavorable.

Comment 6-18

Section 6.3.1.2.2, Formation of Organic Complexes and Colloids, Page 6-87, Paragraph 6

The draft EA states that no information exists for organoradionuclide complexes. However, it states that brines should inhibit the formation of organic complexes because of competing ion effects in brines. This could be true, but requires the formation of inorganic complexes resulting in increased concentrations of radionuclides in solution. Thus, the presence of brine can be both favorable and unfavorable. Furthermore, methane, found in clastic interbeds in the salt (page 3-81 in the draft EA) can form organic polymers when irradiated (Gray, 1984). The ability of these polymers to interact with radionuclides to form organ radionuclide complexes is presently unknown. Consideration of the formation of organic complexes from seemingly inert compounds such as methane as a result of radiation should be considered.

Comment 6-19

Section 6.3.1.2.2. (3) Evaluation Page 6-88 Paragraph 1

The evaluation of the condition concerning the stability of mineral assemblages and how they may affect radionuclide transport [960.4-2-2(b)(3)] is incomplete. The evaluation discusses the melting points of pure halite (NaCl) and pure anhydrite ($CaSO_4$). However, melting in multicomponent systems may occur at much lower temperatures than the melting of the pure end members. For example, melting points of pure NaCl and KCl are 800°C and 774°C, respectively. However, in the binary system, NaCl-KCl, the minimum melting temperature is 660°C (International Critical Tables, 1928, Vol. 4, p. 83). Thus, melting temperatures in the multicomponent systems anticipated in the repository should be considered in evaluating the presence or absence of a favorable condition.

The repository horizon, salt cycle 6, is 238 feet thick and contains 134 feet of carnallite marker bed with an average of 2.39 wt% carnallite. In some thin layers, carnallite makes up 50 percent of the rock (see 3.2.7.1, Host Rock Chemical Properties, page 3-70, paragraph 3). The carnallite-free halite (proposed stratum for repository) below the marker bed is 90 feet thick and is underlain by an interbed containing clays. In order to maximize the distance from the hydrated marker bed and the interbed, it is assumed that the canisters will be placed approximately 45 feet below the carnallite-bearing rock. By extrapolating the curves in the draft EA Figures 6-7 and 6-8 to distances of 45 feet or greater, the temperatures expected in the carnallite bed can be 120°C for a repository containing CHLW or 90°C for one containing SFPWR.

With a melting point of pure carnallite ranging from 130 to 165°C (Roedder and Bassett, 1981), it would seem appropriate that this phase should be included in the multicomponent systems representing the phase assemblages in the repository. The minimum melting temperature in these multicomponent systems may be less than the anticipated temperature in the repository. Consequently, partial melting may occur in the repository which might affect rock strength.

Besides affecting the rock strength, melting and decomposition of hydrated minerals releases H_2O that is bound in the crystalline phases. The melting of carnallite which contains 38.9 wt.% H_2O can release six times more H_2O to the fluid phase than is released from dehydration reactions considered in the draft EA (see detailed comment 6-25). This water will dissolve salts producing a high Mg brine which is more corrosive to the waste canisters than low Mg brine. Furthermore, in the case of an intrusive brine, the high solubility of carnallite could potentially cause a brine rich in magnesium to form (see detailed comments 6-14 and 6-80). In addition to having a low melting point, carnallite readily decomposes in hot water. (CRC Handbook of Chemistry and Physics, 1984). Thus, carnallite in contact with fluid (as in inclusions) might decompose at temperatures as low as 100°C. Without addressing melting in multicomponent systems, insufficient evidence is presented to support a favorable condition.

Comment 6-20

Section 6.3.1.2.2(4) Evaluation Page 6-88, Paragraphs 3 to 5

There are concerns that the performance assessment calculations used to assess the guideline concerning radionuclide solubility (960.4-2-2(b)(4)) may not be conservative. Because the existing data are inadequate to claim that the favorable condition is present the DOE bases its evaluation of this condition solely on performance assessments. A significant portion of the DOE's evaluation of this condition is based on the solubility calculations. However, a "good deal of subjective judgment" was used in selecting the solubilities presented in the WISP Report (Pigford et al., 1983, p. 195). Single numbers presented for elements with more than one oxidation state (e.g., Tc, U, Np, Pu, Sn) "must be used with caution" because solubilities are "very sensitive to slight changes in Eh" (Pigford, et al., 1983, p. 194). In addition, multiple valences may exist simultaneously for actinides. For some elements, solubilities are simply unknown (e.g., Sn, Se, Cm, Am) and numbers presented are "guesses based on chemical similarities" (Pigford et al., 1983, p. 195) that are used in the draft EA (p. 6-204, continuing paragraph). For strontium the solubility value presented in Table 6-30 (page 6-203) does not correspond with the value presented in the WISP Report. The WISP Report states that solubility for Sr is "high", while Table 6-30 presents a value of 0.8 g/m^3. The source of this value is unclear.

It is probable that the radiation field and corrosion reactions will strongly affect the Eh and pH, contrary to what is stated in the draft EA. Pederson et al. (1984), state that "actinide solubilities may be altered by alpha and gamma radiolysis through changes in the Eh/pH of solution." In addition, several factors concerning the geochemical conditions around the waste packages are ignored including gas evolution, radiolysis, the introduction of atmospheric oxygen, and sulfide formation (see detailed comment 6-21).

There are additional concerns regarding matrix dissolution of the waste form, brine migration, initial water content, and waste package geochemical environment that affect the evaluation of these conditions (see comments 6-21, 6-76, and 6-84).

Comment 6-21

Section 6.3.1.2.3(1) Evaluation Page 6-88, Paragraph 8 and 9

There are concerns that the performance assessment calculations used to assess the guideline concerning the effects of groundwater conditions on the solubility or chemical reactivity of the engineered barrier systems (960.4-2-2(c)(1)) may not be conservative. Becasue the existing data are inadequate to claim that the potentially adverse condition concerning repository performance is not present. DOE bases its evaluation of this condition solely on performance assessments.

The performance assessment calculations used in support of this condition include calculations concerning brine migration and waste package corrosion. The BRINEMIG code used in the draft EA to calculate brine accumulations due to thermally induced brine migration is based on a number of assumptions that limit the applicability of its results. First, consideration of melting of carnallite and other hydrated minerals is not presented. Melting would release all bound water to the fluid phase as opposed to minor amounts of water released in dehydration reactions. Second, the assumption of homogeneity and isotropy for Unit 6 salt may not be conservative. The host salt has a number of interbeds and stringers throughout it which have greater amounts of water than the halite and may potentially be pathways for fluid migration. Third, the Jenks and Claiborne (1981) equation used in BRINEMIG is an empirical equation that was derived from single-crystal, intracrystalline migration experiments in pure halite at the Carey mine in Kansas. This equation may not apply to systems that contain solid phases other than halite such as committee and kieserita. Intercrystalline migration is not considered. Intercrystalline inclusions may account for 50% of the initial water (Roedder, 1984, p. 431), and eventually most of the intracrystalline brine in the salt affected by thermal gradients may migrate to intercrystalline areas. Intercrystalline fluids may migrate toward the waste canisters at considerably different rates than predicted by intracrystalline migration theory. Roedder and Chou (1982, p. 1) found that Jenks and Claiborne (1981) used values for major input parameters that were "either nonconservative, selected numbers, or...based on inadequate data" resulting in invalid calculations. Truly conservative estimates should be larger, perhaps by "two orders of magnitude" (Roedder and Chou, 1982, p. 1). Fourth, the use of Salt Block II data to validate the code may be inappropriate. The salt cylinder used in that study (Hohlfelder, 1979) was only 1 meter in diameter--spatial scale effects should cause agreement between the experimental data and the model results to decrease with time because only water within 0.5 meters of the heat source was available for migration. Thus, BRINEMIG may not "overestimate" brine flow at higher temperatures. Fifth, the discussion does not explicitly state whether the accumulation of brine is calculated from fluid inclusions migrating only in a radial direction perpendicular to a waste package, or if migrating fluids reaching the waste package from the volume of salt above and below the waste package are also included in the accumulation. McCauley and Raines (1984) state that BRINEMIG is a one-dimensional code; thus, it would appear that only radial migration, and not three-dimensional migration, was included in the calculations. The difference is that the volume of migrating fluid inclusions should theoretically be an oblong spheroid rather than a cylinder. This difference in volume could be significant and the method of calculation should be explained in more detail. Neglecting the accumulation of fluids from above and below the waste package results in underestimates of brine accumulations and may not be offset by the conservative assumption of a constant maximum temperature gradient.

Several factors concerning the geochemical conditions around the waste packages are not addressed by the DOE in calculating optimistic corrosion rates to show that waste packages in salt should be intact beyond 10,000 years. First, the water released from the melting of hydrated phases is not considered in the draft EA (see comment 6-25). Second, the authors state that 271 cubic meters of hydrogen gas (H_2) will be produced from the water in each 0.32 cubic meters of brine that reacts with the overpack (page 6-190, paragraph 1, item 2). There is no discussion about how this H_2 gas will affect the physiochemical environment around a waste package or the waste package itself. It is suggested that consideration be given to the potentially large volumes of gas liberated in the anticipated reactions and how this would affect repository performance. Third, the effects of radiolysis are not considered. Studies indicate that gases may be formed due to irradiation, such as H_2, chlorine (Cl_2) or oxygen (O_2) (see Panno and Soo, 1984). The radiation field is only considered regarding dose rate at the package surface (page 6-190, paragraph 1, #4). The effects of radiation-induced gases should also be considered. Fourth, it does not appear that the DOE has considered the effect of the repository being open to the atmosphere before closure; i.e., that O_2 will be present initially. Thus, O_2 will be reacting with the iron overpack before the repository is closed and for an indefinite period afterwards. The effects of this scenario on the waste package corrosion calculations should be considered. Fifth, if reducing conditions are actually present, the reduction of sulfates to sulfides would be expected before the reduction of H_2O to H_2. Sulfide formation may negatively affect waste package performance. Furthermore, a protective calcium sulfate or iron oxide layer would not be expected to form.

The gross brine accumulations used by the DOE for "conservative" estimates of radionuclide releases do not account for the possibility of an intrusive brine reaching the waste package, only for thermally migrating brines. This scenario, however, is considered in evaluation of waste package performance (page 6-195, paragraph 3 to page 6-196, paragraph 4). The DOE should consider the intrusive brine scenario in its evaluation of radionuclide releases.

The relevant performance assessment calculations should be evaluated in light of the above concerns and a more conservative position taken relative to this guideline.

Comment 6-22

6.3.1.2.3 Analysis of Potentially Adverse Condition(2)-Geochemistry, Page 6-88, Paragraph Last to Page 6-89, Paragraph 1

The DOE's assertion that the effects of geochemical processes on sorption of radionuclides and rock strength "are expected to be small and localized" (960.4-2-2(c)(2) is not supported by the cited document (Levy and Kierstead, 1982). This document is a "very rough preliminary estimate" concerning colloid formation due to irradiation. The discussion of sorption and rock strength is minimal, and the authors admit that data are scarce and "a large number of extrapolations, interpretations and untested assumptions" were used (Levy and Kierstead, 1982, Abstract, p. i). An important result of the work is that the estimates "point out the deficiencies in the present estimates and the various types of information needed to make reliable estimates" (Levy and Kierstead, 1982, p. 2). Furthermore, the effects of processes such as clay dehydration, brine migration, and salt decrepitation on the sorption of radionuclides and rock strength were not considered for this condition. Of most concern is that the effects of heat on carnallite and kieserite stability are not discussed (see detailed comment 6-19). It is apparent that data are not available and estimates are not demonstrably conservative in the evaluation of this condition. Therefore, based on the discussion in the draft EA, a finding that this potentially adverse condition is present may be appropriate.

Comment 6-23

Section 6.3.1.2.3 Evaluation, Page 6-89, Paragraph 4

The evaluation of the potentially adverse condition pertaining to the existence of chemically oxidizing pre-waste-emplacement groundwater conditions in the host rock is inadequate. The statement is made that, although there are no direct data on the redox conditions of the pre-waste-emplacement groundwater conditions in the host rock, the presence of methane within the Paradox Formation suggests that reducing conditions exist within the host rock. Redox conditions are not always unambiguously determined by the activity ratio of redox-sensitive couples (Lindberg and Runnells, 1984). Furthermore, redox reactions involving methane are generally sluggish at temperatures below 200°C (Ohmoto and Rye, 1979). Consequently, there is insufficient evidence presented to support the conclusion that a potentially adverse condition is not present (see detailed comment 6-16).

Comment 6-24

Section 6.3.1.2.5 Conclusion for the Qualifying Condition, Page 6-89 Paragraph 8

The statement is made that the environment near the waste canisters is an iron-silica dominated system. Inasmuch as the repository is emplaced in a salt deposit, NaCl should be considered a dominant component of the system. The large concentration of Cl^- in the brine might contribute to relatively high solubilities of radionuclides due to formation of chloride complexes.

Comment 6-25

Section 6.3.1.2.5 Conclusion for the Qualifying Condition, Page 6-89, Paragraph 9

The statement that "geochemical conditions in a repository are not expected to enhance radionuclide mobility over pre-waste-emplacement conditions" does not consider melting of the carnallite bed. For every gram of carnallite that melts, 0.39 grams of water are released. If part of the carnallite bed melts, radionuclide mobility might be enhanced (see detailed comments 3-4, 6-15, 6-19) resulting in a decrease of rock strength and an increase in the amount of brine into which radionuclides can dissolve.

Comment 6-26

Section 6.3.1.3.1, Statement of Qualifying Condition, p. 6-90, paragraph 4

It is stated that thermal properties for samples from GD-1 are summarized in Table 3-2; however, this table does not include thermal conductivity (K) values. In addition, the temperature dependence of the thermal conductivity of salt is not discussed in this section. The value of conductivity affects the temperature history and the peak temperature that can be expected at a given location. An inadequate consideration of the k-variation with temperature could result in inaccurate predictions of the thermomechanical response. Bradshaw and McClain (1971, p. 3) present data that indicate a k-variation from 5.0 to 2.4 W/mK in the temperature range of 50°C to 300°C. DOE should consider the variation in K in the evaluation, and present any appropriate available data in the final EA's.

Comment 6-27

Section 6.3.1.3.1, Statement of Qualifying Condition, p. 6-90, paragraph 4

The large uncertainties in the values of creep parameters are not addressed in the draft EA. Site-to-site variations in measured creep rates are different by orders of magnitude as evidenced in Figure 4.6 by Pfeifle et al. (1983, ONWI-450). The assumption of similar salt properties for GD-1 and the site becomes questionable with respect to creep. The DOE should consider the uncertainties associated with the creep law and its various parameters. The evaluation should also consider the possible dependence of the creep constants on temperature.

Comment 6-28

Section 6.3.1.3.3, Analysis of Favorable Conditions, p. 6-91, paragraph 5

This section states that in situ stress conditions will result throughout the waste emplacement rooms due to the creep characteristics of Cycle 6 salt and that fractures will heal almost entirely within 10 years of closure. Rock salt exhibits sufficient ductility provided it is adequately confined and under sufficient pressure. The crushed salt backfill will not be under sufficient confinement nor under sufficient pressure to exhibit ductility to the extent that it will result in lithostatic conditions in the salt backfilled rooms and surrounding rock formation within a reasonably short period of time. In the absence of relevent experience or data, this is an optimistic evaluation of the ductility phenomenon and the possibility of time delay in this phenomenon should be evaluated. The DOE should consider expanding the evaluation presented in the final EA for this guideline based on the above comments and, if appropriate, modify the finding presented based upon the result of the reevaluation.

Comment 6-29

Section 6.3.1.3.3, Analysis of Favorable Conditions, p. 6-91, Paragraph 3-5

The evaluation presented in this section does not consider the effects of host rock mass heterogeneities on thermal properties and creep properties. Heterogeneities existing in the host rock mass may decrease the thermal conductivity and adversely impact thermal expansion and creep relative to pure rock salt. DOE should consider expanding the evaluation to address the uncertainties associated with rock mass heterogeneities and the in-situ host rock thermal and creep properties.

Comment 6-30

Section 6.3.1.3.3, Analysis of Favorable Conditions, Page 6-90, Paragraph 8

This section states that the host rock (salt cycle 6) is laterally extensive and has adequate thickness to support a repository, including the disturbed zone. This finding appears to be based on geophysical evidence and on one borehole. This evidence is insufficient to support the conclusion because uncertainties regarding the existance of major inclusions, anomalous zones, etc. within the salt bed have not been considered. In addition, the analysis and evaluation presented does not address the degree to which the presence of anomalies and inclusions would limit the expected lateral flexibility at the repository level at which depth no data is presently available. Since the presence of heterogeneities would restrict both lateral and vertical flexibility, the finding that adequate flexibility is present may not be correct. The DOE should consider expanding the evaluation presented in the final EA to include a more detailed analysis of the uncertainties involved with sufficient lateral and vertical flexibility particularly with it significance to the "Alternative Design Concept" as discussed in Section 5.5.

Comment 6-31

Section 6.3.1.3.3.4, Analysis of Potentially Adverse Conditions, Page 6-93, Paragraph 1

The draft EA states that the maximum migration rates of brine inclusions within the crystals can be estimated with reasonable confidence using the theoretical model of Jenks and Claiborne (1981). In contrast, according to Roedder (1984), "Roedder and Chou (1982) showed that because the values used by Jenks and Claiborne for the major input parameters were either nonconservative, selected values, or were based on inadequate data, their calculations were not sufficiently conservative. Truly conservative estimates should be larger, perhaps by as much as two orders of magnitude than those made by Jenks and Claiborne". Furthermore, it is stated in the draft EA that salt cycle 6 contains 0.05 to 0.51 percent organic carbon, which is high relative to most other salt deposits. If this carbon is a major component of the fluid inclusions (e.g., as CH_4, CO_2,), calculations derived from theoretical consideration of the $NaCl-H_2O$ system would be invalid. Overpressurized brines have been encountered in the Paradox basin (Section 3.2.7.2 Hydrochemistry, p. 3-71, paragrah 5) which can indicate the presence of hydrocarbons. There is insufficient evidence to state that the anticipated rates of brine migration can be tolerated in a waste repository.

Comment 6-32

Section 6.3.1.3.4, Analysis of Potentially Adverse Conditions, Page 6-92 Paragraph 5

This section comments that performance of the rock mass at Davis Canyon can, in part, be inferred from in situ stress measurements at GD-1 borehole. The expected stress levels at the site cannot be adequately characterized from borehole GD-1 data alone for several reasons. Uncertainties exist for the GD-1 hydrofracturing tests (ONWI-400) related to vertical stress estimation from pore pressure measurements and the assumption that salt responds elastically. In addition, varying degrees of biaxial behavior and stress orientation were observed. Large topographic relief at the site (approximately 1400') will also affect magnitude and orientation of three dimensional principal stresses. Because of the uncertainty of the stress field in the repository area and the possibility of heterogeneities in the rock mass, it is uncertain whether rock conditions would require engineering measures beyond reasonably available technology. Brine and gas pockets of considerable size may be encountered. Such heterogeneities coupled with excessive stresses will impact the ability to retrieve waste canisters and may cause deleterious variations in the repository wide disturbed zone. The DOE should consider expanding the evaluation to address the uncertainties and impacts surrounding the stress conditions and presence of heterogeneities at the site.

Comment 6-33

Section 6.3.1.3.4, Analysis of Potentially Adverse Conditions, Page 6-92, Paragraph 1

The rock characteristics listed in Table 3-1 are for small samples of anhydrite and rock salt. The evaluation for this potentially adverse condition does not appear to have considered the influence of heterogeneities on reported rock properties. In addition, reported Cycle 6 tests represent only the lower third of the repository host rock and no test data appears to be available for the anticipated repository horizon. The evaluation therefore may not be a representative assessment of the in situ behavior of Paradox Salt (i.e., behavior as influenced by heterogeneities). The DOE should consider expanding the evaluation to access the influence of heterogeneities upon the in situ behavior of the salt and their impact on the extent of the disturbed zone.

Comment 6-34

Section 6.3.1.3.4, Analysis of Potentially Adverse Conditions, Page 6-92, Paragraph 2

The evaluation on mineral dehydration presented in this section does not address the consequences of dehydration of shale or clay inclusions nor does it assess the migration of anomalous brine inclusions. DOE should consider expanding the evaluation presented in the final EA to provide an assessment of the density, frequency, and distributions of clay, shale and macroscopic brine inclusions and of the dehydration risk and consequences for shale and clay, and of the potential and consequences for migration of large brine inclusions.

Comment 6-35

Section 6.3.1.3.4, Analysis of Potentially Adverse Conditions, Page 6-92 Paragraph 8

In this section, it is stated that laboratory testing of Paradox salt indicates its actual decrepitation temperature to be greater than 450°C. Due to difficulties in obtaining representative samples (Lagedrost and Capps, 1983) and the effects of rock mass heterogeneities that may exist within the rock mass, it is possible that the results of thermal, strength, and creep parameter testing may underestimate the thermal and geomechanical performance of the in situ rock mass. Considering the significant strength loss exhibited when cores were tested at 200°C (Pfeifle et al., 1983, Figure 4.2), the absence of heterogeneities in the tested rock core that may exist in the rock salt adjacent to the canisters, and the expected temperature of 236°C at the surface of the waste canisters, the potential for thermally induced fractures adjacent to the canisters is significant and could affect the isolation performance of the repository and retrievability. DOE should consider expanding the evaluation presented in the final EA to address the uncertainties stated above.

Comment 6-36

Section 6.3.1.3.4, Analysis of Potentially Adverse Conditions, Page 6-93, Paragraph 3

The evaluation presented does not address uncertainties related to the effects of waste heat generation on dehydration of interbeds, shaft seals, steam generation, and gas generation that could potentially result in disruptions to isolation. The evaluation is therefore considered inadequate. DOE should consider expanding the evaluation in the final EA to include consideration of the above described uncertainties.

Comment 6-37

Section 6.3.1.4, Climate Changes Guideline, page 6-96, Assumptions and Data Uncertainties subsection

Although reference is made to the human influence in future climate changes due to increase of carbon dioxide in the atmosphere, no estimates of the magnitude of disruption of the cyclic pattern or length of the disruption period on characterized climate fluctuations of the Quaternary period are presented. According to Imbrie and Imbrie (1979), the atmospheric warming induced by increasing atmospheric concentrations of carbon dioxide will result in a "super-interglacial" period with a higher mean global temperature than that estimated during the last interglacial period (about 125,000 years before present) and which would last several thousand years. Eventually, the "super-interglacial" period would be overwhelmed by orbital-climate relationships. It is suggested that the discussion of climate change be expanded to include the "super-interglacial" period, particularly with respect to identification of comparable paleoclimates with mean global temperatures of about 63°F (compared to about 61°F estimated during the last interglacial period and observed at present).

Comment 6-38

Section 6.3.1.5.2, Analysis of Favorable Conditions, (Erosion), page 6-102 and 6-103

Site specific data on rates of erosion are not available; therefore, until such data are gathered, it would appear responsible and conservative to utilize maximum rates or upperbound rates rather than rates based on assumptions. Biggar, et al., 1981, gives rates ranging up to a maximum of 1 meter per 1000 years. At this rate, the waste would be exhumed in 1 million years. It may be safe to assume that the favorable condition is expected, but without site-specific data, it is premature to say this favorable condition is present.

Comment 6-39

Section 6.3.1.6, Dissolution, page 6-105, paragraph 6

The NRC has reviewed the four seismic lines discussed in this paragraph. There are several areas on these lines where salt reflections can not be traced. This may be due to several factors such as poor surface coupling, and variations in the lithology of the salt reflectors. However, it could also be caused by dissolution features. In addition, the general resolution provided by these lires, combined with the sparse coverage is such that additional faulting, which could provide a focus for the dissolutioning process, cannot be precluded. Fault R, Figure 3-19, for example, may have sufficient throw to provide a focus for dissolution. The analysis presented for this guideline should better reflect the uncertainties in the data base.

Comment 6-40

Section 6.3.1.6.1, Statement of Qualifying Condition (Dissolution), page 6-105, paragraph 4

The lithologic definition provided by the examination of the four logs described in this paragraph is sufficient to state that there is no indication of major dissolution features; however, minor dissolution features could easily be present which would not be evident. Furthermore, the detailed core log from GD-1 does report evidence of dissolution (Figure 3-16). This may be due to drilling fluids dissolving the more soluble materials. However, there is no evidence presented to show that this is not primary dissolution. The final EA should evaluate and discuss the evidence for dissolution observed in GD-1. In addition, the drilling records for all holes should be reviewed to determine if any zones of fluid loss or gain were present and this information should be presented in the final EA.

Comment 6-41

Section 6.3.1.6.4, Analysis of Disqualifying Condition (Dissolution), page 6-106, paragraph 8

Based on the definition of the site as presented in Chapter 3, page 3-1, the site is approximately 12 kilometers from the Shay/Bridger Jack/Salt Creek fault system. In addition, Gustavson, et al., 1980, page 3, quoted rates of up to 3.2 feet/year which is approximately an order of magnitude greater than the rates used in this analysis. As no site specific data are available on dissolution, a reasonable and conservative approach would be to utilize both the average and the maximum upper or bounding rates in the analysis. Utilizing the maximum rates quoted by Gustavson et al., 1980, dissolution could reach the site in less than 13000 years if dissolution would proceed inward at a uniform rate from the Shay/Bridger Jack/Salt Creek Graben system. If Fault R (figure

3-19) is similarly considered, dissolution at these rates could reach the site in less than 2000 years. Utilizing the WIPP rates, dissolution from Fault R would reach the site in approximately 10,000 years. Application of these non-site-specific rates indicate that there is a potential for the site to be disqualified. The DOE should review these non-site-specific rules to determine if they are appropriate for this geologic setting. The final EA should better reflect the uncertainty associated with the findings on dissolution.

Comment 6-42

Section 6.3.1.7.1, Statement of Qualifying Conditions (Tectonics), page 6-108, paragraph 2

Based on the definition of the site as presented on page 3-1, the site is approximately 12 km from the Shay/Bridger Jack/Salt Creek fault zone. For seismic activity which is assumed to occur on this zone, this should be the maximum distance used to calculate ground accelerations at the site as Kitcho, 1983, indicates that the subsurface expression of this system may be wider than the surface expression suggests.

Comment 6-43

Section 6.3.1.7.2, Analysis of Favorable Condition (Tectonics), page 6-109, paragraph 7

This section states that the maximum horizontal stress is west-northwest-east southeast. This is in contradiction to ONWI-400, page 37, which indicates a east-northeast west-southwest orientation from in situ stress testing. This conflicting data set should be acknowledged and, if possible, clarified in this section.

Comment 6-44

Section 6.3.1.7.2, Analysis of Favorable Conditions (Tectonics), page 6-109, paragraph 7

ONWI-492 indicates microearthquake activity has been observed in the area of the Shay/Bridger Jack/Salt Creek fault system. This should be referenced and used as part of the evaluation.

Comment 6-45

Section 6.3.1.7.2, Analysis of Favorable Conditions (Tectonics), page 6-109, paragraph 10

Due to general uncertainty of the tectonic processes which have and are acting within the area, it is premature to state that a favorable condition is definitely present (see major comment No. 1).

Comment 6-46

Section 6.3.1.7.3, Analysis of Potentially Adverse Conditions (Tectonics), page 6-111, paragraph 2

If the Shay graben and associated structures are seismogenic and could produce events of magnitude 6.5, this indicates that based on correlation of earthquakes and tectonic structures, that the magnitude of earthquakes could increase from historically recorded values. This adverse condition appears to be present.

Comment 6-47

Section 6.3.1.7.3(2), Analysis of Potentially Adverse Conditions, p. 6-110, paragraphs 10, 11, and 12

This section states that the largest earthquakes expected that might occur within the Paradox Basin are M_L 4 to 5, and these are not expected to adversely impact waste isolation. The potential for shaft and borehole seal damage due to a seismic event has not been discussed. Differential strains due to ground movement may occur along the shaft, at the surface, and in the repository (to a lesser degree). This failure mode may compromise the site's ability to store waste. DOE should consider discussing the relationship of effects, expected intensities, and frequencies of seismically propagated ground movements on waste isolation and, if appropriate, modify the finding.

Comment 6-48

Section 6.3.1.8.1, Statement of Qualifying Condition (Human Interference and Natural Resources), page 6-113, paragraph 5

In Section 5.2.1.2, potash is described as a "proven resource" while in this section, it states that it is not likely to underlie the site. These are contradictory statements which affect both environmental concerns and concerns with health and safety which need to be reconciled.

Comment 6-49

Section 6.3.1.8.3, Analysis of Potentially Adverse Condition (Human Interference and Natural Resources), page 6-115 and 6-116

Based on the oil and gas shows encountered in Borehole GD-1 within the Leadville Limestone and Paradox Formation, as well as from other wells in the site vicinity, hydrocarbons should also be discussed in this section.

Comment 6-50

Section 6.3.3.2.1, Statement of Qualifying Condition, Page 6-141, Paragraph 4

In this section of the draft EA, it is stated that design parameters are considered conservative for room closure computation. A reference in support of this evaluation (Pfeifle et al., 1983), however, considers laboratory-derived creep parameters and indicates no basis for what "conservative" design parameters for room closure should be. Evidence is not presented to indicate how the laboratory parameter values would be conservative if extended to an in situ rock mass that is heterogeneous. The DOE should consider expanding the evaluation by presenting additional supporting evidence for this statement or the statement be modified to reflect the amount of available evidence.

Comment 6-51

Section 6.3.3.2.1, Statement of Qualifying Conditions, Page 6-140, Paragraph 6

The draft EA does not consider the difficulty associated with re-excavation of storage rooms and relocation of waste canisters. There are no data, previous experience, or analyses cited to base the expectation that retrieval can be accomplished without undue hazard and reasonably available technology. It is uncertain that reasonably available technology will be adequate to re-excavate relatively hot (more than 100°C) salt and relocate the waste packages. Current availability of technology has not been demonstrated and compliance with the retrieval requirement cannot be guaranteed (NUREG/CR-3489). Uncertainty also exists relating to the possibility of breaching a waste package. The DOE should consider addressing these uncertainties in its evaluation in the final EA.

Comment 6-52

Section 6.3.3.2.2, Analysis of Favorable Condition, Page 6-141, Paragraph 6

This section states that the host rock has adequate thickness and lateral expanse to support a repository and associated disturbed zone. Presently, no site data are available proving the thickness of salt cycle 6 at the repository location. In addition, Section 3.2.7.2 describes the presence of brine in both clastic interbeds within the Paradox formation and the lower portion of the Honaker Trail Formation (overlying the Paradox) suggesting the presence of dissolutioning. Fig. 3-16 mentions the presence of brine pockets within the structures and Section 3.2.3.3 discusses the presence of carnallite and anhydrite beds both of which may increase the extent of the disturbed zone and limit repository horizon location, particularly if the "Alternative Repository Design Concept" is implemented. The evaluation for this guideline does not adequately consider the effects of heterogeneities in the host rock mass on vertical and lateral flexibility. The DOE should consider expanding the evaluation to consider these uncertainties.

Comment 6-53

Section 6.3.3.2.2, Analysis of Favorable Conditions, p. 6-142, paragraph 7

This section states that occasional bolting is considered to be the only artificial support that will be required for controlling underground openings during repository operation and canister retrieval. The discussion does not address the effects of temperature on roof and rib failures (slaking, spalling, etc.) and the resulting support requirements. The effects of heterogeneities (brine and gas pockets, carnallite and clay seams, anhydrite, etc.) on support requirements are not considered. In addition, an analysis of salt/grout/bolt thermomechanical relationships is not provided for evaluating anticipated rock bolt performance. Emplacement rooms will not be backfilled for one year leaving ample time for waste heat to cause thermal loading about the room and support package (bolts). Also, ventilation paths will have to remain open through areas adjacent to waste emplacement panels. Lacking these considerations, uncertainty exists regarding the necessary artificial support in the repository and associated shafts. DOE should consider expanding the evaluation presented to address potential alternative scenarios related to support requirements and, if appropriate, modify the finding presented based upon the results of the reevaluation.

Comment 6-54

Section 6.3.3.2.3, Analysis of Potentially Adverse Conditions, 6-143, Paragraph 4

The draft EA states that if retrieval of the waste form after emplacement is required, the creep closure of salt against the canister will require overcoring of the canister, or removal of the waste form from the in-place overpack, both of which will pose "some difficulty." Based on discussions in the draft EA, it would appear that retrieval will require re-excavation of the rooms in the presence of heat, rapidly creeping openings, high levels of radiation, steam and possibly chlorine (from radiolysis of salt) and hydrogen (from corrosion of canisters). Retrieval operations may occur in thermally-elevated conditions that will pose ventilation, mining, and radiological safety problems and/or will require sophisticated remote mining, rock handling and possibly roof support installation equipment with cooled and shielded enclosures for the operator and all support personnel. The equipment necessary for retrieval still needs to be developed and operators proficient in using such equipment under repository retrieval conditions will need to be trained. This set of conditions would appear to pose significant difficulty. The DOE should consider expanding discussion on retrievability to include these above mentioned uncertainties.

Comment 6-55

Section 6.3.3.2.3, Analysis of Potentially Adverse Conditions, Page 6-142, Paragraph 5

This section states that "there appears to be sufficient flexibility with regard to selecting the configuration and location of an underground facility." Brines found within the Paradox formation and at the interface of the overlying Honaker Trail formation suggest the potential for dissolution (Figure 3-16). Carnallite and anhydrite layers, in conjuction with brine pockets in cycle 6 (shown to exist at GD-1), could significantly limit repository location. The extent of the disturbed zone as well as the additional area required for the "Alternative Repository Design Concept" could increase if the evaluations and analyses consider the presence of heterogeneities and thermomechanical and thermohydrologic conditions that have not been considered in the draft EA. The DOE should consider expanding the evaluation to consider these effects of heterogeneities on restricting repository location and configuration and, if appropriate, modify the finding based on the reevaluation.

Comment 6-56

Section 6.3.3.2.3, Analysis of Potentially Adverse Conditions, p. 6-142, paragraph 8

This section states that no in situ characteristics are present that would require engineering measures beyond reasonably available technology. The evaluation does not consider the effects of mining and thermal loading on in situ rock conditions. If canister emplacement occurs before construction is completed, thermal effects may influence the underground facility construction procedure by requiring extensive remedial work to maintain the openings in the passageways. The effects of repository thermal loading may also require unique construction techniques. In addition, the steel shaft liner and seals must remain effective in preventing flooding to satisfy possible retrieval requirements until permanent closure. Under repository induced thermal loading, the steel shaft liner may not provide adequate protection during the lengthy time period from shaft liner installation until permanent closure. The DOE should consider expanding the evaluation presented to include the requirements for engineering measures in the high temperature environment and, if appropriate, modify the finding to reflect the results of the reevaluation.

Comment 6-57

Section 6.3.3.2.3, Analysis of Potentially Adverse Condition, Page 6-142, Paragraph 11

It is stated that scaling on occasion will be necessary to maintain excavation geometrics adversely affected by salt creep. Although the finding is not in question, the evaluation does not include an analysis of the influence of anhydrite and clay beds, carnallite markers, heat, and mining techniques, etc., on the amount of necessary scaling. The DOE should consider expanding the evaluation to consider these influences in support of the finding.

Comment 6-58

Section 6.3.3.3.3, Analysis of Potentially Adverse Conditions, Page 6-146 Paragraph 3

In this section, it is indicated that anticipated groundwater inflows from the Elephant Canyon formation to shafts can be handled well within standard engineering practice. The evaluation does not recognize that available technology and standard engineering practices have not always been successful. Furthermore, it does not identify which standard engineering practice may be used nor does it recognize possible problems that may be encountered with these practices. The evaluation does not discuss groundwater control techniques and associated problems encountered in the past. The DOE should consider expanding the evaluation to include a discussion identifying standard engineering practices and their potential problems for controlling groundwater inflows to shafts and, if appropriate, modify the finding based upon the reevaluation.

Comment 6-59

Section 6.3.3.4.3, Analysis of Potentially Adverse Conditions, p. 6-148, paragraphs 2 and 3

This section states that no induced earthquakes greater than 3.0 have been observed in the vicinity of the site. The statement is describing studies of mining-induced seismicity associated with coal mines in the Book Cliffs and eastern Wasatch Plateau area, about 150-200 kilometers northwest of the site. On page 97 of the cited reference, (Wong, 1984, ONWI-492) it is stated that the largest events in the Book Cliffs area were approximately magnitude 4. The earthquakes may be mining-induced but location inaccuracies preclude a definite determination. Mining-induced seismicity was also observed in a potash mine within the Paradox Basin about 45 kilometers north of the site although only 1 of 66 events (Wong, 1984, ONWI-492, p. 39) exceeded magnitude 1.0. Although mining-induced seismicity at various localities in the Colorado Plateau only ranges up to magnitude 3, or possibly 4, numerous casualties and damage have resulted from this induced seimicity since mining began (Wong, 2984, ONWI-492, p. 92). A potentially adverse condition appears to be present.

Comment 6-60

Section 6.3.3.4.3, Analysis of Potentially Adverse Condition (Tectonic), page 6-148, paragraph 7

If the Shay graben and associated structures are seismogenic and could produce events of magnitude 6.5, this indicates that, based on correlation of earthquakes and tectonic structures, that the magnitude of earthquakes could increase from historically recorded values. Therefore, this adverse condition appears to be present.

Comment 6-61

Section 6.3.3.4.3, Analysis of Potentially Adverse Condition, Page 6-148, Paragraph 2

This comment was incorporated elsewhere in the comment package.

Comment 6-62

Section 6.3.3.4.4, Analysis of Disqualifying Condition (Tectonics), page 6-148, paragraph 9 and 10

Within the geologic setting, there is a potential for active faulting that does not appear to have been considered regarding the ability to maintain stable openings should tectonic movement occur within the repository. It is presently a matter of geologic judgment as to whether or not this is a likely or even possible event, and, therefore, it may be successfully argued the "evidence does not support a finding that the site is disqualified"; however, the findings should better reflect the uncertainty of tectonic process in the site vicinity.

Comment 6-63

Section 6.4.1, Preclosure Radiological Assessment, page 6-159

In calculating the source term for the preclosure radiological assessment, the selected scenarios are not shown to be bounding scenarios, are into complete and it was conservatively assumed that almost all the released particulates will always be filtered out for all accident scenarios.

In the accident calculations, only hoist/shaft failures and two handling accidents were analyzed for the salt sites. Criteria for selecting and ranking of these scenarios do not appear in the reference cited (SAI 1984, DOE 1980, DOE 1979). To the extent that these accidents scenarios provide bounding conditions, the basis for using them should be documented.

In the quantitive evaluation of radiological consequences, the major source of uncertainty arises from the estimate of source term, i.e., the release fractions of radionuclides. Reliable estimates of release fractions are difficult to obtain largely because of the accident-specific nature of the release and the lack of adequate experimental data. This uncertainty in the release fraction should be recognized. In addition, in the spent fuel accidents, it is assumed that only 30 percent of the void gases in the pins would be released. In the preclosure radiological assessment sections of the EA's nonconservative source term was assumed without supporting data, calculations or specific indication of how releases would be limited by facility design. For the accident scenarios, the release of radionuclides were determined using the assumption that material released passes through a roughing filter and two HEPA filters (with Decontamination Factor for particulates of 10^7) prior to release to the environment. It is conceivable that some scenarios may cause the failure of the ventilation system, e.g., a scenario that onvolves fire in the facility may at the same time damage the filter system. Thus it is important to consider common-cause failure in developing the preliminary design.

The evaluation of radiological consequence outside the restricted areas are used to support conclusion that the evidence does not support a finding that the site is not likely to meet the applicable safety requirements set forth in 10 CFR 20, 10 CFR 60, and 40 CFR 191. The uncertainty that arises from the possible lack of completeness and conservatism in the selected accident scenarios should be considered in the preclosure radiological assessment for the EA.

Comment 6-64

Section 6.4.1, Preclosure Radiological Assessment, Page 6-159-6-171; Preclosure Damage

The Preclosure Radiological Assessment (Section 6.4.1) does not consider damage to the waste package during the preclosure period. Such damage may result in immediate failure of the waste package. The scenario analyzed in the postclosure performance assessment is very slow degradation, failure and subsequent radionuclide release. This assumes an intact container at the time of repository closure and does not include any preclosure damage, such as initial container flaws or loading damage to the container (corrosion of the waste package during the preclosure period is covered in detailed comment 6-89).

Container flaws, resulting either from manfacturing defects, or handling damage during the preclosure phase, have not been assessed quantitatively. Because these flaws could lead to immediate radionuclide release, or could lead to unexpected degradation of waste package performance, absence of preclosure damage assessment leaves a major source of early failures unevaluated. This damage process should be considered in the postclosure performance analysis.

Comment 6-65

Section 6.4.1, Preclosure Radiological Assessment for Davis Canyon, page 6-159

This comment was incorporated elsewhere in the comment package.

Comment 6-66

Section 6.4.1, Preclosure Radiological Assessment for Davis Canyon, page 6-159

This comment was incorporated elsewhere in the comment package.

Comment 6-67

Section 6.4.1, Preclosure Radiological Assessment for Davis Canyon, Page 6-159

The Preclosure Radiological assessment does not consider the full variety of potentially significant source terms. The source term presented for routine operational releases is only one of the source terms expected from the various operations indicated in the facility description, Section 5.1.1.2. There will be other source terms associated with cleaning and decontamination of shipping casks, with fuel disassembly and pin consolidation, with the handling of DHLW containers and TRU packages, with the processing of 17,000 gallons per day of radioactive liquid wastes (Table 5-1) and with the management of the low-level wastes generated on site. Spent fuel when removed from the reactor has a layer of radioactive crud on its outer surfaces that provides a source term for fuel handling operations even if no leaky fuel pins are present. Leaky fuel pins are present in most spent fuel pools and must also be disposed of.

In the contamination found in spent fuel pool water the predominant radionuclides are usually Cesium-134, Cesium-137, Cobalt-58, Cobalt-60, and Ruthenium-106, depending upon the history of the spent fuel and the pool water. It is suggested that the final EA present an assessment that addresses the source terms originating in the various cleaning, handling, packaging, and processing operations that might be conducted in the Waste Handling and Packaging Facility, the expected emissions after cleanup in the HVAC and any other gaseous waste handling systems, and the resulting radiological impacts in the environment (NUREG-0695).

Comment 6-68

Section 6.4.1.2, 10 CFR 20, Calculations, Pages 6-160 to 6-163, Fuel Pin Failure Assumptions

The source term may be underestimated because the assumed pin failure rate may be too low. The assumed pin failure rate of two per million is considerably lower than the 0.25 percent conservatively assumed for normal transport by WASH-1238. In fact, a 0.01 percent failure rate described in the draft EA appears to be more representative of discharged fuel (e.g., NUREG/CR-3602). The 0.01 percent discharge failure rate supported by NUREG/CR-3602 does not consider the effects of shipping, consolidation and other anticipated operations on the spent fuel. In light of this higher value, it is not clear that the low pin failure rate (and associated confidence level) and assumed Poisson distribution are justified in the 10 CFR 20 calculation. For the final EA, DOE should consider including a more representative set of fuel pin failure assumptions (e.g., Section 6.4.1.2.2 of DOE/RW-0012).

Comment 6-69

Section 6.4.1.2, 10CFR Part 20 Calcuation, Page 6-160, Paragraph 6

In the EA the term "accessible environment" is incorrectly applied in discussing preclosure releases. The EA states that, "Atmospheric dispersion can be expected to further reduce concentrations before released radionuclides are transported to the accessible environment." However, in the draft EPA Standard the term "accessible environment" is used only for post-closure releases. For preclosure releases, the EPA refers to the "general environment" which includes areas "outside sites within which any operations is ...conducted."

Comment 6-70

Section 6.4.1.4, Accident Calculations, Pages 6-164 to 6-171; Source Term

The draft EA states that the accident calculations were accomplished in accordance with Regulatory Guide 1.4, "Assumptions Used for Evaluating the Potential Radiological Consequences of a Loss of Coolant Accident for Pressurized Water Reactor." Although the meteorological dispersal assumptions in Regulatory Guide 1.4 may be appropriate for analyzing repository accident conditions, it would appear that those assumptions related to the amount of radioactive material released should be based on Regulatory Guide 1.25, "Assumptions Used for Evaluating the Potential Radiological Consequences of a Fuel Handling Accident." The final EA should clarify what release assumptions were used in the 10 CFR 20 (draft EA Section 6.4.1.2) and accident (draft EA Section 6.4.1.4) calculations, and whether the restrictions (e.g., burnup) of that regulatory guide were met. Differences in the generic portions of the accident calculations (e.g., Section 6.4.1.2.2 of DOE/RW-0012) should also be justified.

Comment 6-71

Section 6.4.1.4, Accident Calculations, Table 6-23, Davis Accident Comparison, page 6-169

Table 6-23 estimates the maximum-exposed individual and population doses from releases of radionuclides under accident conditions. These estimates are based on BMI/ONWI-541 (Waite 1984), Tables 3-1, Calculated X/Q Values for Accident Conditions, and 3-7, Accident Dose Comparisons. Examination of BMI/ONWI-541 (Waite 1984), Table 3-1 reveals a X/Q of 1.74E-05 at 240 meters where the maximum-exposed individual will be located. This value is not consistent with an expected value of 7E-03 for this location (Turner 1967). The expected value has been determined by the NRC staff from the meteorological conditions stated in BMI/ONWI-541 (Waite 1984), and compares favorably with the values at 240 meters found in BMI/ONWI-541 (Waite 1984), Table 2-5, Calculated X/Q Values for Normal Conditions. Because of this difference, the dose for the maximum-exposed individual in BMI/ONWI-541 (Waite 1984), Table 3-7 will be low by about a factor of 400. It is suggested that Table 6-23 be reviewed and revised as appropriate.

Comment 6-72

Section 6.4.2, Preliminary Postclosure Performance Assessment, Pages 6-171 to 6-222; Disruptive Events in Postclosure Analysis

The expected case predictions for waste package failure do not include the possibility of disruptive events. The preliminary postclosure performance assessment in the EA utilize a waste package behavior scenario wherein the easte package is expected to slowly degrade, eventually leading to package failure and radionuclide release. Disruptive scenario, such as human intusion or earthquakes, are only qualitatively treated.

While it is assumed that such events will play a minor role in the overall failure probabilities for the waste package, this assumption has not been quantitatively established. Disruptive events may result in early failures with more significant consequences than relatively slow failure processes, such as corrosion. For the final EA, discrete event failure modes should be considered.

Comment 6-73

Section 6.4.2, Preliminary Postclosure Performance Assessment, Pages 6-171 to 6-222; Disruptive Events in Postclosure Analysis

This comment was incorporated elsewhere in the comment package.

Comment 6-74

6.4.2.2.3 Geologic Subsystem, p. 6-178 para. 1

The DOE may not have considered the shortest flow path from the repository to the accessible environment. The potential for a shorter flow path is supported by hydraulic head data from GD-1. These data indicate that water in the upper and lower aquifers converge in the salt unit rather than flow from the upper aquifer to the lower. This flow path would result in shorter groundwater travel times to the accessible environment.

Comment 6-75

Section 6.4.2.3, Preliminary Subsystem Performance Assessments, Pages 6-176 to 6-213; Uncertainties in Modeling Predictions

Uncertainties in the input data and modeling procedures, which concern radiation conditions, thermal conditions, fluid conditions, and engineered barrier subsystem performance lead to uncertainties in the performance predictions that have not been included in the draft EA.

Given the complexities involved in the models and their input data, an estimate of the confidence that can be placed in the model predictions might appropriately be provided to support the conclusion that the site meets the Postclosure Technical Guidelines.

Comment 6-76

Section 6.4.2.3.1, Thermal Conditions, Page 6-180; Uncertainties in Waste Package Thermal Analysis

Confidence in the waste package thermal analysis may be overstated. Neither the magnitudes nor the effects of uncertainties in thermal analyse are provided in the draft EA, although the existence of the uncertainty is acknowledged. Corrosion rates are generally assumed to have an exponential dependence on temperature. NRC analyses indicate that the effects of temperature uncertainties are important when this dependence is used. For example, using data from Fig. 6-15 in the draft EA, it can be estimated that a difference of 30°C in peak overpack temperature can change the calculated corrosion by up to a factor of 2. The effects of uncertainties in the thermal analysis on waste package lifetime should be considered in the final EA.

Comment 6-77

6.4.2.3.2 Fluid Conditions in Salt; Page 6-183, Paragraph 2

Several statements in the draft EA concerning brine inclusions and brine migration appear to be incorrect. First, brine inclusions are not necessarily small, and there may actually be large brine pockets. A brine pocket containing 2.7×10^6 m^3 of brine was encountered at the WIPP site (National Research Council, 1984). Second, if an intracrystalline inclusion contains a significant vapor phase, it will migrate down a thermal gradient i.e away from the waste canister (see Anthony and Cline, 1972). Migration of vapor-bearing brine inclusions down a thermal gradient may be an important process in transporting radionuclides from the repository. High temperatures in the repository may initially cause fluid inclusions to migrate to the waste packages where the fluid can corrode the canisters and dissolve radionuclides. Thus heated fluid can boil, developing a vapor phase and subsequently migrate away from the waste packages as fluid inclusions.

Third, intracrystalline migration does not necessarily stop at a crystal boundary, but may move across the boundary into an adjacent crystal (see Cline and Anthony, 1971). Intercrystalline movement may be controlled by pressure gradients more than by thermal gradients, and is generally a poorly understood process.

Comment 6-78

6.4.2.3.2 Fluid Conditions in Salt; Analytical Approach, Page 6-183, Paragraph 3, to Page 6-190, Paragraph 1, item 2

The BRINEMIG code used in the draft EA to calculate accumulations due to thermally induced brine migration is based on a number of assumptions that limit the applicability of its results (see detailed comment 6-21). Results from BRINEMIG are used in support of the geochemistry qualifying condition (page 6-86, paragraph 5), favorable condition (4) (page 6-88, paragraph 2) and potentially adverse condition (1) (page 6-88, paragraph 5), and rock characteristics potentially adverse condition (2) (page 6-92, paragraph 7). The DOE should consider these uncertainties regarding BRINEMIG and the application of its results when evaluating the evidence relevant to these conditions and perform a demonstrably conservative analysis.

Comment 6-79

Section 6.4.2.3.2, Other Sources of Water, p. 6-185 para. 6

In the case of a disruptive scenario, there could be more water available to attack the waste package than DOE has considered. Head measurements presented in Section 6.4.2.2.3 indicate that water in the upper and lower HSU's would tend to converge on the salt unit rather than flow from the upper aquifer to the lower. Not having considered the volume of water that could reach the repository horizon from below, as well as a from above, DOE may have overestimated the waste package lifetime.

Comment 6-80

6.4.2.3.3 Waste Package Performance; 3 Brine Composition, Page 6-190, Paragraph 1

Corrosion tests to date using high-Mg brine have used a brine with 35,000 mg/l Mg which may produce results of limited applicability. Hubbard et al (1984), expect brine with 50,000 mg/l Mg to contact the waste packages. Thus, corrosion rates and processes observed during these experiments may underestimate actual corrosion rates (see page 6-196, paragraph 1).

It is not clear that in an intrusive brine scenario the resulting brine will be low-Mg. In the EA (table 6-28, page 6-184), the magnesum concentration of the intrusive brine is assumed to be approximately 120 mg/l. This value comes from analyses measurements of Permin Basin brines of west Texas. However, from McCulley et al., (1984), analysis of groundwater in the Honker Trail Formation form GD-1 contains mg/l Mg. The Honker Trail Formation lies directly above the repository horizon. Performance assessment evaluation using magnesium concentrations of only 120 mg/l may therefore underestimate the magnesium concentrations by a factor of ten. In fact there is strong evidence that the high solubilities of carnallite and kieseite will produce a high-Mg brine under this scenario (see detailed comment 6-14). Thus, waste package corrosion calculations using a low-Mg intrusive brine will likely underestimate actual corrosion rates (see page 6-196, paragraph 2). The DOE should consider a high-Mg intrusive brine scenario in performing conservative corrosion calculations.

Comment 6-81

Section 6.4.2.3.3, Waste Package Performance, p. 6-190, para. 1. Brine Composition

The uncertainties associated with using non-site specific brine compositions have not been recognized. No data are presented to describe the chemical composition of brines in the Paradox Basin. The fact that brines from WIPP and the Permian Basin are different indicates that the chemical composition of brines vary from place to place. Because the composition of brines have not been determined in the Paradox Basin and no samples were available to test the canisters, it is difficult to determine what effects the Paradox Basin brines would have on the corrosion rates of the canisters. The DOE should consider discussing the uncertainties associated with using brine compositions that are not site-specific.

Comment 6-82

Section 6.4.2.3.3, p. 6-195, para. 6, Boundary Stresses

Boundary stress calculations performed by the DOE may underestimate the pressure on the waste package because their caluclations assume only lithostatic pressure. However, the DOE states that a large volume of gas will be generated as the canister decays (p. 6-187, para. 2). The effect of this gas generation would be to increase the pressure on the waste package which in turn could result in an earlier failure of the waste package. The DOE should consider the effects of gas generation in calculations of the waste package lifetime.

Comment 6-83

6.4.2.3.3 Brine Flow Rate, Page 6-190 Paragraph 1, item 2

Brine migration with a thermal gradient, below which flow does not occur, has not been demonstrated to be the expected condition, contrary to the position taken in the draft EA. Although a number of investigators support the concept of a threshold thermal gradient (e.g., Jenks and Claiborne, 1981), others do not (e.g., Roedder and Chou, 1982). Because this is a condition that has not been demonstrated to exist the DOE should not consider analyses using a threshold thermal gradient as representing "expected" conditions.

Comment 6-84

Section 6.4.2.3.3 Waste Package Performance, Page 6-195, Paragraph 1

The statement that "radionuclides cannot dissolve any faster than the fuel pellet (for SF) or the glass (for CHLW)" appears to be partially incorrect. Experimental studies have shown that some radionuclides (e.g. cesium and iodine in spent fuel) are released into solution at a faster rate than the rate of dissolution of the matrix (Johnson, 1982). The first stage in glass dissolution is often a leaching of alkali elements, which could release some radionuclides into solution at a faster rate than the rate of the subsequent mechanism of matrix dissolution (Adams, 1984). It is stated that none of these factors are considered in the performance assessment calculation, implying an additional degree of conservatism. However, because the mechanisms discussed are relevant only for some radionuclides, additional conservatism cannot be claimed for all radionuclides in the calculation.

Comment 6-85

Section 6.4.2.3.3 Waste Package Performance; Corrosion and Failure of the Overpack, Page 6-195, paragraph 3 to Page 6-196, paragraph 4

Several factors concerning the geochemical conditions around the waste packages are not addressed by the DOE in calculating corrosion rates intended to show that waste packages in salt should be intact beyond 10,000 years. These factors include gas evolution, radiolysis, the introduction of atmospheric O_2, and sulfide formation (see detailed comment 6-21). The waste package performance assessments are used in support of findings for the geochemistry qualifying condition (page 6-86, paragraph 5), favorable condition (4) (page 6-88, paragraph 2), and potentially adverse condition (1) (page 6-88, paragraph 7). The degree of conservatism has not been adequately documented. To support the conservation claimed in the draft EA, these factors should be considered.

Comment 6-86

Section 6.4.2.3.3, Waste Package Performance, Pages 6-185 to 6-196; WAPPA Analysis

The Draft Environmental Assessment indicates that WAPPA, BRINEMIG, TEMPV5 and other compter codes, which were used in the EA, may be used to obtain relevant licensing information. Should these codes contain inapporpriate or inaccurate modeling assumptions, these assumptions may lead to incorrect decisions regarding data requirements. Data needed for licensing may, therefore, not be available when required. Peer review is a recognized means confirming these modeling assumptions. Supporting documentation (which identifies the code input data, the source(s) of these data, and the model limitations) makes peer review possible. This documentation should be made available prior to committing these codes to the decision process.

It should be noted that the version of WAPPA used in the waste package performance assessment appears to be different from the version that is currently available from ONWI, and the other codes have not beem released. The versions of these codes that were used should be identified and released as part of the supporting documentation identified above.

Comment 6-87

Section 6.4.2.3.3, Waste Package Performance, pages 6-185 to 6-196, Corrosion and Failure of the Overpack (pp. 6-195 to 6-196), Brine Composition (p. 6-185)

In Section 6.4.2.3.3 of the draft EA, the approach used to calculate waste package failure is described, and the effects of various expected and unexpected input conditions on the failure calculations are presented. For a case of unlimited high-magnesium brine, which is asserted to be "totally unrealistic," it is indicated that failure of SFPWR overpacks could occur at 220 years (a result which is potentially in non-compliance with the 10 CFR 60 waste package containment criterion). Information received at a Geochemistry Overview meeting with DOE at Columbus, Ohio on August 22, 1984 appears to be in conflict with the opinion expressed in the draft EA regarding the potential availability of high-magnesium brine. At the Columbus meeting, a DOE investigator (ONWI) indicated that dissolution of magnesium minerals by low-Mg intrusive brine could result in relatively large quantities of nearly pure $MgCl_2$ (see detailed comment 6-19 and 6-80 for details). That potential situation is inconsistent with the draft EA statement that "if large quantities of water associated with an intrusive scenario existed, the Mg content wouild be diluted."

Clearly, if large quantities of high-Mg brine are likely, the (Level 3) finding (Table 6-10) that "the evidence does not support a finding that the site is not likely to meet the qualifying condition" for Postclosure System Guideline 960.4-1(a) may not be appropriate, i.e., the geologic setting at the site may not allow for the use of engineered barriers such as the currently proposed reference waste package design. Thus, with regard to the draft EA waste package performance assessment and related findings, DOE should either treat the high volume, high-Mg brine scenario as a realistic case or should provide a reasonable explanation of why it is unrealistic. If it cannot be shown to be unrealistic, the ramifications of this should be addressed in the final EA, and the predicted waste package lifetime should be reconciled with the Postclosure Guideline finding. In the long run, unless sufficient information can be developed to rule out the possibility of large volumes of high-Mg brine, it may be necessary to adopt a different, more corrosion-resistant waste package for the Paradox Basin sites.

Comment 6-88

Section 6.4.2.3.3, Waste Package Performance, pages 6-186 to 6-196, Corrosion Rates (for uniform corrosion)

From a comparison of the plotted corrosion rate curves in the draft EA and test data obtained under somewhat similar conditions, it appears that not all the relevant, currently available, data have received adequate consideration in the analysis of corrosion and treatment of uncertainties. For example, for a zero radiation field, hi-Mg brine case at 250°C, the "penetration rate" in Fig. 6-15 is shown to be about 20 mils./y, whereas rates significantly higher than that have been reported (MoLecke, et al., 1981) for low carbon steels in brines having fairly high concentrations of oxygen; (in the draft EA it is assumed that anoxic conditions will prevail, but no data are presented in support of that assertion). Inasmuch as the waste package failure criterion is based upon an integration of the corrosion rates as they vary with temperature, time, etc., and since failure times from 220 years to greater than 10,000 years are reported, depending on what set of conditions is input to the calculation, all available and relevant corrosion rate data and should be considered the uncertainties in both the input and output should be explicitly addressed the final EA.

Specifically, there are three concerns worthy of resolution (in the final EA): (1) uncertainties in the data (or lack of data) for uniform corrosion; (2)

uncertainties in how the data are applied; and (3) the effect of these uncertainties on the calculations of waste package lifetime. These uncertainties should be considered in the final EA.

Comment 6-89

<u>Section 6.4.2.3.3, Waste Package Performance, pages 6-185 to 6-196 Corrosion During the Preclosure Period</u>.

There is no consideration in the draft EA of uniform and localized corrosion during the period prior to repository closure. Depending on the rate of waste package emplacement (and retrieval, if necessary) some containers could be exposed to high-temperature oxic conditions for times up to about 50 years. To obtain an estimate of the container lifetime the preclosure corrosion loss must be added to that for the postclosure period.

To estimate the pre-closure rate, data by Braithwaite and Molecke (1980) may be used. They found that 1018 steel placed in contact with crushed salt at 100°C, in the presence of 100 percent relative humidity, gave a uniform corrosion rate of 0.15 mm/yr. Over a 50-year period this would translate to a metal loss of 0.75 cm, assuming a conservative linear rate of corrosion. Braithwaite and Molecke also cite data from Project Salt Vault (Bradshaw, et al., 1971) in which a low-carbon steel was exposed to synthetic salts containing 0.5 percent water at 200-300°C. The uniform corrosion rate was 0.1 mm/yr. In 50 years this would give a metal loss of 0.5 cm, which is in reasonable agreement with their own study. A recent work (ONWI-9) shows that cast mild steel exposed at 150°C to salt moistened with high-Mg brine had a penetration rate of about 32 mils/year. In 50 years, the metal loss would be approximately 4 cm. This is in excess of the corrosion allowance specified for SFPWR packages using for this low carbon steel. Such an excessive metal loss, if confirmed, would, by definition, constitute failure of the container prior to repository closure. Additionally the temperatures during the could become high enough (and the ambient pressures low enough) to vaporize the brine water near the waste package. This could alter the flow of brine toward the waste packages in many ways which do not appear to have received consideration in the draft EA corrosion analyses. With regard to the effect on corrosion of the reference waste package overpacks, the rate of corrosion of the 1025 steel in a steam environment could be significantly different from that in a liquid brine environment.

Preclosure container corrosion should, therefore, be considered in the final EA.

Comment 6-90

<u>Section 6.4.2.3.3, Waste Package Performance, pages 6-189 to 6-196</u>

The predicted radiation levels associated with the waste package as presented in the draft EA do not correspond to previous predictions. There is nearly a two-order of magnitude discrepancy between the dose rate at the outer surface of the overpack presented in the draft EA and the waste package conceptual design (Shornhorst, J. R., 1982). A simple calculation (Sastre, C., 1984), which would under predict the dose rate gives a dose rate that is also higher by approximately two order of magnitude.

While the EA presents the results of a recent calculation (Jansen G., 1984a) of the expected radiation dose rate with distance and time, more recent calculations (Jansen, G., 1984b) indicate the radiation field should be an order of magnitude greater than that presented in the draft EA. The exact cause of this difference cannot be determined at this time due to lack of information.

Both the Jansen and Shornhorst calculations generate the radiation source term through use of the computer code ORIGEN2. The results from ORIGEN2 are then used in the one-dimensional transport code ANISN to calculate the radiation levels throughout the waste package.

Since both the draft EA and the conceptual design calculations use the same computer codes the major cause for the discrepancy in the results may arise from differences in input or the data bases required by the codes. In particular, using different cross section libraries in ANISN will alter the results. Another source of error could arise in converting the information from ORIGEN2 to a form useful for ANISN. This procedure is not automated and is not straightforward.

Since the radiation field influences the characteristics of the immediate environment and, therefore the predicted containment time and concentration of nuclides in solution, some explanation of why EA values are preferred should be provided.

Comment 6-91

Section 6.4.2.3.3, Waste Package Performance, pp. 6-189 to 6-196, Thermal Conditions: Uncertainty in the Predicted Conditions

The draft EA does not adequately discuss the uncertainties in the predicted temperatures used in waste package performance analysis. There are two components of uncertainty in the prediction of temperatures. The first derives from uncertainty in the data, and the second results from the probability that the model used for the prediction may be inadequate.

Since the temperature is expected to vary linearly with the thermal conductivity, this becomes a dominating factor in the accuracy of the predictions. The thermal conductivity of the salt data reviewed by McNulty (1984) show a wide variability in the data, close to a factor of two. The thermal conductivities used in this analysis are increased by 40% over laboratory measured values as suggested by Lagedrost and Capps, 1983.

Considering the models, it appears that the TEMPV5 code which is used to calculate temperature profiles (McNulty, 1984) treats the host media as a homogeneous isotropic material and therefore, does not account for the effects of non-salt materials.

The maximum temperature at the salt/canister interface depends also on the heat generation rate, the previous thermal history of the rock, the presence of other heat sources such as other waste packages, and the geometry of the source. An independent estimate of the temperatures at the canister/salt interface using a simple model (Sastre, C., 1984) indicates that as much as 100°C or more uncertainty may exist in the predicted profile.

Temperature is one of the most important characteristics associated with the waste package and one which establishes a feedback between materials performance and the immediate host medium. The temperature affects the rock mechanics properties, brine migration rates, the chemical composition of the brine, package degradation mechanisms and, therefore, package lifetime. The temperature gradient in the vertical direction is expected to contribute to brine flow towards the waste package. An assessment of the impact of the uncertainties in temperature on package performance should, therefore, be given potentially adverse conditions at this site (Postclosure System Guideline 960.4-1(a) and Technical Guidelines 960.4-2-1, 960.4-2-2. and 1960.4-2-3). Any uncertainties that do exist in the analysis should be considered.

Comment 6-92

Section 6.4.2.3.3, Waste Package Performance, Page 6-196, Corrosion and Failure of the Overpacks (by non-uniform corrosion)

Some plausible modes of waste package failure have not been considered in the draft EA. In the calculation of waste package lifetime under expected conditions, uniform corrosion, rather than pitting or stress corrosion/cracking, hydrogen embrittlement, etc., is the expected or assumed failure mode. A wastage allowance of 2.5 to 5.0 cm (for SFPWR and CHLW packages, respectively) is provided; it is assumed that the package will fail under lithostatic stress when the overpack is corroded by an amount equal to the wastage allowance.

Although the corrosion wastage allowance approach works reasonably well in materials engineering applications where uniform corrosion is the dominant failure mechanism, it is less suitable where other mechanisms such as pitting, stress/corrosion cracking (SCC), or hydrogen embrittlement apply. The current state of knowledge suggests that such potential failure mechanisms can not be ruled out, as evidenced by the fact that (a) pitting has been observed in Project Salt Vault tests with carbon steel (Bradshaw, et al., 1971) (b) a number of potential SCC agents are present in salt repository environments (Beavers, et al., 1984), and (c) H-embrittlement can occur in low carbon steels (Seabrook, et a.., 1950). Because non-uniform corrosion processes cannot be ruled out at this time, they should be given more attention in the final EA waste package performance assessment. In the absence of definitive experimental results, the uncertainties in the chosen corrosion process should also be considered.

Because non-uniform corrosion processes cannot be ruled out at this time that should be given more attention in the final EA waste package performance assessment. In the absence of definitive experimental results, the uncertainties in the corrosion process should also be considered.

Comment 6-93

Section 6.4.2.3.3, Waste Package Performance, page 6-196, Corrosion and Failure of the Overpack (Brine Distribution)

It is stated in the draft EA that a reduction in the surface covered by brine would cause a decrease in the package lifetime, but a quantitative indication of the amount of decrease is not provided, except in the case of low magnesium brine; (in the case of low-Mg brine, the distribution of the brine reportedly does not affect the conclusion that the waste package will be intact at 10,000 years, because the rate of corrosion in low-Mg brines is low). As is recognized in the draft EA, however, the brine inclusions at the Paradox Basin sites are high in magnesium and, as stated on page 6-196 of the Davis Canyon draft EA, the SFPWR overpack would fail at 220 years for the hypothetical case of unlimited, high magnesium, thermally- migrating brine. Although it is not explicitly stated, that example presumably applies (the draft EA does not say) to a uniform distribution of brine, but in the more plausible case of a large (but limited) quantity of thermally-migrating, high-magnesium brine that is distributed over a limited portion of the overpack surface, it is also conceivable that the overpack could fail at less than 300 years. Consideration should be given in the EA to the corrosion effects of a non-uniform distribution of brine (of varying Mg content), and the results of the calculation should be reconciled with the 960.4-1(a) Postclosure Guideline. Unless adequate justification can be provided for ruling out the possibility that a relatively high amount of high-Mg brine could contact a limited portion of the overpack surface, this site may not be amenable to the use of engineered barriers that would incorporate waste packages with the current reference design, and a different, more corrosion-resistant waste package may be needed.

Comment 6-94

Section 6.4.2.3.3, Waste Package Performance, Boundary Condition at the Package Surface, Subpart 6, Boundary Stresses, Page 6-193; Transient Stresses on the Waste Package

The information provided in Figures 6-16 and 6-17 does not make it clear that there will be sufficient thickness of overpack to withstand lithostatic stresses throughout the required service life of the waste package container.

In the discussion of waste package boundary conditions, transient excess radial and axial pressures are assumed to be 25% and 35%, respectively, of the static lithostatic pressure. However, this does not appear to be consistent with the curves in Figure 6-16 which shows the variation in axial and radial stresses for the first 20 years after burial, starting at time zero.

In Figure 6-17, where time starts at two years after burial, the failure thickness, i.e., the thickness of the overpack required to withstand the applied stress of the overpack is provided as a function of time for the first 20 years following repository closure. No explanation of the different starting times is given.

In Figure 6-17, the failure thickness of the overpack also appears to be nearly equal to the wall thickness 2 years after closure. Since transient pressure peaks at 1 year after closure, the failure thickness may exceed the wall thickness at that time, (i.e., it appears that the overpack could fail one year after closure). These points should be considered and the inconsistencies resolved in the final EA.

Comment 6-95

Section 6.4.2.3.3, Waste Package Performance, Radiation Effects on Waste Form, page 6-185

The possibility of radiation-induced changes in the waste form that could influence the leach rate on canister failure is not addressed in the discussion of the radiation field in and near the waste packages. Rough estimates of the total doses to waste package components indicate that the accumulated radiation-induced changes could make the HLW in the glass form and in the spent fuel more susceptible to leaching. This would tend to increase radionuclide release rates after package failure, making compliance with 10 CFR 60.113 less likely.

The final EA should consider the possibility of radiation-induced changes to the waste form and canister materials.

Comment 6-96

Section 6.4.2.3.4, Release Rate From The Engineered Barrier System
Tables 6-32 to 6-34, Calculational Inconsistencies and Potential Inaccuracies

There appear to be calculational inconsistencies in the estimates of the maximum concentration of nuclides in the waste pakckages and the release rates for a single package that has failed at 300 years. For example, the inventories for C-14, I-129 and Cm-244 (among others) in Table 6-24, when expressed in terms of grams per package, do not appear to agree with those in Table 6-30. These inconsistencies may influence the conclusions drawn in section 6.4.2.3.4 on the ability of the EBS in salt to comply with 10 CFR

60.113. These inconsistencies could also affect the calculation of the volume of saturated brine needed to reach to EPA limits.

The effect could be significant in that comparison of the tabulated values to the NRC controlled release criterion (10 CFR 60.113) shows that the package would not meet those criteria for some radionuclides at the package/salt interface. Variations of two to three orders of magnitude in the solubilities (see detailed Comment 6-97), or related changes in flow rates and total accumulated brine, will introduce further uncertainties into these predicted releases. These preliminary estimates should be reexamined to resolve the inconsistencies and the results should be reconciled with the findings and conclusions associated with Postclosure Guideline 960.4-2-2.

Comment 6-97

Section 6.4.2.3.4, Release Rates from the Engineered Barrier Subsystem: Uncertainties in the Solubility Limits of Radionuclides in Brine

The draft EA for the Davis Canyon Site does not adequately discuss the uncertainties in solubility limts of radionuclides in brine. As noted in tables 6-30 through 6-33 "other solubility data exist, some with higher and some with lower values.... These data may be no more or no less applicable for this preliminary analysis."

Uncertainties exist in the assumption of solubility limited release. These uncertainties are due primarily to the uncertainties in the solubilities of nuclides and uncertainty in the assumption that only dissolved nuclides can be transported. The solubility of an individual element will be affected by the character of the solid phase, the presence of common ions, the pH, the Eh, the temperature, and the presence of concentrated electrolytes. Elemental solubilities are listed, but the chemical and ionic species are not identified.

Strickert and Rai (1982) measured the solubilities of two solid forms of Pu over a pH range from 4 to 8 and under oxidizing conditions. $Pu(OH)_4$ was found to have a higher solubility than crystalline PuO_2 and both forms exhibit a change in solubility of greater than 3 orders of magnitude in the pH range investigated. Solubilities for Americium are ambiguous (Pigford, T. H., 1982), Ogard (1981) estimates that at pH 4 the solubility of uranium in deionized water may very 10 orders of magnitude depending on whether conditions are oxidizing or reducing. Neptunium, like uranium, exhibits a wide range in solubilities depending on Eh and the crystallinity of solid NpO_2 (Pigford, T. H., 1982). Recent data indicates that radiolyses of brines could result in oxidizing conditions thus increasing the solubilities of many nuclides (Gray, W. J. and Simonson, S. A., 1984). While Sr forms relatively insoluble complexes with sulfate and carbonate anions, it does form soluble chlorides; M. A. Clynne (1981) measured the solubilities of $SrCl_2$ in brines and bitterns, and in the quartenary system $SrCl_2$-NaCl-KCl-H_2O at 100°C, the $SrCl_2$ content is 45% by weight.

The combined uncertainties in the nuclide solubilities, brine flow rate, and total accumulated brine appear not to have been specifically included in the assessment of whether the engineered barrier system will meet the controlled release rate performance objective. Unless these uncertainties are specifically addressed and quantified in the final EA performance assessment, it may not be possible to ascertain whether the Level 3 finding for post-closure guideline 960.4-1(a) and associated geochemistry guideline 96.4-2-2 are appropriate.

Comment 6-98

6.4.2.3.4 Release Rates from the Engineered Barrier Subsystem, Page 6-196, Paragraph 6

The gross brine accumulations used for estimates of radionuclide releases do not account for the possibility of an intrusive brine reaching the waste package at some time in the history of waste package failure, only thermally migrating brines are considered for estimating radioactive releases. However, the intrusion brine scenario is considered in evaluation of waste package performance (page 6-195, paragraph 3 to page 6-196, paragraph 4). The final EA should also consider the intrusive brine scenario.

Comment 6-99

6.4.2.3.4 Release Rate from the Engineered Barrier Subsystem, Page 6-196, Paragraph Last

There are a number of uncertainties regarding the solubility data used in the draft EA. These include the uncertain nature of the data itself and the effects of Eh and pH (see detailed comment 6-20). Since there is no site-specific data, as asserted in the draft EA, and all available solubility data are uncertain the DOE should use more demonstrably conservative values. The DOE notes that there are measured solubilities that would be more conservative than the WISP values, but they are not used.

Comment 6-100

Section 6.4.2.3.4 Release Rate From the Engineered Barrier Subsystem, Page 6-204, Paragraph 2

The statement that "dissolution of cesium-137 would be limited by dissolution of the matrix" is not correct based on currently available data. Experimental studies have shown that some radionuclides (e.g., cesium and iodine in spent fuel) are released into solution at a faster rate than the rate of dissolution of the matrix (Johnson, 1982) (see detailed comment 6-76). The DOE should consider the possibility that some radionuclides could be released faster than the rate of dissolution of the matrix.

Comment 6-101

Section 6.4.2.3.4, Release Rate, p. 6-204, para. 1.

All available data were not used in assigning single values for solubilites for each radionuclide in the performance assessment calculations. Solubilities other than those used are reported by Tien et al. (1983). The use of a single value for solubilities may lead to an underestimate in the amount of radionuclides released to the accessible environment. Ranges of data for important parameters should be used in the analyses. For example, solubilities reported by Tien et al. (1983) show a very high solubility (no limit) for Americium and Neptunium, while Pigford et al. use 10^{-4} and 10^{-3} g/m^3 for Am and Np, respectively. If Tien's data were used in the calculations, the results would be very different from those listed in Tables 6-30 to 6-33. Ranges of important data should be used in the analyses. If single values were to be used, they should be very conservative.

Comment 6-102

Section 6.4.2.3.4, Release Rate from the Engineered Barrier Subsystem. Summary of Performance of Engineered Barriers. p. 6-208, para. 4

The conclusions that the performance of engineered barriers is insensitive to variations in parameters are not substantiated because in the analyses some of the "crucial" parameters are not varied. For example, uncertainties of solubility limits are not being considered and analyzed and only one brine volume size is used in the analyses of comparison with 10 CFR 60 and 40 CFR 191. A sensitivity analysis in which all "crucial" parameters are varied should be considered in final EA.

Comment 6-103

Section 6.4.2.3.4, Release Rate from the Engineered Barrier Subsystem, p. 6-208, para. 4

The draft EA states that if the waste package should fail, the solubilities of the radionuclides in the expected volume of brine will limit their release from the package. However, if the package should fail from human intrusion, e.g. borehole, there could also be a continuous supply of water in contact with the package. If this were the case, the analysis performed and results listed in Tables 6-33 and 6-34 will no longer be valid. In fact if the release is leach-limited at 10^{-4} per year, releases of most of the radionuclides will exceed the 10 CFR 60 limit. Analyses should be made more conservative by considering all aspects of waste package failure scenarios.

Comment 6-104

Section 6.4.2.3.5, Geologic Subsystem Performance. Performance of Shaft-Seals, p. 6-211, para. 3

The disturbed zone around the shaft perimeter and the possible dissolution of crush salt which is to be used in shaft sealing were not considered in the DOE calculations on the performance of shaft seals. The disturbed zone around the shaft may be more conducive to groundwater flow than the shaft seal. In addition, the dissolution of sal+ could occur if the shaft seal is not impermeable. Thus, the shaft seal may not be as effective as indicated by the DOE calculations. The DOE should consider the possibility of salt dissolution and flow around the shaft seal in evaluating shaft seal performance.

Comment 6-105

Section 6.4.2.3.5 Geologic Subsystem Performance. Performance Shaft-Seals, p. 6-208, par. 7

The draft EA states that calculations of expected penetration time for ground water to reach repository level is at least tens of thousands of years (Gureghian et al., 1983). However, these calculations are based on a few non-conservative assumptions. For example, the disturbed zone around the shaft perimeter was neglected and dissolution of crushed salt (which is used as part of the shaft system) was ignored. The dissolution of salt could potentially lead to significant consequence if there is a continuous supply of fresh water. In addition, if this dissolution of crushed salt is coupled with the failure of seal around the shaft, water could invade the salt rock around the shaft system.

Comment 6-106

Section 6.4.2.3.5, Geologic Subsystem Performance, Aquifer Ground-Water Flow Page 6-212, Paragraph 1-5

The numerical flow model used to support the conceptual model and veolocity calculations of the Paradox EA's does not simulate the free surface of the uppermost hydrostratigraphic unit. Instead, this potentiometric surface is input as a fixed head boundary. In addition, the uppermost unit is modeled as a confined unit in that transmissivity is not a function of the water table elevation. It is not appropriate to consider this model as supportive of a free surface conceptualization of the uppermost hydrostratigraphic unit, or as providing defensible velocity calculations because velocity depends upon simulated recharge to the uppermost unit which in turn depends upon the assumed head distribution at the upper boundary of that unit. The draft EA uses the results of numerical modeling (Intera, 1984b) in support of groundwater travel time calculations for Guideline 960.4-2-1.

Intera's (1984b) modeling of the Cedar Mesa unit exhibits two problems. The first is that transmissivity of an unconfined unit is a function of the water table elevation because the elevation of the water table controls the saturated thickness of the upper aquifer. In the Paradox model (Intera 1984b) referenced in the draft EA, the transmissivity at each surface node, which controls horizontal flow in the upper unit, is not a function of the water table elevation, but is specified as a constant node input.

The second problem is that typically recharge to a shallow aquifer is specified, based on available data, and head calculated by the model. This hsead surface can then be compared to measured heads during calibration. The Paradox model has specified heads at all nodes in the uppermost unit and calculates recharge at each of these fixed head nodes. Recharge at each node can be calculated from the model solution as a function of the specified head and horizontal fluxes, and the calculated vertical leakage. These calculated recharge values must be examined carefully to assure that the values and the spatial distribution of recharge are realistic based on the system hydrogeology. Intera (1984b) does not present or discuss athis calibration of the model recharge values, noting that calibration is based primarily on observed heads. This calibration cannot be performed for the uppermost unit because the heads are specified and not calcualted.

Intera (1984b) notes that a free surface model might be defensible for this hydrgeologic setting, but states that "the effect of this variability was not believed to be sufficiently important to justify the use of this more complex model." However, a free surface model was used by Intera (1984c) to model the Palo Duro basin, which is very similar to the Paradox Basin. When the free surface feature was added to the model of the Palu Duro Basin, the recharge values dropped by 60 percent from 0.75 cm/yr to 0.3 cm/yr. Intera (1984c) noted "The Ogallala (Palo Duro Basin) is modeled with a free water surface (i.e. water table) in this report, which is considered to be an improved representation of the unit." This alternative is an improved representation both because the numerical model correspondence to the conceptual model, in that the free surface is modeled and not specified, and because the specified recharge values and distribution are more representative. The Intera (1984b) model of the Paradox Basin, which does not simulate the free surface, is not a defensible discretization of the uppermost hydrostratigraphic unit because this model does not correspond to the conceptulization of that unit as an uncofined, free surface unit. Similarly, the recharge values that produce the velocity values are less reliable and less defensible than recharge values calibrated using a free surface model.

Comment 6-107 (This comment was incorporated elsewhere in the package)

Comment 6-108

Section 6.4.2.4.2, p. 6-183, Fluid Conditions in Salt; Brine Migration and Accumulation; Adequacy of the Data; Uncertainties in Predicted Rates and Accumulation Effect of Inhomogeneities

The waste package performance assessment does not address inhomogeneities in the waste package environment, but instead treats the surroundings (e.g., the near field) as if they were homogeneous and isotropic. For example, although the average clay content (which is a source of moisture) at a site may be small (said to be typically 3%), if locally large sections of clay occur the brine accumulation in that area can be much higher than calculated from the mean value for in situ brine inclusions (because the clay could contain about 20 w/o water). Inasmuch as the performance of a given waste package is a function of its local surroundings, not the average, or homogenized, conditions of the site, the waste package performance assessment (including the calculations of brine migration, corrosion of the overpack, and related factors) should be carried out taking into account local (near-field) conditions, including inhomogeneities in in situ brine quantity and composition.

Comment 6-109

Section 6.4.2.6, Effects of Potentially Disruptive Events and Processes, page 6-216 to 6-222

The potential for strong earthquakes in the near field, e.g. Shay and related graben systems, is not discussed nor is the possibility of active faulting at the repository (see major comment No. 1). Dissolution is active in the geologic setting and it is the NRC's opinion that this phenomena has not been adequately assessed (see major comment No. 2). Unless the geologic system can be described with some certainty, or the analysis performed reflects the uncertanties, there is no assurance that the boundary conditions assumed are valid. A thorough analysis of these near-field features and phenomena is needed before a credible evaluation of potentially disruptive events can be made.

Comment 6-110

Appendix 6-A, Construction and Operation Related Changes, Page A-2, Paragraph 6

The evidence presented to support the statement that "present data indicates that mechanical effect (due to excavation) may be limited to no more than 1 to 2 meters from the excavation (rooms and tunnels)" is incomplete. In the Acres American, Inc. (1977) references cited, other evidence is presented that would support an estimate of the distrubed zone (due to excavation) as much as tenfold greater than the estimate presented. Page 21 of the reference states that "gas bursts" or "blowouts" which occur during excavation result in rounded or conical openings into the walls or ceiling that are commonly 1 to 10 meters deep and can conceivably extend to 200 to 300 feet above mining horizon in multi-level workings. Furthermore, in Supplement A to this report (Page A-1), Kupfer states "...salt is highly disturbed for distance of 20 to 50 feet (6-15 meters) into the walls of all mine workings. In this disturbed zone the salt may have a significant porosity and permeability...". Volume II, Appendix II, page 20 of the Golder Associates, 1977 reference states "The processes of mining (salt) develops a jointing that is easily identifiable and extends back into the salt for several tens of feet; how far has not been determined." Appendix II, page 32b, also states that "one might assume that fractures (caused by the mining process) are abundant within three feet (1m) of the surface, commonplace to 10 feet (3m), and potentially present for 20 to 50 feet (6-15m)... This friability might imply openings, porosity, and even permeability that might extend for 10 to 50 feet or more into salt."

Page 33 of the Appendix states that "The largest one (pressure pocket) within the salt that blew explosively at the time of excavation in Cote Blanche is about 6 feet (2m) in diameter and extends up into the roof at least 30 feet (10m)." The DOE should consider expanding the discussion to present a comprehensive analysis of available generic information related to the extent of damage to salt rock walls and ceilings caused by the mining process, and, if appropriate, present a modified estimation of the extent of the disturbed zone.

Comment 6-111

Section Appendix 6-A, Estimation of the Extent of the Disturbed Zone, Pages A-1, Paragraphs A-1 thru A-8

This section gives the rationale for choosing a single value estimate of 10m. for the maximum range of the disturbed zone. There are several concerns with this evaluation. First, the evaluation only considers essentially homogeneous and isotropic conditions and not the influences of anomalous conditions such as existing horizontal anomalous zones or brine pocketss. There is also no mention of the effect of thermally-induced creep and thermal stresses on the disturbed zone. An analysis of tensile stresses in the rock is not sufficient if it only considers linear effects. Furthermore, the reference by Barron and Toews (1963) is not cited correctly in support of a limited disturbed zone. There is not an indication in this reference as to the depth of the constant-volume creep. It is suggested that a more thorough discussion be given with regard to the effect of non-linear and anomalous conditions on the disturbed zone.

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CHAPTER 7 COMMENTS

Comment 7-1

Section 7.2.1.2, Geochemistry - Favorable Conditions, page 7-16, paragraph 5

In chapter 7, the DOE states that carbonate in the groundwater at salt sites may react with radionuclides "to form complexes that would bemore mobile than the uncomplexed radionuclides." However, this potentially adverse effect is not discussed in the chapter 6 evaluation of geochemistry favorable condition (2), although it is discussed briefly in chapter 3 (p. 3-71, paragraphs 1 and 2). The reason why this effect is minimized in the discussions in chapter 3 and 6 but is presented as a potential problem in chapter 7 is unclear.

Comment 7-2

Section 7.3, Preferred Sites for Characterization, Table 1, page 24.

In view of latest Pleistocene-Holocene geologic history in central Washington State, equating the Hanford site with other candidate sites relative to effects of climatic changes is not supported by the data and could seriously affect site rankings. Periglacial to glacial conditions prevailed in the area; lake breakouts caused periodic catastriphic flooding and locally severe eriosion and it is not clear that differential regional ice loadings did not have tectonic effects as a result of perturbed regional stress fields, subsidence and post-glacial rebound.

The data, therefore, allows a different interpretation regarding climatic influences at the Hanford site relative to other candidate sites. Potential effects on both surface and tectonic processes exist and may be of large enough magnitude to affect the overall rankings made by DOE.

Comment 7-3

Section 7.3.1.1.1, Population Density and Distribution, page 7-58, (Table 7-9 Continued)

The entries for Table 7-9 on this page are omitted. They should be included.

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