NRC COMMENTS

ON

DOE DRAFT ENVIRONMENTAL ASSESSMENT

FOR THE

DEAF SMITH COUNTY SITE

March 20, 1985

DEAF SMITH COUNTY
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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

Structural Discontinuities

Guidelines on Geohydrology, 10CFR960.4-2-1; Dissolution, 10CFR960.4-2-6; and Rock Characteristics, 10CFR960.4-2-3 and 960.5-2-9.

The draft EA has not given adequate consideration to the location, nature and extent of structural discontinuities (fractures, joints, faults) in the subsurface near and within the site. Information in published reports, including DOE reports, does not appear to have been considered or synthesized in the analysis in support of the findings for dissolution, geohydrology and rock characteristics (see major comments 2, 3, and 6). The presence and nature of structural discontinuities in and adjacent to the repository are significant factors in evaluating ground water flow, engineering design parameters and dissolution potential. Without adequate consideration of structural discontinuities, the analysis does not reflect the uncertainty of the findings. The following is the basis for the NRC concerns.

Figure 3-25 shows several faults in the site vicinity which have been interpreted to offset units as young as Upper Clear Fork Formation (below the repository horizon). Budnik, 1983, indicates additional faults which offset even younger strata, including the San Andres and Alibates Formations (above the repository horizon) (see detailed comment 3-15). The DOE analyses in support of the various findings do not appear to reflect these alternate interpretations.

Description of lineaments and joints in section 3.2.5.2.of the draft EA is limited to a short discussion of trends in the Southern High Plains (Table 3-1). No discussion is given to explain the difference in trends between strata of different ages apparent from the table, how the difference may relate to tectonic history or the nature of jointing and fracturing known and expected in the site vicinity.

As shown by Finley and Gustavson (1981), lineaments are frequent and widespread across the Southern High Plains, and are reflected largely by linear scarps, alignment of playa-lake depressions, and linear stream segments. Examples of the latter are Palo Duro Creek, south of the Deaf Smith site, and an unnamed tributary to the north of it. The linear characteristics appear to express pronounced throughgoing fracture trends. According to Finley and Gustavson (1981), the lineaments are strongly joint-controlled in the Texas panhandle, and the lineaments and joints are probably reflective of structural control. This is not adequately addressed in the draft EA.

The published literature provides many examples indicating widespread existence of joints and fractures within the Permian evaporite sequence of the Permian Basin, but the analysis in support of the findings for dissolution, hydrology and rock characteristics does not appear to have utilized this information. According to Gustavson and Budnik, 1984, core from some wells on the Southern

High Plains confirm the presence of fractures that are nearly vertical and may or may not be mineralized throughout the stratigraphic column of the Palo Duro Basin. Similar fracturing was noted by the DOE in Figure 3-34 of the Swisher EA (Geotechnical Profile of the Harman No. 1 - Zeeck No. 1 Wells). As shown, an aggregate thickness of about four hundred feet of siltstones are characterized by jointing, and in about half of that aggregate thickness, joints are reported to be moderately to closely spaced. Within the salt units, one 200-foot-thick salt bed is described as blocky, "possibly jointed". In addition, as is shown in BMI/SRP-5004, page C-34, and BMI/SRP-5009, page C-33 and C-34, fractures were also noted in the field logs for the dolomitic limestone at the base of Unit-4. The draft EA does not appear to have used this information in the analyses.

The location, extent and nature of known and suspected structural discontinuities within the site vicinity are important information which needs to be utilized in the analysis of ground water flow, stability of underground openings and dissolution potential. By not fully utilizing this data base the DOE has not presented calculations and analyses which fully reflect alternate conclusions and uncertainties. The lack of consideration of these features is a major basis for the NRC concerns in dissolution (960.4-2-6), geohydrology (960.4-2-1) and rock characteristics (960.4-2-3 and 960.5-2-9) (see major comments 2, 3, and 6).

In revising the draft EA, the DOE should consider the nature, location and extent of known and suspected jointing, fracturing and faulting, the uncertainties in the existing data base, and the uncertainties which these features inherently introduce into the analysis. This information should be factored into revising the guideline findings as appropriate.

Comment 2

Dissolution

Guideline on Dissolution, 10CFR960.4-2-6.

The draft EA does not discuss important available evidence and associated uncertainty regarding dissolution in the geologic setting. The analysis presented in section 6.3.1.6. does not appear to adequately reflect 1) the uncertainty of projected rates of peripheral dissolution, 2) the evidence of present and Pleistocene dissolution in the geologic setting, 3) the effect of structural control on the dissolution process and 4) the possibility that thinning of the host rock in the vicinity of the site may be related to deep interior dissolution. The guideline findings on dissolution, 960.4-2-6, are therefore inadequately supported.

Rates given in the draft EA for peripheral dissolution were determined by evaluating the amount of salt being discharged from each drainage basin. As mentioned on page 6-106, the rates estimated by this analysis of stream solutes vary by four orders of magnitude, expressing an extreme level of uncertainty. In addition these are current rates reflective of the current climatic regime. The potential effect of increased precipitation during future pluvial episodes adds another factor of uncertainty which does not appear to have been reflected in the analysis.

The section further claims that there is no evidence for post-Pleistocene interior dissolution. However, Gustavson and Budnik, 1984, (DOE investigators from the Texas Bureau of Economic Geology (TBEG)) have reported several cases of apparent Pleistocene dissolution on the High Plains. The DOE has presented no information which shows that dissolution and the conditions responsible for Pleistocene dissolution, have stopped.

The DOE also assumes, as is shown by the calculations in section 6.3.1.6.4., page 6-107, that interior dissolution has been and will remain limited to the surface of the uppermost salt. However, most of the evidence for interior dissolution of the upper salt beds on the Southern High Plains indicates that the location at which dissolution has occurred appears to have been controlled by structural influence. The possibility that this structural influence might control features that could present groundwater flow paths such that the underlying salt units could also be effected is not addressed in the draft EA. Gustavson and Finley (1984), and Gustavson and Budnik 1984(b), have compiled numerous examples of pronounced localized effects, including discernible subsurface depressions along Frio Draw and Tierra Blanca Creek in Deaf Smith and Palmer Counties, and beneath Tule Basin, on the Tule Creek at the intersection of Swisher and Briscoe Counties. In these examples, the authors believe that the patterns of dissolution are related to structural adjustment and controls. Based on studies in Caprock Canyons State Park, where the results of dissolution are quite pronounced, Goldstein and Collins, 1984, state that "if dissolution was enhanced along joint zones, regional dissolution might consist of a mosaic of localized areas with varying rates of dissolution. The similarity between the orientation of joints that predate dissolution and the synclinal depressions suggest that this occurred."

Additional evidence for deep interior dissolution within Deaf Smith and Swisher counties does not appear to have been considered in the draft EA. The NRC considers that the possible relationship between areas of relatively thin San Andres Unit-4 and evidence of fractures coincident with this zone suggests possible deep interior dissolution features. Figure 3-19 shows that the thickness of the San Andres Unit-4 varies from less than 120 feet to over 200 feet within Deaf Smith County. Thinning of the San Andres formation is also suggested by the work of DOE investigator Long (1983), who shows elongated zones of thinning based on isopachs prepared from seismic refraction studies. The areas of thinning appear incompatible with the regional net salt thickness pattern of the lower part of the San Andres, shown by DOE investigators (TBEG) Budnik and Smith (1982, figure 48). The northernmost thin area, which is located about 10 kilometers east of the Deaf Smith site closely corresponds with the trace of a pronounced north northwest trending basement fault (Smith, 1983, p. 31, DOE investigator (TBEG). The large area of thinning, located in the southeastern corner of Deaf Smith County, corresponds with a cluster of photolineaments (Finley and Gustavson, 1981, DOE investigators TBEG),and appears to align with the reentrant on the San Andres Unit 4 salt margin (figure 3-20). This zone of thinning in the San Andres Unit-4 also appears to coincide with the zone of thinning of the Seven Rivers formation. The thinnest area of San Andres Unit-4 salt within Swisher County appears to lie beneath a basin on Tule Creek, in an area which Gustavson and Budnik, 1984(b) suggest formed in part from subsidence due to salt dissolution. Gustavson and Budnik, 1984(b), further suggest, that structural adjustments and controls have propagated upwards, perhaps through fracture systems, to influence the pattern of dissolution. There is no direct evidence of dissolution of the San Andres Unit-4, however selective dissolution of the San Andres Unit-4, along fracture zones, would appear to offer a reasonable explanation for the anomalously thin occurrences in the Unit 4 salt. The draft EA presents no evidence which would preclude this interpretation.

The present data base on dissolution contains many pieces of geologic evidence which suggest a high degree of uncertainty not reflected in the findings on dissolution. The apparent thinning of San Andres Unit-4 in both Deaf Smith and Swisher Counties is an uncertainty associated with potential dissolution in both the host rock and the geological setting which is not reflected in the findings for 960.4-2-6(b), 960.4-2-6(c), and 960.4-2-2(b)(1) (geochemical process). The uncertainty associated with structural control, projected rates and apparent Pleistocene dissolution is not adequately reflected in the analysis in support of the qualifying and disqualifying conditions, 960.4-2-6(a) and 960.4-2-6(d). In addition to the direct concerns related to the dissolution findings, the NRC is concerned that these potential features and processes may not have been considered in the analysis supporting the geohydrologic findings (see major comment 3).

The DOE should consider revising the discussion of dissolution within the geologic setting to include addressing the thinning of the San Andres Unit-4 salt, accelerated dissolutioning due to return of pluvial conditions and the effects of fractures on both the location and rate of the processes. The DOE should consider revising the findings for various technical guidelines as appropriate.

Comment 3

Groundwater Travel Time

Guideline on Geohydrology 10CFR960.4-2-1(b)

The draft EA concludes that the favorable condition of a 10,000 year groundwater travel time from the repository to the accessible environment (960.4-2-1(b)) is present because their calculated travel time ranges between 87,000 and 361,000 years. However, many of the assumptions and approaches for this analysis do not properly represent the full range of conditions and values likely to occur at the Deaf Smith Site. Therefore, the lower bound of the calculated travel time range is inappropriately high. Specifically, the assumptions and approaches for the draft EA are not conservative with respect to flow path, vertical hydraulic gradient, permeability, and porosity, as discussed below.

Described in the draft EA is a single likely groundwater flow path downward through the host rock and several thousand feet of underlying formations of interbedded halite, dolomite, anhydrite, siltstone, and shale of hydrostratigraphic unit B, followed by long, slow lateral flow to the northeast in the Wolfcamp brine aquifer of hydrostratigraphic unit C. Not considered in the draft EA are shorter alternative flow paths such as lateral flow directly beneath the host rock in the permeable Lower San Andres unit 4 dolomite. Fractures or other secondary openings in the bed rock above and below the host rock (e.g., unit 4 dolomite) and in interbeds within the host rock may provide shorter or faster groundwater flow paths to the accessible environment (see major comment 1 and 2; and detailed comments 3-50, 6-15 and 6-17). Horizontal flow gradients in hydrostratigraphic unit B are not considered and the vertical hydraulic gradient across hydrostratigraphic unit B is underestimated because underlying Wolfcamp potentiometric head data are converted to equivalent fresh water heads (see detailed comments 3-44 and 3-45). Mean hydrologic parameter data (permeability and porosity) as used in the draft EA do not reflect spacial variation or heterogeneity relative to the distribution of hydrologic data within sedimentary units of hydrostratigraphic units (see detailed comments 3-42 and 3-46 and effective porosity data reported in the draft EA are from laboratory tests that do not measure true effective porosity (see detailed comment 3-37). Furthermore, travel time calculations do not consider that the size of the disturbed zone and controlled area determines the distance groundwater travels to reach the accessible environment (see detailed comment 6-104). Finally, additional areas of uncertainty related to the deep-basin potentiometric mapping, drill-stem test data analyses and use of generic data in absence of site data are not reflected in the groundwater travel time estimates (see detailed comments 3-31, 3-35, 3-43, and 3-47).

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 noted above in its groundwater travel time analyses and accurately convey the uncertainty associated with its conclusion on the pre-waste-empalcement groundwater travel time favorable condition.

Comment 4

<u>Host Rock Clay Content and Dehydration</u>

<u>Guidelines on Geochemistry 10CFR960.4-2-2(c)(1) and (c)(2); and Rock Characteristics 10CFR960.4-2-3(c)(2)</u>

The draft EA did not use all of the available data or consider uncertainties in the data in evaluating the amount of clay impurities within the San Andres Unit 4 salt. The evaluations of the thermally-induced effects of clay impurities on processes or conditions such as rock strength and brine formation and movement that influence repository performance are therefore incomplete.

In technical evaluations and performance assessments, the draft EA uses average mineralogical percentages (i.e., 90% halite and 3% clay) for the host rock that are not supported by the available data. Data presented by DOE investigators Fisher (1984) and Fukui (1984) suggest that average clay percentages are probably at least twice the amount presented in the draft EA. In addition, the draft EA states that impurities in the salt such as muddy salt zones contain much higher percentages of clay, perhaps greater than 50% (page 3-72; see also Fukui, 1983, and detailed comments 3-23). Considerable uncertainties also exist as a result of the vertical and horizontal stratigraphic variability of clay interbeds and muddy salt zones that might be expected at the site in the San Andres Unit 4. This variability is due to the complex patterns of lithofacies in the salt bearing units described in the draft EA (page 3-12, paragraphs 6 and 7 to page 3-25, continuing paragraph). Because the closest well data to the site are about three miles away, predicting the nature and amount of clay at the site, given the variability which might be present, results in additional uncertainty. These sources of uncertainty are not discussed or considered in estimates of the amount of clay in the host rock presented in the draft EA.

If the host rock contains significant clay, thermally-induced clay dehydration reactions may be important with respect to reducing rock strength in addition to those factors discussed in major comment 6. Dehydration also may contribute to brine formation and movement through the salt which in turn would affect waste package corrosion. Illite and smectite, common clay minerals in the San Andres Unit 4, may lose water at temperatures less than 100°C, well below expected maximum repository temperatures (Weaver, 1979; Meyer and Howard, 1983). Data presented by Fisher (1984) and calculations made by the NRC (see detailed comment 3-25) that do not account for uncertainties such as high clay percentages in muddy salt zones suggest that the average water content that could be released from San Andres Unit 4 salt could be more than twice the amount presented in the draft EA. Therefore, performance assessment calculations in the draft EA involving analyses of migration of brine inclusions use water contents that may not accurately account for all the water available for migration, due to inadequate consideration of the amount of water produced as a result of clay dehydration (see detailed comment 6-27).

The potentially adverse effects of significant amounts of clay in San Andres Unit 4 salt influences the evaluation of several guidelines. For guideline 960.4-2-2(c)(1), concerning groundwater conditions that affect the stability or chemical reactivity of the engineered barrier system, a favorable finding is made based only on performance assessment calculations, including analyses of the migration of brine inclusions. Inadequate consideration of the amount of water that could be produced by clay dehydration weakens the evidence used in evaluating this condition (see detailed comments 6-26 and 6-27). The effects of clay dehydration on rock strength are not considered (960.4-2-2(c)(2))--if considered, then the evidence may not support the finding that this potentially adverse condition is not present (see detailed comment 6-28). For guideline 960.4-2-3(c)(2), concerning changes in rock properties due to repository conditions, the potentially adverse condition is present. However, the finding is based solely on the potential occurrence of brine migration due to the thermally driven movement of fluid inclusions in the salt. The draft EA states that dehydration of minerals is insignificant due to the small percentage of clay materials. The DOE should consider revising the evaluations for this guideline considering more realistic amounts of clay and resulting dehydration effects (see detailed comment 6-31). The uncertainty associated with the variability of clay materials also affects other conditions under the rock characteristics guideline (see major comments 6 and 7).

The DOE should consider the available data and uncertainties in the data as discussed above and re-estimate the clay percentage in San Andres Unit 4 salt. The effects of clay dehydration on rock strength and brine formation and movement, which affect waste package corrosion, should then be re-estimated based on the more nearly correct clay percentages and considering the uncertainties involved. The DOE should revise the findings for the guidelines and the relevant performance assessments as appropriate.

Comment 5

Radionuclide Mobility

Guideline on Geochemistry 10CFR960.4-2-2(b)(2), (b)(4), (c)(1), 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 6-28) 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 such as the Unit 4 dolomite underlying the host rock (see major comment 3).

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 assertion that reducing conditions are expected (see detailed comments 3-48 and 6-24). The reduced constituents cited in the draft EA to support the contention that reducing conditions are expected (i.e., CH_4) 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 6-27). 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 comments detailed 3-48 and 6-24).

The discussion of radiocolloid formation and organo-radionuclide complexation uses data that are not applicable to the expected site conditions (see detailed comment 6-23). 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 6-23 and 6-24). The uncertainties in the redox conditions and the amount of brine resulting from clay dehydration do not appear to be used in waste package corrosion and solubility performance assessment calculations, thus limiting the applicability of their results (see major comment 9 and detailed comments 6-26 and 6-27). 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 findings for this guideline and the document referenced in the draft EA is inappropriate to the sorption discussion (see detailed comment 6-28). For guideline 960.4-2-2(c)(3), concerning redox conditions, the present data are too ambiguous to support a finding that the potentially adverse condition of chemically oxidizing conditions will not be present (see detailed comment 6-24).

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 6

Effects of Host Rock Mass Heterogeneity

Guidelines on Rock Characteristics 10CFR960.4-2-3(b)(1), (b)(2), (c)(1), (c)(3), and 10CFR960.5-2-9(b)(1), (b)(2), and (c)(2).

Evaluations of the Rock Characteristics guidelines presented in the draft EA contain statements that suggest the host rock mass at the Deaf Smith site is essentially homogeneous throughout the site. Data from the site vicinity described in the draft EA indicates that heterogeneities such as clay interbeds, thinner clay seams, muddy salt beds, joints and fractures may exist in the salt host rock (see major comments 1 and 4 and detailed comments 3-23 and 6-30). Mining experience such as at the Waste Isolation Pilot Plant (WIPP) also indicates that in the absence of site data unforseen clay interbeds and brine or gas pockets should not be discounted at this time. The effects of such heterogeneities (combined with thermal loads) on construction of the repository, maintenance, potential retrieval operations and on estimating the extent of the disturbed zone have not been discussed. An assumption of homogeneity tends to underestimate these effects. The presence of heterogeneities would also tend to increase the level of uncertainty regarding the draft EA assumption that rock property data derived from core samples of essentially pure salt may be considered representative of thermal-mechanical properties of the salt units at the Deaf Smith site. This source of uncertainty has not been discussed. Therefore, uncertainties related to the heterogeneous nature of bedded salt that would be significant for evaluations of several of the Rock Characteristics guidelines may not have been adequately evaluated in arriving at the findings presented as noted in the following discussion.

The draft EA presents estimated values of physical, thermal, and engineering properties of the salt at the Deaf Smith site as representative of the in situ host rock mass at the site. The estimates are based on data from limited laboratory testing of a few samples of salt rock cores which do not appear to be representative of clay interbeds and muddy salt which might be present in the host rock. These are samples taken from boreholes three to four miles away and may not be representative of site structural and lithologic conditions (see major comments 1 and 4 and detailed comments 6-32 and 6-46). The draft EA has not discussed or estimated the effects of these problems on the values of properties and their uncertainties. It therefore appears that an implicit assumption of homogeneity of the host rock mass was made. It also appears that uncertainties related to the adverse effects of heterogeneities were not factored into the evaluations. Since the engineering behavior of the in situ salt rock mass, especially under waste induced thermomechanical loading conditions, can be dominated by heterogeneities, an assumption of host rock homogeneity would lead to underestimation of the effects of heterogeneities on several rock mechanics related concerns. These include but are not limited to the adverse effects of heterogeneities on the estimated strength, creep, thermal conductivity, and porosity of the host rock as well as dehydration of clay which reduces rock strength (see major comment 4). These may in turn 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 and procedures that are beyond currently available technology to construct and maintain repository openings, and to retrieve waste if required have not been addressed (see detail comment 6-33, 6-36, 6-37, 6-38, and 6-46). The potential adverse effects of combined thermal loads on heterogeneities might also lead to a more extensive disturbed zone in the host rock than the 10 meters estimated in Appendix 6A of the draft EA (see detailed comment 6-110).

Specific guidelines that are affected include 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). The evaluations for these findings do not consider the effect of heterogeneities which could limit the available thickness and lateral extent of host rock needed for locating the underground facility. As a consequence, the evaluations for these guidelines may be inadequate. The finding for post-closure Rock Characteristic guideline 10 CFR 960.4-2-3(c)(1) is also affected. The evaluation does not consider an analysis of the effects of heterogeneities that would tend to increase the expected engineering difficulties and level of complexity of technology required to construct, operate, and close a repository and therefore is not adequately supported. The evaluation 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) does not discuss uncertainties regarding the impact of heterogeneities on artificial support requirement and requirements for engineering measures beyond reasonably available technology related to 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 uncertainties related to the effects of heterogeneities on repository construction, operations, and waste isolation, and if appropriate, modify the findings based upon the results of the reevaluations.

Comment 7

Retrievability

Guidelines on Ease and Cost 10CFR960.5-1(a)(3); and Rock Characteristics 10CFR960.5-2-9(b)(2), (c)(3) and (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 especially in a heterogenous host rock. The evaluations for several rock characteristic guidelines indicate that the draft EA has not adequately discussed the uniqueness of the retrieval technology and the effects of adverse conditions on retrieving the waste canisters.

Section 6.3.3.2.3 (page 6-140) states that "For retrieval, re-excavation of the storage rooms is assumed to be required and, although costly, should not pose undue hazard or difficulty." However, no discussion is presented which addresses the response of a potentially heterogeneous host rock mass to variations in the areal heat loading density and the associated uncertainties related to drift opening maintenance and room stability. In addition, the discussions on retrievability in Section 5.1.3.3 and Section 6.3.3.2.3 do not sufficiently consider the potentially adverse effects associated with heterogeneities of the rock mass and elevated temperatures such as reduced rock strength, accelerated creep, pressurized gases surrounding the waste canisters, and hot brine flow. Re-excavation in areas of heterogeneities (clay interbeds and muddy salt units) may prove difficult. These adverse effects would pose 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 items where technology has not been proven include ground support systems, canister location systems, and canister overcoring systems. In addition, the potentially adverse effects may be unfavorable for the radiological health and safety of the mining personnel retrieving the waste in the event of a breached waste package (see detailed comment 5.3, 6-34, 6-35, and 6-46a). The evaluation for Rock Characteristics guideline 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 the changes anticipated to the rock characteristics due to heating over long periods of time. As a result, the draft EA evaluation may be inadequate (see detailed comment 6-35). In addition, the evaluations for the findings presented for guideline 960.5-1(a)(3) (which addresses ease and cost of construction and operation), 960.5-2-9(c)(3) (which addresses maintenance of underground openings), and 960.5-2-9(c)(4) (which addresses difficulties of retrieval) may be incomplete and overestimate the potential suitability of the site for retrieval operations (see detail comments 6-54a).

The DOE should consider expanding the discussions and evaluations to include consideration of the uncertainties associated with the repository induced thermomechanical loading effects on potentially heterogenous 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 re-evaluations be factored into the conclusions and findings presented.

Comment 8

Shaft Sealing

Guidelines on Rock Characteristics 10CFR960.4-2-3(c)(1), (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 in salt mines and the impact of flooding on safety, operations and retrievability, shaft sealing is a prime high level radioactive waste repository concern. Uncertainties associated with shaft sealing in salt units and overlaying strata include risks associated with 1) contemplated shaft construction methods including both blind hole drilling and drilling and blasting with ground freezing; 2) the effects of ground thaw after construction; 3) the design of sealing materials for long-term compatibility with engineering and chemical properties of shaft wall rock; 4) the response of shaft seals/shaft wall to potential seismic motion and 5) 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 that may be significant for evaluation of rock characteristics guidelines may not have been evaluated in arriving at the findings presented as noted in the following discussion.

In the past, available technology and standard mining practice have not always been successful in sealing salt mining shafts (Kupfer, 1980). As pointed out in D'Appolonia (ONWI-255, 1981), for a repository in salt, "...even a minor seepage into the evaporate section from overlying aquifers could be disastrous in the long-term." Uncertainties with the use of freezing techniques are associated with the drilling and blasting method. Rock disturbance due to the number of boreholes required for freezing and subsequent thawing of sedimentary units overlying salt units, afford potential opportunities for increased permeability immediately adjacent to the shaft that will be difficult to seal. The use of the blind hole drilling method leads to uncertainties due to the limited ability to obtain rock characteristics data needed for locating and placing seals (see detailed comment 4-3, 4-12, 5-4, 6-12 and 6-13). 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 (see detailed comment 5-4). The discussion also does not address the potential for significant damage to shaft seals due to potential dynamic earthquake loads (see detailed comments 6-58).

The evaluation presented in support of the finding for Rock Characteristic guideline 10 CFR 960.5-2-9(c)(2) (which addresses potentially adverse conditions which would necessitate use of engineering measures beyond reasonably available technology) does not address appropriate uncertainties associated with shaft sealing (see detailed comments 6-51, 6-101 and 6-102). As a result the evaluation is 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 analysis of uncertainties associated with long-term seal performance in geohydrologic and thermal environments which could adversely impact on the strength and bonding characteristics of yet undeveloped and untested long-term seals (see detailed comments 6-50). 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 period would prevent or delay groundwater contact with the waste form or limit the rate of radionuclide release into 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, the 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 6-78). In some instances, relevant waste package degradation and failure scenarios, such as pitting corrosion, are apparently either not taken into consideration (see detailed comments 6-67, 6-76 and 6-79) or are not adequately addressed (see detailed comments 6-89 and 6-93). There are also potentially large (but unquantified) uncertainties associated with the calculation of radiation field and thermal conditions (see detailed comments 6-72, 6-80 and 6-82) and with the solubility of radionuclides in brine (see detailed comments 6-91 and 6-95).

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 6-80); (3) lack of consideration of alternative scenarios such as premature failure due to manufacturing defects; (4) the need for a priori 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 6-70).

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 parameters 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 10

Controlled Area

Guidelines on Environmental Quality 10CFR960.5-2-5 and Site Ownership and Control 10CFR960.4-2-8(2)(c) and 960.5-2-2(c)

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 (land use) 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 preliminary controlled area identified on page 3-2 of the draft EA is approximately 9 sq. mi. or 5760 acres. The controlled area is not centered over the underground facility. At the Deaf Smith site, the south and eastern sides of the controlled area are immediately adjacent to the edges of the underground facility. The resulting distance from the edge of the underground facility to the outer edge of the controlled area ranges from less than .5 km to more than 1.5 km. Page 6-6 of the draft EA states that this preliminary area is based on "preliminary data related to radionuclide release time." 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 heterogeneities and thermal effects which might affect the design (see major comment 6), it is possible that the underground facility might be enlarged or reoriented to account for thermal effects and site heterogeneities identified during site characterization or construction. Such changes have occurred during the construction of the Waste Isolation Pilot Plant (WIPP). 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. 5-151 states that DOE is proceeding further with the two-phase concept. The area needed for the underground facilities for the two phase design is 3359 acres, or 50 percent more area than in 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 larger preliminary controlled area.

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 provide enough area to 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 evaluations of environmental quality (land use) (960.5-2-5) and site ownership and control conditions (960.4-2-8(2)(c), 960.5-2-2(c). Furthermore, 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.

The 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 results of these revisions should then be factored into the environmental quality and site ownership and control guidelines as appropriate.

Comment 11

Comparative Evaluation of Sites Against Guidelines on Surface Flooding

Guidelines on Surface Charcteristics 10CFR960.5-2-8(c) and Hydrology 10CFR960.5-2-10(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 12

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.

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DETAILED COMMENTS

EXECUTIVE SUMMARY COMMENTS

Comment ES-1

Section 5, Regional and Local Impacts of Repository Development, Page 14, Paragraph 2

Paragraph 2 states that about 11 million tons of excess salt would be removed from the site for disposal in an offsite mine. This statement is inconsistant with the detailed discussion in Section 5.1.3.4, Salt Disposal, pp. 5-31. The discussions indicates that the final selection of disposal method has not been made. It appears that the selection of the offsite mine disposal option was made only for the purposes of estimating environmental impacts. It is recommend that this inconsistency be clarified.

Comment ES-2

Section 5, Regional and Local Effects of Repository Development, Page 15, Paragraph 5

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, but there is no mention of radiological risk from transportation accidents. It is suggested that the final EA include an assessment of transportation accident effects.

CHAPTER 1 COMMENTS

Comment 1-1

Section 1.2.2, Salt Site, Page 1-7, Paragraph 1

The Draft EA states that "Many salt bodies have remained undisturbed and dry for tens of millions to several hundred million years." The term "dry" is relative and adds confusion to the application of the guidelines to the hydrogeology of this site. The term dry connotes an unsaturated medium as opposed to a saturated medium as discussed subsequently in the Draft EA. This distinction is important to the review of the EA because the nature of the flow through the medium is of primary concern with respect to the guidelines.

CHAPTER 2 COMMENTS

The NRC staff has no comments on Chapter 2.

CHAPTER 3 COMMENTS

Comment 3-1

Section 3.2.1 Regional Geology, Page 3-4, Paragraph 4

The discussion of regional geology begins with the Mississippian strata. There should be a discussion of the varied Precambrian basement beneath the region, the Precambrian structural elements and their influence on subsequent geologic history and a discussion of the early Paleozoic history. The Draft EA should present this information so that the relationship of basement structures to the present tectonic setting can be understood.

Comment 3-2

Section 3.2.1 Regional Geology, Figure 3-4, Page 3-7

Several faults mapped in other literature (NUS, 1982) are omitted from this figure. The map scale of Figure 3-4 is inadequate to allow inclusion of all these faults, but no additional, larger-scale map that would compensate for this is included in the Draft EA. The only larger-scale fault map included in the Draft EA is Figure 3-25, which is too limited in coverage to provide adequate information on faulting near the site.

All recognized and inferred faults in the site vicinity should be presented and a larger-scale map than Figure 3-4 (for instance, one which would show at least the Texas Panhandle and a portion of eastern New Mexico) should be included in the final EA.

Faults shown should be identified in a manner such that ages of last movement can be recognized. For instance, the Meers Fault, a probable Holocene reactivated fault, is not discriminated from other regional faults.

Comment 3-3

Section 3.2.2.1, Physiography, Page 3-9

The origin of High Plains playas needs to be further discussed. These are important ground water recharge locations and significant physiographic features of the High Plains. In paragraph 4 it is stated that wind erosion may have contributed to their development but this clearly implies other contributing processes. The relationship of playas to structural control should be discussed. Finley and Gustavson, 1981, pages 30-32, strongly suggest that dissolution of the carbonate caprock preferentially occurs at the intersection of joint sets. The relationship of playas to salt dissolution needs further discussion. Gustavson and Budnik, 1984, suggest that the Plio-Pleistocene lacustrine basins may indicate that continued dissolution and surface subsidence followed the end of Ogallala deposition. According to

Gustavson and Finley, 1984, the lack of sinkhole development seems only to suggest that dissolution has not resulted in cavernous conditions or catastrophic collapse.

The final EA should present additional information regarding, both the nature and origin of playas with emphasis on structural control and dissolution so that the significance of this feature with respect to waste isolation can be better understood.

Comment 3-4

Section 3.2.2.2, Erosion Processes, Pages 3-9 to 3-11

The Draft EA does not address the erosional status or nature and rates of processes for streams in the site vicinity. A rate of incision of approximately 1×10^{-3} meters/year would exhume the repository in less than 1 million years and rates up to 6×10^{-3} meters/year have been presented in the literature for this geologic setting (Baumgardner, 1983). The final EA should discuss the erosional status of North Palo Duro Creek and other streams in the area, determine if these streams are alluviated or cutting into bedrock, and state if these streams are joint controlled. The final EA should describe the possible interelationship of the stream drainage patterns and playas in the site vicinity.

Comment 3-5

Section 3.2.2.3, Paleoclimate, Page 3-11

The discussion of the impact of increasing atmospheric concentrations of carbon dioxide on future climate needs further consideration. Although reference is made to a delay or reversal in the cooling trend "due to extensive carbon dioxide introduction into the atmosphere", no estimates of the magnitude of warming or length of the period of warming 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 paleoclimate and climate change in the final EA consider 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 3-6

Section 3.2.3.1.2, Pennsylvanian System, Page 3-12, Paragraph 3

Areas of uplift and the relationship of these areas to regional faulting should be shown on a figure in the final EA. The discussion of the Pennsylvanian Period should be expanded to include a summary of its tectonic history as the presence of the Pennsylvanian coarse arkosic clastic derived from basement rocks indicate a time of tectonic activity and uplift.

Comment 3-7

Section 3.2.3.1.5, Trassic System, and Section 3.2.3.1.6, Tertiary System, Page 3-25, Paragraphs 3 and 4.

The Draft EA provides little information on the nature, distribution, and geologic history of the near-surface geologic units.

No information is provided on Quaternary deposits. It is difficult to evaluate the timing and extent of Quaternary processes without this information. The geologic processes which operated within the site vicinity following deposition of the Triassic Dockum Group included extensive erosion and dissolution. Seni, 1980, indicates that the site lies near or within a pre-Ogallala erosional channel as well as an Ogallala depositional distributary channel. Gustavson and Budnik, 1984 (based on studies of the pre-Ogallala erosional surface, the Ogallala Formation, and the Plio-Pleistocene lacustrine deposits) indicate that the paleo-topographic lows overlie an area of thin Seven Rivers salt and conclude that an episode of dissolution occurred during or possibly after disposition of the Ogallala Formation. Understanding the post Dockum geologic history is important in evaluating dissolution; in addition, the weathering which occurred within the Dockum and underlying formations may have altered the physical properties of the material, thereby potentially providing problems for shaft sinking and sealing. The Ogallala distributary channels may be preferential groundwater sources and flow paths and may require altering shaft sinking and sealing procedures. The potential variations in subsurface materials may also effect seismic responses both along the shaft and at the surface.

In Section 2.1, page 2-5, paragraph 2, it was stated that the Dockum Group contains coarse clastics including conglomerates. However, within section 3.2.3.1.5, these materials are not mentioned. These units are potentially important for understanding the groundwater flow regime.

Based on the information presented within the Draft EA it does not appear that all available data on the near surface geologic units has been considered and evaluated. This portion of the final EA should be expanded to provide this information.

Comment 3-8

Section 3.2.3.3, Salt Dissolution, Pages 3-41 to 3-51

Within this section, rates of dissolution are presented which appear to be reasonable if it is assumed that dissolution progresses inward at an essentially uniform rate. It is well known, however, that solution features in other water soluble rocks are strongly joint controlled and there are many suggestions that this is also the case in salt dissolution. Based on studies in Caprock Canyons State Park, Goldstein and Collins 1984, state "if dissolution was enhanced along joint zones, regional dissolution might consist of a mosaic of localized areas with varying rates of dissolution. The similarity between the orientation of joints that predate dissolution and the synclinal depressions suggest that this occurred."

The linear appearance of features such as Palo Duro Creek and the parallelism of these features with regional joint and lineament trends, as reported by Finley and Gustavson, 1981, strongly suggest the potential for dissolution to be concentrated around these features. If preferential dissolution along joints is considered, dissolution could effect the site in a shorter time frame than the calculations presented in this section suggest. The final EA should address the potential and effects of preferential dissolution.

Comment 3-9

Section 3.2.3.2, Site Stratigraphy, Page 3-41, Paragraph 1

The Draft EA states that the Lower San Andres Unit 4 salt, proposed as the host rock, consists of a 48 m section of "relatively clean, bedded salt." However, only 6 m of the 48 m of salt selected as host rock in Unit 4 is characterized as "nearly pure." The lowest 18 m is "brown," i.e., containing considerable claystone and siltstone, and the uppermost 24 m is "brown, gray, milky," with anhydrite, claystone, and siltstone impurities. The Unit 4 salt is not very pure salt, containing impurities disseminated in the salt or as stringers or interbeds which may contain high amounts of brine and organics, and be conduits for groundwater flow, all of which could affect repository performance. Data presented by Fisher (1984), Fukui (1983), and Fukui (1984) suggest that the average percentage of clay in Unit 4 salt is at least 6%, with clay interbeds and muddy salt zones having a much higher percentages (see comment 3-23).

Comment 3-10

Section 3.2.3.3, Salt Dissolution, Page 3-41, Paragraph 6

The final EA should expand the discussion concerning how the collapse features that are described in this paragraph and attributed to salt dissolution differ geomorphically from the playa basins that are widespread on the Texas High Plains. If the playas of the High Plains are also the products of salt dissolution, then the integrity of Palo Duro Basin salt is of concern.

Comment 3-11

Section 3.2.3.3.2, Interior Dissolution, Page 3-49 and 3-51

The Draft EA does not discuss the processes responsible for the thickening and thinning of the San Andres Formation. Gustavson and Budnik, 1984, show a zone of dissolution thinning in the Seven Rivers Formation that trends southwest through Randall and Deaf Smith County and appear on trend with the reentrant on the upper San Andres salt margin shown on Figure 3-23. Long, 1983, shows zones of thinning and thickening of the the San Andres that appear to coincide with the zone of thinning of the Seven Rivers Formation and the areas of thin San Andres Unit-4 shown on Figure 3-19. The final EA should state if the areas of thinning and thickening are the result of deposition, structure, or a reflection of dissolution of the San Andres Formation.

Comment 3-12

Section 3.2.5, Structure and Tectonics, Figures 3-18 3-21, 3-22, 3-24 3-25 and 3-27

Figure 3-25 shows faulting that was inferred based on the work of Long, 1983, however, it is unclear why this faulting was not factored into preparation of Figure 3-24, nor is it clear what relationship structure contour maps prepared by Long have to the structure contours presented in Figures 3-18, 3-21, 3-22, and 3-27. The final EA should reconcile the various structural data sets so that a consistent, coherent structural model is presented and utilized in the analysis.

Comment 3-13

Section 3.2.5, Structure and Tectonics, Pages 3-51 to 3-63

The Matador Arch is the southern boundary of the Palo Duro Basin and essentially separates this basin from the Midland Basin. There is no discussion within this section of the Matador Arch, the associate faulting and the relationship of this feature to the Amarillo-Wichita-Ouachita structural zone. There is also no discussion of the relationship of these major regional structures to structures within the site vicinity. The final EA should present a description of the major regional structural features and the relationship of these features to structures within the site vicinity.

Comment 3-14

Section 3.2.5, Structure and Tectonics, Page 3-51 and 3-63

One of the principal seismo tectonic concerns for this site is the lack of discussion of the potential for activity along the Amarillo-Wichita Uplift. Recent recognition of Holocene movement on the Meers fault, a WNW - ESE trending fault along the north side of the Wichita Mountains, indicates that other similar features may have escaped recognition.

Indications of possible activity along the north side of the Wichita Mountains and its NW extension include:

1. Left-lateral, Holocene movement on the Meers fault;

2. Seismicity (up to Intensity VI) possibly associated with the Amarillo Uplift in the region northeast of the site;

3. Lineaments recognized in the Anadarko Basin and postulated to represent reactivation (not necessarily recent) of the Mt. View or other faults;

4. Regional stress conditions compatible with observed motion on the Meers fault and other WNW - ESE orientation faults

The Draft EA does not present enough information on past fault motion along the Amarillo-Wichita Uplift so that the reader can evaluate this structural system and its relationship to structures in the site vicinity. The Wichita Mountains area is a surface exposure of the same structural system that passes just north of the site. Both areas must have undergone similar histories and a more complete presentation of the understanding of past fault behavior is needed in order to predict future behavior.

A northeast-southwest oriented regional stress field, as was observed in Holtzclaw No. 1, appears orientated so as to favor reactivation of northwest trending faults, such as the Potter County Fault, and may provide an explanation for the reactivation of the Meers fault. The potential for the reactivation of faults in other areas such as in the Amarillo uplift or along the boundary between the Oldham Nose and the Tucumcari basin northwest of the site and the potential for movements on favorably oriented faults in the site vicinity should be considered in the final EA.

Comment 3-15

Section 3.2.5.1, Faulting, Page 3-52, Paragraph 5

This section states that no faulting has been identified that offsets units younger than Upper Clear Fork. The interpretation presented within this section and within Figure 3-25 differs greatly from Budnik, 1983. Because Budnik's interpretation indicates faulting that offsets the San Andres, this interpretation should also be shown so that the reader can evaluate the potential effects that alternate interpretations of the geologic conditions may have on the suitability of the site. Along with showing additional faults, Budnik's Figures 9 and 14 indicate that some faults offset units as young as Alibates. If Budnik's interpretation is correct, these fault planes could be potential paths for ground water flow and be areas where dissolution could be focused.

Comment 3-16

Section 3.2.5.3 Seismicity, Page 3-58, Paragraph 1

A current and past seismographic station distribution map should be presented. The historical record for this region is extremely short, being less than 100 years. The historical level of seismicity is apparently low, and only earthquakes felt in a sparsely populated region are represented. For the reviewer to know the extent of instrumental coverage, a map is needed showing seismographic station locations, time periods of operation, and sensitivities of instruments used. Such a map is presented in the Area Characterization Report (SWEC, 1983), although instrument types and sensitivities are not given. This map indicates the poor instrumentation record for the Texas Panhandle region. The stations located in the panhandle were operational for short time periods (about 6 months), during which no seismic events occurred. A seismographic network is described as being installed in the area for purposes of this study, but no indication of the extent of coverage or resolution capability is given.

Comment 3-17

Section 3.2.5.3, Seismicity, Page 3-58, Paragraph 2

Attenuation relations derived principally from the western U.S. are inferred in the Draft EA to be valid for this region. However, in some parts of the eastern U.S. (for example, the New Madrid, Missouri area), attenuation of seismic waves has been shown to be much less than in the western U.S. Reasons for these differences are not agreed upon. Low attenuation rates may be expected in the south-central U.S. This appears to be indicated by the large felt areas for relatively small magnitude events that have occurred in the Texas Panhandle. The significance of this is that assessments of ground motion at the site may be underestimated.

Comment 3-18

Section 3.2.5.3, Seismicity, Page 3-58, Paragraph 2

Possible activity along the Amarillo-Wichita Uplift could indicate that the maximum credible earthquakes proposed by Nuttli and Herrmann (1978) may be underestimations. The potential for activity of this zone should be evaluated and maximum credible earthquakes reassessed, if appropriate.

Comment 3-19

Section 3.2.5.3, Seismicity, Page 3-59, Figure 3-26

A comparison of epicentral locations shown in Figure 3-26 with the regional tectonic map, Figure 3-4, suggests a spatial correlation between events northwest of the Deaf Smith site and the northern Tucumcari Basin and/or Oldham

Nose. As shown in Figure 3-4, a fault occurs along the boundary between these two structures and trends toward the Deaf Smith site. The final EA should discuss whether or not this fault is the source of the earthquakes detected and whether or not the scatter of events is a function of the recognized poor control existing with respect to the recorded seismic data.

Figure 3-26 appears to be taken from the Area Characterization Report (ACR) by Stone and Webster Engineering Corp (SWEC, 1983), however, some events have apparently been replotted or relocated. If this is the case, it should be stated and a basis for the relocations given. The event nearest the site (about 40 km to the east in west-central Randall County) included in the SWEC report is omitted from the Draft EA. This event does not appear to be included in the earthquake catalog of the ACR. The July 30, 1925 event that occurred northeast of Amarillo was described as Intensity VI in the ACR but as Intensity V in the Draft EA. Since this event had the largest felt area of any earthquake occurring in the Texas Panhandle, one would suspect that the larger value is more accurate.

Replotting or reassignment of different intensity values should be described and a basis given. Knowledge of confidence levels for assigned locations and intensities of historic seismic events is needed for evaluation of these events' significance and relations to structures.

Comment 3-20

<u>Section 3.2.6.1.1 Rock Mechanics Testing, Page 3-64, Paragraph 5</u>

The Draft EA states that compression tests on limestone, dolomite, and anhydrite indicate that these are the strongest rock types (generally) in the section. However, in Figure 3-29 the anhydrite bed above the host rock, at the base of the Unit 5 salt, has lower point-load indices than the salt above and below it. No test results for anhydrite in the Lower San Andres Unit 5 are given in Tables 3-2 through 3-5. It is suggested that the final EA expand the discussion on the quality of the rock within 100 ft. of the repository horizon.

Comment 3-21

<u>Section 3.2.6, Rock Characteristics, Page 3-63, Paragraph 5</u>

In this section, excavating experience from the Waste Isolation Pilot Plant (WIPP) is presented as relevant mining experience for underground construction at the Deaf Smith Co. site. There are substantial differences in rock characteristics and overall geology between the Deaf Smith Co. site and the WIPP site. In general, the conditions at the WIPP site are more favorable for underground construction with less clay seams in salt at the repository level and no major aquifers above repository level to affect shaft construction and sealing.

It is recommended that this section be expanded to describe these differences, and show that the WIPP experience is relevant.

Comment 3-22

Section 3.2.6.1.1 Rock Mechanics Testing Page 3-70, Paragraph 1

The uncertainty in extrapolating in situ creep behavior from laboratory tests has not been adequately addressed. Because creep behavior can vary from sample to sample when tested at elevated temperatures, it is difficult to base a prediction of temperature-dependent behavior on limited testing data. The creep behavior indicated in Figure 3-30 is simplified and does not give a realistic portrayal of the scatter in the data and the relevant uncertainties. The Draft EA does not discuss uncertanties associated with the the effect of impurities on measured salt creep. It is recommended that the discussion be expanded to address the above uncertainties.

Comment 3-23

Section 3.2.6.1.2, Lithostratigraphic Characterization, Page 3-79, Table 3-10 and Page 3-80, Paragraph 1

The discussion of minerological percentages of the host rock in the Draft EA is unclear and not supported by available data. The average percentages of mudstone found in Unit 4 salt in the three existing wells closest to the proposed Deaf Smith site as presented in Table 3-10 are 8.6% (J. Friemel), 7.2% (G. Friemel), and 8.0% (Detten). When these values are multiplied by the "average percent mudstone in mudstone intervals" (i.e., the percentage of clay minerals in mudstone intervals), percentages of clay in the halite are calculated by the NRC staff to be 5.59% (J. Friemel), 4.54% (G. Friemel), and 5.97% (Detten), or an average of 5.37%. The "number of mudstone interbeds" in the halite, per core, multiplied by the "average mudstone bed thickness" and the "average percent mudstone in mudstone intervals" divided by the "halite thickness" should give the same values as above. However, the percentages of clay in the Unit 4 salt calculated by the NRC staff in this manner are 3.54% (J. Friemel), 2.32% (G. Friemel), and 3.02% (Detten), or an average of 2.96%. A value of 3% is used in the text for the average clay percentage in the salt. The Draft EA apparently uses the latter method to estimate clay percentates in Unit 4 salt. The basis for selecting the more optimistic estimate of clay percentage in the Unit 4 salt is unclear.

The document referenced for mineralogical percentages for the host salt (Hubbard et al, 1984), presents values (90% halite, 7% anhydrite, and 3% clay) that are not supported by data. The data presented in Hubbard et al. (1984), are taken from preliminary field lithology logs, and are different from other studies. Fisher (1984) presents data from the four DOE wells closest to the Deaf Smith site (J. Friemel, G. Friemel, Detten, and Mansfield) showing that halite averages only about 61% of Unit 4 salt, and fine clastics (mudstone and claystone) make up 5.8%. The remainder of the rock is composed of anhydrite, limestone, dolomite, and coarse clastics. If all the dolomite and limestone is assumed to be completely below the host rock in the basal dolomite unit, then halite is calculated to make up 82% of the host rock and fine clastics are 7.7%. Calculations using data from a study by Fukui (1984) show that for Unit 4 salt from the G. Friemel well, halite makes up about 87% and clays about 6.5%. "Clay-rich" samples examined by Fukui (1983) (clay percentages between 20% and 68%) are not included in the Fukui (1984) study. Inclusion of these samples in the calculations would yield estimates of the average clay content of the salt which are greater than those presented in Fukui (1984).

The amount of clay in Unit 4 may be at least twice the value presented in the Draft EA. It is necessary to know the amount of clay present in the host salt because clay interbeds and muddy salt zones contain large amounts of water and organics relative to the salt and may provide a pathway from intrusive groundwater flow as well as affect the waste package and radionclide migration. Overly optimistic estimates of halite and clay percentages for are being used for Unit 4 salt, which are not well supported, and which may lead findings for guidelines such as 960.4-2-2(b)(3) and 960.4-2-3(c)(3) to be based on overly optimistic analyses.

Comment 3-24

Section 3.2.7.1 Geochemical Properties of Host Rock; Page 3-83, Paragraphs 3 and 4

The implication made in the Draft EA that Permian Basin salt is essentially unaltered since deposition, is not completely supported by the available data. The Draft EA suggests that the δD vs. $\delta^{18}O$ data for evaporite pan brines, San Felipe Baja, California, and for the Permian Basin overlap extensively, providing a modern analogue for the Permian Basin depositional environment. Observation of the data, however, does not reveal that "the two bodies of data overlap extensively," as stated in the Draft EA. The data presented for the San Felipe Brine Pans are only a range of values, and comparison with the Permian Basin data is difficult. However, there are large areas where the two bodies of data do not overlap. In addition, Roedder (1984) interprets the fluid inclusion chemical data to suggest that different fluids were present at different times during the history of the salt. His interpretation disagrees with the interpretation of Beeunas and Knauth (1984), that the isotopic data suggest that the Permian salt is essentially unchanged since deposition. Roedder also found that the extraction technique used by Knauth for isotopic studies was introducing large errors until it was corrected. It is unclear whether or not this problem was corrected for in the data presented in Beeunas and Knauth (1984). If Roedder's interpretation is correct, there has been active salt dissolution and historical water movement through the salt. The uncertainties caused by Roedder's data should be more explicity addressed in the final EA.

Comment 3-25

Section 3.2.7.2 Brines; Page 3-83, Paragraph 5

The Draft EA presents values for fluid inclusion contents that are not supported by the available data. Fisher's (1984, Figure 7) data suggest that the water content of the salt may actually be significantly higher than the 1.1 wt.% assumed in the Draft EA. In addition, the clay percentage presented for the host salt (3%) is too low (see comment 3-23). Data presented by Fisher (1984), Fukui (1983), and Fukui (1984) suggest that the average clay percentage in the Unit 4 salt is at least 6%, with clay interbeds and muddy salt zones having much higher percentages. Therefore, the amount of clay in Unit 4 salt may be at least twice the value presented in the Draft EA. The contribution of water from clays will therefore be greater than the 0.6 wt. % assumed in the Draft EA. An error was made in the Draft EA in calculating volume % brine from the wt.% water data. The 1.1 wt. % water assumed to be in the host salt (0.5 wt.% from brine inclusions, 0.6 wt.% from clays) is equal to 2.4 vol. % water, assuming pure halite with a density of 2.16 gm/cm^3 (Hurlbut and Klein, 1977, p. 289). This is equivalent to 2.8 vol.% brine, assuming brine with a density of 1.3 gm/cm^3 (p. 3-83, paragraph 5) and a concentration of 35 wt.% salts in brine (see Roedder and Chou, 1982, p. 2), not 1.8 vol. %, as calculated in the Draft EA. If the average clay percentage in the salt is actually 6% or 9% (i.e., 2 or 3 times the in the Draft EA estimate), the total wt. % water is calculated to be 1.7 (3.6 vol. % water) or 2.3 (4.8 vol. % water), respectively, instead of the 1.1 wt.% assumed in the Draft EA. These calculations assume that the solid is pure halite and that 3% clay contains 0.6 wt.% water. If anhydrite and clays are considered, the density of the solid would be higher and therefore increase the calculated percentage of water in the host rock. It is not unreasonable to believe that there could be an average of more than 4 vol. % water in the Unit 4 salt, with clay interbeds and muddy salt zones containing much greater amounts of water. This suggests that the 5.0 vol. % water content used in the Draft EA performance assessments (page 6-181, last paragraph) is not much greater than the expected value. In clay interbeds and muddy salt zones, 5.0 vol.% water may, in fact not be conservative.

Comment 3-26

Section 3.2.7.2 Brines; Page 3-83, Paragraph 6

Roedder (1984) presents no data suggesting that "the average (Mg) concentration is expected to be about 50,000 mg/l" in fluid inclusions, contrary to what is stated in the Draft EA. He only presents relative weight percent data for Mg (magnesium) , Ca, and K concentrations. The 50,000 mg/l Mg average is an assumption made by Hubbard et al. (1984), based on a seawater evaporation model. But, as presented in Hubbard et al. (1984), Mg concentrations can theoretically be as high as 100,000 mg/l before precipitation of Mg minerals is expected to occur. Hubbard also assumes that inclusions are reflects of seawater evaporation, i.e., that they are essentially unaltered since deposition. Roedder's (1984) data, however, cast doubt on this assumption. Roedder interprets the fluid inclusion chemical data to suggest that different fluids were present at different times during the history of the salt (see comment 3-24). If Roedder's interpretation is correct, there has been active salt dissolution and historical water movement through the salt. These uncertainties will affect studies and calculations concerning waste package performance. The final EA should address potential scenarios in which Mg concentrations in fluid inclusions are greater than 50,000 mg/l.

Comment 3-27

Section 3.2.8.1, Hydrocarbon Resources Page 3-86 to 3-92

This section extensively cites Dutton, et al. (1982) and concludes that the Palo Duro Basin is undercharged with respect to hydrocarbon potential, and that the possibility of undiscovered hydrocarbons is low. Dutton, et al. (1982), however, states (page 1) that "the Palo Duro Basin seemingly has all the elements necessary for hyrocarbon generation and accumulation: reservoirs, traps, source rocks, and sufficient thermal maturity. ...The Palo Duro Basin contains source rocks of sufficient quality to generate hydrocarbons. Pennsylvanian and Wolfcampian shales contain up to 2.4 percent total organic carbon and are fair to very good source rocks", concluding on page 73 that "additional discoveries in the Palo Duro Basin are likely." On Figures 52 and 53, in Dalton, et al. (1982), Pennsylvanian and Lower Permian potential reservoir fairways are superimposed over organic-rich source rocks. These maps, which ignore granite wash potential, show that the site area has potential for hydrocarbon production. Although these studies are theoretical, it appears that the potential for oil or gas discoveries has been underestimated in the Draft EA.

Comment 3-28

Section 3.2.8.2 Other Resources Page 3-95 Paragraph 1

This section states "Abundant potassium salts have not been observed in the DOE wells." The final EA should address where, both geographically and stratigraphically, potassium salts have been noted.

Comment 3-29

Section 3.3.1.3, Flooding, Page 3-111, Paragraph 2

Results of flood studies for Palo Duro Creek and an unnamed tributary to North Palo Duro Creek were presented in the Draft EA (Figure 3-44). Based on an examination of these studies, it appears that the magnitude of flooding on these streams may have been underestimated. The probable maximum flood (PMF) for the unnamed tributary was estimated in the report to have a magnitude of 236,200 cfs (Figure 3-44) in the site vicinity, where the drainage area is 256 square miles. Review of historic flood data for this region indicates that a flood having a magnitude of 230,000 cfs occurred on a stream with a drainage area of 142 square miles, located in Western Texas.

Recognizing that streams in the site vicinity could have different flood-producing characteristics than the stream which produced the historic maximum discharge, it is nevertheless important that the PMF represent the upper limit of flood potential for a particular stream. It appears that this upper limit may not have been well defined at this site.

Because the referenced flooding report (NUS, 1984) was not provided to the NRC staff, it is not possible to assess the adequacy of the flooding or water surface profile analyses. This report is necessary to review assumptions and data which were used in the flood analyses, including HEC-1 analyses and HEC-2 analyses. Because these data and analyses are not available, and because there is a possibility that the magnitude of flooding may be underestimated, it is not possible to reach any conclusions regarding Guidelines 960.5-2-8 or 960.5-2-10 (favorable or adverse conditions concerning flooding of surface facilities). While the possibility exists that a flooding problem is of little consequence at this site, the NUS report should nevertheless be made available for review and comment.

Comment 3-30

Section 3.3.2.1, Hydrology and Modeling, Page 3-111, Paragraph 6

The paragraph provides no indication that the hydrostratigraphic grouping described in the Draft EA is preliminary and tends to simplify what is a complex regional hydrogeologic system. The paragraph states that the geologic units of the Palo Duro Basin have been grouped into three regional hydrostratigraphic units based on regional lateral continuity and similarity of permeability, porosity, transmissivity, lithology, structure, and recharge/discharge relationships. This hydrostratigraphic grouping was first described by Bassett et al. (1981) and in detail by Bair et al. (1984). Bassett et al. (1981) describe their model for regional groundwater flow in the Palo Duro Basin as preliminary. The detailed hydrogeologic description credited to Bair et al. (1984) contains no references on regional flow. Their work provides a detailed restatement of the model previously reported by Bassett et al. (1981) in way of background material to discussions of oil field drill stem test date.

Because the conceptual regional flow model provides the basis for determining the path(s) of radionuclide travel from the disturbed zone to the accessible environment it is imperative that the final EA consider the preliminary nature of the conceptual regional flow model, particularly in relation to the uncertainty of applying a simplified regional model to a specific site within the basin. Such consideration should include alternatives to the basic flow model presented.

Comment 3-31

Section 3.3.2.1.1, Regional Hydrostratigraphic Units, Page 3-119, Paragraph 3

This paragraph in the Draft EA does not discuss the analysis of the remaining 145 limited drill-stem tests (DST's) from the 300 analyses of nonHorner plots available for HSU B. In addition, the method used to calculate permeability from nonHorner plots and its limitations is not discussed.

The paragraph states that "a preliminary analysis of 155 Lower San Andres limited DST data (nonHorner plots from the 300 analyses previously mentioned) indicates a median permeability of 0.42 millidarcy." The Draft EA reference cited for this non-Horner plot data (ONWI, 1984) states that permeabilities were computed with methods described by Earlougher (1977). This method calculates an approximate slope of the pressure data with respect to time from two data points (initial and final shut in pressures) to provide a rough approximation of permeability. Discussion of this additional HSU B limited DST data and the limitations of the analysis method should be included in the final EA. This information is important to evaluating the overall permeability of HSU B as well as individual permeable zones within HSU B that may act as pathways for radionuclide transport.

Comment 3-32

Section 3.3.2.1.1, Regional Hydrostratigraphic Units Page 3-119, Paragraph 3

The method for calculating the HSU B mean permeability from permeability data for different zones within HSU B is biased toward zones of lower permeability. The paragraph states that permeabilities from Horner plot analyses of six DSTs in HSU B range from 0.01 to 1.56 millidarcies, with a geometric mean of 0.15 millidarcy (Table 3-19). Seven analyses of repeat formation tests (RFT's) in lower San Anderes Unit 4 range from 0.03 to 3.05 millidarcies, with a geometric mean of 0.14 millidarcy. Table 3-19 indicates that six permeability values for HSU B are distributed within three distinct permeability zones with HSU B with varying hydrologic properties. Because the geometric mean of permeabilities from different zones will be biased toward the zones with lower values, permeabilities among different zones should be averaged arithmetically. The geometric mean should be used to average permeabilities from the same zone.

The NRC staff averaged geometrically the Table 3-19 data within each zone, obtaining means of 0.19 md, 0.01 md, and 1.56 md. The arithmetic mean permeability of the three zones is 0.59 md; a significantly larger value than the mean of 0.15 md cited in the Draft EA. The seven RFTs are not shown in Table 3-19 and are not referenced, however, the variability in the permeabilites reported indicates that they could have been distributed among the different permeability zones known to exist within the Lower San Andres. Therefore, the geometric mean permeability may be inappropriately used here as well, and the 0.14 mean permeability cited for the lower San Andres from the RFT data also may be underestimated.

It is important to site evaluation that conservative approaches be taken to estimate hydrologic parameters (porosity, hydraulic conductivity, and gradients) for groundwater flow analyses. Methods that are biased toward nonconservative results should be reevaluated.

Comment 3-33

Section 3.3.2.1.1 Regional Hydrostratigraphic Units Page 3-119, Paragraph 5

No head data for any unit in HSU B or references are given in the Draft EA, supporting the statement that there are local areas where hydrostatic heads in HSU B are higher than those of HSU A. If these data do exist, then it is important to present or reference these data because it suggests a groundwater conceptual flow model where groundwater could flow directly upward from the repository to the accessible environment or horizontally through more permeable interbeds in HSU B with possible discharge upward to the accessible environment. Data and references supporting this statement should be provided and areas where groundwater in HSU B discharges into HUS A should be delineated.

Comment 3-34

Section 3.3.2.1.1, Regional Hydrostratigraphic Units, Page 3-119, Paragraph 6

The statement that, "The amount of fluid in a saturated rock is directly related to the rock's pore space. Thus the evaporate sequence of HSU B, with extremely low porosity, contains very little fluid." is misleading. It is not clear if the statement is addressing only "pure halite" or the numerous shale and carbonate interbeds within HSU B as well. As stated on page 3-119, paragraph 4, porosities for parts of HSU B range from less than 1 to greater than 10 percent. Tables 3-6, 3-7, 3-8, and 3-9 indicate the porosities among all rock types of the evaporate sequence are variable. These data do not indicate that the porosity of the evaporate sequence is extremely low. If only halite is considered, three basin porosity values for clean salt are 1 percent or less; whereas porosities of dirty salt are slightly higher. However, in considering these values relative to the large volume of halite in HSU B, the amount of water contained in the basin halite could be more extensive than presented in the Draft EA.

Comment 3-35

Section 3.3.2.1.1, Regional Hydrostratigraphic Units, Page 3-122, Paragraph 1 and Pages 3-123 and 124, Figures 3-50 and 3-51

Potentiometric maps of the deep-basin system (Figures 3-50 and 3-51) do not depict present-day transient conditions from human-induced or geologically significant processes. Potentiometric maps (Figures 3-50 and 3-51) for the Wolfcamp and Pennsylvanian systems are derived from regional drill stem test (DST) data (Bair et al., 1984). This report describes how "abnormally" underpressured DST data, attributable to zones associated with oil and gas production, were deleted from the regional data base to produce potentiometric surfaces containing only a few large local mounds and depressions. Further "culling" of underpressured DST's, not directly attributable to oil and gas production and locally overpressured DST's, produces smoother surfaces that are said to have preserved regional and some local variations in flow direction and hydraulic gradients. The report states that elimination of local temporal and aberrant potentiometric surfaces is preferable for developing a deep-basin conceptual flow model and for calibrating numerical models. However, once "abnormal" DST data attributable to oil and gas development are "culled", the deletion of additional data becomes more "subjective".

Culling procedures may remove regional and local perturbations from deep-basin potentiometric maps that are geologically significant. In addition to oil and gas production, "abnormal" pressures in deep-basin systems may be caused by osmosis, pressure unloading, downdip permeability variations, and chemical dissolution or precipitation among others (Bair et al., 1984). Knowledge of local geologically significant processes are vital to site specific groundwater flow analyses and performance assessment. Along with natural variations in the deep-basin, petroleum withdrawals at oil and gas fields in the vicinity of the Deaf Smith site (Figure 2-1) require discussion and evaluation with respect to their possible transient effects on the potentiometric surface. This can not be done from the potentiometric maps presented in the Draft EA.

Potentiometric maps of the deep basin system that realistically depict present-day transient conditions should be developed and evaluated with respect to regional and local processes that are human-induced or geologically significant. The potentiometric maps of the deep basin system (Figures 3-50 and 3-51) presented in the Draft EA should be described as being prepared from "culled" data. Evaluations based on these maps should be qualified with respect to limitations incurred in preparing these maps.

Comment 3-36

Section 3.3.2.1.1 Regional Hydrostratigraphic Units, Page 3-119, Paragraph 9 and Page 3-122, Paragraph 1 and 6

The statement on page 3-122 paragraph 1 that "each unit [Wolfcamp and Pennsylvanian aquifers] is regionally continuous and contains rock of relatively consistent permeability" is not compatable with statements on page 3-119, paragraph 9 and page 3-122, paragraph 6 that transmissive units within HSU C are the Wolfcamp carbonates and granite wash, and the Pennsylvanian marine-shelf carbonates and granite wash, and that most groundwater flow is through these units. The Draft EA implies that flow is directed toward the granite wash and carbonates because the granite wash and carbonates have higher hydraulic conductivities than surrounding units; however, this will not occur if the hydraulic conductivity of the granite wash and carbonates is relatively consistent with other units in the area. Statements on page 3-119, paragraph 9 and 3-122, paragraph 6 are consistent with the conceptual model of Bassett et al. (1981). They state that hydraulic properties are regionally applicable more to generic depositional packages rather than to time-stratigraphic units.

Page 3-122, paragraph 1 suggests that hydraulic properties are consistent within time-stratigraphic units. Resolution of this apparent contrediction is important to the conceptual regional groundwater flow model that is the basis for determining pathways and direction of groundwater flow.

Comment 3-37

Section 3.3.2.1.1, Regional Hydrostratigraphic Units, Page 3-122, Paragraph 5 and Section 3.3.2.1.2, Site Hydrogeologic Setting, Page 3-128, Paragraph 5

Effective porosity data for HSU B and HSU C reported in the Draft EA are from laboratory tests that do not measure true effective porosity. Laboratory core analysis for effective porosity (SWEC, 1984; and REI, 1983) measures only the "apparent porosity", or the volume of interconnected voids in the core sample divided by the bulk volume of core sample, rather than the effective porosity which is 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 or equal to flow velocities calculated using apparent porosities. Because effective porosity is defined with respect to advective flow (Bear, 1979, p. 63), the only method of measuring effective porosity is with tracer tests.

Comment 3-38

Section 3.3.2.1.1 Regional Hydrostratigraphic Units, Page 3-122, Paragraph 9 Continued on Page 3-128

The assumption that "Recharge to HSU C is from lateral infiltration of ground-water from the west, possibly from units cropping out in New Mexico near the Pedernal Uplift," neglects vertical recharge to HSU C. In all probability, a significant contribution of fluids occurs to HSU C from the overlying hydrostratigraphic units. Discussion in the Draft EA (page 3-122) indicates that HSU C is underpressured with respect to the other units; therefore, the potential exists for HSU C to receive fluid from HSU B. Evidence presented in Section 3.3.2.1.3, Geochemistry of Deep Basin Brine Aquifers, page 3-132, suggests that leakage through the evaporite section contributes to flow in the deep basin system. It is important that the final EA present a consistent and realistic picture of groundwater flow within the basin. The assumption is inconsistent with the conceptual and numerical models described in the Draft EA and should be resolved in the final EA.

Comment 3-39

Section 3.3.2.1.1, Regional Hydrostratigraphic Units, Page 3-127, Figure 3-54, Formation Log Normal Permeability Distribution Wolfcamp Series

The permeability distribution presented in this Figure 3-54 shows a preponderance of values between log base 10 permeabilities of 1.0 and -1.5. It is not known whether the shape of the log normal distribution resulted partially from a restriction of testing to zones of similar hydraulic conductivity. The distribution of permeability data could be a reflection of the data collection program, data analysis and test equipment limitations. The validity of test data analyses is paramount in assessing groundwater travel time. Figure 3-54 should be discussed in the final EA in a manner that describes the distribution of permeability data.

Comment 3-40

Section 3.3.2.1.2 Site Hydrogeologic Setting, Page 3-128, Paragraph 3

The average flow velocity for HSU A, calculated in this paragraph, represents a apparent nonconservative approach to calculating flow velocities. The paragraph states that at the Deaf Smith site the flow velocity in HSU A is 48.5 meters per year assuming an effective porosity of 0.15, a permeability of 10 darcys and a gradient of 0.0024. Table 3-18 presents a range of permeability values of 2.0 to 37.1 darcys with an average permeability of 13.4 darcys from 43 wells located in Deaf Smith County. In considering the variable permeability of the Ogallala Aquifer in Deaf Smith County, flow velocity estimates evaluated in terms of ranges should provide a more realistic representation of the groundwater flow velocity through HSU A likely to be encountered at the site. This is important because HSU A flow parameters are used in addressing possible impacts of site characterization, construction, and operation activities on the Ogallala Aquifer.

Comment 3-41

Section 3.3.2.1.2 Site Hydrogeologic Setting, Page 3-128, Paragraph 4

The source of values reported for permeabilities in the G. Friemel No. 1 and Detten No. 1 wells is not cited. Therefore, the permeability values presented in the Draft EA are not supported by adequate documentation. This data was used in the groundwater flow velocity calculations presented in Chapter 3 and should be referenced in the final EA.

Comment 3-42

Section 3.3.2.1.2, Site Hydrogeologic Setting, Page 3-128, Paragraph 5

All of the HSU B porosity data available in the Draft EA was not considered in the computation of the 0.02 average effective porosity used in the HSU B flow velocity analysis for the Deaf Smith site. The Draft EA does not address the representativeness or provide justification for using very limited amounts of data to compute an average HSU B effective porosity for the analysis of groundwater flow through HSU B.

The calculation of average HSU B effective porosity is based on laboratory test data of effective porosity for salt, shale, and carbonate core samples from the Mansfield well in Oldham County, which is over 25 miles from the Deaf Smith site. Although the well penetates over 4,000 feet of HSU B, laboratory tests were conducted on only three samples of core, a few tenths of a foot in length each. Tables 3.6, 3.7, 3.8, and 3.9 present a wide range of neutron porosity values for the various rock materials in HSU B. Although neutron porosity values exceed or equal actual effective porosities, many of the values shown in the tables are less than those used in computing the average effective porosity, suggesting that actual effective porosities may be lower then those used to calculate the average.

Consideration of all available data in estimating input parameters to the flow velocity calculations for each hydrostratigraphic unit is important to site evaluation. A conservative approach warrants that ranges of values be considered in flow velocity calculations to provide a more realistic representation of travel times likely to be encountered at the site. In addition, the reported 0.02 mean porosity is neither the arithmetic mean, harmonic mean nor the geometric mean of the values presented.

The final EA should provide a range of effective porosity values for HSU B based on all of the available data.

Comment 3-43

Section 3.2.2.1.2, Site Hydrogeologic Setting, Page 3-128, Paragraph 6

The Draft EA does not address the representativeness of the generic and text book values used in the Draft EA for estimating site hydrologic parameters in the absence of actual site data. An average HSU B permeability value was computed from generic values for salt and shale. In the absence of basin and site data for salt and shale, a range of available generic and text book values could have been used to more realistically represent the permeability likely to be encountered at the site.

The paragraph states that an average vertical permeability of 1.99×10^{-3} millidarcy (harmonic mean) was computed assuming HSU B is composed of 60 percent evaporite with an average permeability of 0.003 millidarcy, 30 percent shale with an average permeability of 0.001 millidarcy, and 10 percent carbonate with an average permeability of 0.05 millidarcy. As stated in Chapter 3 (page 3-119, paragraph 3), no testing of salt and shale units of HSU B were performed in the Palo Duro Basin. Salt and shale permeabilities, from which an average HSU B permeability for the Deaf Smith site is derived, are median values from a single range of values for the Salado Salt in New Mexico and from Freeze and Cherry (1979), respectively. An average value of 0.05 millidarcy is assumed for the carbonate units of HSU B; this value appears to be too low considering the possible range of values shown on Table 3-19. In addition, the HSU B permeability analysis does not appear to account for units such as the Queen-Grayburg siltstone which appears to have a permeability much higher than the reported values for salt, shale, and carbonate.

Important to site evaluation is the consideration of all available data in estimating input parameters to the flow velocity calculations for each hydrostratigraphic unit. A conservative approach requires that ranges of parameter values be considered in order to provide a more realistic representation of the possible values that may be encountered at the site. The final EA should discuss why this type of average parameter estimation is conservative in light of the greater range of values available from the cited data sources.

Comment 3-44

Section 3.3.2.1.2, Site Hydrogeologic Setting, Page 3-128, Paragraph 7

The analysis presented in this section indicates a single possible groundwater flow pathway through the evaporite sequence (HSU B) to the upper Wolfcamp dolomite (HSU C). This assumption does not consider horizontal hydraulic gradients and groundwater flow through permeable interbeds in the aquitard (HSU B). The Draft EA assumes that if flow exists in HSU B, that it will be downward because the hydrostatic pressure gradient in HSU A is greater than the hydrostatic pressure gradient in HSU C. No pressure data are reported in the Draft EA for HSU B. The gradient across HSU B is calculated by dividing the potentiometric head difference between HSU A and HSU B by the total thickness of HSU B. Because horizontal hydraulic gradients exist in both HSU A and HSU C, horizontal as well as vertical hydraulic gradients must also exist in HSU B. Therefore, horizontal flow through permeable interbeds of carbonate, shale, siltstone etc. is possible.

It is important to site evaluation that the final EA consider horizontal hydraulic gradients and flow through interbeds in the evaporite sequence because flow through interbeds may greatly shorten groundwater flow paths and travel times to the accessible environment. Horizontal gradients and flow through interbeds in HSU B should be included in the analysis of groundwater flow paths and travel times to the accessible environment.

Comment 3-45

Section 3.3.2.1.2 Site Hydrogeologic Setting, Page 3-128, Paragraph 7

The vertical hydraulic gradient across HSU B used in the HSU B groundwater flow velocity calculation is underestimated. The head differential across HSU B is derived by taking the difference between heads presented on Figure 3-48 (Ogallala Potentiometric Surface Map, 1981) and Figure 3-50 (Wolfcamp Potentiometric Surface Map). The potentiometric surface map presented for the Ogallala represents fresh water heads. The potentiometric surface map for the

Wolfcamp represents heads calculated from downhole pressure data that have been converted to equivalent fresh water heads by use of a uniform conversion factor (Bair et al., 1984). Whereas equivalent fresh water heads are appropriate for calculating horizontal gradients, environmental water heads are required for the assessment of potential along a vertical line. This concept is described by Luscynski (1961).

Environmental-water head in groundwater of variable density is defined as a fresh water head reduced by an amount corresponding to the difference of salt mass between fresh water and the point where the head is taken. Thus, environmental-water heads in the Woldcamp Aquifer are lower than the corresponding equivalent fresh water heads, resulting in a gradient across HSU B that is greater than with equalvalent fresh water heads. This point is important to the site evaluation because the vertical flow gradient is required in order to calculate vertical flow velocities from the repository to the Wolfcamp. Use of equivalent freshwater heads to calculate a vertical gradient is inaccurate and nonconservative. Vertical potentials in the final EA should be evaluated in terms of environmental heads.

Comment 3-46

Section 3.3.2.1.2 Site Hydrogeologic Setting, Page 3-132, Paragraph 1

The HSU C groundwater flow velocity analysis for the Deaf Smith site is not performed conservatively. Average effective porosity and hydraulic conductivity values were used in the analysis to estimate an average flow velocity through HSU C. Relative to the distribution of hydraulic parameter data, the average values of permeability and porosity used to represent HSU C at the site do not account for special variations or heterogeneity within the unit.

A conservative approach requires that all available hydrologic parameter data be considered in calculating a range of flow velocities that adequately reflects the large uncertainty associated with flow velocity estimated for the site. Page 3-122, paragraph 5 of the Draft EA indicates that the effective porosities of HSU C range from 21.3 to 3.4 percent. Page 3-122 paragraph 4 notes that based on the Texas Bureau of Economic Geology analysis of drill stem test data, the permeability values for the Wolfcamp range from 0.03 to 44 millidarcies. The range can be extended to 335 millidarcies if the results of core analyses are considered. HSU C groundwater flow velocities should be reevaluated for the final EA, in terms of a defensible range of parameter data from all credible sources. It is important to site evaluation that a conservative and realistic approach be used in the calculation of flow velocities.

Comment 3-47

Section 3.3.2, Groundwater, Page 3-111 through 3-132

The Draft EA does not state that most of the hydrologic parameter values (head, effective porosity, and permeability) presented in this section of the Draft EA are based on test data that have not been "analyzed nor evaluated." Sources for most of the hydrologic data in the Draft EA are reports prepared by Stone and Webster Engineering Corporation (SWEC) for the Office of Nuclear Waste Isolation (ONWI). Potentiometric head data are from drill-stem tests (DSTs) conducted by SWEC or from the data files of Petroleum Information Service (PI) being reviewed by SWEC. Permeability data are from these same sources as well as from pumping tests conducted by SWEC. Effective porosity data are from laboratory tests on cores from wells drilled by SWEC. In all their technical reports, SWEC states that the reported data are "preliminary", that they have been "neither analyzed nor evaluated." Other test data, such as the nonHorner DST plots have been analyzed using very simplistic methods allowing for only very rough estimates in their results. Thus, a significant degree of uncertain-ty with the hydrologic parameter data exists that has not been considered in the Draft EA. It important to the site evaluation that the test data supporting the groundwater travel time analyses in the final EA be more realisticly analyzed and evaluated. The DOE should also complete their review and analysis of all data relevant to the final EA.

Comment 3-48

3.3.2.1.3 Geochemistry of Deep Basin Brine Aquifers: Radionuclide Transport, Page 3-132, Paragraph 8

The assertion that reducing conditions are expected in the deep basin brine aquifers is too strongly stated. The presence of abundant methane (CH_4) is used in the Draft EA to indicate that reducing conditions should exist in the deep basin brine aquifers. The results from Sewell (1984) do not seem to indicate that CH_4 is abundant, contrary to what is stated in the Draft EA. It was detected in only 24 of 68 samples, and the average CH_4 content for those samples (that it was detected in) was about 1.7%. Dissolved oxygen (O_2) was not measured. However, Fisher (1984, Table 4) found significant amounts of O_2 in two of five wells sampled. There are many uncertainties associated with the concept of redox conditions in groundwaters (see Stumm, 1966, and Lindberg and Runnells, 1984), as an example, methane can persist metastably in oxidizing groundwater (see Thorstenson, et al., 1979). The available data do not appear to be sufficient to differentiate between the existence of reducing or oxidizing conditions and this uncertainty should be clarified in the final EA.

Comment 3-49

Section 3.3.2.1.3 Geochemistry of Deep Basin Brine Aquifers: Radionuclide Transport, Page 3-134, Paragraph 1

Complexation of radionuclides, either inorganically or organically, is not expected in the Draft EA to be significant in deep basin brine aquifers. The statement that carbonate concentrations are "very low" is based on extrapolation of the data, not on measurements of carbonate. However, Sewell (1984) did measure carbon dioxide in the deep basin brines, suggesting that there may be significant carbonate in solution available for complexation with radionuclides. In addition, the Draft EA does not consider that radionuclides may already be complexed by the time they reach a deep aquifer. Radionuclides that migrate to deep basin brine aquifers will pass through carbonate beds, which would potentially promote complexation with carbonate ions. Clastic units with relatively large amounts of organics will also be encountered during radionuclide migration from the repository, promoting organic complexation.

Comment 3-50

Section 3.3.2.2 Ground-water Quality, Page 3-134, Paragraph 4

The discussion of groundwater quality of the Dockum is not documented in the Draft EA; nor is there any discussion to explain the nature and cause of salinity in the Dockum. This paragraph states that "the Dockum is a producer of potable ground water, whereas in other areas it is saline." Salinity in the Dockum could be caused by a local fresh water flow system(s) encountering the upper salt units. Salt beds in contact with groundwaters undersaturated with respect to sodium chloride will cause dissolution and zones of high salinity will result. Another possibility is that zones of high pressure deep within HSU B induce saline brines to flow upward into the Dockum. Data pertaining to the distrubution of salinity zone in the Dockum is important because it is evidence suggesting that freshwater flow system(s) may extend down to the repository horizon and then back upward as saline plumes in shallower units, possibly at some distance from the site of dissoltion. The final EA should consider possible sources of Dockum salinity.

Comment 3-51

Section 3.4.2 Terrestrial and Aquatic Ecosystems, Pages 3-154 and 156, Entire Section

The last paragraph states that there are two playas within the site and 14 within the site vicinity. It is also stated that natural playas (versus modified ones) contain distinct populations of flora and fauna. The playas within the site vicinity that are in a natural state need to be defined.

Several playas bordering the site could potentially be impacted by site activities. The status of these playas (natural or modified) should be considered in order to establish their importance and to perform a realistic assessment of impact potential. It is suggested that the playas at risk from site activity be identified in the final EA.

Comment 3-52

Section 3.4.3.4, Severe Weather, Page 3-168

Reference to "the area around the Deaf Smith site" for the purposes of discussing tornado occurrences is vague and ambiguous. Tornado statistics are generally developed for a standard area, such as a one degree latitude-longitude "square" or per 10,000 square miles. It is suggested that the bases for tornado statistics be adequately described in terms of geographic area and period of record examined, with appropriate references. It is also suggested that the discussion of tornado occurrences in the final EA include an estimate of strike probability for the site.

Comment 3-53

Section 3.4.3.5, Atmospheric Transport and Diffusion, Page 3-168

The section does not provide a description of the meteorological data base used for air quality and radiological impact assessments presented in Sections 4.2.1.3, 5.2.5, and 6.4.1. It is suggested that the source of the meteorological data and the period of record used for such assessments be described in Section 3.4.3.5. It is also suggested that the discussion in Section 3.4.3.5 include a comparison of the wind speed distribution, wind direction distribution, and distribution of atmospheric stability classes for the selected data base or "expected" distributions presented as representative of the site.

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CHAPTER 4 COMMENTS

Comment 4-1

<u>Section 4.1.1.1.10 Regional Seismic Reflection and 4.1.1.1.11 Three-Dimensional Seismic Reflection, Page 4-20, Paragraph 1 and 2</u>

The seismic survey methods described in Chapter 4 of the Draft EA might be supplemented by techniques which are less disruptive to the environment. The methods given are standard oil field methods which use an energy source consisting of several large vibrator trucks. The DOE should consider the possibility of modifying or supplementing the planned surveys with both high-resolution shallow reflection and seismic refraction surveys which utilize a high frequency energy source. These 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 4-2

<u>Section 4.1.2.4, Final Disposition, Page 4-58, Paragraph: All</u>

If the site is found suitable and is selected for the first repository, the exploratory shaft facility (ESF) may be incorporated into the repository design (Page 4-58, 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. Discussion might be expanded to address and provide clarification of the above point in the final EA.

Comment 4-3

<u>Section 4.1.2.2.2, Shaft and Surface Facility Construction Figure 4-12, Page 4-40, Paragraph All</u>

The 22-ft-diameter shaft is to be sunk using freezing of the saturated unconsolidated sediments in the Ogallala and Dockum. The extent of the freeze zone is unclear from Figure 4-12. Comparison of Figure 4-11 leads one to conclude that a shaft seal is to be installed at the base of and 4-12 the freezing zone, but the methods or implications of this are not addressed. Seal installation in frozen ground and the performance of this seal once the ground thaws creates uncertainties related long-term performance, postclosure performance assessment, and preclosure safety and shaft performance. These uncertainties need to be addressed. In addition, the extend of the freezing zone needs to be provided since the frozen ground constitutes both a disturbance and a potential interference to near-shaft structures and boreholes.

Comment 4-4

This comment was incorporated elsewhere in the comment package

Comment 4-5

Section 4.2.1.1, Effects on Land Use and Mineral Resources, Pages 4-76 through 4-79

This section discusses only the effects on land use and does not address impacts on mineral resources. It is suggested that the expected effects of site characterization on mineral resources be discussed in this section.

Comment 4-6

Section 4.2.1.2.2, Exploratory Shaft Facility Construction And Operations Page 4-81

The potential effects of the excavated salt storage pile to local aquatic biota/habitat occurring from a catastrophic event or run-off during heavy rain should be considered to have the potential to impact creeks and playas to the north, east, and south of the site. Impacts may occur from saline water runoff and wind-borne salt from the pile or the exploratory shaft. It is suggested that the ecological significance of potential wind-borne salt and saline runoff be considered.

Comment 4-7

Section 4.2.1.2.2, Exploratory Shaft Construction and Operation, Page 4-80, Paragraph 1

It is stated in the Draft EA that construction activities will displace animals and assumes that some of these displaced animals will survive. In most cases the species population will eventually be reduced by the number of individuals the lost habitat supported. It is suggested that emphasis be placed on habitat loss and the associated permanent reduction in wildlife populations. Consideration should be given to whether the habitat is common or unique, or whether the habitat supports a small or large percentage of the species' population (Kroodsma, 1985).

Comment 4-8

Section 4.2.1.2.2, Exploratory Shaft Construction and Operation, Page 4-80, Paragraph 2

It is stated that there are no known populations of protected plant or wildlife species within the site. On page 3-157, it is stated that federally or state endangered or threatened species' natural range include the Deaf Smith site and may occur onsite. It is suggested these two sections be reconsidered in the final EA.

Comment 4-9

Section 4.2.1.3, Air Quality Effects, Page 4-85, Paragraph 7

The Draft EA does not sufficiently describe the meteorological data base that was used to assess the impact to air quality. Meteorological data from Amarillo, Texas are reasonable as input for a preliminary assessment of air quality impacts at the Deaf Smith site. However, it is suggested that the period of record of the data base be specified, and that the data base be representative of "expected" conditions at the site in terms of wind speed, wind direction, and atmospheric stability. Cross-reference to Section 3.4.3.5 may be appropriate.

Comment 4-10

Section 4.2.1.4.2, Exploratory Shaft Facility, Page 4-96, Paragraphs 4

The analysis of the impact of groundwater contamination from failure of the liner under the stock-piled materials is based on an unrealistic assumption. The Draft EA states that should the impermeable liner under the stock-piled materials fail, a saline leachate plume will flow downward through the unsaturated zone to the water table. The maximum increase in dissolved solids concentration expected to occur in the Ogallala aquifer would amount to 10 parts per million. The projected maximum concentration assumes complete mixing of the dense leachate with groundwater at the point where the plume exits the site. This assumption is not realistic because complete mixing of the dense leachate plume with groundwater is not likely to occur. The leachate plume would tend to remain as a zone of higher salinity within the aquifer.

Comment 4-11

Section 4.2.1.6, Noise Effects, Page 4-102, Paragraph 2

The principal off-site drilling activities are the lower HSU test well groupings. Table 4-2, page 4-15, indicates that each lower HSU site is likely to be occupied for a 4 to 9 month period. Therefore, noise impacts in the vicinity of off-site exploratory locations is likely to last 4 to 9 months rather than 3 to 5 weeks as stated in this paragraph.

Comment 4-12

Section 4.3.2, Exploratory Shaft Alternative, Page 4-125, Paragraph 1

This section discusses alternatives in exploratory shaft facility design. No discussions, 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 and 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 chooosing two different approaches is unclear. The Draft EA for the Deaf Smith site gives a strong argument in favor of the drill and blast method. It is recommended that the rationale for the construction methods chosen and how the methods may affect seal placement be included in the discussion.

Chapter 4 Reference

Kroodsma, Roger, "In my opinion...assessing the loss of wildlife habitat in environmental statements," Wildlife Society Bulletin, 13:82-87, 1985

CHAPTER 5 COMMENTS

Comment 5-1

<u>Section 5.1.1.4, Repository Subsurface Facilities, Table 5-3, Page 5-15</u>

No information on transuranic (TRU) package design is presented in the Draft EA. Table 5-3, Approximate Waste Storage Room Quantities, shows that the Deaf Smith site is projected to receive 55,456 TRU packages, 7,899 spent fuel packages and 3,673 Commerical high level waste (CHLW) packages out of a total of 74,048 packages. All of the analyses are in terms of spent fuel and CHLW. However, nearly 75% of waste packages will be TRU packages.

The final EA should present an analysis of waste package performance based on emplacement of TRU packages, or show that the conclusions from the analyses presented are not affected by emplacement of TRU packages.

Comment 5-2

<u>Section 5.1.2.3, On-site Development Page 5-22, Paragraph 2</u>

This section of the Draft EA discusses the storage and handling of the excavated salt, but does not mention whether the clay excavated along with the salt will be separated from the salt or used along with the salt as a backfill material. It is observed that the salt in the San Andres Unit 4 cycle contains clay interbeds, some of which are several feet thick. The possibility exists that, even with avoidance of thicker interbeds, thinner ones will be excavated with the salt. Since the excavated salt is to be used as backfill, its properties are important to the performance of the repository. Presumably, these properties will depend on the amount of salt in the backfill. However, the Draft EA does not mention any need for a cleaning facility for run-of-mine salt. The quality control of salt backfill should be addressed. It is recommended that the discussion be expaned to addresss the above concerns.

Comment 5-3

<u>Section 5.1.3.3., Retrievability, Page 5-31, Paragraph 3,4</u>

In this section a commitment is made to maintain the ability to retrieve emplaced waste packages; the discussion is very brief and does not state how retrievability will be maintained. 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. Thermal load limits, access drift support designs, maintenance, personnel radiological safety, etc., are important factors that affect retrievability, and they have not been addressed. The greater creep tendency for Palo Duro salt at elevated temperatures may influence retrieval operations by limiting the allowable thermal loading, in part, to maintain the retrieval option. It is recommended that the final EA expand the discussion presented to include considerations of all pertinent retrievability considerations.

Comment 5-4

Section 5.2.1.3, Geologic Structure, Page 5-38, Paragraph 5 & 6 and Page 5-39, Paragraph 1

These paragraphs suggest that the effects of excavating the repository and placing waste will include relatively small subsidence followed by slow thermal uplift. Changes in directions of resulting active stresses, strain rates and the potential for fracturing, particularly in strata near the repository horizon are not discussed, even though such fracturing could compromise waste isolation. There is no discussion of the effects of differential subsidence on facilities. The estimated size of the area(s) to be affected by subsidence and subsequent uplift is not stated. In the case of differential subsidence, if the 0.3 m subsidence occurs across an area of radius 1 Km, then for a waste handling building with dimensions as set forth in Section 5.2.5.2, about 8 cm of differential subsidence could occur across the structure. This subsidence could cause significant operating and safety problems with track cranes, cell doors, etc.

The final EA should discuss the concerns above in revising this section.

Comment 5-5

Section 5.2.1.3, Geologic Structure Page 5-39, Paragraph 2

The NRC staff is in the process of preparing a generic technical position on seismotectonic evaluation methods. This paper will cover the types of seismotectonic investigation and evaluation methods that 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 that will be necessary can be determined. At the present time, it is premature to state that the design requirements for a waste repository are the same as those required for nuclear power plants. It can only be stated at this time that the design requirements of structures important to safety will comply with 10 CFR 60.

Comment 5-6

Section 5.2.2, Hydrology, Pages 5-39 through 5-42

The Draft EA does not assess the impact of leakage from the retention pond liner or from the pond embankment. Section 5.1.2.3, Onsite development, (Page

5-22) and Table 5-1 (Page 5-5) states that three major lined retention ponds will be constructed at the site as follows:

1) salt pile runofff detention pond - 12.1 acres and capacity of 17.9 million gallons;

2) treated waste water holding pond - 8.7 acres and capacity of 13.0 million gallons; and

3) storm water detention ponds - 16.0 acres and capacity of 24.0 million gallons.

The Draft EA does not provide estimates of the quality of water retained in these ponds. It is reasonable to expect that the retention ponds, at times, will contain large amounts of waste water contaminated by salt and other site materials, then pond liner leakage or embankment failure could negatively impact surface-water and groundwater resources in the site vicinity.

The final EA should include estimates of the quality of water retianed in the retention ponds and assess the impacts of pond leakage on water resources.

Comment 5-7

<u>Section 5.2.2.2, Ground-water, Page 5-41, Paragraph 4</u>

Because there is no basis in the Draft EA for the estimate that the site will cover 5,760 acres (See Comment 6.1), the NRC staff does not consider the average annual operational water use comparison to irrigated acreage for the site to be valid. Paragraph 4 compares average annual groundwater use at the site during repository operations (418 acre feet), to annual groundwater withdrawals for irrigated farmland.

Comment 5-8

<u>Section 5.2.3.1 Construction, Page 5-43, Paragraph 2</u>

The Draft EA states "It is expected that soil conductance will not be elevated significantly because of the relatively low salt deposition rates". Even if the salt deposition rate is low, the deposition will continue for 25 years. Consequently, the saline concentration in the dry soil environment may in time, cause an adverse impacts. The Draft EA, states that according to Roberts and Zybura (1967), 2,000 pounds per acre of sodium chloride applied directly on the soil, will have an adverse effect on salt sensitive crops. According to Table 5-10, at 100 meters from the source, salt deposition is 562.7 pounds per acre per year (or 14,067.5 pounds in 25 years) and at 200 meters from the source, salt deposition is 150.5 pounds per acre per year (or 3,762.5 pounds in 25 years). It is suggested that the final EA reassess the long term impact of salt deposition to determine if there will be a long term impact on crops near the facility.

Comment 5-9

Section 5.2.4.2, Aquatic Biota, Page 5-46, Paragraph 3

It is stated that impacts are unlikely because there are no important fisheries in the site vicinity. In the same paragraph, it is stated that railroads, pipelines, etc. may result in impacts (especially to playas), but routes have not been selected. Section 3.4.2.4 states that some playas are stocked with fish such playas occur along railroad corridors, etc., they may be subject to impact. The NRC staff suggests that the impact on playas be reassessed in the final EA.

Comment 5-10

Section 5.2.5, Air Quality, Page 5-50

The Draft EA does not sufficiently describe the meteorological data base that was used to assess impacts to air quality. Meteorological data from Amarillo, Texas are reasonable as input for a preliminary assessment of air quality impacts at the Deaf Smith site. However, it is suggested that the DOE specify the period of record of the data base, and that the DOE determine whether the data base represents "expected" conditions at the site (in terms of wind speed, wind direction, and atmospheric stability). Cross-reference to Section 3.4.3.5 should also be considered.

Comment 5-11

Section 5.2.5, Air Quality, Table 5-9, and Pages 5-50 and 5-62

The discussion of air quality impacts in Tble 5-9 of the Draft EA appears inconsistent with the information presented in in the text. For example, in Table 5-9 the maximum predicted 24-hour average concentration for total suspended particulates TSP during construction is 97 ug/m^3, while the text (Section 5.2.5.2, page 5-50) indicates 36 ug/m^3. Similarly, in Table 5-9 the maximum annual average concentration of oxides of nitrogen (NO_x) during construction in Table 5-9 is 18 ug/m^3, while the text (Section 5.2.5.4.2, page 5-62) indicates 11 to 13 ug/m^3. If background concentrations of TSP (assumed to be 62 ug/m^3 in Section 4.2.1.3) are added to the concentration values in Table 5-9, the secondary National Ambient Air Quality Standard (NAAQS) 24-hour standard for TSP would be exceeded during site clearing and site construction. This would contradict the statement on page 5-61 that "the modeling results indicate that both the primary and secondary 24-hour NAAQS for TSP would be met during this phase." It is suggested that the analyses presented in Section 5.2.5 be clarified and checked for consistency to support the conclusions of this section.

Comment 5-12

Section 5.2.7.4, Mitigation, Page 5-70

It is not clear that the DOE's analysis of noise impacts considered the frequency and intensity of the specific noises. It is important to characterize a noise to adequately address the potential impacts. Additionally, in the discussion on the effects of blasting noise, the DOE might consider limiting blasting activities to the daytime, especially during site characterization.

Comment 5-13

Section 5.3, Expected Effects of Transportation and Utilities, Page 5-72

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. It is suggested that the final EA either substantiate the DOE's statement that transportation accident impacts are small, or analyze of the consequences, probabilities, clean up costs and risks for severe transportation accident on route to the site.

Comment 5-14

5.3.1.1.2, Waste Transportation Costs, Page 5-73

Certain transportation corridors along the routes to the site, 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 estmated 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 consideration be included in the DOE's assessment of transportation impacts.

Comment 5-15

Section 5.3.1.2, Radiological and Non-Radiological Associated with Radioactive Waste Tranportation Page 5-75, Third and Fifth Paragraphs

The paragraph states 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 5-16

Section 5.3.1.2, Radiological and Non-Radiological Effects on Nuclear Waste Transportation, Page 5-76, Table 5-13

This table provides estimated collective radiation doses associated with the 30-year operating lifetime of a repository. It is suggested that the table list the exposures for the occupational and non-occupational population subgroups.

Comment 5-17

Section 5.3.2.1, Radiological and Non-Radiological Effects of Nuclear Waste Transportation, Page 5-75, First Paragraph

It is stated in this paragraph that if a transportation accident involving high-level radioactive waste were to occur, that experimental evidence suggests that the consequences would not be great. However, the consequences of a transportation accident enroute are not specifically analyzed in the Draft EA or appendices. It is suggested that the cost of cleanup for transportation accidents be considered in the final EA.

Comment 5-18

Section 5.3.1.2, Radiological and Non-Radiological Effects of Nuclear Waste Transporation, Page 5-76, Table 5-15

This table provides total and average radiation doses to a maximally exposed individual (member of the general public) resulting from routine transportation to the repository. It is suggested that the table also include maximum exposure that is likely to occur in a transportation accident.

Comment 5-19

Section 5.4.1, Population Distribution and Displacement, Page 5-105

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, force size and uncertainty should 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 in the final EA.

Comment 5-20

Section 5.5, Implications of the Two-Phase Repository Design Concept, Pages 5-151 thru 5-153, Paragraphs -All

In this section of the Draft EA, it is stated that it has been decided to proceed further with considerations for a two-phase concept to meet the NWPA Mission Plan objective of having the first repository in operation by 1998. The Draft EA states (page 5-151 paragraph 1) that impacts, somewhat different than those described in Chapter 5 would result. Some possible significant differences between the Reference Design evaluated in the Draft EA and the proposed Two-Phase Concept Design are:

1. Volume of excavated salt will increase and salt handling procedures will change. 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)). Additional, 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 activities.

4. An additional shaft will be required.

5. The construction schedule will be compressed.

These and other differences are far from trivial in the context of all environmental impacts, safety, long-term and short-term performance of shafts and other major repository components, quality assurence probabilities, and site characterization requirements. The environmental impact of the alternative repository design concept mentioned taken up in this section is not discussed in detail, because the two-phase the design concept is evolving. Nevertheless, uncertainties regarding technical aspects of the design concept which impact environmental considerations, contruction, and shaft sealing and retrival operation appear important enough to warrant early consideration. These uncertainties are related to the following areas:

The Two-Phase Concept presents the potential for additional impacts on geologic host rock conditions. The underground facilities area for the two-phase repository will be substantially larger than that for the Reference Design Evaluation in the Draft EA. The increased extraction could result in additional subsidence, larger pillar dilatation and potentially more rapid creep under repository induced thermal conditions. No discussions related to these impacts have been presented.

2. Information has not been presented to demonstrate that the HEPA filter system can handle the increased ventilation requirement.

3. It does not appear that the subject of salt re-handling at the surface is adequately considered in all aspects of its environmental impact.

4. There is no particular difference between the phased and the reference repository concepts which should result in one being regarded as gassy and not the other. 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 the shaft seal systems and repository performance.

6. Changes in the requirements for site characterization activities should be addressed, including the relocation of boreholes to accommodate the larger controlled area and larger underground facility, with due consideration to the uncertainty imposed by the resultant decrease in density of exploration data.

7. The retrieval requirements will be impacted by the effect of possible increase in extraction percentage, waste emplacement schedules as affects thermal build up, changes in amount of waste retrieval that may be required, canister transport distances, and all other applicable factors. These impacts should be considered.

8. The simultaneous activities of both underground construction and waste emplacement operation 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 HLW emplacement which could adversely affect performance of the repository should be considered.

It is recommended the discussion in this section be expanded to address the above items.

Comment 5-21

Section 5-6, Summary Table, Page 5-157, Table 5-49, Item 5

It is stated that, in the controlled area, current land use, such as a commercial seed company, will be prevented (The cross-reference given is Section 5.2.3.1.). This section does not mention anything about a commercial seed company. It is suggested that the impact on the seed company be clarified in the final EA.

Chapter 5 Reference

Roberts, E.C. and E. L. Zyburna, "Effect of Sodium Chloride on Grasses for Roadside Use," Environmental Consideration in Use of Deicing Chemicals, No. 193, Publication 1524, Highway Research Record, Division of Engineering, National Research Council, 1967.

CHAPTER 6 COMMENTS

Comment 6-1

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

The Draft EA states that the DOE can obtain necessary land ownership rights by condemnation. It would be desirable to document this statement by reference to applicable law.

Comment 6-2

6.2.1.1, Site Ownership and Control, Guideline 10 CFR 960.4-2-8-2, Page 6-6 through 6-7

Consideration of controls beyond the control area, as required by 10 CFR 60.121 (b), is not included as part of the evaluation of Guideline 960.4-2-8-2, Site Ownership and Control. All discussions addressing the technical guideline 10 CFR 960.4-2-8-2, Site Ownership and Control, are related to the DOE obtaining ownership and surface and subsurface rights of land and minerals within the controlled area of the repository as required by 10 CFR 60.121. Such control is needed to help ensure the continued isolation of the repository far into the future without adverse human interference. However, to further prevent adverse human actions, 10 CFR 60.121 also requires that appropriate controls including acquisition of water rights, be established outside of the controlled area.

It is important that the DOE consider the need for additional controls beyond the controlled area. To ensure continued functioning of the repository without human interference, the DOE may have to control considerably more land in the site area than currently anticipated. Acquisition of additional land for DOE control may have more environmental and socioeconomic impacts than currently assessed in the Draft EA. Consideration of further control of lands beyond the controled area, as required by 10CFR60.121(b), should be included as part of this evaluation of Guideline 960.4-2-8-2 in the final EA.

Comment 6-3

Section 6.2.1.1, Site Ownership and Control, Page 6-6

There is no specific reference as to how access to Farm-to-Market (FM) Road 2587 will be controlled. Guideline 960.4-2-8-2 pertains to Site Ownership and Control. Since FM 2587 crosses through the site, as shown on Figure 3-45, and is accessible to the general public, there should be some discussion on how access to this road will be controlled, and who will be responsible for controlling it in the event of an accident at the repository.

Comment 6-4

Section 6.2.1.4, Meteorology Guideline, Pages 6-12 and 6-13

The meteorological data base identified in this section is identified as "relevant data". The radiological impact assessment described in Section 6.4.1 utilizes other information. As stated on page 6-13, "For the assessment of dispersion conditions at the Deaf Smith site, data from the Amarillo station provided the most comprehensive data base." Meteorological data from Amarillo, Texas are summarized in Section 3.4.3 and used in the air quality impact assessments described in Sections 4.2.1.3 and 5.2.5. However, the meteorological information used for the 40 CFR 191 calculation described in Section 6.4.1.3 includes data from Dallas, Texas. The use of meteorological information from Dallas to represent conditions at the Deaf Smith site is inconsistent with discussions of meteorology throughout the Draft EA. It is suggested that Section 6.2.1.4.1 be revised to clarify this inconsistency in the evaluation of the qualifying condition.

Comment 6-5

Section 6.2.1.4, Meteorology Guideline, Page 6-13, and Table 6-7, Page 6-59

The discussion of potentially adverse conditions in Table 6-7, Meteorology, page 6-59, indicates that a favorable condition is present for criterion (c)(1), when the discussion in Section 6.2.1.4.3, page 6-13, indicates that a potentially adverse condition is present for the same evaluation criterion. It is suggested that this discrepancy be clarified.

Comment 6-6

Section 6.2.1.5, Offsite Installations and Operations, Page 6-14

Figure 3-74 of the Draft EA shows a 4" natural gas pipeline crossing the site. There are some facts about this pipeline that are unknown. Information as to whether anything other than natural gas could be expected to flow through this pipeline at some future time, the age of the pipeline, etc., should be considered in order to determine if this line will pose a threat to the repository.

Comment 6-6

Section 6.2.1.6.2, Analysis of Favorable Conditions, Page 6-20 Second, Paragraph

The total suspended particulate (TSP) emissions from the site characterization and construction are likely to exceed the primary and secondary EPA air quality standard of 150 ug/m3 for 24 hours.

According to the conclusion on the favorable condition relating to environmental quality standards it states: "DOE projects the ability to meet environmental requirements applicable to the site and support facilities..." According to page 4-89, the secondary National Ambient Air Quality standard for TSP "is more likely to be exceeded on more than one occassion." When background level of 62 ug/mg3 TSP is added to the construction concentration of 97 ug/m3, the total is above the secondary standard. It is suggested that the discussion of air quality impacts be clarified.

Comment 6-8

Section 6.2.1.6.3, Analysis of Potentially Adverse Conditions, Page 6-42, Paragraph 1, and Page 6-40, Table 6-4

The potentially adverse environmental impact as stated is "although loss of farmland cannot be mitigated during construction or operation land use, impacts can be mitigated to an acceptable degree, because the farming facilities will be relocated or adequate compensation will be provided". It is not the land use that is the real concern, it is the fact that "about 78% of the site and vicinity is classified as prime by the U.S. Depart of Agriculture" (page 3-149, Section 3.4.1.1, paragraph 1).

Site characterization will (essentially) irreversibly utilize 102 acres (page-12, pargaraph 4) for shafts and access roads and another 400 acres would be used for the repository surface facilities (page 14, pargraph 1). It is suggested that in evaluating this condition in the final EA, that while the farmers will be compensated, this does not mitigate the loss of prime farmland.

Comment 6-9

This comment was incorporated elsewhere in the comment package.

Comment 6-10

Section 6.2.1.8, Transportation Guideline, 10CFR960.5-2-7, Page 6-55

Examination of "regional" meteorological conditions for determination of "significant" transportation disruptions is ambiguous. The "region" of the Deaf Smith site is not well-defined, nor are the criteria for determining "significant" transportation disruptions. Use of "regional" meteorological information would appear to be of limited value in assessing transportation disruptions. A more meaningful indicator could be whether the site is unique with respect to meteorological conditions which disrupt transportation, or whether the site could be sufficiently isolated during portions of an annual cycle to significantly limit transportation to the repository during a particular period. Another concern is that hazards such as tornadoes or snow and ice could increase the likelihood of transportation accidents, thereby increasing the risk to public health and safety. It is suggested that the discussion of the potential for increased risk at the Deaf Smith site due to meteorological conditions be expanded.

Comment 6-11

Section 6.2.2.1, Preclosure Radiological Safety Guideline, Page 6-70

Specific references are made to the use of meteorological data from Amarillo, Texas for radiological impact assessments, in direct contradiction of the discussion in Section 6.4.1.3, which also references meteorological data from Dallas, Texas. The use of meteorological data from Dallas, Texas, to represent conditions at the Deaf Smith site is inconsistent with discussions of meteorology throughout the draft EA. It is suggested that the discussion of meteorological data used for radiological impact assessments be clarified, and made consistent among Sections 6.2.1.4.1, 6.2.2.1 and 6.4.1.3.

Comment 6-12

Section 6.2.2.2.1, Statement of Qualifying Condition, Page 6-72, Paragraph 1

The Draft EA states in item 5 that "existing shaft sealing technology is sufficient to provide protection of the overlying aquifers." However, no discussion is present on the special requirements for repository shafts.

The existing technology for sealing shafts to provide protection of overlying aquifers is not necessarily sufficient when examined from the stand point of waste isolation, which must consider heat, ground movements, and a high level of reliability in long-term performance.

The discussion in this section should address the uncertainties with respect to shaft sealing technology for repository shafts.

Comment 6-13

Section 6.2.2.2.1, Statement of Qualifying Condition, Page 6-71, Paragraph 10

The draft EA states that one of the seven assumptions made in the analysis of the qualifying condition is: "Existing shaft sealing technology is sufficient to provide protection of the overlying aquifers." This assumption has wide-range implications on the effectiveness of shaft seals in assuring isolation of the waste. As documented in the literature, there are uncertainties in the performance of seals. For example, Kupfer (1980) cites a shaft leak at Belle Isle mine that appears to be due to seal failure. The discussion in this section might be expanded to address the uncertainties associated with shaft sealing.

Comment 6-14

6.3.1.1, Geohydrology, Guideline 10 CFR 960.4-2-1, Page 6-81, Paragraph 6 Continued to Page 6-82

The discussion of assumptions for the groundwater travel time analysis of flow through non-salt layers of HSU B is not consistent with travel time analysis presented in the subject section or elsewhere in the EA.

The section states that "The travel time through the evaporate section is about 57,000 years. This analysis, does not attempt to calculate travel times across the various layers of approximately 600 meters of non-salt material in HSU B, (i.e., it is assumed that a parcel of fluid upon entering an interbed or other non-salt layer, immediately drops to the lower boundary of that layer). Thus, the model conservatively assumes zero travel time across these layers."

The analysis of groundwater travel time presented in this section does not assume zero travel time across the non-salt layers of HSU B. As described in the EA, the downward seepage velocity through HSU B is 1.5 x 10^{-2} meter per year (page 3-128, paragraph 7; page 6-82, paragraph 2), and the distance from the repository horizon to the Wolfcamp is 853 meters (page 6-82, paragraph 2). Thus, the groundwater travel time to the Wolfcamp is 57,000 years. However, if it assumed that the velocity across the 600 meters non-salt layers is zero (effective distance from repository to Wolfcamp is 253 meters), the travel time to the Wolfcamp is only 17,000 years. Therefore, discounting non-salt layers in the calculation reduces stated vertical flow times by approximately 70 percent. The discrepancy between the statement that the travel time across non-salt layers is zero and the travel time calculation should be resolved.

Comment 6-15

Section 6.3.1.1.1, Statement of Qualifying Condition, Page 81, Paragraph 5

Groundwater flow through fractures or other secondary openings in the bedrock above and below the host rock and in the interbeds within HSU B has not been accounted for in the groundwater travel time analysis from the repository to the accessible environment.

The subject paragraph states that fracture flow has been ignored from the assumptions and approaches used for the travel time analysis. However, the bedrock above and below the host rock, and the interbeds within the evaporate section may have fractures, joints, solution channels, and other secondary openings through which groundwater flow occurs. At the WIPP site, travel times determined from tracer test data were more than an order of magnitude less than travel times obtained from porous medium theory. Probable flow rates through discrete fractures or other secondary openings in bedrock at the Deaf Smith Site may be one or more orders of magnitude greater than those based on the analysis of flow through the primary porosity portion of the bedrock.

It is important to site evaluation that a conservative approach be taken toward the groundwater travel time analysis. A conservative approach should include consideration of flow through fractures or other secondary openings. Inclusion of the effects of fractures, etc. in travel time analysis might reduce travel time estimates to less than 10,000 years.

The estimated effects of fractures on travel time should be included in the analysis of travel time estimates. Travel time estimates should be corrected accordingly.

Comment 6-16

Section 6.3.1.1, Geohydrology, Guideline 10 CFR 960.4-2-1, Page 6-82, Paragraph 1

The horizontal flow velocities for the Wolfcamp presented in this section as part of the groundwater travel time analysis to the accessible environment are not based on the Wolfcamp flow parameters and flow velocity calculations presented in Chapter 3, Section 3.3.2.1.2, Site Hydrologic Setting. In Chapter 3, the Wolfcamp flow velocity at the site is calculated to be 1.52×10^{-2} meters per year assuming a hydraulic conductivity of 1 millidarcy, a hydraulic gradient of .0037, and an effective porosity of 0.08.

The analysis of the groundwater travel time presented in Chapter 6 assumes horizontal flow velocities through the upper Wolfcamp are 3.3×10^{-1} to 3.3×10^{-2} meters per year (SWEC, 1983) and an average regional gradient of 0.0027. SWEC, (1983) states that the Wolfcamp flow velocities are based on permeability and porosity values from Bentley (1981). Bentley (1981), in discussing regional hydraulics of the brine aquifers, attempts to approximate average regional flow velocities through the Wolfcamp. No specific data are provided to support his estimates for which an average permeability of 2 millidarcies and a porosity range of .005 to .05. are assumed.

The Wolfcamp flow velocities for the site, presented in Chapter 6 to address the hydrology favorable condition, should be consistent with data and analyses presented in Chapter 3.

Comment 6-17

Section 6.3.1.1.1, Statement of Qualifying Condition, Page 6-82, Paragraph 2

The draft EA does not consider alternative pathways for groundeater flow. Analyses presented in Section 3.3.2.1.1 indicate a single possible pathway: downward from the repository to the upper Wolfcamp dolomite, and then horizontally to the accessible environment.

Carbonates, clays, siltstones, and other sediments are common throughout the evaporite sequence (see Section 6.4.2.3.2 and Tien et al., 1983, page 69). These kinds of strata are being investigated at the Waste Isolation Pilot Project (WIPP) as a likely pathway to the accessible environment. Any analysis of, or mention of, this path is lacking in this section and the entire draft EA. Depending on its properties, such a path may provide a shorter travel time to the accessible environment.

Although the data necessary to calculate travel time for this pathway may be lacking, mention of the pathway and its possible implications on the travel time calculations should be included in this section of the final EA and in Section 3.3.2, Groundwater.

Comment 6-18

Section 6.3.1.1, Geohydrology Guideline 10 CFR 60 4-2-1, Page 6-83, Paragraph 7

Although we agree with the Draft EA conclusion of favorable condition (3), the evaluation does not adequately support the conclusion that this favorable condition is not present. The favorable condition is related to hydrogeologic features at the sites, the evaluation only discusses regional features and modeling.

The evaluation of favorable condition (3) states that the discussion presented in Section 3.2.23 (Stratigraphy), 3.2.5 (Structure and Tectonics), and 3.3.2 (Groundwater) indicates that regional stratigraphy, structure, and hydrogeology can be modeled with some difficulty. However, chapter 3 does not attempt to evaluate the difficulties of modeling the regional hydrogeologic system. It suggests that the hydrogeology of the region and site is simple, as reflected in the simplistic, conceptual hydrologic model for the region that does not consider hydrologic features that may be significant to modeling at the site.

It is important that the complexity of modeling the site be recognized. The analysis of this favorable condition should reflect the idea that site specific data may uncover subtle complexities that are insignificant to regional modeling but of importance to modeling the site.

The discrepancy between the favorable condition finding and the analysis should be resolved.

Comment 6-19

Section 6.3.1.3(1), Analysis of Potentially Adverse Condition, Page 6-85 Paragraph 1-3

In addressing this potentially adverse condition, the analysis does not consider the effects of subsidence from rock excavation or uplift from thermal expansion. The draft EA states that expected geohydrologic condition changes will be limited to a small area around the repository, and that these changes will not significantly increase radionuclide transport to the accessible environment. However, large volumes of material above the host rock could be subjected to movement and stress changes from either subsidence due to rock excavation or uplift due to thermo-expansion of the host rock. These movements and stress field changes could cause changes to geohydrologic conditions that "significantly increase the transport of radionuclides to the accessible environment as compared with pre-waste-emplacement conditions." The increased transport of radionuclides could be significant in fractured zones should enlargement of fractures or rock movement along fractures occur. During the repository operational period, subsidence and uplift could occur simultaneously.

This section of the final EA should be expanded to discuss the effects of subsidence and uplift. Evidence that the potentially adverse condition is present should be considered or less certain findings presented.

Comment 6-20

Section 6.3.1.1.3, Analysis of Potentially Adverse Conditions (1)-Hydrology; Page 6-85, Paragraph 2

The draft EA asserts that brine migration will be toward the waste canisters only. However, brine inclusions with a vapor phase migrate down a thermal gradient, (i.e., away form the waste canisters, see Anthony and Cline, 1972). Migration of brine inclusions with a vapor phase down a thermal gradient may be a significant process in transporting radionuclides away from the repository. Fluids reaching the waste package may cause corrosion of the canisters and dissolution of the radionuclides. High temperatures at the waste package may cause boiling of inclusions, allowing fluids to develop a vapor phase. Inclusions possibly containing radionuclides and vapor phase then have the potential to migrate away from the waste package. The final EA should discuss the implications of this process with respect to this guideline.

Comment 6-21

Section 6.3.1.1, Geohydrology Guideline 10 CFR 60 4-2-1, Page 6-85, Paragraph 7

The draft EA finds that the potentially adverse condition is present. However, the evaluation does not adequately reflect the degree of hydrogeologic complexity existing in the regional groundwater system and is not consistent with the analysis in Chapter 7 concluding that stratigraphic or structural features that could contribute to modeling difficulty have been identified in the geologic setting of all sites.

The evaluation of potentially adverse condition (3) states that the stratigraphy in the geologic setting is relatively simple and predictable and that structural features are not particularly complex. To the contrary, as discussed in Chapter 7 (page 7-13, paragraph 4), it is expected that stratigraphic and structual features at the site could contribute to the difficulty of characterizing and modeling the hydrogeologic system. The evaluation of the potentially adverse condition should be consistent with the discussion in Chapter 7.

Comment 6-22

Section 6.3.1.2.1, Statement of Qualifying Condition-Geochemistry, Page 6-87, Paragraph 4

The 1.8 vol. % value for initial brine contents in the host rock used in the draft EA is considered by the NRC staff to be too low. This is based on an error made in calculating the volume percentages of water and the insufficient amounts of clay considered (see comment 3-25). The draft EA states that "the performance assessment calculations assume" 5.0 vol. % brine initially. In the performance assessment calculations, however, an initial water content of 5.0 vol. % is used (p. 6-181, last paragraph). The two are not the same. Five vol. % water is approximately 6 vol. % brine assuming a brine density of 1.3 gm/cm^3 and a concentration of 35 wt.% salts in brine (see Roedder and Chou, 1982, p. 2). This discrepency should be corrected so that there will be no confusion regarding the value used in the performance assessment calculations. In addition, it is not certain that intrusive brines will have low concentrations of magnesium (Mg). Intrusive groundwater may pass through dolomite interbeds to reach the repository, perhaps even preferentially migrate through the dolomite. Thus, the brine may have higher concentrations of Mg than would be expected if dissolution of halite alone is considered in predicting brine composition, as assumed in the draft EA. The high-Mg intrusive brine scenario should be considered by the DOE.

Comment 6-23

Section 6.3.1.2.2, Analysis of Favorable Conditions(2)-Geochemistry; Page 6-88, Paragraph 2

Portions of the discussion of this guideline (960.4-2-2(b)(2)) do not present existing data that clearly support the conclusion that this favorable condition is present. To make a favorable finding for this guideline, evidence must be presented that the geochemical condition promote or inhibit (as appropriate) one or more of the processes that influence radionuclide migration listed in this guideline. The draft EA discusses several of the listed processes in its evaluation.

In the discussion of precipitation of radionuclides in the host salt, it is stated that the formation of insoluble sulfates will limit the maximum concentrations of very soluble nuclides. The cited document (Langmuir et al., 1983), however, only discusses one radionulide, Radium-226, a radionuclide that the DOE expects will be solubility-controlled (see p. 6-202, paragraphs 1-6). The significance of this potential process is unclear.

In the discussion of precipitation in deep basin aquifers, the draft EA states that chemically reducing conditions are expected. The data do not strongly support this contention (see comment 3-48). In addition, it is uncertain whether or not reducing conditions will actually cause redox sensitive radionuclides to precipitate (see comment 6-24). Groundwater pathways other than deep basin brine aquifers should also be considered for this guideline (see major comment 3). There is evidence presented in the Draft EA that the overlying Dockum Formation contains saline water which may be the result of dissolution of the salt beds (page 3-134, paragraph 4).

The significance of the discussion of sorption in the salt is unclear. The draft EA indicates that brines inhibit sorption, which suggests that consideration of this process is inappropriate in the evaluation of this guideline.

The discussion of colloid formation is incomplete. 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. Colloids may form in the fresh water aquifers surrounding or overlying Unit 4. Without site-specific evidence it is premature to conclude that the favorable condition with respect to colloid formation is present.

Fukui (1984) contains no data on organics in the salt, contrary to the statement in the Draft EA. Organic carbon data is only presented for non-salt samples. Migrating radionuclides may pass through relatively organic-rich clastic interbeds at some point during migration. These interbeds are potentially favored pathways for the movement of fluids. In addition, methane, which may be found in clastic interbeds in the salt, forms organic polymers when irradiated (Gray, 1984). The effect of these polymers on radionuclide retention is presently unknown, but the possibility exists that deleterious effects could result. Consideration of the formation of organic complexes from seemingly inert compounds such as methane as a result of radiation cannot be discounted and, therefore, may not allow the conclusion that this favorable condition is present with respect to organic complexation.

There are a number of uncertainties regarding the migration and retardation of radionuclides. Because data are lacking and uncertain, the draft EA should re-evaluate the evidence relevant to this guideline, considering the uncertainties, and perform a demonstrably conservative analysis.

Comment 6-24

Section 6.3.1.2.2, Analysis of Favorable Conditions(2)-Geochemistry; Page 6-88, Paragraph 2, and 6.3.1.2.3 Analysis of Potentially Adverse Conditions(3); Page 6-90, Paragraph 2

The assertion made in the draft EA that chemically reducing conditions exist, is used as evidence in support of favorable findings for these two guidelines concerning radionuclide mobility (960.4-2-2(b)(2) and 960.4-2-2(c)(3)). However, the data do not conclusively support the contention. It is asserted that chemically reducing conditions exist, despite the fact that "site-specific geochemical information is not available" (page 6-87, paragraph 1). The arguments used to support the assumption of chemically reducing conditions (the presence of methane, hydrogen, and mineral assemblages not likely to create an oxidizing environment) are not well documented or supported. The assertion that oxidizing conditions are not possible cannot be stated unequivocally based on the available data (see comment 3-48). There are many problems associated with the concept of redox conditions in groundwaters (e.g., see Stumm, 1966, and Lindberg and Runnells, 1984). For example, methane can persist metastably in oxidizing groundwater (see Thorstenson et al., 1979). The available data would not appear to be sufficient to differentiate between the existence of reducing or oxidizing conditions (see comment 3-48). There is no reason why oxidizing conditions could not exist in the presence of halite, anhydrite, and clays. For guideline 960.4-2-2(b)(2), the presence of reducing conditions is cited as evidence that precipitation of certain radionuclides, such as uranium and neptunium, would be expected. This assumption, however, is not always warranted. Slow kinetics inhibit the establishment of equilibrium conditions, allowing redox sensitive radionuclides 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. Furthermore, Garrels and Christ (1965, Figure 7.32b) show that even under extremely reducing conditions, uranium can exist in solution in significant concentrations. The uranium bearing species $UO_2(CO_3)_3^{4-}$ which contains uranium in the oxidized state (U^{6+}), can be thermodynamically stable even under reducing conditions. Therefore, reducing conditions do not ensure that redox sensitive ions will be in a reduced state. Considerably more information is needed before chemically reducing conditions and their favorable effects on radionuclide solubility can be assumed for this site. In the absence of data that clearly support conclusions regarding redox conditions for these guidelines, a demonstrably conservative analysis should be made.

Comment 6-25

Section 6.3.1.2.2, Analysis of Favorable Conditions(3)-Geochemistry, Page 6-88, Paragraph 4

The discussion of this guideline concerning mineral stability as it affects radionuclide sorption (960.4-2-2(b)(3) does not conclusively support the finding that the favorable condition is present. The effect of heating on clay minerals is not considered in addressing this condition. Yet, on page 3-80, paragraph 1, it is stated that "clays may undergo thermal dehydration" and "changes in the physical properties of the mudstone layers due to dehydration may also occur." The draft EA discounts the importance of dehydration due to insignificant amounts of clays. However, the amount of clay in Unit 4 may be at least twice the value presented in the draft EA (see comment 3-23).

The evaluation discusses the melting points of pure halite and pure anhydrite. This approach does not take into consideration that melting in multicomponent systems may occur at much lower temperatures than predicted by the melting points of the pure end members. An assessment of melting relationships in the multicomponent systems anticipated in the repository is necessary in order to find that the favorable condition is met.

The draft EA states that the effects of radiation on the host salt are unimportant because only a thin annulus around the waste package will be affected. However, the formation of colloidal sodium and gases which may form due to radiation (see Panno and Soo, 1984) and their effects on rock strength, waste package corrosion, and brine migration are not discussed.

The final EA should consider these uncertainties when evaluating the evidence relevant to this guideline and perform a demonstrably conservative analysis.

Comment 6-26

Section 6.3.1.2.2, Analysis of Favorable Conditions(4)-Geochemistry, Page 6-89, Paragraphs 1 and 2

There are concerns that the performance assessment calculations used to assess this guideline concerning radionuclide solubility (960.4-2-2(b)(4)) may not be conservative. Because the existing data are inadequate to claim that this 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 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) that are used in the Draft EA (p. 6-196, paragraph 6). 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 simulataneously for actinides. For some elements, solubilities are simply unknown (i.e., Sn, Se, Cm, Am) and numbers presented are "guesses based on chemical similarities" (Pigford et al., 1983, p. 195). For strontium (Sr) the solubility value presented in Table 6-32 (page 6-201) does not correspond with the value presented in the WISP Report. The WISP Report states that the solubility for Sr is "high", while Table 6-32 presents a value of 0.8 g/m^3. It is unclear where this value comes from.

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 (p. 6-196, paragraph 6). 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 comment 6-27).

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 this condition (see comments 6-27, 6-86, and 6-96). The final EA should consider the uncertainties discussed above when evaluating the evidence relevant to this guideline and perform a demonstrably conservative analysis.

Comment 6-27

Section 6.3.1.2.3, Analysis of Potentially Adverse Conditions(1)-Geochemistry, Page 6-89, Paragraphs 6 and 7

There are concerns that the performance assessment calculations used to assess this guideline concerning the effects of groundwater conditions on the stability or chemical ractivity of the engineered barrier system (960.4-2-2(c)(1)) may not be conservative. Because the existing data are inadequate to claim that this potentially adverse condition is not present, the DOE bases its evaluation of this condition solely on performance assessments. The performance assessment calculations used in support of the evaluation 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, the assumption of homogeneity and isotropy for Unit 4 salt may not allow for an accurate model of brine migration. 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. Second, the equation of Jenks and Claiborne (1981) 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. Intercrystalline migration is not accounted for. 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 towards the waste canister at considerably different rates than predicted by intracrystalline migration theory. Roedder and Chou (1982, p. 1) found that Jenks and Claiborne 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). Third, 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. Fourth, 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 underestimations of brine accumulations, perhaps offsetting the conservative assumption of a constant, maximum temperature gradient.

The use of 5.0 volume % (about 3 wt. %) for the initial water content in BRINEMIG (page 6-181, paragraph 4) may not be as conservative as asserted in the Draft EA, if it is indeed conservative. Available data suggest that there is more clay in the salt than reported in the Draft EA, which would give an increased amount of water. Data from Fisher (1984) and calculations made by the NRC suggest that there could be an average of more than 4 vol. % water in the Unit 4 salt, with clay interbeds and muddy salt zones containing much greater amount of water (see comment 3-25). These data suggest that the 5.0 vol. % water content used in the Draft EA performance assessments is not as conservative as asserted in the Draft EA. In clay interbeds and muddy salt zones, 5.0 vol. % water may, in fact, not be conservative. Furthermore, it is not certain that bound water released from clays will migrate in the same manner that brine inclusions will. It is conceivable that this water will migrate in interbeds, perhaps at rates much greater than would be expected based on brine migration theory.

Several factors concerning the geochemical conditions around the waste packages are not addressed in calculating optimistic corrosion rates to show that waste packages in salt should be intact beyond 10,000 years. First, 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 6-187, continuing paragraph, 2). There is no discussion about how this H_2 gas will affect the physicochemical 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 by the anticipated reactions and how this would affect repository performance. Second, 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 (6-187, continuing paragraph, 4). The effects of radiation-induced gases should be considered. Third, it does not appear that the effect of the repository being open to the atmosphere before closure has been considered; 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. Fourth, 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. In addition, a protective calcium sulfate or iron oxide layer would not be expected to form.

The gross brine accumulations used in the Draft EA 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 is, however, considered in evaluation of waste package performance (page 6-193, paragraph 4 to page 6-196, paragraph 3). The final EA should discuss the intrusive brine scenario in the evaluation of radionuclide releases.

The final EA should consider the uncertainties discussed above when evaluating the evidence relevant to this guideline and perform a demonstrably conservative analysis.

Comment 6-28

Section 6.3.1.2.3, Analysis of Potentially Adverse Condition(2)-Geochemistry, Page 6-89, Paragraph 9 to Page 6-90, Paragraph 1

The assertion in the Draft EA 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). The 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 in the evaluation of this condition. It is apparent that data are not available and estimates are not demonstrably conservative in the evaluation of this condition.

Comment 6-29

Section: 6.3.1.3.1, Statement of Qualifying Condition, Pages 6-90 - 6-93, Entire Discussion

The analyses of the anticipated stresses as described in this section do not consider the full range of stresses that may act to influence the isolation capability of the host rock in that they consider only a few mechanisms acting alone. Chemical and radiation effects as contributors to rock mass behavior are not considered in this Draft EA section; neither are combined thermal and mechanical behaviors. The conditions such as clay partings, lenticular beds, nonlinearity of thermal properties, and uncertainty in the assignment of creep parameters to represent repository conditions in the postclosure period should be considered. It is recommended that the discussion be expanded to include a thorough consideration of relevant stresses in the postclosure period, arising from mechanical, thermal, radiological, and chemical processes, acting alone or in combination, as appropriate.

Comment 6-30

6.3.1.3.1, Statement of Qualifying Condition-Rock Characteristics; Page 6-91/92, Paragraph 9

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 consistent creep properties across the basin becomes questionable. 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 6-31

Section 6.3.1.3.1, Statement of Qualifying Condition-Rock Characteristics; Page 6-93,
Paragraph 1 and 6.3.1.3.3, Analysis of Potentially Adverse Conditions, Page 6-95, Paragraph 2

Based on the available data, the assumed clay percentage (3%) is too low; therefore, the amount of water calculated to come from the clay due to dehydration (0.6 wt. %) is also low. The amount of clay in Unit 4 may be twice (or more) the value presented in the Draft EA (see comment 3-25). Therefore, the contribution of water dehydrating from the clay will certainly be greater than the 0.6 wt. % calculated in the Draft EA. Data from Fisher (1984) and calculations made by the NRC suggest that there could be an average of more than 4 vol. % water in the Unit 4 salt, with clay interbeds and muddy salt zones containing much greater amounts of water (see comment 3-25). Uncertainties about clay dehydration may affect calculations made concerning settlement of the host rock (page 6-96, paragraph 2). Recommend the evaluation be expanded to address the above comment.

Comment 6-32

Section 6.3.1.3.2, Analysis of Favorable Conditions, Page 6-94, Paragraph 2 & 3

The evaluation presented does not adequately address uncertainties related to the geomechanical and thermal properties of the host rock.

In the first paragraph, data is presented to show high thermal conductivity for Palo Duro Basin salt. The discussion does not state that these data were collected from a very limited number of specimens. (Lagedrost and Capps, 1983, ONWI-522). Further, these data are not specific to the Deaf Smith site and may not reflect the thermal conductivity of the in situ heterogeneous salt mass. This introduces a number of uncertainties. It is stated that the heat from the waste package will spread evenly throughout the host rock and the surrounding strata. The presence of mud seams, siltstone, shale, and carbonates in the surrounding strata that possess differing thermal conductivities, are not adequately discussed in this evaluation. The coeffecient of thermal expansion of thin heat rock is reported to range between 40×10^{-6} to 50×10^{-6} per oc Table 3-11). However, data presented in the literature indicates that this coeffecient is higher than those from Basalt (6.2×10^{-6} to 8×10^{-6}/ oc) and tuff (4×10^{-6} x 9×10^{-6}/oc) (Curtis and Wright 1983), which are other possible repository host rocks. Jumikis (1979) cites average values for igneous, sedimentary, and metamorphic rocks that range from 2×10^{-6} to $6.8 \times 10^{-6}/^{o}c$. In the second paragraph, the observation that creep of rock salt will penetrate fractures in interbeds and thereby heal them appears to be unsubstantiated.

Comment 6-33

Section 6.3.1.3.3(1), Analysis of Favorable Conditions Page 6-93, Paragraph 6

The evaluation presented does not address uncertainties regarding the potential existance of heterogeneities (anomalous zones) within the host rock. In addition, the analysis and evaluation presented does not address the degree to which the presence of anomalies and inclusions within the host rock would limit the expected lateral flexibility at the repository level. As the presence of anomalious zones, brine portals and inclusions would serve to both restrict lateral and vertical flexibility, the potential availability of vertical depth may be uncertain. It is recommended the evaluation presented be expanded to include a more detailed discussion of uncertainty related to flexability in selection of the location of the underground facility.

Comment 6-34

<u>Section: 6.3.1.3.3, Analysis of Potentially Adverse Conditions, Page 6-94, Paragraphs 6, 7</u>

The Draft EA states that "available technology is adequate to design, analyze, and construct the repository" based upon rock strengths, elastic moduli, and in situ stress conditions. The evaluation states that "Extensive experience...at the Waste Isolation Pilot Plant in New Mexico has shown that the technology is available to construct and operate underground facilities in bedded salt". WIPP and other salt mines quoted as examples of successful mining have not experienced the thermomechanical loads that will be expected at the repository. Therefore, the repository response to thermomechanical loading is uncertain based upon other salt mine experience quoted. The discussion does not consider the uncertainties associated with available technology related to retrieval operations. This technology has not yet been demonstrated. It is recommended that the evaluation be expanded to consider the limitations in the extensive experience that is quoted and if appropriate, the finding be modified to reflect the results of the reevaluation.

Comment 6-35

<u>Section 6.3.1.3.3, Analysis of Potentially Adverse Conditions Page 6-95 Paragraph 1</u>

In this section, it is stated that the temperatures of thermal fracture for rock salt in the Permian Basin is on the order of 300^{o} to $400^{o}C$. Uncertainty in the data base exists regarding the representativeness of the rock core to the in situ host rock mass. Because of these uncertainties and 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 $200^{o}C$ (Pfeifle et al, 1983, Figure 4.2), the absence of heterogeneties in the tested rock core that may exist in the rock salt adjacent to the canisters, and the expected temperature of $250^{o}C$ 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. It is recommended that the evaluation presented to expanded to address the uncertainties stated above.

Comment 6-36

This comment was incorporated elsewhere in the comment package.

Comment 6-37

Section: 6.3.1.3.3, Analysis of Potentially Adverse Conditions, Page 6-95, Paragraph 1-6

The draft EA states that no significant geological structures have been identified. However, the occurence of stratification and interbeds are reported in the draft EA. The very preliminary drilling program to date provides no proof of the absence of structures that could be significant at the site.

The statement that rock stresses in the Palo Duro Basin are low appear to be unsupported by available data. The magnitude of the stress should be taken in the context of the rock competence and repository loading conditions.

The heave/settlement argument (Paragraph 2) deals with a very complex thermo-mechanical behavior. The data on creep and thermal expansion, collected independently under differing loading conditions in the lab and on different specimens subjected to different experimental procedures, may not behave together in situ as the simple sum of the two independent behaviors. Further, these mechanisms will not operate in the same places or at the same times, in an actual repository.

The calculated porosity changes take into account clay dehydration and the location and direction differences between creep deformation and thermal expansion. The statement that the porosity change is restricted to the host rock horizon is not adequately supported. The near-100-percent increase in porosity may not be insignificant, for discrete times in the post-closure period and for specific locations within the surrounding strata.

The discussion in this section of the draft EA should be expanded to include a systematic assessment of the effect of heat on the combination of geologic structure, geochemical and thermal properties, and hydrologic conditions in the host rock and surrounding strata and associated uncertainties.

Comment 6-38

Section 6.3.1.3.3, Analysis of Potentially Adverse Conditions, Page 6-96, Paragraph (3)

The draft EA has stated that analysis of the effect of heat on the natural conditions of the host rock demonstrate that the heat generated by the waste would not significantly decrease the isolation provided by the host rock compared with pre-waste emplacement conditions. The conclusion that the heat generated by the waste would not significantly decrease the isolation is based on the analysis in 6.4.2.3. However, the thermal analysis in this section is based on the assumption of uniform homogeneous salt with only microscopic brine inclusions (Section 6.4.2.3.1, p. 6-178, Section 6.4.2.3.2, p. 6-182, first paragraph). The discussion should address uncertainties related to how large brine/gas inclusions/anomalies will respond to repository thermal loading.

It is recommended that the draft EA present a detailed analysis of the above uncertainties.

Comment 6-39

Section 6.3.1.4, Climatic Changes Guideline, Page 6-97

The principal assumption for the discussion of the impacts of climatic change, "that the climatic changes which took place during the Quaternary Period bound the extreme conditions expected over the next 10,000 years," is not adequately supported in this section or in Section 3.2.2.3. Of principal interest is the projected warming during the "super-interglacial" induced by increased atmospheric concentrations of carbon dioxide. The magnitude of the warming during the "super-interglacial" exceeds that estimated during the last interglacial (about 125,000 years before present, Imbrie and Imbrie, 1979). It is suggested that additional corroboration be presented to support the contention that the climate of the "super-interglacial" period is represented by the paleoclimate record during the Quaternary Period.

Comment 6-40

Section 6.3.1.4.1, Statement of Qualifying Condition, Climatic Changes, Page 6-97, Paragraph 1

Until the significance and origin of High Plains playas are understood, the statement that there is no evidence of adverse erosion, salt dissolution or ground water processes under extreme climate conditions is not demonstrated.

Comment 6-41

Section 6.3.1.5.2, Analysis of Favorable Condition, Erosion, Page 6-104, Paragraph 8, 9, and 10

The favorable condition involving no expectation of exhumation within one million years is claimed on the basis of a computation that predicts exhumation in 4.4 million years. However, the computation applies debatable rates of escarpment retreat and river incision.

The rate applied for river incision (9.1×10^{-5} meters/year) is the average over the last 600,000 years, without reflecting more robust erosion which probably occurred during the pluvial periods within that time frame. In light of anticipated near-term return of pluvial conditions, the long term average appears inappropriate. In addition, the escarpment retreat rate presented in the Draft EA applies to the escarpment in general and does not express the potential for much greater local rates associated with reentrants where stream gradients are much steeper.

Given the likely structural control implied by linearity and rectangularity, Palo Duro Creek appears particularly prone to rapid reentrant growth in light of the northeastern orientation of its five mile long linear segment southeast of the site, where such growth could be selectively directed directly toward the repository area. Non-pluvial rates for such growth may be comparable to those estimated for creeks of similar small size and topographic setting. These include rates of 1.6×10^{-3} meters/year for Holmes Creek, (page 6-102, paragraph 1); 1.9×10^{-3} meters/year, estimated as the minimum for incision of the Ogallala Caprock on a tributary of Tierra Blanca Creek (Finley 1981); and 4.7×10^{-3} meters/year (Finley and Baumgardner (1981) to 6×10^{-3} meters/year (Baumgardner, 1983) for Little Red River Basin.

These rates theoretically predict possible exhumation of the repository within 130,000 to 500,000 years. Because all three of these rates reflect Holocene conditions, pluvial conditions anticipated in the future would substantially reduce this range. It is recognized that such rapid incision of Palo Duro Creek will be constrained eventually by a much slower reduction of its local baselevel. However, without the ability to estimate pluvial rates for such rivers, the magnitude of the constraint presently cannot be quantified. Therefore, the data presented do not demonstrate that exhumation cannot occur within 1,000,000 years, and the favorable condition remains unestablished.

Comment 6-42

Section 6.3.1.7, Tectonics, Pages 6-108 through 6-111

The assumptions that "the geologic and seismic information is representative of the site to a degree suitable to address the guidelines" and "it is believed that the major tectonic structures and processes that could affect a repository are known" have not been supported by information in the draft EA. A long history of tectonic stability is a considerable positive factor for location of a waste repository in the Texas Panhandle, but present stability must be based on available analyses of all available data, not assumed. This has not been accomplished in the draft EA. The following are some of the factors that need further consideration:

- o Possible correlations of seismicity with a fault along the boundary of the Oldham Nose and Tucumcari Basin northwest of the Deaf Smith site.
- o The significance of the last Pleistocene/Holocene reactivation of the Meers Fault and the potential for reactivation of other northwest trending faults within the Amarillo Uplift by the present regional stress field.
- o The recognition of probable activity on the Meers fault indicates the possibility of analogous situation in the Texas Panhandle.

Comment 6-43

Section 6.3.1.7.1, Statement of Qualifying Condition, Tectonics, Page 6-109, Continuing Paragraph

The statement is made that "no historic earthquakes have been reported in or near Deaf Smith County." A February 2, 1975 (M = 2.9) event in eastern New Mexico is shown to have been located just 5 km outside of Deaf Smith County. In addition, an earthquake of body wave magitude (Mblg.) 3.1 occurred in Deaf Smith County within 25 km of the site on May 21, 1984 (NEIS, 1984). This sentence should be reworded to reflect seismic activity in and near Deaf Smith County correctly.

Comment 6-44

Section 6.3.1.8.3, Analysis of Potentially Adverse Conditions, Page 6-114, Paragraph 5

No data exists to support the conclusion that zones of high permeability do not exist in the deeper formations in the area of the site. The draft EA states that fluids are not now being injected or stored underground at the site. The draft EA further states that "a deep formation of an unusually high permeability" does not exist. This condition may not exist at the site, however, data at this time are insufficient to eliminate, categorically, the existence of unusually high permeability zones at depth. Data presented in Chapter 3 indicate that over large portions of the basin, the granite wash exhibits a significantly higher permeability than surrounding units. It is important that it be demonstrated in the final EA that there is no potential for fluid injection into deep formations in the area around the site that could adversely change portions of the groundwater flow system. The finding that there is no potential for deep well injection in the site area should be reevaluated.

Comment 6-45

This comment was incorporated elsewhere in the comment package.

Comment 6-46

Section 6.3.3.2.2, Analysis of Faborable Conditions, Page 6-138, Paragraph 6

A discussion of the adverse influence of potential heterogenities such as inclusions, brine/gas pockets, etc., on the reported engineering properities of the insitu host rock mass was not presented in the evaluation in this section. An assessment of the suitability of the in situ rock mass should consider uncertainities relating to the adverse effects of heterogenities on rock characteristics in limiting lateral and vertical flexibility. Recommend that the evaluation be expanded to include an assessment of the uncertainties related to the influence of heterogeneities upon the suitability of the in situ rock mass.

Comment 6-47

Section 6.3.3.2.2, Analysis of Favorable Conditions, Page 139, Paragraph 5

The evaluation presented in this section does not address uncertainties regarding the effects of repository induced thermal loading on roof and rib failures (slaking, spalling, etc.) and the resulting support requirements to prevent such failures. In addition, an analysis of salt rock/rock bolt thermomechanical relationships has not been provided to evaluate anticipated rock bolt performance. Recommend that the evaluation presented be expanded to address uncertainties related to support requirements.

Comment 6-48

Section 6.3.3.2.2, Analysis of Favorable Condition, Page 6-139, Paragraph 5

It is stated that standard minimal support (bolting) may be required where stringers occur. Depending upon flexibility in selection mine horizon, roof support will depend upon roof integrity and including considering of factors such as (1) strata strength, (2) bed thickness, (3) in situ stress, (4) stand-up time, (5) and natural weakness planes. Section 3.2.6 provides some data on laboratory strength tests but omits data for fractures (RQD, orientation, condition). Several rock classification indices (CSIR, NGI) include estimates of roof span stand-up time and support requirements based on RQD, point load or lab tests, and in situ stresses. Recommend the section be expanded to include a discussion related to the uncertainties associated with requirements for support requirement at the Deaf Smith site.

Comment 6-49

Section 6.3.3.2.3, Analysis of Potentially Adverse Conditions, Page 6-139 Paragraph 6

This section states that the host rock is sufficiently laterally extensive to support a repository; however, the evaluation does not consider the uncertainties associated with rock mass heterogeneities or lateral extent. The evaluation presented does not address the degree to which the presence of anamolous zone and major inclusions would limit the expected lateral flexibility at the repository depth. Since the presence of heterogeneities would restrict both lateral and vertical flexibility, concluding that adequate lateral extent is present may not be correct. Recommend the evaluation be expanded to include a more detailed analysis of the uncertainties involved with sufficient lateral extent particularly with its significance to the "Alternative Design Concept" as discussed in Section 5.5.

Comment 6-50

Section 6.3.3.2.3, Analysis of Potentially Adverse Conditions, Page 6-139 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 required 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. It is recommended that the evaluation presented include these requirements for engineering measures in the high temperature environment and if appropriate, modify the finding to reflect the results of the reevaluation.

Comment 6-51

Section 6.3.3.2.3, Analysis of Potentially Adverse Condition, Page 6-139 Paragraph 11

The evaluation presented underestimates the potential problems associated with shaft freezing. The shaft design presented in Chapter 4 of the draft EA presents a plan to freeze the shaft section passing through the Ogallala and Dockum Group aquifers. A seal is to be installed near the base of this interval. This seal and freezing interval will be incorporated into the operating shaft structure and must meet the requirements inherent in repository closure and decommissioning. Although freezing is a widely-practiced technique that has proven practical before, uncertainties exist regarding its applicability to a repository design. Uncertainties associated with freezing and then thawing of the ground have not been discussed.

Recommend the draft EA expand the discussion in this section to include the above uncertainties.

Comment 6-52

This comment was incorporated elsewhere in the comment package.

Comment 6-53

Section 6.3.3.2.3, Analysis of Potentially Adverse Condition, Page 6-140 Paragraph 2

It is stated that scaling on occasion will be necessary to maintain excavation geometrics adversely affected by salt creep. Although the finding is questioned, the evaluation does not include an analysis of the influence of clay interbeds, heat, and mining techniques, etc., on the amount of necessary scaling. It is recommended that the evaluation address the influence of these factors on scaling.

Comment 6-54(a)

Section 6.3.3.2.3, Analysis of Potentially Adverse Conditions, Page 6-140 Paragraph 4-6

The draft EA states that the canister cannot be retrieved without the overcoring of the canister or removal of the waste form from the overpack, and ther is potential for difficulty due to brine migration or radiation effects. Based on discussions in the draft EA, it would appear that retrieval will required re-excavation of the rooms in the presence of heat, and steam and possibly chlorine (from radiolysis of salt) and hydrogen (from corrosion of canisters). Retrieval operations may occur in thermally-evaluated 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 uncertainties. It is recommended that the evaluation be expanded to include these mentioned uncertainties.

Comment 6-54(b)

Section 6.3.3.2.3, Analysis of Potentially Adverse Condition, Page 6-140, Paragraph 10

This section deals with 960.5-2-9(c)(5), the guideline that addresses the effect of discontinuities on stratigraphic features that could affect personnel safety. The discussion should mention the uncertainty of potentially hazardous geological conditions at the site. The stratification of the rock salt and the presence of interbeds presents a potentially adverse condition that could be significant on a site-specific basis. This is not mentioned in the discussion. Recommend the evaluation be expanded to address the uncertainty in projecting the potential degree of hazardous conditions.

Comment 6-55

Section 6.3.3.3.1, Statement of Qualifying Condition, Page 6-142 Paragraph 5

The analysis presented states that cost-effective construction techniques and designs for liner and sealing systems are available.

The large number of holes required for freezing, and the ground disturbance resulting from the freezing/thawing cycle significantly increase the hydraulic conductivity of the ground around the shaft (e.g., NUREG/CR-2854, p. 46) an evaluation of the uncertainties associated with freezing and sealing has not been presented.

It is recommended that the final EA present an evaluation/analysis which discusses the implications of freezing and thawing on water inflow potential, and especially address the risk of initiating dissolution of salt along the shaft penetrations.

Comment 6-56

6.3.3.3.2 Analysis of Favorable Condition, Page 6-143, Paragraph 2.

The Draft EA concludes that adequate quantities of water can be obtained from groundwater supplies to fulfill water demands for repository construction, operation, and closure, and thus the corresponding favorable condition (960.5-2-10(b)(3)) is present at the Deaf Smith site. The Draft EA also recognizes, however, that the information supporting this conclusion is uncertain. Inability of the aquifers to supply water of adequate quantity and quality may impede repository construction and operation. Based on available information, in the Draft EA, the NRC staff concludes that the Draft EA does not provide and evaluate sufficient information to support the conclusion that adequate quantities of groundwater can be obtained from aquifers at the Deaf Smith site for repository construction, operation, and closure.

There are two principal aquifers overlying the host rock in Deaf Smith County: the Ogallala Formation and the Dockum Formation. The Draft EA assumes that water will be available only from the Dockum Formation because the Ogallala Aquifer may be depleted by projected irrigation use during the operating lifetime of the repository.

Other than the general characteristics of the Dockum Formation (e.g., its thickness and lithology), the Draft EA does not provide and evaluate information necessary to assess potential water yield from the formation. Key variables that determine potential yields from aquifers, such as storativity and hydraulic conductivity, are not provided in the Draft EA "because of insufficient data" (p. 3-118). Reporting that the quality of groundwater within the Dockum Formation ranges from potable to saline, the Draft EA provides minimal information regarding the quality of groundwater within the formation near the site. Thus, even if the Dockum Formation can yield abundant quantities of groundwater near the site, the water may not be of suitable quality for its intended use in repository construction and operation effectively making the water unobtainable without considerable expense for pre-use treatment. Lacking such necessary information, the Draft EA never-the-less assumes that the Dockum Formation will supply sufficient water based on unspecified "preliminary data."

Because of the above mentioned concerns, the NRC staff concludes that the favorable condition regarding the availability of water for construction, operation, and closure, is not supported. The NRC staff recommends that DOE either revise the final EA to provide and evaluate existing information necessary to assess the ability of the Dockum Formation to supply adequate quantities of groundwater for construction and operation of the repository, or reverse its affirmative finding with respect to favorable condition 960.5-2-10(b)(3).

Comment 6-57

Section 6.3.3.4.1, Statement of Qualifying Condition, Tectonics, Page 6-144, Paragraph 4

Late Pleistocene-Holocene reactivation of the Meers Fault has been demonstrated and other faults exist that are oriented favorably for reactivation. The statement in this paragraph that no tectonic faults have been active in the region of the site since before the Quaternary Period is not supported by available data and is at least in part refuted by the geologic record.

Comment 6-58

Section 6.3.3.4.3, Analysis of Potentially Adverse Condition, Page 6-145, Paragraph 4

The draft EA states that the ground motions associated with the Nuttli and Herman (1978) prediction for the maximum credible earthquake would not produce ground motions in excess of design limits used for nuclear facilities elsewhere.

The site-specific soil and rock conditions relevant to localized effects of attenuation and amplification of ground motions in the soil column should be assessed in view of the requirements of the surface and subsurface facilities, with particular reference to shaft linings and seals and the critical surface facilities. The analysis should address the magnitude and potential occurrence of human-induced seismicity.

Comment 6-59

This comment was incorporated elsewhere in the comment package.
Comment 6-60

Section 6.3.3.4.3, Analysis of Potentially Adverse Conditions, Tectonics, Page 6-145, Paragraphs 6 through 8

Available data does not clearly support the evaluation that there is no active tectonism in the region. The presence of geologically young offsets along the Meers Fault indicates Quaternary tectonism and many faults in the region are oriented such that they also could be reactivated by the regional stress field. A potentially adverse regional condition appears to be present.

Comment 6-61

Section 6.4.1, Preclosure Radiological Assessment, Page 6-153 to 6-166; Preclosure Damage

Neither the preclosure nor the postclosure Radiological Assessment considers damage to the waste package during the preclosure period. Such damage may result in immediate failure of the waste package. The only 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 Comment WP 6-79).

Because flawed or damaged containers could lead to immediate radionuclide release (preclosure), or could lead to unexpected degradation of waste package performance (postclosure), absence of preclosure damage assessment leaves a major source of early failures unevaluated. Transport of some radionuclides from a defective waste package could conceivably begin immediately after emplacement. This damage process and its potential consequences should, therefore, be considered in the performance analysis.

Comment 6-62

Section 6.4.1, Preclosure Radiological Assessment, Page 6-153 to 6-166

In calculating the source term for the preclosure radiological assessment, the selected scenarios are not shown to be bounding scenarios, are not complete, and it was nonconservatively 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 references cited (SAI 1984, DOE 1980, DOE 1979). To the extent that these accident scenarios provide bounding conditions, the basis for using them should be documented.

In the quantitative 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, calculation or specific indication of how releases would be limited by facility design. For the accident scenarios, the releases 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 involves 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 6-63(a)

<u>Section 6.4.1.2, 10CFR20 Calculations Pages 6-156 to 6-158; Fuel Pin Failure Assumptions</u>

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, the original 0.01 percent failure rate (described in the EA) appears to be more representative of discharged fuel (NUREG/CR-3602) than shipped fuel. The 0.1 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, a more representative set of fuel pin failure assumptions should be considered (e.g., Section 6.4.1.2.2 of DOE/RW-0012).

Comment 6-63(b)

Section 6.4.1.4, Accident Calculations, Pages 6-156 to 6-158; Source Term

The Environmental Assessment 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 assumption in Rgulatory 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 (EA Section 6.4.1.2) and accident (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 Deaf Smith Site Draft EA should also be justified.

Comment 6-64

Section 6.4.1, Preclosure Radiological Asessment for Deaf Smith, Page 6-156

In this section, there is a table (Table 6-14) providing estimates of releases of radon-220, radon-222 and their radioactive decay products. These are derived from a reference (DOE/EIS-0046F, Vol. 1) which give little information about the basis for its estimates, but implies that it includes a concept that no radon will be released except during active mining and backfilling, contrary to experience at uranium mines. In addition to continuing releases from the surfaces of the repository drifts and rooms, the stockpiled mined rock will also continue to release radon. It is not expected that releases of naturally occurring radionuclides at any of the candidate sites would be significant in terms of doses approaching regulatory limits, unless releases are much greater than usual for such rock types. However, a credible indication of the magnitude of the releases can be obtained by monitoring the ventilation pathway during the site characterization process.

Comment 6-65

Section 6.4.1.2, 10 CFR Part 20 Calculation, Page 6-158, Paragraph 6.

In the draft EA, the term "accessible environment" is incorrectly applied in disucssing preclosure releases. The draft 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 operation is ...conducted."

Comment 6-66

Section 6.4.1.3, 40 CFR 191 Calculation, Page 6-158

The meteorological data base identified in this section includes information not identified in Section 6.2.1.4. The use of meteorological data from Dallas, Texas as the bases for the selection of the atmospheric dispersion conditions for the 40 CFR 191 calculation is without substantiation and inconsistent with the atmospheric dispersion analysis presented in Section 3.4.3 and the air quality impact assessments presented in Sections 4.2.1.3 and 5.2.5. Also, the 40 CFR 191 calculation apparently relies on the use of the straight-line, Gaussian atmospheric dispersion model for calculating centerline concentrations to approximate annual average conditions (Waite, 1984). The resultant relative concentration (X/Q) values are consistent with expected annual average values, although this consistency is somewhat fortuitous. Both the meteorological data from Dallas and Amarillo, Texas (used elsewhere in the draft EA) are available in the proper format for use in an appropriate annual average atmospheric dispersion model. It is suggested that Section 6.4.1.3 be revised to be consistent with respect to Sections 6.2.1.4, 3.4.3, 4.2.1.3, and 5.2.5. True annual average conditions could also be calculated and compared to the approximations to ensure consistency.

Comment 6-67

Section 6.4.1, Preclosure Radiological Assessment for Deaf Smith, Page 6-153.

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 surface that provides a source term for fuel handling operations. 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 6.4.1.4, Accident Calculations, Table 6-25, Deaf Smith Accident Dose Comparison, page 6-170.

Table 6-25 estimates the maximum-exposed individual and population doses from releases of radionuclides under accident conditions. These estimates are based on BMI/ONWI-541 (Waite, 1985) Calculated X/Q Values for Accident Conditions, and 3-7, Accident Dose Comparisons. Examination of BMI/ONWI-541 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. The expected value has been determined by the NRC staff from the meteorological conditions stated in BMI/ONWI-541 and compares favorably with the values at 240 meters (based on an "F" stability class with a wind speed of 1 m/sec) found in BMI/ONWI-541 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 Table 3-7 will be low by about a factor of 400. Consequently, it is suggested, Table 6-25 be reviewed and revised as appropriate.

Comment 6-69

Section 6.4.2, Preliminary Postclosure Performance Assessment, Pages 6-166 to 6-220; 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 Draft EA utilizes a waste package behavior scenario wherein the waste package is expected to slowly degrade, eventually leading to package failure and radionuclide release. Disruptive scenarios, such as human intrusion 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 6-70

<u>Section 6.4.2.3, Preliminary Subsystem Performance Assessments, Pages 6-176 to 6-211; Uncertainties in Modeling Predictions</u>

Uncertainties in the input data and modeling procedures, which concern radiation conditions, thermal conditions, fluid conditions, and engineered barrier performance, lead to uncertainties in the performance predictions. An estimate of the uncertainty in these factors has 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 6-71

<u>Section 6.4.2.3.1, Thermal Conditions, Page 6-178, Paragraph 4; Analytical Approach</u>

The TEMPV5 code is based on a method of solution not appropriate for describing heat transfer in salt and the solution may be in error. TEMPV5 code uses an analytical solution of finite line sources in a homogeneous, isotropic, and infinite-medium to model individual waste packages. The code uses linear superposition of temperature contributions from individual finite line sources by an analytical integration to calculate the temperature at a point.

Since the thermal properties of salt vary with respect to temperature, the governing equations are nonlinear and the superposition principle does not apply.

Comment 6-72

<u>Section 6.4.2.3.1, Thermal Conditions, Page 6-178; Uncertainties in Waste Package Thermal Analysis</u>

Confidence in the waste package thermal analysis may be overstated. Neither the magnitudes nor the effects of the uncertainties in thermal analyses are provided in the Draft EA, although the existence of the uncertainties is acknowledged.

Corrosion rates are generally assumed to have an exponential dependence on temperature. The NRC staff analyses indicate that the effects of temperature uncertainties are important when this dependence is used. For example, using data from Figure 6-16 in the Draft EA, it can be estimated that a difference of 30°C or less 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 6-73

Section 6.4.2.3.2, Fluid Conditions in Salt, Page 6-181, Paragraph 1

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 x 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 (Anthony and Cline, 1972). This may be significant because high temperatures at the waste package may cause boiling of inclusions that have migrated to a waste package, allowing fluids to develop a vapor phase and to dissolve radionuclides. Inclusions possibly containing radionuclides then have the potential to migrate away from the waste package. Third, intracrystalline migration does not necessarily stop at a crystal boundary, but may move across the boundary into an adjacent crystal (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 6-74

Seciton 6.4.2.3.2, Fluid Conditions in Salt; Analytical Approach, Page 6-181, Paragraph 3 to Page 6-186, Paragraph 2

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 (see comment 6-27). Results from BRINEMIG are used in support of the geochemistry qualifying condition (page 6-87, paragraph 5), favorable condition (3) (page 6-88, paragraph 4), favorable condition (4) (page 6-89, paragraph 1), and potentially adverse condition (1) (page 6-89, paragraph 6), and rock characteristics potentially adverse condition (2) (page 6-95, paragraph 3). These uncertainties regarding BRINEMIG and the application of its results should be considered when evaluating the evidence relevant to these conditions for the final EA.

Comment 6-75

Section 6.4.2.3.2, Fluid Conditions in Salt; Data Base and Uncertainity, Page 6-181 Paragraph 4

The use of 5.0 volume % (about 3 wt. %) for initial water content may not be as conservative as asserted in the Draft EA. There is more clay in the salt than reported, which would give an increased amount of water. The amount of clay in

Unit 4 may be at least twice the value presented in the Draft EA (see comment 3-23). Therefore, the contribution of water from the clay will certainly be greater than the 0.6 wt. % assumed in the Draft EA. Data from Fisher (1984) and calculations made by the NRC suggest that there could be an average of more than 4 vol. % water in the Unit 4 salt (see comment 3-25). Clay interbeds and muddy salt zones may contain much greater amounts of water. These data suggest that the 5.0 vol. % water content used in the Draft EA performance assessments is not as conservative as is asserted in the Draft EA, because in clay interbeds and muddy salt zones 5.0 vol. % water may be exceeded.

Results from brine migration analyses that use this initial water content estimate are used in support of findings for: the geochemistry qualifying condition (page 6-87, paragraph 5); favorable condition (3) (page 6-88, paragraph 4), favorable condition (4) (page 6-89, paragraph 1); and potentially adverse condition (1) (page 6-89, paragraph 6); and rock characteristics potentially adverse condition (2) (page 6-95, paragraph 3). Estimates of the initial water content should be reconsidered in light of the additional data evaluating the evidence relevant to these conditions.

Comment 6-76

Section 6.4.2.3.2, Fluid Conditions In Salt, Page 6-181: Brine Migration and Accumulation; Adequacy of the Data; Effect of Inhomogeneities

The waste package performance assessment does not address inhomogeneities in the waste package environment, but instead treats the surroundings (i.e., the near field) as if they were homogeneous and isotropic.

Although the average clay content (which is a source of moisture) at a site may be small (claimed 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 wt.% 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 Draft EA predictions of waste package lifetimes, (based on calculations of the amount of brine that would be available to corrode the overpack, and related factors) may be inaccurate. Local (near-field) conditions, including inhomogeneities in in-situ brine quantity and composition, should be considered in the final EA waste package performance assessment.

Comment 6-77

Section 6.4.2.3.3, Waste Package Performance, Pages 6-186 to 6-196; WAPPA Analysis

The Draft EA indicates that WAPPA, BRINEMIG, TEMPV5 and other computer codes, which were used in the Draft EA, may be used to obtain relevant licensing information. Should these codes contain inappropriate 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 been released. The versions of these codes that were used should be identified and released as part of the supporting documentation identified above.

Comment 6-78

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 Figure 6-16 is shown to be about 20 mils/year 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 232 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 should be considered and the uncertainties in both the input and output should be explicitly addressed in the final EA.

Specifically, there are three concerns worthy of consideration: (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 and reconciled with the level 3 finding for postclosure system Guideline 960-4-1(a) with regard to demonstrating for the given reference waste package design, that the site will allow for the use of engineered barriers.

Comment 6-79

Section 6.4.2.3.3, Waste Package Performance, Pages 6-186 to 6-196, Corrosion During the Preclosure Period.

There is no consideration in the Draft EA of 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 from 50 to 80 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 preclosure 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 a range of ferrous materials 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 allowances specified for SFPWR package using this low carbon steel container. Such an excessive metal loss, if confirmed, would, by definition, constitute failure of the container prior to repository closure. Additionally, the temperatures could become high enough (and the ambient pressures low enough) to vaporize the brine water near the waste packages. This could alter the flow of brine toward the waste packages in ways that do not appear to have received consideration in the Draft EA corrosion analysis. With regard to the effect on corrosion of the waste package overpack, the rate of corrosion of the low-carbon 1025 steel in a steam environment could be significantly different from that in a liquid brine environment.

Preclosure container corrosion should be considered in the final EA.

Comment 6-80

Section 6.4.2.3.3., Waste Package Performance, Pages 6-186 to 6-196, Thermal Conditions: Uncertainty in the Predicted Conditions

The Draft EA does not adequately address 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 of the salt, this becomes a dominating factor in the accuracy of the predictions. The thermal conductivity of the salt is affected by the content of non-salt materials, such as water, clay and other materials. 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 profile (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, 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 estimate of the impact of the uncertainties in temperature on package performance should be given to potentially adverse conditions at this site (Postclosure System Guideline 960.4-1(a) and associated Postclosure Technical Guidelines 960.4-2-1, 960.4-2-2 and 960.4-2-3). Any uncertainties that do exist in the analysis should be considered.

Comment 6-81

Section 6.4.2.3.3 Waste Package Performance; Brine Flow Rate, Page 6-187, Continuing Paragraph

Brine migration with a threshold 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 about which there is not a consensus and it is the less conservative alternative, the final EA should not consider analyses using a threshold thermal gradient as representing "expected" conditions.

Comment 6-82

Section 6.4.2.3.3, Waste Package Performance, Page 6-187, Radiation Field, Figures 6-14 and 6-15

The predicted radiation levels associated with the waste packages, as presented in the Draft EA, do not agree with previous predictions. While the Draft EA presents the results of a recent calculation (Jansen, 1984a) of the expected radiation dose rate with distance and time, 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 coneptual design (Shornhorst, 1982). A simple calculation (Sastre, 1984), which would underpredict the dose rate, gives a dose rate that is also higher by approximately two orders of magnitude. More recent calculations by Jansen (Jansen, 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 can not be determined at this time due to lack of information.

The Jansen and Shornhorst calculations (Jansen, 1984a and b; Shornhorst, 1982) generate the radiation source term through use of the computer code ORIGEN2. The ORIGEN2 results 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 neither automated nor straightforward.

The radiation levels associated with the waste package influence corrosion, decrepitation of the salt, and formation of colloidal sodium. Because the radiation field influences the characteristics of the immediate environment and, therefore, the predicted containment time and concentration of nuclides in solution an explanation should be provided for the values used.

Comment 6-83

Section 6.4.2.3.3, Waste Package Performance, Pages 6-186 to 6-196

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 dosages are large enough to warrant discussion.

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

Comment 6-84

This comment was incorporated elsewhere in the comment package.

Comment 6-85

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

The information provided in Figures 6-17 and 6-18 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 6-17 which shows the variation in axial and radial stresses for the first 20 years after burial, starting at time zero.

In Figure 6-18, where time starts at two years after burial, the failure thickness (i.e., the thickness of the overpack required to withstand applied stess) 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 6-18, 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 6-86

Section 6.4.2.3.3, Waste Package Performance, Page 6-193, Paragraph 1

The statement that "radionuclides cannot dissolve any faster than the fuel pellet (for SF) or the glass (for CHLW)" is 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 a leaching of alkali elements, which could release some radio-nuclides 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 certain radionuclides, additional conservatism cannot be claimed for all radionuclides in the calculation.

Comment 6-87

Section 6.4.2.3.3, Waste Package Performance, Page 6-193, Paragraph 2

Boundary stress calculations in the Draft EA assume lithostatic pressure only. The additional pressure on the canister created by the generation of 271 m^3/cm^2 of hydrogen gas (see page 6-187, paragraph 2) is not accounted for. The inclusion of this additional pressure may indicate an earlier waste pakcage failure, and should be considered in the final EA.

Comment 6-88

Section 6.4.2.3.3, Waste Package Performance; Corrosion and Failure of the Overpack, Page 6-193, Paragraph 4 to Page 6-196, Paragraph 4

Several factors concerning the geochemical conditions around the waste packages are not considered 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 comment 6-27). The waste package performance assessments are used in support of findings for the geochemistry qualifying condition (page 6-87, paragraph 5), favorable condition (4) (page 6-89, paragraph 1), and potentially adverse condition (1) (page 6-89, paragraph 7). To support the conservatism claimed in the Draft EA, these factors should be considered.

Comment 6-89

Section 6.4.2.3.3, Waste Package Performance, Pages 6-193 to 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 al., 1950).

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

Comment 6-90

Section 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. Only thermally migrating brines are considered for estimating radioactive releases. However, the intrusive brine scenario is considered in evaluation of waste package performance (page 6-193, paragraph 4 to page 6-196, paragraph 3). The final EA should also consider the intrusive brine scenario.

Comment 6-91

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 does not adequately discuss the uncertainties in solubility limits of radionuclides in brine. As noted in the Tables 6-32 through 6-35 "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, 1983). 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, 1983). Recent data indicates that radiolysis of brines could result in oxidizing conditions thus increasing the solubilities of many nuclides (Gray and Simonson, 1984). While Sr forms relatively insoluble complexes with sulfate and carbonate anions, it does form soluble chlorides; Clynne (1981) measured the solubilities of $SrCl_2$ in brines and bitterns, and in the quarternary system $SrCl_2$-NaCl-KCl-H_2O at 100°C, the $SrCl_2$ content is 45% by weight.

The uncertainties in the nuclide solubilities, combined with uncertainties in brine flow rate, total accumulated brine and brine composition appear not to have been specifically included in the assessment of whether the engineered barrier system will meet the controlled release rate performance objective 910CFR60.113). These uncertainties should be specifically considered in the EA performance assessment.

Comment 6-92

This comment was incorporated elsewhere in the comment package.

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 EA, however, the brine inclusions at the Palo Duro sites are high in magnesium and, as stated *on page 6-196 of the Deaf Smith Draft EA, the SFPWR overpack would fail at 232 years for the hypothetical case of unlimited, high magnesium, thermally-migrating brine. Although it is not explicitly stated, it appears that example applies to a uniform distribution of brine, but in the 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. A corrosion calculation for the latter scenario should be considered for the final EA and the results of the calculation should be reconciled with the 960-4-1(a) postclosure guideline unless adequate justification for ruling out the possibility that a relatively large amount of high-Mg brine would contact a limited portion of the overpack, this site may not be amenable to the use of engineered barriers that incorporate waste packages with the current reference deign, and a different, more corrosion resistant waste package may be needed.

*The text in the 4th paragraph on Page 6-196 refers to results in Table 8-31 that do not exist.

Comment 6-94

Section 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 comment 6-26). Since there are no site-specific data, as confirmed in the Draft EA, and all available solubility data are uncertain, the final EA should use more demonstrably conservative values. The Draft EA notes that there are measured solubilities that would be more conservative than the WISP values, but they are not used.

Comment 6-95

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

Inconsistencies in the amounts of radionuclides tabulated in the Draft EA suggest calculational errors in estimates of the maximum concentration of nuclides at the waste packages and release rates for a single package that has failed at 300 years. For example, the inventories for C-14, I-29 and Cm-244 (among others) in Table 6-26, when expressed in terms of grams per package, do not appear to agree with those in Table 6-32. 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 the EPA limits.

The effect could be significant in that comparison of the tabulated values to the NRC controlled release criterion (10CFR60.113) 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 comment 6-91), 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.

Comment 6-96

Section 6.4.2.3.4, Release Rate From the Engineered Barrier Subsystem, Page 6-202, 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 comment 6-102). The DOE should consider the possibility that some radionuclides could be released faster than the rate of dissolution of the matrix.

Comment 6-97

This comment was incorporated elsewhere in the comment package.

Comment 6-98

Section 6.4.2.3.4, Release Rate from the Engineered Barrier Subsystem, Summary of Performance of Engineered Barriers, Page 6-206, Paragraph 1

The conclusions that the performance of engineered barriers is insensitive to variations in parameters is not substantiated because in the analyses some of the key 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 10CFR60 and 40CFR191. A sensitivity analysis in which all key parameters are varied should be considered in the final EA.

Comment 6-99

This comment was incorporated elsewhere in the comment package.

Comment 6-100

Section 6.4.2.3.5, Geologic Subsystem Performance, Page 6-207, Paragraph 1

The statement that thermomechanical disturbance in a nuclear waste repository results in the closing of openings and healing of fractures (and is, therefore, dismissed) appears to be inconsistent with data elsewhere in the Draft EA. These data indicate that fracture and dehydration of shale beds within the host salt is likely, roof and pillar failures may occur, and that subsidence and thermal uplift will be experienced at the surface. Also, effects on brittle rocks within and above the repository have not been fully analyzed and the absence of potentially adverse effects in these strata as a result of repository creep closure is not demonstrated. The inconsistency should be resolved in the final EA.

Comment 6-101

Section 6.4.2.3.5, Geologic Subsystem Performance, Page 6-208, Paragraph 4

In this section, it is stated that "Preliminary Analyses show that groundwater flow around and through the shaft seal system will likely be very small". However, recorded experience indicates that salt mine shafts have been lost due to water dissolution around the shafts (Kupfer, 1980). The analysis does not explain or predict such failures. It is recommended that the discussion presented be expanded to address how shaft failures such as those that have occurred in the past can be predicted and/or avoided at the Deaf Smith site.

Comment 6-102

Section 6.4.2.3.5, Geologic Subsystem Performance. Performance of Shaft-Seals, Page 6-208, Paragraph 7

The Draft EA states that calculations of expected penetration time for groundwater 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 consequences if there is a continuous supply of fresh water. In addition, if this dissolution of crushed salt is coupled with the failure of the seal around the shaft, water could invade the salt rock around the shaft system.

Comment 6-103

Section 6.4.2.3.5, Geologic Subsystem Performance, Page 6-209, Paragraph 5

The section on geologic subsystem performance suggests that a lateral groundwater flow occurs directly below the repository horizon in the San Andres Dolomite of HSU B. This alternative groundwater flow path is not considered in addressing the favorable condition on the groundwater travel time to the accessible environment.

Results of numerical modeling simulation (INTERA, 1984) of hydrologic perturbations likely in the next 10^5 to 10^6 years are discussed in the subject section. A simulation of doubling recharge to the Ogallala results in increasing vertical flow through the Permian salt by 3 percent and a 17 percent increase in horizontal flow in the San Andres Dolomite. This statement is the only reference in the Draft EA to possible horizontal flow in HSU B; all other analyses are based on vertical flow only.

Horizontal flow in the San Andres Dolomite would result in a much shorter flow path from the repository to the accessible environment and a potentially faster travel time then previously described. The discrepancy between the flow paths considered in the analysis of the geohydrologic guideline groundwater travel time potentially favorable condition and the geologic subsystem performance analysis should be resolved. Credible alternative flow paths from the repository to the accessible environment, including horizontal flow in the San Andres Dolomite, should be considered in the analyses of the geohydrologic guideline 10 CFR 960.4-2-1.

Comment 6-104

Section 6.4.2.3.5, Free Surface Modeling, Page 6-211, Paragraph 3

The Draft EA uses the results of numerical modeling (Intera, 1984a) in support of groundwater travel time calculations for Guideline 960.4-2-1. The Intera (1984a) model of the Palo Duro Basin uses a modified version of the SWENT computer code which has not been documented or validated. This modified version was not used for most of the calibration of the Intera model (see Intera 1984b) and when it was used, major changes were made in the calibrated recharge for the system. The calibration of the current model of the Palo Duro Basin is therefore incomplete, and its use could introduce significant uncertainty into calculations.

The first status report of modeling of the Palo Duro Basin (Intera 1984b) modeled the Ogallala as a fixed head boundary, specifying the water table elevation. Problems with this conceptualization are that the effect of water table elevation on transmissivity is not modeled, and that the model computes the values and spatial distribution of recharge, rather than taking this as input. Recognizing these problems, Intera (1984a) uses a modified version of the SWENT computer code (Intera 1983) which simulates the free surface. This modification is a significant change in the numerics of the code, especially in that recharge is handled very differently. This modified version has not been documented or verified.

Most of the calibration of the Palo Duro Basin model is documented by Intera (1984b) in their first status report. However, when the free surface feature is included in the model (Intera 1984a), the base case recharge is reduced by 60 percent from 0.75 cm/yr to 0.3 cm/yr. This significant difference in recharge, which ultimately controls fluxes through the basin, receives very little attention. It is not clear if the model is recalibrated or not. Intera's total analysis of the issue is "The difference in the recharge rates may be due to the fact that the two values correspond to different modeled areas of the Ogallala." If the model has not been recalibrated, the final EA should consider the uncertainties introduced by that fact. If there has been a recalibration, this fact should be noted in the final EA and the impacts upon uncertainties should be indicated.

Comment 6-105

This comment was incorporated elsewhere in the comment package.

Comment 6-106

This comment was incorporated elsewhere in the comment package.

Comment 6-107

Section 6.4.2.6.2, Human Interférence, Page 6-218, Paragraph 3

The Draft EA states that "even if solution mining were to encounter radioactivity, it is probable that if society were knowledgeable enough to employ solution mining, it would also recognize radioactivity." This sentence makes two implicit assumptions, both false. First, solution mining does not necessarily require much technology: solution mining has been carried out for more than 1,000 years in China. Second, a society that can recognize radioactivity (such as our own) will not necessarily look for it in a place where it is not expected: we do not routinely check our table salt for radioactivity. The Solution Mining Scenario should not be dismissed without analyses similar to that presented under Borehole Intrusion Scenario for expected releases.

Comment 6-108

This comment was incorporated elsewhere in the comment package.

Comment 6-109

This comment was incorporated elsewhere in the comment package.

6-110

<u>Appendix 6A, Estimation of the Extent of the Disturbed Zone, Page 6A-2, Paragraph 4</u>

The evidence presented to support the statement that "present data indicates that mechanical effects (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., reference 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 ceilings that are commonly 2 to 10 meters deep". Furthermore, in Supplement A to this report on page A-18, Kupfer states "...salt is highly disturbed for distances of 20 to 50 feet (6-15m) into the walls of all mining workings. In this disturbed zone, the salt may have a significant porosity and permeability...." In Volume II, Appendix 22, Page 20 of the Golder Associates, 1977 reference, it is stated: "The process of mining (salt) develops a jointing that is easily identifiable and extends back into the salt for several tens of feet (meters); how far has not been determined." Appendix II, page 32b, also stated that "One might assume that fractures (caused by 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)." On the same page, it is stated "...friability might imply openings, porosity, and even permeability that might extend for 10 to 30 feet or more into the salt." On page 33 of this Appendix, it is stated 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)." It is recommended that the discussion be expanded 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 the estimate of the extent of the disturbed zone be modified as appropriate to reflect the results of the evaluation.

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CHAPTER 7 COMMENTS

Comment 7-1

Section 7.2.1.2, Geochemistry - Favorable Conditions, Page 7-16, Paragraph 3

The discussion in the Draft EA states that for the geochemistry favorable conditions (1) and (2), the presence of clays contribute favorably to the isolation capability by strongly enhancing "the sorption of cationic radionuclides". However, this possibility is not discussed in the evaluation of favorable condition (1) (page 6-87, paragraph 6). In the evaluation of favorable condition (2) it is stated that sorption of radionuclides on clays "is expected to be minimized by the presence of brines." (page 6-88, paragraph 2). The evaluation made in the Draft EA for these two conditions in chapter 6 does not support the statement that clays at Deaf Smith will "strongly enhance" sorption of radionuclides.

Comment 7-2

Section 7.2.1.2, Geochemistry Favorable Conditions, Page 7-16, Paragraph 5

In chapter 7 of the Draft EA it is stated that carbonate in the groundwater at salt sites may react with radionuclides "to form complexes that would be more 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 (page 3-134, paragraph 1). The reason why this effect is minimized in the discussions in chapters 3 and 6, but is presented as a potential problem in chapter 7 is unclear.