Lawrence Livermore National Laboratory

WM-RES
WM Record File A-0294 LL
WM Project 10,11,16
Docket No.
PDR V
LPDR B, N, S
Distribution: BLACKSORO
(Return to WM, 623-SS) LS

30 August 1984

Mr. Michael E. Blackford
Project Manager, MS-623ss
Geotechnical Branch, WMGT
Division of Waste Management
Office of Nuclear Material Safety & Safeguards
U.S. Nuclear Regulatory Commission
Washington, DC 20555

SUBJECT: Transmittal of EA Review on Davis Canyon and Lavender Canyon, Paradox Baxin sites.

Reference: NRC FIN A0294

Dear Mr. Blackford:

The purpose of this letter is to transmit the subject EA review.

Our review and evaluation of this EA was requested in your communication dated July 1984. We have successfully accomplished our review on this EA.

If you have any questions, please let us know.

Sincerely yours,

H. Lawrence McKague
FOR

Dae H. Chung
Leader
NRC Nuclear Waste Management Project

DHC/ldb

Attachment: As stated.

xc: P. S. Justus, WMGT
B. J. Rice, WMGT
J. S. Trapp, WMGT
K. B. Westbrook, WMGT

WM DOCKET CONTROL CENTER
'84 SEP -4 A10:45

8409170093 840830
PDR WMRES EXILLL
A-0294 PDR

1 1NN

This report is a preliminary review of the preliminary statutory Environmental Assessments (EA) of the Davis Canyon and Lavendar Canyon Sites, Paradox Basin, San Juan County, Utah.

The report is divided into five sections. The first section contains general editorial comments which reflect the preliminary nature of the EAs. In a final form these comments should not apply. The other four sections deal with Chapters 3, 4, 5, and 6. Comments on each chapter are divided into those which are applicable to both sites or EAs and those which are site or EA specific. All comments references are made with regard to the Davis Canyon EA, unless an (L) follows the section reference, in which case it refers to the Lavender Canyon EA. For an example see question 3-3.

General Editorial Comments

The preliminary drafts contain numerous typographic errors, such as misspelling, omission of words, improper hyphenization of words, and incomplete sentences (Davis Canyon, p. 3-19, paragraph 5, 3rd sentence). Many of these have not been noted in this review. In addition many of the figures are difficult to read or interpret. By way of example, see figure 3-10 of the Davis Canyon EA.

Some 1984 references are currently unavailable. These are noted below, if they appeared to be critical. Most of these can be picked up by scanning the list of references at the end of each chapter. For an example see Kitcho (1984) in the list of references at the end of Chapter 6 of the Davis Canyon EA.

Chapter 3

General Comments

In general the largely descriptive data of Chapter 3 agrees with the published literature. The regional geology, geomorphology and stratigraphy have had a long history of investigation and study and are well known. However, some topics appear to be treated in a cursory way, with little integration of data from various disciplines. For example, the seismicity in the vicinity of the Shay Graben is not mentioned in Section 3.2.5.1 (faulting). The general comments in this section while referenced to one or the other of the repositories are of concern for both repositories or EAs.

3-1 Section 3.2.1 Regional Data
Page 3-7, paragraph 2, Figure 3-4,
Incorrect data.

The sentence describes local deformation by monoclinal drape folds that overlie steeply dipping faults in the basement and refers to Figure 3-4. Figure 3-4 shows the development of the salt anticline not of the monoclinal folds. In addition the positions of both sites relative to the correct structures should be shown and discussed in the adjacent text. Also, the subject figure is nearly illegible and is of such a small scale as to be unusable. A legible and adequately sized drawing is needed along with explanatory text. This information is required in order that the position of the potential repository site with respect to regional structures (including structures at depth) may be envisioned so that sufficient information will be presented to allow the reader to determine how the conclusions were reached.

3-2 Section 3.2.3.3 Thickness, Lateral Extent, and Character of the host rock,
Page 3-35, paragraph 4.
Conflicting information provided.

Text indicates the carnallite zone extends from 975 meters (3200 feet) to 995 meters (3265 feet). On figure 3-17 the interval from 3130 feet to 3270 feet is described as a zone containing dissolution features indicative of "highly solubility grains (potash)". There would appear to be a discrepancy between the text and the figure.

3-3 Section 3.2.3.1 (L)* Regional Stratigraphic History of the Paradox Basin
Page 3-27, paragraph 2
Not enough information.

In the 5th line an unfamiliar geologic term is introduced - Monument upward, - circle Cliffs upward. It appears that the more common term uplift is appropriate. If not, more information needs to be presented to allow the reader to determine how this term is being used in the EA.

*Indicate Lavender Canyon EA.

3-4 3.2.3.2 (L) Site - Specific Stratigraphy
Page 3-29-30 (Figure 3-10, no paragraph no.)
Category c.*

Figure 3-10 is a generalized geologic map for the Lavender Canyon site and vicinity. Lettering on the figure is very small and no terrain features are included so the relationships of the various formations shown to the topography cannot be envisioned. A suitably scaled, detailed and legible geology map is needed so that the reader can independently review the data and determine how the conclusions in the EA were reached.

3-5 Section 3.2.3.2 (L) Site-Specific Stratigraphy
Page 3-31-32 (Figure 3-11, no paragraph no.)
Category c.

The comment made for Figure 3-10 above applies to Figure 3-11.

3-6 Section 3.2.3.2 (L) Site-Specific Stratigraphy
Pages 3-36 and 3-37 (subparagraphs 3.2.3.2.9 through 3.2.3.2.13)
Category c.

Approximate thickness beneath the Lavender Canyon site are given for various formations in these subparagraphs. The basis for their determinations is not stated and is needed to allow the reader to determine how the conclusions regarding thicknesses were reached. Also see 3-32.

3-7 Section 3.2.3.2 (L) Site-Specific Stratigraphy
Pages 3-39 and 3.40 (Figures 3-14, no paragraph no.)
Category c.

The comment made for Figure 3-10 above applies to Figure 3-14.

3-8 Section 3.2.3.2 (L) Site-Specific Stratigraphy
Pages 3-41 and 3-42 (Figure 3-15, no paragraph no.)
Category c.

The comment made for Figure 3-10 above applies to Figure 3-15.

*Refers to categories listed on page 2 of letter from Blackford to Chung, July 1984.

3-9 Section 3.2.3.2 (L) Site-Specific Stratigraphy
Pages 3-43 and 3-44 (Figure 3-16, no paragraph no.)
Category c.

The comment made for Figure 3-10 above applies to Figure 3-16.

3-10 Section 3.2.5.1 Faulting
Page 3-44, paragraph 4
Not enough information provided.

This and following paragraphs contain descriptive material about the Shay Graben. However, microseismicity potentially associated with the Graben (ONWI 491, Fig. 2-17) was not mentioned nor were four more recent earthquakes east of those described in ONWI 491. (See Draft Site Technical Paper Gibson Dome Waste Isolation Project Site, p. 14). Nor is there any attempt to fit this structure into regional tectonic picture. This is the largest prominent structure near both the Davis Canyon and the Lavender Canyon sites. Its origin and current relationship to regional tectonics needs to be known in order to access its affects on both Geologic Repository Operation Areas (GROA).

3-11 Section 3.2.5.1 Faulting
Page 3-42, paragraph 2
Data allows a different interpretation.

Geophysical evidence that the Lockhart fault cuts only the upper Paradox Formation and post-Paradox strata is used as evidence that the fault resulted from collapse owing to dissolution, rather than being a conduit for fluids and thus a cause of dissolution leading to collapse. Mechanisms, other than collapse, causing such faulting are conceivable. These include: 1) local stress fields (i.e. tension) caused by folding and/or salt flowage; 2) differing mechanical behavior of strata above and below (an) evaporite layer(s) resulting in a detachment surface; 3) failure by folding in upper units, rather than by brittle failure; and 4) lateral offset unrecognized in pre-Paradox strata. It seems probable that vertical movement has resulted from collapse, but any of these (or other) mechanisms could have created the conduit allowing dissolution to occur.

Evaluation of settings leading to significant dissolution and collapse is crucial to determination of any potential disruption to the repository. Understanding of the role of the Lockhart fault must be an important part of this evaluation. Investigation of different mechanisms should indicate whether any or all are possible realities. Some mechanisms will likely be easily proved inadequate to explain the setting.

3-12 Section 3.2.5.1 Faulting
Page 3-44, paragraph 5
Data allows a different interpretation

Decrease of block rotations away from the Colorado River in the Needles fault zone is used as evidence that the dominant mechanism of faulting changes from salt flowage to down-dip sliding. The discussion does not address the possibility of collapse due to dissolution as an additional mechanism or of ages of deformation causing this situation without a change in mechanisms. This latter possibility considers the likelihood that faulting initiated near the river and migrated to the east, thus subjecting blocks nearer the river to greater displacement and rotation.

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

3-13 Section 3.2.5.1 Faulting
Page 3-44, paragraph 6
Insufficient information is presented

What are the similarities between the Salt Creek-Bridger Jack-Shay and Verdure-Glade graben systems that indicate similar ages? Not knowing what assumptions have been made, it is not possible for the reader to speculate on the validity of this interpretation. From orientations of the fault systems and the en echelon patterns, it seems likely that these were conjugate systems, with the former system having left-lateral displacement and the latter having right-lateral. If this is the case, it should be stated and not

have to be assumed. This alone would indicate approximately similar ages, but some variation is possible. Are there further similarities indicating similar ages?

Characterization of fault parameters such as mechanism(s), displacements, fault lengths, timing, ages, and sense of movement are important for the determination of past and possible future fault behavior. A more extensive discussion and presentation of these parameters should sufficiently inform the reader.

3-14 Section 3.2.5.1 Faulting
Page 3-44, paragraph 6
Interpretation disagrees with other information.

A Laramide age is implied for the graben systems and should be stated. Late Cenozoic movement is also described (Sec. 3.2.5.1 paragraph 8), but not mentioned here. Faceted spurs would seem to indicate recurrent recent movement. Although reactivation of an older fault is probable, no mention is made of the magnitudes of each period of movement. What amount of offset is indicated by the faceted spurs and for how much of the total offset does this account? Adequate characterization of a fault or fault system requires description of the entire history of faulting. Assigning an initial age of formation does not sufficiently describe its age.

The same needs and concerns exist as outlined in Sec. 3.2.5.1 paragraph 6, previous comment.

3-15 Section 3.2.5.1 Faulting
Page 3-44, paragraph 7
Insufficient information is presented.

Vertical displacement on Shay graben is described, but no mention is made of a lateral displacement. The interpretation of this fault forming in response to left-lateral movement at depth indicates the likelihood of lateral displacement at the surface. Assuming two periods of movement (Laramide and Recent), what sense of motion did each period have? How do these relate to each other? Also, no mention is made of fault length, which is an important parameter for understanding and predicting fault behavior.

The same needs and concerns exist as outlined in Sec. 3.2.5.1 paragraph 6.

3-16 Section 3.2.5.1 Faulting
Page 3-41 to 3-47
Insufficient information presented.

No mention is made of the Imperial fault, which trends east-west, through the southern part of the Needles fault zone. This fault can be inferred, from mapped faults (Huntoon et al. 1982), to lie within a fault zone extending in excess of 40 km, with the eastern end about 9 km to the southwest of the repository operations area. This distance is only slightly less than that to Shay graben, which appears to be part of a more major structure, but the Imperial fault must still be assessed in terms of potential for seismic activity and adverse effects at the site.

3-17 Section 3.2.5.1 Faulting
Page 3-46, paragraph 9
Data allows a different interpretation.

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

The potential for fault movement in basement rocks underlying the site would have significant implications for repository performance, both with respect to ground motion and to deformation of the host rock. If displacement is taken up in the salt containing a repository, there may be greater potential for adverse effects than is indicated at the surface. More detailed determination of where and how faults die out should lead to better understanding of fault age and behavior.

3-18 Section 3.2.5.1 Faulting
Page 3-46, paragraph 10
Interpretation disagrees with other published literature.

Discussion of seismicity implied to be associated with the Colorado lineament indicates a narrow zone along the Colorado River, as is shown in Figure 3-23. Figure 3-22 indicates a somewhat wider zone than this and an average width of the lineament zone is given as 160 km in this paragraph. Brill and Nuttli (1983) indicate the possibility of seismic activity within

this zone where stress conditions are favorable. Ascribing seismicity to this feature suggests that favorable stress conditions exists. Features within this zone and parallel to it include the Lockhart fault and a mapped subsurface fault within 2 1/2 km of the repository operations area (Figure 3-20).

Movement of either of these faults could pose significant threats to repository performance. They must carefully be analyzed in order to determine their relation to the Colorado lineament and potential for reactivation.

3-19 Section 3.2..5.1 Faulting
Pages 3-41 to 3-47
Insufficient information is presented.

Very little attention is given to the Uncompahgre Uplift area. The southwest flank of this structure is approximately 70 km from the site area. This is more distance than other fault systems, but since this is a major structural discontinuity lying within the Colorado Plateau and could have implications of other, similarly oriented systems (i.e. the Paradox Fold and Fault Belt), it requires evaluation. Cater (1970) and Kirkham and Rogers (1981) report considerable movement associated with this structure during Pliocene and Pleistocene time, with a high probability that parts of it are active. This may indicate a greater seismic hazard than is normally ascribed to the area (for example, see Anderson and Miller, 1979).

Any faults or fault systems that might have implications of effects on repository performance need be characterized. Fault systems bounding the Uncompahgre Uplift are among the most significant in the Colorado Plateau. They require as close attention as is given to other fault systems in the region.

3-20 Section 3.2.5.1 (L) Faulting
Page 3-53, paragraph 1
Categories a and c.

The Lockhart fault is here described as a shallow feature possibly related to collapse of the Lockhart Basin. The cause of basin collapse is not clearly stated in the EA and the Lockhart Fault shown in Figure 3-20 extends beyond the areas of thinning of salt cycles 6 and 9 shown in Figures 3-15 and

3-16 respectively. The structure and tectonics of the Lockhart Basin requires expansion in the EA so that the significance of this feature can be adequately evaluated.

The last sentence of this paragraph states that alluvial deposits have been ponded on the basin side of the Lockhart fault but do not appear to be displaced by the fault. The locations where observations were made and their type (e.g. wash exposures, trenches, surface observations) need to be provided so that the reader can determine how the conclusions were reached.

3-21 Section 3.2.7.2 Hydrochemistry
Page 3-64, paragraph 2
Alternate interpretation of data.

This paragraph offers an interpretation of the trend in the chemistry of the groundwater in the upper hydrostratigraphic unit. However the final sentence indicates there are alternate interpretations discussed in McCulley et al. (1984). This is one of the publications which is currently unavailable, thus it is not possible to determine if the alternate interpretations are more conservative with regards to the long term storage of high level radioactive waste in this area.

3-22 Section 3.2.5.2 (L) Seismicity
Page 3-64, paragraph 3
Category c.

The microseismic swarm described in this paragraph and shown in Figure 3-24 defines a seismic zone at least 50 km long. Based upon an empirical total length-magnitude relationship developed by Slemmons (1981), a fault of this length could generate an earthquake of about Ms=6.6. An event of this size, potentially as near as about 20 km to the Lavender Canyon site would be of great significance. Additional data concerning this seismic zone is needed to allow the reader to determine the adequacy of the conclusions reached in the EA text.

3-23. Section 3.2.5.2 (L) Seismicity
Page 3-64, paragraph 3
Category c.

Data concerning magnitudes and sense of motion for earthquakes detected in the Shay Graben area and in the areas south and southwest of the Lavender Canyon site need to be presented so that the reader can determine how the conclusions presented in the EA were reached.

3-24 Section 3.2.5.2 (L) Seismicity
Page 3-65 (Figure 3-24, no paragraph no.)
Category c.

Known areal faults such as the Lisbon Valley fault and faults in the Shay Graben and related structures south and southwest of the Lavender Canyon site need to be added to Figure 3-24. This is necessary so that the reader may better envision the data and observe relationships so that it will be possible to determine if the conclusions in the EA are supported by available geologic and seismic data. The same statement is made with regards to Figure 3-22 of Davis Canyon EA.

3-25 Section 3.2.5.3 (L) Igneous Activity
Page 3-66, paragraph 1
Category c.

The basis for the presumption that the igneous rocks on Shay Mountain are of the same age as the rest of the Abajo Mountains needs to be presented so that the reader can determine how this conclusion was reached.

3-26 Section 3.2.5.4 (L) Uplift, Subsidence and Folding
Page 3-69
Category b.

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

3-27 Section 3.2.5.6 (L) Dissolution
Page 3-71, paragraph 2
Categories a and c.

Data suggesting that the Shay Graben is a possible dissolution feature is not presented in the EA. Seismic activity shown in Figure 3-24 and evident offsets of the Leadville limestone, a formation present beneath the Paradox salt sequence, along the boundary faults of the Shay Graben (Figure 3-33) supports the belief that the Shay Graben is of tectonic origin. Thus this paragraph disagrees with other published information and does not provide enough information to permit the reader to determine how this conclusion was reached. Other graben structures exist south and southwest of the Lavender Canyon site. Are these possible dissolution features and if so what is the significance of a dissolution zone about 50 km in length located within about 5 km of the Lavender Canyon site?

It is presumed that the reference to the Davis Canyon site in this paragraph is in error.

3-28 Section 3.2.8.2.2 Potash
Page 3-77, paragraph 2
Data allows a different interpretation.

Although Figure 3-25 is poorly reproduced it appears that the boundary for both the potentially economic potash deposits and the zero potash deposit are poorly constrained to the southwest and easily could include the Davis Canyon GRUA. This would increase the potential for economic potash extraction at or near both sites.

3-29 Section 3.2.7.2 (L) Hydrochemistry
Page 3-92, paragraph 3
Category c.

This paragraph is ambiguous as to whether the observed chemical separation in water quality is distributed vertically or laterally. If lateral separation is indicated, structural controls may be present. Not enough information is presented to allow the reader to determine how the conclusions were reached or their significance.

3-30 Section 3.2.9 (L) Soils
Page 3-129, paragraph 2
Category c.

The suitability of the Ignacio and Begay series soils for agriculture is not stated. This information is necessary to allow the reader to determine how the conclusions in this section of the EA were reached.

Site Specific Comments

Davis Canyon

3-31 Section 3.2.2.2. Erosion Process
Page 3-12, paragraphs 1 and 2
Not enough information.

This discussion on the erosion process is incomplete in that there is no discussion of mass wasting process and slope stability which could occur at and affect the site operation. Figure 5-2 shows the operations area to be against and beneath the mesa edge and thus it may be subject to rock falls or slides as a result of normal mechanical weathering processes or earthquakes.

3-32 Sections 3.2.3.2.6 to 3.2.3.2.12
Pages 31 to 33.
Conflicting Data

Adding up the estimated thicknesses of formations in the Davis Canyon Geologic Repository Operations Area does not give results consistent with the estimated tops of formations given in the text. Four different depths to the top of the Pinkerton Trail formation can be determined as indicated on the following table.

Formation	Estimated Stratigraphic Thickness (m)	Estimated Stratigraphic Top (m) (from text)	Calculated Stratigraphic top (m) (from thickness and or top)
Moenkopi Fm	9	Ground surface	
Organ Rock Fm	49	9	
Cedar Mesa SS	198	55	49 + 9 = 58
Elephant Canyon Fm	152	238	55 + 198 = 253 58 + 198 = 256
Honaker Trail Fm	335	390	253 + 152 = 405 256 + 152 = 408 238 + 152 = 390
Paradox Fm	792	741	405 + 335 = 740 408 + 335 = 743 390 + 335 = 725
Pinkerton Trail Fm	61	1509	740 + 792 = 1532 743 + 792 = 1535 725 + 792 = 1517 741 + 792 = 1553

While estimates to the top of the Pinkerton Trail formation vary from 1 m to 44 m (1509 vs 1553 m), this is not a reflection of uncertainties related to the estimated thickness and or tops, but is due to internal errors or inconsistencies in the estimation procedures.

3-33 Section 3.2.3.2.19 Ignacio Formation
Page 3-35, paragraph 1
Editorial comment.

Paragraph is out of place.

3-29 Section 3.2.5.1 Faulting
Page 3-42, paragraph 1
Incomplete data.

Only fault mentioned to occur in the Davis Canyon area is a seismically inferred fault in the Precambrian. Lack of data on type of fault, amount of offset, and orientation make it difficult to assess this fault with regards to the GKOA and the current regional stress field. Nor is it indicated how this fault is related, if at all, to the northeast striking subsurface fault shown crossing north of the Davis Canyon site in Figure 3-20.

3-35 Section 3.2.5.6 Dissolution
Page 3-56, paragraph 1
Conflicting Data.

Last sentence on page 3-56 states that relatively little dissolution is expected because the salt is overlain and underlain by relatively impervious carbonate strata. However, on p. 3-57 paragraph 2, the carbonate rocks are characterized as water-bearing.

Specific Side Comments

Lavender Canyon

3-36 Section 3.2.5.1 (L) Faulting
Page 3-53, paragraphs 2,3,4
Categories a and c.

Figure 3-20 shows the Sweet Alice Graben as part of the series of graben structures passing south of the Lavender Canyon site. Figure 3-25 links these features to form a northeast trending zone about 50 km in length. If this feature is a basement fault zone, it is of considerable significance to the Lavender Canyon site since features in Shay graben suggest Quaternary activity. If the south Shay fault represents a single rupture event along this fault zone, then a potential capability of about M = 6.5 is indicated using regression data provided by Bonilla (1967).

Characteristics of all the grabens south of the Lavender Canyon site need to be provided before the reader can determine how conclusions in the EA concerning seismicity were reached and whether these conclusions are supported by available data.

3-37 3.2.6.1 (L) Geomechanical Properties
Pages 3-73 through 3-87
Category c.

These pages are missing from the text. This information is needed so that the reader can determine if the conclusions presented in paragraph 3, page 3-72, are supported by the available data.

3-38 Section 3.2.9 (L) Soils
Page 3-127 (Figure 3-35, no paragraph no.)
Category c.

Figure 3-35 is missing from the text. This information is needed to allow the reader to determine how the conclusions in this section of the EA were reached.

3-39 Section 3.2.9 (L) Soils
Page 3-129 paragraph 3
Category a and c.

This paragraph conflicts with paragraph 1, page 3-129 wherein soils in the Lavender Canyon area are described as sparsely vegetated and formed on wind-blown deposits. The basis for the erosion rates presented needs to be provided so that the reader can determine how the conclusions presented were reached.

3-40 Section 3.2.8 (L) Mineral Resources
Pages 3-95 and 3-96 (Figure 3-28, no paragraph no.)
Category c.

Symbols on Figure 3-28 showing various resource locations are often illegible and very difficult to locate. The comment concerning Figure 3-10 also applies to Figure 3-28.

3-41 Section 3.2.8 (L) Mineral Resources
Pages 3-99 and 3-100 (Figure 3-30, no paragraph no.)
Category c.

The area of the Lavender Canyon Operations Area needs to be added to Figure 3-30 so that the reader can envision the area to be affected by land withdrawal and determine how the conclusions in the EA text were reached.

3-42 Section 3.2.8.2.1 (L) Uranium/Vanadium
Pages 3-111 through 3-122
Category c.

These pages are missing from the text. This information is needed so that the reader can determine if the conclusions presented in paragraph 2, page 3-108, are supported by the available data.

3-43 Section 3.2.8.2. (L) Potash
Page 3-124, paragraph 3
Category c.

Text is missing in this paragraph. This information is necessary so that the reader can determine how pertinent conclusions in the EA were reached.

3-44 Section 3.3.1.4 (L) Flooding
Pages 3-139 through 3-141
Category c.

Tables 3-7 through 3-9 on these pages are missing from the text. This information is needed to allow the reader to determine how the conclusions in the EA were reached.

3-45 Section 3.3.1.3 (L) Flooding
Page 3-142
Category c.

The implications of referenced Figure 3-38 are not discussed in the text. Figure 3-38 shows that nearly 1/3 of the Lavender Canyon site is within the 100 year flood-plain including much of the relatively level portion of the area. Potential erosion and effects upon potential repository development need to be discussed either here or in Chapter 5.

Chapter 4

General Comments

Plans in several areas appear to be inadequate to acquire the information necessary to characterize the sites and evaluate their seismo-tectonic stability. it should be recognized that these planned studies may identify the need for subsequent studies.

4-1 Section 4.1.1.1.8 Trench at Shay Graben
Page 4-26
Incomplete information.

The trench and seismic survey will provide information on the Shay Graben system. However, there appears to be little effort planned to investigate the other graben structures. There are many questions, especially with regard to their tectonic and seismic characteristics, which need to be answered. Their en echelon nature suggest they could be the surface expression of a very large east-west trending fault. It is suggested that additional geophysical and geological studies concentrate on the Salt-Creek and Bridger Jack structures to determine the regional significance of these structures.

4-2 Section 4.1.1.2.1. Seismic Lines
Pages 4-17 to 4-29
Tasks outlined probably will not provide the required data.

Adequate seismic lines may be planned, but this has not been demonstrated in the draft EA. Accurate descriptions of layouts appear to be given, but it would be cumbersome and time consuming for the reader to determine the extent of coverage.

A diagram indicating locations of the seismic lines relative to geologic structures and the GROAs would greatly facilitate evaluation of this section.

4-3 Section 4.2.2.3. Geologic Mapping
Page 4-32, paraghraph 3
Tasks outlined probably will not provide the required data.

The impression is given that there are plans for locating mines and prospects on geologic maps, but not preparing maps specifically of these features. Detailed mapping of them could provide valuable subsurface information. If such mapping projects are planned, it should be more clearly stated.

4-4 Summary Chapter 4
Subpart 1.(a), page 4-V, paragraph 1. (L)
Category c.

The figure number is missing. This information is needed to allow the reader to determine how the conclusions in the EA were reached and whether the summary list in this paragraph is correct.

4-5 Summary Chapter 4
Subpart 2, page 4-vii, paragraph 6. (L)
Category c

Considerable data has been omitted from this paragraph. This information is needed to allow the reader to determine how the conclusions in the EA were reached.

4-6 Section 4.1.1. (L) Field Studies
Page 4-7 (Figure 4-1, no paragraph no.)
Category c.

The scheduling for the geologic mapping phase of site characterization is not given. This is an important element of any characterization study and should occur early in the program. This information is needed to allow the reader to envision the proposed scope of studies and determine how the conclusions in the EA were reached.

4-7 Section 4.1.1.1 (L) Geologic and Hydrologic Studies
Page 4-8, paragraph 1, page 4-100, paragraph 3, and Page 4-V, Subpart 1. (a).
Category a, c, e, f

Data in these paragraphs concerning number of boreholes and sites required conflict.

Page 4-8 "47 deep boreholes at 27 locations."
Page 4-100 "76 boreholes at 26 sites" (in excess of 100 m and therefore "deep" in engineering geologic terms)
Page 4-v "Major boreholes (deep), 57 (21 sites)"

A description of the phasing of subsurface exploration is missing from the Chapter. The impression given is that no more than one deep borehole will be underway at a given time, but in view of the magnitude of the effort required and the limited time in which it must be completed this is clearly unrealistic. Some overlaps between types of borings, particularly between months 7 and 26 are evident from Figure 4-1 but it is not stated how many of a given type of boring, e.g. Lower Hydrostratigraphic Unit Test Wells, may be underway at the same time. This data is needed in order to evaluate the adequacy of the exploration program, e.g. potential for iteration within it, and the potential environmental effects.

No figures are included that show the planned locations of the Site Characterization Borehole (EDBH) as of the Upper Hydrostratigraphic Unit Test Wells. Text references are to Figures 4-3 and 4-4 but these holes are not shown on those figures. This information is needed to allow the reader to envision the exploratory program and determine how pertinent conclusions in the EA were reached.

4-8 Section 4.1.1.1.1 (L) Engineering Design Borehole
Page 4-12, Location and Access paragraph
Category c and e.

Data is missing from this paragraph. This information is necessary to allow the reader to determine how the conclusions in the EA were reached.

4-9 Section 4.1.1.1.2 (L) Stratigraphic Confirmation Boreholes
Page 4-16, paragraph 3
Category c, e and f.

The text states that the locations of four stratigraphic confirmation boreholes (SC-1,2,3,4) are shown on Figure 4-4. No SC-series holes appear on Figure 4-4. This information is needed to allow the reader to envision the site exploratory program in order to determine adequacy, cumulative environmental effects, and determine how the conclusions in the EA were reached.

4-10 Section 4.1.1.1.2 (L) Stratigraphic Confirmation Boreholes
Page 4-17 (Figure 4-4, no paragraph no.)
Category c, e and f.

As noted above data is missing from this figure. Also, a separate figure limited to the Lavender Canyon site and immediate vicinity (scale 1"24,000 of larger) would be appropriate in order to show the EDBH and other planned on-site drilling. This would allow the reader to easily envision the exploratory program for the site itself in order to determine adequacy, cumulative environmental effects, and determine how the conclusions in the EA were reached.

4-11 Section 4.1.1.1.2 (L) Stratigraphic Confirmation Boreholes
Page 4-18 (Figure 4-4, no paragraph no.)
Category c and f.

Are boreholes LB-1 and LB-2 the Lockhart Basin borings referred to on page 4-16? If so this should be made clear in the text. This information is needed to allow the reader to envision the scope of the exploration program in order to determine its adequacy and how the conclusions in the EA were reached.

4-12 Section 4.1.1.1.4 (L) Upper Hydrostratigraphic Unit Test Wells
Page 4-20, paragraph 5, page 4-21, paragraph 1
Category c, e, and f.

Locations of these well groupings cannot be identified on any figure in the EA. They are not shown on referenced Figure 4-4. It is unclear from the text how tests will be performed, for instance will the same zone be tested at different locations; will different zones be tested; why is there only one hole at site 6? What will be the fate of the abandoned wells? This information is needed to allow the reader to determine how the conclusions in the EA were reached, what the environmental impacts may be and whether the planned program will provide the required data.

4-13 Section 4.1.1.1.5 (L) Lower Hydrostratigraphic Unit Test Wells
Page 4-21, paragraph 3
Category c and e.

What will be the fate of the abandoned wells?

This information is needed to allow the reader to assess potential environmental impacts and to determine how the conclusions in the EA were reached.

4-14 Section 4.1.1.1.6 (L) Foundation Borings
Page 4-23, paragraph 4, page 4-24, paragraph 1
Category c, e, and f.

Phasing of this work is unclear. Many of these boreholes are clearly intended for engineering design data and may be deferred until the licensing phase. Others are needed to determine conditions at potential safety-related structure locations and are appropriate parts of site characterization. Phasing for this work needs to be clarified. The borings along the railroad tunnels beneath Canyonlands and Needles overlooks (see Chapter 5) need special attention since the feasibility of tunneling in these areas must be carefully determined because of safety issues relative to waste transport and because of environmental impacts of rail activities in scenic areas. Detailed plans are needed to allow the reader to determine how conclusions in the EA were reached, potential environmental impacts of site characterization and repository development and to assess adequacy of the exploration program.

4-15 Section 4.1.1.1.7 (L) Hydrologic and Geologic Boreholes and Champlin Borehole
Page 4-24, paragraph 2
Category f.

No exploration is listed for the Salt Creek and Bridger Jack Grabens which are located closer to the Lavender Canyon site than are Lockhart or Beef Basins. On Chapter 3 these are identified as en-echelon with Shay Graben, a suspected dissolution feature. Studies of subsurface conditions within Salt Creek and Bridger Jack grabens appear to be an essential part of any Site Characterization activities for the Lavender Canyon site.

4-16 Section 4.1.1.1.7 (L) Hydrologic and Geologic Boreholes and Champlin Borehole
Page 4-25, paragraph 2
Category c, e and f.

A drawing showing how these holes will be completed is necessary in order to allow the reader to determine how pertinent conclusions in the EA were reached, what environmental impacts may arise and whether the monitoring system will be adequate for its intended use.

4-17 Section 4.1.1.1.7 (L) Hydrologic and Geologic Boreholes and Champlin Borehole
Page 4-25, paragraph 5
Category c and f.

The reasons for the hydraulic fracturing experiments described in this paragraph are not given and their pertinence to the Site Characterization effort is not evident based on the information presented. This information is necessary to allow the reader to determine the adequacy and need for the planned tests, to assess any environmental impacts arising from them and to determine how the conclusions in the EA were reached.

4-18 Section 4.1.1.1.8 (L) Trench at Shay Graben
Page 4-28, paragraph 1
Category f.

The proposed work schedule does not allow sufficient time for a field review by NRC staff or consultants. Such review is an established part of seismic hazards investigations.

4-19 Section 4.1.1.1.8 (L) Trench at Shay Graben
Page 4-28, following paragraph 2
Category f.

In view of the distribution of faulting and microseismicity reported in Chapter 3, trenching studies in other grabens south and southwest of Shay Graben are necessary to adequately understand these features. A section outlining and describing this work needs to be inserted in the EA.

4-20 Section 4.1.1.2.1 (L) Seismic Lines
Page 4-29, paragraph 5
Category f.

This paragraph needs to be expanded to include geophysical studies in other grabens near the Lavender Canyon site. Specific locations include Salt Creek Graben, Bridger Jack Graben, and Sweet Alice Graben.

4-21 Section 4.1.1.2.3 (L) Seismic Network
Page 4-31 (Figure 4-5, no paragraph no.)
Category c and f.

The location of the Lavender Canyon site should be shown on the drawing to allow the reader to determine how pertinent conclusions in the EA were reached. As a preliminary assessment, the network shown does not appear to include enough stations south of Lavender Canyon to provide adequate regional monitoring.

4-22 Section 4.1.1.3 (L) Geologic Mapping
Page 4-33, paragraph 1, following paragraph 4.
Category f.

Faults are not included in the list of items to be mapped given in this paragraph. Faults must be carefully mapped, evaluated with improved natural exposures wherever possible and included in trenching studies if Quaternary movements are suggested. A methodology for fault mapping needs to be included in this section either preceding or following the last paragraph on the page.

4-23 Section 4.1.2 (L) Exploratory Shaft
Page 4-35, paragraph 2
Category e and f.

No tests using spent fuel or radiation sources simulating fuel and other wastes are listed. How will the effects of radiation on the stability of the salt be determined and how will attendant environmental impacts, if any, be assessed?

4-24 Section 4.1.2 (L) Exploratory Shaft
Page 4-36 (Figure 4-6, no paragraph no.)
Category c and e.

This figure is omitted. Without it insufficient information exists to allow the reader to determine how pertinent conclusions in the EA were reached and what environmental impacts, if any, may exist.

4-25 Section 4.1.2.2.2 (L) Shaft Drilling
Page 4-50, paragraph 5
Category c and e.

Disposal of salt-contaminated water into a deep aquifer has the potential to result in aquifer pollution and could induce seismicity based upon recent experiences in the Colorado Plateau region, e.g. Rangely Field. A thorough discussion of water quality in the proposed disposal aquifer and of the potential for induced seismicity is required so that the reader can assess potential environmental impacts and determine how pertinent conclusions in the EA were reached.

4-26 Section 4.1.2.2.3 (L) Initial Underground Excavation
Page 4-55, paragraph 3
Category c.

What salt conditions could be anticipated that would make use of a continuous miner impractical? How would their presence affect the feasibility of a nuclear waste repository at the Lavender Canyon site? Insufficient information is presented to allow the reader to determine how the conclusions were reached.

4-27 Section 4.1.2.3 (L) Testing
Page 4-56, paragraph 2
Category f.

An eight month testing period is envisioned. How will a period this short produce adequate data on long-term geomechanical effects, radiation effects and movement of brines in the salt given the very low anticipated flow rates?

4-28 Section 4.1.2.3.2 (L) At-Depth Testing
Page 4-56, paragraph 5
Category f.

Tests using spent fuel or radiation sources simulating such fuel and other radioactive materials planned to be placed in the repository need to be included. Also test package prototypes (or proposed packages) need to be tested under actual repository conditions.

4-29 Section 4.1.2.4.4 (L) Storage Area and Mud Pit Reclamation
Page 4-62, paragraph 3
Category c.

Data is missing in this paragraph. This information is needed to allow the reader to determine how the pertinent conclusions in EA were reached.

4-30 Section 4.2.1.1.1 (L) Geologic Field Studies
Page 4-82, paragraph 5
Category c and e.

Data is missing in this paragraph and it is therefore not possible to determine if the conclusions reached are supported by the actual data.

4-31 Section 4.2.1.1.2 (L) Exploratory Shaft
Page 4-84, paragraph 4
Category e.

It is noted that revegetation of the exploratory shaft site may require several decades. Presumably this situation would apply to major exploratory hole locations and trench sites as well. The cumulative erosion risk could be significant, but is not discussed in the EA.

4-32 Section 4.2.1.2.1 (L) Terrestrial Biota
Page 4-87, paragraph 3
Category c and e.

The statement is made that crusting is known to reduce emission levels from salt storage piles to negligible levels. The source of this data is not given. This comment applies to several other locations in the EA as well. The source of the data is needed so that the reader can determine how this conclusion was reached.

4-33 Section 4.2.1.5 (L) Effects on Soils, Geology and Paleontology
Page 4-102, paragraphs 2, 3, 4, page 4-104, paragraph 1
Category c and e.

Data is missing from paragraphs 2 and 4 on page 4-102 and from the paragraph on page 4-104. Paragraph 3 on page 4-102 states that the effects of accelerated wind erosion during construction have not been evaluated. Not enough information is given therefore to allow the reader to determine likely impacts and how the conclusions presented in the EA were reached.

4-34 Section 4.2.1.8.2 (L) Deep Hydronests
Page 4-115, paragraph 4
Category c.

The word hydronest, does not appear in the Glossary of Geology, Second Edition. This glossary is the generally accepted standard for professional geologic usage. It is not therefore a term in professional use and should not appear in a formal document. An acceptable professional term should be substituted so that readers can determine what is being discussed and how pertinent conclusions in the EA were reached.

4-35 Section 4.2.1.9 (L) Effects on Radiological Levels
Page 4-117, paragraph 3
Category c, e and f.

Since no radioactive wastes or waste simulators are planned to be used during testing, radiological impacts will not be evaluated. This data is needed to determine such effects if any on repository stability.

Site Specific Comments

Davis Canyon

4-36 Section 4.1.1.1.2 Stratigraphic Conformation Boreholes
Page 4-16,19, paragraphs 4 through 7
Missing Data

Sites of SC-1 to SC-4 are not shown on Figure 4-4.

Chapter 5

General Comments

5-1 Section 5.1.1.1 (L) Waste Handling and Packaging Facility
Page 5-9 (Figure 5-2, no paragraph no.)
Category c and e.

The figure is at too small a scale to be legible. Pertinent natural features including steep slope areas, talus accumulations and the 100 year flood plain are not shown. This information is needed to permit evaluation of the environmental impacts and to allow the reader to determine how pertinent conclusions in the EA were reached.

5-2 Section 5.1.3.1.1 (L) Construction Schedule and Personnel
Page 5-18, paragraph 4
Category c and e.

According to Chapter 4 a backfilled exploratory shaft and system of partly backfilled test adits will exist at the site when construction and repository operations begin. How will these facilities be incorporated in the final design and what impacts may these have on operations and radionuclide migration? Could these facilities be incorporated in the final repository design and used in some manner during operations?

5-3 Section 5.1.3.1.3 (L) Onsite Development
Page 5-25, paragraph 6
Category c and e.

Does a positive net evaporation rate exist during all months of the year at the Lavender Canyon site? If not, how much capacity will be required to safely contain excess run-off during periods when precipitation exceeds evaporation? This information is needed to allow the reader to assess potential environmental impacts and to determine how the conclusions in the EA were reached.

5-4 Section 5.1.3.2 (L) Repository Operation Activities
Pages 5-33, paragraph 2 and 5-34, paragraph 2.
Category a and e.

These two paragraphs disagree on future salt disposal. On page 5-33 disposal at the Bonneville salt flats is mentioned. On page 5-34 disposal through SPR facilities is described. Elsewhere in the EA the SPR option is generally cited. Alternative means of salt disposal need to be evaluated thoroughly in parallel and advantages/disadvantages of each examined. Potential impacts of excess salt generated by the repository then need to be evaluated using the preferred method of disposal.

5-5 Section 5.1.3.4.3 (L) Active Monitoring
Page 5-45, paragraph 2
Category c, e and f.

A plan needs to be included to show how monitoring activities will continue from the Site Characterization phase through the construction phase and during repository operations. Such monitoring is necessary for recognition of anomalies as these appear. The plan is necessary so that the reader can determine how the conclusions in the EA were reached and whether an effective monitoring system will be in place and operating during construction and operational phases.

5-6 Section 5.2.1 (L) Geologic Conditions
Page 5-46, paragraphs 2, 3, 4, page 5-47, paragraphs 1, 2
Category b, c, and e.

The discussion of potential subsidence/uplift presented in these paragraphs is inadequate. It appears to be based upon two uncoupled models, one for subsidence, the other for thermally induced uplift. The discussion does not consider time factors, e.g. subsidence will follow mining activities, thermal uplift will come into play as waste is entombed. The effects of differential stresses both in time and space receive no consideration.

Before the reader can assess potential impacts arising from repository excavation followed by waste emplacement, a coupled model simulating the entire process is required. More detailed models of key areas and critical time periods must then be generated before adequacy of information and potential environmental impacts can be assessed.

5-7 Section 5.2.1 (L) Geologic Conditions
Page 5-47, paragraph 4
Category c and e.

The Salt Creek and Bridger Jack Grabens are similar to the Shay Graben and are located closer to the Lavender Canyon site than any of the other features described. Investigations of these structures are required before potential impacts can be assessed and the adequacy of conclusions reached can be determined.

5-8 Section 5.2.1.1.2 (L) Decommissioning and Closure
Page 5-52, paragraph 3
Category c and e.

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

5-9 Section 5.2.2.1 (L) Surface Water
Page 5-55, paragraph 1
Category c and e.

Conceptual repository designs need to be evaluated against the 100-year flood hazard in order to detect possible environmental impacts arising from flooding. A map showing the conceptual repository design with the 100 year flood plain superimposed is needed so that the reader can evaluate effects and determine how conclusions in the EA were reached.

5-10 Section 5.3.2.2 (L) Railroads
Page 5-108, following paragraph 4
Category c and e.

Text is missing following paragraph 4. Key geotechnical issues include the anticipated stability of proposed tunnels beneath Canyonlands and Needles overlooks, stability of slopes elsewhere along the alignment and potential environmental hazards arising from accidents caused by tunnel or slope failures. Not enough information is available to allow the reader to evaluate potential impacts or to determine how pertinent conclusions in the EA were reached.

5-11 Section 5.5 (L) Summary
Page 5-139 through 5-141, Subpart. 2.
Category c.

These paragraphs refer to the Davis Canyon site. They are presumed to have been inserted in error.

Chapter 6

General Comments

Much of the information necessary to access the suitability of the site will be collected during the site characterization phase. Some specific comments of concern are given below.

6-1 Section 6.3.1.b.2 Evaluation (Dissolution)
Page 6-159, paragraph 3 and page 6-160 paragraph 2
Unavailable reference.

A report on four seismic reflection lines is referenced by Kitcho, 1984. This report is currently unavailable. Thus we are unable to review seismic data with regards to salt dissolution along Shay/Bridger Jack/Salt Creek Graben systems and within site. Seismic surveys appear to be only subsurface data available at or near Davis Canyon GRUA. This data should be made available.

6-2 Section 6.3.1.6.2 Evaluation (Dissolution)
Page 6-159, paragraph 4
Unavailable data.

This paragraph discusses the use of borehole geophysical logs to identify dissolution within the site. In this paragraph the four holes which were used in addition to GD-1 are not identified. The types of geophysical logs run in the holes are not identified, nor is there a reference to the data.

6-3 Section 5.3.1.7.2 Evaluation Process
Page 6-158, paragraph 7
Information presented in Chapter 3 will allow a different interpretation.

The EA states "... a conservative estimate for a peak horizontal acceleration for design purposes would be 0.25 g." No basis for this figure is given, leaving it unclear as to where this value was derived. It is agreed that further analysis is necessary to determine if this is indeed a conservative estimate. The design earthquake has not been attributed to a single source or source area. However, it is probable that Shay Graben will be this source. Attenuation relations presented by Seed and Idriss (1982) indicate an earthquake of $M \sim 6$ on this fault could generate 0.25 g at the site. It is possible that an earthquake of $M > 6$ could occur on this fault and that, as a result, 0.25 g might not be a conservative value.

Evaluation of magnitudes and source areas that could produce the strongest ground motions at the site are needed to assess the potential for adverse effects due to seismic events. Characterization of any faults that could potentially cause adverse conditons at the site is needed. Fault or fault zone parameters such as lengths, displacements, ages, and timing and sense of movements should be presented and maximum credible earthquakes calculated. Attenuations needed also be assessed and included as they may be lower in the Colorado Plateau than in most of the Cordillera, possibly resulting in stronger ground motions at farther distances from the source.

6-4 Section 6.3.1.7.3. Analysis of Favorable Conditions
Page 6-161, paragraph 8, Seismicity
Information presented in Chap. 3 will allow a different interpretation.

Although not stated directly, it is implied that since there have not been historical seismic events of magnitude greater than 4 to 5, then they should not be expected to occur in the future. The presence of past surface ruptures indicates the probability of occurrences of larger events than those from the historical record.

The same needs and concerns exist as outlined in comments on Sec. 6.3.1.7.2.

6-5 Section 6.3.1.7.4. Analysis of Potentially Adverse Conditions
Page 6-161, paragraph 4, Faulting
Information presented in Chap. 3 will allow a different interpretation.

That Shay Graben "could be a source of small nearby earthquakes that would not threaten repository performance" seems to be a premature, and perhaps, invalid, conclusion. No information is presented showing what size of seismic events could be expected to be generated by movement on this fault.

The same needs and concerns exist as outlined in comments on Sec. 6.3.1.7.2.

6-6 Section 6.3.1.7.4. Analysis of Potentially Adverse Conditions
Page 6-162, subheading (3)
Information presented in Chap. 3 allows a different interpretation.

This subheading questions whether the historical record is representative of what can be expected in the future. As discussed in Sec. 3.2.5.2 and other locations, the historic record is quite inadequate. There appears to be no basis to state with confidence that "No evidence indicates greater frequency or magnitudes of earthquakes in the recent geologic past". The presence of apparently active faulting nearby indicates the opposite. While this does not necessarily indicate an "anomalously" low level of activity is now occurring, fluctuations in activity can be expected and periods of greater seismic activity are probable. These periods may not pose a threat to repository performance, but that remains to be proven.

The same needs and concerns exist as outlined in comments on Sec. 6.3.1.7.2.

6-7 Section 6.3.1.7..4 Analysis of Potentially Adverse Conditions
Page 6-169, paragraph 2
Inconsistent data.

In this paragraph the distance to the nearest Quaternary volcanism is 138 kilometers. In Section 3.2.5.3. on page 3-52, paragraph 4, this distance is given as 127 kilometer. This will affect a future readers confidence in the EA.

6-8 Section 6.3.3.4.2. Evaluation Process
Page 6-2011, paragraph 7
Information presented in Chap. 3 will allow a different interpretation.

The same comments, needs, and concerns exist as outlined in comments on Sec. 6.3.2.7.2.

6-9 Section 6.3.3.4.3. Analysis of Favorable Conditions
Page 6-203, paragraph 3
Interpretation disagrees with other published literature.

A distance to Shay graben is given as approximately 16 km. Maps such as Huntoon, Billingsley, and Breed (1982) indicate a distance that is somewhat less than this. The distances to possible sources of seismicity are crucial to determination of seismic hazard potential. An exact distance to the closest point of the fault should be given.

6-10 Section 6.3.3.4.3. Analysis of Favorable Condition
Page 6-203, paragraph 3
Insufficient information is presented.

The length of Shay graben is given as 40 km. However, this fault appears to be part of a much longer fault system. It can not be assumed that Shay graben will behave independently of other faults in this system. A fault system contains the potential for producing stronger ground motions than any single fault within that system behaving independently. An assessment of the entire fault system is required.

6-11 Section 6.3.3.4.4. Analysis of Potentially Adverse Condition
Page 6-204, paragraph 6, subheading (3)
Information presented in Chap. 3 allows a different interpretation.

The same comments, concerns, and needs exist as outlined in comments on Sec. 6.3.1.7.4, Subheading (3).

6-8 Section 6.3.1.7.4. Analysis of Potentially Adverse Conditions
Page 6-169, paragraph 6
Data allows a different interpretation.

Based on the historical seismic record and current microearthquake monitoring the largest earthquake predicted for the Paradox Basin is M_l 4 to 5. However, based on length of the Shay Graben faults an earthquake of M_l 7 (LLNL - Draft Technical Position on the Gibson Dome Waste Isolation Project) may be possible. This may have a significantly larger effect on the GROA, and should be considered in the seismic analysis.

Site Specific Comments

Lavender Canyon

All site references in Chapter 6 are to Davis Canyon or to Davis or Lavender Canyons. No specific references to Lavender Canyon were noted. This chapter needs to be revised so that a Statutory Environmental Assessment will exist for Lavender Canyon.

References

Anderson, L.W. and Miller, D.G., 1979, Quaternary fault map of Utah; FUGRO, INC., Consulting Engineers and Geologists, Long Beach, CA.

Brill, K.G. and Nuttli, O.W., 1983, Seismicity of the Colorado lineament; Geology, v. 11, #1, pp. 20-24.

Cater, F.W., Jr., 1970, Geology of the salt anticline region in southwestern Colorado; U.S. Geol. Survey Prof. Paper 637.

Huntoon, P.W., Billingsley, G.H., Jr., and Breed, W.J., 1982, Geologic map of Canyonlands National Park and vicinity, Utah; The Canyonlands Natural History Association, Moab, UT.

Kirkham, R.M., and Rogers, W.P., 1981, Earthquake potential in Colorado, a preliminary evaluation; Colorado Geological Survey Bull. 43.

Seed, H.B., and Idriss, I.M., 1982, Ground Motions and Soil Liquefaction During Earthquakes; Earthquake Engineering Research Institute, Berkeley, CA.