Weston Geophysical CORPORATION

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Mr. Benjamin J. Rice, Project Manager
Geotechnical Branch
Division of Waste Management
Office of Nuclear Material Safety
& Safeguards
NUCLEAR REGULATORY COMMISSION
Washington DC 20555

Dear Mr. Rice:

We have completed Task order 003, which consisted of reviewing DOE Draft Environmental Assessments for the Basalt Waste Isolation Project; Nevada Nuclear Waste Storage Investigations; and salt sites at Cypress Creek, Vacherie, and Richton Domes, Davis and Lavender Canyon, and Deaf Smith and Swisher Counties.

Our report under the above Task Order No. 003 is enclosed.

Very truly yours,

WESTON GEOPHYSICAL CORPORATION

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TASK 003

REVIEW OF DRAFT ENVIRONMENTAL ASSESSMENTS

OF

RICHTON DOME, PERRY COUNTY, MISSISSIPPI
PALO DURO BASIN, SWISHER COUNTY, TEXAS
CYPRESS CREEK DOME, PERRY COUNTY, MISSISSIPPI
BASALT WASTE ISOLATION PROJECT [BWIP], WASHINGTON
VACHERIE DOME SITE, WEBSTER & BIENVILLE PARISHES, LOUISIANA
NEVADA NUCLEAR WASTE STORAGE INVESTIGATIONS [NNWSI], YUCCA MOUNTAIN
DAVIS CANYON AND LAVENDER CANYON, PARADOX BASIN SITE, SAN JUAN COUNTY, UTAH

Prepared for

THE NUCLEAR REGULATORY COMMISION

SEPTEMBER 1984

Weston Geophysical
CORPORATION

RICHTON DOME, PERRY COUNTY, MISSISSIPPI

OVERVIEW

The geologic setting of the Richton Dome appears to be fairly well understood, although there are important features requiring further analysis. Internal structure of the dome is not well known and this results in several items of concern. Faults in the area, F-9 and F-7 faults, require further analysis and should be evaluated during characterization activities. In addition, potentially young faults are identified and their ages should be verified. The DOE has also identified the evaluation of apparently anomalous rates of uplift, determined geodetically, as a characterization task. The source of saline anomalies near the site is also targeted for characterization activities. Internal structure, flow characteristics through the dome, in situ stress, and response to thermal expansion are all topics which require further assessment.

CHAPTER 3

The regional and site geological/geophysical studies to date have resulted in an understanding of the geologic setting of the Richton Dome, but the studies have also discovered features and indicated topics which need further evaluation. Potentially young faults have been mapped over the dome. Extent, mechanism and age of latest movement need to be determined for these faults. Additional faults within the site area, F-9 and F-7 faults, should be confirmed and attributes determined. The Philips fault is postulated near the site area with uncertain extent, this fault should be addressed during the regional site characterization studies. In situ stress data are necessary to evaluate how the dome will respond to excavation and thermal expansion, particularly how the physical changes in the dome may be affected by the presence of faulting.

The hydrogeologic setting is known only in a regional sense; the monitoring during site characterization is necessary to determine actual flow characteristics in and around the dome. Saline anomalies are present and

require complete evaluation. Because flow from the aquifer adjacent to the repository horizon does leak upward, the anomalies in the upper freshwater aquifer may be due to leakage from the aquifer adjacent to the repository horizon.

CHAPTER 6

Because the state of knowledge about actual conditions in the dome is incomplete, most of the conclusions regarding integrity and environmental effects are more appropriately stated with expected results. Flow to the accessible environment, for example, is dependent upon only theoretical considerations. If actual flow is drastically different then many of the subsequent conclusions are in doubt. The same holds true for environmental effect on groundwater and effects on geology. Until the level of knowledge is raised, most conclusions can only be based on extrapolated data.

CHAPTER 5

As noted for Chapter 6, there are uncertainties regarding fluid flow and the effects of siting a repository at Richton Dome. In addition, there may be some effect on the upper freshwater aquifer. Richton Dome has affected geomorphology over the dome as evidenced by the radial drainage pattern, and leakage of brine into the upper aquifer is documented. Differential thermal expansion of the dome may affect surface topography and surface hydrology as well as opening fractures in the aquitard beneath the upper freshwater aquifer allowing greater brine contamination. Therefore, even if the derived rates of flow to the accessible environment are proven, which they may be, and no radio nuclides reach the accessible environment, brine contamination of the regional freshwater source may result.

CHAPTER 4

Site characterization activities planned for the Richton Dome appear to be suitably extensive to address many of the open-ended issues. Although a detailed plan is not included, presumably the regional seismic coverage will be designed to evaluate the F-9, F-7, and Philips faults. It might be appropriate

to acquire some the the gravity data in the site area along the 3-D seismic grid. This grid will be surveyed and cleared anyway and acquiring the gravity data over the same lines as the seismic will enable a closer correlation between techniques and assure a higher confidence level in the results. In addition, in-hole seismic data [VSP, crosshole, downhole/uphole] could be acquired in the EDBH to provide greater detail on internal structure and engineering properties of the dome.

UMBRELLA SITE TECHNICAL PLAN - [STP] - SALT SITES [06/26/84]

Although not site specific, the USTP does address, generally, the areas of concern at Richton Dome. Most of the itemized concerns in the USTP are addressed in the draft EA or included in the comments above.

PALO DURO BASIN, SWISHER COUNTY, TEXAS

OVERVIEW

The broad scale, regional geologic setting of the Swisher County site is presented and seems to be fairly well understood. However, there are no site specific data available at this time. Any geologic, hydrogeologic or environmental conclusions can only be assumed because all conditions are extrapolated into the site. Until data are acquired on site and immediately surrounding the site, few definitive conclusions can be reached concerning structure within and adjacent to the site, actual thickness of repository horizon at the site, groundwater flow characteristics at the site, in situ stress regime at the site, and how all of these may interact or be affected by excavation of the repository and by thermal expansion of the horizon after emplacement of the waste.

CHAPTER 3

As stated in the overview, little is known directly about the geology at the site itself. Regional stratigraphic data are extrapolated through the site, yet the structure contour and isopach maps also show stratigraphic anomalies based on single or few points in a small area. This could be the case here. To be fair, DOE does admit that because of the distribution of data points, structures in the site area, similar to known structures elsewhere could be undetected with the present data base. An additional point regarding the structure contour maps is that structure [faults] should be shown on the maps to illustrate how the faults are indicated in the contours.

The lack of site data also impacts any evaluation of hydrogeology, repository horizon integrity, effects of thermal expansion, and dissolution of the host or adjacent intervals. Even though in situ stress data have been determined based on hydrofracturing tests, these results are anomalous in the region and therefore cannot be termed definitive until the anomalous character is evaluated.

CHAPTER 6

Because most of the conclusions are based on extrapolated regional data, not site specific data, conclusions are interpretive and, at best, expected conclusions. Many of requriements cannot be definitively answered with the present level of knowledge.

CHAPTER 5

Stated affects on the environment, geology and hydrology can only be expected at this point. Insufficient data are available at the site to completely evaluate potential effects of repository siting at this location.

CHAPTER 4

Site characterization activities planned for the Swisher County site are relatively extensive. Detailed information need in the site area should be acquired with this program. In-hole seismic [VSP, cross-hole, uphole/downhole] may be appropriate in the EDBH for detailed evaluation of structure and engineering properties of the host rock. The plan states that regional seismic data will be acquired, but line locations are not noted. These lines should be located to assess regional structure which may impact the site, for example the NW-SE trending faults west of the site. Gravity data acquisition is mentioned in general terms only. Gravity data may help in regional evaluation of basement structures and how they may impact the overlying sedimentary rocks.

UMBRELLA SITE TECHNICAL POSITION [USTP] - SALT SITES [06/26/84]

The salt site USTP appears to be sufficiently thorough for the Swisher Site, despite the fact that the USTP is not site specific. Some of the regional issues raised by the USTP have been addressed in the Swisher County draft EA, but because site specific data are not available, many issues in the USTP are only addressed by extrapolation of regional data into the site area.

CYPRESS CREEK DOME, PERRY COUNTY, MISSISSIPPI

OVERVIEW

The structural setting and character of the Cypress Creek Dome appear to be fairly well understood. There are, however, several aspects of the site which warrant further analysis. Postulated faulting near the site, F-9 and F-7 faults, will persumably be addressed during the regional programs for site characterization. The DOE has identified the evaluation of apparently the anomalous rates of uplift, determined geodetically, as an appropriate task; as well as the need to determine the source of saline anomalies near the site.

Internal structure, flow characteristics through the dome, in situ stress and response to thermal expansion are all topics which require further assessment.

CHAPTER 3

The regional and site geological/geophysical strudies to date have resulted in an understanding of the geologic setting of the Cypress Creek Dome, but the studies have also discussed features and indicated topics which need further evaluation. Faults within the site area, F-9 and F-7 faults, should be confirmed and attributes determined. The Philips fault is postulated near the site area with uncertain extent, this fault should be addressed during the regional site characterization studies. In situ stress data are necessary to evaluate how the dome will respond the excavation and thermal expansion, particularly how the physical changes in the dome may be affected by the presence of faulting.

The hydrogeologic setting is known only in a regional sense; the monitoring during site characterization is necessary to determine actual flow characteristics in and around the dome. Saline anomalies are present and require complete evaluation. Because flow from the aquifer adjacent to the repository horizon does leak upward, the anomalies in the upper freshwater aquifer may be due to leakage from the aquifer adjacent to the repository horizon.

CHAPTER 6

Because the state of knowledge about actual conditions in the dome is incomplete, most of the conclusions regarding integrity and environmental effects are more appropriately stated with expected results. Flow to the accessible environment, for example, is dependent upon only theoretical considerations. If actual flow is drastically different then many of the subsequent conclusions are in doubt. The same holds true for environmental effect on groundwater and effects on geology. Until the level of knowledge is raised, most conclusions can only be based on extrapolated data.

CHAPTER 5

As noted for Chapter 6, there are uncertainties regarding fluid flow and the effects of siting a repository at Cypress Creek Dome. In addition, there may be some effect on the upper freshwater aquifer. Differential thermal expansion of the dome may affect fractures in the aquitard beneath the upper freshwater aquifer allowing greater brine contamination. Therefore, even if the derived rates of flow to the accessible environment are proven, which they may be, and no radius nuclides reach the accessible environment, brine contamination of the regional freshwater source may result.

CHAPTER 4

Site characterization activities planned for the Cypress Creek Dome appear to be suitably extensive to address many of the open-ended issues. Although a detailed plan is not included, presumably the regional seismic coverage will be designed to evaluate the F-9, F-7, and Philips faults. It might be appropriate to acquire some the the gravity data in the site area along the 3-D seismic grid. This grid will be surveyed and cleared anyway and acquiring the gravity data over the same lines as the seismic will enable a closer correlation between techniques and assure a higher confidence level in the results. In addition, in-hole seismic data [VSP, crosshole, downhole/uphole] could be acquired in the EDBH to provide greater detail on internal structure and engineering properties of the dome.

UMBRELLA SITE TECHNICAL POSITION - [STP] - SALT SITE [6/26/84]

Although not site specific, the Umbrella Site Technical Position [USTP] does address the areas of concern at the Cypress Creek site. Most of the itemized concerns are addressed in the draft EA, while the concerns noted above and by DOE for site characterization are also covered by the salt site USTP.

DAVIS CANYON AND LAVENDER CANYON, PARADOX BASIN SITE, SAN JUAN COUNTY, UTAH

The two sites in the Paradox Basin are located in adjacent canyons and are only a matter of 2 to 3 miles apart. In addition, the environmental assessments for the two sites are essentially identical. Therefore, this review treats the two sites as basically the same. Where necessary, appropriate distinctions between the two sites are noted.

OVERVIEW

The regional geologic setting for these two sites is relatively well known. There is even a seismic reflection line traversing part of the Davis Canyon site. However, features interpreted from this seismic reflection coverage and the limited amount of site specific data available leave many issues open. Detailed structure, hydrogeology integrity, in situ stress, and response to excavation and to thermal expansion are all topics which require assessment.

CHAPTER 3

Regional data acquired around the Paradox Basin candidate area present a clear picture of the regional setting for these sites. The extensive testing and analyses from the Gibson Dome will provide data near the sites. Yet, there are issues raised by these data sets and the seismic reflection coverage in the site areas which may significantly impact the repository horizon. Some of the important issues include the presence of faults in the lower Paradox Formation, intrastratal folding which may affect the repository horizon, preliminary nature of hydrostratigraphic interpretation, and potential hydraulic connection between the upper and lower hydrostratigraphic units. Because of these questions there is truly an incomplete picture of the host sites and integrity evaluations are only extrapolated.

Actual rate of flow within and adjacent to the repository level hydrogeologic setting, detailed structure, in situ stress, and response to excavation and thermal expansion, which are interrelated, are not at this time clearly known. All of these topics significantly affect the integrity of the host rock and control what the effects of siting a repository will be.

CHAPTER 6

In most cases, the conclusions stated in response to technical guidelines regarding environmental, geologic and hydrologic attributes of the site can best be stated as expected or anticipated. The uncertainty regarding detailed structure, hydrogeology, and stress, as well as how these may affect or be affected by a repository preclude unequivocal conclusions.

CHAPTER 5

The effects of locating a repository at this site are still uncertain with regard to the physical environment. These issues would require the acquisition of data as described for site characterization to fully respond. Chapter 3 discusses oil and gas potential for the area as moderate to low, yet this chapter states that there is not potential.

CHAPTER 4

Site characterization activities appear sufficient to address the many open issues related to these sites. In hole seismic techniques may be an appropriate addition for evaluating detailed structure and engineering properties related to the host horizon.

UMBRELLA SITE TEHCNICAL POSITION - [STP] - DATED 6/26/84

The STP for salt sites does sufficiently address issues necessary for further evaluating these sites. The itemized concerns are addressed, although possibly completely, by the EA and preceeding review comments are covered generically by the STP.

BASALT WASTE ISOLATION PROJECT [BWIP], WASHINGTON

OVERVIEW

Overall, the DEA is a reasonable summary presentation of the geological, geophysical and seismological data collected and utilized by DOE and their subcontractors in its repository siting studies to date. Very little of the basic geological, geophysical and seismological data is included within the EA, accordingly extensive reviews of data, including data quality and data interpretation, will be necessary to verify the summary statements and conclusions presented in the EA. It is anticipated that much of this information will be presented in the various investigation plans described in Chapter 4.

The draft Umbrella Site Technical Position [STP] has also been reviewed in conjunction with the DEA. The Site Technical Postion [STP] is a very complete list of issues which must be addressed in order to satisfy the DOE's siting guidelines, in order to demonstrate suitability of the site as required by Chapter 6 of the EA. Chapter 6 of the DEA has clearly defined a number of guidelines for which insufficient data currently exist to permit the DOE to reach any conclusion in terms of suitability or non-suitability. The STP has clearly identified the data needs which would allow the DOE to complete their site assessment in terms of the DOE siting guidelines.

The following are comments on the specific chapters of the DEA and on those items or categories of items in the STP thought to be most important in demonstrating that the BWIP site is a suitable repository location.

CHAPTER 3

This chapter includes a relatively thorough presentation of the physiography and geomorphology of the Hanford Site region and the stratigraphic column as known for the Hanford Reservation. The tectonic setting of the repository location in the Cold Creek Syncline, is appropriately presented. The reference repository location in the western Cold Creek syncline area is "tentatively interpreted to consist of large, relatively intact volumes of bedrock whose boundaries are defined by major or intermediate structures". The structural integrity of any repository location is a question which must be answered as quickly as possible especially in an area where tectonic deformation may be continuing. The DEA cites the use of geophysical surveys and surface and subsurface mapping to reach the tentative interpretation. The integrity of the repository location and the data utilized to reach any conclusion drawn by DOE must be thoroughly scrutinized by the NRC and its reviewers.

The structural analysis presented in Section 3.2.3.8 does not present a tectonic model to explain the observed structures and to predict future deformations. All of the structural features observed in the Hanford Reservation area must be explained in terms of the tectonic model so that deformation rates, stress and future seismicity in the vicinity of the reference repository location can be predicted for the proposed life of the facility.

The internal structure of the basalt unit selected for the location of the repository must be adequately known to predict groundwater movement within the basalt. Variations in the dense entabulature and colonade portions of the individual flow basalts must be known before the final repository location is selected. Assumptions used in the assessment of the potential groundwater pathways to date appear adequate. A significant portion of the additional information required to adequately predict groundwater movement may only result from direct observation and testing via the test shaft. The Cold Creek hydrologic "barrier" is a bedrock structural discontinuity that apparently represents an impediment to groundwater flow. This feature must be investigated thoroughly since structural features that impede groundwater flow are typically very recent geologic features.

CHAPTER 6

This chapter evaluates the suitability of the site against the DOE siting guidelines, some of which require site characterization [detailed siting studies] and other which do not require site characterization. This chapter clearly and appropriately presents the information available, describes the favorable conditions, identifies potentially adverse conditions and subsequently arrives at appropriate conclusions. DOE has been very candid in pointing put those areas where data is lacking and therefore conclusions are tentative. All of the geologically related issues fall under the category of evaluation items which require site characterization Section 6.3.1.1.5 clearly identifies the uncertainties regarding the geologic studies and describes [on Table 6.2] the tectonic processes which could affect the hydrologic system of the repository location. This chapter also points out the need for identifiing the geologic features which could potentially affect the groundwater movement in the basalt rock.

Section 6.3.1.3 on rock characteristics identifies numerous evaluations which need to be completed before the site can be qualified as a nuclear waste repository. Included in these items is a determination of the extent of the disturbed rock zone and possible stress induced failures or fractures within the dense basalt interior. The effect of heat on basalt could be a very significant item and needs to be thoroughly evaluated.

The current state of knowledge on tectonics as related to the evaluation process is appropriately presented in Section 6.3.1.7. The need for detailed interpretation of geophysical anomalies and specific structures is identified as well as the uncertainties in the rates and patterns of deformation for the Pasco Basin area. The uncertainty in the tectonic model in terms of the deformational process and its potential effect on the reference repository location are described. It is appropriately noted that the design earthquakes and the design ground motions cannot be determined until other factors involved in the site characterization are completed such as the tectonic model and the associated long term deformation rates. In this regard, continued monitoring of the micro-seismic activity and its possible relationship to structural features in the Pasco Basin area is warranted.

The preclosure section on rock characteristics [Section 6.3.3.2] clearly indicates the need for assessment of the stress conditions within the repository horizon and possible conditions which may be encountered as a result of stress induced instability and methods to counteract such instability. Other basalt flow geologic features to be assessed in order to allow for safe construction of a repository are also identified. The high stress condition indicated by core-discing needs to be thoroughly evaluated. Micro-seismic monitoring and acoustic emission monitoring would significantly help in this evaluation as well as information on the stress levels as obtained during the exploratory shaft program.

The preclosure section on tectonics clearly defines the need to provide a tectonic model for the Pasco Basin area so that deformation rates can be accurately determined. The uncertainties in the current level of knowledge of the tectonic stability of the region are clearly pointed on Page 6-155, next to last paragraph. The comment on Page 6-156 concerning nuclear facilities near the reference repository location is inappropriate since it is the long term seismicity which needs to be predicted for a repository facility.

CHAPTER 5

Chapter 5 describes the repository facility and the effects of locating and constructing the facility at the Hanford site. The only potential effect on the geology of the area would be localized stress relief phenomena possibly including rock bursts.

CHAPTER 4

This chapter on site characterization activities describes six additional work plans that are being developed and identifies other plans which will be described in the next draft of the EA. Of particular interest are the Tectonic Characterization Plan and the Lithologic Characterization Plan which address some of the key issues, namely the structure and integrity of the repository horizon as well as the tectonic modeling needed to establish rates of movement which could have an impact on preclosure and postclosure repository performance.

The geologic characterization tests in the exploratory shafts are briefly described. The plans for such activities require a detailed review to insure that all the geologic aspects of the repository including an assessment of in situ stress conditions are accounted for.

CHAPTER 2

This chapter deals with the decision process by which the reference repository location was identified. The geology, seismology and tectonics of the Hanford site area are presented in a sufficient level of detail to describe the selected site. However, little technical detail is provided to back up the selection of the reference repository location as the candidate site. Only the ten ranking criteria are listed and the method of analysis is presented. Due to the lack of detailed information, four basalt flows were appropriately selected for consideration as the repository horizon.

DRAFT UMBRELLA SITE TECHNICAL POSITION [STP] ON GEOLOGY

The STP has clearly identified the informational data needs required to address the geologic issues for the BWIP site. Of particular interest are the following three issues:

5.2 How does the stratigraphic setting effect waste isolation?
5.3 How does the structural tectonic setting effect waste isolation?
5.4 How does seismic activity effect waste isolation?

The information needs to respond to the above three questions are clearly stated by the NRC, in particular the information required to assess the present tectonic structural setting and the nature and rates of projected tectonic processes are particularly complete. If possible these last two items should be handled on a priority basis since they have the potential along with some of the stratigraphic information for disqualifying the BWIP site in accordance with DOE siting guidelines.

CHAPTER 3

Chapter 3 contains a fairly good and extensive review of existing geological information. The report indicates and clearly shows that there is no original mapping and particularly no site mapping in the area. The data are collected from many authors who have worked in and around the surrounding area and much of the more detailed information that is site specific is extrapolated from the work of these numerous authors. There is reference in the report to some new data secured from wildcat petroleum exploration wells in the area, several test wells that were drilled for the OCRWM Program, and from some seismic reflection surveys in the near vicinity of the site.

The stratigraphy is relatively detailed, very well done, based on numerous authors, and based on a considerable amount of historical data. The repository host rock, which is a bedded salt within the lower San Andreas formation, is described as being approximately 60 meters in thickness near the Deaf Smith site based on stratigraphic information in areas adjacent to the site. It is assumed that this thickness is calculated, estimated, or extrapolated from stratigraphic information near the site. Although the formation doesn't vary abrubtly in thickness, this part of the chapter would be better understood if a more detailed description of how the estimate of the host salt sequence thickness was determined in the report and not just shown on Figures 3-19 and 3-19.

The larger part of this chapter is that part covering structure and tectonics, however, there is considerably more detail particularly in the near vicinity of the site area that could be added from the various authors reports that are cited in this part of the chapter.

Salt dissolution has caused some faulting and subsidence. This phenomena may be of particular interest in the site evaluation process could be more extensively covered even though this particular section refers back to an earlier section which describes the salt dissolution process and the areas in which it occurs in the near vicinity of the site.

The chapter describes rock characteristics and the geomechanical properties of the rocks relatively well. It has a good section on lithostratigraphic characterization, including some stratigraphic cross-sections and some petro-physical parameters contained in a set up of tables. There is considerable detail in both describing the units and physical properties of the units in the near surface areas, particularly those immediately overlying the host rock at the site.

The geochemistry section describes the geochemical properties of the host rock fairly briefly, describes the brines in the area, and briefly touches on the limited mineral resources of the area including the hydrocarbon resources located in the near vicinity of the site. The recent petroleum activities in the near vicinity of the site indicates to the reviewer that there may be some petroleum or exploration company proprietary data available to the DOE that could add to the data base for the geological, hydrological, and resource evaluations of the site and near site vicinity.

CHAPTER 6

This chapter is fairly extensive and does quite an adequate job of calculating and estimating the rates of advancement of the dissolution fronts in the region surrounding the site. It also covers the tectonics of the area and indicates that this is a tectonically quiet and stable area and the supporting information is contained in the data and in the tabular material. One limitation of this section of the chapter is the data base covering the historical seismic activity which is sparse or negligible. The author points out appropriately that it is very difficult to make an extrapolation over the next 10,000 years for the seismic activity in the area for the future based on historical seismic information which is lacking. The mineral resource potential discussion indicates that there are no known metallic, non-metallic or hydrocarbon resources of economic value within the near vicinity and particularly within the site area. The chapter does not contain a discussion of salt dissolution related to the temperature of the fluids, which may be important in selecting this site for a waste disposal repository.

CHAPTER 5

Section 5.2 covers the expected effects on the physical environment, and very briefly describes the geologic conditions of the site by referring you back to Chapter 3 where there is an extensive review of the geology of the site. The impact on surface waters and projections of the impact on the groundwater in the area are discussed. Calculations are made for the consumption of the water usage in the construction and operation of the site. The report covers the impact on groundwater extensively but does not contain an in depth discussion on the impact on geological and soil conditions.

CHAPTER 4

This chapter goes into considerable detail on a proposed, fairly extensive drilling program for improving the data base in the area particularly in the vertical extent. The author recommends geophysical well logging and also recommends a fairly extensive program of hydrologic testing. The report then describes the effort required for site restoration after construction. This review suggests that more detail should be given on selecting the specific geophysical tasks to be performed. This is important since seismic surveys would have a greater impact on the physical environment than electrical resistivity, magnetometer or gravity surveys or for that matter geological mapping activities. It would also be useful to point out the advantages and disadvantages of the various geophysical techniques recommended for providing meaningful data. This review strongly recommends consideration of the new techniques now available in three dimensional vertical seismic profiling since several wells will be drilled at the site. Vertical seismic profiling would provide the DOE with considerable subsurface information in the vicinity of the drillholes.

CHAPTER 3

Surface geologic mapping, and the geophysical data have provided information regarding a shape and structure for both the dome and the mantling sediments. A considerable number of wells have been drilled on the flanks of the dome and in the surrounding area which give good stratigraphic control. There also is considerable amount of faulting associated with the rising of the salt of the dome. This is described in relatively good detail. There is a moderate amount of historical seismic data and both observational data and some instrumental data, and is presented for the site and the region surrounding the site. The chapter describes very well the igneous activity in the near vicinity [closest being 50 miles away in the Monroe uplift] and the history of uplift and subsequent subsidence is described briefly but adequately and the data from the geological and geophysical work on folding is presented. There is a fairly good discussion of salt dissolution in the chapter, and a fair amount of data on salt dissolution. There is data presented in tabular and descriptive form within the text for the chemical analysis of groundwater and numerous water wells in the area. Rock characteristics including geomechanical properties are covered in the chapter and are presented in tabular form, the physical properties of both the overburden of the surrounding strata and salt the geomechanical properties are presented in tabular form and relatively extensive data is provided.

There is a brief discussion of thermal properties and natural radiation and a more extensive discussion of geochemistry. There is a fair amount of data on this as there is an active federal and state geohydrologic program in this area of Louisiana. There is a very brief discussion of geochemistry of the cap rock and salt body, a description of the mineral resources including the non-metallic mineral resources and the fairly extensive hydrocarbon resources that surround the Vacherie Dome area.

There is a fairly good discussion of the present hydrologic conditions in the Vacherie Dome area and this report adequately covers the surface water and the groundwater flow systems, and the chemistry of groundwater. There is a large amount of data that is available, and the author has presented these data in descriptive form within the text and in numerous tables and maps. There is discussion of ground water hydrology in which the author talks about and outlines the various aquifers and water bearing strata in the area and the physical properties in this water bearing strata and the current and potential uses of this water bearing strata. There is a fair amount of data presented on groundwater and groundwater potential in the area of the dome and the groundwater flow in and around the Vacherie Dome area. They review the discussion of a computer based hydrologic model for the area which simulates the groundwater flow in the dome area. There is a considerable amount of information known and presented in this report.

Were the reviewer to recommend anything additional it would be of considerable interest to have a little bit more explanation of the geological and geophysical data that were used and techniques used in the modeling of the salt dome, which was done by a combination of seismic, drillhole, gravity and geological control data from wells.

CHAPTER 6

The particular part of Chapter 6 that we have focused on is the suitability of the Vacherie Dome site for site characterization. In this chapter the author has covered the geohydrologic setting and the groundwater travel times which have been calculated for the host rock, that is, the salt within the dome. The author has done extensive, well documented analysis of the favorable and unfavorable conditions in the site. The author is very open in describing data uncertainties, and assumptions made during the analysis of the data.

This chapter reviews the rock characteristics in the area; including both the caprock and the salt stock within the dome. These data are in descriptive form and tabular form; well covered and well discussed. The question of concern is over the hydrocarbon potential in the area, and the fact that there may be some economic hydrocarbon resources in the area.

Chapter 6 adequately covers the suitability of the site against the DOE guidelines; it is extensively documented, explained and referenced to other chapters within this report.

CHAPTER 5

In this section the author discussed the potential effects of the repository development on geologic conditions and on the hydrologic conditions and on other systems and conditions within the area. Part of the chapter discusses the effects on the thermal expansion of the salt after placing the heat producing radioactive waste into the repository, calculates this expansion, and also discusses the salt dissolution within the host rock. The primary impact noted would be economic because it would require exclusion in the repository site area as a potential mineral or hydrocarbon resource. However, the author points out that this particular site, relative to the surrounding areas, has a very low resource potential for minerals and hydrocarbon. It discusses the impact of the surface and groundwater resources from the development of this repository and that the repository could have some impact on surface and groundwater quality.

CHAPTER 4

This chapter does a fairly good job of discussing a geotechnical characterization program proposed for the area. It is located in the middle of a very active hydrocarbon area; therefore this review again suggests that some of the geological and geophysical data that is now contained in proprietary files in the petroleum exploration companies who have been active in the area, may be made available to the DOE for the specific site; it would provide a more extensive data base.

NEVADA NUCLEAR WASTE STORAGE INVESTIGATIONS [NNWSI], YUCCA MOUNTAIN

OVERVIEW

The designated site for the NNWSI is Yucca Mountain, a prominent topographic feature located on part of the Nevada Test Site [NTS], the Nellis Airforce Range, and land managed by the Bureau of Land Management.

As the result of a selection process involving several other locales Yucca Mountain was designated as a suitable locale that would allow emplacement of waste in a geologic medium above the watertable.

It appears that a large amount of geologic and geophysical investigations and survey data have been accomplished throughout the above noted Federal land areas, including Yucca Mountain and surrounding positions. It also appears that very little information has been obtained on a site specific basis for the primary purpose of evaluating Yucca Mountain as a storage site. The EA clearly references the large amount of scientific information available for the area; an independent perusal of learned journals separately discloses the existence of such a voluminous amount of scientific data. Accordingly, the investigators involved with the matter of Yucca Mountain as a storage site, have chiefly drawn on the available literature and data, and have initiated only a relatively small amount of what would be considered site specific programs or surveys with a primary objective of assessing site suitability for waste storage. Also, the EA is descriptive in an abbreviated sense in that numerous statements and references are provided for a reader or reviewer, but substantitive materials will require considerable acquisition and cross-referencing.

The copy of the EA that is provided for Weston's review is by necessity a photocopy type of reproduction, and all drawings that were of an original nature are presented as a copied, reduced, standard page presentation. Accordingly some details and definition of features of specific concern are often difficult

to assess. Nevertheless we believe that for the purposes of a draft EA review we are able to make adequate use of the graphic materials; but for a final EA review effort, it will be desirable to obtain full size drawings of adequate quality.

CHAPTER 3

As a result of the extensive site investigation work that has taken place throughout the Federal land areas in general [including Yucca Mountain], and extending over "decades" as noted in the EA, the general area is recognized as one of the most intensively studied areas within the continental United States. However, the site specific studies are acknowledged to be in a preliminary stage, and only a few pertinent references are dated as recently as 1983 especially with regard to the unsaturated zone of Yucca Mountain. It therefore appears that although a regional overview of geology is no doubt correct and relatively justified, it is doubtful that even the investigators who prepared the EA would acknowledge that with regard to Yucca Mountain itself the geologic description is complete.

This latter observation is of particular concern with regard to groundwater and the overall physical condition of the four horizons that are designated as "candidates" for the repository.

Since it is noted in the EA that extensive fracturing exists throughout the rock sequence of Yucca Mountain, and that faulting is relatively extensive throughout the entire Yucca Mountain area detailed field evaluation efforts are required. The groundwater regime today and in future years by virtue of fracturing allows high permeability rates, and faulting allows barrier type conditions for groundwater flow; these also will require considerable attention in the future studies and evaluations of this site area as an acceptable repository.

CHAPTER 6

As noted in the initial pages of this extensive chapter [368 pages] only judgements are made in the chapter as opposed to definite conclusions concerning compliance with guideline requirements. Accordingly, this review is performed in the spirit of such a qualification.

As mentioned previously the geologic setting of Yucca Mountain and vicinity is rather well known in general terms as well as the position of Yucca Mountain within a regional setting. Geologic references that are dated as recently as 1983 and 1984 would probably have to be reviewed in detail in order to determine if specifics concerning Yucca Mountain have been considered in a thorough manner and to what extent an interpretive procedure [with subjective conclusions?] was used for understanding the geologic framework of Yucca Mountain in adequate detail.

It is noted that the amount of physical measurements such as test drilling and geophysical studies and surveys both on the surface and in drill holes is rather meager; the area outlined for the repository target is noted as having been penetrated with a limited number of drillholes which are incorporated into the document only by way of reference; they probably have been included in the geologic modeling and mapping efforts referenced in recent documents [1984], which also should be made a part of a final document review.

With regard to features that could affect waste isolation, the hydrogeological characterization and rock properties characterization are of special review concern. The hydrogeological aspects of Yucca Mountain appear to have been evaluated and assessed with regard to present conditions and throughout longer time term periods; however, short term conditions and effects are apparently not of concern or possibly not of interest to the authors of the EA. Such short term conditions and effects such as brief periods of extremely anomalous rainfall ought to be considered; they are significant because of the highly fractured nature of the rock sequence, and the presence of faulting that may allow barrier type conditions. The desirability of considering large scale percolation and permeability measurements would appear useful.

It is evident that the authors have drawn heavily on the decades of scientific studies that have taken place throughout areas adjacent to Yucca Mountain and now recognize the need for more intensive studies throughout the Yucca Mountain itself. Faulting and stress conditions are acknowledged in the EA to occur within Yucca Mountain, but the apparent intensity of effort to this data does not appear adequate to fully characterize such features.

CHAPTER 5

The geologic related environmental effects are of only limited consideration in the EA. It would be desirable to also have information concerning the possbile inducement, by excavation, of erosion and or landslides as well as collapse during underground excavation because of the highly fractured nature of the geologic materials that occur within Yucca Mountain. Furthermore, if drilling and blasting is utilized extensively, there appears to be a further possibility of inducing failure and sliding conditions; these could be usefully assessed in later EA type documents.

CHAPTER 4

Since it is obvious that in an arid environment virtually all site characterization activities, such as drilling of exploratory holes and shafts as well as some of the geophysical survey efforts, will affect environmental conditions in an obvious and sometimes detrimental manner; the building of roads and the use of water for drilling may cause erosional features such as gullying.

The general tasks/activities that are outlined in the EA are of a reasonable nature and will certainly be required for the adequate site characterization. The specific locations and extent of these activities, however, are not designated and therefore cannot be assessed as either reasonable or suitable to fill information gaps. It is doubtful that any of the activities will have an adverse effect of a geologically related nature except for two possible exceptions: deep drilling which utilizes high pressures with the cooling medium and the use of large quantities of high explosives for seismic and similar related types of vibration related measurements which may induce sliding or cratering.

CHAPTER 2

The site screening effort that is discussed considered several sites; the selected site is Yucca Mountain. It is noted that Yucca Mountain occurs within the Nellis Airforce range, a small part within the NTS, and the remainder within lands managed by the Bureau of Land Management. It is further noted in Section 2 that the site of Yucca Mountain is potentially acceptable as consistent with siting criteria of NNWTS-33[2], and is not consistent with 10CFR960. Five areas were considered and three of them were selected for preliminary borings and geophysical testing, although the specifics of such borings and testing are disclosed in only the most general terms. Accordingly the selection of Yucca Mountain as the outcome of a site screening process is difficult to assess and assure. The methodology of the screening process and the ranking of four rock units for the potential repository rock are also included in this section. This rather limited presentation therefore is sufficient to indicate the particular selection process, but the specific input data for that process would have to be obtained from referenced and other documentary presentations.