containment structures receive or contain storm runoff except from the local area of the pad and muck pile.

Water added to control fugitive dust will be tagged with sodium bromide so that its presence in the underground can be identified. The rock-storage pile will be located to the east of the repository block, and will be lined and bermed to minimize potential discharge to the ground water or surrounding land.

The use of radioisotopes for tracer studies and radioactive sources for well logging are discussed in Section 4.1.1.1 of the final EA. The radioactive tracers to be used have short half-lives (from several hours to tens of days), and thus will completely decay within a short period of time (from a few days to a few months depending on the isotope). The well-logging sources are retrievable. This type of testing is commonly performed throughout the United States for exploration of oil, gas, and mineral deposits. No prototype tracer testing involving containers that hold radioactive wastes is currently planned.

Issue: Tracer studies

Five comments were received, all dealing with the chemical and tracer studies planned to be conducted at the exploratory shaft facility site. It was recommended that all vadose water should be collected and analyzed, and that this analysis be included in the final EA. Other commenters opposed the use of water at any time during excavation or drilling of the unsaturated zone, claiming that the tagging of water can differentiate from in situ water in terms of identification only, not in terms of quantity. The use of sodium bromide as a tracer was questioned by all commenters in this area.

Response

No appreciable vadose water is encountered during drilling and attempts to extract pore water have been largely unsuccessful. Considerable effort is being planned to study any vadose zone water that can be obtained during exploratory shaft facility construction testing rather than attempting studies for inclusion in the final EA. This will include collecting water from any observed inflows during shaft construction, and collecting large rock samples for pore water analysis. Although likely to be minor, water seeps in the shaft will be collected by embedding "weep tubes" into the rock at the source of the seepage and collecting this water before it reaches the shaft sump. These studies will be carried out during site characterization. Safety considerations require that some construction water be used for dust control, however, such usage will be held to a minimum.

Sodium bromide will be added to all exploratory shaft facility construction water. Sodium bromide was chosen as a tracer after laboratory testing indicated that neither ion was sorbed by samples of Yucca Mountain rocks. This tracer is also different from that used during surface drilling of USW G-4 so that the source of possible contamination can be determined. It is expected that even with the employment of carefully controlled procedures to minimize water usage during construction, construction water will gain access to seepages in excavations. It is anticipated that large block samples of uncontaminated rock can be obtained for pore water analysis. The

purpose of the tracer is to enable potential contamination to be observed and documented.

Issue: Miscellaneous

Six comments were assigned to this issue. Two commenters wanted to know what the potential alternatives were to decommissioning the exploratory shaft if Yucca Mountain is found to be unsuitable for a repository and what mitigation measures would be followed to ensure habitat restoration. Two other commenters questioned how Coyote Wash was selected as the site for the exploratory shaft. One commenter wanted to know why the DOE does not expect to find perched water during construction of the exploratory shaft, and another questioned the amount of water to be used during construction.

Response

The the Nuclear Waste Policy Act of 1982 (NWPA) states that if the site is not selected for development of a repository, then reclamation and mitigation, as required by NWPA, will occur. All requirements for shaft and borehole sealing will be met. Alternative uses could become part of reclamation or mitigation activities, although no information is available at this time.

The site-selection process for the exploratory shaft location is documented in Bertram (1984), "NNWSI Exploratory Shaft Site and Construction Method Recommendation Report" (SAND84-1003). The site selected in Coyote Wash was the preferred site of the five that were considered.

Water used for compaction of the fill for the site pad construction will be tagged, but the amount to be used is not expected to be excessive. It is also expected to remain near the surface.

The water encountered in drill hole USW UZ-1 contained constituents of drilling fluid, and therefore water introduced to the host rock by drilling of a nearby hole, USW G-1, had probably drained laterally and become temporarily trapped. The DOE acknowledges that perched water zones may occur, although evidence to date suggests very little water will be encountered in drill holes.

C.4.2.3 Other activities

No comments were received in this category.

C.4.2.4 Alternative activities

No comments were received in this category.

C.4.3 THE REPOSITORY

This issue includes 101 comments and questions concerning the design, construction, operation, and decommissioning of a repository at Yucca Mountain. Eight issues were identified within this category: (1) Design and Construction of Surface and Subsurface Facilities; (2) Alternative Repository Designs; (3) Transport of Men, Materials, and Waste; (4) Waste Form, Content, and Packaging; (5) Repository Operations, Waste Emplacement, and Waste Retrieval; (6) Material, Energy, and Labor Requirements; (7) Compatibility with Non-repository Operations; and (8) Miscellaneous.

Section 5.1 of the final Environmental Assessment (EA) has been rewritten to describe the case of the two-stage repository as developed in MacDougall (1985), which has been revised to include more background data. Manpower, material, and costs are based on the vertical waste emplacement case.

Issue: Design and construction of surface and subsurface facilities

Thirty-three comments were received on this issue. Because of the variety of subjects within this issue, it has been separated further into topics which address land resources, site data, transportation, flood control measures, and repository design.

Land resources. Reviewers wanted to know the boundaries of the land that would be withdrawn if Yucca Mountain were selected as a repository site and the number of acres that would be disturbed. Also requested was an estimate of the volume of rock that would be affected by the repository. Another questioner indicated that the western flank of Yucca Mountain does not allow for lateral expansion of the repository block, but if lateral expansion to the west did occur, access to the environment could occur along a fault.

Response. Figure 3-1 (Location of Yucca Mountain site in southern Nevada) shows the location of the site. If Yucca Mountain is selected, approximately 5,000 acres of public land administered by the Bureau of Land Management (BLM) would be withdrawn from public access. The area is labeled "BLM Land" in the lower-left corner of the enlarged area shown on Figure 3-1 (Location of Yucca Mountain site in southern Nevada). As shown on Table 5-7 (Highway, bridge, and railroad construction materials), 150 acres would be cleared for the main surface complex, 1,200 acres would be cleared for the rail spur, and 195 acres would be cleared for the highway.

The underground area of the repository will be 1,520 acres, although many rock pillars and walls will remain. The "volume envelope" is estimated to be about 45 meters thick. The current room design for vertical emplacement is 15 feet wide by 21.5 feet high.

The commenter is correct in that expansion of the repository to the west is not planned; but it is not precluded yet, since the available data are insufficient to reach a conclusion. Areas of probable expansion are to the north and northeast. The emplacement horizons is at least 200 meters (656 feet) below the land surface in all areas.

Site data. A few comments concerned the relation between engineering measures and the natural conditions at the site. One commenter believed that the DOE was building a case to use engineered barriers to overcome natural deficiencies at the site. Another commenter stated that the draft EA was inconsistent in stating in Section 5.1.1.3 that perched water might be found during excavation of the repository and stating in Section 4.1.2.4 that perched water is unlikely. It was also asserted that the DOE had not described in sufficient detail how the access ramp to the repository would be constructed in areas where it would cross faults and joints. Several commenters requested information on the various techniques for mining tuff and information was requested on the size of surface structures and their cost. Another commenter stated that the mined zeolitic tuff could be hazardous to the general public and should be carefully controlled. Finally, one commenter wanted to know how thick the walls of the repository would be.

Response. Regulations issued by the DOE and the Nuclear Regulatory Commission (NRC) require that a system of engineered barriers be used in a repository to supplement the natural barriers to radionuclide transport. Section 6.4.2.1.1 of the final EA has been expanded to discuss in more detail the engineered barriers.

The two statements regarding perched water are not inconsistent; it is unlikely that significant amounts of perched water will be found during construction of the exploratory shaft or the repository, but the possibility cannot be completely ruled out that some perched water may be encountered.

A variety of techniques will be used to ensure that all underground openings remain stable. The standard procedure, which is widely used at the Nevada Test Site (NTS), is to use rock bolts and wire mesh. If stability becomes a problem in areas where underground openings pass through fault planes, other construction materials would be used, such as (1) shot-crete (a concrete mixture sprayed over the wire mesh), (2) structural steel, and (3) poured concrete formed in place. A monitoring system will provide data on underground opening integrity through a performance confirmation program.

The specific mining technique to be used will depend on the results of site characterization, although current information indicates that excavation is feasible using either a drill-blast-mucking technique or a continuous mechanical miner.

Design of the surface facilities is preliminary and will not be detailed until the license application design is complete. The relative size of the facilities is described in Section 5.1 of the EA. Preliminary cost estimates are provided in Section 5.4.1.3 and Table 5-44 (Preliminary cost estimate for the Yucca Mountain repository assuming vertical emplacement) of the final EA.

Zeolites included in the muck pile may require more controls than are required for other rocks to be mined at Yucca Mountain. However, materials particularly high in zeolitic content, such as the Calico Hills tuff underlying the host rock, are not expected to be mined during repository development.

There are no man-made walls in the repository design that would encompass the underground opening where the wastes will be stored. The walls of

the repository are the rock formations comprising Yucca Mountain. The rock pillars that provide support for the underground openings will be a minimum of 30 meters (approximately 100 feet) wide for vertical waste emplacement and 414 meters (1,360 feet) wide for horizontal waste emplacement depending upon which method is finally selected.

Transportation. Several comments concerned the rail spur and the access road that would be constructed if Yucca Mountain were chosen as a waste site. The commenters wanted to know about the exact route of the rail spur, as well as information on heavy hauls, safety, and the construction process. Another commenter suggested that a highway be constructed along the rail route to divert truck traffic around (north of) Las Vegas. Finally, a commenter wanted to know why the DOE plans a 14-meter (46-foot)-wide access road considering that most roads in Nevada are less than 12 meters (40 feet) wide.

Response. The rail spur would be constructed on public lands administered by the Federal Government, except for the federally withdrawn lands of the NTS and the privately owned land in the vicinity of Dike Siding. The spur would originate at Dike Siding, an existing Union Pacific transshipment facility located about 18 kilometers (11 miles) northeast of Las Vegas. The single-track route would extend about 161 kilometers (100 miles) northwest to Yucca Mountain paralleling the north side of U.S. Highway 95. It would lie south of the southern boundary of the Desert National Wildlife Range and enter the NTS south of Mercury. The track would bypass the towns of Indian Springs and Cactus Springs and the Indian Springs U.S. Air Force facilities. No final decision has been made on the use of this route, but this is the route that has been considered in the EA.

Information about heavy hauls, safety, and the construction process cannot be fully determined until route selection has been finalized.

Construction of a highway that would parallel the rail spur and bypass Las Vegas has not been considered at this time but neither has the option been eliminated.

Finally, the access road from the Town of Amargosa Valley to the site is presently conceived as having a 30-meter (100-foot) right-of-way. The right-of-way will be fenced, but controlled public access to the site--perhaps to a visitor center--will be allowed. The actual design of the roadway, however, has not been initiated. Therefore, statements concerning "minimum safe widths" of roadways are not appropriate at this time.

Flood control measures. Several comments concerned run-off and potential flooding at the site. One commenter stated that proper management of flood waters is essential to avoid infiltration into the ground water. Another commenter argued that the DOE should not have tried to demonstrate that flooding at the site could be mitigated because the guidelines address the potential for flooding, not whether the DOE can mitigate flooding. One commenter stated that run-off at the site should be considered contaminated and disposed of in an approved manner. A few commenters requested information about the berm that would be used to retain run-off and leachates from the rock-storage pile, and stated that such a discussion was required because it was included in Chapter 4 for the exploratory shaft. A few commenters expressed concern about seepage of effluents into the subsurface from the

sewage lagoon and rock-storage pile. It was stated that all natural waste containment structures should be lined and monitored. Finally, one commenter stated that the DOE should evaluate the effects that floods would have on surface facilities, bridges, and rail lines in the Yucca Mountain area.

Response. Design of the surface facilities will be based on the Probable Maximum Floods determined in accordance with ANSI/ANS 2.8-1981. Surface facilities will be protected from floods by constructing channels and/or dikes to divert run-off away from (and safely through) the site, and by constructing facilities above flood plains. There is no reason to consider run-off at the site as contaminated because run-off will consist solely of surface water flow. Site preparation will provide for appropriate run-off diversion and control of erosion. The actual design of the surface facilities will be completed during the license application design study after detailed topographic maps become available. All sewage lagoon and rock-storage structures will be lined and monitored although the designs are conceptual at this time. Final designs will address seepage into the subsurface. A statement to this effect has been added to Section 5.1 of the final EA.

The DOE does not claim credit in the guidelines for flood protection by engineering measures. Flood-control structures will nevertheless be constructed at the site to control sheet wash.

It is true that no discussion was included in Chapter 5 on a berm, nor on the possible environmental impacts of run-off from the rock-storage pile. There is currently no specific design of a rock-storage berm for the repository, although its design will comply with all applicable State and Federal environmental requirements.

Finally, the draft EA acknowledges the influence that flood potential has on the design of all surface facilities at and near the site. Additional site-specific information bearing on the design of the repository will be gathered during site characterization.

Repository design. A few commenters asked why the descriptions of surface facilities, shafts, and other components of the repository were not consistent among the EAs and asked that the DOE provide an explanation of these differences. A few commenters wanted to know how the basic assumptions regarding the design, construction, and operation of the repository have changed and what effect these changes could have on the environmental assessment. Another commenter argued that because the repository design is not final, the extrapolation that future design standards can be met is faulty. Another reviewer stated that permits will be necessary for the planned fuel storage facilities depicted in Figure 5-4 (Preliminary site plan for the main surface facilities complex at Yucca Mountain) of the draft EA.

Response. The differences in the descriptions among the EAs reflect site-specific design differences due to such things as differences in surface topography, subsurface access and layout, rock type, and waste-transportation needs at each site.

The basic assumptions about the repository that have changed since issuance of the draft EA are: (1) commercial high-level reprocessing wastes will

not currently be disposed of at the repository; therefore, the waste inventory will consist of spent fuel and a small amount of defense high-level waste; and (2) the concept of the two-stage repository. Each of these new topics is addressed in Section 5.1 of the final EA. However, future acceptance of commercial high-level waste will not be precluded.

The final design of the repository will meet all regulations and standards in effect at the time of licensing. If design standards existing at the time are not met, a license to operate the repository can not be granted by the NRC.

Figure 5-4 in the draft EA (which depicts fuel storage facilities) is a conceptual model of a preliminary plan. The configuration depicted is not necessarily the final design. In this regard, all necessary permits will be obtained.

Issue: Alternative repository designs

Twelve comments were received on this issue. Most comments concerned a lack of information in the EA about alternative designs (particularly a two-stage repository, monitored retrievable storage (MRS), vertical versus horizontal waste emplacement, and backfilling) and their effects on the physical and socioeconomic environments.

Response

The final EA indicates that a two-stage repository as described in the two-stage repository report (MacDougall, 1985) has been fully discussed along with other options in Section 5.1 of the EA. Ramp access is an option for the repository, and Chapter 5 has been rewritten to reflect this; however, vertical shaft access has not been precluded. Chapter 5 also provides a comparison of vertical and horizontal emplacement of waste. Present information indicates that all impacts will be greatest for vertical emplacement, so the EA is conservative. A study has yet to be made to determine the preferred method. However, the choice of an access method is an issue of safety and operating efficiency and will be resolved as part of the conceptual design effort; it is not pertinent to the siting guidelines. The only activity for the two-stage repository approach that is different from the approach described in the draft EA is the construction of the small Stage 1 waste-handling building. Operation of this facility will have negligible health and safety impacts.

The possibility of fuel consolidation elsewhere (e.g., a MRS facility) is under consideration, but has not been resolved. Analyses in the EA have assumed that these operations will be performed onsite, and it is therefore conservative with respect to environmental and socioeconomic assessments of the Yucca Mountain site. Section 141 of the Nuclear Waste Policy Act directs the DOE to study the need for, and the feasibility of, construction of MRS facilities for spent fuel and high-level waste (NWPA, 1983). It also directs the DOE to submit to Congress a proposal that establishes a program for the siting, construction, and operation of MRS facilities.

The initial DOE plans for a MRS facility, as reflected in the April 1984 draft Mission Plan (DOE, 1984), consisted of a MRS facility to provide backup storage capability should there be significant delays in the availability of a geologic repository. In this case, the DOE planned to propose to build and operate a MRS facility to store spent fuel until the repository was ready to receive it. As soon as the repository became available, the spent fuel stored at reactor sites was to be shipped to the repository for packaging and disposal. When the repository had sufficiently reduced the spent-fuel backlog at the reactors, the MRS facility was to ship its spent fuel, packaged in sealed waste disposal containers, to the repository for any additional preparation that might be necessary and for disposal.

The DOE has carefully reanalyzed the provisions of the Nuclear Waste Policy Act (NWPA, 1983) and of the programmatic options in the June 1985 Mission Plan (DOE, 1985) and is currently evaluating an integrated waste management system that consists of both storage and disposal components. A MRS facility is the part of the integrated system that would perform most, if not all, of the waste-preparation functions before emplacement in a repository.

Therefore, the MRS facility in the integrated waste-management system does not have the same role as the MRS facility studied in the past or described in the draft Mission Plan (DOE, 1984). Its primary function is waste preparation for emplacement in a geologic repository. Its role in providing backup storage is secondary, although it could provide temporary backup storage if the startup of the repository is delayed. Locating the waste-preparation functions (i.e., spent-fuel consolidation and packaging) in an integral MRS facility would, to that extent, simplify the design, construction, and operation of the repository facilities. By providing a processing and storage capacity between waste acceptance from the utilities and emplacement in a repository, the MRS facility would help maintain better and more consistent control over the flow of waste from reactor to repository. An integral MRS facility would also provide a hub for the logistics of managing spent-fuel transportation, cask-fleet operations, and cask-fleet servicing. By shipping consolidated fuel to the repository, possibly in dedicated trains, the number of cross-country shipments could be significantly reduced.

Studies conducted during the summer of 1985 to support the January 1986 proposal are intended to define more precisely the waste preparation functions which would be performed by a MRS facility in an integrated waste management system. Qualitatively, the environmental impacts discussed in this EA encompass those for a repository design coupled with a MRS facility, if Congress authorizes a MRS facility. This is due to the fact that the repository concepts evaluated in the present EA include those surface facilities which would be part of the MRS facility if the MRS facility is constructed separately.

Appendix A of this EA presents general background information on transportation topics and issues. A description of a transportation system which integrates the MRS facility into the waste management system was used to

estimate the impacts of transportation costs and risks. This new analysis does not replace the analysis for the reference case but rather is presented in addition to it. The reference case and the MRS transportation analysis is found in Section 3.5 of the final EA.

The description of the backfill option has been clarified in Section 5.1.3 of the final EA. However, sealing the repository (as opposed to back-filling) is a conservative assumption with regard to the severity of environmental impacts.

Finally, Table 5-12 (Comparison between the two-stage repository concept and the preliminary repository concept for the Yucca Mountain site) of the draft EA is now Table 5-1 and has been expanded in the final EA to show a comparison of the two repository design concepts (two-stage design and current design) in terms of socioeconomic, transportation, and environmental impacts.

Issue: Transport of men, materials, and waste

Three comments were received on this issue. Several commenters asked if the routing noted in the draft EA (U.S. Highway 95) would influence the number of shipments to the repository, and which routes would be used to ship construction materials to the site. Other commenters asked about the nuclear waste receipt rate in regard to trucks and trains waiting to be unloaded because of ill-defined "repository acceptance standards." An error was noted in Table 5-11 (Spent fuel waste receipts by year, metric tons uranium equivalent) of the draft EA concerning the number and rate of spent-fuel shipments.

Response

As noted in Section 5.1 of the draft EA, the number of shipments for a given waste disposal container quantity will be determined by the carrier-type (rail or truck) selected, not the route.

The routes used by trucks and trains hauling construction materials for highway construction to the site will depend on their point of origin.

Receipt rate and repository acceptance standards for the waste have been described in more detail in the final EA. The receipt rate indicated in the draft EA on Table 5-11 (Spent fuel waste receipts by year, metric tons uranium equivalent) has been corrected in Table 5-3 of the final EA.

Issue: Waste form, content, and packaging

Twelve comments were received on this issue. Two topics were identified: waste storage and waste disposal container design.

Waste storage. Several commenters stated that defense and transuranic wastes were discussed inconsistently throughout the EA. Comments also focused on whether liquid wastes, fuel rods, and wastes from Three Mile Island would be included in the repository. Two commenters stated that the total amount of waste stored at the repository could be more than 70,000 metric tons of uranium (MTU) and that the possibility of a MRS facility

should be discussed. Another commenter stated that the health, safety, and thermal-loading implications of emplacing 5-year-old fuel (rather than 10-year-old fuel) in the repository should be discussed.

Response. Various sections of the draft EA have been rewritten to include defense wastes. The EA did not consider the disposal of transuranic wastes in the repository, except to the extent that defense high-level wastes can be considered transuranic waste. Spent fuel will be the primary waste material placed in the repository. Other waste types referred to in the EA are site-generated waste (e.g., contaminated tools and clothing) and possibly a small amount of vitrified defense waste. There are no plans to accept waste from Three Mile Island.

In the EA the repository design assumes that a maximum of 70,000 MTU will be emplaced, which is consistent with the DOE interpretation of the Nuclear Waste Policy Act (NWPA, 1983). Furthermore, after the construction of a second repository, there would be no need to increase the capacity of the first repository. However, the Nuclear Waste Policy Act will allow expansion if for some reason it is necessary.

The "Standard Contract for Disposal of Spent Nuclear Fuel and/or High Level Radioactive Waste" (10 CFR Part 961) establishes the contractual terms and conditions under which the DOE will make available nuclear waste disposal services to the owners and generators of spent nuclear fuel and high-level radioactive waste as provided in Section 302 of the Nuclear Waste Policy Act. The contract designates spent fuel aged as little as 5 years out of reactor as standard spent fuel. The Standard Contract (10 CFR Part 961) and the Mission Plan (DOE, 1985) both specify that the DOE will accept fuel for disposal on an "oldest first" basis. Therefore, for most of the first repository receiving and emplacement period, the average age will be greater than 10 years with an estimated 5 to 10 percent aged as little as 5 years. The current EA reference design is based on 10-year-old fuel.

The DOE has not yet conducted studies to assess the impact of accommodating this amount of 5-year-old waste. These studies will be performed during the license application design phase of the repository design process. At this point, the DOE believes that the incremental impacts on the environment due to any received 5-year-old waste will be minor. The impacts will be due to higher thermal and radiation levels and can be accommodated by changes in operating procedures and by increased shielding.

Also, if the MRS facility is approved by Congress, it may be desirable to age the 5-year-old fuel at the MRS facility prior to disposing of it in the repository. An analysis of aging will be performed in conjunction with the studies discussed above, if the MRS facility is approved by Congress. The MRS facility is discussed in the issue entitled "Alternative Repository Designs."

Waste disposal container design. Several commenters requested a better explanation of "high-integrity package," and for the distinction between "canisters," "casks," and "packages." A few commenters stated that there are many unanswered questions about the waste disposal containers, and one commenter asked if the conclusions about the repository would change if the life span of the waste packages is less than 300 years.

Response. The final EA contains a better explanation of waste disposal containers, casks, and packages. High-integrity packages are packages that will contain wastes for at least 300 years. The casks used to transport waste to the repository will be licensed by the NRC. Waste disposal containers used at the repository will be designed to safely contain wastes. This design will be based on tests already in progress.

The waste package is one element of a multiple barrier system designed to provide waste containment. However, if the life span of the waste packages is estimated to be less than 300 years, a redesign of the package would be required.

Issue: Repository operations, waste emplacement, and waste retrieval

Thirteen comments were received on this issue, and separated into two topics: waste acceptance and waste retrieval.

Waste acceptance. Many questions were asked about the standards by which waste will be accepted and emplaced at the repository and the remedial actions that would be taken if the waste was unacceptable. Questions were asked about how the repository will handle a peak of shipments caused by such things as weather-delayed trucks arriving at the same time, and what would be the health and safety effects from such delays. One reviewer wanted to know where the electricity will be purchased to operate the repository and what would happen if there was a power outage. Other reviewers wanted more information about the heliport planned for the repository, including: the number and frequency of flights; whether the stability of subsurface openings will be monitored during operation of the repository; and whether the Air Force would provide security for the repository.

Response. The waste-receiving facility provides the interface between incoming waste shipments and the hot-cell facility in which the waste is placed in waste disposal containers. The waste-emplacement rate of 3,000 MTU per year is an average rate. To allow for variations in receipt rate, unloading facilities will be designed to accept waste at a higher rate. In addition, onsite storage of 150 MTU of waste will be provided for the Stage 1 facility, plus 750 more for the Stage 2 facility to accommodate variations in the shipping rate caused by such things as weather-delayed trucks arriving at the same time. A waste package is suitable for emplacement if the closure weld is sound, the package is not physically damaged, and the outer surface is free of radioactive contamination.

Vehicles waiting to be unloaded will contain waste in licensed shipping casks and could rarely be contaminated. If they were contaminated, washing would be the preferred method of decontamination. The wash water could then be decontaminated, through such means as centrifuging, and re-used as appropriate. Solids extracted from the water could then be packaged in drums and put in the repository.

The incoming waste must meet certain acceptance standards in terms of external radiation and mechanical compatability with waste-handling equipment. Radiation levels will be checked and certified prior to shipment from a reactor and then recertified at the repository. The most likely cause for a waste shipment not meeting acceptance standards is mechanical damage to

the cask fittings during transit. Detection of additional radiation would not necessarily be associated with such damage, but repairs would be required prior to unloading the transport cask.

Studies are currently being done by the DOE for all participants at the NTS and their future power needs. It appears that power is available for NTS expansion, including the repository, from the Nevada Power Company and the Valley Co-op. In case of power disruptions, the repository will be equipped with stand-by generators to provide power to safety-related equipment.

An analysis of helicopter traffic into and from the repository will be considered for the final safety analysis or the Environmental Impact Statement. The aircraft impact-analysis conducted for the safety analysis provides a bounding case for the EA.

Monitoring, maintenance, and inspection of the underground openings would be a normal part of repository operations. Sensors will monitor opening stability, temperature, and radiological and nonradiological air quality. Monitoring of emplacement boreholes will include measurements of temperature, radiation levels, and sidewall conditions.

Security services at the repository will be provided by a private contractor.

Waste retrieval. Additional information was requested about waste retrieval, such as an analysis of a worst-case accident. Also mentioned was a concern that the waste would not be retrievable for more than 50 years after emplacement. One commenter wanted to know where the wastes would be stored if they were retrieved.

Response. The position of the Office of Civilian Radioactive Waste Management (OCRWM) Program on the issue of retrievability is that the repository be designed, constructed, and operated so that the capability to retrieve the previously emplaced waste packages is retained for up to 50 years after the first waste is emplaced in the repository, unless a longer or shorter time period is specified by the Secretary (DOE) and approved by the NRC. This condition will be maintained until the satisfactory completion of a performance confirmation program as stipulated by 10 CFR Part 60.111 (including NRC review) and after decommissioning activities are authorized by the NRC.

The repository design, in accordance with 10 CFR Part 60, will have the capability to begin the retrieval at any time for 50 years after the start of waste-package emplacement. For design purposes, it is assumed that the actual retrieval, if retrieval proves to be necessary, would take approximately as long as the period used for waste emplacement and repository construction. This length of time is consistent with the provision in 10 CFR Part 60.111, in which public health and safety considerations are of primary importance in any waste-retrieval operation.

The capability to retrieve the waste packages from backfilled rooms would be demonstrated prior to a decision to backfill the waste package storage rooms and would be maintained regardless of whether the storage rooms

have been backfilled. Therefore, the decision to backfill would be based in part on an evaluation of the advantages of early backfilling versus the disadvantages of increased difficulty of retrieval.

During the summer of 1985, the DOE developed a position on retrievability to fully describe and document all design, construction, operation, and maintenance equipment requirements associated with retrievability. Progress has been made in evaluating the effects of these requirements on the repository design and in assessing the associated equipment needs. These retrieval effects will be analyzed and addressed during the site characterization period and subsequent design phases supporting the license application.

Use and storage of wastes that had been retrieved would depend on the reason that retrieval was initiated.

Issue: Material, energy, and labor requirements

Twenty-three comments were received on this issue. Because of the variety of subjects within this issue, it has been separated further into two topics: materials requirements and labor force estimates.

Materials requirements. Additional information was requested about the types, amounts, and sources of materials that would be required for the repository (including the rail spur and access road); the source of these estimates; and the potential conflicts these requirements may pose on a growing Las Vegas. A few commenters stated that, to the extent possible, raw materials for the repository should be acquired from Nevada sources. Several commenters wanted to know how much water would be required for the repository and whether the DOE currently has water rights in this area, specifically for Well J-13 which may be the water source for the repository. One commenter wanted to know how much electricity would be required for the project and the effects that this consumption could have on local demand. Finally, one commenter requested the source of information for Table 5-8 (Estimated requirements for construction equipment) of the draft EA.

Response. The types and amounts of materials required for a repository are listed in Section 5.1 of the final EA. Materials for constructing the repository will probably be obtained from the most economical sources, which in many cases may be local. The purchasing details are not known at this time, but are reserved for detailed study at a future date. Material and resource requirements for construction of the rail and road are included in the overall estimates in the EA. It is the DOE view that a comprehensive discussion of potential conflicts between the material-supply requirements of the repository and Las Vegas is more appropriate for the Environmental Impact Statement. Estimates of material and resource requirements in the final EA are derived from MacDougall (1985), which now contains an appendix that provides details on material and resource requirements that are too lengthy to include in the EA.

The maximum yearly water demand for the repository is estimated to rise to a peak of 120,000,000 gallons per year at the end of the sixth year and decrease to about 115,000,000 gallons per year and remain at this level for the next 26 years. The minimum average water demand for the following

23 years of operation would be approximately 2,500,000 gallons per year. Analyses to date indicate that sufficient water to support the repository can be obtained from new or existing wells at the NTS (such as Well J-13) for which the DOE has water rights.

The estimated demand for electricity for the repository is less than 5,000 million kilowatt hours. The DOE is currently conducting a study of future load and power requirements of the Nevada Test Site.

The source of information for construction equipment (Table 5-8) is based on assumptions presented by project participants with construction-related experience. The estimates in this table are based on typical requirements for the construction of a large facility.

Labor force estimates. Several commenters questioned the method by which labor force estimates were made in the draft EA.

Response. Labor force estimates were derived from several sources. The sources used to derive the labor force estimates, are presented in Section 5.1 of the final EA. Briefly, for construction, cost estimates were prepared by an architect-engineer according to the conceptual design of the facility and the material-labor-cost ratios experienced at other large projects. The labor man-hours were then obtained and the number of construction workers calculated. For operations, detailed operations procedures were developed (Dennis et al., 1984), times for each operation estimated, and man-hours determined. Coupled with the number of operations required for the repository capacity, this determined the number of operations workers.

Uncertainty in manpower estimates have been reflected in two ways: (1) a contingency factor, which varies from 20 to 40 percent (MacDougall, (1985)), is applied based on the complexity of the repository component; and (2) an overall contingency allowance of 30 percent applied to manpower estimates. The estimates with and without the contingency factors applied result in upper and lower bounds on these estimates.

Part of the criticism of the labor force estimates is related to the uncertainty surrounding the actual design of the repository. It is true that the design of the repository is still preliminary. That, however, is precisely why additional impact analyses are planned, and why detailed socio-economic studies await more specific information about the design. Results of these future impact studies will be included in the Environmental Impact Statement.

Issue: Compatibility with non-repository operations

Two comments were received on this issue. One requested a discussion of radio and electronic emissions from the repository that could affect nearby military operations and weapons testing. Another requested information about the potential danger to the repository and the repository workers from routine weapons testing.

Response

Construction and operation of the repository would result in both radio-electronic emissions and additional noise levels at the site. Radio traffic would be associated with incoming traffic, material, and waste shipments. Radio frequencies will be selected that will not interfere with ongoing civilian or military activities in the area. Potential effects of radio-electronic emissions on Air Force operations will be continually assessed as the repository program develops.

The DOE proposes to remove underground workers at the repository during weapons testing as a precaution. If a repository is constructed at Yucca Mountain, it will be built to withstand the ground motion from either natural earthquakes or from underground nuclear explosions.

Issue: Miscellaneous

Three comments were received that were classified in this issue area. One commenter requested an explanation of the term indirect employees. Another commenter asked if saboteurs could, at some time in the future, extract the wastes. Finally, one commenter stated that the first paragraph of Section 5.1.2.1 of the draft EA was unclear.

Response

As defined in Section 5.4.1.1 of the draft EA, indirect employment is the "... increase in trade, service, and other employment that can be attributed to the increased demand for goods and services." All of Section 5.1 of the draft EA has been rewritten for the final EA. As a part of this revision, Section 5.1.2.1 was reviewed and edited in an attempt to make the text more clear.

The final repository design will include a number of physical security systems to prevent potential sabotage to the repository or to its contents. Other security measures will be developed in later design stages.

REFERENCES FOR CHAPTER C.4

ANSI/ANS (American National Standard Institute/American Nuclear Society), 1981. "American National Standard for Determining Design Basis Flooding at Power Reactor Sites," ANSI/ANS-2.8-1981.

Bell, E. J., and L. T. Larson, 1982. Overview of Energy and Mineral Resources for the Nevada Nuclear Waste Storage Investigations, Nevada Test Site, Nye County, Nevada, NVO-250, Nevada Operations Office, U.S. Department of Energy, Las Vegas.

Benson, L. V., J. H. Robison, R. K. Blankennagel, and A. E. Ogard, 1983. Chemical Composition of Ground Water and the Locations of Permeable Zones in the Yucca Mountain Area, Nevada, USGS-OFR-83-854, Open-File Report, U.S. Geological Survey, Denver, Colo.

Bertram, S. G., 1984. NNWSI Exploratory Shaft Site and Construction Method Recommendation Report, SAND84-1003, Sandia National Laboratories, Albuquerque, N. Mex.

Brown and Caldwell and Culp/Wesner/Culp, 1980. Las Vegas Valley Water Quality Program, Phase I Treatment Facilities Study, Las Vegas, Nev.

Carr, W. J., 1984. Regional Structural Setting of Yucca Mountain, Southwestern Nevada, and Late Cenozoic Rates of Tectonic Activity in Part of the Southwestern Basin, Nevada and California, USGS-OFR-84-854, Open-File Report, U.S. Geological Survey, Denver, Colo.

Christiansen, R. L., and P. W. Lipman, 1965. "Geologic Map of the Topopah Spring NW Quadrangle, Nye County, Nevada," U.S. Geological Survey Quadrangle Map GQ-444, Scale 1:24,000, Washington, D.C.

Claassen, H. C. 1983. Sources and Mechanisms of Recharge for Ground Water in the West-Central Amargosa Desert, Nevada--A Geochemical Interpretation, USGS-OFR-83-542, Open-File Report, U.S. Geological Survey, Denver, Colo.

Coache, R., ca.1983. "Amargosa Water Use Inventory 1983," State of Nevada, Department of Conservation and Natural Resources, Water Resources Division, Las Vegas (Tabular Material on Water Use).

Craig, R. W., and J. H. Robison, 1984. Geohydrology of Rocks Penetrated by Test Well UE-25p 1, Yucca Mountain Area, Nye County, Nevada, USGS-WRI-84-4248, Water-Resources Investigations Report, U.S. Geological Survey, Denver, Colo.

Czarnecki, J. B., 1985. Simulated Effects of Increased Recharge on the Ground-Water Flow System of Yucca Mountain and Vicinity, Nevada-California, USGS-WRI-84-4344, Water-Resources Investigations Report, U.S. Geological Survey, Denver, Colo.

DOC (U.S. Department of Commerce), 1983. County and City Data Book, 1983, A Statistical Abstract Supplement, U.S. Government Printing Office, Washington, D.C.

DOC (U.S. Department of Commerce), 1985. 1985 OBERS BEA Regional Projections, Volume 1, State Projections to 2035, Bureau of Economic Analysis, Washington, D.C.

DOE (U.S. Department of Energy), 1981. "Environmental Protection, Safety, and Health Protection Program for DOE Operations," DOE Order 5480.1A, Washington, D.C.

DOE (U.S. Department of Energy), 1984. "Environmental Protection, Safety, and Health Protection Standards," DOE Order 5480.4, Washington, D.C.

DOE (U.S. Department of Energy), 1984. Mission Plan for the Civilian Radioactive Waste Management Program, Overview and Current Plans, DOE/RE-0005, (draft), two volumes, Washington, D.C.

DOE (U.S. Department of Energy), 1985. Mission Plan for the Civilian Radioactive Waste Management Program, Overview and Current Program Plans, DOE/RW-0005, three volumes, Washington, D.C.

Donovan, D. E., 1984. Letter from D. E. Donovan (City of Las Vegas) to M. Rogozen (SAI), July 12, 1984; regarding infrastructure - wastewater treatment.

Dudley, W. W., Jr., 1985. Letter from W. W. Dudley (USGS) to D. L. Vieth (WMPO), October 31, 1985; regarding status of on-going neotectonic studies.

Frit, J. W., 1984. Letter from J. W. Frit (Deputy Secretary for Indian Affairs) to Chairman C. R. Surrett (Moapa Band of Paiutes), June 19, 1984; regarding certification of the Moapa Band of Paiutes as an "affected Indian tribe."

Johnstone, J. K., R. R. Peters, and P. F. Gnirk, 1984. Unit Evaluation at Yucca Mountain, Nevada Test Site: Summary Report and Recommendation, SAND83-0372, Sandia National Laboratories, Albuquerque, N. Mex.

Kensler, C. D., 1982. Survey of Historic Structures: Southern Nevada and Death Valley, JAB-00099-121, URS/John A. Blume and Associates, Engineers, San Francisco, Calif.

Kerrisk, J. F., 1983. Reaction-Path Calculations of Groundwater Chemistry and Mineral Formation at Rainier Mesa, Nevada, LA-9912-MS, Los Alamos National Laboratory, Los Alamos, N. Mex.

Las Vegas Review-Journal, Nevada Development Authority, and First Interstate Bank of Nevada, 1985. Las Vegas Perspective, Las Vegas, Nev.

Lipman, P. W., and E. J. McKay, 1965. "Geologic Map of the Topopah Spring SW Quadrangle, Nye County, Nevada," U.S. Geological Survey Quadrangle Map GQ-439, Scale 1:24,000, Washington, D.C.

MacDougall, H. R. (comp.), 1985. Two-Stage Repository Development at Yucca Mountain: An Engineering Feasibility Study, SAND85-1351 (Rev. 1), Sandia National Laboratories, Albuquerque, N. Mex.

McBrien, S. and L. Jones, 1984. Nevada Nuclear Waste Storage Investigations: Socioeconomic Impacts of Constructing a High-Level Waste Repository at Yucca Mountain, SAND84-7201, Sandia National Laboratories, Albuquerque, N. Mex.

Montazer, P., and W. E. Wilson, 1984. Conceptual Hydrologic Model of Flow in the Unsaturated Zone, Yucca Mountain, Nevada, USGS-WRI-84-4345, Water-Resources Investigations Report, U.S. Geological Survey, Lakewood, Colo.

Montazer, P., E. P. Weeks, F. Thamir, S. N. Yard, and P. B. Hofrichter, 1985. "Monitoring the Vadose Zone in Fractured Tuff, Yucca Mountain, Nevada," Characterization and Monitoring of the Vadose Zone, National Water Well Association Symposium, Denver, Colorado, November 19-21, 1985.

Morros, P. G., 1982. "Ruling in the Matter of Applications 34760...45090 Filed to Appropriate Waters from an Underground Source in the Amargosa Desert Ground Water Basin, Nye County, Nevada," Office of the Nevada State Engineer, Carson City.

Murdock, S. H., F. L. Leistritz, and R. R. Hamm, 1985. "The State of Socioeconomic Analysis: Limitations and Opportunities for Alternative Futures," paper presented at the Annual Meeting of the Southern Association of Agricultural Scientists, Biloxi, Mississippi, February 3-6, 1985.

Nevada Historic Preservation Plan, 1982. Archaeological Element for the Nevada Historic Preservation Plan, Nevada Division of Historic Preservation and Archaeology, Carson City.

Nevada Development Authority, 1984. The Southern Nevada Community Profile, Las Vegas, Nev.

Newman, W. J., 1979. Order Designating and Describing the Amargosa Desert Ground Water Basin, Nye County, Nevada, Office of the State Engineer, Carson City, Nevada.

NRC (U.S. Nuclear Regulatory Commission), 1982. Standard Format and Content of Site Characterization Reports for High-Level-Waste Geologic Repositories, Regulatory Guide 4.17, Office of Nuclear Regulatory Research, Washington, D.C., 52 p.

NWPA (Nuclear Waste Policy Act), 1983. "Nuclear Waste Policy Act of 1982," Public Law 97-425, 42 USC 10101-10226, Washington, D.C.

Pippin, L. C., and D L. Zerga, 1983. Cultural Resources Overview for the Nevada Nuclear Waste Storage Investigations, Nevada Test Site, Nye County, Nevada, NVO-266, Nevada Operations Office, U.S. Department of Energy, Las Vegas.

Quade, J., and J. V. Tingley, 1983. A Mineral Inventory of the Nevada Test, and Portions of the Nellis Bombing and Gunnery Range, Southern Nye County, Nevada, DOE/NV/10295-1, U.S. Department of Energy, Nevada Operations Office, Las Vegas.

Reno, R. L., and L. C. Pippin, 1985. An Archaeological Reconnaissance of Yucca Flat, Nye County, Nevada, Technical Report No. 35, Desert Research Institute, Las Vegas, Nevada, pp. 99-110.

Rogers, A. M., S. C. Harmsen, W. J. Carr, and W. Spence, 1983. Southern Great Basin Seismological Data Report for 1981 and Preliminary Data Analysis, USGS-OFR-83-669, Open-File Report, U.S. Geological Survey, Denver, Colo.

Rosenberg, N. J., 1974. Microclimate: The Biological Environment, John Wiley & Sons, New York.

Rush, F. E., 1970. Regional Ground-Water Systems in the Nevada Test Site Area, Nye, Lincoln, and Clark Counties, Nevada, Department of Conservation and Natural Resources, Water Resources--Reconnaissance Series Report 54, State of Nevada, Carson City.

Scott, R. B., and J. Bonk, 1984. Preliminary Geologic Map of Yucca Mountain, Nye County, Nevada, with Geologic Sections, USGS-OFR-84-494, Open-File Report, U.S. Geological Survey, Denver, Colo.

Spengler, R. W., F. M. Byers, Jr., and J. B. Warner, 1981. Stratigraphy and Structure of Volcanic Rocks in Drill Hole USW G-1, Yucca Mountain, Nye County, Nevada, USGS-OFR-81-1349, Open-File Report, U.S. Geological Survey, Denver, Colo.

State of Nevada, ESD (Employment Security Department), 1984. Nevada Area Labor Review 1984, Economic Developments and 1985 Outlook, Carson City.

State of Nevada, OCS (Office of Community Services), 1985. Nye County, Nevada Profile, 1985 Edition, Carson City.

Thordarson, W., 1983. Geohydrologic Data and Test Results from Well J-13, Nevada Test Site, Nye County, Nevada, USGS-WRI-83-4171, Water-Resources Investigations Report, U.S. Geological Survey, Denver, Colo.

United States v. Mary Dann and Carrie Dann, 1985. The United States Law Week, February 19, 1985, No. 83-1478.

UNLV (University of Nevada Las Vegas), 1984. Las Vegas SMSA Study: Community Satisfaction and Educational and Political Attitudes, (computer printout), Department of Sociology, University of Nevada, Las Vegas.

USGS (U.S. Geological Survey) (comp.), 1984. A Summary of Geologic Studies through January 1, 1983, of a Potential High-Level Radioactive Waste Repository Site at Yucca Mountain, Southern Nye County, Nevada, USGS-OFR-84-792, Open-File Report, U.S. Geological Survey, Menlo Park, Calif.

Waddell, R. K., 1982. Two-Dimensional, Steady-State Model of Ground-Water Flow, Nevada Test Site and Vicinity, Nevada-Calfornia, USGS-WRI-82-4085, Water-Resources Investigations Report, U.S. Geological Survey, Denver, Colo.

Waddell, R. K., J. H. Robison, and R. K. Blankennagel, 1984. Hydrology of Yucca Mountain and Vicinity, Nevada-California--Investigative Results Through Mid-1983, USGS-WRI-84-4267, Water-Resources Investigations Report, U.S. Geological Survey, Denver, Colo.

Walker, M., 1985. Letter from M. Walker (Beatty Water and Sanitation District) to M. L. Brown (SAIC), November 5, 1985; regarding grant for engineering and hydrological study.

Wilkinson, K. P., J. G. Thompson, R. R. Reynolds, Jr., and L. M. Ostresh, 1982. "Local Social Disruption and Western Energy Development, a Critical Review," Pacific Sociological Review, Vol. 25, No. 3, pp. 275-296.

Winograd, I. J., and W. Thordarson, 1975. Hydrogeologic and Hydrochemical Framework, South-Central Great Basin, Nevada-California, with Special Reference to the Nevada Test Site, U.S. Geological Survey Professional Paper 712-C, Washington, D.C.

CODES AND REGULATIONS

10 CFR Part 60 (Code of Federal Regulations), 1983. Title 10, "Energy," Part 60, "Disposal of High-Level Radioactive Wastes in Geologic Repositories," U.S. Government Printing Office, Washington, D.C.

10 CFR Part 960 (Code of Federal Regulations), 1984. Title 10, "Energy," Part 960, "General Guidelines for the Recommendation of Sites for Nuclear Waste Repositories; Final Siting Guidelines," 49 FR 47714, Vol. 49, No. 236, December 6, 1984, pp. 47714-47769.

10 CFR Part 961 (Code of Federal Regulations), 1985. Title 10, "Energy," Part 961, "Standard Contract for Disposal of Spent Nuclear Fuel and/or High Level Radioactive Waste," U.S. Government Printing Office, Washington, D.C.

40 CFR Part 61 (Code of Federal Regulations), 1984. Title 40, "Protection of Environment," Part 61, "National Emission Standards for Hazardous Air Pollutants," U.S. Government Printing Office, Washington, D.C.

40 CFR Part 190 (Code of Federal Regulations), 1982. Title 40, "Protection of Environment," Part 190, "Environmental Radiation Protection Standards for Nuclear Power Operations," U.S. Government Printing Office, Washington, D.C.

40 CFR Part 191 (Code of Federal Regulations), 1985. Title 40, "Protection of Environment," Part 191, "Environmental Standards for the Management and Disposal of Spent or Nuclear Fuel, High-Level and Transuranic Radioactive Wastes: Final Rule," Federal Register Vol. 50, No. 182, September 19, 1985.

40 CFR Part 192 (Code of Federal Regulations), 1984. Title 40, "Protection of Environment," Part 192, "Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings," U.S. Government Printing Office Washington, D.C.

7 USC 4201-4209 (United States Code), "Farmland Protection Policy Act," Public Law, Washington, D.C.

16 USC 1531 et seq. (United States Code), 1973. "Endangered Species Act," Public Law, Washington, D.C.

C.5 POSTCLOSURE RADIOLOGICAL SAFETY

This section includes comments on the condition and performance of the repository over the long term, after it is closed and sealed. With the exception of issues related to climatic change and long-term site ownership, all comments address the geologic or hydrologic features of the site.

Comments in this category address the postclosure system guideline and all the suitability analyses for individual guidelines that support the evaluation of the system guideline. These include all analyses in support of the Environmental Protection Agency and Nuclear Regulatory Commission regulations governing the long-term performance of the repository (40 CFR Part 191 and 10 CFR Part 60). Many of these guidelines cannot be evaluated fully until after site characterization. This section, therefore, includes many comments that address some important data uncertainties about the repository system.

C.5.1 GEOHYDROLOGY

The geohydrology guideline addresses the present and expected characteristics of the geohydrologic setting of the site and related processes operating within this setting. The favorable, potentially adverse, qualifying, and disqualifying conditions establish the basis for determining if the geohydrologic characteristics and processes are compatible with waste containment and isolation. The 193 comments received in this category were divided into six issues: (1) General Comments and Challenges, (2) Travel-Time Calculations, (3) Flux Estimates, (4) Climatic Effects, (5) Unsaturated Zone Conditions, and (6) Saturated Zone Conditions.

Issue: General comments and challenges

Twenty-seven comments were received covering general concerns in geohydrology and challenging the adequacy of the data base that was available for evaluation of this guideline. The comments were subdivided into four topics: data adequacy, qualifying condition evaluation, site characterization, and miscellaneous.

Data adequacy. A few commenters questioned the approaches that will be used to test the applicability of conceptual models, to establish that appropriate field data will be obtained, and to maximize the utilization of the limited available data. Additional comments addressed the overall adequacy of the data base to support the conclusions reached in the Environmental Assessment (EA).

Response. The U.S. Department of Energy (DOE) intends to use computer models and professional judgment to refine and test conceptual models. As suggested in one of the comments, output from computer models is a valuable source of direction for future field-data acquisition. It is recognized that the DOE will need to establish by modeling and expert judgment that it has collected sufficient and representative data to support statistically valid conclusions. It is also recognized that a number of analytical approaches should be used in the case of a limited data base. This is exactly the

reasoning that has been applied to estimating flux in the unsaturated zone (see issue on flux estimates). On the question of the overall adequacy of the EA data base, it should be noted that Appendix III of 10 CFR Part 960 does not call for an unequivocal conclusion for qualifying and disqualifying conditions at the present stage of siting. Text changes have been made where appropriate to emphasize the uncertainties inherent in the data base, the conceptual models, and the resulting conclusions.

Qualifying condition evaluation. Some comments were directed at the qualifying condition for geohydrology, stating that evaluations are unsupported and misleading, that the appropriate conclusion would be that no information shows that the site is qualified, or that data are insufficient to draw any meaningful conclusions.

Response. The basis for a preliminary finding that a site may be nominated and recommended for characterization is reviewed in the first response under this issue, and is taken from Appendix III of the DOE siting guidelines. The DOE has evaluated the Yucca Mountain site against the technical guidelines, as required by 10 CFR Part 960, and has reached conclusions of site suitability on the basis of available evidence and best scientific judgment. Text changes throughout Chapter 6 of the final EA have been made to incorporate explicit statements of uncertainty where appropriate. The DOE agrees that information is insufficient to demonstrate that the site is qualified. This decision must await site selection. However, the evidence also does not indicate that the site is not qualified, which is the appropriate finding for the nomination and recommendation of a site for site characterization.

Site characterization. Questions were received relating to site characterization, noting that site-specific data are needed to apply regional models with reasonable certainty to site conditions and processes. It was suggested that future characterization may not change the finding on the third favorable condition, which presently concludes that the site cannot be readily characterized and modeled with reasonable certainty. Several commenters pointed out weaknesses in the brief section entitled "Plans for Site Characterization", specifically noting the difficulties in characterizing the vadose zone. Two commenters requested that some quantitative measures of the amount of investigation that has been conducted be added to the EA.

Response. The DOE recognizes that site characterization could lead to changes in the findings on the technical guidelines. Reevaluation after site characterization is explicitly required for the qualifying and disqualifying conditions by 10 CFR 960.3. The need for more site-specific data to refine and test conceptual models and to apply regional models to site-specific problems is recognized (see the first response under this issue). All aspects of vadose zone hydrology, including fracture flow under saturated conditions, will be studied during site characterization by field testing, in situ testing, laboratory experiments, and numerical analyses and simulations. Information pertaining to the types of site investigations conducted to date are covered as part of the discussion in Section 6.3.1.1.2 and in relevant data sections of Chapter 6. Data from these investigations that were relevant to and representative of site conditions and processes were used in evaluating the suitability of the site for characterization.

Miscellaneous. The miscellaneous comments addressed concern about public health and safety, the conservatism of conclusions regarding behavior of natural barriers at the site, a question of the need for engineered barriers, and the need for an expanded discussion of the basic premises that underlie unsaturated zone disposal.

Response. The DOE is required to meet the requirements of the DOE siting guidelines, the Nuclear Regulatory Commission (NRC), and the Environmental Protection Agency. These requirements should adequately ensure the protection of public health and safety. Although engineered barriers are not used in the evaluations of technical guidelines in support of site suitability, they are to be considered in order to establish that the presence of engineered features will not degrade performance of natural barriers. It should also be noted that the NRC requirement for substantially complete containment for 300 to 1,000 years is intended to ensure that the most hazardous materials, which are present early in the decay process, have been reduced to low levels if and when the period of controlled release begins. The DOE has taken a conservative position in the preliminary assessment of performance. It is recognized that further data and analysis are needed to assess repository performance with the level of confidence eventually required by the NRC.

The basic premises regarding unsaturated zone disposal are covered as part of the discussion in the postclosure system guideline, Section 6.3.2.2.1, except for the point mentioned in the comment that dilution of vadose water by the larger quantities of water in transit in the saturated zone should be considered in the overall evaluation. This aspect of isolation which is provided by the unsaturated zone will be further evaluated as flow paths are better defined during site characterization.

Issue: Travel-time calculations

Forty-four comments were received addressing various aspects of the travel-time calculations that support the evaluation of the disqualifying condition and the first favorable condition. These comments were subdivided into the following topics: challenges to travel times, uncertainties in calculations, and isotope ages of ground water.

Challenges to travel times. Numerous comments contained specific challenges to the DOE conclusions that the travel time from the disturbed zone to the accessible environment exceeds 1,000 years, as required by the disqualifying condition, and that the travel time, in fact, exceeds 10,000 years, as required for claiming the first favorable condition. Several of the commenters challenged the use of 1 millimeter (0.04 inch) per year as the likely flux, and requested that ranges of values for flux and other hydrologic properties and parameters be used to establish a range of travel times that include fracture-flow scenarios. Given the uncertainty and variability in many of the properties and parameters and the absence of critical data, several commenters stated that little confidence should be placed in calculated travel times and, further, that claims of conservatism are unjustified. An alternative travel-time calculation is provided in one of the comments, and results of this calculation were used to claim that the travel time may be less than 1,000 years.

Response. The draft EA text in Section 6.3.1.1 has been revised to include discussion of uncertainties related to travel-time calculations. Section 6.3.1.1.5 has been revised, and total travel-time distributions for the upper bound on expected flux of 0.5 millimeter (0.02 inch) per year are given. The travel-time calculations provided in one of the comments were based on estimated variability in measured hydrologic parameters, whereas the revised travel-time calculations in Section 6.3.1.1.5 are based on random sampling of hydrogeologic parameters for many 10-foot-thick elements in each hydrogeologic unit. The means and standard deviations for effective porosity and saturated matrix conductivity for the hydrogeologic units considered in the travel-time calculations are also presented in the revised text in Table 6-17.

For purposes of calculating travel times, the three-dimensional volume of each hydrogeologic unit beneath the repository area was subdivided into vertical columns and then further subdivided into 10-foot-thick increments. Particle velocity for each element within a hydrogeologic unit was determined by randomly sampling a value of saturated hydraulic conductivity from a range of values appropriate for that unit. This form of random sampling is referred to as random field sampling; the probability of selecting a given parameter value is determined by the shape of the frequency distribution for that parameter. The selected conductivity value was compared with the flux to determine whether flow was through the matrix or through fractures. If the flow was found to be through the porous rock matrix, a particle velocity was calculated by dividing the flux value by a randomly selected value for effective porosity. If the flow occurred through fractures, the velocity of flow was determined by dividing the calculated value of flux in the fractures by 0.0001, the assumed effective porosity for all fracture flow in the unsaturated zone. The portion of flux remaining in the matrix and this value were used to obtain a matrix flow time as well as a fracture flow time for each element characterized by fracture flow. This procedure was repeated for each 10-foot-thick element within each of 963 vertical columns. The sum of all individual element travel times through each column represents one realization of total travel time. The procedure was repeated 10 times for each column to give a representation of the variation in travel time due to the uncertainty from sampling of hydraulic parameters. Results are shown as a total travel-time histogram and cumulative frequency curves for each hydrogeologic unit.

An alternative approach to the calculation of travel times is also presented in Section 6.3.1.1.5, whereby one value of conductivity and effective porosity was sampled for the entire thickness of each column in each hydrogeologic unit. This approach yields higher, but probably physically unrealistic, estimates of the probability of continuous fracture flow and rapid matrix flow than the sampling method just described, which more realistically accounts for vertical as well as horizontal variation in the hydraulic parameters. The results for this highly conservative alternative approach are included in the text to indicate the potential isolation qualities provided by the rock due to variations in hydrologic parameters in the vertical direction and to acknowledge travel times that could occur in the highly unlikely event that fracture flow were sustained throughout continuous vertical paths within each hydrogeologic unit.

Miscellaneous. The miscellaneous comments addressed concern about public health and safety, the conservatism of conclusions regarding behavior of natural barriers at the site, a question of the need for engineered barriers, and the need for an expanded discussion of the basic premises that underlie unsaturated zone disposal.

Response. The DOE is required to meet the requirements of the DOE siting guidelines, the Nuclear Regulatory Commission (NRC), and the Environmental Protection Agency. These requirements should adequately ensure the protection of public health and safety. Although engineered barriers are not used in the evaluations of technical guidelines in support of site suitability, they are to be considered in order to establish that the presence of engineered features will not degrade performance of natural barriers. It should also be noted that the NRC requirement for substantially complete containment for 300 to 1,000 years is intended to ensure that the most hazardous materials, which are present early in the decay process, have been reduced to low levels if and when the period of controlled release begins. The DOE has taken a conservative position in the preliminary assessment of performance. It is recognized that further data and analysis are needed to assess repository performance with the level of confidence eventually required by the NRC.

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The assumptions underlying these travel-time calculations are that unsaturated zone flux below the disturbed zone is vertical and uniformly distributed in time and space, the hydraulic gradient in the unsaturated zone is unity (only vertical flow occurs), the effective hydraulic conductivity through the matrix of any given rock volume is equal to the flux (i.e., the saturation adjusts to a conductivity exactly sufficient to pass the flux), and that water does not flow through fractures until flux reaches about 95 percent of the saturated matrix conductivity. Given those assumptions, particle velocity is simply flux divided by effective porosity.

The travel time in the saturated portion of the flow path is calculated for a distance of 5 kilometers (3 miles), using a hydraulic gradient of 3.3×10^{-4}, which was derived from water level measurements.

In the case of the disqualifying condition (10 CFR 960.4-2-1), the requirement is that "... the pre-waste-emplacement ground-water travel time from the disturbed zone to the accessible environment is expected to be less than 1,000 years along any pathway of likely and significant radionuclide travel." Because this condition is a restatement of the travel-time requirement from 10 CFR Part 60, a recent clarification of the NRC performance objective should be noted. A letter from the NRC to the DOE (Browning, 1985) states that the "likely" modifier in the NRC performance objective anticipates that theoretically possible, but extremely unlikely, paths will be excluded when determining whether the performance objective has been met.

Considering the evidence available to date for the pre-waste-emplacement travel times at Yucca Mountain, the mean unsaturated zone travel time is about 43,000 years; the range of unsaturated zone travel times is estimated to be from 9,345 to 80,095 years. Adding the 5-kilometer (3-mile) saturated zone travel time gives a minimum travel time of 9,485 years and a maximum travel time of 81,235 years. These travel times are given in Section 6.3.1.1.5; they demonstrate that the Yucca Mountain site meets the requirements for not being disqualified with respect to the geohydrology disqualifying condition.

For the first favorable condition, the evaluation is to be for "... any path of likely radionuclide travel". This condition does not specify that significant quantities of radionuclides are likely to follow the path. Therefore any path that could transport radionuclides must be considered in this evaluation. As stated above, the range of travel times is between 9,485 and 81,235 years; only one realization out of 9,630 realizations of the travel time model produced a travel time less than 10,000 years. The favorable condition is therefore judged to be present.

Uncertainties in calculations. Many comments were received regarding various aspects of uncertainty on the parameters used to calculate travel times; they suggested that further studies are necessary to adequately characterize both unsaturated and saturated conditions. Several commenters suggested that a range of saturated zone travel times should be calculated because of simplistic models and paucity of appropriate data. Other commenters pointed out that uncertainties in flux estimates should be stated and the potential effects of higher fluxes should be considered. Effective porosities and hydraulic conductivities in the EA were noted to be provided as single or mean values, with no ranges given and no explanation of why

these values were judged to be conservative. One commenter noted that the degree of saturation was not taken into account for travel-time calculations, and another noted that the cross-over point between matrix and fracture flow cannot be predicted at current levels of understanding. One commenter noted that specific NRC siting regulations have not been met; another noted confusion over the manner in which the disturbed zone was defined in the EA. The possibility for rapid water flow through fractures was mentioned in several comments, and one commenter suggested that the overall uncertainty in estimates of travel time must be the additive uncertainty in all of the parameters used to calculate travel time. Two commenters stated that it would be useful to include the effects of heat in the ground-water travel time estimates.

Response. The DOE agrees that further studies are required to adequately characterize the unsaturated and saturated zones at Yucca Mountain. Various surface and in situ experiments and tests will be conducted during site characterization to attain this goal. The final EA considers a range of effective porosities and saturated hydraulic conductivities in the unsaturated zone travel-time calculations presented in Section 6.3.1.1.5. The text has been revised to convey more accurately the basis for using an upper bound on flux of 0.5 millimeter (0.02 inch) per year for the unsaturated zone travel-time calculations. A flux value of 1.0 millimeter (0.04 inch) per year was also considered in estimating travel times to adequately take into account the potential impacts of a higher flux. The current ranges of effective porosity and saturated hydraulic conductivity for each hydrogeologic unit are provided in Section 6.3.1.1.5 (Table 6-17), along with references to the sources of the values. The DOE disagrees that degree of saturation was not taken into account for travel-time calculations, because estimates of effective porosity took into account the estimated percent of voids drained.

With regard to the comment that cross-over points between fracture and matrix flow cannot be predicted, a recent computer simulation study by Wang and Narasimhan (1985) developed a statistical theory to describe flow along and across fractures that separate partially saturated matrix blocks. Their simulations indicate that fluid flow in a partially saturated, fractured, porous rock unit can be simulated approximately without taking fractures into account. However, to simulate the response of this rock unit to non-steady-state fluid flow that included sufficient flux to induce some fracture flow would require characterization and simulation of fracture network geometries and knowledge of discrete fracture characteristics. This detailed fracture information would be very difficult to obtain.

The comment noting that the NRC siting regulations have not been met illustrates a misconception about the purpose of the EA. NRC requirements for siting will not be applied until licensing interactions between the NRC and the DOE are in process for a potential repository. The purpose of Chapter 6 of the EA is to provide a detailed statement of the basis for nominating a site as suitable for characterization, as required by the Nuclear Waste Policy Act (NWPA, 1983).

Final definition of the boundaries of the disturbed zone will not occur until further understanding of the perturbing effects of a repository have been developed. For purposes of calculating travel times, the assumed

position of the disturbed zone is 50 meters (164 feet) below the centerline of the repository, and it is thought to be unlikely that repository-induced changes beyond these distances could significantly affect repository performance. In the calculations of travel time and in computer simulations of travel times, the possibility for rapid water velocities during fracture flow is explicitly considered. On the question of additive uncertainties, the final EA discussions of travel time clearly describe uncertainties in the calculations. However, it should be noted that extreme application of this philosophy can lead to totally unrealistic predictions that are far removed from the expected conditions and processes.

Heat effects on rock properties that might influence postclosure travel times will be studied during site characterization through performance assessment scenario analysis. The disqualifier for geohydrology is for pre-emplacement travel time and heat is not appropriately considered for that calculation.

Isotope ages of ground-water. Commenters questioned the absence of data from established isotope techniques for dating water and determining travel times. It was suggested that tritium levels could be used to estimate the period of time that water had been out of contact with the atmosphere. Using this approach, one commenter suggested that several wells in Fortymile Wash may contain water components as young as 30 years old. It was further suggested that carbon-14 ages may indicate rapid ground-water movement or substantial recharge through Yucca Mountain. One commenter suggested that travel velocities in fractures within the Rainier Mesa vadose zone have been estimated at meters per day, and further stated that the presence of 10,000-year-old ground waters at Yucca Mountain indicates that either the carbon-14 ages are wrong or the travel-time estimates are off by about a factor of 2. Another commenter combined a question of ground-water age estimates with a statement that no evidence was offered to support the conservatism of placing the disturbed zone at the base of the Topopah Spring welded unit.

Response. Isotope ages for ground water are reported by Claassen (1983); Benson et al. (1983); and Waddell et al. (1984). Tritium data mentioned in the comments may indicate a "soil-water" contribution, although obtaining uncontaminated samples has been difficult in the past and results are not definitive. Claassen (1983) suggests that a major recharge event between 9,000 and 17,000 years ago can be detected by use of carbon-14 ages. The comment regarding the possibility of rapid recharge at Yucca Mountain does not consider the fact that a 10,000-year-old carbon-14 age represents a minimum age for the water. The possibility of mixing of water of different ages, and of the occurrence of local recharge events beneath intermittent streams, makes the isotope age-dating technique an inexact science. Use of corrected carbon-14 ages must contain specification of the correction method used, because no unique solution is possible. A lack of agreement between hydraulically computed velocities and geochemically computed velocities is not surprising. The assumptions are different, and it may be erroneous to assume that water sampled down the hydraulic gradient from another sampling locality is necessarily derived solely from the up-gradient sample. As a result 10,000-year-old water at Well J-13 and a calculated 20,000-year travel time from the repository to the water table are not necessarily contradictory.

Rapid travel times in other layered volcanic sequences are possible, depending critically upon the infiltration and the current degree of saturation. In the case of Rainier Mesa, elevations are 2,250 to 2,340 meters (7,380 to 7,675 feet) (White et al., 1980), whereas the elevation at Yucca Mountain is about 1,500 meters (4,920 feet). Using tables in Czarnecki (1985), recharge at Rainier Mesa would be expected to be at least 7 percent of the annual precipitation, which is currently about 200 to 300 millimeters (7.8 to 11.7 inches) (Figure 7, Czarnecki, 1985). Recharge at Rainier Mesa is probably a minimum of 50 millimeters (2.0 inches) greater than average precipitation at Yucca Mountain; an upper bound on recharge at Yucca Mountain is estimated to be 3 percent of precipitation.

The critical factor regarding travel times in partially saturated, fractured, porous tuff is clearly indicated on the simulations reported by Wang and Narasimhan (1985) and a comparison of degree of saturation in the two tuff settings. Zimmerman (1983) reports that saturation at depth in a welded tuff unit at Rainier Mesa is 95 percent, whereas average saturation in the welded Topopah Spring Member at similar depths at Yucca Mountain is 65 percent (Montazer and Wilson, 1984). Wang and Narasimhan (1985) show that at points near full saturation, the role of fractures is critical in modeling fluid velocities. They point out that vertical velocities in fractures increase rapidly and peak just before the fracture becomes desaturated. After the fractures desaturate, velocities can be approximated by a porous matrix velocity. These results indicate that at higher degrees of saturation, as is the situation at Rainier Mesa, rapid fracture flow is very probable. All evidence to date suggests that very limited fracture flow occurs within the Topopah Spring welded unit under current conditions, although some fracture flow may occur when lateral flow carries excess net infiltration to structural features (Montazer and Wilson, 1984).

The comment on the conservatism of the position of the disturbed zone is covered under the immediately preceding response.

Issue: Flux estimates

Twenty-seven comments were received regarding the approaches for estimating fluxes, the uncertainty of current flux estimates, and the validity of the conceptual model for unsaturated flow. The comments have been subdivided into the following topics: unsaturated zone conceptual model and current flux estimates.

Unsaturated zone conceptual model. Several comments addressed aspects of the conceptual model for the unsaturated zone developed by Montazer and Wilson (1984). Two commenters suggested that the model is treated as though it has been verified and that data are insufficient to reach this conclusion, particularly because other models could be developed. Another commenter suggested that fracture flow is plausible in the densely welded units, although available data are insufficient to resolve this question. Two commenters point out field data for the vitric Calico Hills nonwelded unit that is judged to conflict with predictions of the conceptual model. Other commenters questioned the validity of the capillary-barrier concept.

Response. Text in the EA has been revised to explain how computer modeling will be used in an iterative fashion to refine and test conceptual

models as more data are obtained during site characterization. Given the current understanding of unsaturated flow, the conceptual model is judged to be sufficiently flexible to accommodate improved understanding of the unsaturated zone. If found to be invalid, the conceptual model will be revised.

The DOE believes the concepts of lateral flow, permeability barriers, and capillary barriers are supported by available field data and preliminary results of modeling. The EA text has been revised to elaborate on the evidence that supports this conclusion and to provide additional references. It is not correct, as stated in one of the comments on this topic, that the flux entering through the Tiva Canyon Member must equal the recharge beneath the primary repository area. As discussed in Montazer and Wilson (1984), lateral diversion to bounding faults may cause very limited recharge directly beneath the primary repository area. A higher degree of saturation in the lower Calico Hills nonwelded unit could result from capillary forces drawing water upward from the water table. In addition, water contents reported for the Calico Hills are from both the saturated and unsaturated zones. All of the reported unsaturated zone cores were drilled with foam or water. Preliminary results to date suggest that neither wet- nor dry-drilling methods cause significant changes in water content of core samples. The Calico Hills vitric facies is underlain by a thick zeolitic facies throughout the primary repository area (Montazer and Wilson, 1984) although in part of the area, the zeolitic facies is in the saturated zone. Travel-time calculations are provided for both the vitric and zeolitic Calico Hills units in Section 6.3.1.1.5 of the EA.

The DOE acknowledges that direct evidence is currently lacking to support the concepts of permeability and capillary barriers. Evidence of very low flux in the Topopah Spring unit (Montazer et al., 1985) combined with estimates of higher values of regional recharge fluxes support the concept of lateral flow and the probable effectiveness of the capillary barriers. Perched water is not required for lateral flow to occur, as was suggested by several commenters.

Current flux estimates. Numerous comments addressed aspects of the evidence supporting the current flux estimates for Yucca Mountain. The nature of the contact between the Topopah Spring welded unit and the Calico Hills nonwelded unit was questioned, as was the support for the statement claiming there is no evidence for fracture flow in the host rock. One commenter suggested that authigenic minerals in fractures provide indirect evidence for fracture flow. The long-term constancy of flux was challenged as well as the lack of consideration of future possible higher infiltration rates. Current flux estimates were challenged as unsupported or poorly supported, and it was noted that the vadose zone has not been adequately characterized, particularly with regard to the potential for retardation. Uncertainties in infiltration estimates were noted as an additional source of uncertainty in flux. One commenter noted that because the site cannot presently be readily characterized and modeled with reasonable certainty, there is no proof that future studies will reach this goal, and that other conclusions are weakened by this fact. One commenter pointed out that if current flux estimates were established to be too low, then travel times may

not meet the 1,000 year requirement. It was also noted that fracture flow can occur at almost all stages of saturation, according to Montazer and Wilson (1984), and that the proposed model is not the only reasonable description of available information.

Response. Using various lines of evidence, the DOE has concluded that the downward flux in the host rock probably is less than 0.5 millimeter (0.02 inch) per year. The conclusion is based on information presented in Wilson (1985). The DOE has revised Section 6.3.1.1.5 of the EA to convey more accurately the basis for the estimate of flux and has included statements concerning the degree of uncertainty.

According to the conceptual model (Montazer and Wilson, 1984), little if any flow occurs in the fractures of the lower part of the Topopah Spring welded unit and flow probably enters the Calico Hills unit from the matrix. The nature of flow at the contact between the Topopah Spring and Calico Hills units depends on whether the vitric or zeolitic facies of the Calico Hills nonwelded unit are present. The pore sizes of the vitric facies are much larger than those of the matrix of the Topopah Spring unit and may result in a capillary barrier where those units are in contact. Conversely, the pore sizes of the zeolitic facies are about the same as for the matrix of the Topopah Spring unit, resulting in continuity of matrix flux across the contact. Flux within the Calico Hills nonwelded unit probably occurs with some lateral component of down-dip flux because of the existence of layers with contrasting hydraulic conductivity in the unit. Water that flows down dip along the top of the Calico Hills nonwelded unit slowly percolates into this unit and slowly diffuses downward. This down-dip flow probably persists for longer distances along the upper contact of the zeolitic facies, which has less permeability than the vitric facies. In either case, flux into each facies is more or less distributed evenly. Fracture flow may occur within the uppermost layers of the Calico Hills unit, but diffusion into the matrix probably removes the water from the fractures deeper in the unit, and flow becomes limited mostly to within the matrix except along the structural flowpaths, according to the conceptual model of Montazer and Wilson (1984).

Theoretical curves presented in Montazer and Wilson (1984) indicate that fracture flow can occur even at low saturations; however, fracture flow under such conditions is likely to occur only along fracture walls and would be at velocities similar to matrix flow. Although the DOE believes matrix flow also is predominant in the welded units under current values of flux, travel-time calculations in the final EA (Section 6.3.1.1.5) consider both matrix and fracture flow in all units depending upon the ratio of saturated matrix conductivity to the flux value, as described in the first response under travel-time calculations.

The DOE agrees that the unsaturated zone has not been adequately characterized to date, and many in situ, surface-based, laboratory, and numerical tests and experiments are planned during site characterization to remedy this situation. The DOE believes that the level of understanding will be sufficient to model and describe the processes with reasonable certainty after site characterization.

Travel-time calculations are based on what the DOE believes to be conservative values of percolation through the host rock. Revised Section 6.3.1.1.5 of the final EA includes calculations for an upper bound on expected flux of 0.5 millimeter (0.02 inch) per year, and for 1 millimeter (0.04 inch) per year to take into account the unlikely scenario of flux values twice the current recharge estimate beneath Yucca Mountain. An evaluation of the appropriateness and degress of conservatism of the flux estimates is also included in the EA. Effects of higher percolation rates expected during pluvial times are not appropriate for calculations of pre-waste-emplacement travel times. In addition, evidence from authigenic minerals about fracture flow may represent previous high levels of the water table or may represent near-surface deposition in the pedogenic zone (Vaniman et al., 1985).

Geochemistry of the vadose zone is covered in EA Section 6.3.1.2 and in Section C.5.2 of this document. The DOE position is that some retardation will occur due to sorptive zeolites and matrix diffusion, even under conditions of fracture flow. For a discussion of comments on the 1,000-year travel time, see the second issue in this section, which covers travel-time calculations.

Issue: Climatic effects

Nineteen comments were received regarding the question of how climatic change will affect specific aspects of site suitability related to the geohydrology technical guideline. A number of other comments on climatic change are covered in Section C.5.4 of this document. One commenter stated that the effects of future climatic changes on flux rates, development of perched water, and radionuclide travel times have not been adequately addressed to date. Several commenters questioned the DOE claim that the nature and rates of expected climatic effects would not significantly affect isolation over the next 100,000 years, and suggested that a topic should be added to the first potentially adverse condition to explicitly cover "... changes in elevation of the water table." It was also suggested that expected pluvial conditions, which could increase flux by a factor of 15, indicate that the first potentially adverse condition is present at Yucca Mountain. Several commenters challenging this condition suggested that reliance on retardation under conditions of increased recharge and fracture flow is not warranted. One commenter suggested that current conditions at Rainier Mesa that cause significant fracture flow are probably not unlike those that would exist at Yucca Mountain during a pluvial period. Several commenters questioned the approach used to estimate precipitation-recharge relationships by Czarnecki (1985), noting that expected infiltration in Fortymile Wash is critical in determining water-table levels, and that recharge estimates are tenuous and not valid for site-specific applications. It was also noted that the evaluation of climatic effects did not adequately cover shortened flow paths and the potential for perched zones and springs. Several commenters also offered corrections to factual errors in the text.

Response

The DOE acknowledges that key licensing issues have not been resolved to date. Except in the case of issues that require no site characterization, this would not be expected nor would it follow the intent of the Nuclear

Waste Policy Act (NWPA, 1983). Preliminary site suitability evaluations to support nomination for site characterization is the first step.

The DOE agrees that a return to pluvial conditions could result in geohydrologic changes, namely increased recharge, rising water table, possible fracture flow, and changed gradients and flow paths in the saturated zone. What is not understood at this time is what effects these changes would have on percolation through the Topopah Spring welded unit host rock (i.e., how effective capillary barriers and lateral flow would be at diverting the increased infiltration and maintaining low fluxes through the host rock within the repository block). Furthermore, even if direct sorptive effects are reduced under fracture-flow conditions, matrix diffusion may still provide an effective retardation factor of 400 (Travis et al., 1984). The EA was revised to include an assessment of the effects of changes in water-table elevations based on computer simulations (Czarnecki, 1985), and a discussion of uncertainty in the predicted water table altitude was also added.

The estimate of an increase in flux by a factor of 15 corresponds to a 100-percent increase in precipitation that was used by Czarnecki (1985), based on field studies by Spaulding et al. (1984). The EA points out that up to two-thirds of the increased precipitation may, in fact, become run-off rather than net infiltration. A detailed discussion of the potential similarities and differences between Rainier Mesa and Yucca Mountain is provided in the third and final response under the travel-time calculations issue in this section. There it is noted that the role of fracture transport is critically dependent upon the degree of saturation, and it is unknown whether the host rock and underlying units at Yucca Mountain would reach the current high saturations (greater than 95 percent) observed at Rainier Mesa under expected future pluvial conditions.

The precipitation-recharge relationship used by Czarnecki (1985) is regional, as noted in the comments. However, the Yucca Mountain site is included in the original region over which recharge was estimated by Rush (1970). Therefore, the site-specific application may be more reliable than suggested by the comments. Discussions in the final EA text more clearly specify the uncertainties in recharge estimates and predictions of water-table changes.

It is true that discharge points could occur at some location upgradient from existing discharge points, under conditions of increased recharge (Czarnecki, 1985). However, these points would still be beyond the boundary of the accessible environment, and thus per se would not affect transport of radionuclides to the accessible environment. Perched water tables and springs are not considered likely at the repository level or above. This is in part due to the presence of vitric pumice which is unlikely to have remained unaltered if past moisture conditions were near saturation. Preliminary conclusions are that the travertine and opal observed in fault traces near Yucca Mountain are unrelated to hot spring activity (Vaniman et al., 1985). The EA text corrections in response to comments include several conversion errors in the predicted water table increase, and a change in wording in Section 6.3.1.1.6 to indicate that 130 meters is not a "small" change.

Issue: Unsaturated zone conditions

Fifty comments were received on the issue of unsaturated zone conditions. A number of these comments questioned the concept of free drainage in the unsaturated zone, as well as the evidence for lateral diversion. Uncertainties on measurements and estimates of hydrologic conditions were also the subject of a number of comments. The comments were subdivided into the following four topics: free drainage, infiltration estimates, hydrologic conditions, and corrections and clarifications.

Free drainage. Several commenters questioned aspects of the evidence for free drainage in the host rock. A number of commenters questioned the relationship between air and rock-mass permeabilities; several additional commenters claimed that core analysis results provided by Weeks and Wilson (1984) show that the matrix does not drain, and that apparent perched water encountered in boreholes also suggests that the rock does not drain freely. Four commenters noted confusion over the question of the favorability of free drainage, particularly pointing out that free drainage of radionuclide-bearing water would be highly unfavorable. Several commenters also pointed out that to get free drainage, fracture flow is required, with fluxes in excess of 1 millimeter (0.04 inch) per year for the host rock. In this case, free drainage would lead to short travel times to the accessible environment.

Response. The concept of free drainage is confusing in Chapter 6 of the EA. In the geohydrology guideline (Section 6.3.1.1.3), one of the favorable conditions that is noted for unsaturated zone disposal is free drainage. However, in Section 6.3.1.3.3 on rock characteristics, fracture development that could enhance free drainage is not a favorable condition. It is clear that the difference should be related to whether the freely draining water has contacted the waste and picked up radionuclides. If the free drainage limits the potential contact time of water with the waste, it may serve to limit the amount of radionuclides that can be transported. Alternatively, if the free drainage could in some manner occur after the water has reached saturation with radionuclides, then the effect is clearly unfavorable.

Montazer and Wilson (1984) discuss the measurements of air permeability and reference Montazer (1982) for a complete explanation of the relationship of air permeability measurements to bulk hydraulic conductivities. Free drainage must be evaluated at several scales. Weeks and Wilson (1984) may indicate that the matrix does not drain as suggested in the comment; however, this is for an assumption of unit hydraulic gradient. Presumably the matrix is freely drained as long as gravitational or potential forces overcome capillary-attraction forces.

The EA text has been revised to discuss more fully the evidence regarding free drainage of the host rock. The DOE believes that the general nature of the host rock indicates that the capacity for free drainage exists beneath the repository block. This conclusion is supported by data from borehole USW UZ-6, which was drilled dry and showed no perched water in the host rock. The perched water that was encountered in USW UZ-1 was contaminated with drilling fluid, most likely to have come from USW G-1, which was only about 305 meters (approximately 1,000 feet) away (Henderson and Benson, 1983; Whitfield, 1985). Boreholes USW H-1 and USW UZ-1 are at the margin of the repository block, in a setting where perched water might be

encountered according to the conceptual model. The DOE believes that a time element should be incorporated into the concept of free drainage; if drilling fluid is introduced, some time will be required for the water to drain away, even under free drainage conditions. In the final EA, the DOE does claim the subcondition for free drainage.

Infiltration estimates. Estimates of and methods used to estimate infiltration were questioned in six comments. Several commenters pointed out that high-intensity, short-duration storms and winter snows produce infiltration, some part of which is not lost through evapotranspiration. Several commenters also pointed out that direct measurements of infiltration have not been made at Yucca Mountain and that the DOE should have specific plans as to how this data will be obtained. The Rush (1970) statement that approximately 3 percent of precipitation is expected to provide recharge was challenged. Absence of springs and seeps along washes as evidence for little or no interflow was challenged as negative evidence.

Response. The EA text in Section 6.3.1.1.3 has been revised to clarify the statements on potential evapotranspiration and infiltration. The DOE acknowledges that direct evidence is lacking to support infiltration estimates at this time. Better estimates of infiltration will be available during site characterization in the exploratory shaft. Plans for determining infiltration will be described in Chapter 8 of the Site Characterization Plan. The Yucca Mountain site has been subjected to a number of geological and environmental field surveys; springs or seeps that are the result of interflow of any significant duration would have been discovered.

Hydrologic conditions. Thirteen commenters addressed various aspects of the variability and uncertainty in hydrologic conditions in the unsaturated zone. Comments were received questioning the evidence for degree and constancy of saturation; the evidence for low and downward hydraulic gradient; the evidence for effective permeability; the evidence for diversion of downward percolation causing lateral flow; the role of discrete fault zones in fluid transport; the evidence for capillary barriers; the evidence for the capillary fringe; and the estimates of effective porosity.

Response. Variability in reported saturations is, in part, due to measurement errors that result from measuring moisture content in low-porosity rocks. As the water table or low permeability barriers are approached, local changes in saturation are likely to occur. The subcondition in Section 6.3.1.1.3 on constancy of saturation is assumed to apply to spatial variability rather than constancy of saturation through time. References to paleohydrology were deleted in the final EA text. It is agreed that the terms "dry unsaturated zone" should not be used, and the final EA has been revised to reflect this point. The DOE also agrees with the comment that drilling fluids should not be used in boreholes that are to provide moisture content data. However, several recent unsaturated zone holes were vacuum-air drilled, and preliminary results suggest the introduction of drilling fluids in the past have not caused significant changes in moisture conditions of the matrix. For comments pertaining to favorable condition 4, all text supporting the subconditions has been deleted because this condition explicitly pertains to saturated zone disposal only. Comments regarding low and downward hydraulic gradient and effective porosity in the host rock and surrounding units are in this category.

The minimum distance between the top of the Calico Hills nonwelded unit and the water table is about 30 meters (about 100 feet). Above this unit is the Topopah Spring welded unit, and it is considered unlikely that capillary rise in the fractures of the welded unit would extend more than a few centimeters (Montazer and Wilson, 1984). Therefore, the question of the extent of the capillary fringe must specify whether the fringe is in the matrix or in the fractures. Discussions of effective permeability and lateral diversion in Section 6.3.1.1.3 have been revised to reflect a comment that a pulse of infiltration may induce lateral flow at welded-nonwelded contacts because air becomes trapped in the nonwelded unit and decreases its effective permeability to water.

It should be noted that full or near saturation is not required for lateral flow, particularly when the flow is driven by gravitational forces. There is no direct evidence yet for permeability and capillary barriers. However, the estimates of average recharge are much greater than can be accounted for by the matric potential in the Topopah Spring welded unit, suggesting that lateral flow has diverted some flux so that it does not reach the Topopah Spring welded unit.

The DOE acknowledges that the Ghost Dance Fault may serve as a conduit for downward flow, although current flux conditions in the Topopah Spring Member do not appear to support extensive fracture flow. In fact, Montazer et al. (1985) report that field evidence suggests an upward component of vapor flux rather than downward moisture flux which may exist in the fractures on the Topopah Spring welded unit. Hydrologic characteristics of the fault will be assessed during site characterization.

Corrections and clarifications. Discrepancies in EA text were noted in a number of comments under this issue. Two commenters mentioned an omission of the consideration of thermal effects in the fluid flow regime under the first potentially adverse condition. Several commenters suggested text corrections and noted missing references and incorrect citations.

Response. The first potentially adverse condition applies to expected changes in hydrologic conditions that are not induced by the repository. Thermally induced changes are covered in Section 6.3.1.3 on rock characteristics. The discussion of favorable condition 4 in Section 6.3.1.1.3 has been deleted because this condition applies to saturated disposal only. Omitted text from Section 6.3.1.1.3 in the discussion of diversion of infiltration has been added, and the meaning of this section has been clarified. During revision of the calculation of travel times, errors were corrected in Section 6.3.1.1.5. Incorrect citations in the EA text to statements regarding limited infiltration and recharge in Quiring (1965) and Winograd and Thordarson (1975) have been corrected.

Issue: Saturated zone conditions

Twenty-six comments were received addressing questions about saturated zone conditions at Yucca Mountain. These comments covered a number of different subjects and were subdivided into the following topics: water table, role of fractures, evidence from springs, and corrections and general comments.

Water table. A few commenters noted that a fracture flow system could produce a water table surface with abrupt changes in elevation, making it difficult to characterize and model. It was suggested that use of average hydrologic parameters in this type of system could cause large errors in travel-time estimates.

Response. The DOE agrees that a fracture-flow ground-water system does not necessarily produce a smooth water table, and the description of the potentiometric surface has been qualified in the EA text. Models are being improved to better represent expected conditions at the Yucca Mountain site. Data will be collected during site characterization to test and refine the models.

Role of fractures. Commenters questioned the effects of unidentified subsurface fracture zones and the impact of dissimilarity between surface and subsurface fracture characteristics.

Response. In general, fracture orientations in the subsurface are in good agreement with surface fracture orientations (USGS, 1984). This statement is also true with regard to the orientation of faults that indicate the most recent movement. It is expected that some fault planes become less steep with depth; this can lead to lack of correlation of surface and subsurface data unless changes in orientation with depth can be predicted. Nonwelded units also tend to behave differently from more brittle welded units and therefore smaller features such as cooling joints are unlikely to be continuous.

Evidence from springs. Some commenters suggested the existence of deep-circulating springs or seeps in the Yucca Mountain area, and one commenter requested information about potential mixing between aquifers.

Response. No springs are currently known to occur near Yucca Mountain or within a 10-kilometer (6-mile) radius of the site. Regional and local heat flow is relatively well studied, and extreme anomalies are not observed. The possibility that carbonate deposits located in trenches represent spring deposits is under investigation; however, preliminary conclusions are that these deposits formed at or near surface temperature and that their formation is related to pedogenic processes (Vaniman et al., 1985). Only one data point is available to indicate the possibility for mixing of deep and shallow aquifers. Waddell et al. (1984) reports that the head in the deeper carbonate aquifer is about 20 meters (66 feet) higher than in the overlying tuff aquifer at Well UE-25p#1, indicating flow would be from the deeper aquifer to the shallow aquifer at this location on the east side of Yucca Mountain.

Corrections and general comments. Several commenters addressed general questions regarding the saturated zone or provided text corrections for sections pertaining to the saturated zone. General concern was expressed for contamination of ground water and it was suggested that additional references are available that should be used to expand the discussions. A number of commenters addressed questions related to favorable condition 4 in the geohydrology guideline.

Response. Concerns about potential contamination problems in the Amargosa Desert and Ash Meadows are based on a misconception about ground-water flow. Waddell (1982) shows that ground water that flows under the Yucca Mountain site does not discharge at the springs in Ash Meadows. Travel times within the unsaturated zone are shown in Section 6.3.1.1.5 to be long enough to ensure that contamination of the saturated zone is very unlikely. A review of the bibliography provided in one of the comments is planned. Discussions under favorable condition 4, which applies only to saturated zone disposal, were deleted from the final EA text.

C.5.2 GEOCHEMISTRY

This category addresses 152 comments and questions about the accuracy and adequacy of the analyses conducted for the geochemistry guideline for the Yucca Mountain site. Because of the large number of comments received in this category, and the variety of subjects that the category covers, it has been divided into several issues, as follows: (1) Ground-water Chemistry, (2) Retardation and Sorption, (3) Mineralogy and Petrology, (4) Solubility, (5) Waste Package and Waste-package Environment, and (6) Miscellaneous.

Issue: Ground-water chemistry

Twenty-nine comments were received on this issue. Almost half of the questions concerned the U.S. Department of Energy (DOE) conclusion that water from Well J-13 in the saturated zone is expected to be chemically similar to ground water from the unsaturated zone (vadose zone) at Yucca Mountain where the repository would be located. Many of these reviewers argued that the DOE had no evidence to support this assertion. Some cited evidence that the chemistry of Well J-13 water has changed through time and varies stratigraphically within the well. Some of the commenters contended that the conclusions drawn from such non-conservative assumptions may not be valid.

A few commenters stated that characterization of water chemistry at Yucca Mountain is inconclusive and that the exploratory shaft may not encounter a reasonable spectrum of aqueous, geochemical, and host-rock conditions in the vadose zone. Statements were also made that construction of the exploratory shaft may be incompatible with planned characterization studies. Several other commenters argued that the effects that heat-generation from the repository will have on water movement and mineral stability are unknown, and that fracture flow has not been addressed. Another commenter stated that the possible precipitation of radionuclides in the vadose zone is only an hypothesis and is unsupported by research data. One commenter pointed out possible errors in age dating water samples using the carbon-14 method.

One commenter stated that a discussion of pH should be included in the Environmental Assessment (EA) under potentially adverse conditions, and another commenter inquired why pH data were not presented in Section 6.3.1.2.3 of the draft EA. Several commenters used a study by Henne (1982) to question if there was evidence for very rapid travel times through unsaturated tuffs at Rainier Mesa at the Nevada Test Site (NTS).

Response

The DOE position that Well J-13 water from the saturated zone is expected to be similar to the chemical composition of water from the unsaturated zone is supported by the literature. White et al. (1980) reported the composition of fracture and matrix waters in the unsaturated zone at Rainier Mesa on the NTS. The geologic setting of these waters is very similar to the Yucca Mountain site because both areas are composed chiefly of ash-flow tuffs and associated rocks. Ogard and Kerrisk (1984) showed that water from the saturated zone at Yucca Mountain, including water from Well J-13, fell within the range of fracture and matrix waters from Rainier Mesa. Analyses of cores by Oversby (1985) from the unsaturated zone of the Topopah Spring tuff at Fran Ridge indicated that none of the samples tested contained any evidence of significant amounts of readily soluble material that could increase the anion content of Well J-13 water. Therefore, the available literature does suggest that Well J-13 water is similar to water in the unsaturated zone at Yucca Mountain. When direct measurements of the chemistry of unsaturated-zone waters from Yucca Mountain become available (from site characterization studies), the DOE will evaluate the reference water composition.

The comments related to possible short residence times of water in the unsaturated zone are made on the basis of conclusions of Henne (1982) concerning the retention time of water in the unsaturated zone at Rainier Mesa. This has prompted the conclusion by some that "the ground-water chemistry in the unsaturated zone at Rainier Mesa is controlled by the soil chemistry, not by equilibration with the host rock." The short retention times of water in unsaturated-zone tuffs at Rainier Mesa, along with the implied high water velocities that were calculated by Henne (1982), do not appear to be justified by the data collected. The idea that soil chemistry alone controls water compositions in the unsaturated zone oversimplifies the behavior of water as it moves from the surface down through the tuffs. Both surface and subsurface geochemistries are important.

Hydrologic testing and sampling is planned in the exploratory shaft. Perched water, fracture-bound water, and any other mobile water in the vadose zone will be sampled and monitored. Samples of vadose water will be analyzed for dissolved oxygen, alkalinity, pH, carbon-14, hydrogen-3, chlorine-36, Na, Ca, Mg, K, HCO_3, SO_4, Cl, SiO_2, Mn, Fe, Al, CO_2, fluorocarbons, organic compounds, and for tracers used in drilling/construction water (lithium, bromine, and iodine). In addition, mineralogical and petrological samples from the shaft, and core samples collected in boreholes drilled from the shaft to probe for and characterize water occurrences, will also be analyzed. Samples will be obtained for whole-rock (matrix) mineralogy and fracture surface mineralogy using x-ray diffraction, electron microprobe, and standard petrographic methods. These studies will be supplemented by similar data collected from vertical boreholes drilled as part of the surface-based studies in the event that vadose zone water is encountered. It is believed therefore, that a reasonable spectrum of host-rock aqueous and geochemical conditions will be sampled.

The exploratory shaft will be constructed by conventional mining (not drilling) to prevent ground-water contamination and to provide continuous access to the shaft for study. If conflicts arise between planned tests and

the construction techniques, the techniques will be modified to the extent possible to accommodate planned testing.

The effects of repository heating on water movement have been considered in several studies and are currently being investigated at Sandia National Laboratories. It is true that the stability of minerals depends on temperature and water composition. The majority of the sorptive zeolites at Yucca Mountain, however, will not be subjected to a significant rise in temperature and will remain unaltered (see discussion under Section 6.3.1.2.3(3) of the EA). Temperature profiles will be reasonably well known from numerical simulations, although other factors bearing on mineral stability remain to be analyzed. The effects of fracture flow have been investigated by Travis et al. (1984), and this information forms the basis of the conclusions in Section 6.3.1.2.3(5) of the EA.

The comment concerning precipitation of radionuclides in the vadose zone as only an hypothesis refers to Siting Guideline 6.3.1.2.3(2) which asks if chemical conditions that promote precipitation are present at the site. Whether precipitation of waste elements will occur at a specific location and time cannot be answered until conditions at and near the repository have been defined. Rather than claim conditions that are uncertain at this time, only the pH of the water was claimed as a favorable condition for actinide precipitation. No other conditions that promote precipitation were claimed in the EA. The near-neutral pH of the water from Yucca Mountain is favorable because it is in the range where oxides and hydroxides of actinides and some other waste elements have minimal solubility. For solubility calculations used in the EA, the water was assumed to be oxidizing, which is reasonable for the unsaturated zone. This assumption results in higher solubilities than would exist under reducing conditions, and is thus a conservative assumption.

The commenter is correct in pointing out the possible errors in carbon-14 age dating. Waddell et al. (1984) discusses problems of the mixing of different age waters and intermittent recharge along the flowpath, both of which introduce additional uncertainty to the carbon-14 ages. Claassen (1983) also discusses age-date uncertainties.

A discussion of Eh and pH is included in the draft and final EA in Section 6.3.1.2.4(3). Data on water pH are included in the draft and final EA in Section 6.3.1.2.3(2). It did not seem appropriate to repeat this information in a summary section such as the "Conclusion" section at the end of Section 6.3.1.2.3 of the draft EA.

Issue: Retardation and sorption

Fifty-eight comments were received on this issue. Because of the large number of comments received and the variety of topics that these comments cover, this issue has been further divided into six topics addressing the areas of: general comments; zeolites; particulates, colloids, and complexes; fracture coatings; vapor transport; and fracture flow.

General comments. Many questions were asked on the general aspects of retardation and sorption at Yucca Mountain. The theme of all comments was that the DOE had little data to assess the sorption potential, retardation,

and radionuclide-transport rates and directions to the accessible environment. Moreover, some commenters stated that many of the assumptions used to determine retardation and sorption were unfounded.

Response. All of the data discussed in the draft and final EA apply to the region between the repository and the accessible environment, an area 5 kilometers (3 miles) from the periphery of the repository. Although it is true that retardation capacity along likely flowpaths at Yucca Mountain has not been measured directly, the existence of a major sorptive capacity at depth is shown by drillhole mineralogy. Furthermore the upper bound on water flux within the host rock is 0.5 millimeter (0.02 inch) per year (Wilson, 1985); thus, very little water is available to dissolve the solid radionuclides.

The retardation factors listed on Table 6-23 (Representative sorption ratios and retardation factors for eight radionuclide elements with Yucca Mountain tuff) of the draft EA were calculated assuming saturated, porous-flow conditions. Calculations of retardation assuming both fracture and matrix flow in the unsaturated zone have been reported by Travis et al. (1984). Calculations presented in that paper indicate retardation factors considerably above the threshold mandated in 10 CFR Part 960 to claim the favorable condition. Travis et al. (1984) states that if flux conditions do allow fracture flow in the unsaturated region, diffusion out of cracks into the rock matrix will retard the progress of radionuclides by at least a factor of 100 (Section 6.3.1.2.3).

The assumption of equilibrium sorption for nonactinide radionuclides is justifiable up to fluid velocities of 8×10^4 meters (2.6×10^5 feet) per year (Rundberg, 1985). For actinide elements, lower velocities are indicated by preliminary studies, and these velocities are also well above the regulation for 1,000-year travel time to the accessible environment (10 CFR Part 960).

Preliminary sorption measurements were determined with the use of local waters from various formations along the likely flow paths from the repository toward the accessible environment and crushed tuff samples (including glassy samples). The effects on sorption from varying water composition and mineralogy are being investigated and will be described in more detail during site characterization. Although it is true that some aspects of retardation by sorption are still under study (such as the effects of ferromanganese oxyhydroxides and the effects that temperature will have on clinoptilolite stability), the abundance of sorptive zeolites in the saturated zone where water compositions are well characterized beyond the thermal envelope of the repository has been cited as a partial basis for the conclusions reached in the analysis of the geochemistry guideline.

One commenter requested that the range of sorption ratios be indicated on tables 6-21 (Average sorption ratios from batch sorption experiments on crushed tuff...) and 6-22 (Average sorption ratios from batch desorption experiments on crushed tuff...) of the draft EA in Section 6.3.1.2.3 of the EA. Because the standard deviation of the measured sorption values are provided in these tables, the overall range of values can be calculated for a given confidence level.

The effects of steadily increasing temperature on retardation by diffusional processes was questioned in several comments. Section 6.3.1.3.4 of the final EA has been modified to read, "As the temperature is increased, retardation because of diffusional processes will not be decreased."

Another commenter took issue with the statement in the draft EA that engineered barriers be considered for retardation because it is contrary to the intent of the guidelines (10 CFR 960.3-1-5). In the final EA, the discussion of the retardation capacity of the backfill and packing materials has been deleted from the conclusions in Section 6.3.1.2.3(1).

Commenters questioned the applicability of results from sorption studies in the laboratory using crushed samples to represent intact field rock because the reactive surface area of the crushed samples is much larger. Rundberg (1985), however, has shown excellent agreement between the sorption ratios obtained from crushed tuff and intact tuff for simple cations.

Many of the conditions evaluated for the geochemistry guideline were based on estimates of unmeasured properties and characteristics by using information that is currently available. As is the case for qualifying conditions, the statement is made in the draft and final EA that "... the evidence does not support a finding that the site is not likely to meet the qualifying condition ..."

Zeolites. Many questions were asked about the zeolites at the site, particularly in regard to their distribution and sorptive characteristics. Questions were also asked about whether a geochemical barrier actually exists in the Calico Hills unit beneath the repository.

Response. The capabilities of zeolites to adsorb radioactive particles are described in Section 6.3.1.2.3 of the EA. It is true that compositional variation in zeolites may be a factor in sorption behavior. For example, sorption of most radionuclides of interest by analcime-rich tuff does not compare favorably with clinoptilolite-rich tuff. This has been taken into account in sorption experiments by using zeolites from several horizons at Yucca Mountain.

Preliminary studies by Los Alamos National Laboratory on the effects of dehydration on the sorption characteristics of zeolites (see Section 6.3.1.2.3 of the final EA) indicate that the cation exchange capacity is not substantially altered after long-term heating.

Many zeolitized barriers, whether in the Calico Hills unit or other units, exist far outside the zone of the thermal effects of the repository. Three new figures have been added to Section 6.3.1.2 in the final EA that show the zeolite intervals in other cross sections.

Particulates, colloids, and complexes. Several questions were asked about the formation of particulates, colloids, and organic and inorganic complexes at the site, their transport, and their effect on solubility, sorption, and mobility of radionuclides at the Yucca Mountain site.

Response. The subject of the formation and transport of particulates, colloids, and organic and inorganic complexes will be addressed during site

characterization. With the information now available on porosity and diffusivity, radionuclides are expected to diffuse into the rock matrix; particulates and colloids will be filtered out of the water, and substantial sorption will occur. It is pointed out, however, in Section 6.3.1.2.3(2) of the EA, that no claims were made that the site had geochemical conditions that inhibit the formation of particulates, colloids, and organic and inorganic complexes. Furthermore, the wording in Section 6.3.1.2.3(2) of the EA has been changed from "Considering only mechanical infiltration, and assuming the above size distributions for colloid particles and tuff pore size distribution, it can be shown ..." to "... distribution, the potential exists ..." for bedded tuff underlying the host rock at Yucca Mountain to filter out some of the colloidal americium.

Fracture coatings. A few commenters asked what minerals might precipitate along fractures, and how fracture coatings would affect the migration of water and radionuclides into the rock matrix.

Response. The origin of fracture-coating minerals is not well understood. Although studies are being conducted, the results will not be included in the EA because they are not critical to the conclusions reached in the geochemistry guideline.

The fracture-coating minerals in the unsaturated zone, as stated in the EA, are the zeolites mordenite, heulandite, and clinoptilolite; smectite and illite clays; manganese oxides; minor calcite; and cristobalite. The identification of fracture-coating minerals in the saturated zone is still under study, although ferromanganese oxyhydroxides have been identified.

Experimental work is now being conducted to determine the sorptive capabilities of fracture-coating zeolites. It seems likely, however, that fracture coatings would limit the migration of water and radionuclides into the rock matrix. Until the exploratory shaft is completed, the DOE will have no direct information on fracture abundance at the site. Many drill holes at Yucca Mountain, however, contain many fractures without secondary minerals.

Vapor transport. A few commenters asked about the possibility of vapor-phase transport from the repository to the land surface by way of fractures in the rock overlying the repository.

Response. Because a repository at Yucca Mountain would be located in the unsaturated zone, the possibility of vapor transport of waste elements exists. Only the noble gases such as xenon, krypton, or radon; carbon as CO_2; tritium as H_2 gas or as water vapor; or iodine as I_2 vapor are possible waste elements that can be transported as gases or vapors. The aqueous phase in the unsaturated zone, however, can retard the movement of some of these waste elements because they are soluble in liquid water.

At this time, essentially very little work has been done on gaseous or vapor transport in the unsaturated zone at Yucca Mountain. This type of transport will be addressed during site characterization. A paragraph on gaseous transport has been added to the final EA in Section 6.3.1.2.3.

Fracture flow. A few commenters stated that if fracture flow exists at the site, diffusion of radionuclides into the rock might be significantly

different from those described in the EA because the velocity of fracture flow might be several meters per day.

Response. If fracture flow occurred, it probably would be more effective at moving radionuclides than is matrix flow. At the upper bound on flux of 0.5 millimeter (0.02 inch) per year for the host rock, however, matrix flow is likely to be the most important transport mechanism.

Issue: Mineralogy and petrology

Thirty-two comments or questions were received on this issue. Because of the large number of comments received and the variety of topics that these comments cover, this issue has been further divided into topics in the areas of: mineralogy and mineral stability, areal distribution of sorptive minerals, age of mineralization and alteration, and general comments.

Mineralogy and mineral stability. Several commenters stated that discussions in the EA on the mineralogy and mineral stability of the host rock were contradictory. Several questions were asked concerning the stability of the mineral assemblages at the site in regard to potential dehydration from waste heat.

Response. The draft EA contained several inconsistencies regarding the definition of the host rock, and understandably readers became confused. The definition of the host rock, a zone of nonzeolitized devitrified tuff in the Topopah Spring Member, has been clarified throughout the final EA wherever the definition appears.

As stated in the EA, most of the sorptive zeolites at Yucca Mountain are more than 300 meters (1,000 feet) below the repository. The maximum waste-induced temperatures that these zeolites will be subjected to is about 60°C (140°F) approximately 10,000 years after waste emplacement. This represents an increase above ambient rock temperature of about 23°C (73°F). This minor increase in temperature could affect the rate at which minerals such as clinoptilolite and mordenite recrystallize to less sorptive assemblages, although little reaction is expected over 100,000 years. The 50,000-year duration of the temperature rise caused by the repository is very short compared to the time required for the mineral transformation, estimated by Dibble and Tiller (1981) to be tens of millions of years. Geologic evidence suggests that the zeolites at Yucca Mountain formed before the Quaternary Period and have not been appreciably altered during Quaternary time.

Dehydration of smectites and zeolites is addressed in the EA in Section 6.3.1.3.4. On the basis of the information available, dehydration will not cause significant reductions in the retardation potential of smectites and zeolites.

The rates of diagenetic mineral formation and glass hydration provide useful information for mineral-stability studies, but they do not affect the conclusions in Section 6.3.1.1.4.

Areal distribution of sorptive minerals. Several commenters stated that the DOE has not identified the minerals that contribute most significantly to sorption, and that the distribution of sorptive minerals at Yucca Mountain is

poorly known. Several questions were asked about the distribution and type of minerals in fractures and their sorptive properties.

Response. The minerals that are primarily responsible for sorption of many cationic species have been identified, chiefly by x-ray diffraction studies of more than 600 core samples. The available sorption data are being analyzed to better determine which minerals are responsible for sorption. Because this research is not complete, the statement in Section 6.3.1.2.1 of the draft EA regarding the identification of sorptive minerals has been deleted in the final EA. Research on fracture mineralogy is needed and will be addressed further during site characterization. Work is currently under way to study the minerals in the fractures above and below the water table, and to determine under what conditions they formed so that it will be possible to predict which minerals might form in the future. Experimental studies are also being done to determine the sorptive characteristics of fracture-coating minerals.

At all points across Yucca Mountain, a minimum of 43 meters (140 feet) of zeolitic tuff apparently occurs between the repository horizon and the static water table. Therefore, all aqueous radionuclides must pass either straight downward or laterally and then downward through a minimum of 43 meters (140 feet) of zeolitic tuff before reaching the static water level and ultimately the accessible environment. The location of sorptive minerals are known from cored drillholes and further defined by cuttings from other holes at Yucca Mountain. Los Alamos National Laboratory is now correlating units between the drill holes. Figure 6-4 (North-south cross section through Yucca Mountain showing zeolite intervals) of the draft EA (Section 6.3.1.2.3) shows the location of clinoptilolite at the site. Three new figures have been added to the final EA that show the zeolite intervals in other cross sections.

Age of mineralization and alteration. Many questions were asked concerning the age of zeolitization and the length of time required to alter zeolites to nonsorbing materials.

Response. Timing of zeolitization is inferred from the data and reasoning of Bryant and Vaniman (1984), which relate the timing of zeolitization to major regional faulting in the area which has been estimated from a variety of geologic means to be in excess of 10 million years old.

The time required to convert clinoptilolite and mordenite assemblages to analcime at Yucca Mountain is not known. As described in the EA, the approach to addressing this uncertainty has been to assume the interval of zeolitized tuff containing both clinoptilolite (with possible associated mordenite) and analcime represents a section of rock in which the conversion reaction may be in progress. If the reaction proceeded to completion within the next 100,000 years, the amount of sorptive zeolites lost would be an insignificant part of the sorptive zeolites remaining in the overlying rocks. Available evidence, also cited in the EA, suggests that the time required for conversion is well in excess of 100,000 years. Thus, existing uncertainties about the time it takes for the conversion do not affect the position stated in the EA in Section 6.3.1.2.3.

Zeolitization could occur at any time in the vadose zone as long as sufficient water was available. The near absence of zeolites younger than 10 million years in the vadose zone suggests that there has been insufficient water to permit large-scale zeolitization in the vadose zone throughout all of Quaternary time.

General comments. One commenter requested a definition of "significant quantities" of zeolites and clays as used in Section 6.3.1.2.3(2) of the draft EA, and another commenter stated that despite the extensive geochemical studies conducted at the Yucca Mountain site by the DOE, key issues related to licensing criteria have not been resolved or adequately explored.

Response. The term "significant quantities" indicates greater than 5 percent for clays and greater than 10 percent for zeolites. Many of the bulk-rock samples analyzed contain 40 to 80 percent zeolites. Licensing issues are beyond the scope of the EA.

Issue: Solubility

Thirteen comments or questions were received on this issue. Several commenters acknowledged that the near-neutral pH of water from Yucca Mountain favors minimum solubilities (except cesium, carbon, iodine, and technetium), but wanted to know why elements with higher solubilities were not discussed and why waste silicates, carbonates, and other precipitates were not discussed.

One commenter challenged the assumption that the release of elements with high solubilities will be limited by the dissolution of bulk waste form. Another commenter noted that the implication that the release rate/inventory ratio meets the guidelines is questionable in light of the uncertainties and assumptions presented in Kerrisk (1984).

Some commenters noted that Daniels et al. (1982) discusses the importance of oxidation-reduction potential on solubility of key elements such as uranium and plutonium and that oxidation-reduction capacity of the solid phase (rock mineralogy) needs to be considered as well as the oxidation-reduction potential of the water.

One commenter stated that heat generated from the waste containers will raise the repository temperature and that moisture would be driven away from the heat source, possibly forming precipitates. Several commenters pointed out that the "drying-out scenario" could produce brines that may enhance the formation of uranium and plutonium complexes, thus affecting sorption effectiveness.

One commenter pointed out that the presence of a gas phase in the unsaturated zone would influence reaction temperature and kinetics, as well as potential radionuclide cation and anion transport. It was stated that the water chemistry in the vadose zone has not been characterized. Therefore, possible precipitation of radionuclides is clearly only an hypothesis in need of testing.

Response

The commenters are correct that the pH conditions at Yucca Mountain are favorable for the vast majority (98 percent) of waste elements present in spent fuel at 1,000 years after emplacement. The radionuclides of cesium, carbon, iodine, and technetium constitute only about 0.[illegible] percent of the total activity of spent fuel 1,000 years after waste emplacement.

Silicate, carbonate, and phosphate anions can form solids with waste elements, but can also form aqueous complexes. It is not clear at this time whether the presence of these anions in water at Yucca Mountain would promote or impair precipitation. For this reason the effects of these species on precipitation was not discussed under the favorable condition that lists geochemical conditions that promote precipitation.

In order to investigate the assumption that the release of elements with high solubilities will be limited by the dissolution of the bulk waste form, the release rate/inventory ratio was recalculated. These calculations assumed the maximum fractional dissolution rates of 1×10^{-3} per year for cesium, strontium, iodine, and carbon for spent fuel, and for cesium and strontium for high-level waste. The maximum fractional dissolution rates for spent fuel are consistent with the values reported by Johnson (1982). Other elements were assumed to have maximum fractional dissolution rates of 1×10^{-4} per year. Although increases in the release rate/inventory ratio occurred, the results are still below the annual limit required to meet the favorable condition. The reason that the release rate/inventory ratio at 1,000 years is relatively insensitive to the changes in dissolution rates is that strontrium-90 and cesium-137 have completely decayed by that time, and other radionuclides of cesium, strontium, iodine, and carbon do not make a large contribution to the total inventory.

Kerrisk (1984) presents two computer models that describe the dissolution rate of waste elements from a solid waste form. The results and conclusions of the two models are a strong function of the many assumptions made about solubilities and model parameters. As better and updated data become available, these assumptions will be reviewed.

A study of the oxidation-reduction capacity of the minerals at Yucca Montain was recently completed (Caporuscio and Vaniman, 1985) but was unavailable for the draft EA. In the draft EA, solubilities were calculated using oxidizing conditions, which represents a worst-case condition because most waste elements have higher solubilities under oxidizing conditions rather than reducing conditions.

The effects of a "drying-out scenario" from heat generated by waste containers should be minimal. Actinide compounds in carbonate-rich waters have been investigated by Ogard and Kerrisk (1984). This study suggests that the effect of carbonate-rich water on actinide complexing will be minor. This in turn suggests that the effects of temperature and temperature-induced changes on actinide sorption are likely to be minor. These effects will be further addressed in the site characterization studies.

It has been anticipated that the gas phase in the unsaturated zone will be primarily air, although gas samples from the unsaturated zone have not

been collected and analyzed as yet. Experimental work on solubility, sorption, and radionuclide transport has been carried out in the presence of air (i.e., under oxidizing condition).

Vadose-zone water will be sampled and characterized during construction of the exploratory shaft. Present information indicates that water from the vadose zone is similar in composition to saturated-zone water at Yucca Mountain. The question of precipitation of radionuclides at a specific location and time cannot be answered until conditions at and near the proposed repository have been defined.

Issue: Waste package and waste-package environment

Ten comments were received on this issue. Most of the comments concerned the uncertainties surrounding the potential failure of the metal barriers, particularly in regard to the chemistry of the vadose zone water and oxidizing conditions in the environment of the repository. One commenter disagreed with the DOE conclusion that dissolution and precipitation processes in the host rock will have little effect on permeability because the tests may not represent in situ conditions around the repository. Finally, one commenter asked what assumptions were used in the model for waste dissolution.

Response

The estimates of waste-package lifetimes are preliminary and are based on available data. Laboratory experiments are being conducted for both expected and extreme conditions to derive bounds and values on expected waste-package lifetimes.

The DOE maintains that the mildly oxidizing environment expected at Yucca Mountain may prolong the life of a stainless steel waste disposal container; deleterious effects are not expected. Moreover, the elevated temperatures of most of the packages would not permit liquid water to exist near them for long periods of time. It is true, however, that the chemistry of vadose-zone water is not currently known, but there is good reason to believe that it is similar to water from the saturated zone produced from Well J-13 (see the Ground-water chemistry issue for a discussion of water from Well J-13 and the vadose zone).

It is true that the conclusion regarding possible permeability changes from dissolution and precipitation was based on short-term experiments. However, the significance of those experiments is that no large reduction in permeability was seen for Topopah Spring or Bullfrog tuffs, in contrast with the very large changes observed under similar conditions for other rock types.

In the draft EA in Section 6.3.1.2.3(4), the assumptions that formed the basis of the model for waste dissolution are described. Details behind these assumptions were too long for inclusion in the EA; they can be found in Kerrisk (1984). Experimental work (Wilson and Oversby, 1985) on release rates using spent fuel and glass have been added to Section 6.3.1.2.3(4).

Issue: Miscellaneous

Ten comments were assigned to the miscellaneous issue. The comments focused on conservatism in terms of the entire assessment, stating that the draft EA was not conservative. A few comments noted errors in expression such as referring to water from Well J-13 as Yucca Mountain water. One commenter wanted to know what the quantities of cesium, strontium, and radium would be in comparison to other radionuclides that might evolve. Another commenter pointed out typographical errors in the text of the draft EA.

Response

The DOE believes that the draft EA was conservative; the final EA has been made more conservative as a result of the introduction of public comments.

All errors in expression pointed out by reviewers, including inconsistencies and typographical errors in the text, have been corrected in the final EA.

The relative amounts of cesium and strontium vary with time. In the short-term (a few tens of years), cesium and strontium make up a significant fraction of the radionuclide inventory and become less important over the long-term. Cesium and strontium are virtually nonexistent after a few hundred years due to their 30-year half-lives. Comparatively, radium is an extremely minor contributor to the radionuclide inventory.

C.5.3 ROCK CHARACTERISTICS

The 43 comments received pertaining to the postclosure guideline on rock characteristics primarily are concerned with properties of the host rock. Five issues have been delineated: (1) Vertical and Lateral Extent, (2) Thermal and Mechanical Properties, (3) Mineralogy and Geochemistry, (4) Limitations and Effects of Uncertainties Regarding Rock Properties, and (5) Miscellaneous.

Issue: Vertical and lateral extent

Eight comments were received addressing this issue. Some commenters questioned whether Yucca Mountain has sufficient lateral and vertical extent to provide flexibility in the placement of a repository. Other commenters noted that insufficient data on rock properties are provided to either substantiate or refute the vertical and lateral extent of the host rock indicated in the Environmental Assessment (EA).

Response

Considering only the primary area, sufficient lateral extent to provide flexibility in placement of an underground facility at Yucca Mountain was not claimed. The U.S. Department of Energy (DOE) recognizes that the data presently available are inadequate on which to base a determination of usability

of areas outside the primary area. It is planned to obtain additional data during site characterization.

Issue: Thermal and mechanical properties

Twelve comments were received addressing this issue. All of the comments are concerned directly or indirectly with fractures, either natural or thermally induced and their potential effects on waste isolation. The topics addressed are: host rock effects, thermomechanical model, favorable condition 2, and thermal conductivity.

Host rock effects. A few commenters asked for a discussion of the effects of heat or hydration on glass in the host rock.

Response. Within resolvable limits, there is little or no glass in the Topopah Spring Member (potential repository horizon) at Yucca Mountain; it is considered to be devitrified.

Thermomechanical model. Several commenters indicated that the discussion of natural and thermally induced fractures was based on insufficient data or that the predictive model used was not valid.

Response. The effect of fractures on the potential for gas transport of radioactivity from the repository horizon to the surface will be evaluated from data obtained during site characterization. The Topopah Spring Member (potential repository horizon) in the Yucca Mountain area has been sampled from approximately 30 drill holes. Using measurements of bulk properties and mineralogy, it is reasonable to conclude that the variability in thermal properties of the potential repository horizon is understood. It is true that the thermomechanical model used by Johnstone et al. (1984) has limitations and the results reported are preliminary. However, the high strength of the Topopah Spring Member (Tillerson and Nimick, 1984) and the small size of the regions of overstress predicted by Johnstone et al. (1984) indicate that the conclusions of that study are adequate for the site selection process of the EA. This position is supported by experience and field tests in a similar devitrified welded tuff in a tunnel in Rainier Mesa nearby on the Nevada Test Site (NTS). Statements regarding the preliminary nature of the thermomechanical model have been added to the final EA text in sections where the model is discussed.

Favorable condition 2. Some commenters questioned why the DOE claimed favorable condition 2 when tuff obviously does not have sufficient ductility to seal fractures.

Response. Favorable condition 2 in the rock characteristics guideline requires (1) a high thermal conductivity, (2) a low coefficient of thermal expansion, or (3) sufficient ductility. The favorable condition is claimed on the basis of the fact that the tuff host rock does have a low coefficient of thermal expansion. The DOE believes the wording of favorable condition 2 clearly indicates that the presence of any one of the three characteristics is sufficient to claim the condition.

Thermal conductivity. A few commenters noted that tuff has a low thermal conductivity and coefficient of thermal expansion compared to salt, but

these properties are similar to those of other rock types being considered as potential host rocks at other sites.

Response. The comments regarding the coefficient of thermal expansion and thermal conductivity are correct, both values are low in comparison to salt. As stated above, a low coefficient of thermal expansion is a favorable aspect with regard to the rock characteristics guideline whereas a low value of thermal conductivity is considered to be adverse. Changes in the text have been made to indicate these two properties of welded tuff are comparable to those of other common rock types, except for salt which has significantly higher values.

Issue: Mineralogy and geochemistry

Fourteen comments were classified within this issue. The comments concerned some aspect of the mineralogical and geochemical makeup of the Topopah Spring tuff (host rock). The issue addresses three topics: stability of zeolites, vapor transport and flow regime, and adequacy of data on geochemical conditions.

Stability of zeolites. The majority of commenters were concerned with the stability of zeolites and other hydrous minerals under a thermal load and their consequent ability to retard transport of radionuclides.

Response. Approximately 30 vertical drill holes have provided samples of the host rock at and near Yucca Mountain. Section 6.3.1.1.2 provides a summary of these drill holes. From these samples, it is known that about 98 percent of the host rock is composed of the minerals feldspar, cristobalite, and quartz. None of these minerals are hydrous and all are thermally stable at the temperatures expected under repository conditions. Some clays and zeolites, which are hydrous minerals, do occur in small fractures in the host rock, but the amounts are so small that they are judged not to adversely affect the overall rock properties. In strata underlying the host rock at depths of 300 meters (1,000 feet) or more, zeolites are abundant, but at this depth the thermal effects are unlikely to modify the ability of zeolites to be effective in retarding the movement of radionuclides. The EA was not explicit in describing the occurrence and distribution of zeolites and other hydrous minerals at Yucca Mountain. An attempt has been made to clarify this point in the final EA by modifying the text in Section 6.3.1.3.4 (potentially adverse condition 2) and adding three new cross sections of the zeolite intervals in Section 6.3.1.2.3.

Vapor transport and flow regime. Other commenters addressed the question of vapor transport of radionuclides and fracture flow versus matrix flow of ground water. One commenter asked if heat-stress fracture would enhance flow characteristics through the rocks in all directions. Additionally, it was asked if weapons testing at the NTS has contributed to the fracturing of the rock.

Response. Because a repository at Yucca Mountain would be located in the unsaturated zone, the possibility of vapor transport of waste elements exists. Only the noble gases such as xenon, krypton, or radon, carbon as CO_2, tritium as H_2 gas or as water vapor, or iodine as I_2 vapor are possible

waste elements that can be transported as gases or vapors. The aqueous phase in the unsaturated zone, however, can retard the movement of some of these waste elements because they are soluble in liquid water. Additionally, most of the gaseous radionuclides will have decayed considerably by the time the waste disposal containers begin to leak.

It is recognized in the discussion of the geohydrology guideline (6.3.1.1) that fracture flow of water may occur in both the saturated and unsaturated rocks at Yucca Mountain. The qualifying condition requires that the host rock can accommodate thermal, chemical, mechanical, and radiation stresses induced by repository activities. Admittedly, precise information on the proportion of fracture flow versus matrix flow is lacking, but during site characterization this question will be thoroughly investigated.

With regard to the comment on weapons-testing-induced fracturing, the Yucca Mountain site is sufficiently distant from present or potential underground test locations that collapse or formation of fractures is highly unlikely.

Adequacy of data on geochemical conditions. A few commenters addressed the adequacy of data on actual geochemical conditions at Yucca Mountain.

Response. Questions about the adequacy of data on the geochemical conditions at Yucca Mountain and whether water from Well J-13 is representative of waters beneath Yucca Mountain are discussed in Section 6.3.1.2 of the EA. During site characterization the DOE plans to obtain additional information on geochemical conditions at Yucca Mountain and to obtain and analyze waters from the unsaturated zone. Reference is also made to Section C.5.2, Geochemistry (Ground-water chemistry) for a more detailed discussion regarding Well J-13 water.

Issue: Limitations and effects of uncertainties regarding rock properties

Three comments were received addressing this issue. All of them indicated that limitations and uncertainties in the data on rock properties presented in the EA were so great that the evaluation of the suitability of Yucca Mountain in terms of the postclosure rock characteristics guideline is not convincing. Specifically questioned were the predicted thermal and pressure effects on the rocks, the models used to predict these effects, the extent of the lithophysal zones, and the effect of lithophysae on the thermomechanical properties of the host rock.

Response

For the postclosure rock characteristics guideline, the limitations and uncertainties of the data are discussed individually under each of the favorable and potentially adverse conditions. General statements regarding data uncertainties and assumptions are provided under Section 6.3.1.3.2.

Because the host rock is composed largely of minerals (feldspar, cristobalite, quartz) that would be stable under predicted repository conditions, it is concluded that significant mineralogic changes will not occur (see response to the preceding issue (stability of zeolites) and Section 6.3.1.1.2). As to mechanical effects, for the specific conditions under

consideration, temperature and pressure will tend to increase rock strength because: (1) heat will tend to dry the rock, and dry silicate rock at the temperature predicted is stronger than wet rock and (2) compressive strength of rock increases with confining pressure. The predictive models used by Johnstone et al. (1984) utilized state-of-the-art modeling techniques and the limitations of such techniques are recognized. Confidence in the model is based upon mining experience and field tests in similar devitrified, densely welded tuffs (G-Tunnel at Rainier Mesa). Validation of these models will be addressed during site characterization.

Information has been collected from about 30 vertical drill holes in the Yucca Mountain area. Useful lithophysae data from the cores provide confidence that the position and extent of the high lithophysal content zones in the host rock of the primary area (area 1) are known in a general way. A preliminary evaluation of the strength of the high-lithophysae Topopah Spring Member is presented in Price et al. (1985). However, the effect of various percentages of lithophysae on the thermomechanical properties will be investigated further during site characterization. The predictive model used by Johnstone et al. (1984) assumed 5 percent lithophysal cavities and Tillerson and Nimick (1984) have shown that the thermomechanical properties used by Johnstone et al. (1984) are representative of intact rock with a total porosity of 17 percent (12 percent matrix porosity plus 5 percent lithophysal porosity).

Issue: Miscellaneous

Six miscellaneous comments addressed the topics of: Rainier Mesa collapse; ground-water travel times, fault density, map inconsistencies, and technology for sealing openings.

Rainier Mesa collapse. A few comments were received regarding the collapse of the surface following a nuclear explosion beneath Rainier Mesa on the NTS. As this test was in tuff the commenters questioned the stability of tuff.

Response. The type of collapse that occurred at Rainier Mesa following an underground nuclear explosion is not possible at Yucca Mountain. Underground nuclear explosions have not occurred at Yucca Mountain nor are they planned in the future. At Rainier Mesa, highly fractured areas extended from the testing horizons to the top of the mesa. A subsidence crater formed above the explosion, which resulted from a collapse of rock into the underground cavity created by the nuclear explosion. In the case of Yucca Mountain, the nearest nuclear testing area is 40 to 50 kilometers (25 to 31 miles) away. No large cavities, either from nuclear explosions or underground mining, will be or have ever been created at Yucca Mountain.

The stability of the welded tuff is supported by the tunneling experience in G-Tunnel at Rainier Mesa. This tunnel is partially located in welded tuff of the Grouse Canyon Member of the Belted Range Tuff. No special ground support was required even though a near-vertical fault zone with a 1-meter (3-foot) vertical displacement was encountered (Tibbs, 1985). Information on G-Tunnel support requirements has been added to the final EA in sections 6.3.3.2.3 and 6.3.3.2.4.

Ground-water travel times. One commenter suggested a word change from "decrease" to "increase" in the statement on the travel time at which water moving in fractures is changed because the thermal pulse will tend to close the fractures.

Response. The commenter is correct in suggesting that ground-water travel time in fractures could increase if the thermal pulse caused fracture apertures to decrease. The phrase has been amended in the final EA.

Fault density. One commenter pointed out that fault density in the surface rocks is poorly known and probably greater than mapped because rock exposures are poor, and that fault density in the subsurface is unknown.

Response. The comment regarding fault density has merit. The density of faulting and fracturing at the surface is only known for those areas where rock exposures are good. Rock exposures are poor on much of Yucca Mountain. However, standard geologic mapping techniques and application of geologic models enable extrapolation from well-exposed areas into poorly exposed areas, including the subsurface. The actual fault density in the subsurface can only be determined by underground excavation during site characterization.

Map inconsistencies. One commenter noted that various maps showing the repository area differ in showing the shape and size of the area and are at different scales.

Response. Standard maps and figures with the same scale are not appropriate throughout the text. In many cases, the purpose of a figure is different, and it is useful to highlight or focus on different aspects of a particular subject. A standard size and shape of the repository area is not possible because the exact size and shape has not been determined and because the figures are from different studies covering different areas. A consistent scale is not used because the different figures are intended to emphasize varying aspects of the repository area. For this reason, use of one standard design area and scale would not be reasonable.

Technology for sealing openings. One commenter stated the technology for sealing shafts and boreholes is not described adequately in the EA.

Response. None of the shaft and borehole sealing measures planned for Yucca Mountain require development of new technology. These measures include emplacement of a surface barrier in the upper portion of all shafts, crushed rock in the shaft interior, settlement plugs within all shafts, and plugs within all boreholes. A detailed description of the sealing program will be presented in the Site Characterization Plan if Yucca Mountain is selected for site characterization.

C.5.4 CLIMATIC CHANGES

The climatic-changes technical guideline is concerned with the potential for future climatic changes to favorably or unfavorably affect the ability of a repository to isolate waste over the 10,000-year period required by the

Environmental Protection Agency regulations (40 CFR 191.3). The 43 comments received in this category have been subdivided into four issues: (1) Evidence for Past Water-Table Elevations and Paleoclimates, (2) Effects on Hydrologic Conditions (3) Effects on Waste Isolation, and (4) Miscellaneous.

Issue: Evidence for past water-table elevations and paleoclimates

The fifteen comments received on this issue were subdivided into three topics: past water-table positions, computer modeling, and paleoclimatic studies.

Past water-table positions. Four commenters questioned the field evidence for past water-table elevations noting that the presence of hydrated minerals may not uniquely reflect past water-table positions, and noting that calcite veins in Ash Meadows provide strong evidence of spring discharge for at least 1.7 million years.

Response. The distribution of zeolites and smectite clays provides one source of information on past water-table positions that should be balanced against other indications of water-table elevation. It is recognized that uncertainties due to the potential for perched water tables, potential for uplift or subsidence, and possible chemical differences during formation of minerals should be considered, as expressed by Jones (1982). These uncertainties are reflected in the text of Section 6.3.1.4.3 of the final Environmental Assessment (EA).

The draft EA incorrectly attributed a uranium-thorium date for calcite veins in Ash Meadows to Winograd and Doty (1980); the correct citation should be Winograd et al. (1985); and the dating technique was uranium-uranium. Section 6.3.1.4.3 has also been revised to clearly indicate that Winograd and Doty (1980) used a theoretical approach to estimate a maximum water-table level of 30 meters (100 feet) higher in the central portion of the Ash Meadows ground-water basin, whereas an upper limit of 50 meters (164 feet) higher than the present water table is suggested by calcite vein deposits in Ash Meadows that were deposited during early to mid-Pleistocene. These two results are not considered to be inconsistent with each other.

Computer modeling. A number of commenters questioned aspects of the computer-modeling studies that were used to predict a 130-meter (426-foot) water-table rise on the basis of a 100 percent increase in precipitation. It was noted that mixing computer predictions and field evidence was confusing, and that uncertainty in the results of modeling was so great that it appears possible that the repository host rock could become saturated. The validity of precipitation-recharge relationships used in the model was questioned, as well as the applicability of the model to fracture-flow conditions.

Response. The text in Section 6.3.1.4.4 has been expanded to compare the various lines of evidence for higher water-table positions, namely computer modeling and the vitric-pumice data.

The U.S. Department of Energy (DOE) agrees with the need to recognize uncertainty in the modeling of water-table positions. The precipitation-recharge relationship is an empirical approach, and limitations are specifically stated in Czarnecki (1985). The approach used in this modeling

is considered appropriate for fracture-flow conditions (Czarnecki and Waddell, 1984), although no provision was made for permeability changes when the water-table levels reached previously unsaturated units. The application of a multiplier of 15 to recharge as a result of a 100-percent increase in precipitation may be overly conservative, because evidence from a field site suggests that two-thirds of potential recharge predicted by the Eakin method may become runoff (Czarnecki, 1985). The model also assumes an instantaneous response time, in that water-table rise is not time-dependent. It should be noted that the 55-meter (180-foot) buffer between the repository and the water table position predicted under a 100-percent increase in precipitation is a minimum distance. It is shown in Section 6.3.1.1 that over most of the primary repository area, the buffer distance is at least 250 meters (820 feet) and reaches as much as 400 meters (1,312 feet). Therefore, the 55-meter (180-foot) buffer is a very conservative value, and saturation of the repository due to climatic changes in the next 10,000 years is not considered likely. Field evidence in the form of unaltered vitric pumice, which is found about 100 meters (328 feet) below the repository horizon, also supports the conclusion that the repository level has never been saturated for any substantial length of time. Potentially adverse condition 1 will remain not present at Yucca Mountain.

Paleoclimatic studies. Some commenters questioned the validity of paleoclimatic data in the EA, pointing out inconsistencies in the studies due to a lack of information on ecologic constraints for both modern and past plant distributions. Further evidence was requested to support the statement that semiarid conditions persisted in southern Nevada during pluvial periods.

Response. Information on paleoclimates in the southern Great Basin has been presented in Section 6.3.1.4.3 of the final EA. The inconsistencies present in the draft EA have been corrected. The potential inconsistency related to glacial versus pluvial conditions arises because the two periods may not coincide in time. Using standard climate classifications, a 100 percent increase in precipitation during a pluvial, as predicted by Spaulding et al. (1984), would place the precipitation at about 300 millimeters (11.8 inches), well within the 250- to 600-millimeter (9.8- to 23.6-inch) range for semiarid conditions. Most authors agree that even during pluvials, semiarid conditions persisted in Southern Nevada. Additional references have been provided to justify this statement in the EA.

Issue: Effects on hydrologic conditions

Ten comments were received concerning the effects of hydrologic conditions. These comments have been subdivided into two topics: changes in recharge and EA clarifications.

Changes in recharge. A few commenters addressed the problems of estimating recharge to the water table on the basis of precipitation, pointing out the complications inherent in using regional methods for site-specific applications. The validity of the flux and recharge estimates used in the EA was questioned in several comments.

Response. Various approaches were used to estimate recharge in the EA. The discussion of the approaches in Section 6.3.1.4.2 were expanded to include Czarnecki (1985) and Czarnecki and Waddell (1984). Limitations of

regional methods are explicitly discussed in the EA in Section 6.3.1.1.5, and the text notes that the DOE places confidence in the regional relationships between precipitation, flux, and recharge and in their application to Yucca Mountain. These relationships have provided acceptable results in other areas. It should be recognized that modern recharge estimates derived from regional methods by Czarnecki (1985) are compatible with site-specific flux estimates by Montazer and Wilson (1984). The flux estimates by Montazer and Wilson (1984) are for current conditions; future pluvial conditions would undoubtedly increase flux and recharge. Site hydrologic conditions will be more firmly established after in situ testing in the exploratory shaft.

EA clarifications. Commenters were concerned with inconsistencies in the EA text with regard to the hydrologic effects of climatic changes.

Response. Section 5.2.2 has been revised to acknowledge the potential for climatic changes to modify hydrologic conditions. Inconsistencies in Section 6.4.2 with regard to estimates of increased precipitation during pluvial conditions have been corrected to reflect the most recent estimate by Spaulding et al. (1984) of 100 percent above modern precipitation. The modeling studies on water-table positions during pluvial periods were based on a 100 percent increase in precipitation (Czarnecki, 1985). Text in Section 6.3.1.4.3 discusses possible changes in hydrologic conditions during pluvials.

Issue: Effects on waste isolation

Nine comments were received on the issue of the effects of climatic changes on the ability of the Yucca Mountain site to isolate waste. The comments address two general topics: increases in radionuclide transport, and repository performance.

Increases in radionuclide transport. Commenters questioned the DOE finding on potentially adverse conditions that perturbations in hydrologic conditions over the next 10,000 years are not likely to be sufficient to significantly increase radionuclide transport to the accessible environment. Reliance on geochemical retardation under pluvial conditions was noted to be unsupported, and an inconsistency with a finding of not present on favorable condition 2 in Section 6.3.1.1 (Geohydrology) was also noted.

Response. The DOE position in the draft EA of not present for the second potentially adverse condition in climatic change was claimed because, even though the return to maximum pluvial conditions within the next 10,000 years is considered possible, this would not significantly increase the transport of radionuclides. Under this situation, the scenarios that must be enacted to allow sufficient volumes of water to contact the radioactive waste and dissolve sufficient material to exceed the Environmental Protection Agency release limits are unlikely as can be shown by comparison with Sinnock et al. (1984). EA Section 6.4.2 provides a thorough discussion of potential releases for the upper bound on expected flux of 0.5 millimeter (0.02 inch) per year. Assuming very low direct sorption under fracture-flow conditions, matrix diffusion is expected to remain effective in reducing releases per unit time by a factor of up to 400 (Travis et al., 1984). Calculations by Sinnock et al. (1984) did not include retardation in the fractures, as suggested by several commenters. Increased fluxes sufficient to cause

saturation of the host rock would also decrease radionuclide solubilities because less oxidizing conditions would be developed (Simnock et al., 1984; and Section 6.3.1.2.4, potentially adverse condition 3).

It should be noted that favorable condition 2 in geohydrology differs markedly from both the geohydrology and climatic changes potentially adverse conditions. The favorable condition, which was not claimed, requires that expected changes would not affect or would favorably affect the isolation capability of the repository over 100,000 years. The geohydrology favorable condition is clearly a more severe condition to meet, because it requires that no effect or a favorable effect on isolation result from any possible climatic cycle or trend. The geohydrology potentially adverse condition 1, considered not present, requires that expected changes in geohydrologic conditions be sufficient to significantly increase radionuclide transport compared to pre-waste-emplacement conditions. This condition does not specify a time frame or how significant a change is needed, although it is assumed that 100,000 years should be the period of concern. Findings of not present on both of these potentially adverse conditions have been made in the final EA, and text revisions have been made to strengthen the support for these findings.

Repository performance. A few commenters addressed general questions of repository performance under expected climatic changes, questioning the reliability of extrapolation of climatic information over 10,000 years and the validity of current data on the effects of climatic change.

Response. The DOE has used available evidence to reach preliminary findings for all guidelines as specified in Appendix III of 10 CFR Part 960. Several approaches are used in the EA to establish the likelihood that future climatic changes could lead to diminished isolation performance, including review of evidence from field studies for past positions of the water table; computer-modeling studies to determine the possible effects of maximum pluvial conditions on the water-table position; and review of performance-analysis calculations of a variety of scenarios reflecting climatic extremes and conservative, but realistic, assumptions. During site characterization, further studies will reduce uncertainty in the boundaries of the basins within the Death Valley ground-water system, allowing better predictions of the effects of expected climatic changes on the interaction of the ground-water basins and the concomitant changes in other hydrologic conditions. In situ studies will also improve the ability to predict the effects of climatic changes on conditions in the unsaturated zone. It should be noted that isolation requirements apply to the 10,000 years following closure, although some technical guidelines require an assessment of the long-term predictability of site conditions over 100,000 years.

Issue: Miscellaneous

Nine comments addressed errors in the EA text, or suggested clarifications to improve discussions of climatic trends in the EA. Two topics were identified from the comments: general text corrections and climatic trends.

General text corrections. An error in conversion of temperatures from degrees centigrade to degrees Fahrenheit was noted. In addition, one

commenter felt that the wording relative to a statement on paleoclimatic evidence needed clarification.

Response. The corrected conversion from centigrade to Fahrenheit was added to the final EA. The wording regarding a statement on paleoclimatic evidence for lake positions was clarified by insertion of the term "shorelines" indicating this is the form of evidence that is being used in the final EA.

Climatic trends. A few commenters addressed various aspects of the climatic trends that are recognized in the western United States. One commenter questioned the role that atmospheric increases of carbon dioxide might play in climatic changes in southern Nevada.

Response. The statement in the draft EA on the role of the Sierra Nevada Mountains in the increasing aridity of the Southwest during the Quaternary has been attributed in the final EA to Winograd et al. (1985), rather than Winograd and Doty (1980). A review of literature on paleoclimates has been added to the final EA to provide alternative interpretations where appropriate. Several commenters pointed out that long-term trends toward increasing aridity are not contradicted by cyclic fluctuations from wetter to more arid conditions that are superimposed on the trend. One commenter implied that downgradient migration of discharge points in the Ash Meadows basin during Pleistocene was attributed by Winograd and Doty (1980) to trends of increasing aridity; such is not the case. Section 6.3.1.4.3 clearly describes these changes as related to changes in the configuration of ground-water basins within the Death Valley ground-water system.

C.5.5 EROSION

This category of comments is concerned with rates of erosion at Yucca Mountain and depth of the proposed repository. Ten comments were received in this category. Three commenters noted that the data to support the erosion rates cited in the draft Environmental Assessment (EA) are few and that additional data and alternative interpretations are available in the scientific literature. Two commenters noted that potential tectonic activity is not adequately considered in the discussion of erosion rates. Three commenters stated that the 200-meter depth in the disqualifying condition is an arbitrary number without a sound basis. One commenter noted that the erosion guideline did not address the possibility of fractures providing access from the repository to the surface. Another commenter questioned that data obtained during excavation of the exploratory shaft would provide information on erosion rates at Yucca Mountain.

Response

The U.S. Department of Energy (DOE) agrees that additional data are needed to develop a complete understanding of erosion rates at Yucca Mountain. Comprehensive studies are being planned for site characterization to provide a more complete data base and to evaluate alternative hypotheses regarding the effects of future climates and tectonic activity on erosion rates.

Regarding the 200-meter (656-foot) depth criterion, it is noted that the Nuclear Regulatory Commission concurred with this depth figure. It is further noted that this depth is sufficiently great that any conceivable erosion rate will not uncover or otherwise adversely affect a repository within the next 10,000 years.

The comment regarding fractures providing access from the repository to the surface presumably is a concern related to movement of radioactive gases to the surface. The disqualifying condition for erosion is an explicit constraint on positioning the repository and only requires that the facility be located more than 300 meters (656 feet) below the ground surface. The gas transport question will be thoroughly investigated during site characterization. Until access to the proposed repository depth is provided, it is not possible to evaluate the gas transport question.

The DOE agrees that no information bearing on erosion rates will be obtained from the exploratory shaft and has revised Section 6.3.1.5.7 of the EA accordingly.

C.5.6 DISSOLUTION

The characteristics of rock dissolution within the repository horizon are necessary to determine if radionuclide releases are likely to be greater than are allowed by the regulations. None comments relating to dissolution were received. These comments are categorized into three issues: (1) Repository Conditions, (2) Evidence for Dissolution of Tuffs, and (3) General Criticism.

Issue: Repository conditions

This issue relates to expected repository conditions following closure. One comment received expressed concern that the near-field emplaced repository will not offer standard temperature and pressure conditions. The commenter questioned the validity of the experimental results presented in the draft Environmental Assessment (EA). Two additional commenters asked about the expected temperatures near the waste disposal containers.

Response

Those parties involved with experiments and testing are aware that the repository conditions will not be at standard temperature and pressure. Temperature limits on spent fuel waste disposal containers are 350°C (662°F). The maximum temperature reached in the rock material is related to the spacing of waste disposal containers. The pressure will remain at approximately one atmosphere, but the temperature will rise. Experiments and tests are being conducted at elevated temperatures up to 250°C (482°F) and the equilibrium pressure of water vapor over solutions at those temperatures where experiments are run at over 100°C (212°F). A combination of laboratory experiments and geochemical thermodynamic and kinetic models are being used to predict long-term repository conditions.

Issue: Evidence for dissolution of tuffs

Three comments were received in this area. Two of the commenters questioned the statement that tuffs in the repository setting will have a low dissolution potential, giving the following reasons: little is known about the relevant reaction rates, determination of silicate thermodynamics is a complex problem, and reactions which occurred during the Quaternary were subject to different conditions than those expected within the repository. One commenter agreed that there is no evidence, based on a review of the literature, to presume that significant dissolution will occur that would lead to radionuclide releases greater than are allowable. All of the comments stated that there is a significant relationship between tuff mineralogy, aqueous chemistry, and radionuclide transport.

Response

The question of possible evidence for dissolution of the host rock has been examined in the unsaturated zone in the vicinity of the exploration block and Well J-13 where the Topopah Spring Member is below the water table. The lack of indication of solution, even within the saturated zone, is compelling evidence that the volcanic rocks at Yucca Mountain are not subject to dissolution to any significant extent. Since these conclusions are based on field observations, additional data resulting from laboratory-based studies on rates of dissolution or the complexity of silicate minerals would not serve to change them. Dissolution processes during the Quaternary and future dissolution rates are discussed in Section 6.3.1.6.5 of the EA.

The relationship between tuff mineralogy, aqueous chemistry, and radionuclide transport has been investigated and will continue to be investigated during site characterization. Current information indicates that aqueous chemistry and tuff mineralogy are at or near equilibrium conditions (Ogard and Kerrisk, 1984).

Issue: General criticism

Three comments were received that criticized certain points in the discussion of the dissolution potential of tuffs. One commenter stated that experiments similar to those performed on the Bullfrog Member should also be conducted on the Topopah Spring Member. The second commenter stated that six authoritative references were ignored with respect to the influence of potential changes and water chemistry on dissolution. The third commenter suggested that Section 6.3.1.6.7 contradicts the first paragraph of Section 6.3.1.6.6.

Response

The reference cited in Section 6.3.1.2.2 of the draft EA (Knauss et al., 1984) describes the experiments that have been performed on the Topopah Spring Member. Since the writing of the draft EA, several other publications which discuss these experimental results have been published.

The six references noted in the second comment were considered in arriving at the conclusions that were presented in the section on dissolution. As an example, Kerrisk (1983) referenced four of the six in a discussion of reaction-path calculations of volcanic-glass dissolution.

The experiments that are planned for site characterization (Section 6.3.1.6.7) are to confirm what is stated in Section 6.3.1.6.6.

C.5.7 TECTONICS

Addressed in this category are 123 comments concerning the assessment of postclosure tectonics at Yucca Mountain as presented in the draft EA (Section 6.3.1.7). The primary function of this technical guideline is to ensure that the likelihood of disruption of waste isolation due to tectonic processes is at or below acceptable levels based on all available information. The first two issues cover the potential for volcanic and seismic activity in the vicinity of the site. The potential for a release of radionuclides due to tectonic processes is the focus of the favorable condition (Section 6.3.1.7.3), the qualifying condition (Section 6.3.1.7.1), and the disqualifying condition (Section 6.3.1.7.5) in the Environmental Assessment (EA). The U.S. Department of Energy (DOE) conclusions on all three conditions have been challenged. The comments are categorized into three issues: (1) Potential for Volcanic Activity, (2) Potential for Seismic Activity, and (3) Potential for Tectonically Induced Loss of Containment.

Issue: Potential for volcanic activity

Fifteen comments were received on this issue. Included are remarks on the data used to assess the potential for volcanism at the site and the analyses of those data. Questions directly addressing the possibility of disruption of an underground repository by volcanic activity are addressed separately in the final issue. Specific topics covered below are: silicic volcanism, hydrothermal and hydrovolcanic activity; and eruption of volcanic materials.

Silicic volcanism. Several commenters noted that the effort in the EA concentrated on examining the potential for basaltic volcanism, while silicic volcanism was de-emphasized.

Response. The U.S. Geological Survey (USGS, 1984) reviewed available data on silicic volcanism and concluded that no silicic volcanism has occurred within 100 kilometers (62 miles) of the site during the last 6 million years. First silicic and then basaltic volcanism have become increasingly concentrated toward the margins of the Great Basin during the last 14 million years (Christiansen and McKee, 1978). Based on these observations, the likelihood of silicic volcanic activity over the next 10,000 years is probably negligible.

Hydrothermal and hydrovolcanic activity. A number of commenters noted that the potential for hydrothermal and hydrovolcanic activity was not discussed in the EA.

Response. Significant hydrothermal activity is usually associated with long-lived centers of andesitic to silicic volcanism. As discussed above, evidence for recent silicic volcanism is absent in the vicinity of the site. Areas of small-volume basaltic volcanism with youngest ages close to 300,000 years old are probably characterized by a low thermal flux incapable of supporting hydrothermal activity. Hydrovolcanic eruptions (i.e., explosive volcanic activity associated with magma-water interaction) probably occur in less than 2 percent of all western U.S. eruptions (Smith and Luedke, 1984). The significance of both types of secondary volcanic processes will be further evaluated during site characterization.

Eruption of volcanic materials. Estimates for the probability of volcanic eruption at a site at Yucca Mountain were questioned by the largest number of reviewers commenting on the issue. It was suggested that silicic, hydrothermal, and hydrovolcanic activity should be included in probability calculations. Derivation of the mean probability (approximately 1 chance in 10,000 over 10,000 years) was not clearly explained in the EA. Some commenters noted that age dating of volcanic features was incomplete. One reviewer felt that high heat flow due to subduction processes beneath Yucca Mountain would make construction of a repository there imprudent. Finally, one reviewer asserted that the potential for large-scale impoundment of surface waters induced by volcanic activity (potentially adverse condition in Section 6.3.1.7.4) may be present at the site, in disagreement with the findings of the EA.

Response. As discussed in the previous two topic responses, silicic, hydrothermal, and hydrovolcanic activity are presently thought to be unimportant contributors to recent volcano-tectonics in the vicinity of Yucca Mountain. Should studies conducted during site characterization alter this perception, these processes will be considered in a thorough assessment of the potential for future volcanic activity. Further work is required to better resolve a mean probability for the eruption of volcanics at the site. Section 6.3.1.7.5 in the EA, as well as favorable condition 1, have been revised to include further discussion of volcanic event probabilities. The Site Characterization Plan will outline the requirements for the study. Sampling and age dating of volcanic centers will continue under site characterization. Subduction-controlled volcanism and attendant heat flow probably ceased to be important in the Great Basin more than 10 million years ago.

In response to the challenge to the findings on potentially adverse condition 5 in Section 6.3.1.7.4, the low average rainfall and high evaporation rates make large impoundments of surface waters resulting from any natural phenomenon highly unlikely. This potentially adverse condition is judged to be not present at Yucca Mountain.

Issue: Potential for seismic activity

Seventy-two comments were received concerning the potential for seismic activity in the vicinity of the site. Most of the commenters focused on the incompleteness of the present information on historic and prehistoric faulting and questioned the adequacy of probability, recurrence, and ground-motion computations based on current understanding of tectonics near the site.

Comments concerning the potential effects of fault movement on the containment of waste at the repository are addressed in the following issue. Presented here are responses to comments on the following topics: regional seismicity, fault delineation and dating, earthquake probabilities, and faulting effects on ground-water flow.

Regional seismicity. Reviewers expressed concern over several aspects of the regional seismicity around the Yucca Mountain site. Major comments centered around the proximity and association of the site to zones of seismic activity in the western United States such as Mammoth Lakes, the San Andreas Fault, the Nevada Seismic Zone, the Intermountain Seismic Zone, and the East-West Seismic Belt. Corrections to distances to these features and to earthquakes within them as given in the EA were requested. The quiescence of the Las Vegas Valley Shear Zone was questioned as was the possibility of explosion-induced aftershocks due to testing at the Nevada Test Site (NTS). Citing the short record of historical seismicity at the site, one reviewer challenged the conclusion that potentially adverse condition 4 (Section 6.3.1.7.4 of the EA) of local seismicity exceeding that of the tectonic setting is not present at the site. This commenter and others suggested that more earthquake data are necessary to adequately assess local seismicity patterns.

Response. Location of the site relative to the San Andreas Fault in western California, the Nevada Seismic Zone, and the Intermountain Seismic Zone is not thought to represent a major seismic hazard. In addition, inclusion of seismicity data from these three regions and Mammoth Lakes in assessments of seismic risk at Yucca Mountain may be appropriate for certain purposes, but would not be appropriate for site-specific hazard studies. The mechanism generating earthquakes along the San Andreas Fault is different from that operating at the site, which is far from the boundary. Also, the results of Christiansen and McKee (1978) suggest that the higher rates of seismicity within the Nevada and Intermountain seismic zones and at Mammoth Lakes are consistent with a migration of volcanism and faulting away from the center of the Great Basin and the site, and toward the eastern and western edges of the Great Basin. Seismicity of Mammoth Lakes is almost certainly associated with the migration of magma at depth. There is no evidence that magma bodies exist beneath or near Yucca Mountain. The outline of the East-West Seismic Belt is, of course, subjective and has been removed from Figure 3-9 (Historical seismicity in the western United States) of the final EA. The site is located on the southern fringe of this belt, in a region of relative seismic quiescence. The Las Vegas Valley Shear Zone has also been seismically quiet, as have been most northwest-trending-faults in the Great Basin (USGS, 1984).

Several distance measurements have been changed in the final EA as a result of comments by reviewers. The distance from the site to the Owens Valley earthquake is given as 130 kilometers (81 miles) (Section 6.3.1.7.4). Its magnitude is reported as 8+. The distance to the Intermountain Seismic Zone is stated as "... more than 250 kilometers (155 miles) east of the site ..." (Section 6.3.1.7.4).

The closest underground nuclear explosions have been located 40 to 50 kilometers (25 to 30 miles) from the site. Explosion-induced aftershocks have been documented and analyzed (ERDA, 1977). The vast preponderance of

aftershocks occur at shallow depths (probably less than 5 kilometers (3 miles), and are located within 14 kilometers (9 miles) of ground zero of the preceding explosion (ERDA, 1977).

Though local microearthquake data for the site are limited to a few years, the U.S. Geological Survey (USGS, 1984) reported that the seismic record for the region is complete for all earthquakes greater than or equal to a magnitude of 4 to 5 occurring in the past 40 years. All events between magnitude 7 and 8 that have occurred in the region over the past 130 years are likely to have been documented. New information on focal mechanisms of earthquakes in the vicinity of Yucca Mountain has been presented by the USGS (1984) and has been incorporated into the final EA. Neither the seismic record nor the regional tectonics indicates that future seismicity at the site is likely to be more frequent or of higher magnitude than that occurring throughout the southern Basin and Range Province. Therefore, potentially adverse condition 4 (Section 6.3.1.7.4 of the EA) is considered to be not present at the site. The site characterization program will enhance understanding of seismicity patterns at Yucca Mountain and in the surrounding region and will permit a more confident extrapolation of the data into the future.

Fault delineation and dating. The largest number of comments on this issue addressed the adequacy of information on the delineation and age of faults near the site. It was pointed out that all faults on Yucca Mountain require further study and various techniques for accomplishing this goal (e.g., low-sun-angle photography, trenching, establishing better stratigraphic relationships) were suggested. Citing the work of Swadley et al. (1984) and Szabo and Kyser (1985), several reviewers contested the conclusion that there is no unequivocal evidence for surface faulting within the 1,100-square-kilometer (425-square-mile) area of the site during the last 40,000 years. Commenters interpreted the work of Carr (1984) to indicate that uplift rates on the Windy Wash Fault near the site are equal to those in tectonically active areas of Death Valley. The stratigraphy-determined age of nearby block-forming faults was questioned. Also, reviewers noted that the EA did not adequately consider strike-slip faulting.

Response. Studies and maps of the types suggested will be evaluated for inclusion in the site characterization program to better understand the location, age, and seismic potential of faults at Yucca Mountain. Conclusions presented in the EA appropriately incorporated all available published information on faulting in the vicinity of the site. The Swadley et al. (1984) reference was being produced concurrently with the draft EA. At the time of publication of Swadley et al. (1984), there was no unequivocal evidence of surface fault displacement younger than 40,000 years within a 1,100-square-kilometer (425-square-mile) area around the Yucca Mountain site. New data (6 age-dates) on the thermoluminescent age of a disturbed eolian silt in eastern Crater Flat may indicate surface displacement on the order of 1 to 10 centimeters (0.39 to 3.9 inches) during the Holocene (Dudley, 1985). Dudley also states, however, that this dating technique is highly provisional and that these dates are preliminary and have not been verified.

The work of Szabo and Kyser (1985) reports ages from 26,000 to over 400,000 years for secondary carbonate deposits in fault-related fractures from drill cores at Yucca Mountain. However, these preliminary results were

based on few samples and, as Szabo and Kyser (1985) state, may or may not be indicative of the timing of faulting episodes. These ages represent a minimum age for the fracturing (i.e., the dates represent the age of the carbonate deposition and not necessarily the age of the preexisting fracture).

Reviewers incorrectly interpreted the work of Carr (1984), where the rates of displacement for the Windy Wash Fault were 0.3 meter (1 foot) per 1,000 years during the period of time from 12.9 to 11.7 million years ago, not at the present time. Discussions by the USGS (1984) suggest that the age of block-forming faults near Yucca Mountain, based on the stratigraphic relationship of the Timber Mountain Tuff to Paintbrush Tuff, is between 12.5 and 11.4 million years.

The discussion of strike-slip faulting has been expanded in the final EA to include both major regional strike-slip zones (Section 3.2.2 of the final EA) and to review evidence for lateral movement on faults at and near the site.

Earthquake probabilities. The analysis of the likelihood of faulting and strong ground motion at the Yucca Mountain site was the object of criticism from a number of reviewers. Objections were raised on the exclusion of Yucca Mountain faults from calculations of recurrence rates for large earthquakes near and accelerations at the site, despite the acknowledgment that some faults at Yucca Mountain may be potentially active. Commenters suggested that the potential for future seismicity was not adequately assessed in support of the favorable condition (Section 6.3.1.7.3 of the EA) and that strike-slip faulting should be considered in analyses of the potential for earthquake activity. Reviewers expressed the importance of examining the late Quaternary record to examine short-term, cyclic tectonic trends and also questioned the recurrence rate of major earthquakes in the area given in a preliminary version of Carr (1984). A commenter suggested that surficial warping or faulting due to ground-water withdrawal be assessed. One reviewer requested a wording change concerning the connection between volcanism and surface faulting during the Quaternary.

Response. The calculation of peak acceleration requires a list of faults that are thought to represent the greatest hazard to the site and for which dimensions are well known. At the time of preparation of the seismic-hazard prediction reported by USGS (1984) and Rogers et al. (1977), the fault map (Scott and Bonk, 1984) of the Yucca Mountain site was not available. Although stress measurements indicate that north-trending faults at Yucca Mountain are so oriented that slip may be possible, confidence in the lengths and slip histories of these faults is not sufficient at this time to estimate magnitudes, although estimates will be made during site characterization. Further, the attenuation curves of Schnabel and Seed (1973) used to compute ground-motion estimates for the EA are outdated; newer relationships are presented in Section 6.3.3.4.5 and will be used for seismic hazard evaluations during site characterization. A table of recurrence estimates compiled from available literature for the NTS region for magnitudes of 7, 6, and 5 was added to Section 6.3.1.7.5 of the final EA.

During site characterization, more thorough investigations of seismicity, strike-slip and normal faults of Quaternary age, and attenuation

parameters will permit an improved analysis of the potential for faulting near Yucca Mountain. The recurrence estimate of Carr (1984) has been deleted from Section 6.3.1.7.5 of the EA because of a change in the supporting reference and at the request of the reviewers.

It seems unlikely that warping and faulting due to ground-water withdrawal are possible in locations such as Yucca Mountain where the water table is at least 500 meters (1,640 feet) below the surface. As requested, the sentence in potentially adverse condition 1 in Section 6.3.1.7.4, has been changed to read "... there is suggestive evidence that ... surface faulting may have accompanied the volcanism ..."

Faulting effects on ground-water flow. Several commenters suggested that evidence does not support the conclusion that tectonic processes, specifically faulting, that could adversely affect ground-water flow are not likely at the site (potentially adverse condition 6 in Section 6.3.1.7.4). Reviewers felt that faulting could increase hydrologic flux and travel times and alter the depth to the water table. One reviewer argued that the potential for disruption of the ground-water system should be evaluated for a 100,000-year time period under the full range of conditions expected during that time frame.

Response. The nature of flow under unsaturated conditions in a fractured porous medium (Wang and Narasimhan, 1985) makes it unlikely that the development of new fractures could alter flow conditions to any extent. At Yucca Mountain the water table is at least 500 meters (1,640 feet) below the surface. The DOE concludes that changes in the ground-water flow system are highly unlikely to lead to significant increases in radionuclide transport during the 10,000-year period specified in the DOE siting guideline (10 CFR 960.4-2-1) and thus potentially adverse condition 6 in Section 6.3.1.7.4 of the EA is not present at Yucca Mountain.

Issue: Potential for tectonically induced loss of containment

Reviewers of the draft EA submitted 36 comments directly addressing the potential for radionuclide release due to future tectonic processes or events. As a result, all comments in this issue directly or indirectly challenge the DOE findings on the favorable condition (Section 6.3.1.7.3), the qualifying condition (Section 6.3.1.7.1), or the disqualifying condition (Section 6.3.1.7.5) as detailed in the EA. The favorable condition states that Quaternary rates of igneous and tectonic activity suggest that there is a less than one in 10,000 chance over the next 10,000 years of release of radionuclides to the accessible environment. The first two topics in this issue cover challenges to the finding on the favorable condition based on potential for future volcanic and seismic disruption. Preliminary qualification of the site is possible as long as release of radionuclides above those allowable is not judged to be likely in the future. The site will be disqualified if the Quaternary record suggests that ground motion or fault movement is likely to lead to a loss of waste isolation. Questions on these final two conditions are addressed under the third topic. The following topics are entitled: challenges to findings regarding volcanism, challenges to findings regarding seismicity, and challenges to qualifying and disqualifying conditions.

Challenges to findings regarding volcanism. Several commenters suggested that the favorable condition is not met at Yucca Mountain on the basis of either the record of volcanism near the site or the inadequacy of the volcanic record.

Response. As discussed in the first issue, small-volume basaltic volcanism is thought to be the most likely form of future volcanism in the southern Great Basin. Exhumation of a repository by explosive cratering associated with hydrovolcanism is unlikely; the depth of burial of the repository is about four times the depth of craters formed by such processes (Crowe et al., 1985). The most recent probability calculations for the eruption of basalts at the site is between 4.7×10^{-4} and 3.3×10^{-6} for a 10,000-year period. The smaller probability clearly meets the favorable condition, and the higher bound does not. This conclusion is based on an assumption that penetration of the repository by basalts will lead to radionuclide releases. A study by Link et al. (1982) assessed the potential radionucide releases associated with volcanic activity (see EA Section 6.3.1.7.6). Work completed during site characterization will assess the most appropriate probability value based on an evaluation of data assumptions and on structural controls of past volcanic activities in the region. Until this work is completed, it is concluded that the favorable condition is not present and the EA has been revised to reflect this.

Challenges to findings regarding seismicity. Other reviewers suggested that the favorable condition is not met at the site because of the probability that faulting and ground motion will directly cause a loss of waste isolation or because of potential changes to hydrologic conditions resulting from seismic activity. Commenters noted that seismicity was not evaluated in support of the favorable condition.

Response. The draft EA did not present a thorough analysis of the probability that earthquakes could disrupt waste isolation at the site because such calculations are not yet available. In the event of seismicity in the vicinity, the risk of damage to underground tunnels and postclosure structures is thought to be small because tunnels in tuffaceous rock have been observed to remain stable during nearby underground nuclear testing. More importantly, with the upper bound on flux thought to be present within the potential host rock (0.5 millimeter (0.02 inch) per year, Wilson, 1985), even direct fracture disruption of waste disposal containers in the repository is unlikely to lead to releases of radionuclides to the accessible environment at a sufficiently fast rate to exceed the EPA release limits. To saturate the deepest portion of the repository, the water table would have to rise a minimum of 185 meters (600 feet), which is an unrealistic occurrence.

Challenges to qualifying and disqualifying conditions. Challenges to conclusions on the qualifying condition (one commenter) and to the disqualifying condition (several commenters) were based primarily on the hypothesis that ground motion, faulting, and accompanying perturbations to hydrologic conditions could result in significant release of radionuclides. Most commenters suggested that evidence indicates the potential for a large earthquake over the next 10,000 years. One commenter cited the potential for disruption of the repository due to nuclear testing at the Nevada Test Site. Several commenters questioned the reliance on low water flux to support the absence of the tectonics disqualifying condition.

Response. No mechanisms have been identified that suggest a potential for unallowable loss of radionuclides from the engineered barrier system and transport to the accessible environment. The USGS (1984) estimates that the Bare Mountain Fault, 11 kilometers (9 miles) from the site, is capable of producing a magnitude 6.8 earthquake resulting in an acceleration of 0.4g at the surface of the site. Larger accelerations are possible should active faults exist closer to the site. Only three small earthquakes (magnitudes less than 2) have been recorded at Yucca Mountain during 4 years of intensive monitoring. In addition, nuclear tests are confined to distances of 40 to 50 kilometers (25 to 30 miles) from the site, and aftershocks generally are restricted to distances within 14 kilometers (9 miles) of ground zero. During site characterization, seismic-design analysis by experts in the field of hazard assessment will establish appropriate seismogenic sources for consideration of preclosure and postclosure engineering and geologic structures.

Most importantly, loss of waste isolation due to disruption of the repository by strong ground motion or even direct fracturing alone is highly unlikely. Loss of waste isolation requires a medium capable of dissolving and transporting sufficient radionuclides to the accessible environment within the prescribed period of time. If the flux within the host rock is as low as currently thought (less than 0.5 millimeter (0.02 inch) per year, Wilson, 1985), there will be insufficient flux to cause an unacceptable release of radionuclides (Sinnock et al., 1984).

New fractures produced by faulting would be likely to have negligible effects on hydrologic flow through unsaturated fractured porous rock (Wang and Narasimhan, 1985).

The only possible mechanism for release would be the penetration of the repository by sufficient magma and further eruption of magma so that dispersal of some radionuclides could occur. The probabilities of magmatic penetration of the repository over a 10,000 year period range from 4.7×10^{-4} to 3.3×10^{-6}, and the consequences of volcanic events, as predicted by Link et al. (1982), have been added to the final EA in Section 6.3.1.7.6.

In addition, adverse consequences of any release of waste are predicted to be small. The final EA maintains the findings of the draft EA that (1) the evidence does not indicate that the Yucca Mountain site is disqualified and (2) the evidence does not indicate that the site is not likely to meet the qualifying condition for postclosure tectonics.

C.5.8 HUMAN INTERFERENCE (NATURAL RESOURCES)

The Human Interference technical guideline deals with the potential for the site to contain natural resources that could be economically attractive and thereby cause future interference with the repository. Forty-one comments received in this category have been subdivided into four issues: (1) Mineral Resources, (2) Water Resources, (3) Geothermal Resources, and (4) Miscellaneous.

Issue: Mineral resources

Twenty-three comments were received on the mineral resources issue. These comments address the potential for mining operations at or near the Yucca Mountain site to exploit the mineral resources of the area. The topics addressed include: mineral resource potential, mineralization of calderas, economic mining contributions, geochemical sample reporting, and editorial changes.

Mineral resource potential. Several commenters indicated that the U.S. Department of Energy (DOE) had no basis for concluding, through literature review, that Yucca Mountain does not have an economically feasible potential for mineral resource exploitation. In addition, these comments indicated that all relevant data had not been considered and that other data were misrepresented.

Response. The DOE developed its position regarding the mineral resources of Yucca Mountain by assessing the results of the following activities:

1. Mineral inventories were conducted by literature review (Bell and Larson, 1982) and by combined literature review and field investigation (Quade and Tingley, 1983). The results indicated that there is no evidence of past mining activity at Yucca Mountain nor any evidence of existing economic mineralization. Results also indicated that there are no economically significant nonmetallic mineral deposits located at Yucca Mountain that cannot be found in economical deposits elsewhere in Nevada.

2. Field exploration and geologic mapping was conducted by the U.S. Geological Survey (Christiansen and Lipman, 1965; Lipman and McKay, 1965; Scott and Bonk, 1984) for Yucca Mountain and surrounding areas. No evidence of economic mineralization was reported or mapped.

3. Exploratory boreholes at and near the Yucca Mountain site have been drilled. Cores and cuttings derived from these boreholes are routinely analyzed by geochemical methods. No mineralization has been found of economic importance. A sample from drill hole USW G-1 taken at 1,072 meters (3,515 feet) below the surface showed "... an abrupt increase in the intensity of alteration, presumably caused by hydrothermal solutions ..." (Spengler et al., 1981). An analysis of the sample showed that it contained 0.64 ounce per ton silver and 0.02 ounce per ton gold (reported as parts per million in the reference). These concentrations are not economical at the surface, let alone at a depth of 549 meters (1,800 feet) below the water table.

The preceding evidence establishes a strong defense for the position that no known economic mineral resources are present at Yucca Mountain. The evaluation of mineral resources in the Environmental Assessment (EA) indicates that the potential for significant amounts of minerals to occur at the site is low.

Mineralization of calderas. Some commenters stated that Yucca Mountain sits on the edge of the Crater Flat Caldera and that this and 75 percent of all calderas in Nevada are mineralized.

Response. The rocks exposed at Yucca Mountain are chiefly the products of volcanic-tectonic structures known as calderas that partially coincide in space and time. McKee (1979) evaluated the generic relationship of more than 30 calderas and their volcanic products to the distribution of known ore deposits in Nevada. Of 98 mining districts in Nevada with $1 million or more production of gold, silver, copper, lead, zinc, mercury, antimony, and iron, only 2 are within calderas, and only 5 are in silicic tuffs related to calderas (McKee, 1979). This is significant considering that ash-flow tuff of Tertiary age is the most abundant rock type exposed in Nevada (constituting half of the total surface outcrops) and that 93 percent of the major metal-mining districts in Nevada are in rocks other than silicic tuff (McKee, 1979). This strong negative correlation indicates that large base- and precious-metal deposits in Nevada are generally not associated with calderas or the products of caldera evolution.

Economic mining contributions. A few comments were directed at the DOE's dismissal of the contribution of mineral and mining operations to the economy.

Response. The numbers that the DOE cited for mining production and yield were used to define the relative size of an operation. Regardless of the worth of any existing or future operation (including the Wahmonie District), these mining activities will not be impacted since they lie outside the controlled area. Mineral-resource surveys in the area have been conducted and are presented in the EA. Further evaluations will be undertaken during site characterization.

Geochemical sample reporting. Some commenters stated that geochemical investigations of core samples were not reported in the draft EA.

Response. These data have been included in the final EA. In addition, expanded analyses will occur during site characterization. Samples from existing and future boreholes will be analyzed using x-ray fluorescence and neutron activation analysis for trace elements.

Editorial changes. Various sentence and word changes as indicated in the response were suggested.

Response. In Section 3.2.4.2 the words "mining operations" have been revised to read "exploratory and mining operations" to encompass all practices associated with mining. In the same section, a sentence has been added that reads "Lead and copper were also historically important minerals in northern and central Nevada."

Section 3.2.4.3 has been revised and reorganized to indicate that "Fluorite mineralization, judged to be of local significance, is widespread in Bare Mountain, 16 kilometers (10 miles) west of the site" (Bell and Larson, 1982).

Issue: Water resources

Eight comments were associated with the potential for ground-water resource exploitation. The majority of the comments concerned the availability of water for possible future communities in Jackass Flats, east of Yucca Mountain. One commenter stated that the potential for ground-water extraction at Crater Flat, west of Yucca Mountain, was not considered. A few commenters stated that the draft EA discussions failed to consider the impact on deep regional aquifers and the interconnectivity between aquifers. In addition, it was stated that the shallow carbonate aquifer beneath Yucca Mountain meets safe drinking-water standards.

Response

It is most likely that future developments would occur in areas with easy access to reliable, shallow water resources. However, future use of water by a possible townsite in Jackass Flats would not impact the isolation performance of the repository because the thick, unsaturated zone and very low flux are the major reasons that radionuclides will not be released from the repository. Pumping of water from the saturated zone underlying the repository would not impact the flux and low water content in the repository zone. Furthermore, if the water table dropped due to overuse, the travel time from the repository to the accessible environment would increase.

In general, development of future communities would occur where a reliable and shallow source of water could be obtained. The probability of developments of various size and location will be further investigated during site characterization.

Waddell (1982) discusses the three ground-water basins within the regional ground-water system in the Yucca Mountain area. This study is reviewed in Section 2.1 of the EA. The deep aquifer is unlikely to be a potential source within the Alkali Flat-Furnace Creek Ranch ground-water basin unless the shallow tuff-alluvial aquifer was depleted. This is unlikely to occur under any reasonable use scenario. It is true that in the very distant future (1,000 to 10,000 years), changing climatic conditions or abnormally excessive water usage could change relative head pressures. However, for the immediate future (less than 1,000 years), it is not deemed a plausible scenario that water users would drill to the deep aquifers.

The shallow aquifer beneath Yucca Mountain is not a carbonate aquifer, but a tuff-alluvial aquifer.

Issue: Geothermal resources

Four comments were received relative to the potential for economically feasible geothermal resources in the area of Yucca Mountain and the proposed repository site. The comments address the DOE statement that there is "... no potential for any commercially attractive geothermal resources."

Response

The potential use of the low-temperature geothermal energy located in the Amargosa Valley does not have a bearing on the impacts of a repository at

Yucca Mountain because the Amargosa Valley is outside of the controlled area. The area around Yucca Mountain is extremely well known in terms of heat flow. More than 60 wells (some as deep as 1,830 meters (6,000 feet)) have been drilled and analyzed. The data show the absence of any readily and economically accessible geothermal resources. As indicated in the EA, temperatures at exploitable depths are about one-third to one-ninth the temperature required for commercial power generation. Further studies during site characterization will help to confirm current understanding of geothermal resource potential.

Issue: Miscellaneous

Six comments were received and categorized as miscellaneous. The topics addressed include: natural resources present, radionuclide migration via openings, and editorial changes.

Natural resources present. One commenter suggested that the evidence presented under the Human Interference technical guideline does not support the conclusion that no valuable natural resources are present at Yucca Mountain.

Response. The absence of commercially attractive natural resources at Yucca Mountain, and the estimated low mineral-resource potential of the site, are addressed in sections 6.3.1.8 and 3.2.4 of the EA and are covered in detail in the cited references. Available evidence does not suggest the presence of natural mineral resources at Yucca Mountain as discussed in Section C.4.1.1.

Radionuclide migration via openings. Two commenters suggested that because the DOE stated that any commercial drilling or mining operations could create significant pathways for radionuclide migration, the shafts and boreholes of the repository would also cause this problem. In addition, it was noted that the DOE cannot tell if underground testing may have caused potential pathways for radionuclides.

Response. If nuclear waste is placed in a future repository at Yucca Mountain, all boreholes and shafts will be filled and sealed with materials which have equivalent or better isolation capabilities than the natural system. All underground testing has been conducted at distances far removed from the site, such that there is believed to be no potential for effects at the site (See Section C.6.4).

Editorial changes. Some commenters suggested editorial changes to EA discussions.

Response. The reference citation of Lipman and McKay (1965) has been added to Section 6.3.1.8.2; this section has been revised to read: "Geothermal resources in the area were inventoried by Garside and Schilling (1979) and evaluated by Trexler et al. (1979)."

C.5.9 POSTCLOSURE SITE OWNERSHIP AND CONTROL

Thirteen comments were received in this category. Several comments were requests for the U.S. Department of Energy (DOE) to explain why an additional 50,000 acres of public land now managed by the Bureau of Land Management (BLM) would be required for the repository. Another request was for a map in the final Environmental Assessment (EA) indicating the controlled area and the site.

Many commenters stated that the discussions in the draft EA are inadequate in regard to current and future land ownership and water rights. The contentions were that the discussions were inadequate considering (1) that land-withdrawal actions required for the Nellis Air Force Range have been before Congress for eight years, (2) that the western Shoshone Indian Tribe has filed claim to a large part of Nevada, including Yucca Mountain, (3) that the U.S. Air Force (USAF) has requirements for air space in this area, and (4) the Nevada role in designating the area as a repository site. The confidence that the DOE has expressed with regard to land and water acquisition for the repository were therefore believed to be unfounded.

Finally, one commenter addressed the questions of monitoring and safeguarding the repository after closure.

Response

Approximately 5,000 acres of land now managed by the BLM would be required for withdrawal from public use if Yucca Mountain were recommended as a repository site. The 50,000-acre figure in Section 5.2.3 of the draft EA was an error and has been corrected in the final EA. Also included in the final EA is a figure (Figure 3-1) showing the approximate boundary of the site which is analagous to the controlled area (approximately 24,710 acres) of which about 5,000 acres are managed by the BLM. According to 40 CFR Part 191, the boundary of the controlled area is not to exceed 5 kilometers (3 miles) in any direction from the outer boundary of the original location of the radioactive wastes in a disposal system.

There are several differences between the land-withdrawal situation for the Nellis Air Force Range and that which would be required for a repository at Yucca Mountain. The primary difference, however, is that the Nellis Range has remained a restricted installation, therefore reducing the urgency for Congress to act on the withdrawal request.

The land claims of the western Shoshone Indian Tribe have recently been decided in favor of the United States (United States v. Dann and Dann, 1985).

The DOE is aware of the present-day aircraft flight requirements of the operations conducted at the Nellis Air Force range. The DOE, through past negotiations with the USAF, established the existing operational restrictions for flights through DOE-controlled air space at the Nevada Test Site (NTS), designated R4808W and R4808E. Currently, R4808E is closed to all military aircraft, whereas R4808W is open to military aircraft upon request. In the future, the DOE will designate other air corridors to the USAF if conflicts arise.

The role of the State of Nevada in the ultimate designation of Yucca Mountain as a repository site is limited to the State disapproving the recommendation of the site for a repository. The U.S. Congress, however, has the power to override State disapproval by passing a resolution of repository siting approval (NWPA, 1983).

If it becomes necessary to acquire privately held water rights for the repository, a situation not expected based on available information, the DOE would purchase these rights or begin Federal condemnation proceedings. Such negotiations or proceedings are not expected or planned. Because no existing privately held rights or encumbrances have been identified at the site, the DOE considers that the qualifying condition has been met. Whether superior rights to the water in the same underground source exist with respect to points of extraction outside the NTS has not yet been determined.

The license application for a repository will include a safety analysis report that will address monitoring and safeguarding of the site after closure of the repository. The contents that are required in the safety analysis report are described in 10 CFR 60.21(c). Furthermore, the Environmental Protection Agency (40 CFR Part 191) requires that permanent markers be erected to designate the disposal site.

C.5.10 POSTCLOSURE SYSTEM GUIDELINE

The 14 comments received and classified under this category address concerns for the performance of the entire waste-disposal system after the repository has been closed. The comments were further categorized into three issues: (1) Degree of Conservatism and Data Uncertainties, (2) Effects of Ground-water Flow, and (3) Miscellaneous.

Issue: Degree of conservatism and data uncertainties

Nine commenters addressed the concern that the U.S. Department of Energy (DOE) has presented nonconservative and uncertain data with respect to the repository total waste system. The topics addressed include: guideline conclusions, release rates, degree of conservation, and favorable and potentially adverse conditions.

Guideline conclusions. A few commenters suggested that the conservative quantitative predictions reviewed in Section 6.3.2.2.1 do not lend considerable confidence that after site characterization Yucca Mountain will meet the postclosure system guideline; in fact, such a conclusion was considered overly optimistic and unsupported by the data. The analyses and in turn the conclusions of Section 6.3.2 do not reflect uncertainties affecting most subsystem parameters according to these commenters.

Response. The DOE disagrees with these assertions. The lines of evidence available at the time the draft Environmental Assessment (EA) was written were sufficient to generate considerable, if not complete, confidence in the minds of the responsible investigators that the Yucca Mountain site

could be shown to meet the postclosure system guideline after certain hydrologic and tectonic uncertainties were cleared up during the site characterization phase. Furthermore, uncertainties in most system parameters were taken into account in the analyses supporting the conclusions of Section 6.3.2 either by presenting a range of values of parameters and performance measures as in tables 6-41 (Assessment of release from normal preclosure operations) and 6-45 (Preliminary estimates of cumulative radioactivity released to the accessible environment from a repository containing 70,000 MTHM) in Section 6.4.2 or through the use of conservative assumptions.

The conservative assumptions listed in Section 6.3.2.2.1 of the draft EA are examples of the many assumptions used in the studies (Thompson et al., 1984; Sinnock et al., 1984) that were cited as supplementing the evidence from the preliminary postclosure performance analysis (Section 6.4.2). Brief summaries of some of the results of these studies were given in Section 6.3.2.2.1, but the reader should consult the study reports to gain full appreciation of the range of assumptions and system parameters used in making these preliminary estimates of system performance. The estimated ranges of uncertainty for each of the performance measures tested in Section 6.4.2 are quoted in tables 6-44 (Summary of values and conditions used in preliminary system performance analysis--reference case) and 6-45 (Preliminary estimates of cumulative radioactivity released to the accessible environment from a repository containing 70,000 MTHM) of the draft EA.

Release Rates. Some commenters asserted that the release rates calculated in Section 6.3.2 of the draft EA are nonconservative because there is no indication that spent fuel will be reprocessed into a borosilicate glass waste form; also, radionuclides may be concentrated in the voids surrounding the UO_2 in the fuel rods. The solubility would therefore not be limited by the bulk dissolution rate.

Response. It is agreed that the assumption of congruent leaching, limited solely by the solubility limit of the bulk waste form, could in principle lead to nonconservative estimates of the release rate from spent fuel (the reference waste form in the draft EA, but not necessarily the reference waste form used for studies supporting the draft EA). The release rates calculated in Section 6.4.2.2.2 have been recalculated with a slightly different model than was used in the draft EA. A number of assumptions were taken into account to better include uncertainties.

Degree of conservatism. Some commenters noted that the DOE siting guidelines require that a "realistic but conservative" approach be taken in all analyses used to support findings for the technical or system guidelines. These instances of nonconservatism appear in many areas such as geohydrology, geochemistry, and waste-package performance analyses.

Response. The DOE presumes that the major instances of nonconservatism that occur in the draft EA are contained in the evaluations of the geohydrology and geochemistry technical guidelines, and in the evaluation of the waste disposal container lifetime. Nonconservatism is presumed by the comments to be inherent in (1) the EA assumption of predominant matrix flow at a maximum percolation flux of 1 millimeter (0.04 inch) per year; (2) the assumption that water from the saturated zone of Yucca Mountain (water from Well J-13) will have chemical properties similar to as-yet-untested water

from the vadose zone; and (3) the assumption that attack rates on the waste disposal container wall are bounded by uniform corrosion rates. Revisions to Section 6.3.1.1.5 explain the rationale for flux estimates used in the final EA. The DOE maintains that these assumptions are a reasonable balance between the requirements for "realism" and "conservatism" stated in its own siting guidelines (10 CFR Part 960). Re-evaluations of data and evidence supporting the technical guidelines in question have not changed this opinion: upper bounds on flux of 0.5 millimeter (0.02 inch) per year are justified in Section 6.3.1.1.5 of the present document; the unlikely probability of finding vadose zone ground water with "exotic" chemistry is argued in Section 6.3.1.2; and the lifetime of the waste disposal container is discussed in Section 6.4.2.2.1 with increased emphasis on other possible attack mechanisms.

Favorable and potentially adverse conditions. Commenters suggested that the DOE explain how it will consider favorable and potentially adverse conditions in assessing the ability of the site to meet the systems guidelines. Objections were raised to the discussion of levels of subjective confidence in meeting technical guidelines contained in the first paragraph of Section 6.3.2.2.2; it was maintained that such "confidence levels" are unsupported and irrelevant to an analysis of the postclosure system guidelines, and that the discussion should be removed from the text of the EA.

Response. The DOE intends that the evaluations of favorable and potentially adverse conditions mentioned in the technical guidelines should, during the site-selection process, fulfill roughly the same purpose as is fulfilled by the detailed, often quantitative, analyses of system performance under potentially disruptive or unexpected conditions that are expected by the Nuclear Regulatory Commission in a license application. In other words, evaluations of the technical guidelines must temporarily serve as surrogates for performance analyses of the waste-disposal system which account for unlikely conditions that might occur at the site in the next 10,000 years (climate change, volcanic activity), or changed site characteristics resulting from the continuation of processes currently operating at the site (earthquakes, erosion). The use of technical-guideline evaluations as surrogates for condition-specific analyses must, however, rely heavily on professional judgment attended by expressions of the level of subjective confidence in findings based on that kind of judgment. The evaluations of the technical guidelines in the EA are thus only indirectly related to the analysis of system performance under expected conditions; indeed, the two kinds of results are distinguished in the discussion of the postclosure system guideline (quantitative analysis in Section 6.3.2.2.1, qualitative analysis in Section 6.3.2.2.2).

For reasons mentioned above, the DOE believes that the discussion of levels of subjective confidence contained in Section 6.3.2.2 is highly relevant to the evaluation of the postclosure system guideline; this discussion has been expanded in the present version of the EA in order to clarify and further support the use of the technical-guideline findings as supplementary evidence to be used in arriving at a finding on the postclosure system guideline.

Issue: Effects of ground-water flow

The three comments received regarding this issue address the potential for ground-water flow to disrupt waste inventories of a repository at Yucca Mountain. The topics addressed are: tectonics and ground-water flow, and estimated water flux.

Tectonics and ground-water flow. Commenters claim that the analysis in Section 6.3.2.2.2 of adverse effects on ground-water flow due to tectonic motion is incomplete in that the referenced investigators (Sinnock et al., 1984) did not consider the possibility of tectonic fracturing (increase in fracture density and fracture aperture width) in their parametric analysis using higher flux values. In related comments, the DOE was asked to delete the sentence in Section 6.3.2.2.2 beginning with the words "Current estimates ..." and running to the end of the paragraph; the commenters asserted that there is insufficient support in the EA and in the available literature to draw the conclusion implied by that sentence.

Response. The commenters refer to the argument in Section 6.3.2.2.1 which maintains that tectonically induced increases in fracture density in the host rock (and, implicitly, in rocks between the repository and the water table) would not affect radionuclide migration. The DOE admits that the argument was incomplete and lacked a physical foundation in the draft EA, mainly because some of the supporting technical material had not been formally published at the time the draft EA was printed. The evidential basis for the argument is supplied in the EA through references in sections 6.3.1.1 and 6.3.1.7 to the expanded discussions of the effects of rock fracturing on hydraulic parameters. The sentence to which the comment refers has been changed, but the nature of the conclusions drawn there has not changed.

Estimated water flux. The DOE was asked to state the water flux estimated for that point where proposed Environmental Protection Agency release limits would be exceeded.

Response. Based on figures 27 through 30 in Sinnock et al. (1984), in order to cause the proposed Environmental Protection Agency release limits to be exceeded at the water table, a flux of more than 20 millimeters (0.79 inch) per year (a totally unrealistic assumption) would be required.

Issue: Miscellaneous

One commenter stated that the DOE should use the 10 CFR Part 60 definition of the engineered-barrier system in the analyses and evaluations of Section 6.3.2. Another commenter felt that a statement made in the EA about the lack of water minimizing corrosion of the waste disposal container, the dissolution of the waste, and the transport of radionuclides was not supportable.

Response

The description of the waste-disposal system in Section 6.3.2.1 has been changed in the final EA to the following:

"The waste-disposal system consists of a natural-barrier system (the geologic setting at the site) and an engineered-barrier subsystem (the waste package, and the mined repository excluding boreholes, shafts, and seals)."

The definition of the engineered-barrier system implicit in this description is consistent with the definition in 10 CFR Part 60 and with the definition used in estimates of postclosure performance in Section 6.4.2.

The statement regarding waste disposal container corrosion is accurate; limited water will indeed minimize stainless steel corrosion. Without corrosion, waste cannot be dissolved, and no subsequent transport of waste can occur.

C.5.11 ASSESSMENT OF POSTCLOSURE PERFORMANCE

The 51 comments addressing the postclosure performance of Yucca Mountain as a potential nuclear waste repository cover all aspects of the engineered-barrier subsystem and the natural-barrier subsystem. Specifically addressed are the five issues of: (1) Waste Package Performance, (2) Hydraulic Flux and Fracture Flow, (3) Ground-water Travel Time, (4) Radionuclide Retardation, and (5) Analysis of Radionuclide Releases to the Accessible Environment.

Issue: Waste package performance

Fourteen comments were received regarding the waste package performance issue. Concerns were expressed about the corrosion of steel waste disposal containers and the rates and concentrations of radionuclides released from the waste package.

Concerns were expressed that the U.S. Department of Energy (DOE) assumption of uniform corrosion of steel waste disposal containers did not take into account that scratched waste disposal containers and/or welded joints may be the realistic mode of waste disposal container failure. Also, some commenters indicated that the water used in laboratory experiments to investigate corrosion rates was not representative of actual conditions at Yucca Mountain. One commenter asked what effect over-packing would have on waste disposal container integrity.

Some commenters noted that radionuclide solubilities and release rates from the waste package are poorly known and that the resulting concentrations released from the waste package into the repository environment are uncertain.

Response

Corrosion testing of various waste disposal container steels has not been performed in water taken directly from the unsaturated zone at Yucca Mountain. The reason for this is the practical difficulty of extracting water from unsaturated subsurface rocks without changing the composition of the water by the process of extraction.

Therefore, the DOE has made the reasonable assumption that the chemistry of the waters in the saturated zone beneath Yucca Mountain is representative of waters in the unsaturated zone. (See complete discussion supporting the representative nature of Well J-13 water in Section C.5.2 of this document.) The chemistry of waters in the saturated zone beneath Yucca Mountain is likely to be similar to water from Well J-13, and it is Well J-13 water that is being used in corrosion experiments. Tests to date (July 1985) with exposure times up to two years under a variety of irradiation conditions and water concentrations have shown no attack on crevices (simulated scratches). Therefore, it is concluded that the assumption of uniform corrosion and inferences derived from laboratory experiments are reasonable. Corrosion testing is continuing and water from the unsaturated zone will be obtained and analyzed during site characterization.

In assessing postclosure performance, no over-packing was assumed because no such activity is currently planned at Yucca Mountain.

Radionuclide solubilities and ranges under Yucca Mountain conditions were not published at the time the draft Environmental Assessment (EA) was being written. Since then estimates for some radionuclides have been published (Ogard and Kerrisk, 1984) and have been used to assess the range of release rates and concentrations in the EA. In the draft EA, a reference was made to spent-fuel leaching tests by Wilson and Oversby (1984) to justify using a saturation-limited model for release from the waste form to any water that is inside a breached waste disposal container. This model was then used to predict less than 1 part in 100,000 release across the boundary of a waste disposal container using a simple mass-transfer model. More recent tests by Wilson and Oversby (1985) were made with water from Well J-13 and compared with earlier tests using deionized water on spent fuel. The release rates using Well J-13 water were less than or equal to those obtained using deionized water. In addition, colloidal (or particulate) uranium, which was seen in deionized water, was not found in tests with Well J-13 water. Thus the DOE believes the leach rates used in the preliminary performance assessment are conservative.

Issue: Hydraulic flux and fracture flow

Twelve comments were received regarding hydraulic flux and fracture flow in the postclosure performance assessment (Section 6.4.2) of the draft EA. Two topics were addressed: flux value discrepancies and various aspects of fracture flow.

Flux value discrepancies. Eight of the commenters pointed out that the estimates of hydraulic flux given in the discussion of the geohydrology guideline (Section 6.3.1.1) are larger than the flux values used in the analysis of postclosure performance (Section 6.4.2).

Response. The commenters are correct that inconsistent hydraulic parameters, including flux, were used in sections 6.3.1.1 and 6.4.2. These differences have been corrected in the final EA so that the values and derived estimates used in performance analysis are the same as those presented in the discussion of the geohydrology guideline.

Various aspects of fracture flow. Four commenters indicated that the discussion of water flow in fractures was inadequate, particularly in reference to the unsaturated zone and the level of flux at which fracture flow would begin. Also noted was a discrepancy between the conceptual hydrologic model, which allows fracture flow in the Tiva Canyon tuff, and a statement in Section 6.4.2.5.1 concerning high matric potentials above and around the repository and consequent drainage of fractures to the rock matrix.

Response. Admittedly, the discussion of fracture flow is not presented in detail in the analysis of postclosure performance. However, additional information on fracture flow and a discussion of the level of flux believed necessary to start fracture flow is contained in the discussion of the geohydrology guideline (Section 6.3.1.1 of the final EA).

The DOE agrees that there was a discrepancy between statements on fracture flow in the conceptual hydrologic model and a statement on fracture flow in the analysis of performance in Section 6.4.2.5.1. Both sections have been modified in the final EA to reflect the concept that fracture flow in the unsaturated zone is less likely in nonwelded rocks with high matric potential. However, the current travel-time model for the unsaturated zone includes both matrix and fracture flow (see Section 6.3.1.1.5).

Issue: Ground-water travel time

Five comments were assigned to this issue. A few commenters stated that there were inconsistencies in the calculated ground-water travel times from the repository to the accessible environment. A few comments were received regarding the calculations used to estimate ground-water travel time, and one commenter addressed the overall question of contamination from the repository reaching the accessible environment.

Response

There was a difference in the travel-time calculations between the discussion on the geohydrology guideline (Section 6.3.1.1.3) and the discussion of performance (Section 6.4.2.2.2) in the draft EA. The former estimated a 25,000-year travel time, and the latter a 47,000-year travel time. The source of the difference is that differing values were assumed for effective porosity and length of travel path in the Calico Hills tuff below the repository horizon and the static water level. In the final EA a consistent set of values and calculation methods has been used to conform with those given in the discussion of the geohydrology guideline. Long travel times help to ensure that radioactive decay will have reduced many potential radionuclides to low levels by the time they reach the accessible environment.

Issue: Radionuclide retardation

Four comments were received questioning the applicability to natural conditions at Yucca Mountain of the retardation values obtained from laboratory experiments and used in the analysis of postclosure performance. Specifically questioned was the use of equilibrium sorption and porous flow which may not apply in the unsaturated zone or in fracture flow. Also

questioned was knowledge of water chemistry at Yucca Mountain and the possible effects of that chemistry on retardation values obtained in the laboratory.

Response

Equilibrium sorption values used in the analysis of performance (Section 6.4.2) are justified under the assumption of porous flow, because times for the equilibration of radionuclides between solid and liquid phases are small (in the order of tens of days) compared with transit times of a parcel of water in the matrix flow (approximately 10 years to move 1 centimeter at 1 millimeter per year flux). Current travel-time modeling includes both matrix and fracture flow depending upon relative values of flux and saturated matrix hydraulic conductivity (see Section 6.3.1.1.5).

It is true that the chemistry of waters in the unsaturated zone are not precisely known, but as shown in the geochemistry guideline (Section 6.3.1.2) many sorption experiments have been made using water from Well J-13. There is no reason to believe water from Well J-13 differs significantly from water in the unsaturated zone. For comparison the matrix waters from Rainier Mesa are very similar to the Yucca Mountain site because both areas are composed chiefly of ash-flow tuffs and associated rocks (see Section C.5.2 for a complete discussion of water chemistry). Nevertheless, the validity of this assumption will be confirmed during site characterization.

Issue: Analysis of radionuclide releases to the accessible environment

Sixteen comments were received regarding the preliminary analysis of postclosure performance (Section 6.4.2). These covered two main topics: contamination of land, air, and ground water; and data and modeling uncertainties.

Contamination of land, air, and ground water. Ten comments were received asking or suggesting that the land, air, or ground water near Yucca Mountain would become contaminated if a repository were constructed.

Response. By law, a high-level nuclear waste repository must be licensed by the Nuclear Regulatory Commission and must meet Environmental Protection Agency (EPA) health and safety requirements protecting the land, air, and water. The preliminary analysis of the performance of a repository at Yucca Mountain, given in Section 6.4.2, indicates that the predicted radionuclide releases in the ground water to the accessible environment at 100,000 years are well below the releases permitted at 10,000 years by the EPA requirements (40 CFR 191.13). A much more complete analysis will be completed during site characterization.

Potential exposures to radionuclide gas emanation are presented in Section 5.2.9.1 of the EA. The acceptable levels of radionuclide release are not presented in the draft EA on a radionuclide specific level. However, the regulatory criteria pertaining to releases were presented in Table 6-46 (Comparison of regulatory criteria and the results of preliminary system performance analyses for a repository at Yucca Mountain) of the draft EA.

Similar preliminary analyses of possible releases from the repository to the land and air were not made in the preliminary analysis of performance presented in Section 6.4.2. The reader is referred to Section 6.2.2.1 (Preclosure system guideline: radiological safety) for a discussion of possible releases during the operation period of a repository and to Section C.5.11 (Geochemistry) for a discussion of release of gaseous radionuclides during the postclosure period.

At this time the question of gaseous or vapor transport in the unsaturated zone at Yucca Mountain has not been examined in detail. This mode of transport at Yucca Mountain will be thoroughly investigated during site characterization.

Data and modeling uncertainties. Six comments were received calling attention to uncertainties in data, assumptions, and models used in the preliminary analysis of postclosure performance. Included were comments on the use of 5-year-old spent fuel as the initial inventory, uncertainties in release rates from the engineered-barrier system, the conservative nature of assumptions used, uncertainties in models used, and contradictory statements in the draft EA about the degree of confidence in meeting the postclosure system guideline (10 CFR 960.4-1).

Response. With regard to the assumption of the initial inventory, the performance assessment calculations assumed 10-year-old spent fuel. One commenter suggested that 5-year-old fuel would be overly conservative and another suggested the range in types of waste forms should be more thoroughly discussed. Radionuclides that may contribute to release in the 10,000- to 100,000-year period (carbon-14, technetium-99, and iodine-129) all have half-lives greater than 1,000 years. Assumptions of older or reprocessed waste would make no significant differences in the calculated releases.

With regard to uncertainties in release rates and models used, these are more fully explained in the final EA and the rationale for selecting conservative values is explained.

There were contradictory statements regarding the degree of confidence that Yucca Mountain would meet the postclosure system guideline. The statements indicating unfounded confidence or prejudgment prior to completion of site characterization have been removed or modified to clearly indicate that the analysis is preliminary and subject to later evaluation when more data are available.

REFERENCES FOR CHAPTER C.5

Bell, E. J., and L. T. Larson, 1982. Overview of Energy and Mineral Resources for the Nevada Nuclear Waste Storage Investigations, Nevada Test Site, Nye County, Nevada, NVO-250, Nevada Operations Office, U.S. Department of Energy, Las Vegas.

Benson, L. V., J. H. Robison, R. K. Blankennagel, and A. E. Ogard, 1983. Chemical Composition of Ground Water and the Locations of Permeable Zones in the Yucca Mountain Area, Nevada, USGS-OFR-83-854, Open-File Report, U.S. Geological Survey, Denver, Colo.

Browning, R. E., 1985. Letter from R. E. Browning (NRC) to R. Stein (DOE), June 12, 1985; regarding NRC position on groundwater travel time.

Bryant, E. A., and D. T. Vaniman (comps.), 1984. Research and Development Related to the Nevada Nuclear Waste Storage Investigations, July 1-September 30, 1983, LA-10006-PR, Los Alamos National Laboratory, Los Alamos, N. Mex.

Caporuscio, F. A., and D. T. Vaniman, 1985. Iron and Manganese in Oxide Minerals and in Glasses: Preliminary Consideration of Eh Buffering Potential at Yucca Mountain, Nevada, LA-10369-MS, Los Alamos National Laboratory, Los Alamos, N. Mex.

Carr, W. J., 1984. Regional Structural Setting of Yucca Mountain, Southwestern Nevada, and Late Cenozoic Rates of Tectonic Activity in Part of the Southwestern Basin, Nevada and California, USGS-OFR-84-854, Open-File Report, U.S. Geological Survey, Denver, Colo.

Christiansen, R. L., and P. W. Lipman, 1965. "Geologic Map of the Topopah Spring NW Quadrangle, Nye County, Nevada," U.S. Geological Survey Quadrangle Map GQ-444, Scale 1:24,000, Washington, D.C.

Christiansen, R. L., and E. H. McKee, 1978. "Late Cenozoic Volcanic and Tectonic Evolution of the Great Basin and Columbia Intermontane Regions," Cenozoic Tectonics and Regional Geophysics of the Western Cordillera, R. B. Smith and G. P. Eaton (eds.), Geological Society of America Memoir 152, pp. 283-311.

Claassen, H. C. 1983. Sources and Mechanisms of Recharge for Ground Water in the West-Central Amargosa Desert, Nevada--A Geochemical Interpretation, USGS-OFR-83-542, Open-File Report, U.S. Geological Survey, Denver, Colo.

Crowe, B. M., K. H. Wohletz, D. T. Vaniman, and E. Gladney, 1985. Volcanic Hazard Studies for the Nevada Nuclear Waste Storage Investigations: Part II, Los Alamos National Laboratory, Los Alamos, N. Mex.

Czarnecki, J. B., 1985. Simulated Effects of Increased Recharge on the Ground-Water Flow System of Yucca Mountain and Vicinity, Nevada-California, USGS-WRI-84-4344, Water-Resources Investigations Report, U.S. Geological Survey, Denver, Colo.

Czarnecki, J. B., and R. K. Waddell, 1984. Finite-Element Simulation of Ground-Water Flow in the Vicinity of Yucca Mountain, Nevada-California, USGS-WRI-84-4349, Water-Resources Investigations Report, U.S. Geological Survey, Denver, Colo.

Daniels, W. R., K. Wolfsberg, R. S. Rundberg, A. E. Ogard, J. F. Kerrisk, C. J. Duffy, T. W. Newton, S. D. Knight, F. O. Lawrence, V. L. Rundberg, M. Skyes, G. Thompson, B. Travis, E. Treher, R. Vidale, G. Walter, R. Aguilar, M. Cisneros, S. Maestas, A. Mitchell, P. Oliver, N. Raybold, and P. Wanek, 1982. Summary Report on the Geochemistry of Yucca Mountain and Environs, J. Heiken (ed.), LA-9328-MS, Los Alamos National Laboratory, Los Alamos, N. Mex.

Dibble, W. E., Jr., and W. A. Tiller, 1981. "Kinetic Model of Zeolite Paragenesis in Tuffaceous Sediments," Clays and Clay Minerals, Vol. 29, pp. 323-329.

Dudley, W. W., Jr., 1985. Letter from W. W. Dudley (USGS) to D. L. Vieth (WMPO), October 31, 1985; regarding status of on-going neotectonic studies.

ERDA (U.S. Energy Research and Development Administration), 1977. Nevada Test Site, Nye County, Nevada, Final Environmental Impact Statement, ERDA-1551, Washington, D.C.

Garside, L. J., and J. H. Schilling, 1979. Thermal Waters of Nevada, Nevada Bureau of Mines and Geology Bulletin 91, University of Nevada, Reno.

Henderson, T., and L. Benson, 1983. Memorandum from T. Henderson and L. Benson (USGS) to the Record, October 21, 1983; regarding geochemical interpretation of UZ-1 water samples.

Henne, M. S., 1982. "The Dissolution of Rainier Mesa Volcanic Tuffs, and its Application to the Analysis of the Groundwater Environment," unpublished M. S., University of Nevada, Reno.

Johnson, L. H., 1982. The Dissolution of Irradiated U02 Fuel in Groundwater, AECL-6837, Atomic Energy of Canada Limited, Pinawa, Manitoba, Canada.

Johnstone, J. K., R. R. Peters, and P. F. Gnirk, 1984. Unit Evaluation at Yucca Mountain, Nevada Test Site: Summary Report and Recommendation, SAND83-0372, Sandia National Laboratories, Albuquerque, N. Mex.

Jones, B. F., 1982. Mineralogy of Fine Grained Alluvium from Borehole U11g, Expl. 1, Northern Frenchman Flat Area, Nevada Test Site, USGS-OFR-82-765, Open-File Report, U.S. Geological Survey, Denver, Colo.

Kerrisk, J. F., 1984b. Solubility Limits on Radionuclide Dissolution at a Yucca Mountain Repository, LA-9995-MS, Los Alamos National Laboratory, Los Alamos, N. Mex.

Knauss, K. G., J. M. Delany, W. J. Beiriger, and D. W. Peifer, 1985. "Hydrothermal Interaction of Topopah Spring Tuff with J-13 Water as a Function of Temperature," Scientific Basis for Nuclear Waste Management VIII, Materials Research Society Symposia Proceedings, C. M. Jantzen, J. A. Stone, and R. C. Ewing (eds.), Vol. 44, Pittsbugh, Penn., pp. 539-546.

Link, R. L., S. E. Logan, H. S. Ng, F. A. Rockenbach, and K. J. Hong, 1982. Parametric Studies of Radiological Consequences of Basaltic Volcanism, SAND81-2375, Sandia National Laboratories, Albuquerque, N. Mex.

Lipman, P. W., and E. J. McKay, 1965. "Geologic Map of the Topopah Spring SW Quadrangle, Nye County, Nevada," U.S. Geological Survey Quadrangle Map GQ-439, Scale 1:24,000, Washington, D.C.

McKee, E. H., 1979. "Ash-Flow Sheets and Calderas: Their Genetic Relationship to Ore Deposits in Nevada," Geological Society of America Special Paper 180, pp. 205-211.

Montazer, P., 1982. Permeability of Unsaturated, Fractured Metamorphic Rocks Near an Underground Opening, Ph.D. thesis T-2540 (Mimeo), Colorado School of Mines, Golden, Colo.

Montazer, P., and W. E. Wilson, 1984. Conceptual Hydrologic Model of Flow in the Unsaturated Zone, Yucca Mountain, Nevada, USGS-WRI-84-4345, Water-Resources Investigations Report, U.S. Geological Survey, Lakewood, Colo.

Montazer, P., E. P. Weeks, F. Thamir, S. N. Yard, and P. B. Hofrichter, 1985. "Monitoring the Vadose Zone in Fractured Tuff, Yucca Mountain, Nevada," Characterization and Monitoring of the Vadose Zone, National Water Well Association Symposium, Denver, Colorado, November 19-21, 1985.

NWPA (Nuclear Waste Policy Act), 1983. "Nuclear Waste Policy Act of 1982," Public Law 97-425, 42 USC 10101-10226, Washington, D.C.

Ogard, A. E., and J. F. Kerrisk, 1984. Groundwater Chemistry Along Flow Paths Between a Proposed Repository Site and the Accessible Environment, LA-10188-MS, Los Alamos National Laboratory, Los Alamos, N. Mex.

Oversby, V. M., 1985. The Reaction of Topopah Spring Tuff with J-13 Water at 150 deg. C- Samples from Drill Cores USW G-1, USW GU-3, USW G-4, and UE-25h 1, UCRL-53629, Lawrence Livermore National Laboratory, Livermore, Calif.

Price, R. H., F. B. Nimick, J. R. Connolly, K. Keil, B. M. Schwartz, and S. J. Spence, 1985. Preliminary Characterization of the Petrologic, Bulk, and Mechanical Properties of a Lithophysal Zone Within the Topopah Spring Member of the Paintbrush Tuff, SAND84-0860, Sandia National Laboratories, Albuquerque, N. Mex.

Quade, J., and J. V. Tingley, 1983. A Mineral Inventory of the Nevada Test, and Portions of the Nellis Bombing and Gunnery Range, Southern Nye County, Nevada, DOE/NV/10295-1, U.S. Department of Energy, Nevada Operations Office, Las Vegas.

Quiring, R. F., 1965. Annual Precipitation Amounts as a Function of Elevation in Nevada South of 38-1/2 Degrees Latitude, (Mimeo.) U.S. Weather Bureau, Las Vegas, Nv.

Rogers, A. M., D. M. Perkins, and F. A. McKeown, 1977. "A Preliminary Assessment of the Seismic Hazard of the Nevada Test Site Region," Bulletin of the Seismological Society of America, Vol. 67, No.6, pp. 1587-1606.

Rundberg, R. S., 1985a. Assessment Report on the Kinetics of Radionuclide Adsorption on Yucca Mountain Tuff, Los Alamos National Laboratory, Los Alamos, N. Mex.

Rush, F. E., 1970. Regional Ground-Water Systems in the Nevada Test Site Area, Nye, Lincoln, and Clark Counties, Nevada, Department of Conservation and Natural Resources, Water Resources--Reconnaissance Series Report 54, State of Nevada, Carson City.

Schnabel, P. B., and H. B. Seed, 1973. "Accelerations in Rock for Earthquakes in the Western United States," Bulletin of the Seismological Society of America, Vol. 63, No. 2, pp. 501-516.

Scott, R. B., and J. Bonk, 1984. Preliminary Geologic Map of Yucca Mountain, Nye County, Nevada, with Geologic Sections, USGS-OFR-84-494, Open-File Report, U.S. Geological Survey, Denver, Colo.

Sinnock, S., Y. T. Lin, and J. P. Brannen, 1984. Preliminary Bounds on the Expected Postclosure Performance of the Yucca Mountain Repository Site, Southern Nevada, SAND84-1492, Sandia National Laboratories, Albuquerque, N. Mex.

Smith, R. L., and R. G. Luedke, 1984. "Potentially Active Volcanic Lineaments and Loci in Western Conterminous United States," in Explosive Volcanism: Inception, Evolution and Hazards, National Academy Press, pp. 47-66.

Spaulding, W. G., S. W. Robinson, and F. L. Paillet, 1984. Preliminary Assessment of Climatic Change During Late Wisconsin Time Southern Great Basin and Vicinity, Arizona, California, and Nevada, USGS-WRI-84-4328, Water-Resources Investigations Report, U.S. Geological Survey, Denver, Colo.

Spengler, R. W., F. M. Byers, Jr., and J. B. Warner, 1981. Stratigraphy and Structure of Volcanic Rocks in Drill Hole USW G-1, Yucca Mountain, Nye County, Nevada, USGS-OFR-81-1349, Open-File Report, U.S. Geological Survey, Denver, Colo.

Swadley, W C, D. L. Hoover, and J. N. Rosholt, 1984. Preliminary Report on Late Cenozoic Faulting and Stratigraphy in the Vicinity of Yucca Mountain, Nye County, Nevada, USGS-OFR-84-788, Open-File Report, U.S. Geological Survey, Denver, Colo.

Szabo B. J., and T. K. Kyser, 1985. Uranium, Thorium Isotopic Analyses and Uranium-Series Ages of Calcite and Opal, and Stable Isotopic Compositions of Calcite from Drill Cores UE25a 1, USW G-2, and USW G-3/GU-3, Yucca Mountain, Nevada, USGS-OFR-85-224, Open-File Report, U.S. Geological Survey, Denver, Colo.

Thompson, F. L., F. H. Dove, and K. M. Krupka, 1984. Preliminary Upper-Bound Consequence Analysis for a Waste Repository at Yucca Mountain, Nevada, SAND83-7475, Sandia National Laboratories, Albuquerque, N. Mex.

Tibbs, H., 1985. Letter from H. Tibbs (F&S) to J. J. D'Lugosz (DOE/NVO), September 23, 1985; regarding mining experience through faulted welded tuff beds in U12G Tunnel "Rock Mechanics" drift.

Tillerson, J. R., and F. B. Nimick, 1984. Geoengineering Properties of Potential Repository Units at Yucca Mountain, Southern Nevada, SAND84-0221, Sandia National Laboratories, Albuquerque, N. Mex.

Travis, B. J., S. W. Hodson, H. E. Nuttall, T. L. Cook, and R. S. Rundberg, 1984. Preliminary Estimates of Water Flow and Radionuclide Transport in Yucca Mountain, LA-UR-84-40 (Rev.), Los Alamos National Laboratory, Los Alamos, N. Mex.

Trexler, D. T., T. Flynn, and B. A. Koenig, 1979. Assessment of Low-to-Moderate Temperature Geothermal Resources of Nevada, Final Report for the Period April 1978-June 1979, NVO/01556-1, Nevada Bureau of Mines and Geology, University of Nevada, Reno.

United States v. Mary Dann and Carrie Dann, 1985. The United States Law Week, February 19, 1985, No. 83-1476.

USGS (U.S. Geological Survey) (comp.), 1984. A Summary of Geologic Studies through January 1, 1983, of a Potential High-Level Radioactive Waste Repository Site at Yucca Mountain, Southern Nye County, Nevada, USGS-OFR-84-792, Open-File Report, U.S. Geological Survey, Menlo Park, Calif.

Vaniman, D., J. Downey, D. Bish, J. O'Neil, and S. Levy, 1985. Letter from D. Vaniman (LANL), J. Downey (USGS), D. Bish (LANL), J. O'Neil (USGS), and S. Levy (LANL) to D. L. Vieth (DOE/NVO), TWS-ESS-1-7/85-20, July 17, 1985; regarding impact of Fault-related mineral deposits on site characterization at Yucca Mountain: studies as of July, 1985.

Waddell, R. K., 1982. Two-Dimensional, Steady-State Model of Ground-Water Flow, Nevada Test Site and Vicinity, Nevada-California, USGS-WRI-82-4085, Water-Resources Investigations Report, U.S. Geological Survey, Denver, Colo.

Waddell, R. K., J. H. Robison, and R. K. Blankennagel, 1984. Hydrology of Yucca Mountain and Vicinity, Nevada-California--Investigative Results Through Mid-1983, USGS-WRI-84-4267, Water-Resources Investigations Report, U.S. Geological Survey, Denver, Colo.

Wang, J. S. Y., and T. N. Narasimhan, 1985. Hydrologic Mechanisms Governing Fluid Flow in Partially Saturated, Fractured Porous Tuff at Yucca Mountain, SAND84-7202, Sandia National Laboratories, Albuquerque, N. Mex.

Weeks, E. P., and W. E. Wilson, 1984. Preliminary Evaluation of Hydrologic Properties of Cores of Unsaturated Tuff, Test Well USW H-1, Yucca Mountain, Nevada, USGS-WRI-84-4193, Water-Resources Investigations Report, U.S. Geological Survey, Denver, Colo.

White, A. F., H. C. Claassen, and L. V. Benson, 1980. The Effect of Dissolution of Volcanic Glass on the Water Chemistry in a Tuffaceous Aquifer, Rainier Mesa, Nevada, USGS-WRI-1535-Q, Water-Supply Paper, U.S. Geological Survey, Washington, D.C.

Whitfield, M. S., 1985. "Vacuum Drilling of Unsaturated Tuffs at a Potential Radioactive-Waste Repository, Yucca Mountain, Nevada," Characterization and Monitoring of the Vadose Zone, National Water Well Association Symposium, Denver, Colorado, November 19-21, 1985.

Wilson, C. N., and V. M. Oversby, 1984. Spent Fuel Cladding Containment Credit Tests, preprint, UCRL-89869, Lawrence Livermore National Laboratory, Livermore, Calif.

Wilson, W. W., 1985. Letter from W. W. Wilson (USGS) to D. L. Vieth (DOE/NVO), December 24, 1985; regarding unsaturated zone flux.

Wilson, C. N., and V. M. Oversby, 1985. Radionuclide Release from PWR Fuels in a Reference Tuff Repository Groundwater, UCRL-91464, (preprint), Lawrence Livermore National Laboratory, Livermore, Calif.

Winograd, I. J., and G. C. Doty, 1980. Paleohydrology of the Southern Great Basin, with Special Reference to Water Table Fluctuations Beneath the Nevada Test Site During the Late(?) Pleistocene, USGS-OFR-80-569, Open-File Report, U.S. Geological Survey, Reston, Va.

Winograd, I. J., and W. Thordarson, 1975. Hydrogeologic and Hydrochemical Framework, South-Central Great Basin, Nevada-California, with Special Reference to the Nevada Test Site, U.S. Geological Survey Professional Paper 712-C, Washington, D.C.

Winograd, I. J., B. J. Szabo, T. B. Coplen, A. C. Riggs, and P. T. Kolesar, 1985. "Two-Million-Year Record of Deuterium Depletion in Great Basin Ground Waters," Science, Vol. 227, pp. 519-522.

Zimmerman, R. M., 1983. "First Phase of Small Diameter Heater Experiments in Tuff," in Proceedings of the 24th U.S. Symposium on Rock Mechanics, June 1983, pp. 271-282.

CODES AND REGULATIONS

10 CFR Part 60 (Code of Federal Regulations), 1983. Title 10, "Energy," Part 60, "Disposal of High-Level Radioactive Wastes in Geologic Repositories," U.S. Government Printing Office, Washington, D.C.

10 CFR Part 960 (Code of Federal Regulations), 1984. Title 10, "Energy," Part 960, "General Guidelines for the Recommendation of Sites for Nuclear Waste Repositories; Final Siting Guidelines," 49 FR 47714, Vol. 49, No. 236, December 6, 1984, pp. 47714-47769.

40 CFR Part 191 (Code of Federal Regulations), 1985. Title 40, "Protection of Environment," Part 191, "Environmental Standards for the Management and Disposal of Spent or Nuclear Fuel, High-Level and Transuranic Radioactive Wastes: Final Rule," Federal Register Vol. 50, No. 182, September 19, 1985.

C.6 PRECLOSURE RADIOLOGICAL SAFETY

This section addresses comments on the behavior and effects of radionuclide releases during repository operations. It corresponds to the system guideline on preclosure radiological safety and includes all guideline evaluations that support the system guideline. In this respect, comments on preclosure radiological safety also address the ability of the repository system to meet the requirements of the applicable Nuclear Regulatory Commission and U.S. Environmental Protection Agency regulations (10 CFR Part 20, 10 CFR Part 60, and 40 CFR Part 191, Subpart A).

C.6.1 POPULATION DENSITY AND DISTRIBUTION

The U.S. Department of Energy (DOE) received six comments on its evaluation of the proposed Yucca Mountain site against the population density and distribution guideline (10 CFR 960.5-2-1). These have been categorized into the following issues: (1) Population Density, (2) Transportation-Related Accidents, and (3) Emergency Preparedness Plan.

Issue: Population density

One commenter contended that the population density and distribution guideline demonstrates that Nevada's low population size and density will translate into Nevada's population being "sacrificed" because other more populous states have more political clout, while another asked that the population density of Clark County be considered in impact evaluations and calculations.

Response

The DOE siting guidelines contained in 10 CFR Part 960 govern the DOE site-evaluation process. These siting guidelines establish performance objectives for a geological repository system, define the basic technical requirements that candidate sites must meet, and specify how the DOE will implement its site-selection process. They do not give consideration to a State's "political clout." The objective of the population density and distribution guideline is to ensure the selection of a repository site that will minimize risk to the public and permit compliance with the U.S. Environmental Protection Agency and Nuclear Regulatory Commission (NRC) regulations. This is achieved in part by ensuring that the site is not located in a highly populated area. The disqualifying condition follows the language of Section 112(a) of the Nuclear Waste Policy Act (NWPA, 1983) by disqualifying any site where the surface facility would be located (1) in a highly populated area, or (2) adjacent to a 1-mile-by-1-mile area having a population of not less than 1,000 individuals (NWPA, 1983). Lastly, the population density of Clark County was considered in Section 6.2.1.2.3 of the draft Environmental Assessment (EA).

Issue: Transportation-related accidents

One commenter stated that the DOE finding that the favorable conditions under the population density and distribution guidelines are present ignores potential situations such as transportation-related impacts of an accident and subsequent release of radioactive material in the Las Vegas metropolitan area.

Response

The criteria for the two favorable conditions under the population density and distribution guideline are that there be a low population density in the general region of the site and that the site be remote from highly populated areas. Neither of these criteria requires an analysis of potential accidental releases of radioactive materials in the Las Vegas metropolitan area. Therefore consideration of these potential releases is not relevant to evaluation of the favorable conditions under the population density and distribution guidelines. Nevertheless, Section 5.3.2 of the final EA has been revised to include an assessment of national and regional risk due to transportation of high-level radioactive waste.

Issue: Emergency preparedness plan

Two commenters requested more information about the preparation of an emergency preparedness plan for the Yucca Mountain repository site; one commenter stated that, "... without adequate substantiation, it is difficult to see how the DOE can conclude that the site is not disqualified under Condition 3." Another commenter stated that very little is said in the EA about who would respond in an emergency and if the Federal Emergency Management Agency (FEMA) would be establishing an office in Nevada.

Response

The DOE guidelines (10 CFR 960.5-2-1(d)(3)) state that a site shall be disqualified if, "... the DOE could not develop an emergency preparedness program which meets the requirements specified in DOE Order 5500.3 ... and related guides, or, when issued by the NRC in 10 CFR Part 60, Subpart I, 'Emergency Planning Criteria'." As noted in Section 6.2.1.2.5 of the draft EA, an emergency preparedness plan has already been produced by the DOE in cooperation with the State of Nevada (State of Nevada, Department of Human Resources, 1983). This plan will constitute a starting point for preparation of a more detailed, site-specific plan during the Environmental Impact Statement process. Given that the DOE has the ability to prepare such plans and that a basis for the required plan exists, it is difficult to see how the disqualifying condition could be present. Further information on the current emergency preparedness plan may be obtained from the reference.

The DOE Nevada Operations Office radiological assistance response team is of an excellent caliber and has a capability to respond to most identifiable radiological emergencies. Since this team is on constant alert, response plans do not rely on the participation of FEMA.

C.6.2 SITE OWNERSHIP AND CONTROL

Four comments were allocated to this preclosure category. The subject of preclosure site ownership and control addresses those aspects of owning and controlling the necessary surface and subsurface areas during site characterization, construction, and operation phases of a repository. These comments are divided into three issues: (1) Land Withdrawal, (2) DOE Findings Qualifications, and (3) Public Access.

Issue: Land withdrawal

Most of the comments received questioned the 50,000-acre land withdrawal requirement from the Bureau of Land Management (BLM) portion of the site. This number was quoted in numerous places in the draft Environmental Assessment (EA).

Response

The 50,000-acre requirement was an error in the draft EA. The actual acreage of land to be withdrawn from the BLM portions is approximately 5,000. The number in error has been corrected in the applicable sections of the final EA.

Issue: DOE findings qualifications

Comments were received that stated that the U.S. Department of Energy (DOE) had qualified its findings that the site does not meet the favorable condition of present control of surface and subsurface rights. The same was stated to be true for taking the potentially adverse condition relative to future conflicts over obtaining jurisdiction. The qualifications were, that since the DOE controls remaining portions of the site, it is expected that they can acquire jurisdiction and control over the remaining lands and that in the view of absence of conflicts, no impediments are projected.

Response

The real concern comes in the conclusion addressing whether the site meets the favorable and potentially adverse conditions. The site, as is stated in the EA, does not meet the favorable condition and accepts the potentially adverse condition. Any qualifying statements in the EA have no bearing on the ranking of a site with respect to favorable and potentially adverse conditions.

Issue: Public access

One commenter asked when a Federal Land Policy Management Act land withdrawal would be initiated and what measures would be taken to restrict public access during site characterization.

Response

A Federal land withdrawal action would not be initiated until and unless Yucca Mountain is selected as the first geologic repository. The DOE currently expects to start withdrawal at the time of construction license

application. With regard to restricted public access during site characterization, it should be noted that there is no requirement to take such measures at that stage, although protecting the integrity of the site certainly is an important consideration. In that regard, the portion not under control of the BLM is already within the boundaries of restricted-access Federal installations. The BLM portion that abuts those installations does not normally present public intrusion problems and primarily for that reason, no extraordinary measures were seen as necessary. However, should such problems arise, the DOE would consider seeking withdrawal (for a brief period corresponding to that necessary for characterization) of the otherwise unprotected BLM portion.

C.6.3 METEOROLOGY

This category concerns the data on existing meteorological conditions presented in Chapter 3. Two commenters expressed concern about correlating expected site meteorological conditions with those recorded at nearby monitoring sites, and about the possibility that the Environmental Assessment (EA) did not sufficiently address the potential for extreme weather phenomena. Another commenter identified a typographical error within the text.

Response

Although the data used in the draft EA are not site specific, reasonable generalities can be derived from those data. Because there is a noticeable paucity of such data for the Yucca Mountain site, a comprehensive site-monitoring program has been proposed that will provide the information needed to reassess this particular guideline if the Yucca Mountain site is recommended for site characterization. The frequency, intensity, and occurrence of extreme weather phenomena, as well as data on average or normal conditions, would become available if site characterization activities are implemented at Yucca Mountain.

All typographical errors within the text in question have been corrected in the final EA as suggested.

C.6.4 OFFSITE INSTALLATIONS AND OPERATIONS

This category addresses comments and questions concerning the potential impact that activities, primarily military operations including nuclear-weapons testing, tactical fighter training, and development of new defense systems, might have on a repository located at Yucca Mountain. Because of the large number of comments received in this category and the varied aspects associated with this subject, the comments have been divided into the following issues: (1) Proximity of Nuclear-weapons Testing to the Proposed Repository Site, (2) Increased Frequency of Nuclear-weapons Testing, (3) Effects of Higher Weapon Yields, (4) Release of Tectonic Strain Energy, (5) Defense-Related Development, (6) Military Operations, (7) Rail-spur Activities, and (8) Miscellaneous.

Issue: Proximity of nuclear-weapons testing to the proposed repository site

Twelve commenters expressed concern that the areas for nuclear-weapons testing were too close to Yucca Mountain and that future weapons testing could be closer. A view was expressed that the proximity of testing activities was a sufficient enough threat to a repository to reject the Yucca Mountain site. Another view was expressed that weapons testing should be sufficiently controlled so that it could not get too close to Yucca Mountain. Five commenters were concerned that the collapse of the cavity produced by the detonation at Rainier Mesa was representative of the situation at Yucca Mountain, and that the testing of nuclear weapons close to the proposed site could result in a similar incident if the repository were built at Yucca Mountain. They also questioned the effect of weapons test-induced ground motion on the underground structures proposed for the repository.

Response

The locations where nuclear weapons tests can be conducted on the Nevada Test Site (NTS) are well defined and closely controlled (see Figure 6-1 in the Environmental Assessment). The areas where current and future weapons tests can be conducted have been specified and they include Pahute Mesa, Rainier Mesa, Yucca Flat, the Buckboard area, and Mid Valley. The shortest distance from any of these areas to Yucca Mountain is 23 kilometers (14 miles). Requirements for containment of radioactive material, during and after a nuclear explosion, places constraints on the geologic characteristics of potential testing areas. Locations of testing areas and yield of weapons tests are strictly controlled.

Experience with underground structures at the NTS over a 25-year period demonstrates that ground motion resulting from weapons tests generally has little impact on underground structures except those very close to ground zero. Testing closest to Yucca Mountain could be in the Buckboard area and Mid Valley locations. The distance of 23 kilometers (14 miles), between these areas and the proposed repository underground facility is significantly greater than the 3-kilometer (2-mile) distance between Pahute Mesa (where the highest yield nuclear weapons are detonated) and Rainier Mesa (where three separate tunnel complexes in tuff are located), or the 3-kilometer (2-mile) distance between Yucca Flat and the location of the Climax Spent Fuel Test Facility (a facility in granite designed to simulate a repository). Over the testing history at Pahute Mesa, there is no evidence that tunnels in Rainier Mesa have been damaged or affected by nuclear detonations at Pahute Mesa. Since April of 1980, when construction of the Climax Spent Fuel Test Facility was completed, 90 announced tests have been conducted with one test being within 5 kilometers (3 miles). There has been no evidence of any damage or other impact to this facility as a result of nuclear-weapons testing. Based on this and other experience at the NTS, there is no physical evidence to indicate that a repository at Yucca Mountain would be affected by nuclear-weapons testing and its concomitant ground motion on the NTS.

There is confusion over the comparison of the Rainier Mesa collapse and the potential impact of nuclear-weapons testing on underground structures at some distance from the point where the weapon is detonated. When nuclear devices are detonated at Rainier Mesa, the explosive force released produces

a large spherical cavity the diameter of which is about one-third to one-half the length of a football field. In the case of the Rainier Mesa collapse, the overlying rock that collapsed into this cavity was already weakened by the presence of fractures resulting from previous weapons testing that had taken place in the subsurface tunnel complex.

The situation at Yucca Mountain is very different. There have been no nuclear weapons tested in this area and none will be conducted closer than 23 kilometers (14 miles) in the future. The conditions associated with the Rainier Mesa collapse bear no similarity to the physical situation in a repository.

Issue: Increased frequency of nuclear-weapons testing

Seven commenters were concerned that the increased frequency of nuclear-weapons testing could physically affect the repository in such a way as to cause loss of isolation capability and containment.

Response

As explained in the above response, experience with tunnels at Rainier Mesa, in close proximity to the weapons testing at Pahute Mesa and Yucca Flat, has indicated that weapons testing has not had any impact on the tunnels. Over this period, the frequency with which testing has occurred has varied widely. There is no evidence that frequency of testing has any effect on the tunnels, the geologic materials, or the hydrologic environment in which they are located.

The physical effect of ground motion from weapons testing is a well-understood physical phenomenon. Since 1960 many announced underground tests have been detonated in Pahute Mesa and in Yucca Flat. Observations in the tunnels at Rainier Mesa and in the Climax Spent Fuel Test Facility have shown that no damage has occurred as a result of testing of nuclear weapons. In addition, the hydrologic conditions on Pahute Mesa and Yucca Flat have been measured within 24 kilometers (15 miles) of the point of weapons testing, and these observations have shown no permanent and significant change in the hydrologic characteristics of the area as a result of the testing.

Issue: Effects of higher weapon yields

Three commenters were concerned that the ground motion associated with tests of higher weapon yields would affect the repository. The commenters noted that weapons with yields up to 8 megatons would be tested, and therefore some seismic testing should be initiated at the site.

Response

The ground motion at a repository site resulting from weapons testing is an effect that has been studied for several years. Vortman (1980) estimated the ground motion at Yucca Mountain as a function of size of the explosion for weapons detonated at Pahute Mesa and Yucca Flat.

Limits have been established for the maximum yield of nuclear explosions at Pahute Mesa and Yucca Flat; these are 1,000 kilotons and 250 kilotons, respectively. These limits are based on the natural geologic conditions in the test areas and on offsite damage potential. In addition, the Threshold Test Ban Treaty limits the maximum yield for any test to 150 kilotons. It is clear that tests up to 8 megatons are not realistic and it is highly probable that tests greater than 150 kilotons will not be conducted.

Within the maximum limits on testing at Pahute Mesa and Yucca Flat, the magnitude of the ground motion previously experienced or projected, at the Yucca Mountain site, does not indicate that there is a potential for damage to either the underground repository facility or the surface structures.

Issue: Release of tectonic strain energy

Four commenters were concerned that ground motion, caused by detonation of nuclear weapons at the NTS or from naturally occurring earthquakes, could result in new faulting or fault movement at Yucca Mountain.

Response

The U.S. Department of Energy (DOE) has considered the potential for faulting or fault movement at Yucca Mountain as a result of weapons testing. Movement occurred along Yucca Fault as a result of a nuclear explosion in Yucca Flat. The maximum yield of a weapon tested at Yucca Flat is limited to 250 kilotons. The distance from the weapon detonation point to the most distant point where fault movement has been detected is 14 kilometers (9 miles). While the yield limit for a weapon tested in the Buckboard area is 700 kilotons, the Threshold Test Ban Treaty limit is 150 kilotons. It is not expected that tests of a greater yield than that allowed by this treaty will be conducted. Because the Buckboard area is 23 kilometers (14 miles) from Yucca Mountain, nearly twice the distance of recorded weapons-induced fault movements, there is no evidence to indicate that faulting or fault movement is likely to result at Yucca Mountain from nuclear explosions at any of the present or proposed test areas.

There is no evidence to indicate that nuclear weapons detonated at NTS would cause movement on faults at Yucca mountain. Section 6.2.1.5.5 of the final Environmental Assessment (EA) contains a discussion of the size and distance relationships for underground tests and the repository.

Issue: Defense-related development

Two commenters asked how the repository program will be coordinated with nuclear-weapons testing programs. In particular, one commenter asked how repository operations will affect those of the NTS; that is, whether the NTS will have to alter its testing schedule due to the repository schedule of operations. Another asked whether additional land withdrawal will be required to effect this coordination. A last commenter asked about the potential for and effects of a stray direct hit by military ordnance on the repository site (effects of repository operations on nearby military operations are dealt with under "Military operations").

Response

The potential conflict between the nuclear-weapons testing program and the repository program was resolved in 1978. The management responsible for the testing of nuclear weapons indicated that a repository located in the Nevada Research and Development Area (NRDA) (known also as Area 25) would not have any impact on the weapons testing programs. Consequently, there is no compelling reason for the repository program to be coordinated with the weapons program beyond that necessary to assure worker safety underground during a nuclear explosion. In order to reinforce this position, a 635-square-kilometer (245-square-mile) area adjacent to Yucca Mountain was set aside for nonnuclear-weapons development activities. No additional land withdrawal will be required to effect coordination with the weapons testing program.

At the present time, deployment of small intercontinental ballistic missiles is being considered in the vicinity of Yucca Mountain. It is the policy of the DOE that the commitment to Yucca Mountain as a repository site, if it is recommended, will hold precedence over other activities in the area. If a new activity proposed for the NRDA is not compatible with the repository, it will not be undertaken. The DOE would not recommend a site to the Nuclear Regulatory Commission (NRC) for licensing if there were obvious conflicts that would jeopardize the ability to obtain a license.

Lastly, the potential for a direct hit on surface facilities with a bomb or other military ordnance is highly unlikely. The airspace over the surface facilities is controlled by the DOE, which would not clear a flight over the facility if there was a credible possibility for such an occurrence.

Issue: Military operations

All seven commenters in this area questioned the effects that repository operations would have on military operations, particularly in regard to the air traffic corridors used by military jets in this locale. One commenter questioned the potential for the use of the U.S. Air Force (USAF) radiological assistance team. The effects of sonic booms on repository buildings and their potential to induce earthquakes were also questioned, particularly in regard to sonic coupling.

Response

The DOE is knowledgeable of the present-day aircraft flight requirements of military operations conducted at the Nellis Air Force Bombing Range. The DOE, through past negotiations with the USAF, established the existing operational restrictions for flights through DOE-controlled air space over the NTS (designated R4808W and R4808E). Currently R4808E is generally closed to all military aircraft while R4808W is open to military aircraft only upon request.

The DOE recognizes that the possibility of a USAF aircraft crash or bombing accident, although considered highly unlikely due to the overflight restrictions, has not been completely resolved in the draft EA or in Jackson et al. (1984). Limitations on obtaining and disseminating information about such a scenario must be recognized. The DOE is interacting with the USAF to

address and resolve this concern. A detailed plan for studies during site characterization for an acceptability assessment is being developed. If evaluation of the current situation results in a potential risk that could result in a mission conflict, the DOE is considering several alternatives and mitigation measures to reduce the event probability or consequences so that acceptable risks are realized. These alternatives include:

1. Site hardening and/or expansion of hardened facilities.
2. Relocating the USAF flight corridor.
3. Relocating the repository surface facilities.

If the analysis indicates that alternatives or mitigation measures are required, the detailed plan being developed with the USAF calls for study of the feasibility and the costs and benefits of each scenario, followed by development and implementation of a scenario-selection process.

The DOE Nevada Operations Office (NVO) maintains an excellent radiological assistance team. Therefore, the USAF radiation assistance team would not be called upon for any foreseeable emergency. In the past, the NVO has requested transportation assistance for technical staff. This type of assistance may be required if a large technical team such as the radiological assistance team needed to be transported to a site very quickly.

With respect to sonic effects, the manmade forces that are capable of producing ground motion of significant magnitude are well understood. While sonic booms produce a noise that impacts man in many ways and jars surface structures, the energy transferred to the earth is not very large. The DOE is not aware of any reports of damage to structures as a result of the shock wave produced by planes flying faster than the speed of sound. The total energy in the shock wave of a sonic boom is not great. The earth is readily capable of absorbing that energy within the first 30 meters (100 feet). Because earthquakes generally occur several kilometers below the surface, it is unlikely that an earthquake could be triggered by sonic booms. To date the DOE is not aware of any documented instance where sonic booms have triggered an earthquake.

Because a waste package at Yucca Mountain would be at least 230 meters (754 feet) below the surface, it does not appear reasonable, based on the understanding of the physical phenomena, that a resonant coupling could lead to effects upon a repository at that depth.

Issue: Rail-spur activities

Two commenters questioned the location of the proposed rail spur and expressed the view that it should be moved south of U.S. Highway 95, because, as proposed, it would run very close to several range areas which are used for live weapons delivery and other critical USAF flight training exercises.

Response

Final location of the rail spur will be considered as the site evaluation process continues. The proposed rail route to the repository runs adjacent to the boundaries of Range 63 OT&E Test area, TACS Area, Silver Flag Alpha Range, and Range 64/65 Tactical Training Ranges. It is now recognized,

on the basis of recent communications with the USAF, that aircraft could fly at low altitudes above trains transporting casks of waste to the repository. The policy of the DOE is not to restrict USAF training operations as a result of trains moving along the boundaries of the ranges. The DOE is interacting with the USAF to address and resolve this concern. A detailed plan for an alternative assessment is being developed.

Alternatives which will be evaluated can be classified into two regimes: spatial and temporal. The spatial alternatives will seek to identify and evaluate alternate routes while the temporal alternatives will seek to determine if scheduling of DOE and USAF activities can be accomplished without impacting USAF missions. All alternatives will be evaluated in terms of feasibility, cost, and benefits. Following such an evaluation, a method for selecting among alternatives will be developed and implemented, as called for in the detailed plan noted above.

Issue: Miscellaneous

Seven miscellaneous comments were received which addressed random items associated with offsite installations and operations. One commenter asked who will provide security for the repository, and whether the USAF would be asked to help in this task. In a related comment, it was suggested that site characterization and security activities be implemented with the understanding that live ordnance may be present throughout the site.

Secondly, two commenters asked what the effect of radioactive releases from current testing on the site would be, in regard to ground-water contamination and surface-level radioactivity.

Another commenter asked where shipments of radioactive waste will be kept in the event of an interruption in shipments.

One commenter noted that the EA text, in reference to the presence of other nuclear installations and operations, states that the pertinent regulations (40 CFR Parts 190 and 191) do not apply to nuclear-weapons testing at the NTS. It was asked that the EA further detail why such a situation exists.

One commenter simply stated that there is a low level radioactive waste facility near Beatty, Nevada and that the site was poorly maintained.

Response

With regard to security, the DOE will arrange for security services from a private contractor, and the USAF will not be involved. Standard construction and security operating procedures will be implemented to check for live ordnance prior to initiation of all activities in new areas (i.e., areas previously unused).

With respect to radioactive releases, any water that reaches the waste disposal container will come from the surface of Yucca Mountain. Very low atmospheric fallout is present all over the world; no more radioactivity is likely to be contained in this water than in domestic water supplies. Regulations for the containment of radiation from underground nuclear

explosions are very stringent (ERDA, 1977). Data for airborne radionuclides from the NTS, detected offsite from 1974 through 1983, can be found in Table 6-7 of the EA. This table shows that for four of the last five 1-year monitoring periods, no detectable radioactivity from nuclear explosions was observed outside the NTS boundaries.

The repository will be designed to accept and store wastes equivalent to 3 months of deliveries, so interruptions in repository operations would not interfere with waste receipt. It should be noted that the table in the draft EA that prompted this comment (Table 6-6, Summary of analyses for Section 6.2.1.5 ...) states that repository operations would be interrupted during weapons testing. However, the interruption referred to is due to the fact that workers would be removed from the underground workings for safety reasons, which would not necessarily interrupt waste receipt.

Nuclear-weapons testing, as a defense-related application of atomic energy, is not subject to regulation by the Environmental Protection Agency (which promulgated 40 CFR Parts 190 and 191). Rather, pursuant to the Atomic Energy Act of 1954, as amended; the Energy Reorganization Act of 1974, as amended; and the DOE Organization Act of 1977, as amended; such activities are under the purview of the DOE.

The comment regarding the low-level radioactive waste facility in Beatty, Nevada is noted. The facility is operated by U.S. Ecology.

C.6.5 SYSTEM GUIDELINE - PRECLOSURE RADIOLOGICAL SAFETY

The preclosure radiological safety guideline addresses concerns for protecting both the public and repository workers from accidental or operational radiological exposure. The 29 comments received in this category have been categorized into the following issues: (1) Accidental Radiological Releases, (2) Non-accidental Radiological Releases, and (3) Miscellaneous.

Issue: Accidental radiological releases

Eight comments have been categorized in regard to this issue. Accidental releases consist of those releases that occur from events other than the everyday operational releases that may occur. Four topics are addressed: accidental release scenario, breached waste disposal container scenario, aircraft impact scenario, and emergency preparedness.

Accidental release scenario. Some commenters stated that the references cited in the Environmental Assessment (EA) for accidental radiological release scenarios have changed and that those changes should be reflected in the EA. In addition, it was stated that releases under elevated temperatures should be discussed.

Response. The preliminary safety analysis has not been revised to reflect the two-stage repository concept described in Section 5.1 of the EA. Development of the two-stage concept occurred concurrent with the preparation of the EA, therefore the safety analysis could not be revised in the time available. The phased increase in the waste-receiving rate associated with

the two-stage concept will not necessarily involve an increase over the radiological impacts presented in EA Section 5.2.9, because the maximum waste-receiving rate in the two-stage concept is not greater than the rate upon which the information in Section 5.2.9 is based. The waste-storage capacity on the surface in the two-stage concept is, however, greater than the capacity upon which the information in Section 5.2.9 is based. Therefore, there is a potential for increase in the radiological impact estimates. Numerous design options in storage configuration, structure hardening, and other aspects of the design can be selected to limit this potential increase to insignificant levels, such that the preliminary safety analysis results can still be regarded as representative of the preclosure radiological safety of a repository at Yucca Mountain. These impacts will be further assessed during the license application design process to provide the necessary information for the Environmental Impact Statement and Safety Analysis Report, as well as to support optimization of the design for as low as reasonably achievable radiation exposures and for accident prevention and mitigation. Because many nuclear facilities with comparable amounts of radioactive material in use, or in storage on the surface, exist in areas of greater population density than that of the potential Yucca Mountain repository, there is high confidence that the radiological impacts of a two-stage repository, with up to 750 metric tons of uranium waste stored on the surface, will be well below acceptable limits. Therefore, the conclusion in Section 6.2.2.1.4 on the preclosure radiological safety system guideline is still, "The evidence does not support a finding that the site is not likely to meet the qualifying condition for this preclosure system guideline (level 3)."

With respect to radionuclide releases under elevated temperatures, the spent fuel from which the gaseous emissions originate are themselves under high temperatures. Additionally, accidents, such as fires, and the resultant doses are addressed in Section 5.2.9.2.3 of the EA.

Breached waste disposal container scenario. Some commenters stated that the accident scenario of having to retrieve breached waste disposal containers was not considered. It was stated that these operations could entail considerable dose commitments to workers.

Response. At this point in the Nevada Nuclear Waste Storage Investigations Project, the design is not sufficiently developed to reasonably, and in adequate detail, estimate the conditions that would be encountered during waste retrieval operations. The radiological impacts for normal and accident conditions during retrieval operations will be assessed during the advanced conceptual design and license application design in order to provide the necessary information for the Environmental Impact Statement and Safety Analysis Report, as well as to support optimization of the design for as low as reasonably achievable radiation exposures, and for accident prevention and mitigation.

Aircraft impact scenario. Some commenters addressed the need for substantiation of the conclusions reached regarding an aircraft impact at the site.

Response. The U.S. Department of Energy (DOE) recognizes that the probability of a U.S. Air Force (USAF) aircraft crash/bombing accident has

not been sufficiently substantiated in the draft EA or in Jackson et al. (1984). The DOE is interacting with the USAF to address and resolve this concern; a detailed plan for an event-frequency analysis of this scenario is currently being developed. If evaluation of the current situation results in unacceptable risk, the DOE is considering several alternatives and mitigation measures (some of which will require acceptance by the USAF) to reduce the event probability or consequences, which include the following:

1. Site hardening or expansion of hardened facilities.
2. Relocation of the USAF flight corridor.
3. Rerouting of the rail spur or highway to the repository.
4. Relocation of the repository surface facilities.
5. Assessment of the impacts of a monitored retrievable storage facility on transportation alternatives and the design of repository surface facilities.
6. Scheduling of DOE and USAF operations to be mutually exclusive.
7. Limiting of USAF operations (e.g., altitude, schedule, or activity limitations).

Because there are several ways to reduce the risk of this type of accident, there is high confidence that it can be prevented or adequately mitigated. Therefore, the conclusion in Section 6.2.2.1.4 on the preclosure radiological safety system guideline is still, "The evidence does not support a finding that the site is not likely to meet the qualifying condition for this preclosure system guideline (level 3)."

Emergency preparedness. One commenter questioned whether the DOE would temporarily discontinue repository operations if the combined totals of natural and manmade radiation (weapons testing) were found to be unsafe at Yucca Mountain. Two commenters stated that an emergency preparedness plan for the repository, such as the one that the State of Nevada has in effect, infers a level of confidence that may not be justifiable.

Response. A criticality could not occur with spent fuel, therefore a release of radioactivity would consist of a short-lived fission by-product which could easily be cleaned up. Natural radiation is always present in the atmosphere and is considered a baseline amount for assessing additional man-made releases. If atmospheric levels of radionuclides become unsafe to human life, from whatever source, operations can and will be discontinued until safe levels are achieved.

The DOE is confident that an emergency preparedness plan can be developed for Yucca Mountain if a repository is sited there. The plan would comprehensively establish procedures in the event of a radiological emergency.

Issue: Non-accidental radiological releases

Six commenters were concerned with radiological releases from the operational aspects of a repository. The topics addressed by this issue are: source terms, naturally occurring exposure, and radioactive-source testing.

Source terms. A few commenters suggested that source terms originating in the various cleaning, handling, packaging, and processing operations in

the various facilities be addressed. These concerns include assessments of exposures of workers and the public to various radioactive gases. It was stated that the acceptable radionuclide levels were not adequately presented. Another commenter stated that it is widely recognized that maximum permissible concentrations of radionuclides do not fully characterize the significance of releases.

Response. At this point, the design is not sufficiently developed to reasonably, and in adequate detail, estimate the source terms originating in the various operations conducted in the waste-handling and packaging facility. For example, if a monitored retrievable storage facility is used, waste processing and packaging may not occur at the repository. As stated in EA Section 5.2.9.2.2, the emissions and resulting impacts that occur during normal operations are insignificant because of the measures taken to protect workers and dilution over the transport distance to the environment. EA Section 6.4.1 provides some generic estimates of offsite releases from major sources. All source terms and the resulting radiological impacts will be assessed during the advanced conceptual design and license application design to provide the necessary information for the Environmental Impact Statement and Safety Analysis Report, as well as to support optimization of the design for as low as reasonably achievable radiation exposures (public and repository worker) and for accident prevention and mitigation. Because many nuclear facilities, with comparable amounts of radioactive material being handled in similar operations, exist in areas of greater population density than that of the potential Yucca Mountain repository, there is high confidence that the radiological impacts resulting from cleaning, handling, packaging, and processing operations will be well below acceptable limits. Therefore, the conclusion in Section 6.2.2.1.4 on the preclosure radiological safety system guideline is still, "The evidence does not support a finding that the site is not likely to meet the qualifying condition for this preclosure system guideline (level 3)."

The maximum permissible concentrations in question (Table 6-41 in draft EA Section 6.4.1) are in error by a factor of one million. These have been revised in the final EA (Table 6-46). A defined estimate of the collective dose for those emissions was not made, because the release levels of these nuclides and the remoteness of the site provide assurance that such dose levels would be very low.

Naturally occurring exposure. It was suggested that the EA discuss appropriate measures to limit exposure to naturally occurring radionuclides.

Response. The hazards encountered from naturally occurring radionuclides are recognized and are receiving attention. The forthcoming Site Characterization Plan and Exploratory Shaft Test Plan will describe the work that will be done to characterize the conditions of exposure to natural radioactivity, including such sources as penetrating radiation from the rock, as well as air and surface contamination that develop due to the emanation and subsequent decay of radon isotopes from the rock.

Radioactive-source testing. Concern was expressed in some comments about the plans to utilize radioactive-source materials for in situ testing and the risk factors associated with those tests.

Response. The use of radioisotopes for tracer studies and radioactive sources for well logging are discussed in Section 4.1.1.1. The radiotracers to be used have short half-lives (from several hours to tens of days) and thus will completely decay within a short period of time (from a few days to a few months, depending on the isotope). The well-logging sources are retrievable. This type of testing is commonly performed throughout the United States.

Issue: Miscellaneous

Fourteen comments have been classified into the miscellaneous issue. They consist of various editorial changes and two topics that do not fit into the previous issues: surface-water transport and ground-water release mechanisms.

Editorial changes. Several commenters stated that various parts of the radiological-safety discussions needed some editorial changes to better reflect a technical position. One commenter stated that on page 6-104 (Section 6.2.2.1.3) of the draft EA, the statement, "The arid conditions allow very limited infiltration and recharge ...", is not referenced to legitimate sources.

Response. In Section 6.4.1.2.2, "virtually all (99.9+ percent) ..." has been inserted to show that indeed the filter systems are not 100 percent efficient.

In Section 6.2.2.1.3, the reference to Table 6-45 (Preliminary estimates of cumulative radioactivity released to the accessible environment from a repository containing 70,000 MTHM) in the first sentence (paragraph six, in the draft EA) should have been a reference to Table 6-41 (Assessment of releases from normal preclosure operations). The table is correctly referenced in the final EA. The table lists the allowable limits for concentrations of airborne radionuclides. All of the limits listed in the table were in error and have been corrected.

In Section 6.2.2.1.3 of the draft EA, the last sentence of paragraph 5 beginning with "The air pathway ..." has been deleted because the discussion applies to saturated zone radionuclide migration. The air pathway from normal preclosure operations is discussed in Section 6.4.1.2.2. It is only significant when compared to water transport pathways. It is extremely unlikely that a fracture release scenario would result in offsite doses greater than those calculated in Section 6.4.1.2.2 for preclosure releases. Nevertheless, the significance of fractures as gaseous transport pathways will be studied extensively during site characterization. In Section 6.2.2.1.3, of the draft EA, the second to last sentence in paragraph 5 has been revised in order to make it more understandable.

In Section 6.2.2.1.3, the reference method for predicted krypton-85 release comes from Nuclear Regulatory Commission Regulatory Guide 1.25, (Safety Guide 25), "Assumptions Used for Evaluating the Potential Radiological Consequences of a Fuel Handling Accident in the Fuel Handling and Storage Facility for Boiling and Pressurized Water Reactors" (NRC, 1972).

The comment regarding inappropriate use of references is correct; the reference should be to Montazer and Wilson (1984) and Wilson (1985) only. The final EA has been revised accordingly.

Surface-water transport. A few commenters stated that weather conditions, including rainfall and snowfall should be assessed relative to the likelihood of surface-water transport of radionuclides that may reach the ground surface.

Response. The average weather conditions at Yucca Mountain suggest that surface transport mechanisms are not a likely scenario. The precipitation data for Yucca Mountain will be tabulated and compared to regional estimates after more than one year of data are available. During performance assessment in support of licensing, various scenarios that include severe weather and accidental surface releases will be considered. Also, Table 5-24 (Preliminary population dose commitments from postulated accidents) of the final EA presents results of a postulated flood scenario.

Ground-water release mechanisms. Comments were received stating that sentences in Section 6.2.2.1.3, paragraph 5, of the draft EA were misleading and unsupported. The discussion relates to ground-water transport not being a reasonable release mechanism due to the long travel times and the potential for retardation in zeolitized zones.

Response. The Calico Hills tuff is zeolitized beneath the repository horizon, and at least some sizable portion of the radionuclide flowpath passes through this unit; therefore, retardation will occur. The nearest water wells are further than 20 kilometers (13 miles) from Yucca Mountain.

Major revisions to the geohydrology discussion (EA Section 6.3.1.1.5) provide justification for flux estimates used for travel-time calculations. The new travel-time model for the unsaturated zone explains ideas on fracture flow versus matrix flow as presently understood.

C.6.6 ASSESSMENT OF PRECLOSURE PERFORMANCE

The assessment of preclosure performance embodies radiological assessments including evaluations of potential radiological releases and doses, and comparison with the requirements of the applicable guidelines and regulations.

Three comments were received under this category. One commenter agreed that worker exposure to radon would be low, but felt that the exposures should be discussed in terms of the uranium miner of 4 working level months (WLM) per year. Another comment concerned the fact that there was an error of 1 x 10^6 in the maximum permissible concentrations (MPC) listed for Table 6-41 in the draft EA. Additionally, the commenter felt that the discussion relative to MPCs confuses two systems of evaluation (ICRP-30 and 10 CFR Part 20).

One commenter pointed out that a discussion in EA Section 6.4.1.2.3, regarding releases of radioactive gases, references additional discussions within that section but that the additional discussions do not appear.

Response

Since 4 WLM per year is roughly equal to a lung dose rate of 56 rems per year, worker exposure would be well within the occupational dose limit for miners. However, specific data needed to quantify miner doses are lacking at this time.

The MPC values in Table 6-41 of the draft EA were indeed in error by a factor of 1 million and have been corrected in the final EA. The ICRP-30 (1982) system values used are only for dose conversion and the results are not compared to the concentration limits in 10 CFR Part 20, Appendix B, Table II. The conversion factor used was in error and has been revised in the final EA.

The reference in EA Section 6.4.1.2.3, to additional discussions within that section, was a typographical error. The correct reference is to Section 6.4.1.2.2 and has been corrected in the final EA.

REFERENCES FOR CHAPTER C.6

DOE (U.S. Department of Energy), 1981. "Reactor and Nonreactor Facility Emergency Planning, Preparedness and Response Program for Department of Energy Operations," DOE Order 5500.3, Washington, D.C.

ERDA (U.S. Energy Research and Development Administration), 1977. Nevada Test Site, Nye County, Nevada, Final Environmental Impact Statement, ERDA-1551, Washington, D.C.

ICRP (International Commission of Radiological Protection), 1982. Limits for Intake of Radionuclides by Workers, Annals of the ICRP, ICRP Publication 30 Pergamon Press, Oxford, England.

Jackson, J. L., H. F. Gram, K. J. Hong, H. S. Ng, and A. M. Pendergrass, 1984. Preliminary Safety Assessment Study for the Conceptual Design of a Repository in Tuff at Yucca Mountain, SAND83-1504, Sandia National Laboratories, Albuquerque, N. Mex.

Montazer, P., and W. E. Wilson, 1984. Conceptual Hydrologic Model of Flow in the Unsaturated Zone, Yucca Mountain, Nevada, USGS-WRI-84-4345, Water-Resources Investigations Report, U.S. Geological Survey, Lakewood, Colo.

NRC (U.S. Nuclear Regulatory Commission), 1972. Assumptions Used for Evaluating the Potential Radiological Consequences of a Fuel Handling Accident in the Fuel Handling and Storage Facility for Boiling and Pressurized Water Reactors, NRC Regulatory Guide 1.25 (formerly Safety Guide 25), Washington, D.C.

NWPA (Nuclear Waste Policy Act), 1983. "Nuclear Waste Policy Act of 1982," Public Law 97-425, 42 USC 10101-10226, Washington, D.C.

State of Nevada, Department of Human Resources, 1983. Radiological Emergency Response Plan, Division of Health, Carson City.

Vortman, L. J., 1980. Prediction of Ground Motion From Underground Nuclear Weapons Tests as it Relates to Siting of a Nuclear Waste Storage Facility at NTS and Compatibility with the Weapons Test Program, SAND80-1020/1, Sandia National Laboratories, Albuquerque, N. Mex.

Wilson, C. N., 1985. Results from NNWSI Series 1 Spent Fuel Leach Test, HEDL-TME-84-30, Hanford Engineering Development Laboratory, Richland, Wash.

CODES AND REGULATIONS

10 CFR Part 20 (Code of Federal Regulations), 1984. Title 10, "Energy," Part 20, "Standards for Protection Against Radiation," U.S. Government Printing Office, Washington, D.C.

10 CFR Part 60 (Code of Federal Regulations), 1983. Title 10, "Energy," Part 60, "Disposal of High-Level Radioactive Wastes in Geologic Repositories," U.S. Government Printing Office, Washington, D.C.

10 CFR Part 960 (Code of Federal Regulations), 1984. Title 10, "Energy," Part 960, "General Guidelines for the Recommendation of Sites for Nuclear Waste Repositories; Final Siting Guidelines," 49 FR 47714, Vol. 49, No. 236, December 6, 1984, pp. 47714-47769.

40 CFR Part 190 (Code of Federal Regulations), 1982. Title 40, "Protection of Environment," Part 190, "Environmental Radiation Protection Standards for Nuclear Power Operations," U.S. Government Printing Office, Washington, D.C.

40 CFR Part 191 (Code of Federal Regulations), 1985. Title 40, "Protection of Environment," Part 191, "Environmental Standards for the Management and Disposal of Spent or Nuclear Fuel, High-Level and Transuranic Radioactive Wastes: Final Rule," Federal Register Vol. 50, No. 182, September 19, 1985.

42 USC (United States Code), 1974. "Energy Reorganization Act of 1974," Public Law 93-438, H.R. 11510, 88 Stat. 1233, Sections 202 (3) and 202 (4), Washington, D.C.

42 USC 2012 et seq. (United States Code), "Atomic Energy Act of 1954," Public Law 85-256, Washington, D.C.

42 USC 7101 (United States Code), 1977. "Department of Energy Organization Act," Public Law 95-91, 91 Stat. 565.

43 USC (United States Code), "Federal Land Policy and Management Act," Public Law 97-579, Washington, D.C.

C.7 ENVIRONMENT, SOCIOECONOMICS, AND TRANSPORTATION

This section addresses comments on (1) the environmental, socioeconomic, and transportation-related effects of repository development and site characterization; (2) the technical guidelines for socioeconomics, transportation, and the environment; and (3) the use of these guidelines in evaluating the relevant system guideline. Most comments in this category are concerned with the characteristics of the repository before it is closed and decommissioned. There are many parallels between this category and Section C.4, which includes comments on the data base, proposed activities, and repository design. Whereas Section C.4 discusses baseline conditions, Section C.7 discusses how site characterization or repository development changes those conditions. Most comments about the effects of the repository on the environment or communities near the repository are included in this category.

C.7.1 EXPECTED EFFECTS OF SITE CHARACTERIZATION

The comments that were received relating to effects of site characterization have been divided into two categories: (1) Effects on the Physical Environment and (2) Effects on Socioeconomic Conditions.

C.7.1.1 Effects on the physical environment

The comments in this issue address the expected effects on the physical environment from site characterization. The comments in this category have been divided into the following issues: (1) Ground-Water Contamination, (2) The Unsaturated Zone, (3) Air Quality, (4) Archaeology, (5) Effects on Mineral Resources, (6) Water Resources, (7) Land Use, and (8) Repository Expansion.

Issue: Ground-water contamination

The one comment received on this issue stated that water used during site characterization-related construction will compromise the results of geotechnical and hydrogeochemical testing.

Response

The concern is valid and care will be taken to avoid contaminating the in situ ground water being sampled. Potential seepage sources will be lined or located away from the shaft. Water added to control fugitive dust will be tagged with sodium bromide so that it can be traced or identified. In situ tests for hydrologic characterization will be positioned as far away as possible from the potential sources of fluids during drilling. In light of these precautions, it is not expected that construction water will compromise site characterization-related testing.

Issue: The unsaturated zone

Three commenters expressed concern regarding the effects of land disturbance on ground-water infiltration into the unsaturated zone. The draft Environmental Assessment (EA) states that 285 hectares (705 acres) of regolith would be disturbed, and these commenters stated that the potential for increased infiltration to the unsaturated zone should be evaluated. More information was requested on the effect of soil-surface disruption on the chemical composition of naturally percolating waters.

Response

The draft EA estimated the amount of land that would potentially be disturbed using assumptions that maximized the disturbed area. Borehole drilling will require that some new roads be constructed and will require use of several existing roads near the exploratory shaft site. It is expected that these roads will also be used to provide access to geophysical survey sites and that a minimal amount of additional land disturbance will result. Changes in infiltration rates caused by land disturbances during construction of roads and drill pads is expected to be minimal.

The great depth of the repository suggests that the composition of percolating waters will be unaffected by soil chemistry. Studies by Knauss et al. (1984) and Oversby and Knauss (1983) suggest that a sample taken 24 meters (78 feet) into an air-drilled hole did not contain soluble salts that could change the composition of percolating water. Further, these examples indicate that the presence of soluble salts is a surface-evaporation phenomenon and such materials are unlikely to be present at the depth of the repository. This topic will be further investigated by examining cuttings from drill holes in the unsaturated zone during site characterization.

Issue: Air quality

One commenter expressed concern that, depending on the mode of waste emplacement, the proposed action may exceed prevention of significant deterioration criteria. While the emission calculations for site characterization use a mid-value of fuel consumption, the extreme case would produce a high value of nitrogen oxides. The commenter makes a recommendation to use both values in calculations.

Response

If Yucca Mountain is selected for further development, detailed engineering information and emission calculations will be necessary to satisfy Nevada Department of Environmental Protection permitting requirements. The emission rates presented in Table 4-1 (Summary of nonfugitive atmospheric emissions from site characterization) of the draft EA are based on the horsepower rating of each stationary source combined with emission factors from AP-42 (EPA, 1977) in grams per horsepower-hour, not on the amount of diesel fuel consumed. The hours of operation for each piece of equipment are considered maximum estimates of projected use over the 23 to 26 months during which these activities would be taking place.

Issue: Archaeology

Five commenters addressed potential impacts to the prehistoric and historic sites identified in the draft EA, their significance with regard to Federal preservation efforts, and the need for protection or mitigation plans for identified sites. It was felt that the four prehistoric sites noted in the draft EA were not described in regard to their status with respect to the National Register, eligibility procedures and criteria, or how the opinion of significance was determined. In addition the U.S. Department of Energy (DOE) methods of prohibiting excavation or collection were questioned, particularly in light of similar unsuccessful efforts on the Nevada Test Site.

Response

Four sites were identified and are eligible for nomination to the National Register. Artifacts found at these sites were collected in consultation with the Nevada State Historic Preservation Officer (SHPO) to ensure that the information potential of these sites was preserved. A report is in preparation on these findings entitled, "Limited Test Excavations at Selected Archaeological Sites in the NNWSI Yucca Mountain Project Area, Southern Nye County, Nevada," Desert Research Institute Technical Report (Pippin, 1984).

Mitigation plans for adverse impacts will be developed with a Programmatic Memorandum of Agreement between the DOE, the Nevada SHPO, and the Advisory Council on Historic Preservation.

Issue: Effects on mineral resources

One comment was received concerning the lack of a discussion regarding the expected effects of site characterization on mineral resources and suggested that such a discussion be included in the final EA.

Response

To clarify the effects of site characterization on mineral resources, the following sentence has been added to Section 4.2.1.1.3 of the EA:

"A Class I resource survey (Bell and Larson, 1982) found no evidence of significant mineral or energy resources in the region surrounding Yucca Mountain, and therefore future exploration and development is not expected."

Issue: Water resources

Three commenters addressed the fact that a discussion of the effects of water use during site characterization was not provided, and that a more complete estimate of this usage should be provided. Similarly, it was felt that the final EA should include a discussion on potential impacts to local ground-water quality as a result of liquid effluent disposal.

Response

A preliminary estimate of water use for site characterization is less than 494,000 cubic meters (400 acre-feet) per year pumped from Well J-13. There are no nearby water users due to land-use restrictions around the site. Users that are within the same ground-water basin as the site are considered in draft EA sections 6.2.1.7.5 and 6.3.3.3.3. It is unlikely that a sewage lagoon will be used and that a septic tank and a drain field will be used instead. This system will be placed away from the shaft facility to minimize the chance for contamination of the testing facility area. The rock-storage pile will be lined with an impervious material to prevent infiltration. Discharge from the septic system would be sufficiently above the water table to ensure that there will be no impact to ground water.

Water use during site characterization has been reviewed in the final EA. The amount of water to be used during tests is expected to be limited in order to avoid potential interference with testing of moisture conditions at depth.

Issue: Land use

Three commenters expressed the opinion that the description of the uses of the public lands should be expanded. While land-use effects are not likely on federally controlled lands, the DOE should comply with pertinent State and local regulations governing land use and building construction. Lastly, the DOE should clearly indicate that the land to be used is in the public domain.

Response

Site characterization activities will comply with all applicable State and local regulations governing land use and construction activities. A description of the specific uses of the public lands is provided in Section 4.1 of the final EA.

Yucca Mountain is on land administered by the Federal Government. This is not to say that all of the land is restricted; part of the site is on public lands administered by the Bureau of Land Management.

Issue: Repository expansion

One commenter noted the lack of a description of potential impacts resulting from characterization of expansion areas, and suggested that such text be added to the final EA.

Response

There are no detailed plans to develop the expansion areas; therefore, potential environmental impacts cannot be adequately evaluated. The expansion areas, however, are within the site boundary shown in Figure 3-1 (Location of Yucca Mountain site in southern Nevada) of the draft EA.

C.7.1.2 Effects on socioeconomic conditions

The evaluation of potential socioeconomic effects of site characterization (including economic, demographic, community services, social, and fiscal and governmental effects) are covered by this category. Thirty-eight comments were received, and these have been grouped into the following issues: (1) Lincoln County, the State of Nevada, and Local Government; (2) Effects on State Tourism; (3) Site Characterization Impacts; (4) Disaggregate Community Services Impacts and Settlement Scenarios; (5) Work Force Estimate and Percent New Workers; (6) Sector-Specific Comparison of Labor Demand; (7) Indirect Employment Multiplier; (8) Transportation Impacts; and (9) Miscellaneous.

Issue: Lincoln County, the State of Nevada, and local government

Three commenters felt that the Environmental Assessment (EA) should examine the socioeconomic effects of site characterization on Lincoln County and the State of Nevada as a whole. A fourth commenter perceived that no recognition is given in the Nuclear Waste Policy Act (NWPA) of 1982 to local government participation in planning or financial assistance during site characterization.

Response

The reasons why Lincoln County and the State of Nevada were, in general, not used as units of analysis were presented in Section C.4.1.5 of this Appendix. In addition, the U.S. Department of Energy (DOE) analysis of socioeconomic impacts of site characterization, as presented in Section 4.2.2 of the draft EA, led to the conclusion that the majority of the socioeconomic impacts of site characterization in the bicounty area would be small or insignificant. If these impacts are spread over a base of more than two counties, or the State as a whole, their relative magnitude would be even smaller.

The NWPA does recognize the participation of local governments in planning for the repository. Specifically, Section 117(c)(5) states that a consultation and cooperation agreement shall specify procedures, "... by which the Secretary shall assist such State, and the units of general local government in the vicinity of the repository site, in resolving the offsite concerns of such State and units of general local government..." (NWPA, 1983). Additionally, Section 116(c)(3) of the NWPA provides for grants equal to taxes to be made to units of general local government in which a site for a repository has been approved for site characterization.

Issue: Effects on State tourism

The DOE was asked to include an assessment of the potential for impacts that the decision to conduct site characterization could have on the Nevada tourism industry and the State's economic diversification program, and to lay the groundwork for continuing research to quantify such impacts as they occur. A second commenter noted that the term "tourism" seemed to be directed toward the hotel and gaming industries, and that this view should be

broadened to include the variety of recreational opportunities which draw visitors to southern Nevada.

Response

The suggested analysis of the effects of perception on tourism in southern Nevada is not included in Chapter 4 of the EA since the impacts of site characterization activities on all sectors of the bicounty economy are expected to be insignificant. However, the DOE would monitor site characterization activities to validate the expected socioeconomic impacts of site characterization activities presented in Section 4.4.2 of the EA. As was discussed in Section C.4.1.5, the scope of the analysis in the EA is the bicounty area; the State as a whole was not included in the definition of the affected area. If the Yucca Mountain site is approved for site characterization, a broader geographical area would be evaluated if appropriate, based on the Environmental Impact Statement (EIS) scoping process. Additional studies on both tourism, and attitudes and perceptions of locating a repository at Yucca Mountain would be conducted. The comment regarding a definition of the word "tourism" would be noted in future studies.

Issue: Site characterization impacts

Eight comments were assigned to this issue. Three commenters pointed out that in Chapter 4 of the draft EA, the DOE states that the social and economic impacts of site characterization are expected to be small and insignificant without describing the impacts. Five commenters stated that the bicounty area (Clark and Nye) is an inappropriate unit of analysis of the socioeconomic impacts of site characterization, and suggested that these impacts should be analyzed at the county or community level.

One commenter questioned using the total baseline bicounty employment as a basis for comparison with the expected number of new direct site characterization jobs, and suggested a comparison with baseline employment in the mining and construction sectors only. One commenter stated that the dependency factors applied in the draft EA need supporting documentation, since factors for offsite workers are likely to differ from those for onsite workers who are employed temporarily at a remote location.

Response

The socioeconomics section of the draft EA Chapter 4 does discuss several types of impacts which would result from site characterization activities. For example, Section 4.2.2.1.1 describes employment impacts, while Section 4.2.2.2 shows that the most likely impact on population would be an increase of about 830 new residents in southern Nevada. This section has been revised to show estimates of the distribution of the maximum population increase to communities nearest the Yucca Mountain site (Table 4-5 of the final EA). These community population estimates are small. Community services impacts are discussed in Section 4.2.2.3.

The appropriate unit of analysis of labor markets is the bicounty area, or even a larger area. This is evident from the observation that workers currently employed at the Nevada Test Site (NTS), which is adjacent to the proposed Yucca Mountain repository site, come from many areas in addition to

Nye County. A comparison of the expected 109 new direct site characterization jobs (40 percent of the total new direct site characterization jobs) with the projected mining and construction employment in Nye and Clark counties (tables 3-12 and 3-13 of the final EA), indicates this number of jobs would be about one-half of one percent over the expected 1985 baseline employment in these two sectors.

Supporting documentation for dependency factors appears in U.S. Department of Energy, Environmental Aspects of Commercial Radioactive Waste Management, (DOE/ET-0029) Volume 3, Appendix C, Washington, D.C., 1979. These factors are also used in McBrien and Jones (1984). Use of a different, but reasonable, value for the dependent ratio assigned to the offsite direct work force would not significantly affect the results of the population impact analysis appearing in Section 4.2.2.2 of the draft and final EAs. For example, assume that the dependent ratio for all of the direct offsite workers were 2.47 instead of 1.28. The maximum site characterization related population would then be 2,229. This represents 0.4 percent of the estimated 1985 bicounty baseline population, which is not different than the percentage reported in the draft EA.

Issue: Disaggregate community services impacts and settlement scenarios

Seven commenters thought that a small change in population in some communities would have noticeable and perhaps significant community service, social, and fiscal impacts. One commenter expressed a belief that the discussion of the problems with Beatty water quality implies that "... because a problem exists, adding to it is acceptable ..." Five of these same commenters asked that a variety of settlement scenarios be examined and that the potential impacts upon community services, social conditions, and fiscal conditions resulting from each scenario be evaluated.

Response

If a significant number of the projected new residents were to settle in one of the smaller communities of Nye County during site characterization, noticeable impacts could indeed occur. Section 4.2.2.2 of the EA was revised to show the estimated distribution of maximum site characterization population (i.e., direct and indirect workers and their dependents) to individual communities in Nye and Clark counties nearest the Yucca Mountain site. If the settlement patterns described in Table 5-26 (Settlement patterns of Nevada Test Site employees) of the final EA apply, and the projected maximum site characterization related population increase is 2,080 persons (assuming all direct and indirect workers and their dependents are immigrants), then population increases ranging from 0.1 to 5.9 percent would result (Table 4-5 of the final EA). These percentage increases are not considered significant and, from the community services information presented in Chapter 3 of the EA, would not appear likely to overload community services providers. The small number of new residents is also unlikely to result in significant changes in social conditions. Finally, only minor changes in local government revenues and expenditures would result from such population increases.

Section 4.2.2.3 of the draft EA should not be interpreted to imply that "... because a problem exists, adding to it is acceptable ..." In the judgment of the DOE, the magnitude of the incremental impact of site

characterization on the Beatty water supply problem will be "very small." This judgment is reasonable, based on Table 4-5 of the final EA which shows that a maximum of two additional persons could be expected to settle in Beatty during site characterization. Furthermore, the Beatty Water and Sanitation District and the Nye County Commission, as mentioned in Section 3.6.3.3 of the draft EA, are taking positive action to alleviate the water quality problem. No judgment is made, however, about the acceptability of the impact to present or future residents.

The DOE believes that use of the recent settlement patterns of workers employed at the NTS provides a reasonable indication of the expected settlement patterns of site characterization workers. Development of alternative settlement patterns would have required considerably more information than was available during preparation of the EA, and would not likely have resulted in substantially different conclusions regarding the suitability of the site.

Issue: Work force estimate and percent new workers

Two commenters could find no reference to support the work force estimates given for site characterization, as presented in Table 4-3 (Peak regional employment effects of site characterization) of the draft EA. The commenters also noted that the EA does not substantiate the conclusion that 60 percent of the work force would be individuals currently employed by the DOE and 40 percent would be new workers.

Response

There are two sources for the employment estimates shown in Table 4-3 (Peak regional employment effects of site characterization). The direct employment estimates are based on the site characterization activities described in Section 4.1 of the EA. The indirect employment estimates were developed by applying an indirect employment multiplier of 1.54 to the direct employment estimates. Section 5.4.1.1 of the EA has been revised to discuss further the derivation of this multiplier.

Based on similarities between site characterization activities described in Section 4.1 and the construction and drilling activities currently carried out by the DOE and its contractors at the NTS, it was estimated that about 60 percent of the direct work force shown in Table 4-3 would already be employed in DOE activities. Both the work force estimates and the 60 percent assumption would be validated using data gathered by the site characterization socioeconomics monitoring program. Information on the percentage of current DOE workers was provided to give the reader a realistic understanding of the likely increase in the number of new DOE-related jobs that would be associated with site characterization.

Issue: Sector-specific comparison of labor demand

Two commenters felt it to be inappropriate to compare the Project-related demand for site characterization workers with total bicounty employment. Instead, the comparison should be made with mining and construction work force estimates only.

Response

As seen in Table 4-3 (Peak number of site characterization workers), site characterization activities are expected to generate a total of 273 direct jobs. Baseline mining and construction employment in Clark and Nye counties in 1985 is projected to be 20,876 as shown in Table 3-12 (Employment in selected industries in Nye County, 1978-2000) and Table 3-13 (Employment in selected industries in Clark County, 1978-2000) of the final EA. Therefore, the project would increase employment in those sectors by no more than 1.3 percent. This sector-specific impact is probably overstated, because some of the 273 workers are in neither mining nor construction.

Issue: Indirect employment multiplier

The DOE received six comments which questioned the use of a multiplier of 1.54 indirect workers for each direct worker.

Response

Section 5.4.1.1 of the final EA was revised to discuss the derivation of the indirect employment multiplier. That discussion also appears in section C.7.4.2 of this document.

Issue: Transportation impacts

The DOE received five comments on the draft EA discussion of transportation impacts during site characterization. These comments concerned limitation of the discussion of highway impacts to U.S. Highway 95 and failure to discuss rail transportation impacts, potential damage to highways, and the hazards of transporting fuel and explosives.

Response

Because U.S. Highway 95 will be the main route for transportation of workers and materials to the Yucca Mountain site during site characterization, it was logical to focus the analysis upon that road. Rail transportation will not be used for workers and materials during site characterization. In addition, there will be no shipments which are unique from either a weight or content standpoint; consequently, no additional analyses were performed.

Issue: Miscellaneous

Two comments were considered under the miscellaneous issue; these concerned the request for additional information on site characterization, and clarification of the DOE policy regarding withholding of State funding.

Additional information. One commenter requested additional details on site characterization activities, including calendar time-phasing, costs associated with construction and testing, incomes earned by site characterization workers, housing accommodations and project-provided transportation for commuting direct workers, and the skill and wage mix of direct workers and likely union representation of direct workers.

Response. The site characterization phase, as defined in 10 CFR Part 960, begins after a site is recommended to, and approved by, the President. These decisions are expected to be completed sometime in 1986. The footnotes to Table 4-3 (Peak number of site characterization workers) in the final EA show the schedule for the 55 months of planned site characterization activities.

According to the June 1985 Mission Plan (DOE, 1985), the total cost of site investigations for the first repository is expected to be about $767 million. The specific dollar allocations for each site are not explicitly known at this time due to the uncertainty as to which sites will be selected. Once three sites have been chosen for detailed studies, it is expected that the amount applied to the Yucca Mountain site would be approximately one-third of the total available funding.

The assumption of an average annual wage of $36,200 for repository workers made in Chapter 5 of the EA would also apply to direct site characterization workers.

The results of the socioeconomic impact analysis are independent of the level of amenities provided for workers at the site. While more detailed information about the amenities that workers receive would give some insight into the quality of life of the workers, this information is not directly applicable to the analysis in the EA. However, such information could be incorporated into the socioeconomics monitoring program associated with site characterization activities.

Detailed information on the skill and wage mix of direct workers and likely union representation would not affect the results of the analysis and has therefore not been incorporated into the EA.

DOE funding. One commenter noted that the DOE policy has been to withhold State-requested funds for developing independent data on selected technical issues, and that this statement is inconsistent with the DOE actions at Yucca Mountain. In the view of the commenter, the EA should reflect the practiced DOE policy, or the DOE policy should conform to both the spirit and letter of the Nuclear Waste Policy Act (the Act) of 1982.

Response. The DOE acknowledges that just prior to the issuance for comment of the draft EA, the State of Nevada brought suit (State of Nevada v. Herrington) with respect to the DOE denial of Nevada's request under the Act to grant funding for the purpose of collecting certain independent, primary "site characterization data." However, a detailed discussion of that litigation or of the DOE grant policies in implementation of the Act is not considered appropriate to the context of the EA document.

C.7.2 ENVIRONMENTAL QUALITY

The twenty-nine comments received in this category concern eight issues that involve: (1) Water Resources, (2) Containment, (3) Nuclear Waste Heat Generation, (4) Recreation, (5) Water Rights, (6) Effects of Waste Retrieval,

(7) Effects on the Physical Environment, and (8) Application of Major Federal Environmental Laws.

Issue: Water resources

This issue concerns the problems of use and potential contamination of water resources, an important issue in the West. The repository will use locally available ground water. Commenters questioned the extent, quantity, and quality of the existing ground-water aquifer; the potential evapotranspiration rate; the amount of water to be used for repository activities; plans to conserve water; and the possible effects to the aquifer from use of the water; discharges from facilities; and the postulated release of radioactive materials into the ground water. One commenter pointed out that Devils Hole is a warm spring, not a hot spring. Fourteen comments were received on this issue.

Response

Water consumption at the repository will rise to a peak of over 120,000,000 gallons per year at the end of the sixth year and decrease to about 115,000,000 gallons per year and remain at this level for the next 26 years. The average demands for the following 23 years of operation will be approximately 2,500,000 gallons per year. The latter time period represents the minimum water requirements for the repository.

The water would be pumped by an onsite well from the Alkali Flat-Furnace Creek Ranch ground-water basin. The draft Environmental Assessment (EA) has been revised to include an estimate of public and commercial use of ground water from this basin.

The repository will be designed to conserve water and to prevent degradation of the underlying aquifer. A hypalon-lined evaporative pond will be used for mine waste water effluents and sewage systems will conform to the regulations of the State of Nevada Board of Health. Although the exploratory shaft facilities will have a septic system located off the Yucca Mountain fault block that allows infiltration, the repository will be designed so that there will be no ground-water infiltration.

A second comment, dealing with overall water use, stressed the importance of integrating water conservation and reuse into the repository design. Although conservation concerns will be considered in the design, preliminary estimates indicate that there will be an adequate supply of water available for repository operations independent of conservation strategies. The U.S. Department of Energy (DOE) will have to meet very strict Nuclear Regulatory Commission (NRC) and U.S. Environmental Protection Agency (EPA) release limits so that the public health and safety are protected for both the short- and long-term periods.

Devils Hole will not be affected because waters in the Devils Hole area are fed from the Ash Meadows ground-water basin (Waddell et al., 1984; Dudley and Larson, 1976; Waddell, 1982). The ground-water basin that is the source for the Ash Meadows springs is not the same as the one underlying Yucca Mountain. Further studies during site characterization are expected to confirm

these ground-water-flow patterns. The draft EA text in Section 6.2.1.6.5 has been changed to explain that Devils Hole is a warm spring, not a hot spring.

Repository water use will not impact the Las Vegas valley water shortages, although a small population increase in the valley resulting from an influx of repository workers would add a very small increment to the projected shortages in the mid-2000s. Potential impacts to existing water users in the area were evaluated in Section 6.2.1.7.5 of the final EA. In sections 5.2.2, 6.2.1.7.5, and 6.3.3.3.3, information on water use in the same ground-water basin is compared with repository water-use estimates. The reader was referred from Section 5.2.9.2.3 to sections 6.3.3.3 and 6.2.2.1.3 where it is indicated that there are no permanent surface-water impoundments in the area of the repository and that the underground repository is located in the unsaturated zone. Sections 6.3.2 and 6.4.2 discuss the potential for releases over a 500-year time frame. Accidental release of radionuclides into the ground-water system is very unlikely. The thick unsaturated zone contains very limited moisture, and without moisture, there is no transporting medium to carry the radionuclides down to the water table. There are also no surface impoundments in the area that could cause potential surface dispersion.

For the draft EA, potential evapotranspiration was estimated by an empirical method (the Thornthwaite method) reviewed in Rosenberg (1974). Potential evapotranspiration for Yucca Mountain has been estimated to be about 0.6 meters (2 feet) per year. Estimates in Craig and Robison (1984) suggest 1.1 to 1.5 meters (3.5 to 5 feet) of potential evapotranspiration. The U.S. Geological Survey, in comments to the draft EA, stated that potential evapotranspiration is between 1.8 and 2.4 meters (6 and 8 feet) per year. Either of these estimates is consistent with the estimates of precipitation that are 20 percent or less of annual potential evapotranspiration as reported at the end of Section 6.3.1.1.3 of the draft EA. These estimates are preliminary and speculative, and the final EA has been revised to reflect this uncertainty. The climatic regime will be studied in more detail during site characterization.

Issue: Containment

This issue concerns the potential long-term risk that contamination would occur should containment fail, the adequacy of the many investigations to minimize the uncertainties, and what the DOE actions would be if water contamination did occur. Six comments were received in these areas.

Response

The DOE will be required to meet the NRC and the EPA regulations and will be required to show compliance with the regulations during the licensing of a repository. Investigations during site characterization will provide the data that will be used during the licensing process. The findings from these investigations will be reported in several publicly reviewed documents during the Environmental Impact Statement and the NRC regulatory processes.

As explained in Chapter 5 of the EA, natural and engineered barriers will be used to prevent and retard radionuclide migration. A radiological

monitoring program will be implemented to monitor local and regional groundwater supplies. Should a problem be identified, an appropriate mitigation program will be designed.

Issue: Nuclear waste heat generation

One commenter requested detailed information on ambient temperatures and heat generation during isolation of the waste.

Response

Section 6.3.2.4 on preclosure rock characteristics evaluates the potential for thermal effects to cause operational problems in the repository. Section 6.3.1.3.4 on postclosure rock characteristics evaluates the potential for thermal and radiation effects in the long-term isolation phase. Thermal calculations are reviewed in that section, as well as in the discussion of waste package performance in Section 6.4.2.1.1.

Issue: Recreation

Two commenters raised the potential for decreased use of the Death Valley National Monument and the Floyd R. Lamb State Park because of proximity to the Yucca Mountain site and the supporting railroad line.

Response

Effects on visitation at recreation facilities from the transport and disposal of nuclear waste may be evaluated if the Yucca Mountain site is approved for site characterization. Rail line discussions are addressed in the EA sections 5.1, 5.2, and 5.3.

Issue: Water rights

This issue concerns the possible inconsistency in the discussion of potential senior water rights located off the Nevada Test Site and other water rights discussed in the draft EA. One comment was received on this issue.

Response

Under Nevada law, water rights are held independently of land ownership. Those rights are allocated by the State of Nevada on the basis of the actual water supply available in a particular ground-water basin. Preliminary analyses in the draft EA and a revised analysis in the final EA indicate that sufficient water is available for existing rights and projected repository-related requirements. This preliminary conclusion was consistently presented throughout the draft and final EA.

Issue: Effects of waste retrieval

This issue concerns whether the impacts associated with the retrievability phase of the project were adequately assessed. Two comments were received on the issue.

Response

The retrievability phase is merely the period of time after emplacement is completed during which the repository must remain open in case retrieval operations are initiated. During this period, there would be essentially no activity at the repository. Impacts associated with actual retrieval operations have not been addressed. To clarify this point in the final EA, the retrievability phase has been referred to as the "caretaker" phase, or some other aptly descriptive phrase, that reflects the types of activities that will be taking place during that time.

Issue: Effects on the physical environment

One commenter recommended that the effects of a repository on physical characteristics should be of greater importance and receive more consideration than socioeconomic factors. A second commenter was concerned that the impact analysis was too generalized.

Response

Physical factors are thoroughly considered in the postclosure siting guidelines and in four preclosure guidelines. The intent of the impact assessment in the EA is to evaluate impacts against the 10 CFR Part 960 guidelines by using available referenceable information. A more thorough impact analysis will be done as a part of the studies associated with the Environmental Impact Statement.

Issue: Application of major Federal environmental laws

One commenter questioned why the summary of major Federal laws that may apply to a repository was different in the Yucca Mountain EA from the summary in the salt site EAs. Another commenter asked why only Clark and Nye counties had been considered in the EA, when the Nuclear Waste Policy Act provides that the entire State of Nevada becomes the "affected area."

Response

Draft EAs written for the salt sites presented a list of requirements that may or may not apply (e.g., the Coastal Zone Management Act of 1972 clearly does not apply to the Texas site but has been included in its EA). The Yucca Mountain site draft EA did not take this same broad purview; it included only those laws that do apply. The EA was revised to contain a consistent list of requirements.

The DOE will comply with all of the Federal, State, and local laws and regulations that apply to the Yucca Mountain site. These regulations will continually be evaluated over the next 6 years before repository development to ensure that the repository is in compliance with applicable regulations. The evaluation will include further analyses to cover the broader region of impact.

C.7.2.1 Land use

This category addresses comments on the effects on land use if a repository is developed at Yucca Mountain; a total of fourteen comments were received.

Eight commenters requested that the U.S. Department of Energy (DOE) clarify the discussion about the acreage that would be required for withdrawal at Yucca Mountain if a repository is constructed. Another comment concerned potential land-use impacts from housing and commercial development in the vicinity of Yucca Mountain as a result of repository development. Other commenters asked about the ramifications if U.S. Air Force (USAF) land was unavailable for the proposed Yucca Mountain repository. One commenter contended that transportation impacts to the Las Vegas Paiute Council's holdings, which are near potential transportation routes, were not adequately addressed in the Environmental Assessment (EA).

Response

In brief, the land area for which the DOE must obtain control for development of a repository at Yucca Mountain is no larger than 24,710 acres (i.e., the controlled area), which includes Bureau of Land Management, Nevada Test Site, and Nellis Air Force Base lands. The Bureau of Land Management portion to be withdrawn is approximately 5,000 acres. The number of 50,000 acres was in error, and the EA has been changed to accurately explain the acreage.

Induced growth is important, but it would be premature in the planning process to conduct a detailed impact assessment of secondary impacts. The assessment will be conducted as part of the Environmental Impact Statement process. The DOE will comply with applicable State and local land-use regulations.

Because the USAF land is an integral part of the proposed site and because of the progress of the repository site-selection process, all legal as well as interagency cooperative consultation processes are being pursued. If Yucca Mountain is chosen as the first repository site, a land withdrawal action will be initiated. At this point in time discussions between all involved agencies are continuing toward resolving any conflicts that may exist.

The Paiute Council has not been designated an affected Indian Tribe within the meaning of Section 2(2)(B) of the Nuclear Waste Policy Act of 1982. However, specific note was made in Section 5.4.4.2 of the draft EA that a potential exists for impacts on Native American cultures from transportation activities. Detailed analysis of impacts to communities along transportation corridors would be undertaken once actual routes are identified.

C.7.2.2 Ecosystems

Twenty-three comments dealt with the impacts of the proposed repository on the ecosystems found at the Yucca Mountain site. These comments were classified into the following issues: (1) Mitigation Measures, (2) Endangered Species, (3) Effects of Soil Heating, (4) Railroad Spur Construction, (5) Ash Meadows, and (6) Miscellaneous.

Issue: Mitigation measures

Seven comments were received in the area of mitigation measures that were divided into three topics: impact on flora and fauna, impact on the desert tortoise, and rehabilitation of drill sites.

Impact on flora and fauna. Two commenters asked what provisions had been made to minimize the destruction of vegetation (and therefore, habitat loss) and suggested that emphasis be placed on discussion of habitat loss and the associated permanent reduction in wildlife populations.

Response. Efforts will be made to minimize or mitigate the effects of the repository project on flora and fauna. The destruction of approximately 680 hectares for site characterization and repository development should not affect the ecological balance of the surrounding, similar habitat. Reclamation and restoration procedures will serve to mitigate the long-term ecological effects of the project and help to eventually return the site to the desert ecosystem.

Further, it is agreed that destruction of vegetation, in most cases, results in the destruction and not mere displacement of the wildlife inhabiting the affected area. Thus, the discussion in Section 5.2.4 in the draft Environmental Assessment (EA) about displaced wildlife has been revised to address their probable destruction.

Impact on the desert tortoise. Three commenters expressed concern that discussions involving impacts to the desert tortoise be presented with the thought that the species may soon be afforded threatened-species status. Further, these comments questioned why translocation was not considered a viable mitigation measure.

Response. The recommendation that tortoises not be translocated was based primarily on the studies that showed that captive tortoises reintroduced into the wild had low survival rates. Whether a viable plan or method of translocating tortoises can be developed for Yucca Mountain requires further study. However, references to translocating tortoises have been modified to indicate that the technique may be used after further study.

Rehabilitation of drill sites. Three commenters questioned the procedures to be used in rehabilitation of abandoned drill sites and suggested that rehabilitation could begin with existing disturbed sites.

Response. Site investigations will be carried out to establish the best approaches for dealing with the disturbed sites; it should also be noted that

reclamation requirements are specified in the Nuclear Waste Policy Act (1983).

Issue: Endangered species

Three comments were received on this issue, all of which dealt with impacts to threatened or endangered plant and animal species. The first noted that the draft EA does not include an assessment of the potential damage to the habitats of endangered species or their well-being. Another related comment indicated the existence in the Project area of both the Mojave fishhook cactus and the desert tortoise, and indicated the need for a plan specifying protection measures to be employed during construction and operation. One commenter referenced an inventory entitled Nevada Outdoor Recreation Resources Index and Survey, and suggested that it be reviewed for additional information.

Response

No federally listed threatened or endangered plant or animal species occur within the Yucca Mountain study area, although the desert tortoise and Mojave fishhook cactus are currently under review for such status. Ad hoc protective measures designed to mitigate the impact of the repository project on the desert tortoise and Mojave fishhook cactus are discussed in chapters 4, 5, and 6 of the EA. These measures involve the use of preconstruction surveys at all sites to be disturbed. Using information gathered during preconstruction surveys, construction activities can be sited to avoid the cactus and desert tortoise. The reference to the Index and Survey has been noted.

Issue: Effects of soil heating

One comment that was submitted twice cited the statement within the draft EA that heat generated by wastes is expected to increase the temperature of the ground at the surface of the site by approximately 1°C (approximately 2°F), and that the resultant ecological consequences are not expected to be significant. This conclusion is considered in the comment to be inconsistent with other statements that say available information is insufficient to enable quantification of ecological consequences resulting from the temperature increase.

Response

The EA does state that the ecological consequences of raising soil temperatures are unknown at this time. The expectation that significant ecological impacts would not occur was based on the small temperature increase and the size of the affected area (approximately 800 hectares or 1,977 acres). Further, it is doubtful that temperature-induced changes to 800 hectares would have a significant effect on the vast amount of similar, unaffected desert habitat in the region.

Issue: Railroad spur construction

One comment that was submitted twice noted that the EA briefly discussed possible development of a railroad spur from near Las Vegas to the Yucca Mountain site, but provided no discussion of the potential impacts of such a rail spur on wildlife values. It was stated that if the proposed development included a rail spur, the final EA should address the potential impacts of the same.

Response

While the EA does discuss the possibility of developing a railroad spur from the vicinity of Las Vegas to the Yucca Mountain site, no final determination has been made as to the use of rail transport or routing if rail transport is to be used. When these plans or decisions are completed, additional assessment studies will be carried out to investigate the impacts and effects of such actions.

Issue: Ash Meadows

Four commenters expressed concern that construction and operation of a repository will cause irreparable damage to Ash Meadows in such areas as drawdown of the water table due to ground-water usage, long-term contamination of ground water, and endangering of resident species and citizens.

Response

Construction and operation of a repository will not cause a drawdown of the water table in Ash Meadows because ground water used for repository purposes will be drawn from the Alkali Flat-Furnace Creek Ranch ground-water basin, which is not part of the recharge system for Ash Meadows. Similarly, no detrimental impacts are expected at the site with regard to floral or faunal species. Since Ash Meadows receives no ground water from the Alkali Flat-Furnace Creek Ranch ground-water basin, no contamination of the ground water is expected to occur.

Issue: Miscellaneous

Five comments were received which represented personal opinions regarding ecosystems studies. Most of these were philosophical statements regarding the science of ecosystem study.

Response

These comments were noted, but no specific response was possible, and no change to the EA was required.

C.7.2.3 Air quality

Many of the fourteen comments received in the category of air quality dealt with the dispersion modeling analysis presented in the Environmental

Assessment (EA). There were also concerns raised over the inclusion of emissions associated with the project without subsequent comparisons of these emissions to standards. Two commenters questioned the effects from secondary emission sources like trucks. Another asked that emission of radionuclides in relation to the standards be evaluated. A commenter suggested stringent controls on zeolitic rock mining and disposal. A commenter suggested that there seemed to be discrepancies in the amount of land that may be disturbed. A few questions were asked about the proposed monitoring presented in the referenced Meteorological Monitoring Plan. Additional commenters requested that the reference to Nevada Air Quality Regulations be correctly cited as NAC 445 (State of Nevada, 1981).

Response

Every attempt was made to base the analysis on data that have been published and were available to the general public. As such, the air quality analysis is based almost exclusively on a report prepared for the U.S. Department of Energy (DOE) by the Desert Research Institute. Because the repository design specifics have changed as the project has developed, the repository design now envisioned at Yucca Mountain is slightly different from that used in the referenced document. Therefore, certain modeled parameters were adjusted to more realistically reflect the present design. The basis for these adjustments is included in the draft EA and has been reviewed for consistency. The reader is cautioned, however, that the analysis based on this report is a screening-level assessment that is meant to identify potential impacts that can be more fully evaluated using detailed, comprehensive emission calculations, onsite meteorological data instead of assumed worst-case conditions, inclusion of readily available standard pollutant control techniques, and more sophisticated computer dispersion modeling techniques. This process will be carried out if the project proceeds through site characterization and subsequent environmental documents are prepared. However, the screening-level assessment does indicate that the Project can be developed without violating applicable ambient air quality standards.

Much of the emission information was included merely for comparative purposes and could not be related to ambient air quality standards without further dispersion analyses.

A detailed evaluation of construction impacts due to transportation from Las Vegas and other secondary impacts would be conducted in the Environmental Impact Statement process if Yucca Mountain is selected for further development.

The air quality analysis presented in Section 5.2.5 of the draft EA specifically excluded radionuclide emissions and their subsequent impacts. Radiological impacts are discussed in sections 5.2.9 (Radiological Effects) and 6.4.1 (Preclosure Radiological Safety Assessments) of the draft EA. These impacts, however, are not compared to limits set forth in 40 CFR Part 61 because Subpart H of 40 CFR Part 61 excludes DOE facilities that are regulated under 40 CFR Parts 190, 191, or 192. The repository at Yucca Mountain would comply with releases set forth in 40 CFR Part 191 (Environmental Radiation Protection Standards for Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Wastes) rather than 40 CFR Part 61.

Data on the properties and hazards of mining geolitic material underlying the proposed host rock will be collected during site characterization. This information can then be used to ensure that worker and public health is protected by applying appropriate control measures.

Discrepancies in the amount of land that will be disturbed during the various stages of repository development arise from the dynamic nature of the repository and exploratory shaft design. Plans for these facilities change as more information becomes available, and will most likely not become final until a decision has been made to proceed with development at Yucca Mountain. Estimates of disturbed land in the draft EA were those that were being considered when the draft EA was published and that were considered reasonable estimates.

The meteorological monitoring program is a separate element of the development at Yucca Mountain that will support permitting and licensing activities. As such, it has no bearing on the information and conclusions presented in the draft EA.

The references to Nevada Air Quality Regulations have been corrected in the final EA.

C.7.2.4 Aesthetic conditions

This category assesses the changes imposed on aesthetic conditions which will be caused by site characterization and repository development. One comment was received which suggested that aesthetics of the facilities and the supporting railroad be explicitly discussed in the final Environmental Assessment (EA).

Response

The new rail line will be visible to highway travelers along most of the proposed right-of-way. The trains are not expected to cause an unacceptable impact to the people living or driving along the rail line. The effects of the repository activities on aesthetics are addressed in a preliminary manner in Section 5.2.7 of the draft EA. The effects of site characterization activities on aesthetics are addressed in Section 4.2.1.5 of the draft EA.

C.7.2.5 Noise

This category assesses the impacts of increased noise levels resulting from site characterization, repository construction, and repository operation. Five comments were received. Two comments related to impacts resulting from construction noise, two comments related to truck transportation noise, and one commenter questioned what the U.S. Department of Energy will do to maintain the 55 dBA noise level.

Response

The estimate of construction noise was based on the most intense periods of construction, regardless of time, in Table 5-22 (Summary of maximum noise impacts from construction activities) of the draft EA. Surface construction activities, which are scheduled for a 5-year period, will have no impact on urban Las Vegas. Truck transport related noise was calculated for areas which would experience the most significant increase in noise levels. These are areas in which (1) existing noise levels are the lowest (i.e., rural areas) and (2) the least traffic exists (i.e., the proposed access road corridor and U.S. Highway 95 outside Las Vegas). The incremental increase in the noise level in the Las Vegas metropolitan area due to truck transport related noise would be nearly indistinguishable to the human ear.

The 55 dBA annual day/night noise level is a guideline; it is not a standard. However, during site characterization, it is possible that noise levels may be measured in order to establish a baseline. The impacts noted in this section will be reevaluated during field investigations in support of the Environmental Impact Statement process. If required, maintenance or mitigation measures will be proposed at that time.

C.7.2.6 Archaeological, cultural, and historical resources

This category addresses the potential impacts to archaeological, cultural, and historical resources resulting from the construction and operation of a repository at Yucca Mountain. Because of the variety of subjects covered by the eleven questions, these comments have been divided into three issues, as follows: (1) U.S. Department of Energy (DOE) Interaction with Federal and State Agencies, (2) Current Use of the Land by Native Americans, and (3) Miscellaneous.

Issue: DOE interaction with Federal and State agencies

Four comments were received on this issue. Several commenters stated that the draft Environmental Assessment (EA) should have described the interaction between the DOE and the Nevada State Historic Preservation Officer, and with the keepers of the National Register of Historic Places and the Advisory Council on Historic Preservation to ensure compliance with the National Historic Preservation Act.

Response

A programmatic Memorandum of Agreement between the DOE, the Nevada State Historical Preservation Officer, and the Advisory Council on Historic Preservation will, when prepared, describe the interactions between and the roles of three agencies during the Nevada Nuclear Waste Storage Investigations Project.

Issue: Current use of the land by Native Americans

Two commenters requested that information be presented in the EA about current uses of the land by Native Americans, not just historical uses.

Response

Historic and prehistoric cultural resources in the Yucca Mountain area document the seed gathering and hunting activities of Native Americans. Consequently, there is little doubt that this area has been used by Native Americans. Nevertheless, the majority, if not all, of the proposed area probably has not been used by Native Americans since Federal land withdrawal in the early 1940s.

Issue: Miscellaneous

Five comments were assigned to this issue. Several questions were received about direct and indirect impacts to archaeological, cultural, and historical resources, including the effects from road and rail construction. Also questioned was the DOE mitigation plan in which a 10 percent sampling of some sites was deemed by the DOE to be adequate; the comment suggested an 80 percent sampling. Finally, one commenter took issue with the statement in the draft EA that some sites would be avoided or salvaged.

Response

By preparing and implementing a plan to mitigate direct and indirect impacts (the programmatic Memorandum of Agreement mentioned in preceding paragraphs), the potential loss of archaeological and cultural resources caused by all project activities should be kept to a minimum.

The sampling percentage at each site will be determined in accordance with the programmatic agreement described in preceding paragraphs. A statement has been added to Section 4.2.1.6 of the final EA, however, stating that before any activities begin, all sites in the area would be identified and evaluated for their significance and eligibility for the National Register.

C.7.2.7 Background radiation

Thirteen comments were received concerning radiological health impacts of developing Yucca Mountain as a nuclear waste repository. In the context of the Environmental Assessment (EA), background radiation refers to those radionuclides already present at the site. Comments received in this category have been divided into two issues: (1) Adequacy of the Analysis and (2) Radioactive Releases.

Issue: Adequacy of the analysis

Of the nine comments received on this issue, one commenter noted that the analysis in the EA of accidents during repository operation was difficult to assess and should contain more discussion on the methods and data used, as well as the costs incurred as a result of the postulated accidents.

Another concern was that the basis for much of the accidental-exposure data contained in the draft EA was based on a report that had been revised to include the possibility of a phased repository subsequent to the issuance of

the draft EA. Several commenters questioned the ability of the site to contain stored wastes and potential implications of releases to the environment. A commenter objected, without elaboration or specific reference to a section of the EA, that there is a chance of release of radioactivity at the site. A last commenter asked for a simplified explanation of what the EA contained.

Response

The accidental exposure analyses have not been revised to reflect the most recent design information (phased repository). Development of the two-stage concept occurred concurrently with the preparation of the EA, making revision impossible in the time available. Revisions to the reference design have not significantly altered the information presented in the draft EA, principally because the maximum waste-receiving rate has not changed. The safety issue will be dealt with in a more comprehensive manner through the permitting and licensing process if Yucca Mountain is selected as a candidate for further development. An expanded discussion of the phased repository concept has been presented in Section 5.1 of the final EA. In addition, further discussion has been added to describe the bases and assumptions used.

The repository will be so sited and designed that releases to the accessible environment do not occur for a minimum of 10,000 years. Section 6.4.2 of the draft EA presents information on cumulative radioactivity releases at 10,000 and 100,000 years and inventories of the various radionuclides and their half-lives. But no discussion is included of the potential damage from releases of radioactivity to the environment because all the predicted releases are well below the Federal standards. Additional information on the method used to assess the impacts of construction activities has been provided in the final EA.

With regard to what the EA contains, Section 3.4.7 explains the types of background or existing radiation at the site, prior to any development. This section also explains the radiation dose assessment. Section 5.2.9 of the EA explains those radiological effects expected to occur as a result of locating a repository at Yucca Mountain. The explanation includes units of measure for assessing biological effects and the types of radiation that may cause those effects.

Issue: Radioactive releases

Four comments were received on this issue; all dealt with measures of radiological releases. One commenter asked how many rems is a dangerous dose. Another commenter questioned the potential exposure as a consequence of vapor and gas venting through natural fractures. The releases of radon appeared low to another commenter, who compared them to releases from mining activities. A last commenter noted that 10 CFR Part 20 does not specify "a design objective" of 5 rems per year; rather, the limit is 3 rems per quarter, not to exceed 5(N-18) rems, which yields an average annual dose of 5 rems per year.

Response

It is difficult to define a dangerous dose, since the threshold for effects requiring medical attention varies widely depending on the sensitivity of the individual, the type and energy of radiation, the time over which the dose is delivered, etc. An appendix describing radiation health effects and doses will probably be included in the Environmental Impact Statement. For the types of exposures (whole body) resulting from normal transportation, no detectable clinical effects (e.g., nausea, low blood count) would result at doses below approximately 25,000 millirems. This figure is thousands of times higher than the doses likely to result. The information concerning medical aspects of radiation exposures and the levels at which effects can be detected was taken from "The Handbook of Radioactive Nuclides" (Wang, 1969).

The consequences of radioactivity accompanying a release of gaseous radionuclides through the natural fracture system in the repository medium depend on factors such as the number of waste disposal containers that are breached, the age and cladding integrity status of the fuel involved, and the nature of the fracture system. It is extremely unlikely than any postulated venting through fractures would result in exposures comparable to those calculated for normal operational releases, which are discussed in Section 6.4.1.2.2.

The calculations regarding radon releases have been reviewed, and the magnitude of these releases is correct. These values are based on Table 5.4.8 (granite medium) of the U.S. Department of Energy Environmental Impact Statement document (DOE, 1980). However, since the current repository design differs from that in the draft EA, these values have been revised to reflect the differences in excavation volume.

The comment regarding the design objective is correct. The occupational whole body exposure limit is 3 rems per quarter. The dose to the whole body, when added to the accumulated occupational dose shall not exceed 5(N-18) rems where N is the age of the individual in years. The terms under 10 CFR Part 20 do not specify a "design objective." The text will be revised to correct the dose limit, and to state that the design objective will incorporate "as low as reasonably achievable" (ALARA) principles and will be within regulatory limits.

C.7.3 EXPECTED EFFECTS OF TRANSPORTATION

Comments regarding effects of transportation have been subdivided into the following two major areas: (1) comments that are applicable to all potential sites; of national interest; or derived from national laws, regulations, policies, etc; or (2) comments that are site-specific.

The first set of comments are described and responded to in Section C.2.4.1 of this Appendix. Where the response calls for a change in the Environmental Assessment (EA), it is usually contained in the transportation

appendix. The second set of comments is described and responded to in the issues described below.

This issue concerns the assessment of the effects of transporting nuclear waste as well as all operations-related personnel and materials to the potential Yucca Mountain repository location. The 202 comments in this category were assigned to the following issues: (1) Radiological Exposure, (2) Emergency Response, (3) Routing Data and Analysis, (4) Guidelines and Conclusions, and (5) Miscellaneous.

Issue: Radiological exposure

Fifty-two comments were received under the Radiological Exposure issue of transportation impacts. This issue addresses potential radiological exposure to the public from a transportation-related scenario.

These comments were focused primarily on the following topics: site-specific radiological exposure, transportation risk and cost assessment, and discrepancies in tables and text.

Site-specific radiological exposure. Most of the commenters in this topic requested more information on the potential for regional and local radiological exposure, population density, location of maximum radiation exposure, fatalities, accidents, and RADTRAN II methodologies. It was suggested that residents of Caliente may receive doses approaching the dose calculated for the maximally-exposed individual. One commenter noted that visitors and tour guides at Hoover Dam could receive significant doses from shipments passing over the dam. It was pointed out that any nuclear accident in Las Vegas would destroy the tourist industry. It was also suggested that the EA include exposures for subgroups within occupational and non-occupational population groups.

Response. More region-specific information on the potential risk of public exposure to radiation has been developed for the final EA and will be further developed during the Environmental Impact Statement process. In particular, route-specific population data have been incorporated into the impact assessment, and a maximum-credible accident scenario has been added. In addition, risk associated with transportation of high-level waste through areas such as Caliente and over Hoover Dam will be investigated in association with the Environmental Impact Statement. The transportation appendix of the final EA includes more information regarding accidents and the maximally exposed individual, as described in Section C.2.4.1 of this document. There is little evidence that a transportation accident in Las Vegas would have any long-term effect on tourism. Nevertheless, the U.S. Department of Energy (DOE) plans to comply with all applicable standards and regulations in an effort to prevent such accidents.

Table 5-36 (Estimated population radiation doses from the transportation of waste to Yucca Mountain) of the draft EA was not changed in the final EA to include exposures for subgroups within the occupational and non-occupational population groups because, considering the uncertainty in the dose estimates, little would be gained by further breakdown of exposure categories. In addition, Appendix A includes an assessment of occupational exposures due to postulated accidents.

Transportation risk and cost assessment. Some commenters suggested that the draft EA be revised to clarify the basis for the truck and rail fatality comparisons. Several commenters indicated that the transportation risk assessment in the draft EA is incomplete without the inclusion of a worst-case accident scenario. There was a concern expressed by some reviewers that the waste carrier would not comply with highway speed limits and that transportation risk assessments should evaluate all phases of repository development. One commenter requested that Section 5.3.2.1 of the draft EA be revised to include specific information about exposure of drivers and handlers. In addition, a commenter stated that human error-related incidents would be unpredictable. One commenter noted that more information on costs for new highway and railroad facilities constructed to bypass populated areas should be provided.

Response. Section 5.3.2.2 of the final EA has been revised to clarify the basis for the truck and rail fatality comparisons. The EA has been revised to include credible accident scenarios.

Waste carriers will be required to follow specific operating procedures, which include obeying posted highway speed limits.

Additionally, refined cost information will be developed during the Environmental Impact Statement process. Nuclear waste shipments will not be routed away from populated areas unless it is demonstrated that risks are reduced by such measures. Appendix A presents U.S. Department of Transportation routing regulations in detail.

All phases of the repository including construction, operation, retrievability, and decommissioning will be discussed in the Environmental Impact Statement. Section 5.3.2.1 has been revised to include information on occupational and nonoccupational exposures from normal and accident conditions. Human error can never be totally predicted, but most serious accident scenarios can be postulated and contingencies developed for these events. Appendix A assesses the impacts of a severe transportation accident. Human error is also discussed in Section C.2.4.1 of this document.

Discrepancies in tables and text. It was suggested that Table 5-57 (Summary of environmental effects associated with the construction, operation, retrievability, and decommissioning phases of the repository) in the draft EA (Section 5.5) include in the Standard Operating Practice column that the waste would be routed away from urban areas. The accident rates in Table 5-31 (Projected annual accidents on U.S. Highway 95, 1996) of the draft EA (Section 5.3.1.1.2) were also questioned.

It was suggested that tables 5-38 (Assumed regional transport conditions for scenario I) and 5-39 (Assumed regional transport conditions for scenario II) in the draft EA (Section 5.3.2.1) be changed to include actual route population, accident-rate history, and stop-time data.

An apparent inconsistency between statements was noted: Section 5.3.2.1 of the draft EA stated that accidents severe enough to release radioactivity are extremely unlikely, while Section 5.2.9.2.3 identified four transportation accidents that would result in potential releases. It was also stated

by one commenter that the tests of impact damage to shipping casks using truck and train tests proved that nuclear waste can be transported safely.

Response. Table 5-57 (Summary of environmental effects associated with the construction, operation, retrievability, and decommissioning phases of the repository) in Section 5.5 has been revised to include standard operating practices that minimize the potential impacts of transporting radioactive wastes. These practices include complying with the regulations described in Appendix A.

Accident rates in Table 5-31 (Projected annual accidents on U.S. Highway 95) in Section 5.3.1.1.2 may not be appropriate for high-level waste shipments which generally have a lower accident rate than other types of travel (Foster and Jordan, 1984). Accident statistics presented in Table 5-31 are based on projections of historical data including accidents due to inclement weather (Pradere, 1983).

Tables 5-38 (Assumed regional transport conditions for scenario I) and 5-39 (Assumed regional transport conditions for scenario II) in Section 5.3.2.1 of the draft EA were revised to include actual route population data. Route-specific accident rates and stop times will be developed in association with the Environmental Impact Statement. The EA presents a revised dose assessment for two routing scenarios of postulated truck and rail shipping modes using route-specific population data.

The transportation accidents in Section 5.2.9.2.3 are accidents postulated to occur at the repository receiving facilities. These accidents are extremely unlikely and do not result in serious releases of radioactivity.

Issue: Emergency response

Twenty-six comments were received on the emergency response issue. These comments and responses address the plans and procedures necessary for responding to a transportation-related nuclear waste accident.

Most of the commenters requested more detailed emergency response information including: responsibilities of and resources required by Federal, State, and local jurisdictions; present and future plans; cost to communities; training; personnel; and equipment. Commenters also questioned the need for more information on insurance including Price-Anderson criteria and the costs associated with a potential uncontrolled release of radioactivity. Several commenters requested more information on responsibilities of the Nevada agencies that already exist.

Response

The brief discussion of emergency preparedness in chapters 5 and 6 and Appendix A of the EA provides the data to evaluate the suitability of Yucca Mountain for site characterization. More detailed information and evaluation concerning costs, resources, and responsibilities will be developed in the Environmental Impact Statement process. Local government response capabilities will be evaluated, including their ability to respond to remote areas.

Appendix A of the EA has been revised to include more information concerning the costs of an accidental release of radioactivity. A description of the Price-Anderson Act, which provides coverage for public liability in the event of a nuclear incident, as well as the DOE role in implementing the Price-Anderson Act, is presented in Appendix A.

The Nevada Health Division and Division of Emergency Management (DEM) will be contacted and interviewed as more detailed information is required for the Environmental Impact Statement. Additional DEM references will be included in the Environmental Impact Statement. Table 2-8 (Summary of evaluations of the Yucca Mountain site against the disqualifying conditions) in Section 2.3 was revised to explain that the emergency preparedness plan should be prepared in cooperation with State and local planning officials. The section discussing the disqualifying condition for population density and distribution was revised to explain that a Memorandum of Understanding exists between the State of Nevada and the DOE defining responsibilities in response to a radiological accident. The references for Chapter 2 were revised to include the DOE Nevada Operations Office reference on notification procedures (DOE/NVO, 1985). Section 5.3.2.6 describes the function of the DEM and explains that the DEM provides radiological monitoring training.

Issue: Routing data and analyses

Sixty-nine comments were categorized within this issue. The routing data and analyses are associated with various postulated transportation routes for nuclear waste shipments. Topics addressed include: route information, population areas, railroad versus truck transport, peak traffic conditions, and settlement patterns.

Route information. Several commenters were concerned over the location of transportation routes to be used for the shipment of high-level waste, how these routes were selected, and potential impacts to people living along these routes. In addition, comparison of the various alternative routes was requested. More site-specific data was requested, including data on weather, accidents, road and railroad conditions, costs for route improvements, and population densities. It was also suggested that the railroad spur be located south of U.S. Highway 95. One commenter stated that some of the intended regional and national transportation networks go through local towns and communities.

Response. A designated preferred route was identified in the final EA; specific route selection, and the potential effects to people along the route will be evaluated in the Environmental Impact Statement. Regional site-specific data will be provided for each postulated road and rail route. Specific information to be provided will include data on weather, accidents, population densities, route conditions, etc.

The Environmental Impact Statement will discuss all repository phases including construction, operation, retrievability, and decommissioning. This document will answer where the shipments will go, how the waste will be transported, and the potential risk from these shipments. The shipment of waste will comply with applicable Federal and State laws. The DOE is also considering an alternative corridor for the railroad spur south of U.S. Highway 95. In response to one comment, the proposed railroad spur will not

cross the Desert National Wildlife Refuge. The transportation effects to local towns and communities have been assessed as part of the transportation analysis. Further studies will be accomplished in conjunction with the Environmental Impact Statement process.

Population areas. Commenters suggested that the EA present more maps showing regional transportation routes, rather than just maps near Yucca Mountain, and the community impacts along the preferred routes. Another commenter suggested that the real cost of new facilities would be the cost of building facilities to route the waste around populated areas of Clark County. Commenters also suggested that Chapter 5 should have more information on operating procedures such as loading and unloading of casks.

Response. Transportation sections in Chapter 5 of the EA have been revised to include enhanced route maps. The EA addressed radiological and nonradiological impacts along the State's only designated preferred route (i.e., U.S. Highway 95 from Las Vegas to Beatty) as well as other postulated routes. More encompassing community impacts for regional routes will be presented in the Environmental Impact Statement.

Federal highway routing guidelines (49 CFR 177.825) passed in response to the Hazardous Materials Transportation Act are described in Appendix A of the final EA. Operating procedures for the transportation of waste will include complying with all regulations applicable to such shipments. A summary of these regulations is presented in Appendix A of the final EA.

Rail versus truck transport. Information was requested on the 30-70 percent split in favor of railroad transport that was presented in Section 5.1.2.1.

Response. The 30-70 percent split is a best guess for all shipments made to the first repository and is based on existing facilities at reactors. Slight variations around these values will not significantly affect repository or transportation operations. Additional discussions of the modal split are presented in Section C.2.4.1 of this Appendix.

Peak traffic conditions. One commenter was concerned with the need for more data on trips associated with induced and indirect travel as well as travel associated with inmigrating direct workers. Other commenters suggested that the EA did not indicate possible damage to roadways because of extra heavy truck hauls. It was suggested that the EA did not evaluate peak conditions but only routine operations and that the incremental use of the main line in Las Vegas should be calculated.

Response. Section 5.4.3.7 of the EA discusses where inmigrants may locate. Trips and potential accidents will probably occur close to these locations. The EA presents a traffic increase of 2.6 percent on major arteries.

The EA considers legally weighted trucks following interstate standards. Upgrading of roadways will again be considered, as appropriate, before transporting waste.

The average numbers used to calculate levels of service are conservative and already account for some unpredicted conditions. Peak conditions as noted may decrease the level of service, but when the frequency and duration of such peak conditions are accounted for, constructing facilities for these peak conditions does not seem practical. The EA includes the incremental usage of the main line in Las Vegas in Section 5.3.

Settlement patterns. Table 5-29 (Settlement patterns of Nevada Test Site employees) of the draft EA (Section 5.3.1.1.1) was questioned for the use of ZIP codes as the resource for determining settlement patterns. In Section 5.3.1.1, it was questioned whether existing road conditions maximize or minimize risk. A commenter suggested that two tribal governments were not mentioned in the transportation section.

Response. ZIP codes were used in Table 5-29 in Section 5.3.1.1.1 of the draft EA to determine the major routes used by the majority of Nevada Test Site employees. See Section 3.6 of the final EA and Section C.4.1.5 of this Appendix for a discussion of ZIP codes as the basis for allocating projected repository-related population to communities.

The two tribal governments were not mentioned because there was no attempt to identify responsible parties along any of the possible Nevada routes. Such regional identification is beyond the scope of the EA process.

Issue: Guidelines and conclusions

Thirty-one comments were received on transportation-related guidelines and conclusions. Several of the transportation comments related to the evaluation of the site against the 10 CFR Part 960 guidelines presented in Chapter 6. The comments have been grouped into the following topics: guideline-related conclusions, weather conditions, and construction requirements.

Guideline-related conclusions. A few commenters questioned the guideline-related conclusion in Table 6-12 (Summary of analyses for Section 6.2.1.8, Transportation) that significant upgrading would not be required. It was also suggested that the conclusions in Table 6-12 were tenuous and that the analysis falls short of addressing regional impacts as specified by the Nuclear Waste Policy Act. Other commenters questioned the validity of the guideline-related conclusion in Table 6-14 (Summary of analyses for Section 6.2.2.2, Preclosure system guideline: environment, socioeconomics, and transportation) since an accident and worst-case release were not analyzed. Another commenter noted that credit should not be taken in the evaluation against the guidelines for the existence of the State of Nevada emergency preparedness plan, since it is questionable whether the plan would provide an effective procedure for handling a transportation accident involving an uncontrolled release of radioactive material. One commenter stated that the documentation relative to the qualifying condition was deficient because there was inadequate consideration of variables associated with the proximity of power plants or temporary storage to the repository. One commenter stated that the whole transportation network violates a disqualifying condition that states that no surface facility will be located in a populated area or adjacent to a high density area.

Response. With regard to the guideline addressing upgrading (Table 6-12), although not explicitly clear, upgrading refers to local roads and railroads. Since the proposed access road will intersect U.S. Highway 95, a regional highway, and the proposed railroad spur will intersect the Union Pacific main line, there will be no repository-related traffic (and therefore no upgrading requirements) on local roads and railroads. U.S. Highway 95 will experience some degradation in the level of service during peak periods. Neither this degradation nor the number and weight of trucks analyzed in the EA require that upgrading and improvements be made. However, this will be assessed in more detail during the Environmental Impact Statement process.

The final EA addresses accidents both in Chapter 5 and Appendix A, and the conclusion reached in Table 6-14 (Summary of analyses for Section 6.2.2.2, Preclosure system guideline: environment, socioeconomics, and transportation) has been modified accordingly. Discussions regarding emergency response in Nevada were provided as input for the evaluation of the transportation guidelines in Chapter 6 of the draft EA. It was not the intent of the EA to do a complete analysis of an emergency response situation, but rather to present the information required for the transportation guideline. Detailed evaluations of emergency response requirements will be performed in conjunction with the Environmental Impact Statement.

The EA has been expanded to include temporary storage considerations. This is the Monitored Retrievable Storage (MRS) analysis found in Section 5.3.2 and revised Appendix A.

Under the Siting Guidelines, surface facilities are defined as "... repository support facilities within the restricted area ..." (10 CFR 960.2). A restricted area is defined as "... any area to which access is controlled by the DOE for purposes of protecting individuals from exposure to radiation and radioactive materials before repository closure ..." From the discussion accompanying the final version of the Siting Guidelines (10 CFR Part 960) it is clear that interstate highways and railroads used for transporting nuclear waste are not considered to be surface facilities for the purpose of evaluating the cited disqualifying condition.

Weather conditions. A few commenters questioned statements that weather conditions, especially flooding and rock slides, in southern Nevada would not affect transportation. Additionally, it was questioned how flash floods will be reduced by standard drainage control measures as discussed in Section 6.2.1.8.3.

Response. Weather conditions evaluated by the guidelines represent routine seasonal occurrences that could affect the repository acceptance rate. Data on road closures have been added to Chapter 6 of the final EA to indicate potential problems in this area. Mitigation measures for drainage control along transportation routes have not been identified. Existing problems along existing roads and railroads will be identified and mitigation measures will be developed during the Environmental Impact Statement process.

Construction requirements. A few commenters questioned the DOE's taking of a favorable condition for transportation when the site is 137 kilometers (85 miles) from the connecting railroad and that the railroad, including Dike

Siding, will need significant upgrading at considerable cost. Several commenters questioned whether local highways and railroads are sufficient to meet repository traffic needs without significant upgrading or reconstruction costs and why just the rail line from Dike Siding is considered in these costs.

Response. The DOE does not claim the favorable condition 1(i), as noted in Table 7-15 (Comparative evaluation of the sites against the guideline on transportation) of the draft EA because of the length and cost of the railroad spur (approximately 161 kilometers or 100 miles, instead of 137 kilometers or 85 miles) and access road. Favorable conditions 2 and 3 address the potential impact that the transportation network will have on local roads and railroads; specifically, favorable condition 2 addresses upgrading requirements while favorable condition 3 addresses proximity to regional highways and main line railroads.

The guidelines call for an evaluation of local transportation networks between the site and regional networks. Upgrading requirements (including cost) have been assessed and will be further evaluated in conjunction with the Environmental Impact Statement studies.

Issue: Miscellaneous

Twenty-four comments were grouped under this miscellaneous issue. These comments were further divided into three topics: data deficiencies, EA changes, and radioactive testing materials.

Data deficiencies. Commenters suggested that there may not be any experts in the area of waste transportation. Other commenters stated that the draft EA did not present enough data about routes, prenotification, escorts, and defense wastes. One commenter was concerned with the manner in which waste vehicles would be marked. Another commenter questioned the effects to a driver while traveling behind a waste truck, while another requested more information on the non-radiological effects of transportation.

Other commenters questioned liability for accidents and another questioned regulations governing waste transportation and their interpretation. One commenter requested a definition of low-level radiation, as it pertains to incident-free transportation of high-level waste.

Response. In the present context, low-level radiation refers to radiation dose rates that are not high enough to represent an acute radiation exposure hazard. Doses to persons exposed to low levels, as the term is used in the EA, are a small fraction of the doses received from natural background.

The DOE will follow the Nuclear Waste Policy Act in carrying out its mission of transporting and disposing of the waste. Experts that are available will be consulted. More specific information is provided in Appendix A on routes, prenotification, and escorts. The EA has been revised to consider defense waste shipments from Savannah River Laboratory, South Carolina; Idaho National Engineering Laboratory, Idaho; and Hanford Engineering Development Laboratory, Washington. Transport vehicles will be marked according to

Department of Transportation regulations. Effects expected to result from a driver following a waste disposal truck are calculated by the RADTRAN II model, and these are included in the results reported under the category of non-occupational, normal (i.e., incident-free) effects. Information on the nonradiological effects of transportation, including the factors used in their assessment, can be found in Appendix A of the final EA.

Liability for accidents will follow Federal Price-Anderson Act provisions. Regulations governing waste transport are presented in Appendix A of the final EA. Also, Section 5.3.2 of the EA has been revised to include more definitions of regulating terms.

EA changes. Several commenters stated that specific changes should be made to the EA in Section 5.3.2 and related transportation sections.

Response. Section 5.3.2 incorrectly states that variations from a route plan "... require 30 days notice ..." As set forth at 49 CFR 177.825(c), carriers of spent nuclear fuel must report any variation from the route plan as soon as possible but within 30 days following the deviation. The text has been changed to reflect the additional information. Additionally, the updated reference (DOT, 1984) has been obtained and correctly cited in the final EA.

The reference to "... State routing agencies, which were established by the states and are defined in 49 CFR 171.8 ..." in Section 5.3.2 created a false impression. Not all states have established state routing agencies. Such an agency may be a common agency of more than one state, such as one established by interstate contract. It may also be an Indian tribal authority who regulates and enforces highway routing requirements on tribal lands. In view of this, the above-quoted passage was changed to read, "State routing agencies as defined in 49 CFR 171.8."

Section 5.3.2 of the draft EA was also changed to more accurately represent U.S. Department of Transportation (DOT) regulations. As defined in 49 CFR 171.8, a State-designated route is one which is selected in accordance with the DOT guidelines "or an equivalent routing analysis which adequately considers overall risk to the public." The definition goes on to state expressly that, "designation must have been preceded by substantive consultation with affected local jurisdictions and with any other affected states to ensure consideration of all impacts and continuity of designated routes." The text of the EA has been modified to clarify the discussion. More detailed discussions of DOT regulations are presented in Appendix A.

The text in Section 5.3.2 stated that the State Routing Agency of Nevada "... has not identified the preferred transportation routes within the State ..." In fact, there has been a designation of U.S. Highway 95 between Las Vegas and Beatty, Nevada as a preferred route, and the text has been revised to reflect this information.

Table 5-33 (Projected annual accidents on U.S. Highway 95, 1998) incorrectly referenced Figure 5-8 (Surface facility plan for a two-stage repository) in the draft EA. The reference was corrected to Figure 5-9 (Total (60-year) resource requirement for vertical emplacement) in the final EA.

In Table 6-12 (Summary of analyses for Section 6.2.1.8, Transportation), item (8) of the draft EA was not changed to read "radioactive materials." The EA addresses only the effects of transporting radioactive wastes, and not all radioactive materials. Therefore, no judgment has been made regarding the plans, procedures, and capabilities for transporting all "radioactive materials."

Radioactive testing materials. One commenter asked what precautions would be taken on the transportation of radioactive testing materials for site characterization.

Response. Such shipments are routinely performed for hydrologic testing throughout the United States and will not amount to significant quantities. They will be carried out in compliance with State and Federal regulations. No impacts on the transportation network or on public health and safety are expected.

C.7.4 EXPECTED EFFECTS ON SOCIOECONOMIC CONDITIONS

Listed in this section are 93 comments dealing with the U.S. Department of Energy (DOE) evaluation of the Socioeconomic Impacts Guideline (10 CFR 960.5-2-6). Additional comments concerned general aspects of the Environmental Assessment (EA) evaluation of socioeconomic conditions in chapters 5 and 6. Because all of the latter group of comments covered more than one area of the socioeconomic impact analysis, responses to them were placed here, rather than in sections 7.4.1 through 7.4.5.

The comments have been assigned to 21 issues: (1) Favorable Condition 1, (2) Favorable Condition 2, (3) Favorable Condition 3, (4) Favorable Condition 4, (5) Potentially Adverse Condition 1, (6) Potentially Adverse Condition 2, (7) Potentially Adverse Condition 3, (8) Potentially Adverse Condition 4, (9) Disqualifying Condition, (10) Qualifying Condition, (11) Mitigation, (12) General Opinion, (13) General Comments, (14) Restriction to Clark and Nye Counties, (15) Moapa Indians, (16) Lack of Community-Specific Data and Analysis, (17) Safety Assumptions, (18) Mitigation Needs, (19) Transportation Effects Analysis, (20) Closure and Decommissioning, and (21) Special Effects.

Issue: Favorable condition 1

The DOE received three comments on favorable condition 1, "Ability of an affected area to absorb the project-related population changes without significant disruptions of community services and without significant impacts on housing supply and demand." One commenter stated that insufficient evidence is presented in the EA to determine whether the favorable condition is present. Another pointed out that "... significant disruptions ..." could have different meanings to the DOE and local communities. The third commenter questioned the validity of the historical population growth criterion, since changes are computed from small bases and because high growth rates in southern Nye County have been significantly influenced by the U.S. Department of Defense (DOD) and the DOE activities in the area.

Response

The criteria for evaluating the siting guidelines were designed to facilitate comparison of alternative repository sites. In order to use its resources effectively, the DOE conducted a coarse screening, and only investigated a few sites in detail according to the process specified in the Nuclear Waste Policy Act of 1982. In the case of the evaluation of favorable condition 1 for the Yucca Mountain site, county-level population changes were assumed to significantly affect community services and housing when the total (baseline plus repository-related) population increase in any year exceeded that historically experienced by the area. Whether historical growth rates may have been influenced by DOD and DOE activities is immaterial; the magnitudes of historical population growth rates, rather than their causes, constitute the basis for this comparison. Since the projected maximum one-year population growth rate with the repository would be less than average annual growth rates in recent years (see tables 3-15 and 3-16 of the final EA), favorable condition 1 is present.

It is true that "... significant disruptions ..." may be defined differently by the DOE and local communities. The draft EA has been revised to acknowledge this.

Issue: Favorable condition 2

The DOE received two comments on favorable condition 2, "Availability of an adequate labor force in the affected area." Both commenters questioned the adequacy of the analysis presented in the draft EA that leads to the conclusion that the favorable condition is not present.

Response

The evaluation of all favorable conditions is based on reasonable, but conservative, assumptions which aim to prevent exaggeration of the ability of a site to meet the condition and on the data and analyses contained in chapters 3 through 5. For favorable condition 2, the evaluation that the site does not have an adequate available local work force is based upon preliminary estimates that the repository project could result in a maximum 3 percent increase over projected baseline construction employment in the bicounty area and about a 40 percent increase over projected baseline mining employment in Nye County, as presented in Section 5.4.1.1 of the final EA. Thus, the development of a repository would place significant demands on the local mining sector and moderate demands on the local construction sector. The DOE feels such estimated employment increases in a basic sector of the bicounty economy are an appropriate basis for concluding that an adequate labor force would not be available.

Issue: Favorable condition 3

Four comments concerned favorable condition 3, "Projected net increases in employment and business sales, improved community services, and increased government revenues in the affected area." The DOE finding that the condition was present was found by one reviewer to be based on unsupportable estimates of the number of new jobs which would be created by the repository project. That commenter also noted that impacts to communities are based on

employment estimates. Three of the commenters stated that the DOE conclusion that tax revenues would rise cannot be deduced from information presented in the EA. Other criticisms were that the DOE is forced to include possible mitigation to achieve net project-induced revenues and improvements in community services, and that the Nevada tax base is extremely narrow, so that higher wage earnings are unlikely to lead to large revenue increases.

Response

While it is true that predictions of impacts on communities are sensitive to employment assumptions, the DOE believes that the direct and indirect employment estimates presented in Section 5.1.5 and elsewhere in the final EA are realistic, although preliminary. It is true that tax effects were not quantified in the EA. It is also true, however, that tax revenues are certain to rise as a result of wage payments to repository workers who are inmigrants, and as a result of repository-related purchase of goods and services in the bicounty area. Thus, the conclusion that tax revenues will rise can be deduced from information in the EA.

Favorable condition 3 requires increases in government revenue in the affected area, but it does not require a positive net fiscal balance or that the increases be large. Thus, in light of the above discussion, the favorable condition is met with respect to local government revenue. The EA has been revised to clarify this point. The EA has also been revised to delete the dependence upon mitigation measures to achieve improved community services.

Issue: Favorable condition 4

The DOE received four comments on favorable condition 4, "No substantial disruption of primary sectors of the economy of the affected area." Two of the commenters questioned the conclusion by the DOE that the repository project would not significantly disrupt tourism. Another commenter suggested that the EA ignores potential negative effects on the State's mining sector that could occur if fewer workers than are needed inmigrate to the bicounty area. The commenter suggests this could lead to a drain of workers from productive mining activities in other areas of the State, because of increased wages for repository mining workers. The final comment suggests that DOE findings are based upon the most easily passed tests of nonsignificance, that is, evaluation of the ability of the bicounty area to absorb socioeconomic impacts.

Response

The reasoning behind the DOE conclusion that the repository project would not significantly disrupt tourism is presented in sections 5.4.1.6 and 6.2.1.7.3 of the final EA. It is true that the EA does not address all of the distributional effects which would be associated with the potential increases in mining wages noted in Section 5.4.1.1 of the final EA. However, the evaluation of favorable condition 4 concerns the entire mining sector of the bicounty area (not the entire State), where overall effect of mining activity in the bicounty area would be positive. Regarding "... most easily passed tests of nonsignificance ..." the DOE believes that the bicounty area

is the most reasonable unit of analysis of effects upon primary sectors of the economy in southern Nevada.

Issue: Potentially adverse condition 1

The DOE received three comments on potentially adverse condition 1, "Potential for significant repository-related impacts on community services, housing supply and demand, and the finances of State and local government agencies in the affected area." The main point of these comments was that data were insufficient to determine whether this potentially adverse condition exists. One commenter also questioned the reliance upon mitigation to avoid negative impacts on fiscal conditions.

Response

Two of the main purposes of the EA are to make intersite comparisons and to identify potential impacts. To make the most effective use of its resources, the DOE conducted a coarse screening, so that detailed studies would not be performed on sites which ultimately would not be chosen for site characterization. The DOE's evaluation of this potentially adverse condition for the Yucca Mountain site was therefore limited to: (1) estimation of total population growth rates with the repository and (2) a qualitative evaluation of the ability of service providers to furnish, in a timely manner, services required by the increased population. By limiting the analysis of this potentially adverse condition to these two measures, the DOE was able to use readily available information and avoid the false impression of precision which could result from the combination of a more sophisticated analytical approach with insufficient data. Section 6.2.1.7.4 of the EA has been revised to discuss estimates of population growth rates, with a repository, for communities nearest the Yucca Mountain site. Population growth rates are manifested through increases in service and housing demands. Incremental values for the latter are shown for Nye and Clark counties in tables 5-50 and 5-51 of the final EA. These values do not indicate any major repository-related housing or community-services impacts on either county. Furthermore, sections 5.4.3 and 6.2.1.7.4 of the final EA have been revised to indicate that potential community services impacts would be mainly on county-wide service providers, which are more likely to have resources for managing growth than are town governments. Finally, the qualitative information presented in sections 3.6.3 and 5.4.3 of the final EA does not indicate the potential for major repository-related housing and community services impacts on communities in the bicounty area.

Because the finding that potentially adverse condition 1 does not require assumption of mitigation, references to mitigating measures have been deleted from Section 6.2.1.7.4 of the final EA.

Issue: Potentially adverse condition 2

One comment was received on the DOE evaluation of potentially adverse condition 2, "Lack of an adequate labor force in the affected area." The commenter notes that the labor force issue was discussed under favorable condition 2, yet favorable condition 2 was found by the DOE to be unfavorable. This seeming contradiction was held to be an example of the quality of presentation of data and analysis in the draft EA.

Response

The DOE found that favorable condition 2 was "not present;" it did not find it "unfavorable." The title, "Favorable Conditions" of Section 6.2.1.7.3 of the final EA, along with the underscored criteria, establishes a framework for analysis of socioeconomic impacts. The criteria do not describe the results of the analysis.

Issue: Potentially adverse condition 3

The DOE received three comments on potentially adverse condition 3, "Need for repository-related purchase or acquisition of water rights, if such rights could have significant adverse impacts on the present or future development of the affected area." According to one commenter, Section 6.2.1.7.4 of the draft EA should be revised to provide a more accurate estimate of repository water use, identify existing offsite water rights, and identify and consider potential effects to local users. Another commenter said that the DOE should "... address potential impacts to ground-water resources that recharge municipal and agricultural water supplies in southern Nevada."

Response

The DOE estimate of repository water use has been changed, on the basis of a more detailed analysis, to 350 acre-feet per year. In addition, an inventory has been conducted of agricultural, industrial, municipal, and domestic water users in the Alkali Flat-Furnace Creek Ranch ground-water basin. Potential effects upon local users appear, on the basis of this information, to be negligible.

Taken literally, the second comment requests an analysis of the impacts of the project on recharge areas for the aquifers which supply water for agricultural and municipal uses in southern Nevada. Since the project will neither physically disturb recharge areas nor affect regional rainfall, there will be no effect on recharge. The comment could also be understood to request an evaluation of impacts on ground-water availability. The maximum annual water use by the repository represents only about 1.5 percent of the sustainable yield of the Amargosa Desert ground-water basin and about 0.8 percent of the combined sustainable yields of aquifers in the Amargosa and Pahrump valleys.

Issue: Potentially adverse condition 4

Two commenters addressed potentially adverse condition 4, "Potential for major disruptions of primary sectors of the economy of the affected area." One commenter suggests that there is insufficient information to conclude that there will be no disruption of the mining and tourism sectors of the southern Nevada economy and that there is evidence that both sectors could be adversely affected in a significant way. One commenter felt that population inmigration to the Pahrump and Amargosa valleys could result in conversion of agricultural land to residential or commercial use and ultimately raise the cost of agricultural operations.

Response

While it is true that there is insufficient information to draw a final conclusion that there would be no impact, information available to date does not suggest that the repository is likely to have significant effects on tourism. It would significantly increase employment in mining and moderately increase employment in the construction sector. The DOE does not consider these potential employment increases to be a major disruption. The comment does not provide reasons for the assertion that ".. both sectors could be adversely affected in a significant way." Section 3.6.3.3 of the draft EA noted that land in the Pahrump and Amargosa valleys has been undergoing conversion from agricultural to residential use for the last 10 years. Although it is possible that repository-related inmigration could contribute to this trend, it would not, by itself, constitute a major disruption to the agricultural sector in the affected bicounty area.

Issue: Disqualifying condition

The DOE received five comments on the disqualifying condition, "A site shall be disqualified if repository construction, operation, or closure would significantly degrade the quality, or significantly reduce the quantity of water from major sources of offsite supplies presently suitable for human consumption or crop irrigation and such impacts cannot be compensated for, or mitigated by, reasonable measures."

One commenter asked that "... a more accurate estimate of repository water use ..." be provided and that the DOE identify and consider potential effects on local users. Another commenter stated that "... other industrial requirements ..." including dust control, are apparently not included in the calculation of average annual water demand associated with the repository.

One commenter stated that a reference cited in the draft EA (Young, 1972) indicates a historical decline of ground-water levels in Jackass Flats from pumpage at the Nevada Test Site (NTS); if projected into the future, this decline could impact regional water quantities and qualities.

Finally, one commenter stated that the EA does not demonstrate that "... long-term (10,000 years) storage of highly radioactive materials only slightly above the water table ..." will not eventually cause contamination of, and thereby degrade, water quality.

Response

The DOE estimate of repository water use has been changed, on the basis of a more detailed analysis, to 350 acre-feet per year. As noted above, an inventory of present uses in the area indicates that effects upon the availability of water to local users appear to be negligible and can certainly be mitigated. A variety of water uses, including dust control, were accounted for in the calculation of average annual repository water use. These uses are identified in Morales (1985).

Young (1972) had to make many assumptions due to the lack of information on the regional ground-water system in 1972. More recent reports (Waddell et al., 1984; Thordarson, 1983) indicate that his assumptions (e.g., no

recharge to the welded tuff aquifer) were incorrect. Although recharge is limited, it is not zero.

Finally, socioeconomic impacts are covered only in a preclosure guideline. All water resource contamination issues are covered in postclosure guidelines on geohydrology (Section 6.3.1.1 of the final EA) and performance assessment (Section 6.4.2 of the final EA). These postclosure guidelines deal with the long time periods referred to by the commenter.

Issue: Qualifying condition

The DOE received seven comments on the EA conclusion that the evidence does not support a finding that the site is not likely to meet the qualifying condition for socioeconomics. These commenters criticized the overall analysis by the DOE of the Guideline on Socioeconomic Impacts, saying that the conclusions of Chapter 6 are "... based on incomplete, inadequate and erroneous data, questionable data analysis methodologies, unsubstantiated assumptions, and seriously incomplete assessments."

Response

These comments are assumed to represent the reviewers' conclusions after considering a wide variety of specific issues. As such, they cannot be responded to directly. Instead, the reader is referred to the specific issues and responses presented above.

Issue: Mitigation

These commenters asked how the draft EA can state that all impacts can be mitigated or compensated when the DOE admits that it does not know what the impacts are.

Response

The discussion in Section 6.2.1.7.6 refers to the ability to offset any significant repository-induced adverse social or economic impacts in communities and surrounding regions by reasonable mitigation or compensation, under the financial and technical assistance provisions of the Nuclear Waste Policy Act (NWPA). Potentially significant impacts identified in Section 5.4 are not unlike those accompanying large construction projects in the past. In those cases, several factors have affected whether mitigation occurred. These include the experience of the project management, the local leaders, and the planning community in general in responding to such impacts; the availability of lead time; and the presence of monitoring programs or other communication between the project and the community during the project lifetime. These factors appear to be present in the case of the Yucca Mountain repository and so the preliminary conclusion has been drawn that it is reasonable to expect that mitigation of otherwise significant adverse impacts is possible.

It is also true that the impact analysis presented in Section 5.4 is preliminary and does not include any detailed investigation of community-specific impacts. In addition, the investigation of the potential for economic impacts arising from the public perception of a repository is

preliminary. Additional investigations on these subjects would be undertaken should the Yucca Mountain site be approved for site characterization.

Issue: General opinion

The DOE received six comments from the general public which expressed various opinions on the proposed Yucca Mountain repository project but did not concern specific data, analyses, or conclusions presented in the EA. Two of the commenters expressed support for the project, accompanied by concern that "... boom and bust ..." cycles might occur. One stated that economic development based upon nuclear waste will have "... devastating effects on future generations ...", while another expressed doubt that "... other industries will find this area desirable." Finally, one commenter noted that if a railroad were constructed for the project, it could be used for other purposes.

Response

The DOE has noted these comments and will continue its exchange of information with residents of the affected area.

Issue: General comments

Eleven comments were received which expressed concern about the general quality of the socioeconomic impact analysis in the EA. Most of these remarks were located in introductory or summary sections of comment documents.

Response

Because each of the introductory or concluding remarks corresponded to specific issues presented and responded to in sections C.7.4.1 through C.7.4.5, the reader is referred to those portions of this Appendix.

Issue: Restriction to Clark and Nye counties

The DOE received 24 comments which questioned the restriction of the socioeconomic impact analysis to Clark and Nye counties. In particular, it was asked why Lincoln County was excluded, since it would be traversed by the most likely nuclear waste rail transportation route. Other commenters stated that Lincoln County, the City of Caliente, and the town of Alamo should be included in post-EA studies, including preparation of an Environmental Impact Statement.

Response

If a repository were located at Yucca Mountain, social and economic impacts would occur in areas where repository-related expenditures would be made and where the inmigrating repository-related work force would reside. To the extent that resources are available at competitive prices, it is expected that the majority of repository-related expenditures would be made in Nye County, where the site is located, and in neighboring Clark County, the major metropolitan area in southern Nevada. The NTS, adjacent to the Yucca Mountain site in Nye County, employs DOE and contractor personnel with

skills similar to the construction and mining skills which would be required by the repository work force. Historical settlement patterns of workers at the NTS provide a reasonable indication of where repository workers and their families would settle. Recent settlement patterns of these NTS workers were determined through an analysis of the ZIP codes reported by NTS workers. This analysis, the results of which are summarized in Table 5-26 of the final EA (Table 5-29 of the draft EA), indicates that most (96 percent) of the NTS workers reported ZIP codes in Nye and Clark counties in 1984. The socioeconomic analyses presented in Section 5.4 of the EA focus on this bicounty area, where almost all of the Yucca Mountain work force would be expected to settle. However, since the data summarized in Table 5-26 of the final EA indicate that about 1.5 percent of the recent NTS workers also reported ZIP codes in other Nevada counties (Douglas, Lander, Lincoln, Lyon and White Pine) and Carson City (a consolidated municipality), the DOE intends to consider a larger geographic area in future studies if the Yucca Mountain site is approved for site characterization.

See Section C.7.4.3 of this Appendix for other comments regarding Lincoln County.

Issue: Moapa Indians

A single commenter noted that the EA ignores impacts on the Moapa Indian Reservation which lies along potential shipping corridors for radioactive waste.

Response

Because Native Americans in southern Nevada have not been certified as affected tribes within the meaning of Section 2(2)(B) of the NWPA (1983), they have not been singled out for special analysis in the EA. Furthermore, American Indian reservations, being relatively distant (e.g., about 250 kilometers or 155 miles for the Moapa Paiute Indian Reservation; about 161 kilometers or 100 miles for the Las Vegas Tribe of the Paiute Indians; about 322 to 467 kilometers or 200 to 290 miles for the Yomba Shoshone Indian Reservation; and about 443 kilometers or 275 miles for the Duckwater Indian Reservation) from the Yucca Mountain site, are not expected to be affected significantly by the inmigration of repository-related workers and their dependents. However, specific note was made in Section 5.4.4.2 of the EA of the potential for impacts on Native American cultures from transportation activities. This aspect will receive appropriately detailed treatment in research to be performed if the Yucca Mountain site is approved for site characterization. The potential impacts of the repository project on Native Americans who live outside of reservations (as well as on other cultural groups in southern Nevada) will also be included in the detailed, community-level data gathering and analysis to be undertaken later. Note that all mileages given above are measured along the existing road network.

Issue: Lack of community-specific data and analysis

Two commenters noted that the EA lacks community-specific data and analyses. It was suggested that as a minimum, the EA should have used existing data on boom-town phenomena in the modern American West to provide

some indication of the potential magnitude of the impact of repository siting.

Response

The various conditions of the Socioeconomic Impacts guideline were evaluated at the level most appropriate given the overall evaluation philosophy and availability of information. For example, it was most appropriate to evaluate employment and income impacts at the county and regional levels, since (1) a substantial portion of the potential labor supply for the repository would come from southern Nevada and (2) community-specific employment data were unavailable. On the other hand, some community-specific information was presented and analyzed (see sections 3.6.3 and 5.4.3 of the EA). A comprehensive review of the boom-town literature was not considered appropriate for the EA because (1) the boom-town literature is not relevant for the entire affected area, as noted in Section 3.6.4 of the EA; and (2) a focus on boom-town literature presupposes that the repository would also cause boom-town conditions, and this is by no means certain, given the planning and mitigation procedures provided in the Nuclear Waste Policy Act of 1982.

Issue: Safety assumptions

The introduction to Section 5.4 of the draft EA states that "... it has been assumed that safety questions about waste transportation and disposal would be resolved before the repository would be constructed" and two commenters stated that to dismiss such issues out-of-hand eliminates major potential influences on socioeconomic conditions that should be addressed in the EA.

Response

The Department of Transportation (DOT) has regulatory responsibility for safety in the transportation of all hazardous materials, including radioactive waste. This responsibility extends to all modes of transportation that would be considered for shipping waste to the repository. The Nuclear Waste Policy Act requires the DOE to comply with the DOT regulations.

The Nuclear Regulatory Commission has responsibility for authorizing licenses to construct a repository, to receive and possess spent nuclear fuel and high-level waste in such a repository, and to close and decommission a repository.

Regulations by these Federal agencies will ensure that safety questions are resolved before transportation of radioactive waste or construction of the repository. It is beyond the scope of the socioeconomic section to demonstrate the adequacy of safety measures required by these regulations.

Issue: Mitigation needs

Two commenters noted that applying the rule of indemnifying local residents of risks to their economic well-being would require that mitigation actions be taken to provide the State of Nevada and its citizens with an

"... insurance policy ..." against these general risks. One mitigating measure suggested by the commenter was to use van pools or buses for employees to decrease the accident potential.

Response

The DOE believes that the financial assistance provisions contained in the Nuclear Waste Policy Act of 1982 demonstrate the Federal Government's commitment to impact mitigation. Because the DOE will not recommend a site for repository development until the early 1990s, specific impact mitigation strategies (fiscal or other) have not yet been developed. The development of such specific mitigation strategies will be based on further impact studies conducted by both the DOE and the State if the Yucca Mountain site is approved for site characterization, and on impact mitigation agreements negotiated between the DOE and the State pursuant to Section 116(c)(2)(B) of the Nuclear Waste Policy Act.

Issue: Transportation effects analysis

Five commenters noted that there are only a limited number of transportation routes within the State that would serve a repository at Yucca Mountain. These comments stated that there is no reason why each community along these routes should not be included in the analysis of social (as well as socioeconomic) conditions; failure to consider transportation effects generically or to use a simulation approach is a major shortcoming.

Response

Because actual transportation routes have not yet been identified, communities which could be affected by transportation have not yet been identified. The focus of the DOE's socioeconomic analysis in the EA was the area where repository workers would be expected to settle. To consider transportation-related impacts generically would not be meaningful, since the potential impacts could differ significantly among communities along a route. An analysis of transportation-related socioeconomic impacts will be conducted once actual transportation routes have been identified.

Issue: Closure and decommissioning

One commenter noted that the analysis of the socioeconomic impacts of the repository should include a discussion of the impacts during and following closure and decommissioning.

Response

Socioeconomic impacts during and following closure and decommissioning are discussed briefly in the final EA: Tables 5-5a and 5-5b contain direct and indirect employment estimates for decommissioning; tables 5-47 and 5-48 show population estimates for decommissioning; and tables 5-47, 5-48, 5-50, and 5-51 show population and community services estimates, for decommissioning. In general, however, the socioeconomic impacts of a repository would be greatest during construction and operation. Expanding the analysis to include more information on closure and decommissioning would not affect the conclusions of the socioeconomic impact analysis for the purpose of determining site suitability.

Issue: Special Effects

Two commenters maintained that the final EA should begin to identify major "special effects" associated with all socioeconomic and transportation subcategories discussed in sections 5.3 and 5.4 of the draft EA.

Response

Section 5.4 defines "special effects" as those stemming from concerns about radioactive material. Changes in expectations can have economic consequences as well as broader, socioeconomic consequences if they result in changes in behavior of people. Section 5.4.1.4 of the draft EA considers the economic consequences of public perceptions of the presence of a repository on tourism. Special effects on social structure and social organization are considered in Section 5.4.4.1.2. Further research on attitudes and perceptions would be undertaken should the Yucca Mountain site be approved for site characterization.

C.7.4.1 Population density and distribution

This category addresses the effects of the proposed action on population density and distribution in the affected area. The 16 comments received are divided into two issues: (1) Inmigrant Settlement Patterns and (2) Population Increases.

Issue: Inmigrant settlement patterns

Nine comments were received; these concerned the use of residence patterns of Nevada Test Site (NTS) employees. These fell under two topics: forecasting settlement patterns and assessment of population changes.

Forecasting settlement patterns. The use of NTS settlement patterns as the basis for projecting likely settlement patterns for repository-related workers was felt to be speculative. A more detailed, sector-by-sector analysis of settlement patterns before drawing conclusions in the final Environmental Assessment (EA) was requested. It was also questioned whether it was true, as shown in Table 5-29 of the draft EA (Settlement patterns of Nevada Test Site employees), that some employees live in other Nevada counties and in California.

Several other commenters indicated that there are at least two reasons to doubt that 83 and 13 percent of the project-related inmigrants would settle in Clark and Nye counties, respectively: (1) commuting times to the Yucca Mountain site will be about 1.45 hours per day longer than times to the NTS; and (2) this additional commuting time will make Amargosa, Beatty, and Pahrump more attractive. Finally, it was pointed out that the settlement pattern distribution assumed in the EA will become even more doubtful in the later phases of the project as local communities adjust to the impacts created by the project.

Response. Recent settlement patterns of workers at the NTS (which is adjacent to the Yucca Mountain site) constitute the best available data on the likely settlement pattern of repository-related workers. NTS workers include construction and mining workers. Contrary to the suggestion of the comment, use of other available means of estimating likely settlement patterns would be speculative. Additional analysis of the NTS work force and of worker settlement patterns on other projects will be an important part of studies to be performed if the Yucca Mountain site is approved for site characterization. These will lead to additional information regarding the intracounty settlement of the work force as well as a reevaluation of intercounty settlement.

The results of future studies of the impacts of a repository on local communities will be sensitive to the assumption about intracounty worker settlement patterns. Thus, the settlement behavior of workers currently employed near the Yucca Mountain site will be the subject of further investigation. It is also true that settlement patterns may change over time. This will be an important consideration in forecasting community-level settlement patterns and preparing an analysis of impacts on local communities.

The comment correctly notes that according to data on recent settlement patterns of workers employed at the NTS, it is likely that some repository workers would commute to the Yucca Mountain site from other Nevada counties and from California.

With regard to settlement patterns in Clark and Nye counties, both factors cited have been taken into account in the analysis in the final EA. The data shown in Table 5-29 of the draft EA (Settlement patterns of Nevada Test Site employees) represent the best available information on likely settlement patterns of project employees at Yucca Mountain. The possibility that workers employed in Mercury would be more likely to live in Clark County than would workers employed in the northern areas of the NTS which are further from Clark County (see Figure 3-21, Bicounty area surrounding the Yucca Mountain site, of the EA) was considered in compiling the settlement pattern data shown in the table. The fraction of workers who reside in Nye County does not appear to be sensitive to the location of their work area within the NTS.

Assessment of population changes. Other commenters noted that the final EA should contain a detailed assessment of population changes in local communities including Amargosa Valley, Beatty, Pahrump, Tonopah, Las Vegas, North Las Vegas, Henderson, Boulder City, Caliente, and the remaining areas of Clark, Nye, and Lincoln counties.

Response. As was discussed in Section C.7.4 of this Appendix, the evaluation of the Yucca Mountain site against potentially adverse condition 1 included estimation of total population (i.e., baseline plus that due to the repository) growth rates in individual communities nearest the repository location. Because baseline population data on most of the smaller communities, especially those nearest the Yucca Mountain site, were limited, a detailed population growth assessment was not possible. Instead, it was assumed that the settlement patterns presented in Table 5-29 (Settlement patterns of Nevada Test Site employees) of the draft EA (Table 5-26 of the final EA) would be valid in the future and that individual communities would

retain their recent shares of total county population. Section 6.2.1.7.4 of the EA has been revised to present community population growth forecasts for the peak year of expected population inmigration.

Issue: Population Increases

Seven comments were received on this issue; all were related to various aspects of the methodology used in the calculation and the examination of the effects of future population increases. One commenter requested the sources of the information presented in footnotes a, b, and c to Table 5-49 (Projected maximum total population increase for Clark and Nye Counties for vertical emplacement) of the draft EA. The same commenter asked why a situation in which all employees would come from and return to areas other than Nye and Clark counties be considered a conservative assumption. Further, it was questioned why this situation would be examined at all, given the experience of recent NTS worker residence patterns. Some commenters expressed a general concern over projected levels of population growth in the affected area, while others expressed concern about the effects of even a small population increase on the small communities in the affected area. For example, it was noted that the population of Pahrump could reach 100,000 by the year 2000. In the long run, it was felt that the proposed project will make areas such as Pahrump Valley into detached suburbs of the Las Vegas metropolitan area.

Response

Table 5-47 (Maximum population increase for vertical emplacement and bicounty population forecast with and without the repository) of the final EA indicates that the repository project would increase the bicounty population by about 16,100 in 1998 and about 14,100 in the year 2000. In the absence of the project, Nye County population is expected to reach 42,408 by the year 2000 (Table 3-15 (Population of Nye County, 1970-2000) in the final EA). Even if all project-related inmigrants were to settle in Nye County, the county population would still be less than 100,000 in the year 2000.

Footnote "a" in tables 5-47 and 5-48 of the final EA (tables 5-49 and 5-50 of the draft EA) presents assumptions about the employment multiplier and the number of dependents per worker. The employment multiplier used in this analysis is discussed in Section C.7.4.2 of this Appendix. The assumptions regarding dependents per worker were taken from U.S. Department of Energy, Environmental Aspects of Commercial Radioactive Waste Management (DOE/ET-0029) Volume 3, Appendix C, Washington, D.C. (1979). The EA has been revised to acknowledge this source. Footnote "b" presents assumptions about settlement patterns of repository-related inmigrants. The percentages for Nye and Clark counties were obtained from NTS worker residence pattern data (see Table 5-26 of the final EA). A new footnote "c" was added to clarify that population growth rates are calculated from the previous year. Footnote "d" presents the projected 1992 population of Clark and Nye counties without a repository (i.e., the baseline population). The EA has been revised to clarify that this value was obtained from a linear interpolation of the population projections presented in tables 3-15 and 3-16.

The assumption that all employees would come from and return to areas other than Nye and Clark counties is considered conservative because it overstates the likely upward (or downward) responses of bicounty population to changes in project labor requirements. Any other population distribution assumption would lead to lower estimates of some types of impacts. Using the conservative immigration assumption enabled the DOE to estimate an upper bound for community services requirements.

The concern regarding small communities is valid in that the same increment in population in a small community will represent a greater fractional population increase than in a large one. In the quantitative analysis of community-services impacts, service requirements were assumed to be proportional to population, and the percentage increase in service requirements would be greater for the smaller communities. Future community-level studies will address this issue.

Population forecasts for Nye County prepared by the State of Nevada (Table 3-15 of the final EA) do not indicate that the entire county is expected to have a population of 100,000 by the year 2000. Therefore, it is very unlikely that the population of Pahrump alone would reach 100,000.

C.7.4.2 Economic conditions

This category addresses those sections of the Environmental Assessment (EA) which provide the economic impact analysis for the proposed action of siting a repository at Yucca Mountain. The U.S. Department of Energy (DOE) received 69 comments in this category; these comments have been organized into six issues: (1) Employment Analysis, (2) Prices and Income, (3) Materials Estimates and Impacts, (4) Repository Costs, (5) Effects on Economic Development, and (6) Impacts on Tourism.

Issue: Employment analysis

The DOE received 32 comments on the labor analysis presented in Section 5.4.1.1 of the draft EA. Among the topics covered by these comments were: indirect employment multiplier, employment fluctuations, wage rate effects, and effects on the mining industry.

Indirect employment multiplier. Commenters requested that the EA present details on the methods used to generate the employment multiplier of 1.54. Also, they suggested that the possibility of spillover support employment in Clark County from base employment in Nye County should be considered. In a related comment, it was observed that it is possible that job opportunities at Yucca Mountain would "... drain employees from the labor supplies which characterize neighboring counties, creating a net outmigration and decline in local economies."

Response. The indirect employment multiplier of 1.54 was estimated using data presented in White et al. (1975). To briefly summarize, the indirect employment multiplier was estimated as the average ratio of nonbasic (i.e., indirect) to basic (i.e., direct) employment in the Clark County area from 1961 to 1974. The annual ratio was fairly constant over that interval. Basic employment was defined as the combined total employment of the resort industry, the Nevada Test Site (NTS), Nellis Air Force Base, and part of the manufacturing sector. Nonbasic employment was defined as total employment in the Las Vegas Standard Metropolitan Statistical Area minus basic employment. (See White et al., 1975, for a more rigorous definition.) Section 5.4.1.1 of the EA has been revised to document more thoroughly the derivation of this employment multiplier.

Net outmigration of workers could lead to economic decline in two ways. First, unemployed workers could leave an area. Even though these workers do not earn income, they generate income for others through their expenditures (e.g., food and shelter). The result would be a reduction of economic activity in the support sector. This type of impact is not considered significant because such workers are likely to leave the area in search of work independently of the repository project. Second, local economic decline could occur if outmigration of workers resulted from upward pressure on regional wage levels for certain skills and if such increases led to the reduction of marginal business activity. Upward pressure on wages, if any, would most likely occur in the mining and construction sectors (Section 5.4.1.1 of the EA). Reduction in marginal business activity in these sectors is as likely within the bicounty area as outside of it. It is the possibility of an increase in the regional wage rate and not the migration of workers per se that introduces the possibility of such a geographic redistribution of economic activity.

The proximity of labor supply in California, Utah, and other western states would reduce upward pressure of project-related labor demand on regional wages. The net effect of the project on wages would depend on economic conditions in those areas in the early 1990s.

Employment fluctuations. Several other commenters stated that the draft EA assumes that "... all markets work with perfect efficiency ..." and that the required work force will appear at just the right time. Commenters suggested that it is more likely that "... there will be significant unemployment, social, and fiscal impacts--even during the boom phase of the project." Therefore, the usefulness of the socioeconomic evaluation was found to be limited by the assumption that workers enter and leave the southern Nevada area as project needs rise and fall. In addition, it was felt that the EA consistently ignores the declines in employment which occur as the operation moves from construction to operations and from operations to closure. Similarly, the construction employment baseline value with which labor demand is compared was found to be misleading because of the large fluctuations which occur in construction employment.

Response. It is as reasonable to expect that too many workers will enter the area in response to project-related job opportunities as it is to expect that too few workers will enter the area at the onset of the project.

An important factor in determining which situation prevails is the level of information available about project-related opportunities. Over or undersupply of workers would result from unreasonable expectations about those opportunities. At present, it is not known what quality or quantity of information about job opportunities would be available at the outset of the project. The possibility of unemployment and associated social and fiscal impacts would be considered as part of future investigations of labor market impacts of the project. Public announcements of the number and timing of job opportunities may be considered as an action that the DOE and its contractors could take to avoid the adverse impact suggested by the comment.

It is true that forecasts of project-related population growth are based on the conservative assumption that all employees would come from and return to areas other than Clark and Nye counties and that the number of inmigrants varies with the project labor requirements. As stated in Section 5.4.2 of the EA, this results in an overstatement of the likely fluctuation of bicounty population in response to changes in project labor requirements. Similarly, it leads to an overstatement of the fluctuation over time of requirements for community services. Given the preliminary nature of the data, the use of this extreme assumption regarding population fluctuation is appropriate. The intent is to identify adverse impacts which may be important in distinguishing among sites or in identifying important topics for subsequent, more detailed investigation.

It is consistently recognized in the draft EA that declines in employment would occur as part of the repository project (e.g., Figure 5-7a of the final EA (Number of direct workers over time for vertical emplacement) and the text of Section 5.4.1.1). It is true that while the impact of project-related decline is discussed in the EA, the socioeconomic analysis focuses attention on the impacts of project-related growth. The focus of the socioeconomic analysis tends to correspond to the timing of the impact, with the greatest attention given to more immediate impacts and less attention given to impacts which would occur at later stages of the project. With both growth and decline, negative impacts tend to be associated with the difficulty of adjusting to change.

The fluctuations in historical construction employment (in Nye County) was noted in Section C.4.1.5.2 of this Appendix. These may indicate that the uncertainty surrounding baseline construction employment projections is probably greater than that surrounding projections for other sectors.

Wage rate effects. Several commenters stated that two statements in Section 5.4.1.1 of the draft EA are seemingly inconsistent: "... there might be an increase of wages and salaries to induce workers having mining and construction skills to relocate to the area ..." and "... potential increases in wages and salaries in the bicounty area could be mitigated by the inmigration of skilled workers from other areas ..." Further, the commenters stated that the income analysis contained in the EA was based upon "... fairly low assumptions of average annual wages, particularly for construction and operations ..." and that the EA should contain information on construction and operating workers by skill mix, based on union scale, since Davis-Bacon rules require payment of prevailing union wages on Federal projects.

Response. The statements in the EA are consistent. The inmigration of workers is evidence of either unemployment in neighboring areas or of wage increases that cause a geographic reallocation of the existing work force. "Mitigation" was not used in its usual sense here. The purpose of its use was to emphasize the relationship between the likely project-induced escalation of wages, if any, and the elasticity of supply of workers from surrounding areas. The greater the elasticity of supply of workers from outside the area, the lesser the increase in wages that would be required to meet project labor requirements, other things being equal. This word, however, has been deleted in the final EA.

The commenter is correct in noting that the wage for construction and operations workers shown in the draft EA appears low. This figure was revised upward in the cited reference subsequent to its use in the draft EA. Although the results of the analysis in the EA are not sensitive to this adjustment in the average wage, the final EA has been revised to show $36,200 per direct worker, based on annual wages currently paid to workers at the NTS, under the Davis-Bacon Act, and as cited in McBrien and Jones (1984).

Effects on the mining industry. A last commenter questioned the effect that the Yucca Mountain project demand for mining-related workers would have on the viability of the traditional mining industry in Nevada.

Response. The repository project would have two potential effects. The first effect concerns the total level of mining activity. Growth of the mining sector has traditionally contributed to the overall economic growth of the region. Similarly, project-related growth in mining activity would contribute to regional economic growth.

The second potential effect concerns the distribution of activities within the mining industry. As noted in Section 5.4.1.1 of the EA, project-related demand for miners may increase the regional wages of miners. The amount of such an increase, if any, would depend on the condition of minerals markets at the time and the availability of mining workers from outside Nevada. Unlike mining workers, owners of mines would be negatively impacted by wage increases. Mines that are marginally profitable in the absence of the project could become unprofitable and close in the event of sufficiently large wage increases.

Issue: Prices and income

The DOE received four comments on the following topics: repository influence on regional prices and income, and potential for a recession.

Repository influence on regional prices and income. Several commenters stated that not only are wages likely to increase in certain sectors, but the influx of workers in a small community will increase demand for goods and services, thereby driving prices upward.

In addition, the same commenters noted that the draft EA contains no discussion of what portion of the total wage estimates in tables 5-47

(Potential annual wage expenditures associated with vertical emplacement) and 5-48 (Potential annual wage expenditures associated with horizontal emplacement) of the draft EA would actually go to workers and contractors outside the bicounty region. Also, there is no provision for encouraging or requiring repository contractors to hire or buy locally.

Response. It is not obvious that worker influx would cause the prices of goods and services in communities to increase. Unlike the experience of some small towns, the smaller towns surrounding the Yucca Mountain site are not the only potential recipients of inmigrants. Rather, workers could live in the urban part of Clark County, as demonstrated by the historical settlement patterns presented in Table 5-26 (Settlement patterns of Nevada Test Site employees) of the final EA. The presence of this alternative significantly reduces the potential for significant increases in wages in the smaller towns. Nevertheless, the potential for increased community price levels will be the subject of additional research as part of planned investigations of the socioeconomic impacts of the repository project.

The wage estimates presented in the cited tables apply only to those employees of the project who would be assigned to work in southern Nevada. Such wages would only be spent outside the region to the extent that workers either commuted from, or sent a portion of their incomes to, outside areas. The project includes no provision favoring local hiring or purchasing. Decisions on whether to hire or purchase locally in the absence of DOE restrictions would be sensitive to local economic conditions (e.g., the prices and availability of goods and services from local sources as compared with sources outside the region).

Potential for a recession. In stating that periods when repository-related employment decreases "... would probably resemble similar periods of slower economic growth that the bicounty region has experienced during previous fluctuations in the mining and construction industries ..." the DOE is in effect admitting that it plans to cause three recessions.

Response. A fluctuation in two employment sectors would not, in general, be classified as a recession. There is no short and simple definition of an economic recession, as officially measured by the National Bureau of Economic Research. However, the contraction phase of the business cycle (i.e., a recession) clearly represents a change in aggregate economic activity, not a single factor such as employment in one or two sectors. It is for this reason that the Bureau must collect a number of comprehensive economic series, and construct and evaluate a variety of indicators (e.g., composite and diffusion indices, leading and lagging indicators) (Moore, 1983) before a contraction phase in the business cycle can be ascertained.

Issue: Materials estimates and impacts

The DOE received four comments on the EA estimates of project materials requirements and the impacts of materials acquisition on the availability and price of local materials such as cement and aggregate.

Response

Information necessary for conducting an analysis of the effects of the project upon local materials markets was unavailable during preparation of the EA. A detailed analysis of these potential impacts would be conducted if the Yucca Mountain site is approved for site characterization.

Issue: Repository costs

The DOE received one comment requesting details of the methods used to estimate the cost of the repository.

Response

The methods by which repository costs were estimated have been described in MacDougall (1985). Footnote "a" in Table 5-44 (Preliminary cost estimates for the Yucca Mountain repository assuming vertical emplacement) in the EA has been revised to provide this new reference.

Issue: Effects on economic development

The DOE received two comments on the long-term effects of the repository project on economic development in the bicounty area. These expressed concern that a 50,000-acre withdrawal of land for the repository could seriously affect the development potential of the Town of Amargosa Valley.

Response

The 50,000-acre withdrawal number is an error; the correct value for the acreage to be withdrawn is 5,000. As part of more detailed investigations of the impacts of a repository on communities, it will be important to develop a clear understanding of their planned development; these studies will be conducted if the Yucca Mountain site is approved for site characterization. Based on present information, it is unreasonable to expect that the presence of a repository would inhibit the growth of Amargosa Valley. Instead, it is more reasonable to expect that a repository would contribute to its growth.

Issue: Impacts on tourism

The DOE received 38 comments on the EA discussion of potential impacts of the repository project on the tourist industry in southern Nevada. The major topics of these comments included: adequacy of the analyses, historical bases for analyses, effects of media coverage, usefulness of weapons-testing tourism effects, effects on recreation sites, and determination of damages and compensation.

Adequacy of analyses. Several commenters stressed that potential impacts on tourism are of extreme importance to Clark County and that a substantive analysis which would examine the influence of the transporting of waste and the siting of the repository on tourism should be included in the EA.

In addition, it was felt that the DOE tourism analysis does not differentiate between short-term, crisis-related events and the implications of a project that will be ongoing for 10,000 years.

Response. The EA recognizes the importance of the tourism industry to State and local economies. Section 5.4.1.6 of the EA presents the results of a substantive, although preliminary, analysis of the possibility that a repository might affect visitors' perception of Las Vegas and whether this would harm tourism. The EA explicitly states that the "Research to date concerning the potential effect of repository operation on tourism is inconclusive; therefore, further investigation has been planned." As more specific information becomes available about repository-system design, actual transportion routes, the mode of transportation, and the appearance of the transportation activity to tourists, this information will be used to develop a better understanding of the potential effect on tourist perceptions of a repository and the effect of a repository on tourism. Section 5.4.1.6 of the draft EA has been revised to provide more details about the preliminary analyses performed by Science Applications International Corporation (SAIC).

The analysis discussed in the draft EA refers to impacts of repository operation. It does not address the impacts of possible accidents. Information about the observable effects of historical short-term, crisis-related events is used only to draw inferences about the potential future implications of the long-term operation of a repository on southern Nevada tourism. The purpose of the information on short-term, crisis-related events is to place an upper bound on the potential effects of long-term operation. The project, if interpreted to mean construction and operation of a repository, would not be ongoing for 10,000 years. Rather, all activities are expected to be completed in about 100 years (if the full retrievability period is used).

Historical bases for analyses. The DOE received comments which maintained that information on such historical cases as the major hotel fires and the Three Mile Island accident cannot be used to draw conclusions relative to the effect of the repository on the Nevada tourism industry. In addition, it was stated that the reference to the Las Vegas hotel fires in Section 5.4.1.6 of the draft EA is "inaccurate" without a discussion of the measures that were taken to mitigate the potential concerns of the tourist population.

Response. Information about historical cases is a reasonable basis for preliminary conclusions about the future effects of repository operation on tourism. The section of the SAIC report (1985), entitled "Case Selection" describes the criteria used to select cases for study. In general, cases were selected to investigate the presence of effects on tourism of (1) the siting of nuclear facilities, (2) high levels of media attention regarding potential safety hazards, and (3) the presence of nuclear testing in the Las Vegas area.

The reference to the Las Vegas hotel fires is accurate. However, information about such measures would contribute significantly to the understanding of the alternative means of mitigating potentially adverse effects of highly publicized concerns about safety hazards. This information will be taken into account in future, more detailed investigations of the potential impacts of a repository on the tourist industry.

Effects of media coverage. Other comments received indicated a concern that the image of Nevada would be tarnished by a "... nuclear waste image." In addition, the draft EA text was perceived to state that losses in tourism and gaming were considered certain. According to the commenters, the DOE tourism analysis seems to have the foregone conclusion that tourists will perceive nuclear waste as something that need not be avoided. Tourist perceptions should be evaluated in more detail, since a tourism- and recreation-based economy could be seriously harmed by an accident involving high-level radioactive material and resulting in media coverage. Some tourists may never come here after hearing that Nevada is to be the site of the first high-level radioactive waste repository.

Response. The purpose of past and ongoing research on the potential impact of a repository on tourism is to test such prior beliefs as this. As described in Section 5.4.1.6 of the EA, the available evidence supports the preliminary conclusion that the repository would not change the total appeal of the Las Vegas area to tourists. That evidence is inconsistent with the view that losses are certain. However, research to date concerning the potential effect of repository operation on tourism is not conclusive; therefore, further investigation has been planned.

The analysis of potential impacts on tourism begins with the recognition that tourists may perceive nuclear waste as being unattractive and unsafe regardless of the opinions of informed experts. For this reason, cases of highly-publicized concerns about safety were investigated to learn the effects of such perception on tourism. As explained in the EA, those cases included the Three Mile Island incident and the Las Vegas hotel fires. The analysis of data on tourism levels surrounding those events does not reveal that the concerns resulted in sustained declines in tourism levels. This may either be because the relationship between publicly stated perception and behavior is very weak or because the empirical tests used to seek evidence of a relationship are not strong enough. The available evidence does not constitute proof. Thus, as stated in the EA, more research is planned.

The possibility that media coverage alone could affect the tourist industry has been addressed in Section 5.4.1.6 of the EA. The preliminary result is that such coverage would not significantly affect the appeal of the area to tourists. However, research to date concerning the potential effect of repository operation on tourism is not conclusive; therefore, further investigation has been planned. An assessment of tourists' potential perceptions of repository-related activity, which will depend upon presently unavailable detailed information about repository design characteristics (including its physical appearance), will be an important part of those studies.

Usefulness of weapons-testing tourism effects. Another commenter stated that it is questionable whether information about the past effect of weapons testing on tourism is useful for drawing conclusions about the tourism effects of a future repository project.

Response. It is true that there is a real difference between controlled, isolated nuclear-weapons testing and the transport of high-level radioactive waste. It is also true that one potential means by which the

presence of a repository could affect tourism is through an adverse effect on the aesthetic appeal of Las Vegas and surrounding tourist attractions that extend beyond safety concerns and the area associated with the nuclear nature of the waste materials. Time-series econometric analyses of the relationships between gaming revenues and the number and timing of weapons tests were conducted to test the premise that if the radioactive threat posed by the Nevada Test Site were very great, then gaming revenues would be negatively related to the frequency of occurrence of tests over time, after taking into account variation explained by fluctuations in the level of economic activity (indicated by gross national product).

Effects on recreation sites. In a specific question, one commenter asked what effect the repository project will have on various recreational sites in Lincoln County.

Response. It is not possible, with information now available, to predict what impacts on tourism, if any, would result from high-level radioactive waste transport. Further analyses of this issue will be conducted if the Yucca Mountain site is approved for site characterization.

Determination of damages and compensation. A last commenter asked what measures will be taken to determine damages and to compensate the Henderson tourism-dependent population if an accident or the existence of the repository affects local tourism.

Response. Such information is not available. The EA states the preliminary conclusion that the repository would not change the total aesthetic appeal for the Las Vegas area, which includes Henderson. The economic consequences of an accident of a magnitude greater than historically experienced by the area are not considered in the EA.

Further investigations of the effect of repository-related activity on tourism are planned. The preliminary conclusion will be reevaluated to take into account additional information about the design and appearance of the repository system and tourists' potential perceptions of the repository-related activity as it becomes available. These investigations may consider alternative means of mitigating unlikely economic impacts of the activity.

C.7.4.3 Community services

Increased population growth as a result of the proposed action will result in an increase in the demand for local, state, and regional public services. The U.S. Department of Energy (DOE) received 55 comments on the assessment of project impacts on community services. These have been divided into issues according to the type of community services discussed: (1) Housing, (2) Nye County Education, (3) Water Supply, (4) Waste-water Treatment Facilities, (5) Public Safety Services, (6) Medical Services, (7) Mitigation, (8) Lincoln County or Statewide Impacts, (9) Transportation Systems, and (10) General Comments.

Issue: Housing

The DOE received three comments on the analysis of the impacts of the project on housing. All three called for a more detailed discussion of the housing market in the affected area, including housing preferences of inmigrating workers and their dependents, impacts on housing prices, and impacts on the local banking industry.

Response

The literature on housing preferences of construction workers and other inmigrants to sites of major projects is fairly extensive. It would have been possible to present historical information on the types, tenure, and price of housing preferred by workers on other projects. There would have remained, however, a serious question as to the applicability of these data to the proposed repository project. Likely housing preferences and prices can be projected only by an in-depth analysis which takes into account many community-specific factors, data for which were unavailable during preparation of the Environmental Assessment (EA). Because of the importance of housing impacts, additional research on housing market conditions in the affected area will be conducted as part of post-EA studies, if the Yucca Mountain site is approved for site characterization.

Issue: Nye County education

The DOE received two comments on the impacts of the repository project on the Nye County School District. The commenter noted that the incremental requirement for schools and teachers, as forecast in tables 5-52 (Incremental service requirements associated with the location of a repository at Yucca Mountain -- vertical emplacement) and 5-53 (Incremental service requirements associated with the location of a repository at Yucca Mountain -- horizontal emplacement) of the draft EA, would rise and fall during different phases of the project. It was asked whether schools would have to be built and closed and whether teachers would have to be hired and laid off.

Response

Tables 5-52 and 5-53 of the draft EA (tables 5-50 and 5-51 of the final EA) show the incremental number of schools and teachers needed to accommodate project-induced population growth during each period of the project. It is likely that the new schools built during 1993-1998 would serve the community throughout the remainder of the project. Any excess capacity during years when incremental demand is lower could be used to respond to baseline growth in demand. It is true that there may be a need to lay off teachers after the operations period. However, since this period would last for 50 years, there would be ample time for the Nye County School District to plan for such changes.

Issue: Water supply

The DOE received nine comments on potential impacts of the project on water supply in the affected area. These have been divided into two topics: impacts of ground-water use, and projection of regional needs.

Impacts of ground-water use. Two commenters expressed concern that the repository project would reduce the availability of water for future uses, whether by physical effects on the water table or by consumption of a major portion of the annual sustainable yield. Others pointed specifically to Nye County, asking whether the population growth due to the project will conflict with future baseline water use.

Response. The DOE estimate of repository water use has been changed, on the basis of a more detailed analysis, to 350 acre-feet per year. In addition, an inventory of agricultural, industrial, municipal, and domestic users in the Alkali Flat-Furnace Creek Ranch ground water basin has been conducted. Potential effects upon local users appear, on the basis of this information, to be negligible. Section 5.4.3.3 of the draft EA has been revised to incorporate the additional information.

The DOE agrees that a more thorough review of water supply and demand in southern Nye County is required in order to gain a complete understanding of potential impacts of repository-induced population growth in the area. Information available from published sources was, however, sufficient to enable the preliminary conclusion that water supplies would be sufficient, given solution of some existing problems. The analysis presented in Section 3.6.3.3 of the EA showed that if the present trend of conversion of land use in the Pahrump Valley from irrigated agriculture to residential development continues, then the valley-fill aquifer can support up to about 16,900 people without a decline in usable storage. The situation in the Amargosa Valley, whose ground-water basin has been designated by the State Engineer, is less clear. Although the basin is over-appropriated, actual irrigation water use is less than half of the sustained yield. If agricultural development remains limited, then there would be considerable opportunity for expansion of domestic and quasi-municipal uses, which would have the highest preference. Conversion of land use from agricultural to residential as in Pahrump would improve the water supply situation further. The Beatty water supply problems are discussed in Section 3.6.3.3 of the EA. If new high-quality water sources are not found for that community, then its growth potential could be limited. Section 5.4.3.3 of the EA has been revised to incorporate new information about Amargosa Valley.

Projection of regional needs. Other commenters noted that the discussion in Section 5.4.3.3 of the draft EA appears to be contradictory: one paragraph states that municipal and private water supplies near Yucca Mountain appear to be adequate, while the second paragraph reports legal and technical uncertainty of water sources to meet increased demands in the Las Vegas Valley beyond the year 2000.

It was asked if it is conceivable that the Las Vegas area may need to draw water from the aquifer beneath Yucca Mountain in 500 or 1,000 years. Finally, it was requested that the EA include a discussion of pre- and postclosure contamination of aquifers by radionuclides.

Response. The first citation applies to communities in Nye County near the Yucca Mountain site. The second citation applies only to the Las Vegas valley. The first paragraph of Section 5.4.3.3 of the draft EA was revised to clarify this.

It is conceivable that the Las Vegas Valley could seek to augment its water supplies by an interbasin transfer of water from the Alkali Flat-Furnace Creek Ranch ground-water basin 500 to 1,000 years from now. However, it is equally conceivable that such augmentation would draw on other basins.

For a discussion on radionuclide behavior and transport, the reader is referred to Section 6.4 of the EA.

Issue: Waste-water treatment facilities

The DOE received two comments on the discussion of the project impacts on waste-water treatment facilities in the affected area. First, it was stated that the EA should discuss possible impacts on sewage treatment capacity, including any expansion needs, and locations of new waste-water treatment facilities. It was also pointed out that the text of Section 5.4.3.4 of the draft EA does not mention Clark County.

Response

From the information which was available from published sources during preparation of the draft EA, waste-water treatment systems in both Nye and Clark counties will be adequate for the increased demand resulting from repository-related population growth. For the method used to evaluate the Yucca Mountain site against the Socioeconomic Impacts Guideline, detailed information on the locations of new facilities was not necessary. The draft EA has been revised to say that waste-water treatment systems in Clark County probably will be adequate for the increased demand resulting from repository-related population growth.

Issue: Public safety services

Four comments concerning impacts of the project on public safety services in the affected area were received. Two requested more information on responses to radiological emergencies, saying that the impacts on training and equipment to prepare the volunteer fire fighters in Nye County for handling radiological emergencies may be severe. In addition, it was felt that large numbers of inmigrants to Nye County (or even Clark County) who do not have jobs (people attracted in hope of work) could cause a strain on the police systems of the county.

Response

It is not likely that the impacts on local emergency service providers will be severe, since the Nuclear Waste Policy Act provides for mitigation of identifiable impacts of this nature. Further research will be conducted to identify potential training and equipment requirements and the need for mitigation.

It is not certain, from the information available at this time, whether, or to what extent, the repository project would result in inmigration of people who would not find employment. Information on whether these unemployed persons would cause more or less of a strain on police services than do presently unemployed persons is also not available. To make any judgments

at this point would be speculative. Instead, further research on the potential for increases in demand on public safety services by repository-related inmigrants will be conducted in future studies if the Yucca Mountain site is approved for site characterization.

Issue: Medical services

The DOE received five comments on the effects of the repository project. These address the following topics: impacts of radiological accidents, and impacts from inmigrants.

Impacts of radiological accidents. Two commenters requested discussion of what demands a major accident involving radioactive waste (either at the site or in adjacent communities) would place on existing or proposed medical facilities.

Response. Section 5.3.2.2 of the final EA discusses the radiological impacts associated with occupational and nonoccupational exposure due to normal and accident conditions; impacts due to accidents alone were not calculated for the southern Nevada region. Depending upon the transportation route and mode (i.e., rail or truck), and whether a monitored retrievable storage (MRS) facility were used, there would be between 0.07 and 0.91 fatality due to transportation-related exposure in southern Nevada during the operations period. Section 5.3.2.3 of the final EA discusses nonradiological impacts due to high-level radioactive waste transportation. Again, depending upon the transportation route and mode, and whether a MRS facility were used, there would be between 1.5 and 18.8 injuries during the operations period. These additional cases are unlikely to overload existing and planned health-care facilities.

Impacts from inmigrants. Two commenters requested projections of what the current medical service situation means in terms of future growth projections for the area. Included in such an analysis would be information on whether more doctors will be attracted to the affected area because there are more people or whether the characteristics of rural living will continue to keep the number of health professionals low.

One commenter noted that the EA should include a considerably more detailed analysis of impacts on rural health care facilities, since health care might be significantly affected in Nye County if large numbers of families move there for a few months only (i.e., during the construction phase).

Response. The EA already uses the current medical service situation to predict incremental service levels, in that service ratios are assumed to remain constant. For example, tables 5-50 (Maximum service requirements associated with the location of a repository at Yucca Mountain--vertical emplacement) and 5-51 (Maximum service requirements associated with the location of a repository at Yucca Mountain--horizontal emplacement) of the final EA show estimated increases in the number of doctors and hospital beds required to accommodate increased population. In addition, Section 5.4.3.6 of the final EA states that "... a small increase in the demand for health-care facilities ... would result from repository construction." The question

of what influences the decisions of doctors to settle (or not to settle) in health-service shortage areas was beyond the scope of the EA. As is discussed below, the evaluation of health care facilities was part of the same coarse screening analysis applied to all community services. The detailed information requested was not necessary for the evaluation. The incremental health services requirements reported in tables 5-50 and 5-51 of the final EA apply during each period of the project, regardless of the tenure of residence of the inmigrants. The preliminary conclusion of the DOE, based upon available information, is that impacts on health care services are not likely to be significant. Further research in this area will be conducted during post-EA site investigations should the Yucca Mountain site be approved for site characterization.

Issue: Mitigation

The DOE received three comments concerning mitigation of potential community services impacts. One stated that "... a more adequate quantification of potentially required resources and the need for mitigation funding by the Federal Government should be addressed more substantially in the assessment."

Response

At this point of the site selection process, identification and quantification of mitigation measures related to repository construction and operation is inappropriate. The need for mitigation will be identified as the result of more detailed analyses to be performed during preparation of an Environmental Impact Statement.

Issue: Lincoln County or Statewide Impacts

The DOE received eight comments which objected to the limitation of the community services impact analysis to Clark and Nye counties. Additionally, two commenters suggested that their calculation of the percent population increase for the city of Alamo, in Lincoln County (13 percent), would far exceed the population growth rate shown in Table 5-49 of the draft EA for Clark and Nye counties (2.9 percent) and consequently would severely strain local community services.

Response

The rationale for limiting the community services analysis to the bicounty area is the same as that for limiting the remainder of the socioeconomic analyses to Clark and Nye counties. The reader is referred to Section C.7.4 of this Appendix and Section 3.6 of the final EA for a discussion of this rationale. The population growth rates shown in the EA are year to year (i.e., annual) growth rates and cannot be compared to a growth rate expected to occur over a 16-year period (i.e., between 1980 and 1996). When the annual population growth rate for Alamo is calculated using the methods used to prepare Table 5-49 of the draft EA, the annual growth rate between 1995 and 1996 (the period of the highest annual growth rate shown in the draft EA) which is comparable to 2.9 percent for Clark and Nye counties (shown in the draft EA as the annual growth rate between 1995 and 1996) is 2.0 percent.

Issue: Transportation systems

The DOE received five comments concerning the impacts of the repository project on local roads. Commenters suggested that in the long run, the project could make areas like Pahrump into detached suburbs of the Las Vegas metropolitan area. Growth in these areas will strain the existing transportation network and there will be a need for new roads. They asked what effect the transportation of heavy equipment and materials will have on the physical condition of roads in the affected area. They also asked what the basis is for the selection of the roads listed in Table 5-55 (Projected annual average daily traffic on U.S. 95 in Las Vegas, 1996). A number of these are not limited-access roads and traverse densely populated segments of urbanized Las Vegas.

Response

Insufficient information is available to determine whether Pahrump and other communities near the Yucca Mountain site would become detached suburbs. It is true that increased population levels will increase demands on regional and transportation networks. However, the preliminary conclusion of the analysis conducted for the EA is that the incremental increases due to the repository project would not be significant. It is true that the draft EA does not address the question of potential damage to roads due to transportation of heavy materials and equipment.

It appears that the reviewer misinterpreted tables 5-55 (Projected annual average daily traffic on U.S. 95 in Las Vegas, 1996) and 5-56 (Projected annual average daily traffic on I-15 in Las Vegas, 1996) of the draft EA (tables 5-53 and 5-54 of the final EA, respectively). The road names listed in the left-most column of each table are segments of U.S. Highway 95 and Interstate 15, respectively, rather than a sequence of surface roads. Both highways have limited access in the Las Vegas metropolitan area. The fact that they traverse densely populated areas was taken into account in the transportation impact analysis presented in Section 5.3.2. It is highly likely that Interstate 15 and U.S. Highway 95 will carry high-level waste to the proposed repository should truck transport be involved.

Issue: General comments

The DOE received 16 comments which covered more than one community services area or concerned the general quality of the community services impact assessment. These have been organized into the following topics: technical approach, Table 5-57, form of analysis, effects on community services, capabilities of social and welfare services, recreational issues, and impact definition.

Technical approach. Several commenters noted that the approach used in the EA is fairly simplistic, as it fails to consider service capacity, scale effects of population change, marginal demand, and other institutional effects.

Response. As was explained in Section C.4.1.5.3 of this Appendix, the DOE used a coarse screening so that detailed studies would not be performed on sites which ultimately would not be chosen for site characterization. The

extensive primary research which would be necessary for a thorough evaluation of existing services and projection of future service needs, and which will be conducted if the Yucca Mountain site is approved for site characterization, was therefore beyond the scope of the EA investigation.

Table 5-57. One commenter pointed out that in Table 5-57 (Summary of environmental effects associated with the construction, operation, retrievability, and decommissioning phases of the repository) of the draft EA (Table 5-55 of the final EA), neither the "Standard Operating Practice" nor the "Residual Impacts of Significance" column reflects impacts or potential solutions.

Response. It is not true that the "Residual Impacts of Significance" column of Table 5-57 of the draft EA does not reflect impacts. Several expected impacts, including some deemed potentially significant, are reported. In several cases, the need for additional research is reported as necessary.

Form of analysis. Another commenter objected to the form of the analysis, saying that "DOE is being selective without basis in assessing impacts (e.g., education section relative to Clark County)."

Response. Assessment of community services impacts was neutral with respect to counties. Incremental increases in community services demand were assumed to be proportional to incremental population growth. Because Clark County has a much higher current population than does Nye County, the percentage by which service demands are projected to increase is higher in Nye County than in Clark County, although the absolute numbers (e.g., number of new teachers) are projected to be higher in the latter.

Effects on community services. Ten commenters addressed the general topic of effects on community services. Nine commenters noted that uneven settlement patterns within rural Clark, Nye, or Lincoln counties could have a drastic effect upon the ability of these counties to provide adequate community services. Further, workers may move into communities well in advance of the time they can be expected to be hired. This will have far greater impacts on all local services than would be the case if labor supply and demand forces worked perfectly. These same commenters felt that the impact on service needs resulting from an influx of repository-related workers and families who are in the aggregate dissimilar in age, race, sex, income, etc. from residents already in the area should be discussed in the EA. For example, greater demands may be placed on law enforcement agencies, while the demand for library books may be smaller. Because estimates of community services requirements ultimately depend upon employment requirements, it was suggested that the final EA must base all such impact analyses on defensible labor-force calculations.

Response. As was discussed in sections C.4.3 and C.7.1.2 of this Appendix, the direct labor force estimates have been revised in the light of new design information and the EA has been revised to reference the documents used to obtain them. The DOE considers the multipliers used to forecast indirect employment and dependents per worker to be reasonable. Section 5.4.1.1 of the EA has been revised to discuss the derivation of the indirect employment multiplier and to document its sources.

For the socioeconomic analyses, the DOE assumed that the Nevada Test Site settlement pattern described in Table 5-29 (Settlement patterns of Nevada Test Site employees) of the draft EA (Table 5-26 of the final EA) is a reasonable indicator of the settlement patterns of potential repository-related inmigrants. In the absence of community-level population forecasts, it was also assumed that the present ratios between town and county populations will exist in the future. Using these assumptions and estimates of project-induced population growth, the DOE estimated maximum annual population growth rates for several communities in the affected area with the presence of a repository (see Section 6.2.1.7.4 of the final EA and Section C.7.4 of this Appendix). In addition, it was noted that the service providers who would most likely be responsible for responding to repository-related demand are better equipped than are unincorporated town governments. While settlement patterns will most likely be uneven, they are not likely to have drastic effects on service providers.

As is noted in C.7.4.1, it is not necessarily certain that inmigrants will settle in the affected area well in advance of the project. Forecasts of leads and lags in inmigration will be the subject of research in post-EA investigations. In any event, since significant population growth impacts during the peak year of inmigration are not expected, it is unlikely that impacts would be significant during one of the preconstruction years. Finally, communities will have ample time during site characterization and preparation of an Environmental Impact Statement to prepare for some pre-project inmigration.

Estimates of the demographic characteristics of the projected work force were not necessary for the analyses presented in the EA. Such estimates may be made as part of future analyses if the Yucca Mountain site is approved for site characterization.

Capabilities of social and welfare services. Four commenters noted that it is important that the final EA carefully examine the current and future capabilities of local, county, and State social and welfare services to meet expanding needs. These commenters also stated that the existing service ratios are extremely questionable because (1) the population distribution assumed in the EA (83 percent for Clark County, 13 percent for Nye County) probably understated the impacts in Nye County, (2) mining and construction workers place different types of demands on services than do existing residents, and (3) some services may be at their capacity while others may be below.

Response. Given the coarse screening methodology described above, it was not necessary to examine all types of community services in the same depth. Furthermore, published information on provision of social services by local agencies was unavailable in sufficient detail to enable a thorough analysis. However, given the potential for impacts sometimes associated historically with rapid population growth, local social service delivery systems will be examined in later studies, if the Yucca Mountain site is approved for site characterization.

The assumption that 83 and 13 percent of inmigrants would settle in Clark and Nye counties, respectively, has no bearing on the validity of applying existing service ratios to future populations. The same ratios

would be multiplied by the Nye County population forecast, whatever its value. It is true that an analysis of the adequacy of community services at the margin (i.e., of the additional services required by each additional member of the community, be it a construction worker, miner, other type of worker or dependent) would be preferable. However, insufficient data were available for such an analysis. More detailed investigations, to be undertaken if the Yucca Mountain site is approved for site characterization, will include consultation with communities to ascertain appropriate measures of service levels. Finally, it is reasonable to expect that actual average historical service levels (in the form of per capita ratios) reveal citizen preferences; they implicitly take into account community judgment as to the adequacy of services.

Recreational issues. Three commenters pointed out that the EA does not address recreational issues in any detail. No systematic attempt is made to study potential impacts.

Response. Potential impacts on the ability of communities to provide recreational services were judged to be rather small, and thus were not discussed in the EA.

Impact definition. A last commenter asked for the definition of an impact as used in the draft EA, noting that what may seem insignificant to the DOE may in fact be significant to the community.

Response. The DOE agrees that impacts may be perceived differently by different parties. However, the nature of these impacts will not be arbitrarily defined by the DOE without consultation with local community representatives.

C.7.4.4 Social conditions

The U.S. Department of Energy (DOE) received 18 comments on the Environmental Assessment (EA) analysis of the potential impacts of the Yucca Mountain repository on social conditions in the affected area. These were divided into six issues: (1) Impacts Along Transportation Routes, (2) Impacts on Urbanized Las Vegas, (3) Effects of Inmigration, (4) Special Effects, (5) Native Americans, and (6) Culture and Lifestyle Effects.

Issue: Impacts along transportation routes

Five commenters expressed concern that the EA does not address the sociocultural effects of transportation along potential high-level radioactive waste transportation routes.

Response

A thorough analysis of the transportation effects on social conditions cannot be undertaken until actual transportation routes and primary socio-cultural data have been collected.

The DOE is aware of, and has indeed identified in Section 5.4.4 of the EA, the potential for the occurrence of special effects from high-level

radioactive waste transportation throughout the region. Particular note was made of the potential for mobilization and formation of opposing and supporting groups (Section 5.4.4.1.2), of the likelihood that Clark County residents would view high-level radioactive waste transportation negatively (Section 5.4.4.3), and of the potential threat to Native American cultures (Section 5.4.4.2). The sensitivity to the social effects of high-level radioactive waste transportation will guide future studies to be undertaken if the Yucca Mountain site is approved for site characterization. The gathering of primary, community-level data and greater certainty concerning all aspects of high-level radioactive waste transportation will permit a more detailed assessment to be undertaken at that time.

Issue: Impacts on urbanized Las Vegas

One commenter, in reference to an unspecified paragraph in EA Section 5.4.4, noted that it refuted earlier statements of insignificant impact in urbanized Las Vegas.

Response

If the comment refers solely to the first paragraph of Section 5.4.4.1.1 of the draft EA, and the contrast between the second sentence and the remainder of the paragraph, then the criticism is valid. In any event, the sentence was reworded to read: "In light of...the overall effects are not expected to be significant. Further study is required to assess whether there could be impacts on particular communities."

If the comment refers to the contrast between sections 5.4.4.1.1 and 5.4.4.1.2 of the EA, then the criticism is not valid. The former section refers to standard effects, while the latter refers to special effects.

Issue: Effects of inmigration

The DOE received four comments on the social impacts resulting from inmigration of repository workers and their dependents to communities in the affected area. These have been divided into the following topics: social structure and organization, absorption of outside workers, advance inmigration, and stability of employment.

Social structure and organization. One commenter noted that standard effects on social structure and organization may be extremely significant if large groups of repository workers settle in relatively small Clark County communities or are concentrated in a few specific neighborhoods.

Response. It is true that, although these effects on social structure and organization are unlikely to be significant overall, there could be impacts on particular communities or areas if such settlement patterns occur. The EA has been revised to acknowledge this possibility. However, it is also true that the data on Nevada Test Site workers presented in Table 5-29 (Settlement patterns of Nevada Test Site employees) of the draft EA do not

indicate that the type of settlement patterns postulated in this comment are likely to occur. Additional investigation and evaluation of present and potential future settlement patterns will be conducted if the Yucca Mountain site is approved for site characterization.

Absorption of outside workers. One commenter observed that it is inappropriate, given the level of data and the paucity of research, to suggest that the social heterogeneity of the area will automatically facilitate absorption of outside workers.

Response. The text does not suggest that the heterogeneity of the area will automatically facilitate absorption of outside workers. However, absence of a homogeneous culture and assimilation of large numbers of inmigrants in the past, do suggest that cultural assimilation will be facilitated; impacts on social structure and social organization could occur, as noted in Section 5.4.4.1 of the EA and associated subsections.

Advance inmigration. The last commenter on this issue noted that the draft EA postulates that the long lead time of the project may reduce eventual social disruption. It does not consider the converse possibility that the long lead time may exacerbate the problem by causing workers, motivated by rumors of lucrative employment, to flow into the area well in advance of actual construction. Such a situation would strain existing local institutions and compound whatever natural conflicts there might be between residents and newcomers.

Response. The EA has been revised to acknowledge the possibility of social impacts due to advance inmigration.

Stability of employment. One commenter questioned whether the claim that stability of employment would be created by the project was valid and noted that employment is only stable in the operation phase, not the construction phase.

Response. Different readers could have different interpretations of the meaning of stable employment. However, under the schedule for the two-phase repository, construction workers would be required for about seven and one half years. For the construction industry, 7 years' employment on a single major project may reasonably be construed to be stable.

Issue: Special effects

The DOE received six comments regarding special social effects. Three topics were identified: public perceptions of risk, additional special effects, and details of future investigations.

Public perceptions of risk. Commenters noted the importance of analyzing attitudes and perceptions on which behavior and decisions are based, and queried the implications of public perceptions of risk. The latter included specific queries about the long-term effects on social structure and social institutions and the implications of likely public perception of the site and surrounding area as dangerous and radioactively contaminated.

Response. The significance of attitudes and perceptions is not questioned. However, primary data collection and analysis are required to ascertain the nature of public perceptions and to identify their implications. This type of analysis is more appropriate to an Environmental Impact Statement (EIS) than to an Environmental Assessment.

Additional special effects. One commenter requested inclusion of an additional effect in the list of special effects cited in Section 5.4.4 of the draft EA. It was stated that the effect to be included is that of public perception of risks associated with a repository and with shipping highly radioactive materials through the State. Other commenters critized the inadequate treatment afforded special effects throughout the entire socioeconomic sections of the draft EA and noted the wide range of social, economic, and political effects that could occur.

Response. It would be more accurate to view the public's perception of risks associated with a repository and with shipping radioactive materials as a source of special effects. Special effects were specifically identified in the social section of the draft EA. Future analyses would be conducted if the Yucca Mountain site is approved for site characterization.

Details of future investigations. Commenters requested a description of the methodology and framework by which further investigations of special effects will be undertaken.

Response. Such information is not available at this time.

Issue: Native Americans

One commenter stated that a discussion of possible impacts, if any, on Native American tribes should be added to the EA.

Response

As was stated in Section C.7.4 of this Appendix, Native Americans have been treated in a manner similar to other cultural units in the affected area. They have not been singled out for special analysis because they have not been certified as "affected" tribes within the meaning of Section 2(2)(B) of the Nuclear Waste Policy Act.

Native American issues were considered, but no identifiable impacts were found. The location of American Indian reservations in urban Las Vegas and in three rural areas distant from the site (as reported in sections 3.6.4.2.1 and 3.6.4.2.2 of the final EA) is such that they are not expected to be affected by the inmigration of repository workers. The final EA has been revised to include more detail concerning the number of American Indians residing in the bicounty area and the location of reservations relative to the proposed Yucca Mountain site. Specific note was made in Section 5.4.4.2 of the potential for impacts on Native American culture from transportation activities. This aspect will receive appropriately detailed treatment in future studies, following identification of actual transportation routes.

Issue: Culture and lifestyle effects

One commenter requested a clear description of what constitutes culture and lifestyle effects and variables for analysis, inclusion of a preliminary analysis of the major potential impacts on each community, and establishment of a comprehensive framework by which additional investigation will be carried out if Yucca Mountain is selected for site characterization.

Response.

A detailed description of the constituents of culture was presented in Section 3.6.4.2 of the draft EA. Briefly, culture can be defined as shared ideas that regulate behavior. Primary variables for analysis include attitudes, beliefs, and values, all of which require primary data collection. The community-level data collection and analysis requested by the commenters was beyond the scope of the EA. A study plan will be developed if the Yucca Mountain site is approved for site characterization.

C.7.4.5 Fiscal conditions and government structure

The U.S. Department of Energy (DOE) received 16 comments on the analysis of the potential impacts of the Yucca Mountain repository on fiscal conditions and government structure in the affected area. Issues include: (1) Predeterminations by the DOE, (2) Provisions for Mitigating Fiscal Impacts, (3) Revenue Lag, and (4) Impacts in Lincoln County.

Issue: Predetermination by the DOE

One commenter stated that DOE has predetermined that no significant impacts will occur without providing an analysis to substantiate its claims.

Response

The DOE does not agree with this statement. The EA states that the repository could create fiscal impacts through the increased demands on community services. The EA also states that the level of significance of these impacts would be a function of the level of repository-related population inmigration. The statement in the EA that community service-related fiscal effects might be "insignificant" refers only to those urban areas of Clark County where the expected number of repository-related inmigrants represent a very small percentage increase over the existing population. The EA also recognizes the need for quantitative analysis of fiscal impacts and eventual fiscal assistance for impact mitigation.

Issue: Provisions for mitigating fiscal impacts

The DOE received 11 comments on the EA discussion of measures to mitigate impacts on local and State governments' fiscal conditions. Topics include: mitigation provisions, funding mechanisms, effects on local government, and EA organization.

Response. The comment incorrectly assumes that all readers are familiar with the content of the NWPA. The mitigation provisions of the NWPA are directly relevant to the probable fiscal consequences of the project. For this reason, the discussion of the NWPA has been included.

Funding mechanisms. Other commenters asked whether State and local governments will have to absorb increased costs for community services during repository operation, whether the State would be required to provide impact aid and funds, and if so, whether financial assistance would be provided for timely planning. One commenter questioned the statement in the EA that some repository-related costs to local government would be offset partially by increased revenues.

Other commenters felt that alternative procedural mechanisms should be developed to ensure that necessary planning and mitigation assistance is directed to both State and local governments affected by the repository. An equitable means should be developed to determine the amount of compensation required to offset social costs that fall outside traditional community-impact-assistance formulas.

Response. The NWPA provides for financial and technical assistance for states involved in the repository-siting process to help mitigate repository-related impacts. The nature and amounts of such assistance are to be contained in a report prepared by the State at the end of site characterization and submitted to the DOE. The DOE is required to negotiate a written agreement with the State which details the nature and amount of impact mitigation assistance during repository construction and operation.

While it is true that potential increases in State and local government revenue have not been quantified in the EA, it is reasonable to expect that tax revenues would rise as a result of repository-related wage payments to inmigrants and repository-related purchases of goods and services in the affected area.

Regarding the timeliness of DOE assistance for planning, the DOE grants to the State of Nevada are already in place to support efforts on the part of the State and affected localities to plan for potential economic, social, and public health and safety impacts of a repository. The purpose of these grants is to enable the State and localities to work with the DOE to identify potential impacts and requirements well in advance of the beginning of construction and to allow timely mitigation. Thus, pre-impact assistance is currently available for mitigation planning. Additional grants will be provided according to the schedule specified in the NWPA and summarized briefly in Section 5.4.5 of the EA.

Procedural mechanisms and methods of determining the appropriate amount of compensation would be developed in future studies if the Yucca Mountain site is approved for site characterization. Issues concerning the distribution and quantification of financial aid would be addressed at that time. Quantitative estimates of fiscal impacts would appear in the Environmental Impact Statement.

Effects on local governments. Another reviewer asked how the DOE could justify any site-comparative evaluation unless it has identified the major implications a repository is likely to have on the structure and stability of affected governments.

Response. It is not anticipated that repository development would affect local government structure. Detailed financial analysis of fiscal impacts to State and local governments will be conducted in future studies if the Yucca Mountain site is approved for site characterization.

EA organization. A last commenter noted that the EA should be organized so that each socioeconomic and transportation section contains an analysis of the potential costs projected for each level of government.

Response. As is explained in Section C.4.1.5.3 and elsewhere in this Appendix, a detailed analysis of the type suggested is neither possible nor appropriate in a screening study such as was performed to select sites for characterization. It is, however, appropriate for an Environmental Impact Statement. Thus, detailed analyses of repository-related impacts on State and local governments and the fiscal ramifications of those impacts will be conducted in future studies if the Yucca Mountain site is approved for site characterization.

Issue: Revenue lag

Three commenters noted that State and local government revenues lag behind population growth. Immigrants may demand full services upon arrival, but do not contribute to revenues until they have lived in a community for some time.

Response

It is true that government revenues tend to lag behind population growth. As noted above, the NWPA provides for financial assistance to State and local governments. The State may take the lag problem into account in developing its report on the nature, amount, and timing of the required assistance.

Issue: Impacts in Lincoln County

One commenter asked that Lincoln County be noted as a rural community having potentially significant impacts.

Response

The reader is referred to Section C.4.1.5 for a discussion of the reasons for limiting the fiscal impacts analysis to Clark and Nye counties.

C.7.5 SYSTEM GUIDELINE

This issue addresses the preclosure system guideline on environment, socioeconomics, and transportation. Questions and comments assigned to this

category concern the health and safety of the public and the protection of the environment during repository siting, construction, operation, closure, and decommissioning.

Three comments were received on this issue. One commenter stated that the draft EA should have assessed an accident and a worst-case release of radioactivity in an urban area. Another commenter noted that the socioeconomic segments of the EA lacked substantive analysis. A last commenter felt that the DOE cannot, on the basis of information contained in the EA, support the finding that the public and the environment shall be adequately protected from the hazards posed by the disposal of radioactive waste.

Response

Chapter 6 of the final EA contains an assessment of the consequences of an accident and the subsequent release of radioactivity in an urban area. The DOE notes the commenter's view regarding adequate protection for the public and the environment but feels that the presentation of information and analyses in chapters 3, 4, 5, and 6 of the EA adequately support the guideline finding relative to environment, socioeconomics, and transportation. If the Yucca Mountain site is nominated for additional investigative studies, then further detailed geotechnical and environmental investigations will be undertaken.

REFERENCES FOR CHAPTER C.7

Bell, E. J., and L. T. Larson, 1982. Overview of Energy and Mineral Resources for the Nevada Nuclear Waste Storage Investigations, Nevada Test Site, Nye County, Nevada, NVO-250, Nevada Operations Office, U.S. Department of Energy, Las Vegas.

Craig, R. W., and J. H. Robison, 1984. Geohydrology of Rocks Penetrated by Test Well UE-25p 1, Yucca Mountain Area, Nye County, Nevada, USGS-WRI-84-4248, Water-Resources Investigations Report, U.S. Geological Survey, Denver, Colo.

DOE (U.S. Department of Energy), 1979. Environmental Aspects of Commercial Radioactive Waste Management, DOE/ET-0029, Vol. 3, Appendix C, Washington, D.C.

DOE (U.S. Department of Energy), 1980. Final Environmental Impact Statement on the Management of Commercially Generated Radioactive Waste, DOE/EIS-0046F, three volumes, Washington, D.C.

DOE (U.S. Department of Energy), 1985. Mission Plan for the Civilian Radioactive Waste Management Program, Overview and Current Program Plans, DOE/RW-0005, three volumes, Washington, D.C.

DOE/NVO (U.S. Department of Energy/Nevada Operations), 1985. Radiological Assistance Team, NV Notification Procedure, Revision 11, Las Vegas, Nev.

DOT (Department of Transportation), 1984. Guidelines for Selecting Preferred Highway Routes for Highway Route Controlled Quantity Shipments of Radioactive Materials, DOT/RSPA/MTB-84/22, Materials Transportation Bureau, Washington, D.C.

Dudley, W. W., Jr., and J. D. Larson, 1976. Effect of Irrigation Pumping on Desert Pupfish Habitats in Ash Meadows, Nye County, Nevada, U.S. Geological Survey Professional Paper 927, Washington, D.C.

EPA (U.S. Environmental Protection Agency), 1977. Compilation of Air Pollutant Emission Factors, AP-42, Third Edition (with Supplements 1-15), Research Triangle Park, N. C.

Foster, B., and J. Jordan, 1984. A Guide to Radioactive Materials Transportation, S. Bjorkman (ed.), SAND84-7143, Sandia National Laboratories, Albuquerque, N. Mex., 50 p.

Knauss, K. G., J. M. Delany, W. J. Beiriger, and D. W. Peifer, 1985. "Hydrothermal Interaction of Topopah Spring Tuff with J-13 Water as a Function of Temperature," Scientific Basis for Nuclear Waste Management VIII, Materials Research Society Symposia Proceedings, C. M. Jantzen, J. A. Stone, and R. C. Ewing (eds.), Vol. 44, Pittsbugh, Penn., pp. 539-548.

MacDougall, H. R. (comp.), 1985. Two-Stage Repository Development at Yucca Mountain: An Engineering Feasibility Study, SAND85-1351 (Rev. 1), Sandia National Laboratories, Albuquerque, N. Mex.

McBrien, S. and L. Jones, 1984. Nevada Nuclear Waste Storage Investigations: Socioeconomic Impacts of Constructing a High-Level Waste Repository at Yucca Mountain, SAND84-7201, Sandia National Laboratories, Albuquerque, N. Mex.

Moore, G. H., 1983. "National Bureau of Economic Research Studies in Business Cycle, No. 24," Business Cycles, Inflation, and Forecasting, 2nd Edition, Ballinger Publishing Co., Cambridge, Mass.

Morales, A. R. (comp.), 1985. Technical Correspondence in Support of the Final Environmental Assessment Document, SAND85-2509, Sandia National Laboratories, Albuquerque, N. Mex.

NWPA (Nuclear Waste Policy Act), 1983. "Nuclear Waste Policy Act of 1982," Public Law 97-425, 42 USC 10101-10226, Washington, D.C.

Oversby, V. M., and K. G. Knauss, 1983. Reaction of Bullfrog Tuff with J-13 Well Water at 90 deg C and 150 deg C, UCRL-53442, Lawrence Livermore National Laboratory, Livermore, Calif.

Pippin, L. C , 1986. An Overview of Cultural Resources on Pahute and Rainier Mesas on the Nevada Test Site, Nye County, Nevada, Desert Research Institute Technical Report Series No. 45, Las Vegas, Nev, pp. 1-8, 55-70.

Pradere, P. F., 1983. Letter from P. F. Pradere (State of Nevada, Department of Transportation) to J. Bradbury (SAI), November 17, 1983; data on transportation attached.

Rosenberg, N. J., 1974. Microclimate: The Biological Environment, John Wiley & Sons, New York.

SAIC (Science Applications International Corporation), 1985. High-Level Nuclear Waste Transport and Storage Assessment of Potential Impacts on Tourism in the Las Vegas Area, Las Vegas.

State of Nevada, 1983. Air Quality Regulations, Air Pollution Control Law, Title 40, Chapter 445, The Bureau of National Affairs Inc., Washington, D.C.

State of Nevada v. John Herrington, 1985. United States Court of Appeals for the Ninth Circuit, Filed December 2, 1985, Ca. No. 84-7846.

Thordarson, W., 1983. Geohydrologic Data and Test Results from Well J-13, Nevada Test Site, Nye County, Nevada, USGS-WRI-83-4171, Water-Resources Investigations Report, U.S. Geological Survey, Denver, Colo.

Waddell, R. K., 1982. Two-Dimensional, Steady-State Model of Ground-Water Flow, Nevada Test Site and Vicinity, Nevada-Calfornia, USGS-WRI-82-4085, Water-Resources Investigations Report, U.S. Geological Survey, Denver, Colo.

Waddell, R. K., J. H. Robison, and R. K. Blankennagel, 1984. Hydrology of Yucca Mountain and Vicinity, Nevada-California--Investigative Results Through Mid-1983, USGS-WRI-84-4267, Water-Resources Investigations Report, U.S. Geological Survey, Denver, Colo.

Wang, Y. (ed.), 1969. Handbook of Radioactive Nuclides, The Chemical Rubber Company, Cleveland, Ohio, pp. 845-867.

White, W. T., B. Malamud, and J. E. Nixon, 1975. Socioeconomic Impacts of the Second Stage of the Southern Nevada Water Project and Its Alternatives, U.S. Bureau of Reclamation, Boulder City, Nev.

Young, R. A., 1972. Water Supply for the Nuclear Rocket Development Station at the U.S. Atomic Energy Commission's Nevada Test Site, USGS-WSP-1938, Water-Supply Paper, U.S. Geological Survey, Washington, D. C.

CODES AND REGULATIONS

10 CFR Part 20 (Code of Federal Regulations), 1980. Title 10, "Energy," Part 20, "Standards for Protection Against Radiation," U.S. Government Printing Office, Washington, D.C.

10 CFR Part 960 (Code of Federal Regulations), 1984. Title 10, "Energy," Part 960, "General Guidelines for the Recommendation of Sites for Nuclear Waste Repositories; Final Siting Guidelines," 49 FR 47714, Vol. 49, No. 236, December 6, 1984, pp. 47714-47769.

40 CFR Part 61 (Code of Federal Regulations), 1984. Title 40, "Protection of Environment," Part 61, "National Emission Standards for Hazardous Air Pollutants," U.S. Government Printing Office, Washington, D.C.

40 CFR Part 190 (Code of Federal Regulations), 1982. Title 40, "Protection of Environment," Part 190, "Environmental Radiation Protection Standards for Nuclear Power Operations," U.S. Government Printing Office, Washington, D.C.

40 CFR Part 191 (Code of Federal Regulations), 1985. Title 40, "Protection of Environment," Part 191, "Environmental Standards for the Management and Disposal of Spent or Nuclear Fuel, High-Level and Transuranic Radioactive Wastes: Final Rule," Federal Register Vol. 50, No. 182, September 19, 1985.

40 CFR Part 192 (Code of Federal Regulations), 1984. Title 40, "Protection of Environment," Part 192, "Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings," U.S. Government Printing Office, Washington, D.C.

49 CFR Part 171 (Code of Federal Regulations), 1983. Title 49, "Transportation," Part 171, "General Information, Regulations, and Definitions," U.S. Government Printing Office, Washington, D.C.

49 CFR Part 177 (Code of Federal Regulations), 1983. Title 49, "Transportation," Part 177, "Carriage by Public Highway," U.S. Government Printing Office, Washington, D.C.

C.8 EASE AND COST OF SITING, CONSTRUCTION, OPERATION, AND CLOSURE

This section addresses comments about the problems and costs of constructing, operating, and closing the repository. It focuses on the evaluation of guidelines related to the engineering and design of the repository and how those guidelines are used to evaluate the system guideline for ease and cost of repository development. This evaluation draws heavily on the baseline description of the site and the repository system in Section C.4. In contrast to Section C.7, which focuses on the effects of site characterization and repository development, this section, like sections C.5 and C.6, focuses on the evaluation of site suitability on the basis of the siting guidelines.

C.8.1 SURFACE CHARACTERISTICS

Seven comments were received, two dealing with a reference omission and five regarding facility flood potential. The comments on flooding indicated that the data presented in Squires and Young (1984) are not adequate to support the conclusion that the surface facility will be located in areas subject to only minor and infrequent flooding.

Response

The current reference conceptual repository is not expected to require flood protection through engineering measures. The only measures that would be taken are on adjacent washes over which access roads would pass. Although the Environmental Assessment states that significant flooding of the surface facilities is not likely, the Probable Maximum Flood will be determined during site characterization.

The potential for flooding, as a result of sheet flow due to rare extreme storms, does exist. The U.S. Department of Energy has determined that for this evaluation, credit cannot be taken for engineered flood protection measures, regardless of how routine they might be. Therefore, the potentially adverse condition related to potential flooding of surface and underground facilities has been changed to present.

The reference to the topographic map of Lipman and McKay (1965) is incorrect. The reference should be USGS (1961).

C.8.2 PRECLOSURE ROCK CHARACTERISTICS

Twenty-six comments were received on preclosure rock characteristics. In question are data and interpretations used in the draft Environmental Assessment (EA) to provide a preliminary, conservative evaluation of the characteristics of the Topopah Spring tuff and potential effects during site characterization, construction, and the life of the repository. The comments

received were classified into four issues: (1) Present In Situ Rock Properties and Stress, (2) Potential Thermal Effects, (3) Comparisons with Rainier Mesa G-Tunnel, and (4) Requirements for Support of Repository Components.

Issue: Present in situ rock properties and stress

Nine comments were received on the preliminary characterization of several properties of the host rock presented in the draft EA. Included are comments on the completeness of analyses of fractures, fracture fillings, joints, lithophysae, faults, and breccia in the host rock. Reviewers questioned uncertainties in the in situ stress measurements. Also addressed are the constraints that these geologic properties and the vertical thickness of the host rock had on the flexibility in selecting the location and configuration of the repository. One commenter felt that a section should be added regarding expected effects of radionuclides venting through the fracture system.

Response

Much of the available data on in situ fracture characteristics were derived from studies of Yucca Mountain boreholes and drill cores presented in Maldonado and Koether (1983), Scott and Castellanos (1984), and Spengler and Chornack (1984). These data confirm earlier data of Spengler et al. (1981) and substantiate analyses based on these data. Hustrulid (1984) considered many potential fracture dips in a stability analysis and concluded that shaft walls would be stable over a wide range of coefficients of friction across the fractures. Lithophysal cavity content was a major factor in selecting a location for the underground facility (Mansure and Ortiz, 1984). In drill holes USW GU-3, G-4, and G-1, the lithophysal cavity content at the proposed horizon was found to average less than 5 percent (Spengler and Chornack, 1984). The proposed horizon, classified as the moderately to densely welded, devitrified section of the Topopah Spring Member, volumetrically contains a very low percentage of zeolites or clays.

One commenter stated that flexibility in the placement of the repository may be more limited than expressed in the draft EA, because of the possibility of a random distribution of fractures, faults, and breccia at depth. Section 6.3.3.2.3 of the final EA describes the criteria that were used to estimate the portion of the primary area (Area 1) that is likely to be suitable for development. The final EA also includes a statement in Section 6.3.3.2.3 clarifying the relationship of unit thickness to repository placement flexibility. The statement indicates that the vertical thickness of the host rock is probably more than 3 times the thickness required (based on Mansure and Ortiz, 1984). Note that the favorable condition of significant flexibility in host rock lateral extent is not claimed for Yucca Mountain (Section 6.3.3.2.3 of the EA).

The results of Stock et al. (1984) eliminate some of the uncertainty with respect to in situ stress measurements. These data confirm the Healy et al. (1984) data taken at greater depths. In addition, these new data include some measurements in the unsaturated zone of the host rock which are consistent with vertical extrapolation of the earlier Healy et al. (1984) data.

Thus, conclusions drawn on earlier data are substantiated. In situ rock properties and stress will be more fully evaluated during site characterization.

During construction and operation of the repository, the ventilation system would maintain less than atmospheric pressure throughout the underground openings. By doing this, any releases of radioactive or nonradioactive material would be drawn into the repository openings, not blown or vented from the repository, if the ventilation system were to fail. It is anticipated that this procedure would preclude "venting" through the fracture system because there would be no net positive pressure in the repository. A description of the repository ventilation system is presented in Section 5.1 of the EA.

Issue: Potential thermal effects

Four commenters addressed possible heating of the host rock after emplacement and its effect on preclosure structures and waste retrieval.

Response

State-of-the-art numerical techniques were used by Johnstone et al. (1984) to complete a conservative estimate of the thermomechanical response of the rock mass. This study is considered preliminary, but confidence in the calculations is based on experience and field tests in similar devitrified, welded tuff in G-Tunnel at Rainier Mesa. Rock strengths used in the analysis are from water-saturated samples, whose strengths are less than that measured on dry rock under similar conditions. The thermal properties used considered the potential effects of 5 percent lithophysal porosity which translates to a lower thermal conductivity. The potential effects of discontinuities were considered as part of the analysis through an evaluation of joint slip. Small-diameter heater experiments conducted at G-Tunnel were used to help understand the thermomechanical response. Further, the presence of less than 2 percent smectites and zeolites in the repository horizon precludes anything but minor dehydration effects. An indepth study of the effects of heating on the proposed repository horizon, as well as on structural elements like grouted bolts, will be completed during site characterization. A discussion of long-term stability of structural elements of the support system has been added to Section 6.3.3.2.3 in the final EA.

Issue: Comparisons with Rainier Mesa G-Tunnel

Three commenters expressed concern over comparisons between properties of the Topopah Spring tuff at Yucca Mountain and that of the Grouse Canyon tuff, which is penetrated by G-Tunnel at Rainier Mesa.

Response

A detailed comparison of properties of the Grouse Canyon and Topopah Spring members is not considered to be necessary in the EA. This comparison is available in supporting references. The purpose of the information presented in the EA is to gain confidence on predictions of drift stability at Yucca Mountain based on the G-Tunnel experience at Rainier Mesa. The EA

compares two rock mass classifications for the Topopah Spring Member. The draft EA contains discussions of this latter comparison in Section 6.3.3.2.3, with supporting data in Tillerson and Nimick (1984) and the forthcoming Site Characterization Plan.

Issue: Requirements for support of repository components

Ten comments were received and categorized as pertinent to this issue, which addresses comments pertaining to the stability of underground openings in the host rock (Topopah Spring tuff). The issue is divided into three topics: maintenance of underground openings, support requirements, and retrievability.

Maintenance of underground openings. The majority of comments in this topic addressed the subject of minimal support and maintenance of repository drifts. These comments also questioned whether reasonably available technology will be adequate for maintaining underground openings.

Response. The only available data that can be applied to repository excavations at this time are those from other tunnels in similar rocks at Rainier Mesa and from mining, as well as civil excavations. Civil excavations are entirely appropriate to use for comparison because they are designed on an extremely conservative basis to ensure long existence. In comparing other excavations to those planned at Yucca Mountain, the expected in situ conditions do not appear to necessitate the use of technology beyond that which is reasonably available. In support of this conclusion, additional documented information has been added to sections 6.3.3.2.3 and 6.3.3.2.4 in the final EA, regarding tunneling experience in G-Tunnel and the Grouse Canyon Member at Rainier Mesa (Tibbs, 1985). The support requirements of the repository excavations in the Topopah Spring Member at Yucca Mountain are expected to be similar to those used in the welded portion of the G-Tunnel (Ortego, 1985). A near-vertical fault with at least a 1-meter (3-foot) vertical displacement was encountered in this tunnel, but no special support measures were required (Tibbs, 1985). Although the rock mass classification systems mentioned in the draft EA were developed for large excavations, they are considered to be applicable to the proposed repository because of the wide spacing between openings and the low extraction ratio that will be used in constructing the repository. In addition, support in the form of rock bolts and wire mesh was considered minimal in the discussions presented in the draft EA. All data, assumptions, and uncertainties were considered in evaluating the siting guidelines with respect to the potential need for extensive maintenance of underground openings. A discussion of the long-term stability of possible support components (e.g., shotcrete, rock bolts, and epoxies) has been added to the final EA in Section 6.3.3.2.3. Additional detailed and site-specific studies regarding drift support requirements, as well as thermal effects on those support systems, will be addressed during site characterization.

Support requirements. Some of the commenters stated that the effects of the uncertainties resulting from the lack of data on faults and fractures have not been adequately taken into account in the evaluation of support requirements. In addition it was stated that in situ stress data suggests a potential for fault-stress release during repository construction.

Response. Fracture patterns and stress measurements obtained from drillholes were the basis for determining the expected in situ stress conditions. The results of Stock et al. (1984) diminish some of the early uncertainty with respect to in situ stress measurements because the new data confirm the Healy et al. (1984) data taken at greater depths. Also, these new data include some measurements in the host rock (unsaturated zone) which are consistent with vertical extrapolation of the earlier Healy et al. (1984) results. Thus, conclusions drawn on earlier data are substantiated. Fault characteristics and the patterns of existing fractures as determined from Yucca Mountain drill core and field mapping are presented in Maldonado and Koether (1983), Scott and Castellanos (1984), and Spengler and Chornack (1984). These data confirm the earlier data of Spengler et al. (1981) and substantiate analyses based on these data. Hustrulid (1984) considered many potential fracture dips in a stability analysis which predicts stable conditions for a shaft opening over a wide range in the possible coefficient of friction for the fractures. It is also unrealistic to assert that excavation of a repository (a few square kilometers) could result in tectonic activity. The surface area of a tectonic fault could reach dimensions of tens to hundreds of square miles.

Retrievability. One commenter stated that support should be given for the concept that steel borehole sleeves would mitigate some retrieval difficulties.

Response. Although the reference design is vertical emplacement, the alternate design is horizontal emplacement, in which case the steel sleeves could be an aid in waste retrieval. The principal reason for the sleeves would be to ensure that no rock material collapses into the borehole during the 30 to 50 years during which retrievability must be maintained.

C.8.3 PRECLOSURE HYDROLOGY

Twenty-one comments were related to concerns about preclosure hydrology and address the geohydrologic setting of the site. The setting of the site must be compatible with all repository activities including construction, operation, and closure. Geohydrologic conditions that may exist at the site must not compromise the functions of shaft liners and seals. The comments are categorized into three issues: (1) Flooding Potential, (2) Water Supply, and (3) Ground-Water Conditions.

Issue: Flooding potential

Six comments were assigned to this issue. Five of the comments related to the placement of the repository surface facilities and the exploratory shaft facility in an area subject to sheet flow or flooding from the Probable Maximum Flood (PMF) and the Regional Maximum Flood (RMF). One commenter suggested that the U.S. Department of Energy (DOE) decide whether credit for flood protection through engineering measures be considered in determining the findings for guidelines 10 CFR 960.5-2-8(c) and 960.5-2-10(b)(2).

Response

The draft Environmental Assessment (EA) notes that part of the area being considered for construction of surface facilities could be inundated by the 500-year and RMF along Fortymile Wash. According to the draft EA, a combination of surface grading and construction of flood barriers and diversion channels would be used to prevent the flooding.

The RMF, which is used in the EA, represents an estimated maximum potential flood for a given drainage area. It is not dependent upon slope, duration, or surface features, nor does it provide frequency. The PMF will be calculated during site characterization and will be considered during license application design and selection of the exact location of the repository surface facilities. Shafts and portals to the subsurface facilities, as well as the exploratory shaft facilities, will be designed to be above the area inundated by the PMF and the RMF. Facilities may, however, be subject to sheet flow. Sheet flow is not flooding in the normal sense; it is of short duration, limited areal extent and carries a small volume of flow. Sheet flow cannot be controlled as a natural occurrence but can be diverted through standard drainage control measures.

Credit for flood protection, even if considered as standard drainage control measures, will not be taken for 10 CFR 960.5-2-10(b)(2). The favorable condition has been changed to "not present" in the final EA for the Yucca Mountain site.

Issue: Water supply

Eight comments relating to water supply were received. These comments dealt with the adequacy of water supplies for characterization, construction and operational phases of the repository, and present and planned water-supply needs of local water users. Many commenters indicated that the estimates of present and future water needs for both the repository and local uses were inaccurate, and suggested a reassessment of the impacts of repository-related water withdrawals.

Response

The water-supply figures presented in the draft EA were incomplete. Additional information containing updated water supply data, estimates of repository water use, and related impacts from water withdrawals are in sections 5.2.2, 6.2.1.7.5, and 6.3.3.3.3 of the final EA.

It does not appear that regional or local development plans exist in southern Nye County. The maximum annual water use for the repository would be only 3.3 percent of the sustainable yield of aquifers in the Amargosa Desert ground-water basin as defined by the State Engineer. This figure includes an estimated 86,000 gallons of water per day for dust suppression. The majority of the water will evaporate from the surface with minimal infiltration to the subsurface. The pumping history for Well J-13, which is likely to supply water to the repository, shows that lowering of the water table will probably be negligible.

Issue: Ground-water conditions

Seven comments relating to ground-water conditions within and above the potential repository host rock were received. The commenters suggested that further hydrologic investigations be conducted to determine the potential for perched water above the repository zone and the possibility that evaporation ponds will become recharge sources. There were also concerns relative to travel times of surface runoff from storm events to subsurface work tunnels, and the effects of a repository on the regional ground-water system.

Response

Further studies during site characterization will enhance understanding of the Death Valley ground-water system. These studies will also clarify whether a zero-discharge facility can be maintained. Evaporation ponds and storage piles will be lined to prevent infiltration of effluents into the local ground-water system. The travel time of surface runoff into subsurface work tunnels differs from most other systems in the case of Yucca Mountain since the overlying rocks are unsaturated. The very low moisture content in the potential host rock indicates that water traveling in a single fracture would quickly be pulled into the matrix pore space.

Further drilling during site characterization will provide more information on the potential for perched water. Should any perched water be encountered, it would be pumped or drained. The DOE has revised the final EA to include a discussion on the possibility of perched water.

C.8.4 PRECLOSURE TECTONICS

Twenty-four comments were submitted addressing the potential effects of tectonic processes and events on the preclosure of surface and underground facilities at Yucca Mountain. Several reviewers suggested changes of words and references presented in the draft Environmental Assessment (EA). A request was made that phrases indicating a similarity of design requirements for nuclear power plants and nuclear waste repositories be altered. A suggestion was made that the volcanic hazard during the preclosure time frame be more thoroughly examined. Concern was expressed that not all faults at Yucca Mountain have been satisfactorily examined and that strike-slip faulting in particular was largely overlooked in the EA. One commenter pointed out that estimates of acceleration at the site due to earthquakes on nearby faults were computed with outdated attenuation curves and relationships between fault length and event magnitude. Another commenter suggested that underground damage is very unlikely to result from surface accelerations less than 0.5g. Arguments were made against the U.S. Department of Energy (DOE) position that the second and third potentially adverse conditions listed in the EA are not present at the site. The second potentially adverse condition states that reasonable design requirements may be exceeded if historical earthquakes or underground nuclear explosions recur. The third potentially adverse condition states that tectonic evidence suggests a possibility that the magnitude of an earthquake occurring during operation of the surface facility (approximately the next 90 years) could exceed the magnitude

predicted on the basis of the historical seismic record. One commenter suggested that concern about tectonics should cover a longer time period, and another requested consideration of the potential for excavation-induced seismicity. Finally, four reviewers challenged the EA finding on the disqualifying condition (i.e., that the evidence does not suggest that engineering measures beyond reasonably available technology will be necessary for exploratory shaft construction or for repository construction, operation, or closure).

Response

Seismic design requirements for structures important to repository operation and personnel safety will comply with 10 CFR Part 60 and appropriate U.S. Environmental Protection Agency regulations. It is premature to state that requirements for the design of nuclear power plants are the same as those to be applied to a waste repository (Nuclear Regulatory Commission Comment 6-110 on Yucca Mountain Draft EA) (NRC, 1985). A summary of plans and methodology that will be used in developing seismic design criteria for the Yucca Mountain site was added to the final EA text in Section 6.3.3.4.5.

Earthquake recurrence intervals based on a preliminary copy of Carr (1984) have been deleted because of a change in the supporting document. Igneous activity at or near the site within the next 90 years is highly unlikely. Small volume basaltic volcanism is thought to be the most likely form of future volcanism in the southern Great Basin. The probabilities of volcanic activity are thoroughly discussed in Section 6.3.1.7.3 in the favorable condition evaluation. Exhumation of a repository by explosive cratering associated with hydrovolcanism is unlikely; the depth of burial of the repository is about four times the depth of craters formed by such processes (Crowe, 1985). The most recent probability calculations for the eruption of basalts at the site are on the order of 1 chance in 20 million to 1 chance in 3 billion per year (USGS, 1984).

Further consideration has been given in the final EA to the nature of strike-slip faulting in the vicinity of the site. Also, the nature and probability of movement of strike-slip and normal faults will be extensively studied during site characterization. The 0.4g acceleration that was estimated on the basis of a 6.8 magnitude earthquake on the Bare Mountain Fault (USGS, 1984) will not constitute the primary seismic risk estimate for Yucca Mountain. As discussed in Section 6.3.3.4.5, seismic design experts will evaluate the potentially active faults near the site to establish those that should be considered as potential seismogenic sources for repository design purposes. A table that provides estimates of acceleration as a function of earthquake magnitudes and distance from a fault has been added to Section 6.3.3.4.5 of the final EA. The fault rupture length required to produce a given earthquake magnitude is also included in the table. This table can be used to estimate the expected accelerations at the site if fault lengths and locations are known. However, the attenuation relationships provided are regional rather than site-specific.

Recurrence intervals for major earthquakes were compiled from a number of sources and are presented in Section 6.3.1.7.5. For earthquake magnitudes greater than or equal to 7, the recurrence interval for the Nevada Test Site

(NTS) region, from estimates in the literature, is on the order of 25,000 years; for earthquake magnitudes of greater than or equal to 6, the recurrence interval is estimated to be on the order of 2,500 years; and for earthquake magnitudes greater than or equal to 5, the recurrence intervals are about 250 years. Two historic earthquakes within the East-West Seismic Belt had magnitudes of 6, with the closer occurring in 1908 at a location 110 kilometers (68 miles) southwest of Yucca Mountain. For purposes of evaluation of the third potentially adverse condition evidence for higher-magnitude earthquakes than predicted from historical seismicity, it is assumed that the likelihood of a larger-than-historic event in the preclosure period (90 years) is low. Revisions to the text in the final EA explain the basis for this assumption.

Through July 1985, in a 4-year period of intensive monitoring, three microearthquakes with magnitudes less than 2 have been located within 2 kilometers (1.2 miles) of the Yucca Mountain near-field seismic network (approximately 5 kilometers (3 miles) by approximately 10 kilometers (6 miles), roughly centered on drill hole USW G-4). No historic earthquakes with determinable magnitudes greater than 3.6 have occurred within 10 kilometers (6 miles) of the site. Consideration of seismic data over a broader region, including several major earthquakes that have occurred within 350 kilometers (210 miles) of the site (USGS, 1984), ensures that the seismic potential of the site is not being underestimated. In situ stress measurements indicate that the local stress field is consistent with that throughout the Basin and Range (USGS, 1984) and that future slip may be more likely to occur on north- to northeast-trending fault planes. It should be noted that the attenuation curves that were used to estimate ground motion at the site, due to earthquakes in the vicinity (USGS, 1984), are outdated and were based largely on surface measurements of California events.

The ability of subsurface structures near the NTS to withstand strong ground motions is demonstrated by the many tunnels at Rainier Mesa which remain open and stable through extensive disturbances from both naturally occurring earthquakes as well as nearby underground nuclear explosions (Section 6.3.1.3). Extraordinary measures are not required throughout the region to cope with seismicity, as is the case in some parts of the world where development spans highly active tectonic plate margins (e.g., Japan, California, western South America). The EA text in Section 6.3.3.4.5 has been revised to explain the basis for claiming that reasonably available technology is sufficient to construct and operate a repository at Yucca Mountain. The text includes a review of design options that have been used for other facilities to accommodate strong ground motion and displacements. A major discussion was also added to Section 6.3.3.4.5 on the methodology that will be used by the Nevada Nuclear Waste Storage Investigations Project for assessing the significance of seismic and tectonic events, both for the preclosure and postclosure periods.

C.8.5 SYSTEM GUIDELINE

No comments were received in this category.

REFERENCES FOR CHAPTER C.8

Carr, W. J., 1984. Regional Structural Setting of Yucca Mountain, Southwestern Nevada, and Late Cenozoic Rates of Tectonic Activity in Part of the Southwestern Basin, Nevada and California, USGS-OFR-84-854, Open-File Report, U.S. Geological Survey, Denver, Colo.

Crowe, B. M., K. H. Wohletz, D. T. Vaniman, and E. Gladney, 1985. Volcanic Hazard Studies for the Nevada Nuclear Waste Storage Investigations: Part II, Los Alamos National Laboratory, Los Alamos, N. Mex.

Healy, J. H., S. H. Hickman, M. D. Zoback, and W. L. Ellis, 1984. Report on Televiewer Log and Stress Measurements in Core Hole USW-G1, Nevada Test Site, December 13-22, 1981, USGS-OFR-84-15, Open-File Report, U.S. Geological Survey, Menlo Park, Calif.

Hustrulid, W., 1984. Lining Considerations for a Circular Vertical Shaft in Generic Tuff, SAND83-7068, Sandia National Laboratories, Albuquerque, N. Mex..

Johnstone, J. K., R. R. Peters, and P. F. Gnirk, 1984. Unit Evaluation at Yucca Mountain, Nevada Test Site: Summary Report and Recommendation, SAND83-0372, Sandia National Laboratories, Albuquerque, N. Mex.

Lipman, P. W., and E. J. McKay, 1965. "Geologic Map of the Topopah Spring SW Quadrangle, Nye County, Nevada," U.S. Geological Survey Quadrangle Map GQ-439, Scale 1:24,000, Washington, D.C.

Maldonado, F., and S. L. Koether, 1983. Stratigraphy, Structure, and Some Petrographic Features of Tertiary Volcanic Rocks at the USW G-2 Drill Hole, Yucca Mountain, Nye County, Nevada, USGS-OFR-83-732, Open-File Report, U.S. Geological Survey, Denver, Colo., 83 p.

Mansure, A. J., and T. S. Ortiz, 1984. Preliminary Evaluation of the Subsurface Area Available for a Potential Nuclear Waste Repository at Yucca Mountain, SAND84-0175, Sandia National Laboratories, Albuquerque, N. Mex.

NRC (U.S. Nuclear Regulatory Commission), 1985. NRC Comments on DOE Draft Environmental Assessment for Yucca Mountian Site, March 20, 1985.

Ortego, P. K., 1985. Letter from P. K. Ortego (F&S) to J. J. D'Lugosz (DOE/NVO), ADM-9415, September 17, 1985; regarding NTS ground support experience.

Scott, R. B. and M. Castellanos, 1984. Stratigraphic and Structural Relations of Volcanic Rocks in Drill Holes USW GU-3 and USW G-3, Yucca Mountain, Nye County, Nevada, USGS-OFR-84-491, Open-File Report, U.S. Geological Survey, Denver, Colo.

Spengler, R. W., and M. P. Chornack, 1984. Stratigraphic and Structural Characteristics of Volcanic Rocks in Core Hole USW G-4, Yucca Mountain, Nye County, Nevada, with a section of geophysical logs by D. C. Muller and J. E. Kibler, USGS-OFR-84-789, Open-File Report, U.S. Geological Survey, Denver, Colo.

Spengler, R. W., F. M. Byers, Jr., and J. B. Warner, 1981. Stratigraphy and Structure of Volcanic Rocks in Drill Hole USW G-1, Yucca Mountain, Nye County, Nevada, USGS-OFR-81-1349, Open-File Report, U.S. Geological Survey, Denver, Colo.

Squires, R. R., and R. L. Young, 1984. Flood Potential of Fortymile Wash and Its Principal Southwestern Tributaries, Nevada Test Site, Southern Nevada, USGS-WRI-83-4001, Water-Resources Investigations Report, U.S. Geological Survey, Carson City, Nev.

Stock, J. M., J. H. Healy, and S. H. Hickman, 1984. Report on Televiewer Log and Stress Measurements in Core Hole USW G-2, Nevada Test Site, October-November 1982, USGS-OFR-84-172, U.S. Geological Survey, Menlo Park, Calif.

Tibbs, H., 1985. Letter from H. Tibbs (F&S) to J. J. D'Lugosz (DOE/NVO), September 23, 1985; regarding mining experience through faulted welded tuff beds in U12G Tunnel "Rock Mechanics" drift.

Tillerson, J. R., and F. B. Nimick, 1984. Geoengineering Properties of Potential Repository Units at Yucca Mountain, Southern Nevada, SAND84-0221, Sandia National Laboratories, Albuquerque, N. Mex.

USGS (U.S. Geological Survey), 1961. Topopah Spring SW Quadrangle Map, Nevada-Nye County, U.S. Geologic Survey 7.5 minute series (Topographic), Denver, Colo.

USGS (U.S. Geological Survey) (comp.), 1984. A Summary of Geologic Studies through January 1, 1983, of a Potential High-Level Radioactive Waste Repository Site at Yucca Mountain, Southern Nye County, Nevada, USGS-OFR-84-792, Open-File Report, U.S. Geological Survey, Menlo Park, Calif.

CODES AND REGULATIONS

10 CFR Part 60 (Code of Federal Regulations), 1983. Title 10, "Energy," Part 60, "Disposal of High-Level Radioactive Wastes in Geologic Repositories," U.S. Government Printing Office, Washington, D.C.

10 CFR Part 960 (Code of Federal Regulations), 1984. Title 10, "Energy," Part 960, "General Guidelines for the Recommendation of Sites for Nuclear Waste Repositories; Final Siting Guidelines," 49 FR 47714, Vol. 49, No. 236, December 6, 1984, pp. 47714-47769.

C.9 COMMENT-RESPONSE INDEX

In its Federal Register notice of December 20, 1984, announcing the availability of the draft EAs, the DOE requested that interested parties review the documents and send their comments to the DOE in Washington, D.C. for the comment record. In addition, the DOE held a series of public hearings in the six first-repository States and one adjacent State. The written and oral testimony from these hearings was also included in the formal comment record.

Each letter and the testimony of each hearing participant were assigned a number. The letters and testimony were then reviewed to identify comments, and the comments in each letter were numbered sequentially. Copies of the comments and letters can be seen at the DOE reading rooms in Washington, D.C.; Columbus, Ohio; Las Vegas, Nevada; and Richland, Washington. The individual comments were assigned a classification code that corresponds to a subject area in the comment-response document (CRD). In some cases, a comment was addressed in more than one subject area in the CRD, and these comments were assigned more than one classification code.

This index lists all of the comments that apply to the Yucca Mountain draft EA. By using this index, the commenter can find the section of the CRD that discusses the issues raised in his or her comment letter or testimony at a public hearing. The commenters are listed by State. The index lists the commenters alphabetically by their last name, their organizational affiliation where applicable, the number assigned to the letter or testimony, the comment numbers, and the classification number for that comment. If the issues raised by the comment are discussed in more than one section of the CRD, additional classification numbers were assigned and are listed in the second, third, and fourth classification columns. Up to four classifications can be listed for each comment.

Thus, to see how the DOE classified the comments and responded to the issues raised in your comment letter or hearing testimony, look up your name under the listing from your State. Under the comment column number you will find a list of the comments the DOE identified in your letter. In the classification column find the classification number(s) assigned to that comment. The classification numbers refer to the sections of the CRD, and the CRD Table of Contents will show the page numbers for the section that discusses the issues raised by your comments.

INDEX OF COMMENTS ON THE DRAFT ENVIRONMENTAL ASSESSMENT FOR THE YUCCA MOUNTAIN SITE

STATE	NAME	ORGANIZATION	LETTER NUMBER	COMMENT NUMBER	CLASSIFICATION FIRST	SECOND	THIRD	FOURTH
Alabama								
	Leonard, R. Michael		02077	00001	C.3.1.2	--	--	--
			02077	00002	C.3.4.4	--	--	--
			02077	00005	C.3.4.4	--	--	--
Arkansas								
	Mote, Mike		00306	00001	C.3.1.2	--	--	--
Arizona								
	Campugano, Elizabeth	Friends Southwest Center	00175	00002	C.3.1.2	--	--	--
	Connolly, Marjorie		02675	00001	C.3.1.2	--	--	--
			02675	00003	C.3.1.2	--	--	--
	Coxhead, Richard A.		00409	00001	C.3.4.4	--	--	--
	Dankwort, Rudolf		00413	00001	C.3.4.4	--	--	--
			00413	00002	C.3.4.2.2	--	--	--
	Dugall, Dr. John C.		00104	00001	C.3.4.4	--	--	--
			00104	00003	C.3.4.4	--	--	--
	Evans, Arthur H.		00096	00001	C.3.4.4	--	--	--
	Findlay, III, Robert S.		00253	00001	C.3.4.4	--	--	--
	Hill, Richard C.		01347	00006	C.3.4.4	--	--	--
	Kissock, Kelly	Verde Valley School, Math dept.	01533	00001	C.3.1.2	--	--	--
			01533	00002	C.3.1.2	--	--	--
			01533	00003	C.3.1.2	--	--	--
	Lawson, Duane		01313	00001	C.3.1.2	--	--	--
			01313	00004	C.3.1.2	--	--	--
			01313	00005	C.3.4.4	--	--	--
	Lundquist, Evelyn		01084	00001	C.3.4.4	--	--	--
	Lundstrom, Kristen		00067	00001	C.3.1.2	--	--	--
	McCarty, Doug		00223	00004	C.2.4.1	--	--	--
			00223	00006	C.2.8.1	--	--	--
			00223	00007	C.3.4.3	--	--	--
	McClelland, Brian K.		01353	00001	C.3.4.4	--	--	--
			01353	00002	C.3.4.4	--	--	--
			01353	00004	C.2.1.2	--	--	--
	O'Neill, Colleen		00329	00003	C.3.1.2	--	--	--
	Vicini, Linda M.		00244	00001	C.3.4.4	--	--	--
	Winter, John T.		00310	00001	C.3.1.2	--	--	--
			00310	00003	C.3.4.4	--	--	--

INDEX OF COMMENTS ON THE DRAFT ENVIRONMENTAL ASSESSMENT FOR THE YUCCA MOUNTAIN SITE

STATE	NAME	ORGANIZATION	LETTER NUMBER	COMMENT NUMBER	CLASSIFICATION FIRST	SECOND	THIRD	FOURTH
California								
	Anonymous		00106	00001	C.3.4.4	--	--	--
	Bacher Jr., Mrs. Frederick A.		00101	00001	C.3.1.2	--	--	--
			00101	00005	C.3.4.4	--	--	--
	Ballsun, C.		00075	00001	C.3.4.4	--	--	--
	Berke, Eleanor		00351	00001	C.3.4.4	--	--	--
			00351	00002	C.3.1.2	--	--	--
	Bock, A.J.	American Rock Art Research Assc.	01056	00001	C.3.4.4	--	--	--
	Brideabecker, John S.	Southern CA Edison Co.	01351	00001	C.2.3.3	--	--	--
			01351	00002	C.4.1	C.2.7	--	--
			01351	00003	C.4.3	C.4.3	--	--
			01351	00004	C.4.3	C.4.3	--	--
			01351	00005	C.2.8.3	C.4.3	--	--
			01351	00006	C.2.4.1	--	--	--
	Cameron, Lillian S.		00115	00001	C.3.4.4	--	--	--
			00115	00005	C.3.4.4	--	--	--
	Campbell, Todd		00267	00001	C.3.4.4	--	--	--
	Durbin, Emily	Sierra Club	01221	00001	C.4.1.2.2	--	--	--
			01221	00002	C.5.4	--	--	--
			01221	00003	C.4.1.2.2	--	--	--
			01221	00004	C.6.4	--	--	--
			01221	00005	C.5.7	--	--	--
			01221	00006	C.4.1.3.3	--	--	--
			01221	00007	C.4.1.3.3	--	--	--
			01221	00008	C.4.1.3.2	--	--	--
			01221	00009	C.3.1.2	--	--	--
	Geisler, Dorothy		00073	00001	C.3.4.4	--	--	--
			00073	00004	C.3.4.4	--	--	--
			00073	00005	C.2.8.1	--	--	--
	Goodman, Michael		00222	00001	C.3.4.4	--	--	--
			00222	00002	C.2.8.3	--	--	--
	Gross, Caroline		00225	00001	C.2.8.1	--	--	--
			00225	00002	C.3.1.2	--	--	--
	Gundky, Frederic R.		00068	00001	C.3.3.1	--	--	--
	Holladay, Kevin		01060	00001	C.3.1.2	--	--	--
			01060	00002	C.3.4.4	--	--	--
	Jett, Dr. Stephen C.	Univ. Cal. Geog. Dept	00016	00002	C.3.4.4	--	--	--
	Jones-Johnson, Ola Mae		00027	00001	C.3.4.4	--	--	--
	Jones-Smith, Aree		00023	00001	C.3.4.4	--	--	--

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STATE	NAME	ORGANIZATION	LETTER NUMBER	COMMENT NUMBER	CLASSIFICATION FIRST	SECOND	THIRD	FOURTH
California (continued)								
	Jones-Smith, Willie Lou		00032	00001	C.3.4.4	--	--	--
	Lundholm, Mrs. A. M.		02108	00001	C.2.5.2	--	--	--
	Martin, Frankie and Bob		00197	00001	C.3.4.4	--	--	--
	McCreery, Scott		01133	00001	C.3.4.4	--	--	--
	Mitchell, Mrs. Barbara A.		00179	00005	C.3.1.2	--	--	--
	Moore, Carey		00019	00001	C.3.4.4	--	--	--
	Moore, Willie		00025	00001	C.3.4.4	--	--	--
	Moore, Calvin		00033	00001	C.3.4.4	--	--	--
	Moore, Sr., Albert J.		00018	00001	C.3.4.4	--	--	--
	Moore-Loud, Gloria D.		00039	00001	C.3.4.4	--	--	--
	Moore-Parker, Laura		00024	00001	C.3.4.4	--	--	--
	Moore-Robinson, Annie		00026	00001	C.3.4.4	--	--	--
	Oman, Barbara		02704	00001	C.3.1.2	--	--	--
			02704	00002	C.3.4.4	--	--	--
	Parkins, Cheryl		01062	00001	C.3.4.4	--	--	--
	Patterson, Wendy Bents		02610	00001	C.3.1.2	--	--	--
			02610	00003	C.3.1.2	--	--	--
	Poland, Roscoe A.	Conservation Call	00198	00002	C.3.1.2	--	--	--
	Preyer, Bernard		02700	00001	C.3.4.4	--	--	--
			02700	00002	C.3.1.2	--	--	--
	Ramsey, Rande		01194	00003	C.3.1.2	--	--	--
			01194	00004	C.7.1	--	--	--
	Ready, James P.	The James P. Ready Co.	01577	00001	C.3.1.2	--	--	--
	Rittenhouse, Jan		00328	00002	C.3.1.2	--	--	--
	Robertson, Marilyn		01579	00001	C.3.4.4	--	--	--
	Ryall, Marjorie M.		00117	00001	C.3.4.4	--	--	--
			00117	00006	C.3.4.4	--	--	--
	Saretsky, Richard D.		00279	00002	C.3.1.2	--	--	--
	Sawyer, Benjamin		02701	00001	C.3.4.4	--	--	--
			02701	00002	C.3.1.2	--	--	--
			02701	00003	C.2.8.1	--	--	--
	Schuster, Megan H.		00439	00002	C.3.1.2	--	--	--
	Skews, Geoff		00133	00005	C.3.1.2	--	--	--
	Stansfield, Elaine	Ecology Ctr. of So. California	00059	00001	C.3.4.4	--	--	--
			00059	00002	C.2.1.1	--	--	--
			00059	00003A	C.2.7	--	--	--
			00059	00003B	C.3.4.2.1	--	--	--
			00059	00038	C.2.8.1	C.2.8.2	--	--

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STATE	NAME	ORGANIZATION	LETTER NUMBER	COMMENT NUMBER	CLASSIFICATION FIRST	SECOND	THIRD	FOURTH
California (continued)								
	Swanson, John R.		00446	00001	C.3.4.4	--	--	--
	Wasson, Glenn E.		00254	00001	C.5.7	--	--	--
			00254	00002	C.3.1.3	--	--	--
			00254	00003	C.3.4.4	--	--	--
			00254	00004	C.2.3.1	--	--	--
			00254	00005	C.2.6.1	--	--	--
			00254	00006	C.2.8	--	--	--
			00254	00007	C.2.1	--	--	--
			00254	00008	C.3.4.4	--	--	--
			00254	00009	C.5.7	--	--	--
			00254	00010	C.5.7	--	--	--
			00254	00011	C.2.8.2	--	--	--
			00254	00012	C.2.8.2	--	--	--
			00254	00013	C.2.8.2	--	--	--
	Weatherwax, Robert K.	Sierra Energy & Risk Assessment	01366	00001	C.3.4	--	--	--
			01366	00002	C.3.4.3	--	--	--
			01366	00003	C.3.4.3	--	--	--
			01366	00004	C.3.4	--	--	--
			01366	00005	C.3.4.3	--	--	--
			01366	00006	C.3.4.2	--	--	--
			01366	00007	C.3.4.3	--	--	--
			01366	00008	C.3.4.3	--	--	--
			01366	00009	C.3.3	--	--	--
			01366	00010	C.3.4.1	--	--	--
			01366	00011	C.3.4.3	--	--	--
	Webster, Donald B.		00613	00001	C.3.4.4	--	--	--
	Yasuda, Don		00443	00001	C.3.4.4	--	--	--
	York, Jennifer		00060	00001	C.2.8.1	--	--	--
			00060	00001A	C.3.1.2	--	--	--
			00060	00001B	C.2.7	--	--	--
Colorado								
	Adams, Cass		01178	00001	C.3.4.4	--	--	--
	Adams, Craig		01304	00001	C.3.1.2	--	--	--
			01304	00002	C.2.2	--	--	--
	Anderson, John and Leanna		00527	00003	C.3.1.2	--	--	--
	Anderson, Virginia S.		00581	00001	C.3.1.2	--	--	--

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STATE	NAME	ORGANIZATION	LETTER NUMBER	COMMENT NUMBER	CLASSIFICATION FIRST	SECOND	THIRD	FOURTH
Colorado (continued)								
	Anderst, Daryl		00318	00001	C.3.1.2	--	--	--
	Andy, Charles		00562	00001	C.2.1.1	--	--	--
	Anonymous		01184	00001	C.3.1.2	--	--	--
	Auerlah, Catherine E.		00601	00001	C.3.4.4	--	--	--
	Bartley, Ben		00565	00001	C.3.4.4	--	--	--
	Bedwell, Jackie		00636	00001	C.3.4.4	--	--	--
			00636	00002	C.3.4.4	--	--	--
	[illegible] A.		00594	00001	C.3.1.2	--	--	--
	Benjamin, Laurie		00350	00001	C.3.4.4	--	--	--
	Bennett, Sandy		01049	00001	C.3.1.2	--	--	--
	Bernard, Joan		00307	00001	C.3.1.2	--	--	--
	Bertram, Diane		00410	00001	C.3.4.4	--	--	--
	Biggers, John		01371	00002	C.3.1.2	--	--	--
	Binkowski, David J.		00634	00002	C.7.1	--	--	--
	Bloom, Claudia		00260	00002	C.3.4.4	--	--	--
	Bly, Karel S.		01141	00001	C.3.1.2	--	--	--
	Bomer, Frances		00559	00001	C.3.1.2	--	--	--
	Borkovec, Rick		01256	00001	C.3.1.2	--	--	--
			01256	00003	C.3.1.2	--	--	--
	Borowski, Ann		01377	00002	C.3.1.2	--	--	--
	Borton, Perry		01334	00002	C.3.1.3	--	--	--
	Boss, Roger		01336	00002	C.3.1.3	--	--	--
	Boyce, Cheryl		00584	00001	C.3.1.2	--	--	--
	Brainerd, Alice		00346	00001	C.3.4.4	--	--	--
			00346	00002	C.2.8.1	--	--	--
	Breazzano, Debra		00558	00001	C.3.1.2	--	--	--
	Brown, Keri		00596	00001	C.3.1.2	--	--	--
	Burpee, Elizabeth		00586	00003	C.2.8.1	--	--	--
	Byerly, Alan		00549	00001	C.3.1.2	--	--	--
	Byerly, Gay Porter		01303	00001	C.3.1.2	--	--	--
			01303	00002	C.3.1.2	--	--	--
			01303	00003	C.3.1.2	--	--	--
	Carney, Jerry & Jennifer S.		00078	00001	C.3.4.4	--	--	--
			00078	00007	C.3.1.2	--	--	--
			00078	00009	C.3.4.4	--	--	--
	Clark, Caroline		01349	00001	C.3.1.2	--	--	--
	Coff, Harry E.		01182	00003	C.2.1.1	--	--	--
	Cole, Sally J.		01138	00001	C.3.1.2	--	--	--

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Colorado (continued)								
			01138	00003	C.3.1.2	--	--	--
	Cook, Jane M.		00607	00001	C.3.4.4	--	--	--
	Cooper, Sandra H.		00660	00004	C.3.1.2	--	--	--
	Cunningham, Hartley, Timothy & Janice		00385	00003	C.3.4.4	--	--	--
	Dailey, Carolyn J.	Fort Lewis College	00655	00001	C.3.4.4	--	--	--
			00655	00003	C.3.1.2	--	--	--
	Dobben, Talie		01046	00001	C.3.1.2	--	--	--
	Dowell, Bill, March & Ryan		01546	00001	C.3.1.2	--	--	--
			01546	00002	C.3.1.2	--	--	--
	Dyson, Rick		01064	00001	C.3.1.2	--	--	--
	Engman, Shelley		00572	00001	C.3.1.2	--	--	--
	Ewert, Daniel,Alex & Krista		01559	00001	C.3.4.4	--	--	--
	Farnsworth, Pam		00441	00001	C.3.1.2	--	--	--
			00441	00002	C.3.1.2	--	--	--
	Fay, Thomas		01223	00001	C.3.1.2	--	--	--
			01223	00002	C.3.1.2	--	--	--
	Fay, Janet M.		02255	00001	C.3.1.2	--	--	--
	Ferst, F.		01185	00002	C.3.1.2	--	--	--
			01185	00003	C.2.3	--	--	--
			01185	00004	C.2.3	--	--	--
	Fitzpatrick,Jr., Joseph W.		01309	00001	C.3.1.2	--	--	--
			01309	00003	C.3.1.2	--	--	--
	Fogarty, Steven		00569	00001A	C.3.4.4	--	--	--
			00569	00001B	C.3.4.4	--	--	--
	Fogg, Peter L.		01123	00002	C.2.4.1	--	--	--
			01123	00004	C.3.1.2	--	--	--
			01123	00006	C.3.1.2	--	--	--
			01123	00008	C.3.1.2	--	--	--
			01123	00009	C.3.1.1	--	--	--
			01123	00010	C.2.7	--	--	--
			01123	00011	C.3.4.4	--	--	--
	Fowler, Catherine		00566	00001	C.3.1.2	--	--	--
	Fowler, Jessica		00606	00001	C.3.4.4	--	--	--
	Fox, Genevieve		00577	00001	C.3.4.4	--	--	--
			00577	00002	C.3.1.2	--	--	--
	Frankel, Miriam		01345	00004	C.2.4.1	--	--	--
	Friedman, Margaret		00615	00001	C.3.4.4	--	--	--
	Friedman, Jonathan		01089	00001	C.3.4.4	--	--	--

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STATE	NAME	ORGANIZATION	LETTER NUMBER	COMMENT NUMBER	CLASSIFICATION FIRST	SECOND	THIRD	FOURTH
Colorado (continued)								
	Geraghty, Matt		00428	00001	C.3.1.2	--	--	--
	Gibbons, Mary Jo & John		01561	00001	C.3.4.4	--	--	--
	Gobhardt, Larry		01375	00002	C.3.1.2	--	--	--
	Goodtimes, Art	Telluride Times	02186	00001	C.3.4.4	--	--	--
	Goswick, Jeffrey		00603	00001	C.3.4.4	--	--	--
			00603	00002	C.2.8.2	--	--	--
	Gray, Douglas E.		01179	00001	C.3.1.2	--	--	--
	Grayson, Arlie		00085	00001	C.3.1.2	--	--	--
			00085	00002	C.3.1.2	--	--	--
	Green, Douglas J.		00654	00001	C.2.8.2	--	--	--
			00654	00002	C.3.4.4	--	--	--
	Gregory, Lee		00215	00001	C.3.4.4	--	--	--
	Gronwall, Raymond J.		00348	00001	C.3.1.2	--	--	--
			00348	00005	C.2.4.1	--	--	--
			00348	00006	C.2.4.1	--	--	--
	Groth, Mark and Kathy		00414	00002	C.3.1.2	--	--	--
	Groves, Anthony		01176	00001	C.3.1.2	--	--	--
			01176	00003	C.3.1.2	--	--	--
	Gruer, Mary K.		01177	00001	C.3.4.4	--	--	--
	Gudavski, LeCindra		00545	00001	C.3.1.2	--	--	--
	Hackl, Diane		00602	00001	C.3.4.4	--	--	--
	Hannegan,Jr., David W.		01159	00005	C.2.8.2	--	--	--
			01159	00006	C.2.8.1	--	--	--
	Hart, Robert L. & Linda P.		00289	00001	C.3.1.2	--	--	--
	Hassan, Peter C.		00637	00002	C.3.4.4	--	--	--
	Heitzer, Mark		01330	00002	C.3.1.3	--	--	--
	Hempel, Paul		01189	00001	C.3.1.2	--	--	--
	Hinchman, John S.	Bent, St. Vrain Partners Inc.	01310	00001	C.3.1.2	--	--	--
			01310	00002	C.3.1.2	--	--	--
			01310	00003	C.3.1.2	--	--	--
	Hines, LeAnne		00444	00001	C.3.4.4	--	--	--
	Humphrey, Peter		02075	00005	C.3.4.4	--	--	--
	Jackson, Cathy		01332	00002	C.3.1.3	--	--	--
	Jernigan, Richard		01257	00001	C.3.1.2	--	--	--
			01257	00003	C.3.1.2	--	--	--
	Johnson, Nina		00371	00001	C.3.1.2	--	--	--
	Johnson, Misti		01255	00001	C.3.1.2	--	--	--
			01255	00003	C.3.1.2	--	--	--

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STATE	NAME	ORGANIZATION	LETTER NUMBER	COMMENT NUMBER	CLASSIFICATION FIRST	SECOND	THIRD	FOURTH
Colorado (continued)								
	Jones, Charles A.	Allied Bendix Aerospace	02660	00001	C.2.7	--	--	--
	Kaempfer, Suzanne H.		00013	00001	C.3.1.2	--	--	--
			00013	00004	C.3.4.4	--	--	--
	Kapushion, Nettie		01376	00002	C.3.1.2	--	--	--
	Kelly, Allen L.		02078	00002	C.3.4.4	--	--	--
	Kiklevich, Roark, Eric & Abby		01548	00001	C.3.1.2	--	--	--
			01548	00002	C.3.1.2	--	--	--
	Kimmer, Sheryl A		01137	00001	C.2.2.1	--	--	--
			01137	00005	C.2.4.1	--	--	--
	Kirk, Allison		01059	00001	C.3.4.4	--	--	--
			01059	00003	C.3.4.4	--	--	--
			01059	00004	C.2.4.1	--	--	--
	Kornreich, Scott K.		01225	00002	C.3.1.2	--	--	--
	Kovanic, Ronald		01374	00002	C.3.1.2	--	--	--
	Kurtz, Frederick W.		01254	00001	C.3.1.2	--	--	--
			01254	00003	C.3.1.2	--	--	--
	Kurtz, Robyn		01378	00002	C.3.1.2	--	--	--
	Lamm, Governor Richard	State of Colorado	01398	00001	C.2.4.1	--	--	--
			01398	00002	C.2.4.1	--	--	--
			01398	00003	C.2.4.1	--	--	--
			01398	00004	C.3.4.3	--	--	--
			01398	00005	C.2.4.1	--	--	--
			01398	00006	C.2.4.1	C.7.3	--	--
			01398	00007	C.3.4.2.2	--	--	--
			01398	00008	C.2.4.1	--	--	--
			01398	00009	C.2.4.1	--	--	--
			01398	00010	C.2.4.1	--	--	--
	Landing, Sharon A.		00475	00001	C.3.4.4	--	--	--
	Larsen, Suzanne		01204	00001	C.3.1.2	--	--	--
			01204	00003	C.3.1.2	--	--	--
	Lehman, Dale E.	Fort Lewis College	00118	00001	C.2.1.1	--	--	--
			00118	00002A	C.3.4.3	--	--	--
			00118	00002B	C.2.1.1	--	--	--
			00118	00002C	C.2.1.1	--	--	--
			00118	00004	C.3.4.4	--	--	--
			00118	00006	C.3.4.2.2	--	--	--
			00118	00007	C.3.4.2.2	--	--	--
	Lehmann, Scott K.	Univ. of Colorado, Boulder	00503	00001	C.3.1.2	--	--	--

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STATE	NAME	ORGANIZATION	LETTER NUMBER	COMMENT NUMBER	CLASSIFICATION FIRST	SECOND	THIRD	FOURTH
Colorado (continued)								
			00503	00005	C.3.1.2	--	--	--
			00503	00006	C.3.4.4	--	--	--
	Lucas, David		00405	00001	C.3.4.4	--	--	--
			00405	00003	C.3.1.2	--	--	--
	M., D.		00639	00001	C.2.8.1	--	--	--
	Magyar, John and Mike		02661	00001	C.3.4.4	--	--	--
			02661	00007	C.3.1.2	--	--	--
	[illegible]		00082	00001	C.3.4.4	--	--	--
	Marsh, Robin		00571	00002	C.3.1.2	--	--	--
	Marshall, Katherine J.		00548	00001	C.3.1.2	--	--	--
	Martin, James B.	Environmental Defense Fund	01259	00001	C.2.1.1	--	--	--
			01259	00002	C.2.4.1	--	--	--
			01259	00003	C.2.4.1	--	--	--
			01259	00004	C.2.4.1	--	--	--
			01259	00005	C.3.1.2	--	--	--
			01259	00006	C.3.1.2	--	--	--
			01259	00007	C.2.4.1	--	--	--
			01259	00008	C.2.4.1	--	--	--
			01259	00009	C.2.4.1	--	--	--
			01259	00010	C.5.7	--	--	--
			01259	00011	C.2.4.1	--	--	--
			01259	00012	C.2.4.1	--	--	--
			01259	00013	C.2.4.1	--	--	--
			01259	00014	C.2.4.1	--	--	--
			01259	00015	C.2.4.1	--	--	--
			01259	00016	C.2.4.1	--	--	--
			01259	00017	C.2.4.1	--	--	--
			01259	00018	C.2.4.1	--	--	--
			01259	00019	C.2.4.1	--	--	--
			01259	00020	C.2.4.1	--	--	--
			01259	00021	C.2.4.1	--	--	--
			01259	00022	C.2.4.1	--	--	--
	Mattina, Carol		01047	00001	C.3.1.2	--	--	--
	Mattox, Paul		00638	00001	C.3.1.2	--	--	--
	May, Jeffrey		00311	00001	C.3.4.4	--	--	--
			00311	00003	C.3.4	--	--	--
	Maynard, Andrea G.		00153	00001	C.3.1.2	--	--	--
	McCool, Lewis		02182	00001	C.3.4.4	--	--	--

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Colorado (continued)								
			02182	00005	C.7.2	--	--	--
			02182	00006	C.7.2	--	--	--
			02182	00007	C.7.2	--	--	--
	McFarland, Kristy		01287	00001	C.3.4.4	--	--	--
	McNabb, Donald		01145	00001	C.3.4.4	--	--	--
	Mcllellan, Rosalind		01331	00002	C.3.1.3	--	--	--
	Mears, Mike		01547	00001	C.3.1.2	--	--	--
			01547	00002	C.3.1.2	--	--	--
	[illegible], [illegible]		01063	00001	C.3.1.2	--	--	--
	Monash, Jessica		02611	00001	C.3.1.2	--	--	--
			02611	00003	C.3.1.2	--	--	--
			02611	00019	C.3.4	--	--	--
	Montfredo, Steven		01373	00002	C.3.1.2	--	--	--
	Morehouse, Don		01312	00001	C.3.1.2	--	--	--
			01312	00002	C.3.1.2	--	--	--
	Muhlbeim, Robert John		00319	00001	C.3.1.2	--	--	--
			00319	00002	C.3.1.2	--	--	--
	Muller, Fred R.		01180	00001	C.3.4.4	--	--	--
	Mullhauser, Amy		00658	00001	C.3.4.4	--	--	--
	Nabil, David		01572	00001	C.3.1.2	--	--	--
			01572	00002	C.3.1.2	--	--	--
	Nailling, Elizabeth	[illegible]	02257	00001	C.3.4.4	--	--	--
	Najaft, Melinda		00561	00001	C.3.1.2	--	--	--
	Nall, Chris		00354	00001	C.3.4.4	--	--	--
			00354	00002	C.3.1.2	--	--	--
	Nichell, David		00568	00001	C.3.1.2	--	--	--
	Nowlin, Dawn		01329	00002	C.3.1.3	--	--	--
	Oberling, Bill		01562	00001	C.3.4.4	--	--	--
	Palmer, Alice G. & Mark F.		01318	00001	C.3.1.2	--	--	--
			01318	00003	C.3.1	--	--	--
	Papp, Lawrence A.		00557	00004	C.3.1.2	--	--	--
			00557	00005	C.3.1.2	--	--	--
	Pearson, Mark D.		01337	00002	C.2.4.1	--	--	--
			01337	00006	C.3.1.2	--	--	--
			01337	00007	C.3.1.2	--	--	--
	Pehowski, Paula		00412	00001	C.3.4.4	--	--	--
	Peineiaro, John	[illegible]	01191	00001	C.3.4.4	--	--	--
	Pena, Mayor Frederico	City and County of Denver	02115	00001	C.2.4.1	--	--	--

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STATE	NAME	ORGANIZATION	LETTER NUMBER	COMMENT NUMBER	CLASSIFICATION FIRST	SECOND	THIRD	FOURTH
Colorado (continued)								
			02115	00002	C.2.4.1	--	--	--
			02115	00003	C.2.4.1	--	--	--
			02115	00004	C.2.4.1	--	--	--
			02115	00005	C.2.4.1	--	--	--
	Petersen, Paul		01201	00001	C.3.4.4	--	--	--
			01201	00002	C.3.1.2	--	--	--
			01201	00003	C.2.4.1	--	--	--
	[illegible] S.		00598	00001	C.3.1.2	--	--	--
	[illegible]		00604	00001	C.3.4.4	--	--	--
	Phillips, Jeff		01188	00001	C.3.1.2	--	--	--
	Pond, Timothy C.		00578	00001A	C.3.1.2	--	--	--
	Robnett, Douglas B.		02071	00001	C.3.4.4	--	--	--
	Rolphe, Timothy M.		01560	00001	C.3.4.4	--	--	--
	Roof, Steven R.		00236	00003	C.3.1.2	--	--	--
	Ruckel, H. Anthony	Sierra Club Legal Defense Fund	01358	00019	C.3.1.2	--	--	--
	Salek, P.		01051	00001	C.3.1.2	--	--	--
	Salk, Joy L.		00560	00001	C.3.1.2	--	--	--
	Shaw, Karyl L.		00605	00001	C.3.4.4	--	--	--
			00605	00003	C.3.1.2	--	--	--
	Shinn, Joyce A.		01300	00001	C.3.4.4	--	--	--
			01300	00002	C.3.4.4	--	--	--
			01300	00003	C.3.4.4	--	--	--
			01300	00004	C.3.4.4	--	--	--
	Slater, Mark		00406	00001	C.3.4.4	--	--	--
			00406	00003	C.3.1.2	--	--	--
	Somrak, Mary Jo & Michael		01379	00002	C.3.1.2	--	--	--
	Spence, Robin E.		01564	00001	C.3.4.4	--	--	--
	Spezia, John W.		00012	00001	C.3.4.4	--	--	--
			00012	00002	C.3.1.2	--	--	--
	Spivak, Paul		00579	00002	C.3.1.2	--	--	--
	Starnsberry, Donna		01192	00001	C.3.1.2	--	--	--
	Stokes, Wendy L.		00284	00002	C.2.8.1	--	--	--
	Street, [illegible]anna		01050	00001	C.3.1.2	--	--	--
	Sucheraan, Kathy		00147	00001	C.3.4.4	--	--	--
	Sweeney, Chris		01045	00001	C.3.1.2	--	--	--
	Tausehn, Guy		00576	00001	C.3.4.4	--	--	--
			00576	00002	C.3.4.4	--	--	--
	Thomas, Jan		01277	00001	C.3.4.4	--	--	--

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STATE	NAME	ORGANIZATION	LETTER NUMBER	COMMENT NUMBER	CLASSIFICATION FIRST	SECOND	THIRD	FOURTH
Colorado (continued)								
	Tuchyna, DeeAnn R.		00561	00001	C.3.1.2	--	--	--
	Tyzzer, Andrew		01563	00001	C.3.4.4	--	--	--
	Vanderbeek, Gerard J.		00352	00001	C.3.4.4	--	--	--
			00352	00004	C.2.4.1	--	--	--
	Vick, Ronald E.		00609	00001	C.3.4.4	--	--	--
			00609	00003	C.3.4.4	--	--	--
	Vogler, Harry W.		00420	00001	C.3.4.4	--	--	--
	Vosiav, M.		01048	00001	C.3.1.2	--	--	--
	[illegible]		00282	00001	C.3.4.4	--	--	--
	Walker, Robin		00540	00001	C.3.1.2	--	--	--
	Walker, Jeannette		01220	00001	C.3.1.2	--	--	--
			01220	00002	C.2.2	--	--	--
	Weiner, Kathleen		01087	00001	C.3.4.4	--	--	--
	Welch, Thomas E.		01258	00001	C.3.1.2	--	--	--
			01258	00003	C.3.1.2	--	--	--
	West, David		00630	00001	C.3.1.2	--	--	--
	Wiggans, Tamara		02181	00003	C.2.4.1	--	--	--
			02181	00004	C.2.3.2	--	--	--
	Will, Dale		00458	00001	C.3.4.4	--	--	--
			00458	00003	C.2.8.2	--	--	--
	Worthington, Michael		01105	00001	C.3.4.4	--	--	--
			01105	00002	C.3.4.4	--	--	--
	Wurtz, Tom		02116	00001	C.3.1.2	--	--	--
	Yanz, John & Bonnie		01308	00001	C.3.1.2	--	--	--
			01308	00003	C.3.1.2	--	--	--
	Zinn, Sonya		01106	00001	C.3.1.2	--	--	--
			01106	00003	C.3.1.2	--	--	--
	Zinn, Lennard		01174	00001	C.3.1.2	--	--	--
Connecticut								
	Ceraso/Huang, Jane/William	Yale Env. Litigation Program	00523	00001	C.3.1.2	--	--	--
			00523	00003	C.4.3	--	--	--
			00523	00005	C.8.3	--	--	--
			00523	00006	C.2.2	--	--	--
			00523	00007	C.5.2	--	--	--
			00523	00012	C.2.7	--	--	--
			00523	00014	C.5.7	--	--	--

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STATE	NAME	ORGANIZATION	LETTER NUMBER	COMMENT NUMBER	CLASSIFICATION FIRST	SECOND	THIRD	FOURTH
Connecticut (continued)								
			00523	00015	C.7.4	C.7.3	--	--
			00523	00016	C.7.2.2	--	--	--
			00523	00017	C.2.7	--	--	--
			00523	00018	C.2.1.1	--	--	--
	Hughes, Mrs. John Farrel		00069	00001	C.3.4.4	--	--	--
	Shesler, Alysia		00220	00001	C.3.4.4	--	--	--
			00220	00002	C.2.3.2	--	--	--
District of Columbia								
		U.S. Nuclear Reg. Commission	02679	00058	C.3.4.3	--	--	--
			02679	00089	C.2.1.1	--	--	--
	Bedker, Ervin	Department of Air Force	01074	00001	C.6.4	--	--	--
			01074	00002	C.6.4	--	--	--
			01074	00003	C.4.3	--	--	--
			01074	00004	C.6.4	--	--	--
			01074	00005	C.2.4.1	C.6.4	--	--
			01074	00006	C.6.4	--	--	--
			01074	00007	C.6.4	--	--	--
			01074	00008	C.6.4	--	--	--
			01074	00009	C.6.4	--	--	--
			01074	00010	C.6.4	--	--	--
	Bedker, Ervin J.	Department of Air Force	01529	00001	C.6.4	--	--	--
			01529	00002	C.6.4	--	--	--
			01529	00003	C.4.3	--	--	--
			01529	00004	C.6.4	--	--	--
			01529	00005	C.6.4	--	--	--
			01529	00006	C.6.4	--	--	--
			01529	00007	C.6.4	--	--	--
			01529	00008	C.6.4	--	--	--
			01529	00009	C.6.4	--	--	--
			01529	00010	C.6.4	--	--	--
	Boschwitz, Senator Rudy	U.S. Senate Comm. on Environment	01399	00001	C.2.7	--	--	--
			01399	00003	C.2.7	--	--	--
			01399	00006	C.2.3.1	--	--	--
			01399	00008	C.2.1.1	--	--	--
			01399	00009	C.2.7	--	--	--
			01399	00010	C.2.7	--	--	--

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STATE	NAME	ORGANIZATION	LETTER NUMBER	COMMENT NUMBER	CLASSIFICATION FIRST	SECOND	THIRD	FOURTH
District of Columbia (continued)								
			01399	00011	C.3.1.1	--	--	--
			01399	00018	C.3.1.2	--	--	--
			01399	00026	C.2.7	--	--	--
	Berick, David	Environmental Policy Institute	01385	00001	C.3.3	--	--	--
			01385	00005	C.2.1.1	--	--	--
			01385	00006	C.3.1.1	--	--	--
			01385	00007	C.2.2	--	--	--
			01385	00008A	C.2.7.1	--	--	--
			01385	00008B	C.2.7.1	--	--	--
			01385	00009A	C.3.1.2	--	--	--
			01385	00009B	C.3.1.1	--	--	--
			01385	00010	C.3.1.2	--	--	--
			01385	00011	C.2.2.1	--	--	--
			01385	00012A	C.2.2.1	--	--	--
			01385	00012B	C.2.7	--	--	--
			01385	00012C	C.3.1.1	--	--	--
			01385	00012D	C.3.1.1	--	--	--
			01385	00012E	C.3.1.2	--	--	--
			01385	00012F	C.2.7	--	--	--
			01385	00013	C.3.3	--	--	--
			01385	00014	C.3.3	--	--	--
			01385	00015	C.3.3	--	--	--
			01385	00016A	C.2.7	--	--	--
			01385	00016B	C.2.4.1	--	--	--
			01385	00016C	C.2.4.1	--	--	--
			01385	00016D	C.2.4.1	--	--	--
			01385	00017	C.2.6.1	--	--	--
			01385	00018	C.3.4.3	7.3	--	--
			01385	00019	C.2.4.1	--	--	--
			01385	00020	C.2.4.1	--	--	--
			01385	00021	C.3.4.2.2	C.3.4.3	--	--
			01385	00022A	C.2.6.1	--	--	--
			01385	00022B	C.2.4.1	--	--	--
			01385	00023A	C.2.5.1	--	--	--
			01385	00023B	C.2.4.1	--	--	--
			01385	00024	C.2.4.1	--	--	--
			01385	00025	C.2.4.1	--	--	--
	Berick, David	Environmental Policy Institute	01387	00001	C.2.1.1	--	--	--

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STATE	NAME	ORGANIZATION	LETTER NUMBER	COMMENT NUMBER	CLASSIFICATION FIRST	SECOND	THIRD	FOURTH
District of Columbia (continued)								
			01387	00005	C.2.1.1	--	--	--
			01387	00006	C.3.1.1	--	--	--
			01387	00007	C.2.2	--	--	--
			01387	00008A	C.2.7.1	--	--	--
			01387	00008B	C.2.7.1	--	--	--
			01387	00009	C.2.2.1	--	--	--
			01387	00010	C.3.1.2	--	--	--
			01387	00011	C.2.2.1	--	--	--
			01387	00012A	C.2.2.1	--	--	--
			01387	00012B	C.2.2.1	--	--	--
			01387	00012C	C.3.1.1	--	--	--
			01387	00012D	C.3.1.1	--	--	--
			01387	00012E	C.3.3	--	--	--
			01387	00012F	C.2.2.1	--	--	--
			01387	00013	C.3.3	--	--	--
			01387	00014	C.3.3	--	--	--
			01387	00015	C.3.3	--	--	--
			01387	00016A	C.2.7	--	--	--
			01387	00016B	C.2.4.1	--	--	--
			01387	00016C	C.2.4.1	--	--	--
			01387	00016D	C.2.4.1	--	--	--
			01387	00017	C.2.6.1	--	--	--
			01387	00018	C.3.4.3	C.7.3	--	--
			01387	00019	C.2.4.1	--	--	--
			01387	00020	C.2.4.1	--	--	--
			01387	00021	C.2.4.1	C.3.4.3	--	--
			01387	00022A	C.2.6.1	--	--	--
			01387	00022B	C.2.4.1	--	--	--
			01387	00023A	C.2.4.1	--	--	--
			01387	00023B	C.2.4.1	--	--	--
			01387	00024	C.2.4.1	--	--	--
			01387	00025	C.2.4.1	--	--	--
	Berick, David	Environmental Policy Institute	01388	00001	C.3.3	--	--	--
			01388	00002	C.2.1.1	--	--	--
			01388	00005	C.2.1.1	--	--	--
			01388	00006	C.3.1.1	--	--	--
			01388	00007	C.2.2	--	--	--
			01388	00008A	C.2.7.1	--	--	--

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District of Columbia (continued)								
			01388	00008B	C.2.7.1	--	--	--
			01388	00009	C.2.2.1	--	--	--
			01388	00010	C.3.1.2	--	--	--
			01388	00011	C.2.2.1	--	--	--
			01388	00012A	C.2.2.1	--	--	--
			01388	00012B	C.2.2.1	--	--	--
			01388	00012C	C.3.1.1	--	--	--
			01388	00012D	C.3.1.1	--	--	--
			01388	00012E	C.3.3	--	--	--
			01388	00012F	C.2.2.1	--	--	--
			01388	00013	C.3.3	--	--	--
			01388	00014	C.3.3	--	--	--
			01388	00015	C.3.3	--	--	--
			01388	00016A	C.2.7	--	--	--
			01388	00016B	C.2.4.1	--	--	--
			01388	00016C	C.2.4.1	--	--	--
			01388	00016D	C.2.4.1	--	--	--
			01388	00017	C.2.6.1	--	--	--
			01388	00018	C.3.4.3	C.7.3	--	--
			01388	00019	C.2.4.1	--	--	--
			01388	00020	C.2.4.1	--	--	--
			01388	00021	C.2.4.1	C.3.4.3	--	--
			01388	00022A	C.2.6.1	--	--	--
			01388	00022B	C.2.4.1	--	--	--
			01388	00023A	C.2.5.1	--	--	--
			01388	00023B	C.2.4.1	--	--	--
			01388	00024	C.2.4.1	--	--	--
			01388	00025	C.2.4.1	--	--	--
	Berick, David	Environmental Policy Institute	01389	00001	C.3.3	--	--	--
			01389	00002	C.2.1.1	--	--	--
			01389	00005	C.2.1.1	--	--	--
			01389	00006	C.3.1.1	--	--	--
			01389	00007	C.2.2	--	--	--
			01389	00008A	C.2.7.1	--	--	--
			01389	00008B	C.2.7.1	--	--	--
			01389	00009	C.2.2.1	--	--	--
			01389	00010	C.3.1.2	--	--	--
			01389	00011	C.2.2.1	--	--	--

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STATE	NAME	ORGANIZATION	LETTER NUMBER	COMMENT NUMBER	CLASSIFICATION FIRST	SECOND	THIRD	FOURTH
District of Columbia (continued)								
			01389	00012A	C.2.2.1	--	--	--
			01389	00012B	C.2.2.1	--	--	--
			01389	00012C	C.3.1.1	--	--	--
			01389	00012D	C.3.1.1	--	--	--
			01389	00012E	C.3.3	--	--	--
			01389	00012F	C.2.2.1	--	--	--
			01389	00013	C.3.3	--	--	--
			01389	00014	C.3.3	--	--	--
			01389	00015	C.3.3	--	--	--
			01389	00016A	C.2.7	--	--	--
			01389	00016B	C.2.4.1	--	--	--
			01389	00016C	C.2.4.1	--	--	--
			01389	00016D	C.2.4.1	--	--	--
			01389	00017	C.2.6.1	--	--	--
			01389	00018	C.3.4.3	C.7.3	--	--
			01389	00019	C.2.4.1	--	--	--
			01389	00020	C.2.4.1	--	--	--
			01389	00021	C.2.4.1	C.3.4.3	--	--
			01389	00022A	C.2.6.1	--	--	--
			01389	00022B	C.2.4.1	--	--	--
			01389	00023A	C.2.5.1	--	--	--
			01389	00023B	C.2.4.1	--	--	--
			01389	00024	C.2.4.1	--	--	--
			01389	00025	C.2.4.1	--	--	--
	Berick, David	Environmental Policy Institute	01386	00001	C.2.1.1	--	--	--
			01386	00005	C.2.1.1	--	--	--
			01386	00006	C.3.1.1	--	--	--
			01386	00007	C.2.2	--	--	--
			01386	00008A	C.2.7.1	--	--	--
			01386	00008B	C.2.7.1	--	--	--
			01386	00009	C.2.2.1	--	--	--
			01386	00010	C.3.1.2	--	--	--
			01386	00011	C.2.2.1	--	--	--
			01386	00012A	C.2.2.1	--	--	--
			01386	00012B	C.2.2.1	--	--	--
			01386	00012C	C.3.1.1	--	--	--
			01386	00012D	C.3.1.1	--	--	--
			01386	00012E	C.3.3	--	--	--

STATE	NAME	ORGANIZATION	LETTER NUMBER	COMMENT NUMBER	CLASSIFICATION FIRST	SECOND	THIRD	FOURTH
District of Columbia (continued)								
			01386	00012F	C.2.2.1	--	--	--
			01386	00013	C.3.3	--	--	--
			01386	00014	C.3.3	--	--	--
			01386	00015	C.3.3	--	--	--
			01386	00016A	C.2.7	--	--	--
			01386	00016B	C.2.4.1	--	--	--
			01386	00016C	C.2.4.1	--	--	--
			01386	00016D	C.2.4.1	--	--	--
			01386	00017	C.2.6.1	--	--	--
			01386	00018	C.3.4.3	--	--	--
			01386	00019	C.2.4.1	--	--	--
			01386	00020	C.2.4.1	--	--	--
			01386	00021	C.2.4.1	C.3.4.3	--	--
			01386	00022A	C.2.6.1	--	--	--
			01386	00022B	C.2.4.1	--	--	--
			01386	00023A	C.2.5.1	--	--	--
			01386	00023B	C.2.4.1	--	--	--
			01386	00024	C.2.4.1	--	--	--
			01386	00025	C.2.4.1	--	--	--
	Blakey, L. H.	Department of Army, Plan. Div.	02065	00026	C.2.7	--	--	--
			02065	00027	C.3.1.1	--	--	--
			02065	00028	C.3.1.1	--	--	--
			02065	00033	C.3.1.2	--	--	--
			02065	00034	C.3.3	--	--	--
			02065	00045	C.3.1.1	--	--	--
			02065	00066A	C.3.1.1	--	--	--
			02065	00077	C.3.1.1	--	C.8.2	--
			02069	00001	C.4.1.2.1	--	--	--
			02069	00002	C.4.1.3.2	--	--	--
			02069	00003	C.4.1.3.2	--	--	--
	Blanchard, Bruce	U.S. Dept. of Interior	02123	00001	C.2.7	--	--	--
			02123	00002	C.2.1.1	--	--	--
			02123	00004	C.2.3.3	--	--	--
			02123	00005	C.3.4.4	--	--	--
			02123	00006	C.3.4.4	--	--	--
			02123	00007	C.3.4.3	--	--	--
			02123	00008	C.3.4.3	--	--	--
			02123	00009	C.3.4.3	--	--	--

INDEX OF COMMENTS ON THE DRAFT ENVIRONMENTAL ASSESSMENT FOR THE YUCCA MOUNTAIN SITE

STATE	NAME	ORGANIZATION	LETTER NUMBER	COMMENT NUMBER	CLASSIFICATION FIRST	SECOND	THIRD	FOURTH
District of Columbia (continued)								
			02123	00010	C.3.4.1	--	--	--
			02123	00011	C.3.4.1	--	--	--
			02123	00012	C.3.4.1	--	--	--
			02123	00013	C.3.4.3	--	--	--
			02123	00014	C.3.4.1	--	--	--
			02123	00015	C.3.4.1	--	--	--
			02123	00016	C.3.4.3	--	--	--
			02123	00017	C.3.4.1	--	--	--
			02123	00018	C.3.4.1	--	--	--
			02123	00019	C.3.4.1	--	--	--
			02123	00020	C.3.4.1	--	--	--
			02123	00021	C.3.4.1	--	--	--
			02123	00022	C.3.4.3	--	--	--
			02123	00023	C.3.4.1	--	--	--
			02123	00024	C.3.4.1	--	--	--
			02123	00025	C.3.4.1	--	--	--
			02123	00026	C.3.4.1	--	--	--
			02123	00027	C.3.4.1	--	--	--
			02123	00028	C.3.4.1	--	--	--
			02123	00029	C.3.4.1	--	--	--
			02123	00030	C.3.4.1	--	--	--
			02123	00031	C.3.4.1	--	--	--
			02123	00032	C.3.4.1	--	--	--
			02123	00033	C.3.4.1	--	--	--
			02123	00034	C.3.4.2.1	--	--	--
			02123	00035	C.3.4.2.1	--	--	--
			02123	00036	C.3.4.2	--	--	--
			02123	00037	C.3.4.2.3	--	--	--
			02123	00039	C.2.7	--	--	--
			02123	00040	C.2.7	--	--	--
			02123	00041	C.2.7	--	--	--
			02123	00047A	C.2.4.1	--	--	--
			02123	00047B	C.3.1.2	--	--	--
			02123	00067	C.6.1	--	--	--
			02123	00068	C.3.3	--	--	--
	Blanchard, Bruce	U.S. Dept. of Interior	01598	00001	C.2.7	--	--	--
			01598	00004	C.2.3.3	--	--	--
			01598	00005	C.3.4.4	--	--	--

INDEX OF COMMENTS ON THE DRAFT ENVIRONMENTAL ASSESSMENT FOR THE YUCCA MOUNTAIN SITE

STATE	NAME	ORGANIZATION	LETTER NUMBER	COMMENT NUMBER	CLASSIFICATION FIRST	SECOND	THIRD	FOURTH
District of Columbia (continued)								
			01598	00006	C.3.4.4	--	--	--
			01598	00007	C.3.4.3	--	--	--
			01598	00008	C.3.4.3	--	--	--
			01598	00009	C.3.4.3	--	--	--
			01598	00010	C.3.4.1	--	--	--
			01598	00011	C.3.4.1	--	--	--
			01598	00012	C.3.4.1	--	--	--
			01598	00013	C.3.4.3	--	--	--
			01598	00014	C.3.4.1	--	--	--
			01598	00015	C.3.4.1	--	--	--
			01598	00016	C.3.4.3	--	--	--
			01598	00017	C.3.4.1	--	--	--
			01598	00018	C.3.4.1	--	--	--
			01598	00019	C.3.4.1	--	--	--
			01598	00020	C.3.4.1	--	--	--
			01598	00021	C.3.4.1	--	--	--
			01598	00022	C.3.4.3	--	--	--
			01598	00023	C.3.4.1	--	--	--
			01598	00024	C.3.4.1	--	--	--
			01598	00025	C.3.4.1	--	--	--
			01598	00026	C.3.4.1	--	--	--
			01598	00027	C.3.4.1	--	--	--
			01598	00028	C.3.4.1	--	--	--
			01598	00029	C.3.4.1	--	--	--
			01598	00030	C.3.4.1	--	--	--
			01598	00031	C.3.4.1	--	--	--
			01598	00032	C.3.4.1	--	--	--
			01598	00033	C.3.4.1	--	--	--
			01598	00034	C.3.4.2.1	--	--	--
			01598	00035	C.3.4.2.1	--	--	--
			01598	00036	C.3.4.2	--	--	--
			01598	00037	C.3.4.2.3	--	--	--
			01598	00039	C.2.7	--	--	--
			01598	00040	C.2.7	--	--	--
			01598	00041	C.2.7	--	--	--
			01598	00043	C.4.1.4	--	--	--
			01598	00045	C.3.4.2.2	--	--	--
			01598	00046	C.3.4.1	--	--	--

INDEX OF COMMENTS ON THE DRAFT ENVIRONMENTAL ASSESSMENT FOR THE YUCCA MOUNTAIN SITE

STATE	NAME	ORGANIZATION	LETTER NUMBER	COMMENT NUMBER	CLASSIFICATION FIRST	SECOND	THIRD	FOURTH
District of Columbia (continued)								
			01598	00047A	C.3.4.1	--	--	--
			01598	00047B	C.3.4.1	--	--	--
			01598	00047C	C.3.4.1	--	--	--
			01598	00048	C.3.4.1	--	--	--
			01598	00049	C.3.4.3	--	--	--
			01598	00053	C.3.4.3	--	--	--
			01598	00055C	C.3.4.3	--	--	--
			01598	00056	C.3.4.3	--	--	--
			01598	00057	C.2.7	--	--	--
			01598	00058	C.3.1.2	--	--	--
			01598	00059	C.2.7	--	--	--
			01598	00060	C.2.7	--	--	--
			01598	00199	C.3.4.3	--	--	--
			01598	00200	C.2.8.3	--	--	--
			01598	00217	C.2.7	--	--	--
			01598	00245	C.3.4.4	--	--	--
			01598	00246	C.3.4.1	--	--	--
			01598	00247	C.3.4.1	--	--	--
			01598	00248	C.3.4.1	--	--	--
			01598	00249	C.3.4.1	--	--	--
			01598	00250	C.3.4.1	--	--	--
			01598	00251	C.3.4.2.2	--	--	--
			01598	00252	C.2.4.1	--	--	--
			01598	00253	C.2.7	--	--	--
			01598	00254	C.2.7	--	--	--
			01598	00255	C.2.7	--	--	--
			01598	00256	C.2.7	--	--	--
			01598	00257	C.2.7	--	--	--
			01598	00258	C.2.7	--	--	--
			01598	00259	C.2.7	--	--	--
			01598	00260	C.2.7	--	--	--
			01598	00261	C.2.7	--	--	--
			01598	00262	C.2.7	--	--	--
			01598	00263	C.2.7	--	--	--
			01598	00264	C.2.7	--	--	--
			01598	00321	C.3.4.3	--	--	--

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STATE	NAME	ORGANIZATION	LETTER NUMBER	COMMENT NUMBER	CLASSIFICATION FIRST	SECOND	THIRD	FOURTH
District of Columbia (continued)								
			01598	00326	C.3.1.2	--	--	--
			01598	00327	C.2.2	--	--	--
			01598	00328A	C.3.4.1	--	--	--
			01598	00335	C.3.3.1	--	--	--
	Blanchard, Bruce	U.S. Dept. of Interior	02122	00001	C.2.7.4	--	--	--
			02122	00002	C.2.1.1	--	--	--
			02122	00004	C.2.3.3	--	--	--
			02122	00005	C.3.4.4	--	--	--
			02122	00006	C.3.4.4	--	--	--
			02122	00007	C.3.4.3	--	--	--
			02122	00008	C.3.4.3	--	--	--
			02122	00009	C.3.4.3	--	--	--
			02122	00010	C.3.4.1	--	--	--
			02122	00011	C.3.4.1	--	--	--
			02122	00012	C.3.4.1	--	--	--
			02122	00013	C.3.4.3	--	--	--
			02122	00014	C.3.4.1	--	--	--
			02122	00015	C.3.4.1	--	--	--
			02122	00016	C.3.4.3	--	--	--
			02122	00017	C.3.4.1	--	--	--
			02122	00018	C.3.4.1	--	--	--
			02122	00019	C.3.4.1	--	--	--
			02122	00020	C.3.4.1	--	--	--
			02122	00021	C.3.4.1	--	--	--
			02122	00022	C.3.4.3	--	--	--
			02122	00023	C.3.4.1	--	--	--
			02122	00024	C.3.4.1	--	--	--
			02122	00025	C.3.4.1	--	--	--
			02122	00026	C.3.4.1	--	--	--
			02122	00027	C.3.4.1	--	--	--
			02122	00028	C.3.4.1	--	--	--
			02122	00029	C.3.4.1	--	--	--
			02122	00030	C.3.4.1	--	--	--
			02122	00031	C.3.4.1	--	--	--
			02122	00032	C.3.4.1	--	--	--
			02122	00033	C.3.4.1	--	--	--
			02122	00034	C.3.4.2.1	--	--	--
			02122	00035	C.3.4.2.1	--	--	--

INDEX OF COMMENTS ON THE DRAFT ENVIRONMENTAL ASSESSMENT FOR THE YUCCA MOUNTAIN SITE

STATE	NAME	ORGANIZATION	LETTER NUMBER	COMMENT NUMBER	CLASSIFICATION FIRST	SECOND	THIRD	FOURTH
District of Columbia (continued)								
			01565	00032	C.3.4.1	--	--	--
			01565	00033	C.3.4.1	--	--	--
			01565	00034	C.3.4.2	--	--	--
			01565	00035	C.3.4.2.1	--	--	--
			01565	00036	C.3.4.2	--	--	--
			01565	00037	C.3.4.2.3	--	--	--
			01565	00039	C.2.7	--	--	--
			01565	00040	C.2.7	--	--	--
			01565	00041	C.2.7	--	--	--
			01565	00042A	C.5.8	--	--	--
			01565	00042B	C.5.1	--	--	--
			01565	00043	C.2.7	--	--	--
			01565	00044	C.3.1.3	--	--	--
			01565	00045	C.3.1.3	--	--	--
			01565	00046	C.3.1.3	--	--	--
			01565	00047	C.4.1.2.2	--	--	--
			01565	00048	C.3.1.3	--	--	--
			01565	00049	C.3.1.3	--	--	--
			01565	00050	C.3.1.3	--	--	--
			01565	00051	C.4.1.1	--	--	--
			01565	00052	C.4.1.1	--	--	--
			01565	00053	C.4.1.1	--	--	--
			01565	00054	C.5.1	--	--	--
			01565	00055	C.4.1.1	--	--	--
			01565	00056	C.4.1.3.3	--	--	--
			01565	00057	C.4.1.2.1	--	--	--
			01565	00058	C.4.1.2.2	--	--	--
			01565	00059	C.4.1.2.2	--	--	--
			01565	00060	C.4.1.2.2	--	--	--
			01565	00061	C.4.1.2.3	--	--	--
			01565	00062	C.4.1.3.2	--	--	--
			01565	00063	C.4.1.3.5	--	--	--
			01565	00064	C.4.1.3.6	--	--	--
			01565	00065	C.4.1.3.6	--	--	--
			01565	00066	C.4.1.3.6	--	--	--
			01565	00067	C.4.1.3.6	--	--	--
			01565	00068	C.4.1.3.6	--	--	--
			01565	00069	C.4.1.3.6	--	--	--

INDEX OF COMMENTS ON THE DRAFT ENVIRONMENTAL ASSESSMENT FOR THE YUCCA MOUNTAIN SITE

STATE	NAME	ORGANIZATION	LETTER NUMBER	COMMENT NUMBER	CLASSIFICATION FIRST	SECOND	THIRD	FOURTH
District of Columbia (continued)								
			02122	00036	C.3.4.2	--	--	--
			02122	00037	C.3.4.2.3	--	--	--
			02122	00039	C.2.7	--	--	--
			02122	00040	C.2.7	--	--	--
			02122	00041	C.2.7	--	--	--
			02122	00046	C.2.7	--	--	--
			02122	00047	C.2.7	--	--	--
	Blanchard, Bruce	U.S. Dept. of Interior	01565	00001	C.2.7.4	--	--	--
			01565	00002	C.2.1.1	--	--	--
			01565	00003	C.5.1	--	--	--
			01565	00004	C.2.3.3	--	--	--
			01565	00005	C.3.4.4	--	--	--
			01565	00006	C.3.4.4	--	--	--
			01565	00007	C.3.4.3	--	--	--
			01565	00008	C.3.4.3	--	--	--
			01565	00009	C.3.4.3	--	--	--
			01565	00010	C.3.4.1	--	--	--
			01565	00011	C.3.4.1	--	--	--
			01565	00012	C.3.4.1	--	--	--
			01565	00013	C.3.4.3	--	--	--
			01565	00014	C.3.4.1	--	--	--
			01565	00015	C.3.4.1	--	--	--
			01565	00016	C.3.4.3	--	--	--
			01565	00017	C.3.4.1	--	--	--
			01565	00018	C.3.4.1	--	--	--
			01565	00019	C.3.4.1	--	--	--
			01565	00020	C.3.4.1	--	--	--
			01565	00021	C.3.4.1	--	--	--
			01565	00022	C.3.4.3	--	--	--
			01565	00023	C.3.4.1	--	--	--
			01565	00024	C.3.4.1	--	--	--
			01565	00025	C.3.4.1	--	--	--
			01565	00026	C.3.4.1	--	--	--
			01565	00027	C.3.4.1	--	--	--
			01565	00028	C.3.4.1	--	--	--
			01565	00029	C.3.4.1	--	--	--
			01565	00030	C.3.4.1	--	--	--
			01565	00031	C.3.4.1	--	--	--

INDEX OF COMMENTS ON THE DRAFT ENVIRONMENTAL ASSESSMENT FOR THE YUCCA MOUNTAIN SITE

STATE	NAME	ORGANIZATION	LETTER NUMBER	COMMENT NUMBER	CLASSIFICATION FIRST	SECOND	THIRD	FOURTH
District of Columbia (continued)								
			01565	00070	C.4.1.3.6	--	--	--
			01565	00071	C.7.3	--	--	--
			01565	00072	C.4.1.4	--	--	--
			01565	00073	C.4.2.2	--	--	--
			01565	00074	C.7.1.1	--	--	--
			01565	00075	C.7.1.1	--	--	--
			01565	00076	C.7.1.1	--	--	--
			01565	00077	C.7.2.6	--	--	--
			01565	00078	C.7.2.6	--	--	--
			01565	00079	C.7.2	--	--	--
			01565	00080	C.7.4.3	--	--	--
			01565	00081	C.7.2	--	--	--
			01565	00082	C.7.2	--	--	--
			01565	00083	C.5.1	--	--	--
			01565	00084	C.5.1	--	--	--
			01565	00085	C.5.1	--	--	--
			01565	00086	C.5.1	--	--	--
			01565	00087	C.5.8	--	--	--
			01565	00088	C.5.1	--	--	--
			01565	00089	C.5.1	--	--	--
			01565	00090	C.5.2	--	--	--
			01565	00091	C.5.3	--	--	--
			01565	00092	C.5.3	--	--	--
			01565	00093	C.5.3	--	--	--
			01565	00094	C.5.3	--	--	--
			01565	00095	C.5.4	--	--	--
			01565	00096	C.5.4	--	--	--
			01565	00097	C.5.4	--	--	--
			01565	00098	C.5.4	--	--	--
			01565	00099	C.5.4	--	--	--
			01565	00100	C.5.5	--	--	--
			01565	00101	C.5.7	--	--	--
			01565	00102	C.5.7	--	--	--
			01565	00103	C.5.7	--	--	--
			01565	00104	C.5.7	--	--	--
			01565	00105	C.5.7	--	--	--
			01565	00106	C.5.7	--	--	--

INDEX OF COMMENTS ON THE DRAFT ENVIRONMENTAL ASSESSMENT FOR THE YUCCA MOUNTAIN SITE

STATE	NAME	ORGANIZATION	LETTER NUMBER	COMMENT NUMBER	CLASSIFICATION FIRST	SECOND	THIRD	FOURTH
District of Columbia (continued)								
			01565	00107	C.5.7	--	--	--
			01565	00108	C.5.8	--	--	--
			01565	00109	C.5.8	--	--	--
			01565	00110	C.5.8	--	--	--
			01565	00111	C.5.8	--	--	--
			01565	00112	C.8.1	--	--	--
			01565	00113	C.8.4	--	--	--
			01565	00114	C.8.4	--	--	--
			01565	00115	C.8.4	--	--	--
			01565	00116	C.8.4	--	--	--
	Blanchard, Bruce	U.S. Dept. of Interior	01599	00001	C.2.7	--	--	--
			01599	00002	C.2.1.1	--	--	--
			01599	00004	C.2.3.3	--	--	--
			01599	00005	C.3.4.4	--	--	--
			01599	00006	C.3.4.1	--	--	--
			01599	00007	C.3.4.1	--	--	--
			01599	00008	C.3.4.3	--	--	--
			01599	00009	C.3.4	--	--	--
			01599	00010	C.3.4.1	--	--	--
			01599	00011	C.3.4.1	--	--	--
			01599	00012	C.3.4.1	--	--	--
			01599	00013	C.3.4	--	--	--
			01599	00014	C.3.4.1	--	--	--
			01599	00015	C.3.4.1	--	--	--
			01599	00016	C.3.4.1	--	--	--
			01599	00017	C.3.4.1	--	--	--
			01599	00018	C.3.4.1	--	--	--
			01599	00019	C.3.4.1	--	--	--
			01599	00020	C.3.4.1	--	--	--
			01599	00021	C.3.4.1	--	--	--
			01599	00022	C.3.4.3	--	--	--
			01599	00023	C.3.4.1	--	--	--
			01599	00024	C.3.4.1	--	--	--
			01599	00025	C.3.4.1	--	--	--
			01599	00026	C.3.4.1	--	--	--
			01599	00027	C.3.4.1	--	--	--
			01599	00028	C.3.4.1	--	--	--
			01599	00029	C.3.4.1	--	--	--

INDEX OF COMMENTS ON THE DRAFT ENVIRONMENTAL ASSESSMENT FOR THE YUCCA MOUNTAIN SITE

STATE	NAME	ORGANIZATION	LETTER NUMBER	COMMENT NUMBER	CLASSIFICATION FIRST	SECOND	THIRD	FOURTH
District of Columbia (continued)								
			01599	00030	C.3.4.1	--	--	--
			01599	00031	C.3.4.1	--	--	--
			01599	00032	C.3.4.1	--	--	--
			01599	00033	C.3.4.1	--	--	--
			01599	00034	C.3.4.2.1	--	--	--
			01599	00035	C.3.4.2.1	--	--	--
			01599	00036	C.3.4.2	--	--	--
			01599	00037	C.3.4.2.3	--	--	--
			01599	00039	C.2.7	--	--	--
			01599	00040	C.2.7	--	--	--
			01599	00041	C.2.7	--	--	--
			01599	00047B	C.3.4.1	--	--	--
			01599	00047C	C.3.4.1	--	--	--
			01599	00048	C.3.4.1	--	--	--
			01599	00050A	C.4.1.2.1	C.3.4.1	--	--
			01599	00062	C.3.1.1	--	--	--
			01599	00066	C.4.1.4	C.7.3	--	--
			01599	00068	C.3.1.1	--	--	--
			01599	00069	C.3.4.1	--	--	--
			01599	00070A	C.3.4.1	--	--	--
			01599	00070B	C.3.4.1	--	--	--
			01599	00070C	C.3.4.1	--	--	--
			01599	00071	C.3.4.1	--	--	--
			01599	00072	C.3.4.2.1	--	--	--
			01599	00076	C.3.4.3	--	--	--
			01599	00078	C.3.4.3	--	--	--
			01599	00078C	C.3.4.3	--	--	--
			01599	00079	C.3.4.3	--	--	--
			01599	00081	C.2.7	--	--	--
			01599	00082	C.2.7	--	--	--
			01599	00083	C.2.7	--	--	--
			01599	00208	C.3.1.1	--	--	--
			01599	00209	C.2.8.3	--	--	--
			01599	00216	C.2.7	--	--	--
			01599	00217	C.2.7	--	--	--
			01599	00226	C.2.7	--	--	--

INDEX OF COMMENTS ON THE DRAFT ENVIRONMENTAL ASSESSMENT FOR THE YUCCA MOUNTAIN SITE

STATE	NAME	ORGANIZATION	LETTER NUMBER	COMMENT NUMBER	CLASSIFICATION FIRST	SECOND	THIRD	FOURTH
District of Columbia (continued)								
			01599	00246	C.3.4.1	--	--	--
			01599	00247	C.3.4.1	--	--	--
			01599	00248	C.3.4.1	--	--	--
			01599	00249	C.3.4.1	--	--	--
			01599	00250	C.3.4.1	--	--	--
			01599	00251	C.3.4.2.2	--	--	--
			01599	00252	C.2.4.1	--	--	--
			01599	00252B	C.3.4.2.2	--	--	--
			01599	00264	C.2.7	--	--	--
	Blanchard, Bruce	U.S. Dept. of Interior	01566	00002	C.2.1.1	--	--	--
			01566	00003	C.2.7	--	--	--
			01566	00004	C.2.3.3	--	--	--
			01566	00005	C.3.4.4	--	--	--
			01566	00006	C.3.4.1	--	--	--
			01566	00007	C.3.4.3	--	--	--
			01566	00008	C.3.4.3	--	--	--
			01566	00009	C.3.4	--	--	--
			01566	00010	C.3.4.1	--	--	--
			01566	00011	C.3.4.1	--	--	--
			01566	00012	C.3.4.1	--	--	--
			01566	00013	C.3.4	--	--	--
			01566	00014	C.3.4.1	--	--	--
			01566	00015	C.3.4.1	--	--	--
			01566	00016	C.3.4.1	--	--	--
			01566	00017	C.3.4.1	--	--	--
			01566	00018	C.3.4.1	--	--	--
			01566	00019	C.3.4.1	--	--	--
			01566	00020	C.3.4.1	--	--	--
			01566	00021	C.3.4.1	--	--	--
			01566	00022	C.3.4.3	--	--	--
			01566	00023	C.3.4.1	--	--	--
			01566	00024	C.3.4.1	--	--	--
			01566	00025	C.3.4.1	--	--	--
			01566	00026	C.3.4.1	--	--	--
			01566	00027	C.3.4.1	--	--	--
			01566	00028	C.3.4.1	--	--	--
			01566	00029	C.3.4.1	--	--	--
			01566	00030	C.3.4.1	--	--	--

INDEX OF COMMENTS ON THE DRAFT ENVIRONMENTAL ASSESSMENT FOR THE YUCCA MOUNTAIN SITE

STATE	NAME	ORGANIZATION	LETTER NUMBER	COMMENT NUMBER	CLASSIFICATION FIRST	SECOND	THIRD	FOURTH
District of Columbia (continued)								
			01566	00031	C.3.4.1	--	--	--
			01566	00032	C.3.4.1	--	--	--
			01566	00033	C.3.4.1	--	--	--
			01566	00034	C.3.4.2.1	--	--	--
			01566	00035	C.3.4.2.1	--	--	--
			01566	00036	C.3.4.2.3	--	--	--
			01566	00037	C.2.3.2	--	--	--
			01566	00038	C.2.7	--	--	--
			01566	00039	C.2.7	--	--	--
			01566	00040	C.2.7	--	--	--
			01566	00123	C.3.4	--	--	--
			01566	00124	C.3.4	--	--	--
			01566	00125	C.3.4	--	--	--
			01566	00126	C.3.4	--	--	--
			01566	00127	C.3.4	--	--	--
			01566	00128	C.3.4	--	--	--
			01566	00129	C.3.4	--	--	--
			01566	00130	C.3.4	--	--	--
			01566	00131	C.3.4	--	--	--
			01566	00132	C.3.4	--	--	--
			01566	00133	C.3.4	--	--	--
			01566	00134	C.3.4	--	--	--
	Blanchard, Bruce	U.S. Dept. of Interior	01567	00001	C.2.7	--	--	--
			01567	00002	C.2.1.1	--	--	--
			01567	00004	C.2.3.3	--	--	--
			01567	00005	C.3.4.4	--	--	--
			01567	00006	C.3.4.4	--	--	--
			01567	00007	C.3.4.3	--	--	--
			01567	00008	C.3.4.3	--	--	--
			01567	00009	C.3.4.3	--	--	--
			01567	00010	C.3.4.1	--	--	--
			01567	00011	C.3.4.1	--	--	--
			01567	00012	C.3.4.1	--	--	--
			01567	00013	C.3.4.3	--	--	--
			01567	00014	C.3.4.1	--	--	--
			01567	00015	C.3.4.1	--	--	--
			01567	00016	C.3.4.3	--	--	--
			01567	00017	C.3.4.1	--	--	--

INDEX OF COMMENTS ON THE DRAFT ENVIRONMENTAL ASSESSMENT FOR THE YUCCA MOUNTAIN SITE

STATE	NAME	ORGANIZATION	LETTER NUMBER	COMMENT NUMBER	CLASSIFICATION FIRST	SECOND	THIRD	FOURTH
District of Columbia (continued)								
			01567	00018	C.3.4.1	--	--	--
			01567	00019	C.3.4.1	--	--	--
			01567	00020	C.3.4.1	--	--	--
			01567	00021	C.3.4.1	--	--	--
			01567	00022	C.3.4.3	--	--	--
			01567	00023	C.3.4.1	--	--	--
			01567	00024	C.3.4.1	--	--	--
			01567	00025	C.3.4.1	--	--	--
			01567	00026	C.3.4.1	--	--	--
			01567	00027	C.3.4.1	--	--	--
			01567	00028	C.3.4.1	--	--	--
			01567	00029	C.3.4.1	--	--	--
			01567	00030	C.3.4.1	--	--	--
			01567	00031	C.3.4.1	--	--	--
			01567	00032	C.3.4.1	--	--	--
			01567	00033	C.3.4.1	--	--	--
			01567	00034	C.3.4.2.1	--	--	--
			01567	00035	C.3.4.2.1	--	--	--
			01567	00036	C.3.4.4	--	--	--
			01567	00037	C.2.3.2	--	--	--
			01567	00038	C.2.7	--	--	--
			01567	00039	C.2.7	--	--	--
			01567	00040	C.2.7	--	--	--
	Buren, Mindy A.	LeBoeuf, Lamb, Leiby, & MacRae	02252	00001	C.2.4.1	--	--	--
			02252	00002	C.2.4.1	--	--	--
			02252	00003	C.2.4.1	--	--	--
			02252	00004	C.2.4.1	--	--	--
			02252	00005	C.2.4.1	--	--	--
			02252	00006	C.2.4.1	--	--	--
			02252	00007	C.2.4.1	--	--	--
			02252	00008	C.2.4.1	--	--	--
			02252	00009	C.2.4.1	--	--	--
			02252	00010	C.2.4.1	--	--	--
			02252	00011	C.2.4.1	--	--	--
			02252	00012	C.2.4.1	--	--	--
			02252	00013	C.2.4.1	--	--	--
			02252	00014	C.2.4.1	--	--	--
			02252	00015	C.2.4.1	--	--	--

INDEX OF COMMENTS ON THE DRAFT ENVIRONMENTAL ASSESSMENT FOR THE YUCCA MOUNTAIN SITE

STATE	NAME	ORGANIZATION	LETTER NUMBER	COMMENT NUMBER	CLASSIFICATION FIRST	SECOND	THIRD	FOURTH
District of Columbia (continued)								
			02252	00016	C.2.4.1	--	--	--
			02252	00017	C.2.4.1	--	--	--
			02252	00018	C.2.4.1	--	--	--
			02252	00019	C.2.4.1	--	--	--
			02252	00020	C.2.4.1	--	--	--
			02252	00021	C.2.4.1	--	--	--
			02252	00022	C.2.4.1	--	--	--
			02252	00023	C.2.4.1	--	--	--
			02252	00024	C.2.4.1	--	--	--
			02252	00025	C.2.4.1	--	--	--
			02252	00026	C.2.4.1	--	--	--
			02252	00027	C.2.4.1	--	--	--
			02252	00028	C.2.4.1	--	--	--
			02252	00029	C.2.4.1	--	--	--
			02252	00030	C.2.4.1	--	--	--
			02252	00031	C.2.4.1	--	--	--
			02252	00032	C.2.4.1	--	--	--
			02252	00033	C.2.4.1	--	--	--
			02252	00034	C.2.4.1	--	--	--
			02252	00035	C.2.4.1	--	--	--
			02252	00036	C.2.4.1	--	--	--
			02252	00037	C.2.4.1	--	--	--
			02252	00038	C.2.4.1	--	--	--
			02252	00039	C.2.4.1	--	--	--
			02252	00040	C.2.4.1	--	--	--
			02252	00041	C.2.4.1	--	--	--
			02252	00042	C.2.4.1	--	--	--
			02252	00043	C.2.4.1	--	--	--
			02252	00044	C.2.4.1	--	--	--
			02252	00045	C.2.4.1	--	--	--
			02252	00046	C.2.4.1	--	--	--
			02252	00047	C.2.4.1	--	--	--
			02252	00048	C.2.4.1	--	--	--
			02252	00049	C.2.4.1	--	--	--
	Davis, John G.	U.S. Nuclear Reg. Commission	01037	00008	C.3.4.2.3	--	--	--
			01037	00137	C.3.4.3	--	--	--
			01037	00139	C.7.3	--	--	--
			01038	00009	C.3.4.2.3	--	--	--

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STATE	NAME	ORGANIZATION	LETTER NUMBER	COMMENT NUMBER	CLASSIFICATION FIRST	SECOND	THIRD	FOURTH
District of Columbia (continued)								
			01038	00010	C.3.4.3	--	--	--
			01038	00015	C.2.7	--	--	--
			01038	00017	C.2.7	--	--	--
			01038	00018	C.2.7	--	--	--
			01038	00084	C.2.4.1	--	--	--
			01038	00085	C.2.4.1	--	--	--
			01038	00087	C.2.1.2	C.7.4	--	--
			01039	00011	C.3.4.2.3	--	--	--
			01039	00012	C.3.4.3	--	--	--
			01039	00015	C.7.3	--	--	--
			01039	00199	C.3.4.1	--	--	--
			01039	00200	C.2.7	--	--	--
	Davis, John G.	U.S. Nuclear Reg. Commission	01040	00005	C.5.3	C.8.2	--	--
			01040	00010	C.3.4.2.3	--	--	--
			01040	00011	C.3.4.3	--	--	--
			01040	00014	C.7.3	--	--	--
			01040	00168	C.3.4.1	--	--	--
			01040	00169	C.3.4.1	--	--	--
			01040	00170	C.3.4.1	--	--	--
	Davis, John G.	U.S. Nuclear Reg. Commission	01041	00013	C.3.1.3	C.3.4.2.3	--	--
			01041	00014	C.3.4.3	--	--	--
			01041	00015	C.3.1.2	--	--	--
			01041	00018	C.7.3	--	--	--
			01041	00214	C.3.4.1	--	--	--
			01041	00215	C.3.4.1	--	--	--
	Davis, John G.	U.S. Nuclear Reg. Commission	01042	00001	C.5.7	--	--	--
			01042	00002	C.5.7	--	--	--
			01042	00003	C.5.1	--	--	--
			01042	00004	C.5.1	--	--	--
			01042	00005	C.5.2	--	--	--
			01042	00006	C.5.2	--	--	--
			01042	00007	C.5.2	--	--	--
			01042	00008	C.5.4	--	--	--
			01042	00009	C.8.3	C.3.4.2.3	--	--
			01042	00010	C.5.10	--	--	--
			01042	00011	C.3.4.3	--	--	--
			01042	00012	C.3.1	C.2.7	--	--
			01042	00013	C.2.4.1	--	--	--

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STATE	NAME	ORGANIZATION	LETTER NUMBER	COMMENT NUMBER	CLASSIFICATION FIRST	SECOND	THIRD	FOURTH
District of Columbia (continued)								
			01042	00014	C.3.1	C.2.7	--	--
			01042	00015	C.4.1.3.1	C.2.7	--	--
			01042	00016	C.4.1.3.1	--	--	--
			01042	00017	C.4.1.1	--	--	--
			01042	00018	C.5.1	--	--	--
			01042	00019	C.4.1.1	--	--	--
			01042	00020	C.4.1.1	--	--	--
			01042	00021	C.4.1.1	--	--	--
			01042	00022	C.4.1.1	--	--	--
			01042	00023	C.4.1.1	--	--	--
			01042	00024	C.4.1.1	--	--	--
			01042	00025	C.4.1.1	--	--	--
			01042	00026	C.4.1.1	--	--	--
			01042	00027	C.4.1.1	--	--	--
			01042	00028	C.4.1.1	--	--	--
			01042	00029	C.4.1.2.2	--	--	--
			01042	00030	C.4.1.2.2	--	--	--
			01042	00031	C.4.1.2.3	--	--	--
			01042	00032	C.4.1.3.3	--	--	--
			01042	00033	C.4.1.3.3	--	--	--
			01042	00034	C.4.1.5.3	--	--	--
			01042	00035	C.7.1.1	--	--	--
			01042	00036	C.7.1.1	--	--	--
			01042	00037	C.4.2.2	--	--	--
			01042	00038	C.4.2.2	--	--	--
			01042	00039	C.4.2.2	--	--	--
			01042	00040	C.4.2.2	--	--	--
			01042	00041	C.4.2.2	--	--	--
			01042	00042	C.4.2.2	--	--	--
			01042	00043	C.7.1.1	--	--	--
			01042	00044	C.7.1.1	--	--	--
			01042	00045	C.7.1.1	--	--	--
	Davis, [illegible] G.	U.S. Nuclear Reg. Commission	01042	00046	C.7.2.2	--	--	--
			01042	00047	C.7.2.6	--	--	--
			01042	00048	C.4.3	--	--	--
			01042	00049	C.4.3	--	--	--
			01042	00050	C.4.3	--	--	--
			01042	00051	C.4.3	--	--	--

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STATE	NAME	ORGANIZATION	LETTER NUMBER	COMMENT NUMBER	CLASSIFICATION FIRST	SECOND	THIRD	FOURTH
District of Columbia (continued)								
			01042	00052	C.4.3	--	--	--
			01042	00053	C.4.3	--	--	--
			01042	00054	C.4.3	--	--	--
			01042	00055	C.4.3	--	--	--
			01042	00056	C.4.3	--	--	--
			01042	00057	C.4.3	--	--	--
			01042	00058	C.6.5	--	--	--
			01042	00059	C.8.4	--	--	--
			01042	00060	C.7.2	--	--	--
			01042	00061	C.8.3	--	--	--
			01042	00062	C.5.4	--	--	--
			01042	00063	C.4.3	--	--	--
			01042	00064	C.7.2	--	--	--
			01042	00065	C.7.2.3	--	--	--
			01042	00066	C.4.1.3.4	--	--	--
			01042	00067	C.7.2.7	--	--	--
			01042	00068	C.6.5	--	--	--
			01042	00069	C.6.5	--	--	--
			01042	00070	C.7.3	--	--	--
			01042	00071	C.7.3	--	--	--
			01042	00072	C.7.3	--	--	--
			01042	00073	C.7.3	--	--	--
			01042	00074	C.7.3	--	--	--
			01042	00075	C.7.3	--	--	--
			01042	00076	C.2.4.1	C.7.3	--	--
			01042	00077	C.2.4.1	C.7.3	--	--
			01042	00078	C.4.3	--	--	--
			01042	00079	C.7.4.3	--	--	--
			01042	00080	C.7.4.5	--	--	--
			01042	00081	C.5.9	--	--	--
			01042	00082	C.5.9	--	--	--
			01042	00083	C.7.2	--	--	--
			01042	00084	C.6.3	--	--	--
			01042	00085	C.6.4	--	--	--
			01042	00086	C.6.5	--	--	--
			01042	00087	C.6.4	--	--	--
			01042	00088	C.7.2.4	--	--	--
			01042	00089	C.7.2.3	--	--	--

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STATE	NAME	ORGANIZATION	LETTER NUMBER	COMMENT NUMBER	CLASSIFICATION FIRST	SECOND	THIRD	FOURTH
District of Columbia (continued)								
			01042	00090	C.7.2	--	--	--
			01042	00091	C.7.4	--	--	--
			01042	00092	C.7.4	--	--	--
			01042	00093	C.4.3	--	--	--
			01042	00094	C.2.4.1	C.7.3	--	--
			01042	00095	C.5.7	--	--	--
			01042	00096	C.5.1	--	--	--
			01042	00097	C.5.1	--	--	--
			01042	00098	C.5.1	--	--	--
			01042	00099	C.5.1	--	--	--
			01042	00100	C.5.1	--	--	--
			01042	00101	C.5.1	--	--	--
			01042	00102	C.5.1	--	--	--
			01042	00103	C.5.1	--	--	--
			01042	00104	C.5.1	--	--	--
			01042	00105	C.5.1	--	--	--
			01042	00106	C.5.1	--	--	--
			01042	00107	C.5.1	--	--	--
			01042	00108	C.5.1	--	--	--
			01042	00109	C.5.1	--	--	--
			01042	00110	C.5.1	--	--	--
			01042	00111	C.5.1	--	--	--
			01042	00112	C.5.1	--	--	--
			01042	00113	C.4.1.2.2	--	--	--
			01042	00114	C.5.1	--	--	--
			01042	00115	C.5.1	--	--	--
			01042	00116	C.5.1	--	--	--
			01042	00117	C.5.1	--	--	--
			01042	00118	C.5.1	--	--	--
			01042	00119	C.5.1	--	--	--
			01042	00120	C.5.1	--	--	--
			01042	00121	C.5.2	--	--	--
			01042	00122	C.5.1	--	--	--
			01042	00123	C.5.1	--	--	--
			01042	00124	C.5.1	--	--	--
			01042	00125	C.5.1	--	--	--
			01042	00126	C.5.1	--	--	--
			01042	00127	C.5.1	--	--	--

INDEX OF COMMENTS ON THE DRAFT ENVIRONMENTAL ASSESSMENT FOR THE YUCCA MOUNTAIN SITE

STATE	NAME	ORGANIZATION	LETTER NUMBER	COMMENT NUMBER	CLASSIFICATION FIRST	SECOND	THIRD	FOURTH
District of Columbia (continued)								
			01042	00128	C.5.1	--	--	--
			01042	00129	C.5.1	--	--	--
			01042	00130	C.5.1	--	--	--
			01042	00131	C.5.2	--	--	--
			01042	00132	C.5.2	--	--	--
			01042	00133	C.5.2	--	--	--
			01042	00134	C.5.2	--	--	--
			01042	00135	C.5.2	--	--	--
			01042	00136	C.5.2	--	--	--
			01042	00137	C.5.2	--	--	--
			01042	00138	C.5.2	--	--	--
			01042	00139	C.5.2	--	--	--
			01042	00140	C.5.2	--	--	--
			01042	00141	C.5.2	--	--	--
			01042	00142	C.5.2	--	--	--
			01042	00143	C.5.2	--	--	--
			01042	00144	C.5.2	--	--	--
			01042	00145	C.5.2	--	--	--
			01042	00146	C.5.2	--	--	--
			01042	00147	C.5.2	--	--	--
			01042	00148	C.5.2	--	--	--
			01042	00149	C.5.2	--	--	--
			01042	00150	C.5.2	--	--	--
			01042	00151	C.5.2	--	--	--
			01042	00152	C.5.2	--	--	--
			01042	00153	C.5.2	--	--	--
			01042	00154	C.5.3	--	--	--
			01042	00155	C.5.3	--	--	--
			01042	00156	C.5.3	--	--	--
			01042	00157	C.5.3	--	--	--
			01042	00158	C.5.3	--	--	--
			01042	00159	C.5.3	--	--	--
			01042	00160	C.5.3	--	--	--
			01042	00161	C.5.2	--	--	--
			01042	00162	C.5.2	--	--	--
			01042	00163	C.5.4	--	--	--
			01042	00164	C.5.4	--	--	--
			01042	00165	C.5.5	--	--	--

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STATE	NAME	ORGANIZATION	LETTER NUMBER	COMMENT NUMBER	CLASSIFICATION FIRST	SECOND	THIRD	FOURTH
District of Columbia (continued)								
			01042	00166	C.5.5	--	--	--
			01042	00167	C.5.5	--	--	--
			01042	00168	C.5.7	--	--	--
			01042	00169	C.5.7	--	--	--
			01042	00170	C.5.7	--	--	--
			01042	00171	C.5.7	--	--	--
			01042	00172	C.5.7	--	--	--
			01042	00173	C.5.5	--	--	--
			01042	00174	C.5.8	--	--	--
			01042	00175	C.5.10	--	--	--
			01042	00176	C.5.10	--	--	--
			01042	00177	C.5.10	--	--	--
			01042	00178	C.8.1	--	--	--
			01042	00179	C.8.3	--	--	--
			01042	00180	C.8.3	--	--	--
			01042	00181	C.8.2	--	--	--
			01042	00182	C.8.2	--	--	--
			01042	00183	C.8.2	--	--	--
			01042	00184	C.8.2	--	--	--
			01042	00185	C.8.2	--	--	--
			01042	00186	C.8.2	--	--	--
			01042	00187	C.8.2	--	--	--
			01042	00188	C.8.4	--	--	--
			01042	00189	C.8.4	--	--	--
			01042	00190	C.8.4	--	--	--
			01042	00191	C.8.4	--	--	--
			01042	00192	C.2.8.3	C.6.5	--	--
			01042	00193	C.5.11	--	--	--
			01042	00194	C.5.11	--	--	--
			01042	00195	C.5.11	--	--	--
			01042	00196	C.5.11	--	--	--
			01042	00197	C.5.11	--	--	--
			01042	00198	C.5.11	--	--	--
			01042	00199	C.5.11	--	--	--
			01042	00200	C.5.11	--	--	--
			01042	00201	C.5.11	--	--	--
			01042	00202	C.5.11	--	--	--
			01042	00203	C.5.11	--	--	--

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STATE	NAME	ORGANIZATION	LETTER NUMBER	COMMENT NUMBER	CLASSIFICATION FIRST	SECOND	THIRD	FOURTH
District of Columbia (continued)								
			01042	00204	C.5.11	--	--	--
			01042	00205	C.5.11	--	--	--
			01042	00206	C.5.11	--	--	--
			01042	00207	C.3.4.1	--	--	--
	Davis, John G.	U.S. Nuclear Reg. Commission	01043	00013	C.3.4.2.3	--	--	--
			01043	00014	C.3.4.3	--	--	--
			01043	00020	C.3.1.2	--	--	--
			01043	00105	C.2.4.1	--	--	--
			01043	00218	C.3.4.1	C.5.11	--	--
			01043	00219	C.3.4.1	--	--	--
	Davis, John G.	U.S. Nuclear Reg. Commission	01044	00011	C.3.4.2.3	--	--	--
			01044	00012	C.3.4.3	--	--	--
			01044	00014	C.7.3	--	--	--
			01044	00015	C.2.7	--	--	--
			01044	00200	C.3.4.1	--	--	--
			01044	00201	C.3.4.1	--	--	--
	Davis, John G.	U.S. Nuclear Reg. Commission	01036	00157	C.3.4.2.3	--	--	--
			01036	00158	C.3.4.3	--	--	--
	Finamore, Barbara	Natural Res. Defense Council	01244	00001	C.2.6.1	--	--	--
			01244	00002	C.2.1.1	--	--	--
			01244	00003	C.2.6.1	--	--	--
			01244	00004	C.2.6.1	--	--	--
			01244	00005	C.2.6.1	--	--	--
			01244	00006	C.2.6.1	--	--	--
			01244	00007	C.2.6.1	--	--	--
			01244	00008	C.2.4.1	--	--	--
			01244	00009	C.2.4.1	--	--	--
			01244	00010	C.2.4.1	--	--	--
			01244	00011	C.2.4.1	--	--	--
			01244	00012	C.2.4.1	--	--	--
			01244	00013	C.2.4.1	--	--	--
			01244	00014	C.2.6.1	--	--	--
			01244	00015	C.2.7	--	--	--
			01244	00016	C.2.1.1	--	--	--
	Garrison, Roy F.	U.S. Dept. of Energy	01677	00001	C.2.8.2	--	--	--
	Hirsch, Allan	U.S. Env. Protection Agency	01397	00001	C.3.4.3	--	--	--
			01397	00002	C.3.4.3	--	--	--

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STATE	NAME	ORGANIZATION	LETTER NUMBER	COMMENT NUMBER	CLASSIFICATION FIRST	SECOND	THIRD	FOURTH
District of Columbia (continued)								
			01397	00003	C.3.4.1	--	--	--
			01397	00004	C.3.4.1	--	--	--
			01397	00005	C.3.4.3	--	--	--
			01397	00006	C.3.4.3	--	--	--
			01397	00007	C.7.3	C.2.4.1	--	--
			01397	00008	C.2.7	--	--	--
			01397	00009	C.2.7	--	--	--
			01397	00068	C.3.4.3	--	--	--
			01397	00082	C.5.1	--	--	--
			01397	00083A	C.5.1	--	--	--
			01397	00083B	C.4.1.2.2	--	--	--
			01397	00083C	C.4.1.2.2	--	--	--
			01397	00083D	C.4.1.2.2	--	--	--
			01397	00083E	C.4.1.2.2	--	--	--
			01397	00083F	C.7.4	--	--	--
			01397	00083G	C.4.1.2.2	--	--	--
			01397	00083H	C.4.1.2.2	--	--	--
			01397	00084A	C.4.1.1	--	--	--
			01397	00084B	C.4.1.1	--	--	--
			01397	00085	C.7.4.3	C.4.3	--	--
			01397	00086	C.6.5	--	--	--
			01397	00087	C.4.2	--	--	--
			01397	00093	C.3.1.2	--	--	--
			01397	00097	C.2.7.1	C.4.1.3	--	--
	Hodel, Secretary Donald	U.S. Dept. of Energy	01716	00001	C.2.8.2	--	--	--
	Kearney, John J.	Edison Electric Institute	01275	00001	C.2.2.1	--	--	--
			01275	00002	C.2.7	--	--	--
			01275	00003	C.2.7	--	--	--
			01275	00004	C.3.3	--	--	--
			01275	00005	C.3.4.3	--	--	--
			01275	00006	C.2.7	--	--	--
			01275	00007	C.3.4.3	--	--	--
			01275	00008	C.3.4.3	--	--	--
			01275	00009	C.6.6	C.5.11	C.5.11	C.3.4.4
			01275	00010	C.5.1	C.5.11	C.3.4.4	--
			01275	00011	C.7.4.1	C.2.7	--	--
			01275	00012	C.4.3	C.2.8	--	--
			01275	000121	C.3.4.3	--	--	--

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STATE	NAME	ORGANIZATION	LETTER NUMBER	COMMENT NUMBER	CLASSIFICATION FIRST	SECOND	THIRD	FOURTH
District of Columbia (continued)								
			01275	00013	C.4.2.2	C.4.3	--	--
			01275	00015	C.8.2	C.2.7	--	--
			01275	00016	C.2.7	--	--	--
			01275	00017	C.2.1.1	--	--	--
			01275	00026	C.3.4.4	--	--	--
			01275	00034	C.2.7	--	--	--
			01275	00035	C.3.1	--	--	--
			01275	00036	C.7.4	--	--	--
			01275	00037	C.7.4.4	--	--	--
			01275	00038	C.2.7	--	--	--
			01275	00039	C.6.4	--	--	--
			01275	00040	C.7.2	--	--	--
			01275	00041	C.5.1	--	--	--
			01275	00042	C.5.1	--	--	--
			01275	00043	C.5.1	--	--	--
			01275	00044	C.5.1	--	--	--
			01275	00045	C.5.1	--	--	--
			01275	00046	C.5.3	--	--	--
			01275	00048	C.5.3	--	--	--
			01275	00049	C.2.7	--	--	--
			01275	00050	C.3.1	--	--	--
			01275	00051	C.2.7	--	--	--
			01275	00073	C.2.7	--	--	--
			01275	00075	C.2.7	--	--	--
			01275	00096	C.2.7	--	--	--
			01275	00097	C.4.3	C.4.2.2	--	--
			01275	00098	C.4.3	C.4.3	--	--
			01275	00099	C.7.1.1	C.7.2.3	C.7.2.3	C.7.1.1
			01275	00100	C.7.2.3	C.7.1.1	--	--
			01275	00101	C.7.2.3	C.7.1.1.3	C.7.1.1	--
			01275	00102	C.4.3	C.4.2.2	C.3.7	C.7.1
			01275	00103	C.4.2.2	C.3.7	C.7.1	--
			01275	00104	C.4.2.2	C.7.1	C.3.7	--
			01275	00108	C.6.6	C.6.5	--	--
			01275	00109	C.5.11	--	--	--
			01275	00110	C.5.11	C.5.11	--	--
			01275	00111	C.4.3	C.4.3	--	--
			01275	00112	C.5.11	C.5.11	C.5.11	--

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STATE	NAME	ORGANIZATION	LETTER NUMBER	COMMENT NUMBER	CLASSIFICATION FIRST	SECOND	THIRD	FOURTH
District of Columbia (continued)								
			01275	00114	C.2.7	--	--	--
			01275	00115	C.2.7	--	--	--
			01275	00116	C.2.8.2	--	--	--
			01275	00117	C.3.4.1	--	--	--
			01275	00118	C.3.4.4	--	--	--
			01275	00119	C.3.4.3	--	--	--
			01275	00120	C.3.4.3	--	--	--
			01275	00121	C.3.4.3	--	--	--
			01275	00128	C.8.4	C.8.4	--	--
			01275	00129	C.2.7	C.8.7	--	--
	Kearns, Artis		01440	00001	C.7.3	--	--	--
			01440	00002	C.7.3	--	--	--
			01440	00003	C.2.4.1	--	--	--
			01440	00004A	C.2.8	--	--	--
			01440	00004B	C.2.4.1	--	--	--
	Magnees, III, Col. Thomas H.	Dept. of Army Corps of Engineers	02697	00023	C.2.4.1	--	--	--
	Martin, Terri	National Parks & Cons. Assc.	02195	00001	C.3.4.4	--	--	--
			02195	00009	C.3.4.4	--	--	--
	Parker, Frank L.	National Research Council	02669	00001	C.3.4.3	--	--	--
			02669	00002	C.3.4.3	--	--	--
			02669	00003	C.3.4.3	--	--	--
			02669	00004	C.3.4.3	--	--	--
			02669	00005	C.3.4.3	--	--	--
			02669	00006	C.3.4.3	--	--	--
			02669	00007	C.3.4.3	--	--	--
			02669	00008	C.3.4.3	--	--	--
			02669	00009	C.3.4.3	--	--	--
			02669	00010	C.3.4.3	--	--	--
			02669	00011	C.3.4.3	--	--	--
			02669	00012	C.3.4.3	--	--	--
			02669	00013	C.3.4.3	--	--	--
			02669	00014	C.3.4.3	--	--	--
			02669	00015	C.3.4.4	--	--	--
			02669	00016	C.3.4.3	--	--	--
			02669	00017	C.3.4.3	--	--	--
	Santman, L.D.	U.S. Dept. of Transportation	01568	00001	C.2.4.1	C.7.3	--	--
			01568	00002	C.2.4.1	--	--	--
			01568	00003	C.2.4.1	--	--	--

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STATE	NAME	ORGANIZATION	LETTER NUMBER	COMMENT NUMBER	CLASSIFICATION FIRST	SECOND	THIRD	FOURTH
District of Columbia (continued)								
			01568	00004	C.2.4.1	--	--	--
			01568	00005	C.2.4.1	--	--	--
			01568	00006	C.2.4.1	--	--	--
			01568	00007	C.2.4.1	--	--	--
			01568	00008	C.2.4.1	--	--	--
			01568	00009	C.2.4.1	--	--	--
			01568	00010	C.2.4.1	--	--	--
			01568	00011	C.2.4.1	--	--	--
			01568	00012	C.2.4.1	--	--	--
			01568	00013	C.2.4.1	--	--	--
			01568	00014	C.2.4.1	--	--	--
			01568	00015	C.2.4.1	--	--	--
			01568	00016	C.2.4.1	--	--	--
			01568	00017	C.2.4.1	--	--	--
			01568	00018	C.2.4.1	--	--	--
			01568	00022	C.2.7	--	--	--
			01568	00029	C.7.3	--	--	--
			01568	00030	C.7.3	--	--	--
			01568	00031	C.7.3	--	--	--
			01568	00032	C.7.3	--	--	--
			01568	00033	C.7.3	--	--	--
			01568	00034	C.7.3	--	--	--
	Severance, Owen	Natl. Parks & Conservation Assoc.	01276	00001	C.3.1.3	--	--	--
			01276	00002	C.3.1.3	--	--	--
			01276	00003	C.3.1.3	--	--	--
			01276	00004	C.3.1.3	--	--	--
			01276	00008	C.3.1.3	--	--	--
			01276	00010	C.3.1.3	--	--	--
			01276	00018A	C.3.1.3	--	--	--
			01276	00026	C.3.1.3	--	--	--
			01276	00032	C.2.8.3	--	--	--
			01276	00034	C.2.6.1	--	--	--
			01276	00055	C.2.8.2	--	--	--
	Shiflet, Thomas	U.S. Dept. of Agriculture	01238	00001	C.6.6	C.5.11	C.2.7	--
			01238	00003	C.4.1.1	C.4.1	C.4.1.1	--
			01238	00032	C.4.1.3.1	--	--	--
			01238	00033	C.3.4.4	--	--	--
	Smith, David W.		00040	00001	C.2.1.1	--	--	--

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STATE	NAME	ORGANIZATION	LETTER NUMBER	COMMENT NUMBER	CLASSIFICATION FIRST	SECOND	THIRD	FOURTH
District of Columbia (continued)								
			00040	00002	C.2.1.1	--	--	--
	Stennis, John	U.S. Senate	01680	00001	C.3.1.2	--	--	--
	Swift, Congressman Al	U.S. House of Representatives	02617	00001	C.3.1.2	C.7.2	--	--
			02617	00002	C.2.1.1	--	--	--
			02617	00004	C.3.1	--	--	--
			02617	00005	C.3.1.2	--	--	--
			02617	00006	C.3.1.1	--	--	--
			02617	00010	C.3.1.2	--	--	--
			02617	00011	C.3.1.2	--	--	--
	Yeager, Brooks B.	Sierra Club	01239	00001	C.2.1.1	--	--	--
			01239	00002	C.2.2	--	--	--
			01239	00003A	C.3.1.1	--	--	--
			01239	00003B	C.3.1.2	--	--	--
			01239	00004	C.3.1.2	--	--	--
			01239	00005	C.3.1.2	--	--	--
			01239	00006	C.3.1.2	--	--	--
			01239	00007	C.3.1.3	--	--	--
			01239	00008	C.2.4.1	C.7.3	--	--
			01239	00009	C.2.6.1	--	--	--
			01239	00013	C.2.6.3	6.4	--	--
Florida								
	Holloway, Mrs. Anita		00555	00001	C.3.1.2	--	--	--
	Laping, Mrs. T.		00062	00001	C.3.4.4	--	--	--
	Votoe, Deborah		02691	00001	C.7.2	--	--	--
	Williams,Jr., J.W.	Florida Power & Light Company	01556	00001	C.2.4.1	--	--	--
Georgia								
	Sokol, Jean	The Wilderness Society	00652	00004	C.3.4.4	--	--	--
	Yarbrough, Mrs. J. C.		00083	00001	C.3.1.2	--	--	--
			00083	00002	C.3.4.4	--	--	--
			00083	00003	C.2.8.3	--	--	--

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STATE	NAME	ORGANIZATION	LETTER NUMBER	COMMENT NUMBER	CLASSIFICATION FIRST	SECOND	THIRD	FOURTH
Idaho								
	Anonymous	C.A.N.W.E	01162	00001	C.2.3.1	--	--	--
			01162	00002	C.2.4.1	--	--	--
			01162	00003	C.2.4.1	--	--	--
			01162	00004	C.2.4.1	--	--	--
			01162	00006	C.2.8.3	--	--	--
	[illegible], Cheryl		02609	00001	C.3.1.2	--	--	--
			02609	00004	C.3.1.2	--	--	--
	Funderburg, Robert D.	State of Idaho	00173	00001	C.2.4.1	--	--	--
			00173	00002	C.2.4.1	--	--	--
			00173	00003	C.2.4.1	--	--	--
			00173	00004	C.2.4.1	--	--	--
	Hall, S.J.		00150	00001A	C.2.4.1	--	--	--
	Hanson, Wes & Gertie		01142	00001	C.2.4.1	--	--	--
			01142	00003	C.2.3.1	--	--	--
	Patchin, Margaret		01149	00001	C.2.4.1	--	--	--
	Pinkham, Allen V.	Nez Perce Tribal Exec. Comm.	01253	00001	C.2.7	--	--	--
			01253	00003	C.2.5.2	--	--	--
			01253	00004	C.3.4.4	--	--	--
			01253	00005	C.2.6.1	--	--	--
			01253	00006	C.2.5.1	--	--	--
			01253	00008	C.2.7	--	--	--
			01253	00015	C.2.1.2	--	--	--
			01253	00078	C.2.4.1	--	--	--
			01253	00103	C.3.4.1	--	--	--
			01253	00104	C.3.4.1	--	--	--
			01253	00105	C.3.4.1	--	--	--
			01253	00106	C.3.4.1	--	--	--
			01253	00107	C.3.4.1	--	--	--
			01253	00108	C.7.3	--	--	--
			01253	00109	C.7.3	--	--	--
			01253	00110	C.7.3	--	--	--
			01253	00111	C.7.3	--	--	--
			01253	00112	C.3.4.3	--	--	--
	Robinson, Mary & Dwight		01585	00001	C.2.4.1	--	--	--
			01585	00002	C.2.6.2	--	--	--

INDEX OF COMMENTS ON THE DRAFT ENVIRONMENTAL ASSESSMENT FOR THE YUCCA MOUNTAIN SITE

STATE	NAME	ORGANIZATION	LETTER NUMBER	COMMENT NUMBER	CLASSIFICATION FIRST	SECOND	THIRD	FOURTH
Illinois								
	Dinelli, Wayne	DuPage Audubon Society	00149	00001	C.3.4.4	--	--	--
	Gursh, Marla Kay		00161	00001	C.3.1.2	--	--	--
			00161	00002	C.3.1.2	--	--	--
	McGuire, Margaret A.		00052	00001	C.3.4.4	--	--	--
	Rice, Larry		00172	00001	C.3.1.2	--	--	--
	Smith, Jill Janine		00146	00001	C.3.1.2	--	--	--
	Sperow, Sam J.		00302	00001	C.3.4.4	--	--	--
			00302	00002	C.3.4.4	--	--	--
	Tsiang, Margaret		01071	00001	C.3.4.4	--	--	--
	Warble, Steve		01066	00001	C.3.4.4	--	--	--
	Wyatt, John J.	Illinois Central Gulf	01740	00001	C.2.8.2	--	--	--
Indiana								
	Read, Charlotte J.	Save the Dunes Council	00048	00001	C.3.1.2	--	--	--
Kansas								
		Boy Scouts of America,Pack 3	02736	00001	C.3.1.2	--	--	--
	Klann, Erik		02737	00001	C.3.1.2	--	--	--
	Moore-Anderson, Carol J.		00034	00001	C.3.4.4	--	--	--
	Moore-Fleming, Delores B.		00036	00001	C.3.4.4	--	--	--
	Moore-Jones, Joan E.		00037	00001	C.3.4.4	--	--	--
	Russell, Derek		02738	00001	C.3.1.2	--	--	--
	Sperry, Theodore M.		00080	00001	C.3.1.2	--	--	--
	Tyseh, Nathan		02739	00001	C.3.1.2	--	--	--
Kentucky								
	Kelly, James C.		00197	00001	C.3.4.4	--	--	--
			00197	00004	C.3.1.2	--	--	--
Louisiana								
	Anonymous		02178	00004	C.3.1.2	--	--	--
			02178	00005	C.2.4.1	--	--	--
			02178	00006	C.2.4.1	--	--	--
			02178	00007	C.2.4.1	--	--	--