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Nuclear Waste Policy Act
(Section 112)

Environmental Assessment Overview

Richton Dome Site, Mississippi

May 1986

U.S. Department of Energy
Office of Civilian Radioactive Waste Management

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FOREWORD

The Nuclear Waste Policy Act of 1982 (the Act) established a process for the selection of sites for the disposal of spent nuclear fuel and high-level radioactive waste in geologic repositories. The first steps in this process were the identification of potentially acceptable sites and the development of general guidelines for siting repositories. In February 1983, the DOE identified nine sites in six States as potentially acceptable for the first repository. The Richton Dome site in Perry County, Mississippi, was identified as one of those sites. The general guidelines were issued in November 1984 as Title 10 of the Code of Federal Regulations, Part 960. The DOE is now proceeding with the next step in the site-selection process for the first repository: the nomination of at least five of the nine potentially acceptable sites as suitable for site characterization, which is a program of detailed studies.

The Act requires that site nomination be accompanied by an environmental assessment (EA). The DOE has prepared EAs for the nominated sites through a process that provided opportunity for public input. Public hearings were held during March, April, and May 1983 to obtain recommendations on the issues to be addressed in an EA. All such recommendations were considered in preparing the EAs. The DOE issued draft EAs for public review and comment in December 1984 and conducted a series of public hearings in February and March 1985. The issues raised in the comment letters and hearings were considered in preparing the final EAs. These issues are addressed in a comment-response document appended to the final EAs (Appendix C).

The information presented in the EAs is derived from hundreds of technical reports containing more-detailed data and analyses. All of these reference documents are available to the public in various libraries and reading rooms; a listing of their locations is given in Appendix B.

After the nomination, the Secretary is required by the Act to recommend to the President not fewer than three of the nominated sites for characterization as candidate sites for the first repository. This recommendation will be submitted and documented in a separate report that is being issued separately from this environmental assessment. After submittal, the Act provides the President 60 days to approve or disapprove the candidate sites. The President may delay his decision for up to six months if he determines that the information supplied with the recommendation of the Secretary is insufficient to permit a decision within the 60-day period. If the President does not approve, disapprove, or delay the decision, the candidate sites shall be considered approved. After the President approves the candidate sites, the DOE will start site characterization.

ABSTRACT

In February 1983, the U.S. Department of Energy (DOE) identified the Richton Dome site in Mississippi as one of the nine potentially acceptable sites for a mined geologic repository for spent nuclear fuel and high-level radioactive waste. To determine their suitability, the Richton Dome site and the eight other potentially acceptable sites have been evaluated in accordance with the DOE's General Guidelines for the Recommendation of Sites for the Nuclear Waste Repositories. These evaluations were reported in draft environmental assessments (EAs), which were issued for public review and comment. After considering the comments received on the draft EAs, the DOE prepared the final EAs.

The site is in the Gulf interior region, which is one of five distinct geohydrologic settings considered for the first repository. This setting contains two other potentially acceptable sites--the Cypress Creek Dome site in Mississippi and the Vacherie Dome site in Louisiana. Although the Cypress Creek Dome and the Vacherie Dome sites are suitable for site characterization, the DOE has concluded that the Richton Dome site is the preferred site in the Gulf interior region. On the basis of the evaluations reported in this EA, the DOE has found that the Richton Dome site is not disqualified under the guidelines.

Furthermore, the DOE has found that the site is suitable for site characterization because the evidence does not support a conclusion that the site will not be able to meet each of the qualifying conditions specified in the guidelines. On the basis of these findings, the DOE is nominating the Richton Dome site as one of five sites suitable for characterization.

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1. INTRODUCTION

By the end of this century, the United States plans to begin operating the first geologic repository for the permanent disposal of commercial spent nuclear fuel and high-level radioactive waste. Public Law 97-425, the Nuclear Waste Policy Act of 1982 (the Act), specifies the process for selecting a repository site, and constructing, operating, closing, and decommissioning the repository. Congress approved geologic disposal by declaring that one of the key purposes of the Act is "to establish a schedule for the siting, construction, and operation of repositories that will provide reasonable assurance that the public and the environment will be adequately protected from the hazards posed by high-level radioactive waste and such spent nuclear fuel as may be disposed of in a repository" [Section 111(b)(1)].

A geologic repository can be viewed as a large underground mine with a complex of tunnels occupying roughly 2,000 acres at a depth between 1,000 and 4,000 feet. To handle the waste received for disposal, surface facilities will be developed which will occupy about 400 acres. The repository will be operational for about 25 to 30 years. After the repository is closed and sealed, waste isolation will be achieved by a system of multiple barriers, both natural and engineered, that will act together to contain and isolate the waste as required by regulations. The natural barriers include the geologic, hydrologic, and geochemical environment of the site. The engineered barriers consist of the waste package and the underground facility. The waste package includes the waste form, the waste disposal container, and materials placed over and around the containers. The underground facility consists of underground openings and backfill materials, not associated with the waste package, that are used to further limit ground-water circulation around the waste packages and to impede the subsequent transport of radionuclides into the environment.

In February 1983, the DOE carried out the first requirement of the Act by formally identifying nine sites in the following locations as potentially acceptable sites for the first repository (the host rock of each site is noted in parentheses):

1. Vacherie dome, Louisiana (domal salt)
2. Cypress Creek dome, Mississippi (domal salt)
3. Richton dome, Mississippi (domal salt)
4. Yucca Mountain, Nevada (welded tuff)
5. Deaf Smith County, Texas (bedded salt)
6. Swisher County, Texas (bedded salt)
7. Davis Canyon, Utah (bedded salt)
8. Lavender Canyon, Utah (bedded salt)
9. Reference repository location, Hanford Site, Washington (basalt flows).

The locations of these sites are shown in Figure 1.

Figure 1. Potentially acceptable sites for the first repository.

After identifying these potentially acceptable sites, the DOE published draft General Guidelines for the Recommendation of Sites for Nuclear Waste Repositories (the guidelines) in accordance with the Act. The draft guidelines were revised in response to extensive comments and received the concurrence of the Nuclear Regulatory Commission (NRC) in June 1984. Final guidelines were published in December 1984 as 10 CFR Part 960.

The Act requires the DOE to nominate at least five sites as suitable for site characterization--a formal information-gathering process that will include the sinking of one or more shafts at the site and a series of experiments and studies underground. The DOE must then recommend not fewer than three of those sites for characterization as candidate sites for the first repository. After site characterization is complete, one of the characterized sites will be recommended for development as a repository.

The Act also requires the DOE to prepare environmental assessments (EAs) to serve as the basis for site-nomination decisions. These EAs contain the following information and evaluations consistent with the requirements of Section 112 of the Act:

- A description of the decision process by which the site is being considered for nomination (EA chapters 1 and 2).
- A description of the site and its surroundings (EA Chapter 3).
- An evaluation of the effects of site characterization activities on public health and safety and the environment and a discussion of alternative activities that may be taken to avoid such effects (EA Chapter 4).
- An assessment of the regional and local effects of locating the proposed repository at the site (EA Chapter 5).
- An evaluation as to whether the site is suitable for site characterization (EA Chapter 6).
- An evaluation as to whether the site is suitable for development as a repository (EA Chapter 6).
- A reasonable comparative evaluation of the site with other sites that have been considered (EA Chapter 7).

This overview highlights the important information and evaluations found in the EA for the Richton Dome. Section 2 of this overview presents a summary of the decision process and findings leading to the nomination of the Richton Dome site. Sections 3 through 7 summarize the results of evaluations contained in corresponding chapters in the EA.

2. DECISION PROCESS AND PRELIMINARY CONCLUSIONS

2.1 DECISION PROCESS

The guidelines require the DOE to implement the following seven-part evaluation and decision process for nominating and recommending sites for characterization:

1. Evaluate the potentially acceptable site against the disqualifying conditions specified in the guidelines.

2. Group all potentially acceptable sites according to their geohydrologic settings.

3. For those geohydrologic settings that contain more than one potentially acceptable site, select the preferred site on the basis of a comparative evaluation of all potentially acceptable sites in that setting.

4. Evaluate each preferred site within a geohydrologic setting and decide whether such site is suitable for the development of a repository under the qualifying condition of each applicable guideline.

5. Evaluate each preferred site within a geohydrologic setting and decide whether such site is suitable for site characterization under the qualifying condition of each applicable guideline.

6. Perform a reasonable comparative evaluation under each guideline of the sites proposed for nomination.

7. Consider an order of preference of the nominated sites as recommended sites and, on the basis of this order of preference, recommend not fewer than three sites for characterization to the President.

The DOE prepared a draft EA for each of the nine potentially acceptable sites to give all interested parties an opportunity to review the full evaluation of all sites considered. In preparing the final EAs for the five nominated sites the DOE has considered all comments that were received.

The final EAs will accompany the formal nomination of five sites as suitable for characterization. The Secretary of Energy will then recommend not fewer than three of these sites to the President as candidate sites for characterization. After the President approves the Secretary's recommendation, characterization activities will begin at those sites. After characterization is completed, the DOE will again evaluate each site against the guidelines and, after completing an environmental impact statement, will recommend one site to the President for the first repository. The President may then recommend the site to Congress. At this point, the host State may issue a notice of disapproval that can be overridden only by a joint resolution of both Houses of U.S. Congress. If the notice of disapproval is not overridden, the President must then submit another repository site recommendation within 12 months. If no notice of disapproval is submitted, or if Congress overrides the notice of disapproval, then the site designation is effective, and the DOE will file an application with the NRC to obtain a construction authorization for a repository at that site.

2.2 FINDINGS AND DETERMINATIONS

The DOE's findings and determinations that apply to the Richton Dome site are summarized below.

2.2.1 EVALUATION AGAINST THE DISQUALIFYING CONDITIONS

The evidence does not support the disqualification of the Richton Dome site under the guidelines, nor are any of the other eight potentially acceptable sites found to be disqualified.

2.2.2 GROUPING OF SITES BY GEOHYDROLOGIC SETTING

The nine potentially acceptable sites are contained within the following five distinct geohydrologic settings as defined by the U.S. Geological Survey. The sites are grouped by the DOE's geohydrologic designations as follows:

Geohydrologic Setting	Site
Columbia Plateau	Reference repository location, Hanford Site, Washington
Great Basin	Yucca Mountain, Nevada
Permian Basin	Deaf Smith County and Swisher County, Texas
Paradox Basin	Lavender Canyon and Davis Canyon, Utah
Gulf Interior Region of the Gulf Coastal Plain	Vacherie Dome, Louisiana; Cypress Creek Dome and Richton Dome, Mississippi

The distinctions among the geohydrologic settings and the host rocks are clear not only among basalt, salt, and tuff, but also among the three basins in salt. The bedded salts of the Permian and Paradox Basins are distinct from the dome salt of the Gulf Interior Region in terms of their structure, their rock properties, and the relationship of the host rock to the aquifers in the geohydrologic environment. The bedded salts of the Permian and Paradox Basins are sequences of sedimentary layers of salt and impurities bounded by aquifers above and below. The domes, on the other hand, are anomalous structures that penetrate the thick sedimentary layers, including aquifers, that are characteristic of the Gulf Interior Region. The bedded salt of the Paradox and Permian Basins are also distinct in terms of their stratigraphic sequence, regional hydrologic setting, history of deposition, and physiography.

2.2.3 SELECTION OF THE PREFERRED SITE IN THE GULF INTERIOR REGION

On the basis of a comparison of the Richton Dome with the other two domes in the Gulf Interior Region, the DOE has identified the Richton Dome as the preferred site, mainly because of its ability to better ensure compliance with the waste-isolation requirements. The features of the Richton Dome that make it preferred are as follows:

- The significantly larger size of the dome allows significant flexibility in the location and design of the underground facility so as to ensure waste isolation.
- There is an absence of known collapse features suggestive of dissolution activity.
- There is an absence of previous subsurface mining or resource extraction within the site that could affect containment or isolation.
- There is limited potential for flooding of the dome area and minimal requirements for the alteration of existing drainages during the construction of the repository.
- There is an absence of projected land ownership conflicts that cannot be successfully resolved through voluntary agreements or legal proceedings.

The Vacherie Dome is expected to be less favorable as a repository site with respect to waste containment and isolation because of the following features:

- The limited lateral extent of the host rock at the proposed repository depth would necessitate a multiple-level repository.
- The presence of an overdome collapse feature is suggestive of host-rock dissolution.
- There is a potential for flooding in the area of the dome and a need for stream diversion during repository construction.

The Cypress Creek Dome is also less favorable than the Richton Dome for the following reasons:

- The limited lateral extent of the host rock at the proposed repository depth would necessitate a multiple-level repository.

- The presence of an overdome depression is suggestive of host-rock dissolution.

- The oil and gas production wells that exist on one flank of the dome could affect waste containment and isolation.

- Congressional action may be required to transfer control of National Forest lands to the DOE.

- There is a potential for flooding in the area of the dome and a need for stream diversion during the construction of the repository.

2.2.4 SUITABILITY OF THE RICHTON DOME SITE FOR THE DEVELOPMENT OF A REPOSITORY

The Act requires the DOE to evaluate the suitability of a site for development as a repository under each guideline that does not require site characterization as a prerequisite for the application. The intent is to preclude the investment of money and effort in sites that could be disqualified under those guidelines for which substantial information is already available for site evaluation. The guidelines that do not require characterization primarily relate to the effects of a repository on public health and safety, the quality of the environment, and socioeconomic conditions before the repository is closed and sealed.

For a site to be suitable for repository development under each of those guidelines that do not require site characterization, no disqualifying conditions can be present, and each of the qualifying conditions under those guidelines must be met. A final determination of suitability for repository development cannot be made until site characterization is complete. However, at this stage, the evidence does not support a finding that the Richton Dome site is disqualified. Furthermore, the evidence does not support a finding that the Richton Dome site is not likely to meet all the qualifying conditions under the guidelines that do not require site characterization.

2.2.5 SUITABILITY OF THE RICHTON DOME SITE FOR CHARACTERIZATION

To determine whether a site is suitable for characterization, the DOE must evaluate the site against all of the guidelines, including those that require site characterization. In order to judge that a site is suitable, the DOE must then conclude that the evidence does not support a finding that the site is not likely to meet all of the guidelines. As a result of the evaluations reported in Chapter 6 of the Richton Dome EA, the DOE has found that the Richton Dome site is suitable for characterization.

2.2.6 DECISION ON NOMINATION

Having made the above findings, the DOE has decided to nominate the Richton Dome site as suitable for site characterization. The other potentially acceptable sites selected for nomination are Davis Canyon, Utah; Deaf Smith County, Texas; the reference repository location at the Hanford Site, Washington; and Yucca Mountain, Nevada.

2.2.7 COMPARATIVE EVALUATION OF THE SITES PROPOSED FOR NOMINATION AND ORDER OF PREFERENCE

The DOE has performed a comparative evaluation of the five sites proposed for nomination against each of the siting guidelines. On the basis of the rankings developed during this evaluation, the DOE has determined the three sites that are preferred for characterization. In alphabetical order, those sites are Deaf Smith County, Texas; the reference repository location at the Hanford site, Washington; and Yucca Mountain, Nevada. No order of preference is assigned to these three sites.

3. THE SITE

As shown in Figure 2, the Richton Dome site is in Perry County, Mississippi, 29 kilometers (18 miles) east of Hattiesburg and 16 kilometers (10 miles) northeast of New Augusta (population 585), the county seat. The site is located in a heavily vegetated rural setting, in a region characterized by high annual precipitation and extensive surface-water systems. The proposed restricted area is about 4 kilometers (2.5 miles) northwest of Richton, a town with a 1980 population of 1,205 persons. The nearest interstate highway, I-59, passes about 40 kilometers (25 miles) west and northwest of the site. Hattiesburg is the junction of two main lines of the Illinois Central Gulf Railroad.

All of the land in the area of the Richton Dome is privately owned, and is used mainly for forestry and agriculture, with less than 1 percent in residential use. Approximately 36 percent of the area in the general vicinity of Richton Dome meets U.S. Soil Conservation Service requirements for classification as prime farmland. There are three farm dwellings located within the dome area. West of the town of Richton are several single-family dwellings located within the eastern part of the dome area. The De Soto National Forest is located 5.6 kilometers (3.5 miles) northeast of the center of the Richton Dome. Two federally-designated wilderness areas, parts of the DeSoto National Forest, are about 40 kilometers (25 miles) south of the Richton Dome site. Camp Shelby Military Reservation is located approximately 15 kilometers (9 miles) south of the dome in De Soto National Forest.

The Richton Dome is a northwest-trending elliptical salt dome. A caprock of anhydrite, the residuum of salt dissolution during the growth of the dome, covers the top of the dome and, to some degree, drapes its flanks (Figure 3). The salt bed from which the dome originated is now at a depth of more than

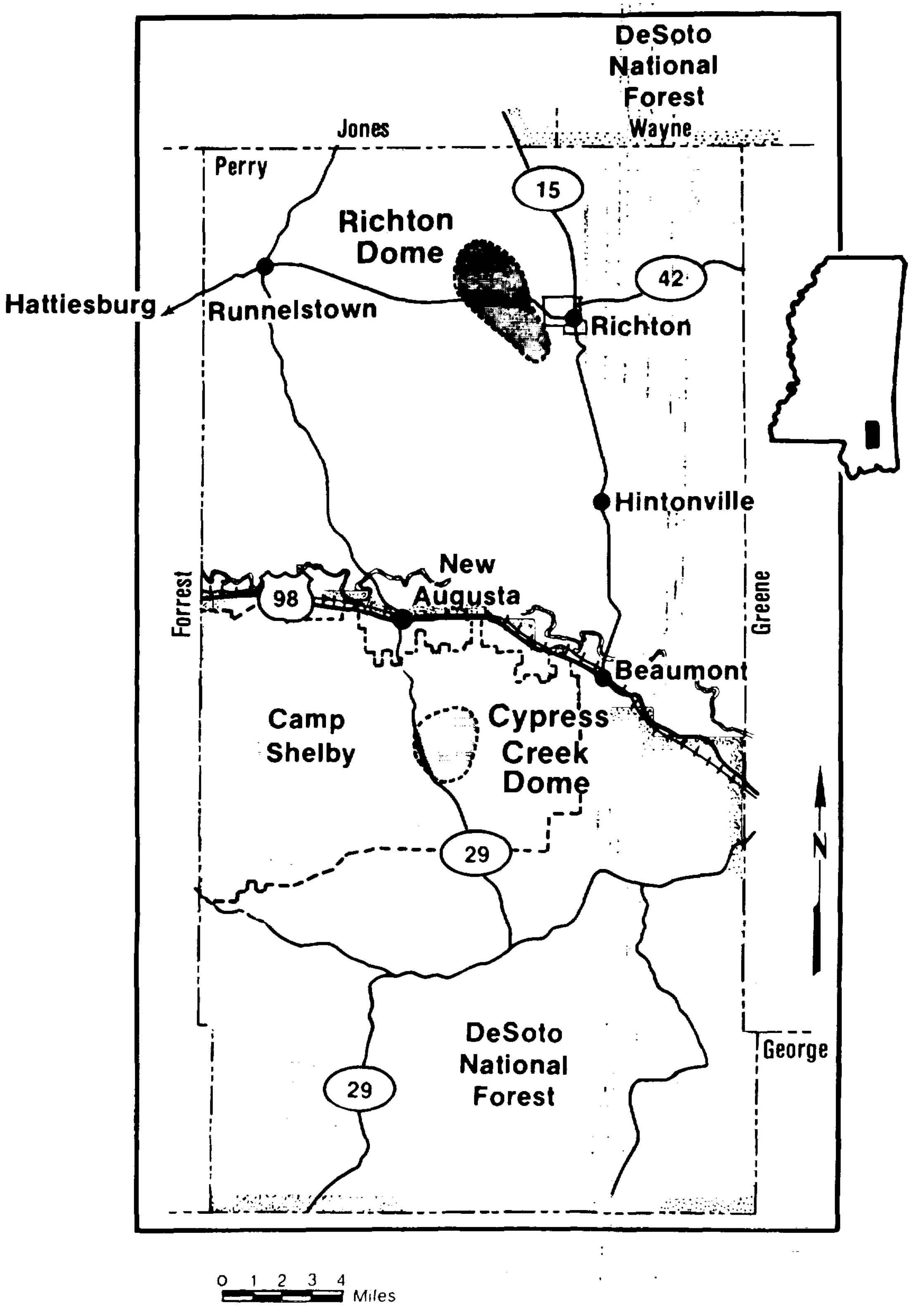

Figure 2. Richton and Cypress Creek Dome, sites, Mississippi.

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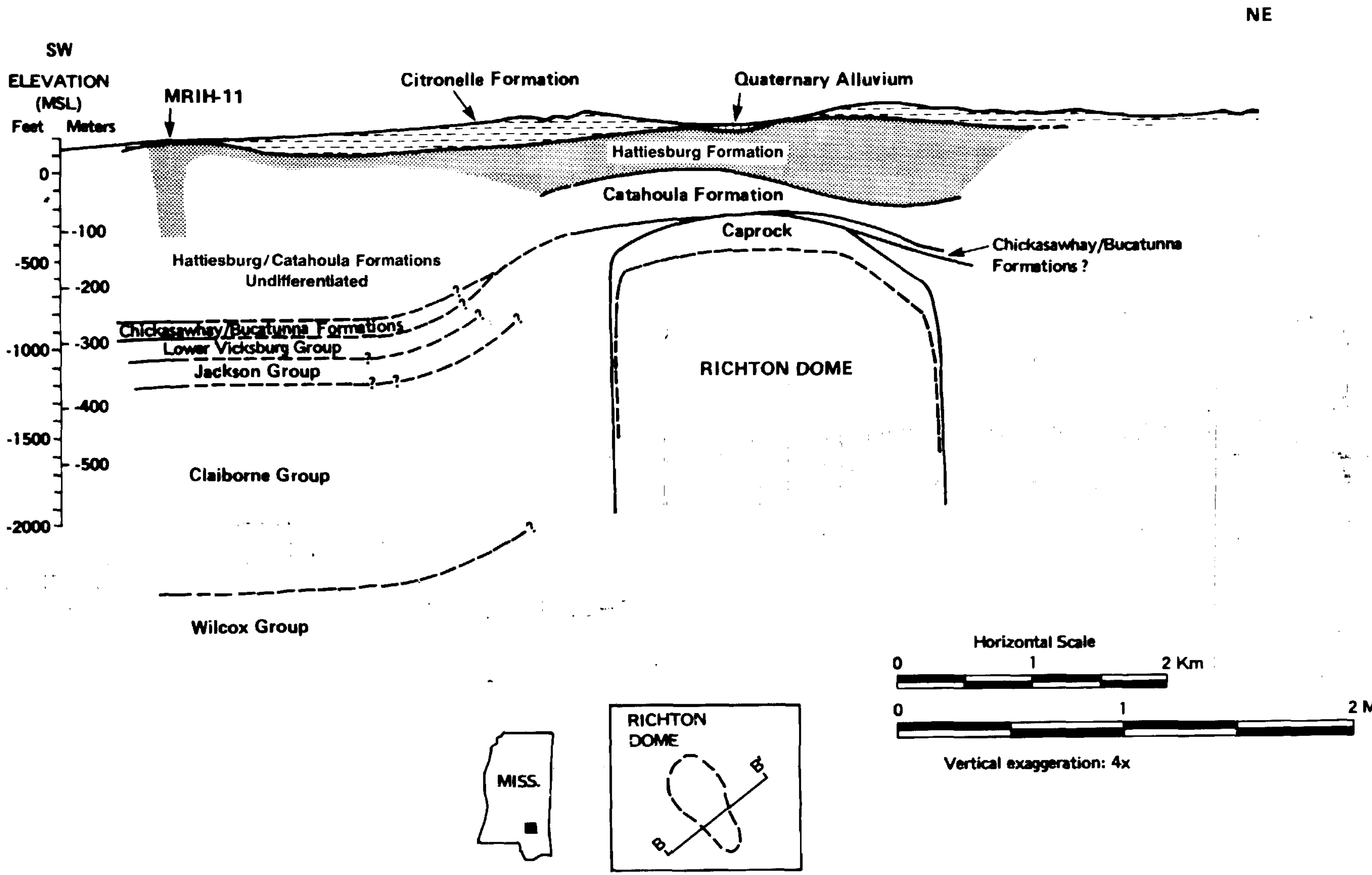

Figure 3. Geologic cross section Richton Dome site.

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7,000 meters (23,000 feet), and the top of the salt stock is within 244 meters (800 feet) of the ground surface. At the depth proposed for the repository, the horizontal cross-sectional area of the dome is approximately 2,222 hectares (5,489 acres). The sedimentary strata overlying and adjacent to the Richton Dome consist of a thick sequence of clays and silts, with lesser amounts of interbedded limestones and sands. Two parallel faults, trending north and south, have been identified in the subsurface a minimum of 8 kilometers (5 miles) east of the Richton Dome. Another small fault intersects the northwestern edge of the dome, and was probably formed during the period of upward dome movement. Disruption of recent sediments over the dome has not been confirmed. No local earthquake shocks have been felt in the vicinity of Richton Dome, which is in an area of low seismicity.

The Richton Dome site lies on the interfluve of Bogue Homo and Thompson Creeks and is well drained. In the surrounding area, drainages are characterized by low gradients and are associated with marshy swamps. The area experiences localized flooding from summer thunderstorms and hurricanes as well as frontal storms in late winter and early spring. No part of the area of the dome lies within a 100-year floodplain; however, a portion of the probable maximum flood plain is coincident with the proposed restricted area. Surface waters in the area have been classified by the State of Mississippi as either "fish and wildlife" waters or as water for recreation use, and they generally meet their respective water-quality criteria. Surface waters are used mainly for the generation of electricity and for industrial purposes.

Three principal aquifers have been identified in the area of the Richton Dome; from shallowest to deepest, they are the Upper Aquifer, the Upper Claiborne Aquifer, and the Wilcox aquifer. These aquifers consist of a number of sedimentary strata possessing similar hydraulic characteristics, and each aquifer unit is separated from the other by a relatively impervious confining unit. Regional ground-water flow within the aquifers is generally southward and southwest, downdip from outcrop areas where they recharge to areas along the Gulf Coast and in the Gulf of Mexico where they discharge. Local variations in the regional flow pattern are attributable to ground-water withdrawal, vertical leakage from one aquifer to another, and discharge to local streams. These local variations are most prominent near the recharge areas of the aquifers. Most municipal and residential water supplies in the region tap the upper aquifer unit.

Several small oil and gas fields are present within 16 kilometers (10 miles) of the Richton Dome. However, the potential for discovering additional fields seems to be very low, because intensive exploration efforts by private companies have tested all potentially favorable structures and have not located any petroleum reserves. Exploration for sulfur in the caprock over the dome indicates a very low probability of economic mineral resources. The large size, shallow depth, and pure salt of the Richton Dome make it a potential source of salt as well as a potential storage chamber for liquid or gas reserves. Under current market conditions, however, salt production from Richton Dome is considered sub-economic.

The natural vegetation of the Richton Dome area is typified by longleaf pine and slash pine forests; there are also significant numbers of loblolly pine, shortleaf pine, and other southern pines in the area. There are natural bands of hardwoods along small intermittent creeks which cross the dome area.

Much of the land has been disturbed by agriculture, forestry, and urban activities. Most of the area which would be restricted for repository development has been recently clear-cut of all woody vegetation and reseeded. There are no unique ecosystems, and no threatened or endangered species or critical habitats are known to occur in areas which would be occupied by repository facilities. However, the endangered red-cockaded woodpecker has been reported in the region, and the endangered American alligator occurs several miles south and west of the dome. The occurrence of the bald eagle and gray bat in the dome area is possible but not expected. Several other State-listed species which inhabit mesic pine flatwoods also could inhabit the dome area. Twenty-six threatened or endangered plant species could potentially occur in the Richton Dome area.

The climate in the area of the Richton Dome is subtropical and humid, with long hot summers and short mild winters. The mean annual precipitation is about 152 centimeters (60 inches). Thunderstorms occur throughout the year, whereas hurricanes occur in the Gulf region from June to November. The prevailing meteorological conditions around the site are expected to provide fair to good atmospheric dispersion of pollutants. The ambient air quality in the area meets or exceeds primary national standards for all regulated air contaminants. Being located in a predominantly rural area, the Richton Dome is removed from major industrial sources of emissions.

There is a potential for prehistoric and historic cultural resources in the dome area, although this potential may be low. No such resource sites near the dome are included in the National Register of Historic Places. One prehistoric site that may have cultural deposits, located 0.8 kilometer (0.5 mile) from the proposed restricted area, is on file in the State of Mississippi Department of Archives and History. The clear-cut proposed restricted area has no unique aesthetic features.

Perry County, in which Richton Dome is located, has a population of 15.2 persons per square mile. Of the eight counties surrounding the dome, two have greater population densities than the national average of 76 persons per square mile. Within 80 kilometers (50 miles) of the site, Hattiesburg (1980 population, 40,829) is the largest city. Other urban areas and their 1980 populations are Laurel, 21,897; Palmer Crossing, 2,765; Petal, 8,476; Ellisville, 4,652; Wiggins, 3,205; and Waynesboro, 4,368. Between 1985 and 2005, the population in the study area is projected to increase by 23 percent. A large summer seasonal population, involving a maximum of 6,000 people during any 2-week period, is associated with summer National Guard training at Camp Shelby in Perry County.

The major employment sectors in the region are manufacturing and government, with wholesale and retail trade important in populated areas. A new paper pulp mill approximately 14 kilometers (9 miles) from Richton Dome is expected to attract 400 employees. In 1982, unemployment in the area ranged from 8.6 to 17.2 percent. Adequate housing, health, and community services are available.

4. EFFECTS OF SITE CHARACTERIZATION

This section describes the activities that would be conducted if the Richton Dome site were selected for site characterization. To obtain the information necessary for evaluating the suitability of the Richton Dome site for a repository, the DOE would conduct a site-characterization program of underground testing. To carry out this program, the DOE would construct two shafts down to the level of the repository (one shaft for removing salt and other materials and lowering test apparatus into the shaft and one for services and facility emergency egress), excavate drifts at the proposed repository depth, and construct support structures on the surface. In addition to the tests performed underground and in the exploratory shaft, geologic field studies would be conducted to characterize underground conditions.

At the same time, the DOE would study the environment of the site and its vicinity, including weather conditions, air quality, noise, plant and animal communities, and archaeological and cultural resources. Socioeconomic conditions would also be investigated in the area expected to be affected by the repository.

Site characterization would produce both adverse and beneficial effects. Current land uses in parts of the site would be disrupted. Approximately 28 hectares (70 acres) of land would be cleared for the exploratory shaft and access roads. The DOE would obtain the needed surface and subsurface rights to this land through negotiation and purchase or, if necessary through condemnation. To conduct geotechnical studies, the DOE would lease or purchase small parcels of land totaling about 202 hectares (500 acres). Most of these activities would have minor land-use impacts and would be located so as to minimize conflict wherever possible.

The excavation of salt from the underground test area would create a surface stockpile of approximately 104,000 cubic meters (136,000 cubic yards), covering an area of about 4 hectares (10 acres). An impermeable liner beneath the pile and surface-runoff ponds would be used to minimize the potential for surface- and ground-water contamination from the salt pile. During salt-handling operations, some windblown salt is likely to be deposited on the ground nearby, but similar salt excavation and management experience indicates that the salt-related impacts of site characterization would not be significant. When stockpiled salt is wetted after spreading and compacting a hard surface crust forms in a few days. This crust prevents the spread of windblown particles. Waste salt and residues would be removed from the site and disposed of in a licensed landfill in the region.

Air quality effects would result mainly from fugitive dust (a major contributor to particulate emissions) and combustion gases from equipment engines. The total concentration of suspended particles (TSP) will meet the 24-hour and annual National Ambient Air Quality Standards (NAAQS). Impacts from gaseous nitrous oxide (NO_x) emissions will not exceed the annual NAAQS. Fugitive dust can be controlled by various measures, such as spraying with water and use of surface-stabilizing agents, if necessary.

Runoff and erosion from land disturbed during site characterization may increase sediment discharge and turbidity in nearby creeks. Onsite discharges of liquid wastes and runoff at the exploratory shaft facility and the salt stockpile would be collected in retention ponds. No waste water from these ponds would be discharged to local surface waters. Because the exploratory shaft site would be above the level of the 100-year flood, it would have no effect on floodplain management in the area.

The penetration of water-bearing units, primarily within the Upper Aquifer geohydrologic unit, is unlikely to affect the quality of ground water in local wells. The water needed for site characterization would be obtained from onsite wells.

Wildlife associated with the site would be displaced, and wildlife in the surrounding areas could be disturbed by human presence and activity. Wet areas in the vicinity of the dome could experience temporary changes in water quality and quantity as well as alterations in the composition of plant communities. The measures that can be undertaken to avoid or mitigate these effects include minimizing land clearing and making provisions for revegetation after site characterization. Although any threatened or endangered species that inhabit the area may be affected by the characterization activities, the overall ecological effects are not likely to be significant because most of the site has recently been clear-cut, and the plant communities that are present at the site are common throughout the State of Mississippi. Moreover, no important or unique habitats appear to be present at the site, and mitigation measures, such as avoiding undisturbed areas, would be undertaken wherever possible to reduce adverse ecological effects.

The forest cover in the area would provide some screening for site features from offsite areas. Site characterization is unlikely to disturb any archaeological, historical, or cultural resources. Before any ground is disturbed, an intensive survey would be made to locate any significant cultural resources. During development of the exploratory shaft facility, blasting to break rock in the shafts will be audible offsite. Over a period of 6 to 12 days, the blasting will be audible 9.6 kilometers (6 miles) from the source under average meteorological conditions. Noise from the diesel generators and heavy construction equipment also will be audible near the site.

Approximately 473 of the 526 workers expected during site characterization would move into the area together with their dependents; the number of people migrating into the area would total approximately 1,027. No adverse effects on economic conditions in the area are expected but local communities may experience some social effects in accommodating the newcomers. Depending on the housing preferences of the in-migrants, population increases would create a need for 95 extra housing units in the town of Richton. The DOE could provide technical assistance to local government and community officials in planning to accommodate service needs of the site characterization project.

Site characterization at Richton Dome would cost $250 million for exploratory shaft facility construction and $225 million for other activities, primarily geologic activities. Seventy percent of this amount would be for materials and 30 percent for wages. It is likely that some materials (such as fuel, concrete, small equipment, lumber, and other building supplies) will be purchased locally. A part of the wages will be spent locally, including wages from indirect jobs generated by the project.

5. REGIONAL AND LOCAL EFFECTS OF REPOSITORY DEVELOPMENT

To determine the effects of developing a repository at the site, three phases of repository development were examined: construction, operation, and closure and decommissioning. During the construction phase, which will last approximately 6 years, the DOE would construct surface and support structures, construct access shafts, excavate and prepare underground tunnels and waste-disposal rooms, and improve access roads and utility services. During the first few years of the operation phase, the repository would receive small amounts of waste -about 400 metric tons (440 tons) per year - while the surface and underground facilities are completed. After construction is completed, the rate of waste receipt would increase to a maximum of 3,000 metric tons (3,300 tons) of radioactive waste per year. During the operation phase, underground development would continue concurrently with waste emplacement until the required area is excavated. This full-operation phase is estimated to last from 25 to 30 years; it would be followed by a "caretaker" period because the NRC requires the DOE to preserve the option of retrieving the waste for 50 years after the initial emplacement. During closure and decommissioning the underground repository would be backfilled, shafts and boreholes would be closed and sealed, land-use controls would be instituted, the surface facilities would be decontaminated and decommissioned, and permanent markers or monuments would be erected at the site to warn future generations about the presence of the underground repository.

Both adverse and beneficial effects would result from developing a repository at the Richton Dome site. The DOE would obtain title to the site, a surface area of about 1,988 hectares (4,910 acres). About 165 hectares (407 acres) of land would be used for the surface facilities of the repository. The use of the site for commercial forestry would be lost, but this forested land is less than 1 percent of the total forested land in Perry County. About 25 percent of the 299 hectares (739 acres) required for repository surface facilities and utility corridors would already have been disturbed during site characterization. Approximately 7.5 hectares (18.5 acres) of Federally identified wetlands would be disturbed, and 6.6 of these hectares (16.3 of these acres) would be lost. After the closure of the repository, the disturbed areas may be returned to forestry use. Expansion of the town of Richton to the west, including local industrial development, would be influenced by the presence of repository facilities. A number of residences would have to be relocated.

Approximately 3 million tons of excavated salt would be stored at the site to be used for backfilling the repository during closure. The salt-storage pile would cover about 21 hectares (53 acres) and reach a height of about 9 meters (30 feet). Although a hard crust would form over the salt pile, some windblown salt is likely to be deposited in the immediate vicinity of the site during salt-transfer operations. An impermeable liner would be used under the pile to minimize effects on ground water. Collection ponds would be constructed to contain any runoff from the salt pile. It is not expected that windblown salt from salt-handling activities or from the salt pile would significantly affect local soils or surface waters. About 9 million metric tons (10 million tons) of excess salt would be removed from the site. Excess salt can be disposed of by several methods, including placement in an offsite mine; no method of salt disposal has yet been selected.

The ecological effects of repository development would be largely confined to the site; they would be similar to those of site characterization (Section 4). The overall ecological effect is not expected to be significant, especially since extensive logging operations have removed vegetation at the site. However, 6.6 hectares (16.3 acres) of wetlands would be lost.

The potential for adverse air-quality effects arises principally from the emissions of particulates and nitrogen oxides; the greatest levels of these pollutants would be reached during site preparation. The 24-hour National Ambient Air Quality Standards (NAAQS) for total suspended particles (TSP) and the annual average NAAQS for TSP and nitrous oxides (NO_x) will be met during repository construction, operation, decommissioning, and closure.

The water needed for the repository would be supplied by offsite wells, and therefore no surface waters would be withdrawn and consumed. Local hydrologic conditions could be affected by changes in runoff patterns as well as by stream diversion and rechannelization. The degradation of surface-water quality by spills of fuel and other contaminants is not expected. Protective measures that could be used include erosion-control dikes; retention ponds that can accommodate a 100-year, 24-hour storm; channel diversion; and salt pile management. Ground-water withdrawals and changes in surface conditions might cause changes in the local ground-water system, such as declines in water level. Surface developments and repository shafts would be designed and constructed to avoid potential effects on the surrounding ground-water system.

The erection of large structures and the development in a rural landscape would affect the visual character of the area. Night lighting would contribute to the visual impacts, but the overall effect would be lessened somewhat by the surrounding forest cover. Dust clouds would be visible for short periods during construction. Control measures would be employed to prevent dust from dissipating off site.

Noise impacts from blasting at the locations of the repository shafts will be similar to those from blasting during site characterization. Construction of the rail spur leading to the site also will rovide a short-term noise-level increase. Rail traffic and increased road traffic, as well as repository operation, will produce noise which can be mitigated by control measures such as maintaining a buffer zone of pine forest along the repository boundary.

During the peak year of repository construction, about 2,120 direct and indirect jobs would be created in the region, and a maximum of 2,420 persons would in-migrate. By the peak year of operation, about 2,190 direct and indirect jobs would be created (although there would be a smaller proportion of direct jobs than during construction), and a maximum of 1,970 persons are expected to have migrated into the region. The maximum repository-related population increases during peak operation (approximately the year 2005) will be 2 percent of the baseline populations of Hattiesburg and Laurel and 3 percent of the baseline population of Petal. Richton will undergo a 37 percent population increase during construction, reducing to 28 percent during peak operation. Potentially adverse socioeconomic effects in Richton should be offset by an increased tax base, by grants-equal-to-taxes, and financial assistance provided by the DOE. Residents displaced as a result of project activities would be eligible for assistance, and real property would be acquired at fair market value.

Local business activity would increase. During the 7-year construction period an estimated $37 million would be spent for materials purchased locally. An additional $15 million would be spent locally by in-migrating workers and their families. A portion of the $3 billion anticipated repository operation cost would be recirculated in the local economy.

Two types of transportation effects would result from increased commuter traffic and the hauling of supplies, excess salt, and radioactive waste. Radiological risks would result from the direct external radiation emitted by the radioactive waste as a shipment passes by. Nonradiological risks include traffic accidents and the health effects that result from the pollutants emitted by combustion engines; they would occur regardless of the cargo carried by the railcar or truck. In general, both types of risk will vary with the distance traveled and with the mode of transportation (road or rail). Since the Richton Dome site is closer to the sources of waste from commercial nuclear power plants than the other potentially acceptable sites, the nonradiological risks will be relatively low.

Although the risks would vary with the transportation mode, they are expected to be low. The radiological risks for the Richton Dome site are expected to be significantly lower than the nonradiological risks. The transportation costs for the Richton Dome site are projected to be approximately 936.1 million dollars for truck and 982.0 million dollars for rail transport. These costs are lower than for the other salt sites.

The terrain presents no hazards to the transportation of waste, and there are no local conditions that would increase the cost of transportation or pose significant risks to public health and safety. However, the transportation of waste may experience delays due to heavy rains and flooding.

6. EVALUATIONS OF SITE SUITABILITY

The DOE has evaluated the Richton Dome site to determine its suitability as a candidate for site characterization. This evaluation was based mainly on the siting guidelines, but it was also based on the expected effects of site characterization and of repository development, as summarized in the preceding sections.

6.1 THE STRUCTURE OF THE GUIDELINES

The guidelines are divided into two sets: postclosure (the period after the repository is permanently closed) and preclosure (the period of repository siting, construction, operation, closure, and decommissioning). The postclosure and the preclosure guidelines contain both Technical and System guidelines. The Technical guidelines address the specific characteristics of the site that are considered to have a bearing on the preclosure and the postclosure performance of the repository. The System guidelines address the expected performance of the total system, including its engineered components; their objective is to protect public health and safety and to preserve the quality of the environment.

The postclosure Technical guidelines address the characteristics that could affect the long-term ability of the site to isolate the waste from the accessible environment. In particular, they cover geohydrologic conditions, geochemical conditions, rock characteristics, climatic changes, erosion, dissolution, tectonics, and human interference. The postclosure System guideline requires the site to contain and isolate the waste from the accessible environment in accordance with the standards and the regulations specifically promulgated for repositories by the EPA and the NRC. In order to achieve the specified level of containment and isolation, both natural and engineered barriers may be used.

The preclosure guidelines are divided into three groups: (1) preclosure radiological safety; (2) the environment, socioeconomics, and transportation; and (3) the ease and cost of siting, construction, operation, and closure. A preclosure System guideline is specified for each of these groups. The associated Technical guidelines address site suitability in terms of population density and distribution, site ownership and control, meteorology, offsite installation and operations, environmental quality, socioeconomics, transportation, surface characteristics, rock characteristics, hydrology, and tectonics.

6.2 SUMMARY OF SITE EVALUATIONS AGAINST THE POSTCLOSURE GUIDELINES

The features that would contribute most to the ability of Richton Dome site to isolate the waste from the accessible environment are a dry environment and favorable geomechanical properties. Very little water is available in the Richton Dome to dissolve the waste and transport radionuclides. Because rock salt is nonporous, it is uncertain whether there is currently any movement of fluids within the Richton Salt Dome. Under the conservative assumption that fluid movement occurs through interconnected pores, the minimum ground-water travel time from the edge of the engineered-barrier system to the dome flank has been calculated to exceed 100,000 years. A calculated median travel time over the same distance is 3.5 x 10^7 years. Furthermore, there is evidence of a chemically reducing environment within and around the dome; such an environment would maintain radionuclides in their least-mobile state by diminishing their solubility and promoting precipitation. Another favorable characteristic is the ability of a relatively homogeneous body of salt to dissipate waste-generated heat rapidly and to deform plastically, which promotes the closing and sealing of fractures and openings in the salt. Such a combination of conditions is conducive to the containment and isolation of radio- nuclides within the dome. In addition, the area shows almost no evidence of tectonic instability and has a historical record of low seismicity.

Conditions that might adversely affect the waste-isolation capability of the natural barriers at the site include the process of salt dissolution and the presence of mineral resources that could be considered commercially extractable. The geologic characteristics of the area over the dome suggest that the dissolution of the salt stock in the Richton Dome ended about 2.3 million years ago and has definitely been insignificant during the last 2 million years. The projected rates of dissolution are very low, and dissolution is not expected to significantly affect waste isolation over the next 100,000 years. Considerable past exploration for oil and gas in the dome area indicates little potential for additional economically recoverable reserves. The large size of the dome and the small depth to high-purity salt make the Richton Dome attractive as a future source of salt; however, under current market conditions, this resource is sub-economic. Depending on the method of salt extraction, the mined-out space could be used for underground storage.

To meet the EPA's standards for long-term waste isolation, the NRC specifies two requirements for the engineered-barrier system: the waste package is to contain the waste for 300 to 1,000 years, and the radionuclide-release rate beyond the period of containment is not to exceed one part in 100,000 per year of the repository inventory at 1,000 years after closure. The waste-package lifetime at the Richton Dome is estimated to exceed 10,000 years. This estimate is based on expected conditions and current information regarding the corrosion of metals like those used for the waste canister. The rate of radionuclide release after the period of containment is estimated to meet regulatory requirements. Preliminary assessments of engineered-barrier performance based on realistic but conservative assumptions indicate that the EPA's limit for releases from the engineered-barrier system would be met at the Richton Dome site.

6.3 SUMMARY OF SITE EVALUATIONS AGAINST THE PRECLOSURE GUIDELINES

The evaluations of the Richton Dome site against the three groups of preclosure guidelines are summarized below.

6.3.1 RADIOLOGICAL SAFETY

Preliminary assessments of preclosure performance for the Richton Dome site do not indicate that any of the applicable radiation standards would be exceeded during repository operation and closure. In addition, the site was evaluated against the four Technical guidelines that address the radiological effects of repository operation: population density and distribution, site ownership and control, meteorology, and the effects of operations and accidents at nearby installations.

The average population density in the region is low, 40 persons per square mile, and the nearest highly populated area, Hattiesburg, is sufficiently remote (28 kilometers [18 miles] from the site). The proposed restricted area at the Richton Dome is 4 kilometers (2.5 miles) from the town of Richton.

Severe weather phenomena around the site include tropical storms (some reaching hurricane status) and tornadoes. Surface facilities would be designed to withstand severe weather events, but it may not be possible to mitigate some effects from high winds and severe weather.

6.3.2 ENVIRONMENT, SOCIOECONOMICS, AND TRANSPORTATION

Three Technical Guidelines address the environmental, socioeconomic, and transportation effects of a repository. These effects, which could be both beneficial and adverse, are summarized in Sections 4 and 5 of this executive summary. Preliminary analyses indicate that the expected adverse effects can be mitigated.

With respect to the System Guideline on the environment, socioeconomics, and transportation, there is no evidence to support a finding that the Richton Dome site is not likely to meet the qualifying conditions of protecting the public and the environment from the potential hazards of waste disposal.

6.3.3 EASE AND COST OF SITING, CONSTRUCTION, OPERATION, AND CLOSURE

Four Technical Guidelines address the ease and cost of siting, construction, operation and closure: surface characteristics, rock characteristics, hydrologic conditions, and tectonics.

The surface characteristics are generally favorable because the site (particularly the proposed surface facility area) lies in flat, well-drained terrain. However, a portion of the proposed surface facility area is coincident with the probable maximum flood plain. The Richton Dome is sufficiently large to accommodate a repository with an ample buffer for waste isolation. Furthermore, this great volume allows for flexibility in design and construction to deal with conditions that may be found at depth. The underground excavation in the salt mass of the site should require only minimal support, such as rock bolting. Because salt is plastic under pressure at depth, underground openings in the salt will tend to close and seal. Thus, the openings would require maintenance to keep passage-ways open to the required dimensions. Gas pockets or brine pockets may be hazardous to workers, but preliminary analyses and previous mining experience in salt domes indicate that the potential for such hazards can be diminished by exploration in advance of excavation, repository design, and proper operation. Significant anomalous salt conditions (sedimentary inclusions, shear zones) are not expected within Richton Dome.

The historical seismicity of the area, and thus the predicted seismicity of the site, is significantly lower than that for most other areas of the United States. This should mean a simple design for the surface facilities of the repository, making it less costly to construct. Sufficient water appears to be available from surface- and ground-water sources for repository construction, operation, and closure. There is a potential for localized, temporary ponding of water after major rainstorms.

These preliminary evaluations indicate that the repository can be constructed and operated with reasonably available technology and the costs would be comparable to those of constructing a repository at the other potentially acceptable sites. Thus, with respect to the System guidelines for the ease and cost of construction, there is no evidence to support a finding that the Richton Dome site is not likely to meet the qualifying condition.

7. COMPARATIVE EVALUATION OF NOMINATED SITES

7.1 INTRODUCTION

7.1.1 PURPOSE AND REQUIREMENTS

Chapter 7 presents a comparative evaluation of the five sites nominated as suitable for site characterization in order to satisfy the following:

1. Section 112(b)(1)(E)(iv) of the Nuclear Waste Policy Act of 1982, which requires that a "reasonable comparative evaluation" be included in the environmental assessments that accompany site nomination.

2. Section 960.3-2-2-3 of the DOE's siting guidelines (10 CFR Part 960), which requires that a reasonable comparative evaluation be made and that a summary of evaluations with respect to the qualifying condition for each guideline be provided to "allow comparisons to be made among sites on the basis of each guideline."

The evaluation in Chapter 7 is intended to allow the reader to compare the more detailed suitability evaluations of the individual sites that are presented in Chapter 6 of each environmental assessment. The comparison should assist the reader in understanding the basis for the nomination of five sites as suitable for characterization; it is not intended to directly support the subsequent recommendation of three sites for characterization as candidate sites.

7.1.2 APPROACH AND ORGANIZATION

This comparative evaluation of the five nominated sites is based on the postclosure and preclosure guidelines (10 CFR Part 960, Subparts B and C, respectively). The approach used to compare the sites with respect to each system and technical guideline is summarized below.

7.1.2.1 Technical guidelines

Major considerations that could be used to compare the sites on the basis of the qualifying condition of each technical guideline were derived by identifying the favorable, potentially adverse, and disqualifying conditions that deal with the same general topic. Contributing factors that represent the characteristics of the site that are potentially important in evaluating the sites with respect to each major consideration were also identified. The relative importance of the major considerations was determined primarily by the degree to which they contribute to the qualifying condition; that is, the stronger the tie between the consideration and the qualifying condition, the greater the importance of the consideration.

The purpose of identifying major considerations for each guidelines is to combine closely related site conditions so that the balance of the favorable and potentially adverse conditions can be considered directly. Most guidelines that contain a disqualifying condition also have one or more potentially adverse conditions that relate to the disqualifying condition. Since these potentially adverse conditions are considered in the formulation of a major consideration, the important aspects of the disqualifying conditions indirectly enter the comparative evaluation. Where a major consideration that is needed to evaluate the qualifying condition does not have a related favorable or potentially adverse condition, the consideration is derived directly from the qualifying or disqualifying condition.

7.1.2.2 System guidelines

The comparison of sites on the basis of the individual technical guidelines uses the major considerations to incorporate the favorable and potentially adverse conditions in an evaluation of a site's standing on the qualifying conditions for each technical guideline. It is not appropriate, however, to use this approach for a comparative evaluation of sites on the basis of the system guidelines. The qualifying conditions for the system guidelines do not lend themselves to the identification of major considerations in the way that the qualifying conditions for the technical guidelines do. The system guidelines for postclosure repository performance and preclosure radiological safety are stated in terms of regulatory requirements of the NRC and the EPA. The evaluations of these two system guidelines are based on preliminary performance assessments. These evaluations are summarized directly in Chapter 7 from Sections 6.3.2 and 6.2.2.1 of each environmental assessment.

The system guidelines for environmental quality, socioeconomics, and transportation, and for the ease and cost of repository construction, operation, and closure are not stated as regulatory standards, and they cannot be evaluated by a performance assessment as are the other two system guidelines. Instead, they are evaluated by considering the individual guidelines that make up these two system guidelines collectively to determine whether each site meets the qualifying condition of the relevant system guidelines. The evaluation of these system guidelines is summarized in Chapter 7 from information contained or referenced in Sections 6.2.2.2 and 6.3.4 in each environmental assessment.

This overview summarizes the major considerations and contributing factors for each technical guideline. It does not discuss the comparative evaluations of sites in Chapter 7; these comparisons are already a summary of information in Chapter 6 of each environmental assessment, and the DOE believes that a further synopsis of the evaluation in Chapter 7 for the purpose of this overview would distort the information and possibly mislead the reader. For the systems guidelines, this overview summarizes (1) the conclusions of the performance assessments for postclosure repository performance and preclosure radiological safety, and (2) the conclusion on the qualifying condition for environmental quality, socioeconomics, and transportation, and the ease and cost of constructing, operating, and closing the repository. For a discussion of the initial order of preference of sites, the reader is referred to the separate report on the multiattribute utility analysis of the nominated sites.

7.2 COMPARISON OF THE SITES ON THE BASIS OF THE POSTCLOSURE GUIDELINES

The postclosure guidelines are concerned with the characteristics, processes, and events that may affect the performance of the repository after closure. Their objective is to ensure that the health and safety of the public will be protected for thousands of years, until the radioactivity of the waste has diminished to safe levels.

7.2.1 TECHNICAL GUIDELINES

7.2.1.1 Geohydrology

Four major considerations are identified that influence the favorability of the sites with respect to the qualifying condition for the geohydrology guideline. The first consideration, ground-water travel time and flux, addresses geohydrologic conditions that control ground-water travel time between the disturbed zone and the accessible environment, and ground-water flux (volumetric flow rate) across or through the repository and through the host rock to the accessible environment. This is the most important major consideration because transport by ground water is the primary control of radionuclide movement from the repository to the accessible environment. At each of the sites there are uncertainties in the conceptual ground-water flow model and in the values of key hydraulic parameters that control ground-water travel time and flux. Taking these uncertainties into account, there are ranges of possible travel times between the disturbed zone and accessible environment at each site. Therefore, ground-water travel time was stochastically modeled at each site, using reasonably conservative assumptions about the geohydrologic system and ranges of hydraulic parameters. In general, ground-water flux is expected to be low to very low at each of the nominated sites.

The second consideration, changes in geohydrologic processes and conditions, addresses potential changes in natural processes in the geologic setting that could change geohydrologic conditions so as to affect the ability of a repository to isolate the waste. The DOE has concluded that climatic change is the only factor that has a likely potential for significantly affecting the hydrologic system at any of the nominated sites during the next 100,000 years. Therefore, climatic change is the only potential cause of change to the geohydrologic system that is addressed in the evaluations of individual sites.

The third consideration is ease of characterizing and modeling the geohydrologic system. Since it is not an intrinsic physical characteristic of the geohydrologic setting, this consideration is not as important as the first two considerations. Some of the contributing factors that influence the ease of characterization and modeling are the presence of faults, folds, and brine pockets, dissolution effects, lithologic variations, interrelationships among hydrostratigraphic units, availability of testing techniques and analytic models, and understanding of flow mechanisms.

The last consideration, presence of suitable ground-water sources, addresses the possibility that radionuclides migrating from a repository could mix with ground-water sources suitable for crop irrigation or human consumption without treatment along flow paths to the accessible environment. This consideration is less important than the other three, because it is unlikely that ground-water resources could be contaminated if a site is selected on the basis of its ability to isolate wastes, as reflected in the other three considerations.

7.2.1.2 Geochemistry

Three major considerations are identified that influence the favorability of the sites with respect to the qualifying condition for the geochemistry guideline. The first consideration, mass transfer of radionuclides, includes geochemical conditions within the immediate vicinity of the waste package after permanent closure of the repository. The mass transfer of radionuclides is the most important consideration because it describes the processes by which radionuclides that are initially sealed in the waste package as part of the solid waste form will be released to the ground-water system or be contained within the engineered-barrier system. The most important contributing factors include the volumetric flow rate of ground water near (within a few meters) the waste package and the chemistry of the ground water.

The second consideration, radionuclide transport, addresses geochemical conditions outside the immediate vicinity of the waste package after the permanent closure of the repository. Radionuclide transport near the waste package is considered to be slightly less important than the first major condition because geochemical conditions that influence transport may act as a secondary barrier to radionuclides escaping from the engineered barrier system. The contributing factors that are the most important for the quantitative evaluation of this consideration include the potential for sorption and precipitation, and redox conditions.

The last consideration addresses geochemical processes that could adversely affect the sorptive capacity or strength of the host rock, or both. This is the least important consideration under the geochemistry guideline because mineral alteration and changes in rock strength in the vicinity of the waste-package would affect only a small percentage of the total rock mass surrounding the repository. The major contributing factors for this consideration are the stability of mineral assemblage and effects of changes in the structure of minerals on sorption and rock strength.

7.2.1.3 Rock characteristics (postclosure)

Three major considerations are identified that influence the favorability of the sites with respect to the qualifying condition for rock characteristics guideline. The first consideration is the impact on waste isolation of repository-induced heat. The contributing factors for this condition are thermal properties of the host rock such as its ability to conduct heat or expand in response to heat; mechanical properties such as ductility; thermomechanical behavior such as the potential for thermally induced fractures; and geochemical factors such as the potential for brine migration, hydration, or dehydration of the mineral components. The impact of repository-induced heat is the most important of the three major considerations because it has the greatest potential for affecting waste isolation.

The complexity of engineering measures is the second major consideration. It addresses in situ characteristics and conditions that could require engineering measures beyond reasonably available technology to ensure waste containment and isolation. The major contributing factors to this consideration are the uncertainty in the integrity of man-made sealing materials during the postclosure period and the effects of the in situ environment on the performance of engineered-barriers (such as the effects of brine on the waste-disposal container). Complexity of engineering methods is considered less important than repository-induced heat effects because of the greater potential of repository-induced heat to impair the isolation capabilities of the site.

The last consideration for this guideline is whether the host rock is large enough to allow flexibility in determining the depth, configuration, and location of the underground facility. Added flexibility in locating the repository will help avoid geologic features or anomalies that could adversely affect the isolation capabilities of the site. Even after requirements for preclosure host-rock flexibility have been satisfied, added flexibility is still necessary to satisfy this postclosure consideration in terms of depth of excavations, orientations of drifts and where they intersect, and location of seals. A greater volume of host rock could provide isolation capability over and above the degree deemed minimally acceptable. However, the contribution to waste isolation added flexibility in locating the underground facility is less than that of the other two considerations for this guideline.

7.2.1.4 Climatic changes

One major consideration, the effects of climatic changes in the future on the ability of the site to isolate waste, is identified that influences the favorability of the sites with respect to the qualifying condition for the climatic changes guideline. The major contributing factors to this consideration are climatic cycles during the Quaternary Period and in situ conditions at a site.

7.2.1.5 Erosion

The single major consideration under this guideline is the potential effects of erosion on the ability of the repository to isolate wastes. Contributing factors include the depth of waste emplacement, evidence of extreme erosion during the Quaternary Period, the potential for the waste to be exhumed by erosion, and the assessment of future erosion rates and geomorphic processes.

7.2.1.6 Dissolution

The single major consideration for this guideline is evidence of dissolution of the host rock during the Quaternary Period. The contributing factors for this consideration include the solubility of the host rock under nonextreme geologic and hydrologic conditions, and unusual ground-water chemistry.

7.2.1.7 Tectonics (postclosure)

The single major consideration for this guideline is the potential for increased igneous and tectonic activity during next 10,000 years and the effect that these processes have on radionuclide releases. The contributing factors include evidence of tectonic or igneous activity during the Quaternary Period, the likelihood of tectonic and igneous events during the next 10,000 years that could alter the regional ground-water flow system, the historical record of seismicity, the correlation of earthquakes with tectonic features, and evidence of tectonic activity during the Quaternary Period.

7.2.1.8 Human interference

The potential for human interference after the repository is closed and decommissioned requires an analysis of (1) the natural resources at or near a site, including past, current, and future exploration for and uses of these resources and (2) site ownership and control.

7.2.1.8.1 Natural resources

Three major considerations are identified that influence the favorability of the sites with respect to the qualifying condition for the natural resources guideline. Although the major considerations are listed in decreasing order of importance, there are relatively small differences in importance, particularly between the second and third considerations.

The first consideration is evidence of subsurface mining, resource extraction, and drilling at the site. It assesses the impacts on the isolation and containment system from existing mines and drill holes within the site.

The second consideration is the potential for foreseeable human activities that could affect the ability of the site to contain and isolate wastes. Contributing factors include the potential for ground-water withdrawal, irrigation, injection of fluids, underground pumped storage, and large-scale surface-water impoundments. This consideration is not as important as the first major consideration because the first consideration is based on existing evidence of resources, while the second is based on projected, more speculative human activities. In evaluating this major consideration the environmental assessments have qualitatively considered the effectiveness of markers and records in reducing the potential for of human intrusion in the controlled area.

The last major consideration, potential for intrusion to extract resources after the repository is closed. Contributing factors include the presence or indications of resources (including water) at the site, their value, scarcity, and depth, and whether they are available from other sources. This consideration is third in importance because the potential for resources is based on speculative or indirect evidence.

7.2.1.8.2 Site ownership and control

The purpose of the postclosure guideline on site ownership and control is to help ensure that the repository can function far into the future without adverse human interference. This guideline specifies that the DOE, in accordance with the requirements of 10 CFR Part 60, must obtain ownership of surface and subsurface rights to land and minerals within the controlled area of the repository. A similar guideline on site ownership is also provided for the preclosure period. The DOE has determined that the necessary land area and controls are the same for both the postclosure and preclosure periods at the five nominated sites. Whichever site is selected, the DOE must obtain ownership and surface and subsurface rights before beginning construction; there is no basis for distinguishing among the sites on the basis of their site ownership and control status at the beginning of the postclosure period.

7.2.2 POSTCLOSURE SYSTEM GUIDELINE

The results of preliminary system-performance assessments are described in Section 6.4.2 of each environmental assessment and briefly reviewed here. These preliminary assessments are based on limited geologic, hydrologic, and geochemical information, preliminary conceptual models, and relatively simple analytical techniques. The DOE is therefore not yet prepared to provide assurance that the regulatory criteria will be met at any of the sites. These preliminary assessments do, however, appear adequate to evaluate the sites in terms of the postclosure system guideline.

The guideline addresses the following capabilities of the geologic setting at a site:

1. The capability of the geologic setting at the site to allow for the physical separation of the waste from the accessible environment after closure in accordance with the requirements of the EPA standard in 40 CFR Part 191, Subpart B, as implemented by the NRC rule in 10 CFR Part 60.

2. The capability of the geologic setting at the site to allow for the use of engineered barriers to ensure compliance with the requirements of the EPA and the NRC. Two requirements are pertinent here: (1) the time of substantially complete containment (i.e., a period between 300 and 1,000 years); and (2) the limit on the rate of radionuclide releases from the engineered-barrier system (i.e., one part in 100,000 per year of the individual radionuclide inventory or one part in 100,000 per year of the total inventory calculated to be present at 1,000 years after repository closure, whichever is greater).

With regard to the capability of the geologic setting to separate the waste from the accessible environment, the results of the preliminary assessments do not exceed the EPA standard at any of the sites. For example, the mean ground-water travel time from the repository to the accessible environment is expected to be much longer than 10,000 years at all five nominated sites.

Because of the different characteristics of the sites, different approaches to the performance assessments and different levels of conservatism have been used for each site. Since site-specific data is limited prior to characterization, the degree of conservatism resulting from such assumptions in each case is not currently known. Nonetheless, the degree of conservatism is believed to be sufficient to establish outside bounds on actual site performance. The preliminary performance assessments do not provide any reason to believe that any of the sites would not adequately isolate the waste from the accessible environment.

With regard to the requirements for the performance of the engineered-barrier system, the preliminary assessments indicate that the system would meet the regulatory performance objectives at all sites. For example, analyses of the waste-package performance indicate that the container lifetime is expected to exceed the 300- to 1,000-year requirement for substantially complete containment at each site. For each site, the calculations of the rate of radionuclide release after the failure of the waste package suggest that the criterion for the rate of release from the engineered-barrier system would not be exceeded. Extremely conservative assumptions have been used to make these estimates. Again, the degree of conservatism provided by these assumptions is not presently known. However, the DOE is confident that the use of conservative assumptions establishes outside bounds on actual performance of the waste package, and the analyses appear to be sufficient to indicate that there is no evidence that the criteria for the performance of the waste-package and engineered-barrier systems would not be met at each of the nominated sites. Furthermore, the available data and the preliminary analyses based on these data have not identified any conditions or features at any of the sites that would prevent these engineered components from meeting the performance requirements.

7.3 COMPARISON OF SITES ON THE BASIS OF PRECLOSURE GUIDELINES

The preclosure guidelines address (1) preclosure radiological safety; (2) the environmental, socioeconomic, and transportation-related impacts associated with repository siting, construction, operation, and closure; and (3) the ease and cost of repository siting, construction, operation, and closure. Both technical and system guidelines are provided for each of these three categories.

7.3.1 PRECLOSURE RADIOLOGICAL SAFETY

7.3.1.1 Technical guidelines

There are four technical guidelines that contribute to the assessment of preclosure radiological safety: (1) population density and distribution, (2) site ownership and control, (3) meteorology, and (4) offsite installations and operations. The objective of these guidelines is to protect the health and safety of the public and the workers at the repository by keeping exposures to radiation within the limits prescribed by regulations.

7.3.1.1.1 Population density and distribution

Two major considerations are identified that influence the favorability of the sites with respect to the qualifying condition for the population density and distribution guideline. The first major consideration is the remoteness of a site as measured by the site's distance from highly populated areas of 2,500 people or more, or from a one mile by one mile (2.6 square kilometers) area that contains 1,000 or more individuals. The contributing factors for this consideration are the air distance of the site from population concentrations and the size of those concentrations.

The second major consideration, population density, is evaluated for each site on the basis of density within the projected site boundaries, near the site (within a radius of 10 miles), and in the general region of the site (within a radius of 50 miles). In the evaluation of this major consideration, a "low population density" is defined as being less than the average population density of the contiguous United States in 1980, or 76 persons per square mile.

7.3.1.1.2 Site ownership and control

The single major consideration for this guideline is the complexity of procedures for acquiring land needed for the repository. The DOE has evaluated this guideline on the basis of what property would be required for repository construction, operation, closure, and decommissioning. Land acquisition procedures, such as leasing, that might be employed during site characterization are not considered in the evaluation of this guideline.

Sites for which land will be easier to acquire from a procedural and legal point of view are more favorable than sites that are more difficult to acquire. This does not mean that the DOE discounts the socioeconomic impact of acquiring land, especially privately-owned land. The socioeconomic impacts of land acquisition are considered under the socioeconomic guideline.

7.3.1.1.3 Meteorology

Two major considerations are identified that influence the favorability of the sites with respect to the qualifying condition for the meteorology guideline. The first major consideration is conditions that affect the transport of radionuclides in the atmosphere to unrestricted areas where the public might be exposed, and the significance of transport. Contributing factors include dispersion characteristics of the atmosphere, wind speed and direction, frequency of stagnation episodes, atmospheric mixing levels, local terrain, and locations of nearby population concentrations. This is the most important consideration under this guideline because the potential for radionuclides to be transported in the direction of population concentrations directly affects a site's ongoing ability to meet the requirements of the preclosure system guideline for radiological safety, and reflects the focus on routine exposures in the qualifying condition for meteorology.

The second major consideration, extreme-weather phenomena, addresses the historical frequency and intensity of extreme weather such as hurricanes, tornadoes, floods, and winter storms that could have a significant effect on repository operations or closure. This consideration is less important than the first major consideration because, unlike atmospheric transport characteristics, which tend to reflect on-going or frequent meteorological conditions, extreme weather phenomena reflect infrequent or episodic conditions.

7.3.1.1.4 Offsite installations and operations

Two major considerations are identified that influence the favorability of the site with respect to the qualifying condition for the offsite installations and operations guideline. The first major consideration is the presence of nearby nuclear installations or operations. This consideration addresses radionuclide releases from atomic energy defense activities and nuclear installations regulated by the NRC, which could, together with operational releases from the repository, subject the general public to radionuclide exposures above allowable limits. The evaluation of this consideration accounts for the proximity of nuclear installations and operations to the site and the level of radionuclide releases during accidents and routine operating conditions at these installations.

The second major consideration is the possible adverse effects of nearby hazardous operations and installations on repository, construction, operation, and closure. Such operations and installations could include chemical plants; fuel production, refining, transportation, and storage facilities; pipelines; major transportation routes that could carry hazardous materials; air traffic associated with nearby airports; military operations areas; and facilities that handle toxic materials including hazardous waste disposal sites.

7.3.1.2 <u>Preclosure system guideline for radiological safety</u>

For preclosure radiological safety the pertinent system elements are (1) the site-specific characteristics that affect radionuclide transport; (2) the engineered components whose function is to control releases of radioactive materials; and (3) the people who, because of their location and distribution in unrestricted areas, may be affected by radionuclide releases. This guideline is assigned the greatest importance among the three preclosure system guidelines because it is directed at protecting both the public and the repository workers from radiological exposures.

This guideline requires that projected radiological exposures of the general public and projected releases to restricted and unrestricted areas during the preclosure period shall meet applicable requirements set forth in 10 CFR Part 20, 10 CFR Part 60, and 40 CFR 191, Subpart A. The specific requirements of these regulations and how well each site performs against these regulations are detailed in performance assessments that are presented in Section 6.4.1 of each environmental assessment. On the basis of these preliminary assessments it appears that a repository can be located and operated at any of the nominated sites with insignificant radiological exposure risks to the public.

7.3.2 ENVIRONMENT, SOCIOECONOMICS, AND TRANSPORTATION

7.3.2.1 Technical guidelines

Three technical guidelines are associated with the preclosure system guideline for environmental quality, socioeconomics, and transportation. Their objective is to ensure that the well being of the public and the quality of the environment are adequately protected from the hazards posed by the disposal of radioactive wastes.

7.3.2.1.1 Environmental quality

Four major considerations are identified that influence the favorability of the sites with respect to the qualifying condition for the environmental quality guideline. The first major consideration is the ability of a site to meet applicable environmental requirements. This consideration addresses the procedural and substantive requirements of environmental regulations with which the repository project must comply. A site's standing against this consideration is determined by evaluating the degree to which project activities will comply with applicable requirements as well as their ability to do so within specific time constraints.

The second major consideration is the significance of environmental impacts that could arise from the project and the degree to which such impacts can be mitigated. It also considers features of the mitigation measures such as their time requirements and technological feasibility, and the social, economic, or environmental factors that affect their applicability to a particular site. Because the environmental requirements and environmental impact considerations both reflect the requirement in the qualifying condition that the quality of the environment as a whole must be protected, these considerations are of equal importance. At the same time, they are each more important than either of the two remaining considerations.

The third major consideration is effects of the repository on protected Federal resource areas. It addresses the following Federal lands: the National Park System, the National Wildlife Refuge System, the National Wild and Scenic Rivers System, the National Wilderness Preservation System, and National Forest Land, as well as designated critical habitats for threatened or endangered species. The evaluation of sites for this consideration is based on their proximity to, and the degree of projected impacts on, the listed areas, except for critical habitats. Critical habitats are considered on the basis of whether they could be compromised by the repository.

The fourth major consideration under the environmental quality guideline is impacts on protected State or regional resource areas, Native American resources, and cultural sites. The evaluation of this consideration addresses the combined effects of a site's proximity to resource areas and the projected level of impact on those areas. Because these last two considerations address the protection of the environment in terms of a subset of environmental conditions (i.e., specific resource areas), they are equally important as a group, but less important than the first two considerations.

7.3.2.1.2 Socioeconomic impacts

Six major considerations are identified that influence the favorability of the sites with respect to the qualifying condition for the socioeconomics guideline.

The first consideration is potential impacts to community services and housing. This consideration relates to the requirement in the qualifying condition that impacts on community services or housing in affected areas and communities can be mitigated or compensated. Impacts on community services and housing depend on five contributing factors: population composition and density, the distribution of in-migrants, current capacity and trends in use of community services and infrastructure, housing supply and demand, and the ability of affected communities to accommodate growth.

The second major consideration is potential impacts on direct and indirect employment and business sales. Two factors contribute to the evaluation of this consideration: project-related needs for labor and expected local hires, and local project-related purchases of materials.

The third major consideration is potential impacts on primary sectors of the economy. The three contributing factors for this consideration are the major sectors of the economy, employment distribution and trends by economic sector, and the compatibility of a repository with the economic base of the affected area.

The fourth major consideration is potential impacts on the revenues and expenditures of public agencies in the affected area. Impacts on revenues and expenditures depend on three contributing factors: the sources of, and trends in, expenditures and revenues of local government, the additional needs for community services induced by the repository project, and economic growth in the area and resulting increases in tax revenues associated with the repository.

The fifth major consideration is the need to purchase or acquire water rights that could affect development in the area. The need to acquire water rights depends on two contributing factors: project-related water requirements, and current water rights, use, and capacity.

The last major consideration under the socioeconomics guideline is potential social impacts. Three factors contribute to the potential for social impacts: the quality of life and existing social problems in the affected communities, the size of the in-migrating population in comparison to the existing population, and the compatibility of the in-migrating population with the lifestyles and characteristics of the current residents.

7.3.2.1.3 Transportation

Four major considerations are identified that influence the favorability of sites with respect to the qualifying condition for the transportation guideline. The first and most important major consideration is transportation safety. Contributing factors include the distance of travel, the location of access routes, local terrain, and regional weather conditions.

The second major consideration is the environmental impacts of improving the existing infrastructure and of constructing new access routes to the site. For example, transportation operations and development of access routes might adversely affect sensitive species on a large scale (over many miles), and the aesthetic quality of the region may be degraded by the construction of road and rail routes. This consideration focuses on local conditions around the site since the environmental concerns along the national highway and rail network were already considered during the development of those networks for regular commercial traffic. In this respect, the incremental environmental impacts of transporting radioactive wastes are not considered to be significant on a national scale. Contributing factors for this consideration include the need to construct lengthy access roads, conflicts with current land use plans, and the need for cuts, fills, tunnels, or bridges to reach the site.

The third major consideration is the cost of constructing and upgrading the access routes to the sites. This is not as important as the first consideration since the protection of health and safety is more important than reducing costs. The main contributing factors that influence costs are the extent of needed repairs, local terrain, and costs for rights-of-way.

The least important consideration is the cost of developing the cask fleet and shipping the wastes to the repository. The cost of transporting spent fuel to the repository is determined, in part, by the distance of the site from the spent-fuel sources. Nonetheless, it costs about as much to ship waste 1,000 miles as it does 500 miles. This consideration, as well as the consideration of transportation safety, is also affected by decisions about the configuration of the waste-management system, such as the second repository. The effect of the second repository is considered as quantitatively as possible. Other contributing factors include local weather conditions, availability of carriers, emergency-response capabilities, legal impediments to transport, and the number of railway crew changes.

7.3.2.2 System guideline on environment, socioeconomics, and transportation

Ranked second in importance in the preclosure system guidelines is environment, socioeconomics, and transportation. The pertinent system elements will, in general, consist of (1) the people who may be affected, including their lifestyles, sources of income, social and aesthetic values, and community services; (2) the air, land, water, plants, animals, and cultural resources in the areas potentially affected by such activities; (3) the transportation infrastructure; and (4) the potential mitigating measures that can be used to achieve compliance with this guideline.

On the basis of the evaluation of the guidelines for environmental quality, socioeconomics, and transportation, the evidence does not support a conclusion that the qualifying condition for this system guideline would not be met at any of the nominated sites.

7.3.3 EASE AND COST OF SITING, CONSTRUCTION, OPERATION, AND CLOSURE

7.3.3.1 Technical guidelines

The four technical guidelines in this group address the surface characteristics of the site, the characteristics of the host rock and the surrounding strata, hydrologic conditions, and tectonics. These guidelines are concerned with the ease and cost of siting, constructing, operating, and closing the repository.

7.3.3.1.1 Surface characteristics

Two major considerations are identified that influence the favorability of the sites with respect to the qualifying condition for the surface-characteristics guideline. The first consideration is the potential for flooding of surface or underground facilities. This is the most important consideration under this guideline because the effects of flooding can be important factors in the design of the repository. The primary contributing factors for this consideration include the location and likelihood of flooding due to natural causes at the surface or in the underground facilities, or the potential for failure of man-made surface water impoundments or engineered components of the repository.

The second consideration is the effects of the terrain and drainage characteristics of a site on repository construction, operation, and closure. It is less important than the first consideration because terrain and drainage are more closely related to the ease and cost of construction than to safety, and can generally be mitigated more readily than conditions that could cause flooding (i.e., the first consideration). Contributing factors for this major consideration include the configuration of the repository, the potential for landslides, and soil characteristics.

7.3.3.1.2 Rock characteristics (preclosure)

Three major considerations are identified that influence the favorability of the sites with respect to the qualifying condition for the rock characteristics guideline. The first consideration addresses in situ conditions that could lead to safety hazards or difficulties during repository siting, construction, operation, and closure, including retrieval. Because of the DOE's emphasis on safety of personnel, this is the most important major consideration of the three related to this guideline.

The second consideration addresses in situ characteristics and conditions that could require engineering measures beyond reasonably available technology in the construction of shafts and underground facilities. Although the success of repository construction depends on its technical feasibility, the complexity of engineering measures is second in importance to personnel safety because of the DOE's primary emphasis on safety.

The third major consideration is whether the host rock is large enough to allow flexibility in selecting the depth, configuration, and location of the underground facility. This consideration is judged to be third in importance, because although adequate host rock to accommodate a repository is necessary, and additional host rock to provide flexibility is desirable, it is not as essential as worker safety and technical feasibility.

7.3.3.1.3 Hydrology

Three major considerations are identified that influence the favorability of the sites with respect to the qualifying condition for the preclosure hydrology guideline. The first major consideration is ground-water conditions that could necessitate complex ground-water control measures in shafts and drifts during repository siting, construction, operation, and closure. This is the most important consideration because it has the most impact on the ease and cost of repository construction, operation, and closure.

The second major consideration is the existence of surface-water systems that could flood the repository. This consideration includes ponds, lakes, streams, and man-made impoundments that could flood the underground workings. Surface-water flooding of the underground workings is a concern because it could endanger the safety of personnel and interrupt repository operations. However, standard engineering measures such as dikes and berms can minimize the risk of flooding. This consideration is considered second in importance because it is generally easier to manage the potential for surface flooding than underground flooding.

The last major consideration under this guideline is the availability of an ample source of ground or surface water for repository construction, operation, and closure. This consideration is third in importance because, although it affects the ease and cost of construction, it has a limited effect on the technical feasibility of developing the repository.

7.3.3.1.4 Tectonics (preclosure)

Two major considerations are identified that influence the favorability of the sites with respect to the preclosure tectonics guideline. The first consideration is the potential for earthquake ground motion at the site. This consideration requires an evaluation of whether ground motion at the site could lead to safety hazards or difficulties during repository siting, construction, operation, and closure. The evaluation of ground motion depends on the evaluation of potential surface faulting in the geologic setting. Contributing factors for this major consideration include the historical earthquake record, evidence of man-induced seismicity, estimates of ground motion from historical and man-induced earthquakes, correlation of earthquakes with tectonic structures and faults, and evaluations of the effects of ground-motion hazards on design.

The second consideration, expected impact of fault displacement at the site, requires an assessment of the potential for fault displacement at the site that could lead to safety hazards or difficulties during repository siting, construction, operation, and closure. This consideration is about equal in importance to the potential for earthquake ground motion. Although the likelihood of faulting at a site is generally lower than the likelihood of ground motion, the need to design for fault displacement can have a significant effect on the site's favorability. Successful construction experience where fault displacement conditions exist is an important contributing factor to this consideration. The other major contributing factors are the evidence and location of, and rates of movement on, Quaternary faults in the geologic setting.

7.3.3.2 System guideline on the ease and cost of siting, construction operation, and closure

The third preclosure system guideline is ease and cost of siting, construction, operation, and closure. It is ranked lowest because it does not directly relate to the health, safety, and welfare of the public or the quality to the environment. Here the pertinent elements are (1) the site characteristics that affect siting, construction, operation, and closure; (2) the engineering, materials, and services necessary to conduct these activities; (3) written agreements between the DOE and affected States and affected Indian tribes and the Federal regulations that establish the requirement for these activities; and (4) the repository personnel at the site during siting, construction, operation, or closure.

On the basis of the technical guidelines for ease and cost of repository siting, construction, operation, and closure, the evidence does not support a conclusion that the qualifying condition for this system guideline would not be met at any of the nomimated sites.

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