DOE/RW-0077

Nuclear Waste Policy Act
(Section 112)

Environmental Assessment
Overview

Davis Canyon Site, Utah

May 1986

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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 Davis Canyon site in San Juan County, Utah, 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 Davis Canyon site in Utah 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 Davis Canyon 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 EA.

The Davis Canyon site is in the Paradox Basin, which is one of five distinct geohydrologic settings considered for the first repository. This setting contains one other potentially acceptable site--the Lavender Canyon site. Although the Lavender Canyon site is suitable for site characterization, the DOE has concluded that the Davis Canyon site is the preferred site in the Paradox Basin. On the basis of the evaluations reported in this EA, the DOE has found that the Davis Canyon 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 Davis Canyon 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 Davis Canyon site. Section 2 of this overview presents a summary of the decision process and findings leading to the nomination of the Davis Canyon site. Sections 3 through 7 summarize the results of evaluations contained in corresponding chapters of 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 sites 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 site, the DOE has considered all comments that were received.

The final EAs will accompany the formal nomination of at least 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 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 Davis Canyon site are summarized below.

2.2.1 EVALUATION AGAINST THE DISQUALIFYING CONDITIONS

The evidence does not support the disqualification of the Davis Canyon 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 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 rock are clear not only among basalt, salt, and tuff, but also among the three basins in salt. The bedded salt of the Paradox and Permian Basin are distinct from the dome salt of the Gulf Interior Region in terms of their structure, rock properties, and the relationship of the host rock to the aquifers in the

geohydrologic environment; the Paradox Basin is also distinct from the bedded salt in the Permian Basin in terms of stratigraphic sequence, regional hydrologic setting, history of deposition, and physiography.

2.2.3 SELECTION OF A PREFERRED SITE IN THE PARADOX BASIN

On the basis of the information and evaluations reported in the Davis Canyon EA and, in particular, a comparison of the Davis Canyon and the Lavender Canyon sites in the Paradox Basin, the DOE has identified the Davis Canyon site as the preferred site in the Paradox Basin.

The Davis Canyon site was identified as the preferred site primarily because of land-acquisition uncertainties. Both the Davis and the Lavender Canyon sites are located on public lands managed by the Bureau of Land Management (BLM) as well as some private and State-owned land. Part of the Lavender Canyon site, however, extends into the Bridger Jack Mesa Wilderness Study Area, an area under review for possible inclusion in the National Wilderness System. Therefore, the Lavender Canyon site would require, in addition to the Congressional action needed to permanently withdraw public land, a Congressional determination of the status of the Wilderness Study Area. The time frame for such Congressional action is not scheduled and could potentially delay site characterization and other program activities. As a result of the uncertainties associated with this land transfer, the Davis Canyon site is considered to be more favorable than the Lavender Canyon site.

Because the Davis Canyon site is only 2.4 kilometers (1.5 meters) from the Lavender Canyon site, differences between the two sites tend to be minor. While the Lavender Canyon site is closer than the Davis Canyon site to a known geologic fault, a known dissolution feature, and a population center, these differences are considered insignificant. Similarly, estimated differences in the potential impacts on the Canyonlands National Park are not distinguishable between the two sites.

2.2.4 SUITABILITY OF THE DAVIS CANYON SITE FOR DEVELOPMENT AS A REPOSITORY

Section 112(b) of the 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 of the guidelines. 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 available for site evaluation. The guidelines that do not require characterization primarily relate to those characteristics of a site that are related 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 Davis Canyon site is disqualified. Furthermore, the evidence does not support a finding that the Davis Canyon 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 DAVIS CANYON 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 Davis Canyon EA, the DOE has found that the Davis Canyon site is suitable for characterization.

2.2.6 DECISION ON NOMINATION

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

3 THE SITE

The Davis Canyon site is in northern San Juan County, Utah, in a sparsely populated southeastern portion of the State (Figure 2). The site is located in a semiarid setting and is in an area of rugged terrain. Davis Canyon is a relatively flat valley surrounded by nearly vertical cliffs and long, narrow mesas. The 2,331-hectare (5,760-acre) Davis Canyon site is composed of 92 percent public lands managed by the BLM, 4 percent State lands, and 4 percent private lands. The nearest communities are Monticello, 44 miles by road (23 air miles) to the south, and Moab, 69 miles by road (33 air miles) to the north. The community of Blanding is 74 miles by road (34 air miles) to the south. The nearest regional highway is U.S. Highway 191, which is 47 kilometers (29 miles) from the site via Utah State Highway 211 (Utah 211), its National Park Service extension, and a short unimproved road. The nearest rail line to the site is the Kane Creek branch of the Denver & Rio Grand Western Railroad (D&RGW). This 57.5-kilometer (35.7-mile) line extends south from the D&RGW main line at Crescent Junction, Utah, to Potash, on the north bank of the Colorado River west of Moab.

The Davis Canyon site is within the area in San Juan County managed under the BLM Indian Creek-Dry Valley management plan. The management plan provides for multiple uses including livestock grazing, mining, oil and gas development, recreational vehicle use, and dispersed recreation (The BLM is currently preparing a new resource management master plan). The area's

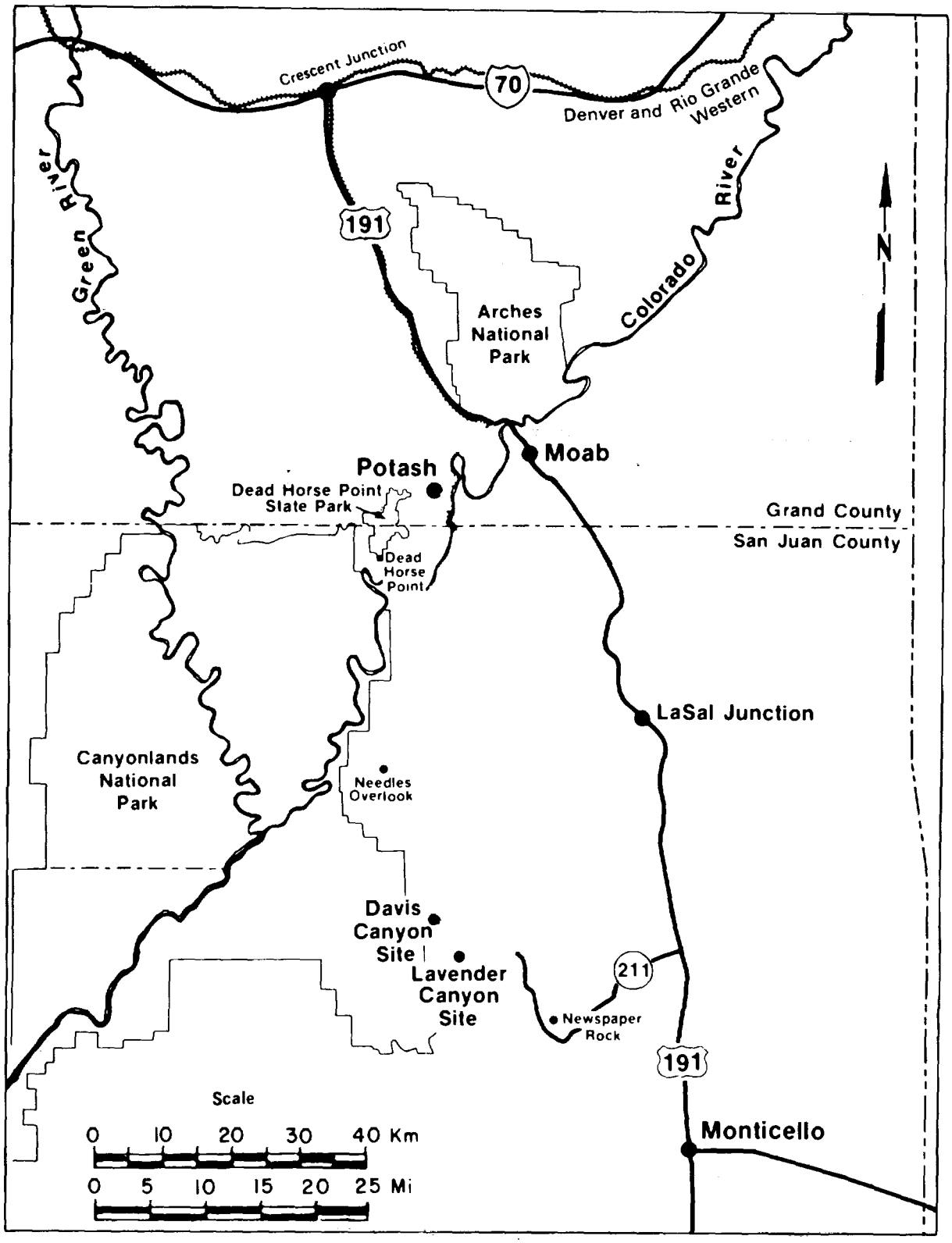

Figure 2. Davis and Lavender Canyon Sites.

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primary uses are agriculture (principally cattle grazing) and recreation. Important recreation resources include Canyonlands National Park, Manti-La Sal National Forest, Newspaper Rock State Historical Monument, Canyon Rims Recreation Area, Beef Basin, and three wilderness study areas.

The southeastern district of Canyonlands National Park (the Needles district) is within 0.3 kilometer (0.2 mile) of the Davis Canyon site. This district is accessible by Utah 211, the road which also provides access to Davis Canyon. The Needles district is characterized by colorful stone spires and numerous arches. Its recreational uses include hiking, camping, backpacking, and nature study. Canyonlands National Park, including the Needles district, is open to visitors throughout the year.

The Davis Canyon site is in the southwest part of the Paradox Basin (Figure 3). The rocks beneath the site consist of siltstones, sandstones, salt, and limestones that overlie a basement complex of crystalline rock. The host rock under consideration is a salt bed that is approximately 61 meters (200 feet) thick and lies about 884 meters (2,900 feet) underground. The bed is one of the 29 evaporite layers comprising the Paradox Formation. Although faults have been identified 16 kilometers (10 miles) west of the Davis Canyon site, none have been identified within the site. Known salt-dissolution features occur at the Lockhart and Beef Basins, 19 kilometers (12 miles) north and 23 kilometers (14 miles) southwest of the site, respectively. Salt dissolution is also possible in the vicinity of the two fault areas. There is no evidence of igneous or volcanic activity in the site area in the last 25 million years.

Davis Canyon is a tributary of Indian Creek, which ultimately drains into the Colorado River. The canyon includes a small ephemeral wash, flowing only during, and immediately after, intense summer storms. The 100-year floodplain in Davis Canyon encroaches on a portion of the land needed for the repository. The quality of the surface water in the region is typified by high salinity as well as high concentrations of other dissolved solids. The major use of surface water in this area is irrigation.

The ground-water system of the western Paradox Basin is divided into three hydrostratigraphic units. The first is an upper hydrostratigraphic water-bearing unit that overlies the second unit, which is an aquitard consisting of the salt beds of the basin, including the host salt. The third, or lower, hydrostratigraphic unit underlies the salt beds. Ground-water discharge from the upper hydrostratigraphic unit in the Davis Canyon area is from springs and subriver-level seeps into the Colorado River. There are several small-capacity livestock and domestic wells; five wells supplying Canyonlands National Park in the Needles area can produce from 4 to 60 gallons of water per minute. There is apparently no significant discharge from the middle or lower hydrostratigraphic units. Potentiometric levels for tests in the upper hydrostratigraphic unit are generally higher than those for tests in the lower hydrostratigraphic unit. This suggests a downward hydraulic gradient from the upper to the lower aquifer. Fluid pressure and potentiometric levels on the middle hydrostratigraphic unit have an anomalous trend (i.e., they do not decrease uniformly). This could suggest that the

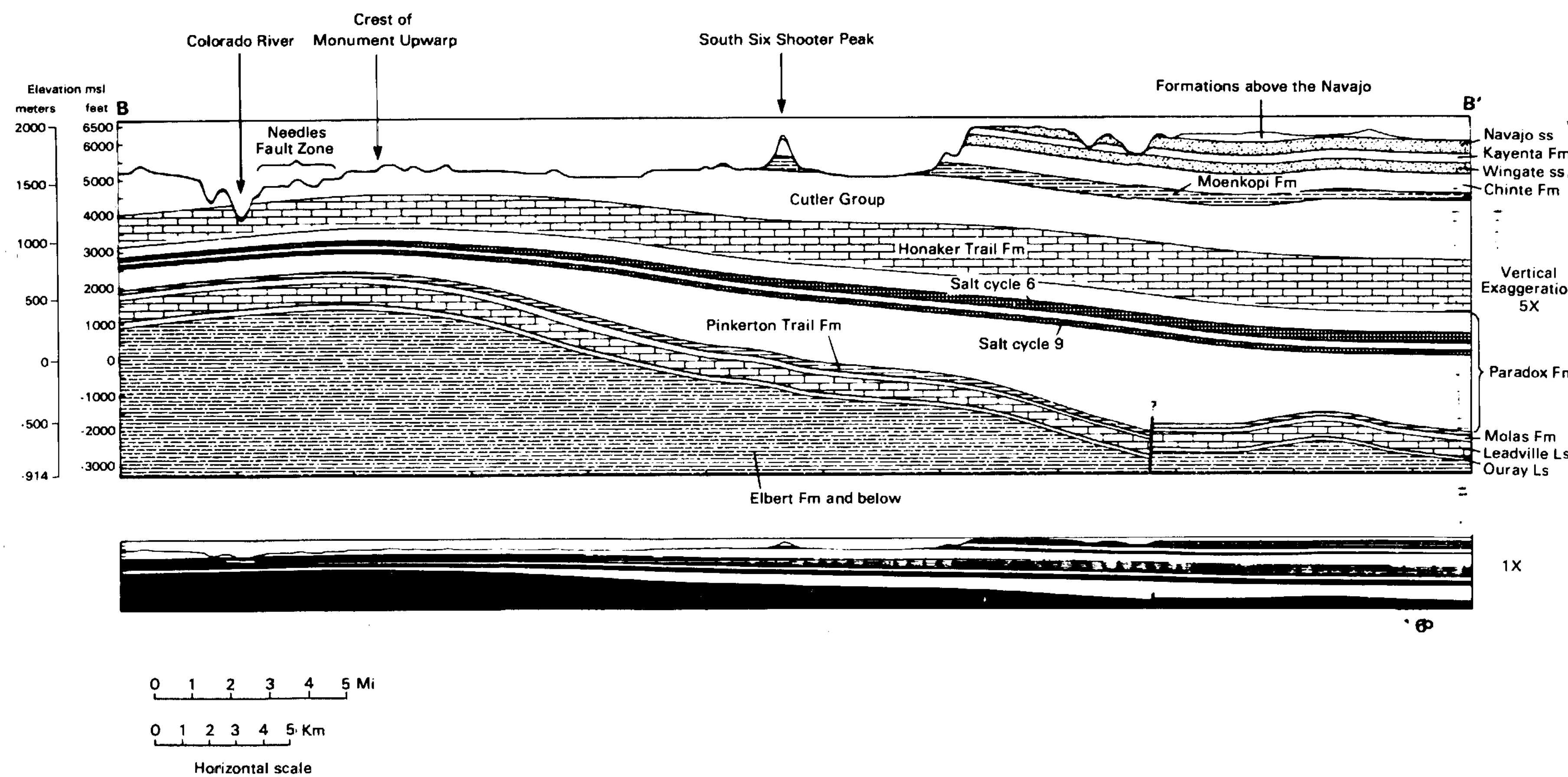

Figure 3. Geologic cross section of Davis and Lavendar Canyon sites.

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upper and lower hydrostratigraphic units are not connected. Ground-water flow for the upper unit is predominately to the north, toward the Colorado River; ground-water flow in the lower unit is west-southwest.

Mineral resources at the Davis Canyon site consist primarily of uranium and vanadium as well as potash, with minor deposits of copper, manganese, quartz, iron oxide, sand and gravel, and dimension stone. The vicinity of the site contains only four documented localities of uranium and vanadium production. There are also potential oil and gas resources within the area; however, there is no record of hydrocarbon production at the site, and the area is classified as "undiscovered speculative resources" by the Bureau of Mines and the USGS.

The major vegetation types in the site area are the Great Basin desert shrub and pinyon pine-juniper woodland communities. Much of the Davis Canyon site is a native pasture supporting open-range livestock operations. Overgrazing and other human activities have altered the natural vegetation. There are no aquatic ecosystems on the site.

The generally low diversity and productivity of the natural vegetation in this area results in a corresponding low abundance and diversity in wildlife populations. Two threatened or endangered and 21 rare plant species are known to occur in San Juan and Grand Counties. The only such species that occurs near the site is the Monument Valley milkvetch, a species recommended for threatened status. Conditions are favorable in the site area for eight animal species listed as endangered or under review for such status. In winter, bald eagles roost along the Colorado River, and there are active peregrine falcon eyries within 16 kilometers (10 miles) of the site. The Davis Canyon site is not known to contain any critical or unique habitats. No existing or proposed units of the National Wildlife Refuge System occur within 80 kilometers (50 miles) of the Davis Canyon site.

The climate in southeastern Utah is predominantly semiarid. The annual precipitation averages about 20.8 centimeters (8.2 inches) at Moab and 35.1 centimeters (13.8 inches) at Monticello. Tornadoes are very infrequent. Flash floods from summer thunderstorms may cause localized flooding in Davis Canyon.

The Davis Canyon site is located in a prevention of significant deterioration (PSD) Class II area that meets all air-quality standards for that designation. Because of the site's proximity to the Canyonlands National Park, a PSD Class I area begins 0.3 kilometers (0.2 miles) west of the site. The nearest major source of emissions (the town of Moab) is 33 air miles north of the site. The sources of pollution in the site area are vehicular traffic and dust from sparsely vegetated rangeland, roads, and trails. Conditions in the site area are generally conducive to the dispersion of pollutants. However, the dispersion of emissions can be hampered by the area's mountain-and-valley terrain; local inversions can cause the air to be trapped in a valley.

The Davis Canyon vicinity contains abundant cultural artifacts, dominated by the remains of the Mesa Verde Anasazi Indians. It also includes several historical sites associated with the area's livestock frontier and earlier mining ventures. Two sites on the National Register of Historic Places are

near Davis Canyon: the Newspaper Rock State Historical Monument and the Salt Creek Archaeological District in Canyonlands National Park, which includes hundreds of recorded archaeological sites.

The scenic character of the Davis Canyon area is one of open spaces with unusual rock formations and color contrasts. The landscape includes broad basins, prominent cliffs, isolated buttes, mesas, spires, and deeply entrenched meandering canyons. The numerous scenic attractions that are nearby include the Canyonlands National Park, the Needles Overlook in the Canyon Rims Recreation Area, and the Newspaper Rock State Historical Monument.

The average population density in the 80-kilometer (50-mile) radius around the site is 3.8 persons per square mile. The towns in this region, and their 1980 populations, are as follows: Moab, 7,173 (including Spanish Valley); Monticello, 1,929; and Blanding, 3,118. Population estimates for 1984 show an 8-percent decrease for Moab and no significant changes for Monticello and Blanding. Projections for the year 2006 show substantial increases for all three communities over their 1984 levels.

The Indian reservations in the region include a part of the Unitah and Ouray Reservation in northeastern Grand County, which belongs to the Ute tribe, and a part of the Navajo tribal lands in southern San Juan County.

The economy of the study area is generally tied to natural resources, in terms of energy-related activities. Mining (primarily uranium), trade, and government have been the major employers in Grand and San Juan Counties. The economy of the two Counties has been declining over recent years, consistent with a decline in the uranium industry. In 1984, Grand County and San Juan County experienced unemployment rates of 16.0 and 10.7 percent, respectively.

Mayor-council municipal governments exist in Monticello, Blanding, and Moab. Monticello and Blanding also have city managers. Monticello is the county seat of San Juan County, and Moab is the county seat of Grand County. Both communities also are the centers of county-wide school systems which are at or below capacity. In 1984, Monticello, Blanding, and Moab had approximately 400 vacant housing units available, including units for rent or sale and mobile home spaces.

4 EFFECTS OF SITE CHARACTERIZATION

This section describes the site-characterization activities that would be performed if the Davis Canyon site were selected for site characterization.

To obtain the information necessary for evaluating the suitability of the Davis Canyon 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 facility, and one for services and emergency egress), excavate drifts at the proposed repository depth, construct support structures on the surface, and construct an access road to the site. In addition to the

tests performed underground and in the exploratory shaft facility (ESF), 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 nine-county area expected to be affected by the repository.

The site-characterization program would last several years. At the end of this period, if the Davis Canyon site is found unsuitable for a repository, the shafts would be filled and sealed, and the site would be reclaimed.

Site characterization will entail some adverse effects. Current land uses in parts of the site will be disrupted. Approximately 24 hectares (59 acres) of public land will be required for constructing the ESF, and an additional 14 hectares (35 acres) of land will be needed for a 7.7-kilometer (4.8-mile) access road, connecting with the National Park Service extension of Utah 211. The DOE will obtain access to public land by entering into a cooperative agreement with the BLM. State-owned and private land needed to conduct field studies will be purchased or leased.

Protection of land approximating the controlled area around a geologic repository site will be necessary. This area, to be protected during characterization, consists of approximately 2,331 hectares (5,760 acres). Public land would be acquired for protection by filing a withdrawal application with the BLM. State and private lands would be purchased or leased.

The excavation of salt from the underground test area would create a surface stockpile of approximately 222,345 cubic meters (170,000 cubic yards), covering an area of about 2 hectares (6 acres). An impermeable liner would be placed beneath the salt pile and ponds would be used to control surface-water runoff so as to minimize the potential for surface- and ground-water contamination. During salt-handling operations, some windblown salt would be deposited on nearby ground. The DOE has successfully managed salt excavation and stockpiling on a similar scale at two different sites. This experience has shown that salt emissions during excavation would not be significant. Waste salt and residues would be removed to an offsite licensed landfill.

Wildlife would be removed from the immediate area of surface structure development, while wildlife in the surrounding areas could be disturbed by site-characterization activities. The measures that can be taken to mitigate these effects include minimizing land clearing and making provisions for revegetation after site characterization. Because the site and its immediate surroundings do not support any ecologically unique communities, and the area to be cleared is very small in comparison with the surrounding undisturbed area, the ecological effects are expected to be minimal.

Air-quality effects would result mainly from fugitive dust (a contributor to particulate emissions) and the gases emitted by equipment and vehicle engines. When total suspended particulate (TSP) concentrations from site characterization are added to background concentrations, the peak

concentration may exceed secondary National Ambient Air Quality Standards (NAAQS) at the immediate site boundary but not at the Park boundary. This excess would be limited to small areas. Examples of measures to mitigate air-quality effects include the spraying of disturbed areas with water or chemicals, soil stabilization, and the management of the salt and spoils piles.

Some structures and the night lighting needed for site-characterization activities would be visible from a stretch of Utah 211 and a small area in the Canyonlands National Park. The degree of visual intrusion would be reduced by such measures as orienting and painting buildings and other structures to blend with the surrounding environment. Site characterization would also temporarily elevate noise in offsite areas. Possible mitigation measures include the scheduling of noise-generating activities and the use of physical sound barriers.

The Canyonlands National Park and other recreational areas in the vicinity of the site could lose some tourists who would come to the area to seek a wilderness experience. The greatest effect would occur during the drilling of test wells and the construction of shafts. A small percentage of users of the Canyonlands National Park would be affected by noise and visual intrusion. These effects would be mitigated as discussed above.

The Needles district of Canyonlands National Park (adjacent to the Davis Canyon site) is managed by the National Park Service to provide a range of interpretive and recreational activities to hikers and users of four-wheel-drive vehicles. Access to this district is by Utah 211, the road which also provides access to Davis Canyon. Current traffic along this road is approximately 45 vehicles per day; however, over 1,000 vehicles per day travel this road on peak visitation days at the Park. During site characterization, traffic volume associated with the project would average approximately 300 vehicles per day, with a peak volume increase of 600 vehicles per day. This peak volume would last 3 months. Improvements could be made to minimize traffic flow problems on this highway.

Potential indirect impacts on cultural and archaeological resources are possible because the access route to Davis canyon (Utah 211) passes Newspaper Rock State Historical Monument and because the Salt Creek Archaeological District in Canyonlands National Park is near the proposed location of the ESF. To minimize these and any other effects, the DOE would conduct site surveys before disturbing any land and make every effort to design project activities to avoid damage to historic or archaeological properties. A worker awareness and education program would be implemented to stress the need for resource conservation.

There would not be any major disturbances of residents located near the site, and no relocation of any residents is expected. Nor is any significant displacement of economic activity expected in the area. Approximately 439 of the 488 workers needed for site characterization would move to the area, with the total number of in-migrating people estimated at 953. Local communities may experience some social effects in accommodating in-migrants. Population increases may place a housing burden on Blanding and Monticello. The mitigation measures that could be undertaken to reduce local effects would

include hiring as many local residents as possible and attempting to influence the settlement patterns of in-migrants toward communities with the best capacity to accommodate new residents.

Site characterization at Davis Canyon would cost $250 million for ESF construction and $225 million for other (primarily geologic) activities. Seventy percent of this amount would be for materials and 30 percent for wages. Although only a portion of these funds would be spent locally, it could result in considerable economic activity. The site characterization project would be the biggest single employer in southeastern Utah.

5 REGIONAL AND LOCAL EFFECTS OF REPOSITORY DEVELOPMENT

To determine the effect 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 7 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 (441 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 some 25 to 30 years; it would be followed by a "caretaker" period because the U.S. Nuclear Regulatory Commission (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 Davis Canyon site. A 189-hectare (467-acre) surface site would be used for repository facilities, and an additional 2,142 hectares (5,293 acres) would be needed for the controlled zone.

While the removal of a total of 2,331 hectares (5,760 acres) of land would result in closing almost all of the land in Davis Canyon accessible to cattle, it may be feasible to continue to allow grazing on land outside the surface site. Grazing would also be lost from the lands developed as access and utility corridors. The corridors could have the additional effects of changing grazing patterns and blocking livestock access to water. These effects would be addressed when the specific corridors are identified.

Recreational use of Davis Canyon will be affected during the construction and (to a lesser extent) operation of a repository. Direct impacts will be characterized by impaired access to Canyonlands National Park and Newspaper Rock State Historical Monument. Indirect impacts will be created by a change in the status of the land to a single-purpose repository site. If an exclusive-use repository access road is built, there will be only temporary construction-traffic impacts along Utah 211. This new access road, or an improved Utah 211, will bypass Newspaper Rock State Historical Monument.

Approximately 3.3 million tons of excavated salt would be stored at the site to be used for backfilling the repository. The salt-storage pile would cover about 20 hectares (50 acres) and reach a height of about 11 meters (35 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 the windblown salt from salt-handling activities or from the salt pile would have a significant effect on local soils. It is estimated that about 10 million tons of excess salt would require removal and offsite disposal. 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 and would be similar to those experienced during site characterization (see 4). Transportation and utility corridors may serve as behavioral barriers to some area wildlife. Land clearing and route selection would take into account measures to reduce ecological impacts.

Air-quality effects would result from fugitive dust and gases emitted by equipment and vehicle engines; these effects would be greatest during site preparation. The 24-hour National Ambient Air Quality Standards (NAAQS) for total suspended particulates (TSP) and the annual average NAAQS for TSP and nitrous oxides (NO_x) will be met during repository construction, operations, and decommissioning and closure. Visibility impacts at Davis Canyon (atmospheric discoloration) probably would be imperceptible.

Individual repository activities would be potentially visible from limited areas within Canyonlands National Park (including the end of Davis Canyon). These areas have no designated hiking or jeep trails for park visitors. The repository facility is potentially visible from Utah 211 at South Six-Shooter Peak, Davis Canyon jeep trail, and Bridger Jack Mesa. The proposed access road from U.S. Utah 191 to the repository is visible from several observation points. All four of the rail route alternatives to the repository potentially can be seen from the Island-in-the-Sky district of the National Park, but none can be seen from jeep and hiking trails in the Needles district of the park. The siting and construction of support facilities would take into account measures to reduce visibility and the degree of contrast with local conditions.

During repository and rail route construction, short duration noise levels from intermittent blasting may be audible over 24 kilometers (15 miles) from the site for the initial period of construction (approximately 2 weeks) under typical conditions. During operation, machinery noise would be heard in

the park, and the noise made by the trains hauling waste may be audible up to 12.1 kilometers (7.5 miles) into the park for short periods of time. Possible mitigation measures include the proper scheduling of activities and the use of physical sound barriers.

The effects on local tourism during repository construction would be similar to those experienced during site characterization (see 4). Some reduced tourism could continue during operation because of the negative perception of the repository.

A potential exists for indirect impacts resulting from increased human intrusion into the area during construction and operation of the repository. Increased vandalism and unintentional destruction of cultural resources could occur because there would be more people at and near the repository site. The effects could be mitigated by restricting offsite and off-road vehicle use and through educational programs.

Because runoff from the site would be controlled, only minor siltation and salt addition to surface and underground waters are projected. All significant contaminants will be controlled in lined ponds. Shaft sinking will employ seals to prevent ground-water contamination and degradation of aquifer quality. Water for repository construction and operation could be supplied from a variety of sources. Data indicate that sufficient water would be available for the repository.

During the peak of repository construction, about 2,070 direct and indirect jobs would be created in the region, and approximately 4,690 persons (workers and their families) are expected to in-migrate. During the peak of operation, also about 2,070 direct and indirect jobs would be created (although there would be a smaller proportion of direct jobs than during construction), and a maximum of 3,730 persons are expected to in-migrate. The maximum project-related increase in the population of the Grand and San Juan Counties in the year 1997 is estimated to be 20 percent over the 1977 baseline population projection. This level of in-migration would necessitate increased housing and increases in community services. The area may also experience some stress-related social problems associated with boomtown conditions.

Local business activity would increase. During the 8-year construction period, an estimated $43 million would be spent for materials purchased locally. Wages and salaries available to be spent locally would approximate $141 million during the construction phase. During the 26 year period of repository operations, an estimated $93 million would be spent locally for materials. Wages and salaries to be spent locally would amount to about $530 million. Potentially adverse socioeconomic effects should be offset by the increased tax base, by grants-equal-to taxes, and financial assistance provided by the DOE. It is not expected that any households would be displaced because of land requirements for the repository or for transportation and utility corridors.

Two highway routes are being studied for access to Davis Canyon. One would involve upgrading Utah 211 to the 7.7-kilometer (4.8-mile) access road into the repository. The other would be a 40-kilometer (25-mile) repository highway from U.S. 191 (including a 1.9 kilometer [1.2-mile] tunnel). Four feasible railroad access routes are under study. Three of the routes extend

south from the Denver & Rio Grande Western (D&RGW) Kane Creek branch line at Potash, and all four routes require bridges cross the Colorado River. (The fourth route leaves the Kane Creek branch near Arches National Park.) All of the routes include tunneling.

Two types of transportation effects would result from increased commuter traffic and the hauling of supplies, excess salt, and radioactive waste. They are radiological risks, which would result from the direct external radiation emitted by the radioactive waste as a shipment passes by, and nonradiological risks. The latter are 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, the types of risk will vary with the distance traveled and with the mode of transportation (road or rail). Because of the distance of the Davis Canyon site from sources of waste, its nonradiological risks are likely to be higher than those for the sites in the Gulf States and Texas. Although risks would vary with the transportation mode, the overall risks (radiological and nonradiological) are expected to be relatively low. The radiological risks for the Davis Canyon site are expected to be significantly lower than the nonradiological risks.

The transportation costs for the Davis Canyon site are projected to be about $1.30 billion for truck and about $1.21 billion for rail transport. These costs are higher than those for the other salt sites.

6 EVALUATIONS OF SITE SUITABILITY

The DOE has evaluated the Davis Canyon 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 U.S. Environmental Protection Agency (EPA) and the Nuclear Regulatory Commission (NRC). In order to achieve the specified level of containment and isolation, both natural and engineered barriers may be used.

The set of preclosure guidelines is 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 installations 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 of bedded salt at the Davis Canyon site that could contribute to its ability to isolate waste from the accessible environment include (1) the low permeability of the host rock (salt) and the long time predicted for ground-water travel to the accessible environment, (2) the presence of a vertical geohydrologic gradient from the upper to the lower hydrostratigraphic units, and (3) the favorable geomechanical and geochemical properties of the host unit. Estimates indicate that the time of ground-water travel through the host rock would exceed 100,000 years, and the travel time from the host rock to the accessible environment would exceed 10,000 years. In addition, the host rock has the ability to rapidly dissipate the heat generated by the emplaced waste, which reduces the potential for heat-induced fractures. Other favorable characteristics of bedded salt are its plasticity under confining pressure at depth and the resulting tendency of fractures and openings to close and seal. The favorable geochemical properties that would help retard the migration of radionuclides into the accessible environment are the presence of clays in the interbeds surrounding the host rock and within the overlying and the underlying evaporite section; these properties would retard radionuclides by sorption. There is also evidence of a potential for chemically reducing conditions, which would diminish the solubility of the waste and promote precipitation. Finally, since the Paradox Basin is in a relatively stable geologic region, tectonic activity is not likely to disrupt the geohydrologic system at the site.

A condition that could compromise the ability of the site to isolate the waste is the ongoing geologic process of salt dissolution. Although there is evidence of salt dissolution in the Paradox Basin, there is no evidence of dissolution within the site. Estimated rates of dissolution from potential or known dissolution features in the region suggest that dissolution is not expected to adversely affect waste isolation. If dissolution continues at the rates estimated for the last 2 to 3 million years, the dissolution front would not reach the repository for considerably longer than 10,000 years, the time required by Federal standards for waste isolation.

Another important factor in the site's ability to isolate wastes is the potential for human intrusion through exploration for natural resources. As described above in the section, The Site, potential resources such as uranium and vanadium are present at Davis Canyon, and exploration for oil and gas has occurred in the surrounding area. However, there has not been any oil and gas production in the immediate site area that would have created pathways between the repository horizon and the accessible environment. Moreover, the site is considered to have a low economic potential in comparison with the rest of the region, which indicates that there is little likelihood of human intrusion into the repository horizon.

With regard to the performance of engineered barriers at the site, the NRC standards specify that the waste package is to contain the waste for 300 to 1,000 years and that the rate of radionuclide release beyond this period of containment is not to exceed 1 part in 100,000 per year. Current information on the corrosion of metals like those used for the waste canisters suggests that at the Davis Canyon site the lifetime of the waste package is expected to exceed 10,000 years. The potential for corrosion will be addressed further during site characterization. The DOE estimates that the release rate beyond the period of containment will not only meet the regulatory limits, it may be much lower. Preliminary assessments of engineered-barrier performance under realistic but conservative assumptions indicate that the EPA's limit on the release rate to the accessible environment would be met at the Davis Canyon site.

6.3 SUMMARY OF SITE EVALUATIONS AGAINST THE PRECLOSURE GUIDELINES

The evaluation of the Davis Canyon site against the three groups of preclosure guidelines are summarized below.

6.3.1 RADIOLOGICAL SAFETY

Preliminary assessments of preclosure performance for the Davis Canyon site do not indicate that any releases of radioactive material from the repository would exceed any applicable radiation standards during repository operation and closure. In addition, the site was evaluated against the following Technical Guidelines that are concerned with the radiological effects of repository operation on public health and safety: population density and distribution, site ownership and control, meteorology, and offsite installations and operations.

No people are residing within the boundaries of the Davis Canyon site, and the population density in the region is low (3.8 persons per square mile). The closest highly populated areas are Moab, 33 air miles away with a 1980 population of 5,333 (1,772 persons per square mile), and Blanding, 34 miles away with a 1980 population of 3,118 (1,973 persons per square mile). Monticello, 23 air miles from the site, had a 1980 population of 1,929. The Davis Canyon site is located on land for which the DOE can obtain ownership and control access.

The meteorological characteristics are not favorable, according to the Technical Guidelines. The inversions that can occur at the site may decrease the dispersion of pollutants, and the region experiences such potentially disruptive events as flooding, heavy fog, and snowstorms. Also, the City of Moab is 53 kilometers (33 miles) downwind of the site. Nevertheless, preliminary assessments indicate that the radiation-exposure limits of 10 CFR Part 20 and 40 CFR Part 191 would not be exceeded.

There are no nearby industrial, transportation, or military installations or operations so close to the site that they would significantly affect the safety of the repository. There are three uranium mills within 80 kilometers (50 miles) of the site; the closest is in Moab, 53 kilometers (33 miles) away. However, there is no evidence that regulatory standards would be exceeded when the releases from the mills are added to the conservative values calculated for the repository.

6.3.2 ENVIRONMENT, SOCIOECONOMICS, AND TRANSPORTATION

Three Technical Guidelines address the environmental, socioeconomic, and transportation effects of a repository before closure. These effects, which would be both beneficial and adverse, are summarized above. Preliminary analyses indicate that the expected adverse effects can be mitigated to an acceptable level.

With respect to the System Guideline on the environment, socioeconomics, and transportation, the evidence does not support a finding that the Davis Canyon site is not likely to meet the qualifying conditions of protecting the public and the environment from the potential hazards associated with 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; they are concerned with surface characteristics, rock characteristics, hydrology, and the tectonic stability of the site. The surface facilities of the repository would be located within a generally flat, well-drained area surrounded by rugged terrain. Part of the site is within the floodplain of the 100-year flood, but this potential for flooding can be mitigated by fill placement to elevate the area out of the floodplain. There are no man-made surface impoundments in the area that could interfere with the repository.

The host rock at the Davis Canyon site affords significant flexibility in repository locations. Minimal artificial support would be required to maintain underground openings; however, salt creep would necessitate regular maintenance, including scaling, to keep passageways open. If waste retrieval is necessary, it could be adversely affected by thermal cracking or by radiation effects on the mechanical behavior of the adjacent rock. Creep around, and the stresses induced on, the overpack could pose difficulties in

retrieval, as could brine migration toward the canister. There is a potential for brine or gas pockets in the repository horizon, but the associated hazards can be mitigated.

The Elephant Canyon Formation, which lies between the host rock and the land surface, yields a small quantity of ground water. As stated above, there is a potential for surface flooding, which can be mitigated. Sufficient water is currently available for repository construction and operation. Overall, the surface- and ground-water systems are compatible with the activities associated with a repository.

Active faults (Shay Graben, 16.1 kilometers [10 miles] to the south) do occur in the area, and conservative estimates of ground motion are not significantly lower than those generally allowed at nuclear power plants. However, the Davis Canyon area is unlikely to experience earthquakes or man-induced seismicity that could pose serious design or operational-safety problems.

Preliminary evaluations indicate that the repository can be constructed and operated with reasonably available technology, and the costs would be comparable to those of a repository at any of the other potentially acceptable sites. Therefore, the evidence does not support a finding that the Davis Canyon site is not likely to meet the qualifying condition of the System Guideline on the ease and cost of siting, construction, operation, and closure.

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 Preclosure system guideline for radiological safety

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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