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YUCCA MOUNTAIN

Information on Alternative Uses of the Site and Related Challenges

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Why GAO Did This Study

The future of the Yucca Mountain project in Nevada—originally designated for permanent storage of nuclear waste—is uncertain. Since 1983, the Department of Energy (DOE) has spent billions of dollars to evaluate the Yucca Mountain site for potential use as a nuclear waste repository. In February 2010, the President proposed eliminating funding for the project, and in March 2010, DOE filed a motion to withdraw its license application. Stakeholders—federal officials, state and local government officials, private companies, and others—have expressed interest in whether the site’s characteristics are suitable for alternative uses.

GAO was asked to examine alternative uses for the Yucca Mountain site. This report examines: (1) the characteristics of the Yucca Mountain site; (2) stakeholders’ proposed alternative uses, and experts’ evaluations of them; and (3) challenges, if any, in pursuing alternative uses. We selected a nonprobability sample of experts that included experts affiliated with nationally recognized research organizations, universities, and national laboratories, and that did not represent or benefit from any of the stakeholders’ proposed alternative uses of the site. Using a data collection instrument, we elicited comments from these experts on stakeholders’ proposed uses. The alternative uses discussed in this report reflect the alternative uses these stakeholders proposed; they may not reflect all potential uses of the site. This report contains no recommendations. Interior generally agreed with our findings, while DOE, the U.S. Air Force, and NRC neither agreed nor disagreed.

View [GAO-11-847](#) or key components. For more information, contact Frank Rusco at (202) 512-3841 or ruscof@gao.gov.

YUCCA MOUNTAIN

Information on Alternative Uses of the Site and Related Challenges

What GAO Found

The Yucca Mountain site has several geographical, structural, and geophysical characteristics that may be relevant in considering potential alternative uses. Geographically, the site spans a large land area in a remote part of Nevada and partially includes some of the lands of two adjacent highly-secure national security sites—the Air Force’s Nevada Test and Training Range and DOE’s Nevada National Security Site. The site’s lands were historically under the control of three federal agencies: DOE, the Department of Defense, and the Bureau of Land Management (BLM) under the Department of the Interior. The most notable structural features include two large tunnels—one about 5 miles long and 25 feet in diameter, and another 2 miles long that branches off of the main tunnel. Geophysically, the Yucca Mountain area is semiarid and has little surface water; is comprised of strong, very low permeability volcanic rock; and is located in an area with low levels of seismic activity.

Stakeholders we contacted proposed 30 alternative uses of the Yucca Mountain site; however, there was no broad consensus regarding the benefits and challenges of these uses among the experts we consulted. The alternative uses span five broad categories: (1) nuclear or radiological uses, such as locating a nuclear reprocessing complex at or near the site; (2) defense or homeland security activities, such as testing systems to detect and identify radioactive materials; (3) information technology uses, such as secure electronic data storage; (4) energy development or storage, such as using the site for renewable energy development; and (5) scientific research, such as geology or mining research. While some experts we contacted identified benefits of the site for certain uses, experts also noted that many of these proposed uses would be costly and may face significant challenges. Several experts also noted that Yucca Mountain’s characteristics would not be critical to a number of the proposed uses, and that many could be undertaken elsewhere.

Alternative uses of the Yucca Mountain site face a number of legal and administrative challenges. First, DOE’s withdrawal of its application to build a repository at Yucca Mountain is subject to continuing legal proceedings, and resolution of these proceedings could preclude or significantly delay alternative uses of the site. Second, potential litigation regarding mining claims may affect alternative uses of the site. Following the 2010 expiration of a land withdrawal order, 35 mining claims were recorded and processed by BLM. Although BLM declared these claims void in August 2011, their legitimacy could be litigated, which could delay or pose challenges to alternative uses of the site. Third, because control of the site is divided among three different federal agencies, potential alternative uses may face challenges related to management of the site’s lands. Fourth, potential alternative uses of the site may be limited by national security activities that currently take place on adjacent lands. Fifth, as with any activity, proposed uses of the site will require the user to comply with applicable federal and state regulations.

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Abbreviations

BLM	Bureau of Land Management
DOD	Department of Defense
DOE	Department of Energy
Interior	Department of the Interior
NRC	Nuclear Regulatory Commission

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G A O

Accountability * Integrity * Reliability

United States Government Accountability Office
Washington, DC 20548

September 16, 2011

The Honorable Harry Reid
Majority Leader
United States Senate

Dear Senator Reid:

The United States has relied on electricity produced by nuclear power plants for more than 50 years. As a byproduct, the plants also produce highly radioactive materials that the federal government has planned to dispose of in a deep underground facility. Since 1983, the Department of Energy (DOE) has spent billions of dollars to study the Yucca Mountain site in Nevada for potential use as a nuclear waste repository. Activities at the site have included investigating the characteristics of the site, building tunnels and other infrastructure, and developing and submitting an application for a license to construct a nuclear waste repository there. Despite this investment and the years of study, opinions differ on whether a repository should be located at the Yucca Mountain site. In 2009 and 2010, DOE and the administration took steps to terminate the Yucca Mountain repository program; legal proceedings concerning some of these actions continue.

The Yucca Mountain site comprises 230 square miles of federal land, including Yucca Mountain.¹ The site is located in a remote area of the Mojave Desert in southern Nevada. The area in and around Yucca Mountain was subject to three decades of extensive studies for suitability as a nuclear waste repository—making it, according to some experts, one of the most studied sites in the world. During the course of these studies, DOE made several changes to the site, including boring two large tunnels into the rock under Yucca Mountain, among other things. Some stakeholders—federal officials, state and local government officials, private companies, and others—have expressed interest in alternative uses for the site that they believe may benefit from its characteristics. In

¹For the purposes of this report, we have defined the Yucca Mountain site to include the location expected to house the potential nuclear waste repository as well as the surrounding lands that were withdrawn or on which rights were reserved for site investigation. Our definition of the Yucca Mountain site includes lands that DOE did not include in its license application for a nuclear waste repository at Yucca Mountain.

this context, you asked us to examine alternative uses for the Yucca Mountain site. Specifically, we examined: (1) the characteristics of the Yucca Mountain site; (2) alternative uses stakeholders have proposed that may utilize these characteristics, and experts' evaluations of those uses; and (3) challenges, if any, in pursuing alternative uses.

To examine the characteristics of the site, we inspected parts of the site to assess its condition and conduct a limited assessment of existing assets.² We reviewed documents, including DOE's license application and environmental impact statements. We interviewed current and former federal officials with knowledge of the site, including officials from DOE, the U.S. Air Force in the Department of Defense (DOD), and the Bureau of Land Management (BLM) in the Department of the Interior (Interior). To examine proposed alternative uses, we contacted officials from federal, state, and local government agencies; DOE national laboratories; private firms; and others to identify stakeholders with ideas for alternative uses of the Yucca Mountain site. We asked stakeholders to generate a list of alternative uses. However, because the site has long been expected to be the future site of a permanent nuclear waste repository and has not been the subject of widespread consideration for other purposes, it is important to note that the alternative uses discussed in this report may not reflect all of the potential alternative uses for the site. In order to identify experts to comment on the stakeholders' proposed uses in each of the five broad categories, we approached experts within nationally recognized organizations, including the National Academy of Sciences, the Brookings Institution, and the RAND Corporation, as well as other experts we knew of from our work in these areas. We asked these experts to recommend other experts we should include in this effort. We also took steps to ensure that all of these experts could provide independent and objective opinions on the proposed uses, including ensuring that none of them had any financial or nonfinancial interests in any of the potential uses and that they did not represent, advocate for, or benefit from any of the stakeholders' proposed alternative uses of the site. From the list of experts generated, we selected a nonprobability sample of 16 experts to comment on the proposed alternative uses.

²Our assessment of the site did not include an inspection of the tunnels. Following the President's proposal to eliminate federal funding for the Yucca Mountain Project, DOE terminated activities at the site in 2010 and took steps to close the site, including closing access to the tunnels and turning off utilities. As a result of these actions, DOE determined that reopening the tunnel for a day would cost \$20,000 to \$50,000.

Appendix III lists the experts we consulted. We asked experts to respond to a structured data collection instrument with questions on whether the potential uses would utilize the site's characteristics and the benefits of and challenges to the potential alternative uses. The scope of our work did not include asking experts to evaluate the benefits of not using the site for any use; moreover, no one we contacted for proposals documented a proposal that the site not be used. To evaluate the extent to which any of the potential alternative uses could conflict with current or anticipated missions at the sites, we interviewed officials from federal agencies operating at the adjacent Nevada National Security Site and Nevada Test and Training Range.³ To identify statutory, regulatory, and other challenges that would have to be addressed to pursue alternative uses of the site, we reviewed relevant laws and statutes and interviewed officials from the Nuclear Regulatory Commission (NRC), BLM, U.S. Fish and Wildlife Service, and General Services Administration; state officials from Nevada, including the State Engineer and officials from the Nevada Attorney General's office; and local officials, including officials from Nye and Clark counties. See appendix I for additional information about our scope and methodology.

We conducted our work from October 2010 to September 2011 in accordance with all sections of GAO's Quality Assurance Framework that are relevant to our objectives. The framework requires that we plan and perform the engagement to obtain sufficient and appropriate evidence to meet our stated objectives and to discuss any limitations in our work. We believe that the information and data obtained, and the analysis conducted, provide a reasonable basis for any findings and conclusions in this product.

Background

The Nuclear Waste Policy Act of 1982 directed DOE to investigate sites for a federal geologic repository to dispose of spent nuclear fuel and high-level nuclear waste from commercial nuclear power plants and some defense activities. DOE studied six sites in the West and three sites in the South, and by 1986, DOE recommended three candidate sites for site characterization: Hanford in Washington state, Deaf Smith County in

³The Nevada National Security Site was formerly known as the Nevada Test Site and is managed by DOE's National Nuclear Security Administration. The Nevada Test and Training Range was formerly known as the Nellis Air Force Range and is managed by the U.S. Air Force.

Texas, and Yucca Mountain in Nevada. In 1987, however, Congress amended the act to direct DOE to focus its efforts only on Yucca Mountain—a site about 100 miles northwest of Las Vegas, Nevada. Under the amendment, DOE was to perform studies to determine if the site was suitable for a repository. Since 1987, DOE studied the site, in conjunction with its national laboratories, its private contractors, and other federal agencies such as the U.S. Geological Survey. In addition, DOE was authorized to contract with commercial nuclear reactor operators to take custody of their spent nuclear fuel for disposal at the repository beginning in January 1998. Ultimately, DOE was unable to begin receiving waste by 1998 because of a series of delays due to, among other things, state and local opposition to the construction of a permanent nuclear waste repository in Nevada and technical complexities.⁴

In June 2008, DOE submitted a license application to the NRC seeking authorization to construct a high-level nuclear waste repository at Yucca Mountain.⁵ In the application, DOE stated that it planned to open the repository in 2017. DOE later delayed the date to 2020. In March 2009, however, the Secretary of Energy announced plans to terminate the Yucca Mountain repository program and instead study other nuclear waste options. The President's fiscal year 2011 budget proposal, released in February 2010, proposed eliminating all funding for the Yucca Mountain repository program.⁶ At about the same time, the administration directed DOE to establish a Blue Ribbon Commission of experts to conduct a comprehensive review of policies for managing spent nuclear fuel, including all alternatives for the storage, processing, and disposal of

⁴Some technical complexities, such as DOE's assessment of how heat from the spent nuclear fuel might affect the performance of the repository, became the focus of years of scientific inquiry. GAO has recently issued reports on the storage of spent nuclear fuel and high-level nuclear waste: GAO, *Commercial Nuclear Waste: Effects of a Termination of the Yucca Mountain Repository Program and Lessons Learned*, [GAO-11-229](#) (Washington, D.C.: Apr. 8, 2011); *DOE Nuclear Waste: Better Information Needed on Waste Storage at DOE Sites as a Result of Yucca Mountain Shutdown*, [GAO-11-230](#) (Washington, D.C.: Mar. 23, 2011); and *Nuclear Waste Management: Key Attributes, Challenges, and Costs for the Yucca Mountain Repository and Two Potential Alternatives*, [GAO-10-48](#) (Washington, D.C.: Nov. 4, 2009).

⁵NRC has authority to authorize construction of the repository, as well as operations and closure of a repository, which are separate licensing actions.

⁶In April of 2011, Congress passed a continuing resolution to provide funding for federal departments and agencies for fiscal year 2011. In that legislation, Congress appropriated \$0 under the heading "Department of Energy, Energy Programs, Nuclear Waste Disposal."

civilian and defense spent nuclear fuel and other radioactive waste. The commission provided an interim report in July 2011 and plans to release a final report by January 2012.⁷

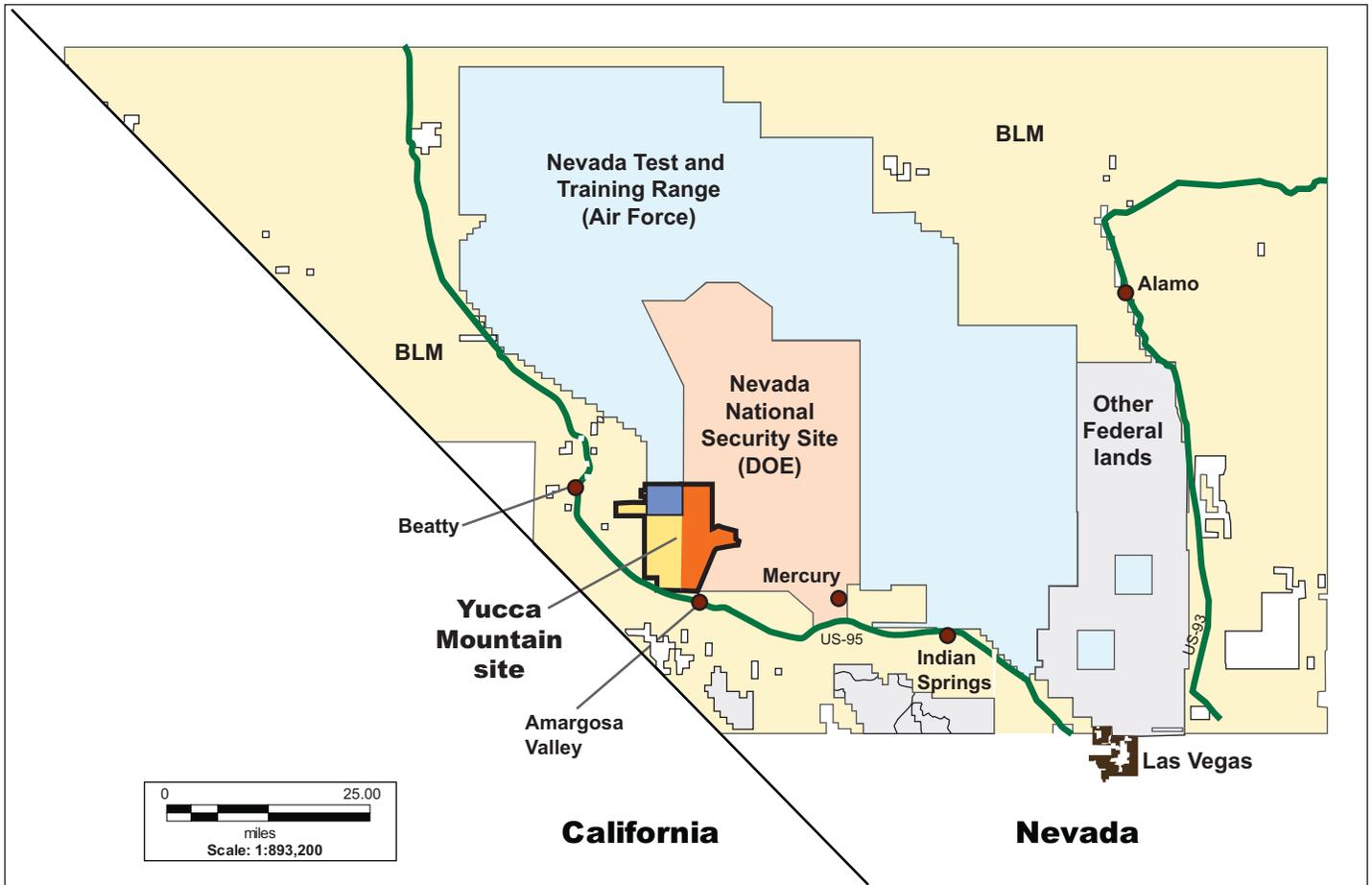
On March 3, 2010, DOE submitted a motion to the NRC's Atomic Safety and Licensing Board to withdraw its license application with prejudice, a term described by DOE to mean the Yucca Mountain site would be excluded from further consideration as a repository site. On June 29, 2010, the licensing board denied DOE's motion, ruling that DOE was obligated under the Nuclear Waste Policy Act of 1982, as amended, to continue with the licensing effort. The board noted that, even if the NRC approved the license application, there was no guarantee the Yucca Mountain repository would ever be constructed for any number of reasons, including congressional action changing the law or a decision by Congress not to fund the proposed repository. In the meantime, DOE took steps to dismantle the Yucca Mountain repository program by the end of September 2010.

The lands of the Yucca Mountain site in southern Nevada partially include some of the lands of two large federal sites: DOE's Nevada National Security Site (formerly the Nevada Test Site) and DOD's Nevada Test and Training Range (formerly the Nellis Air Force Range). The site comprises the following lands historically under the control of three federal agencies—DOE, the U.S. Air Force within DOD, and Interior's BLM (see fig. 1):

- lands from DOE's Nevada National Security Site, managed by the National Nuclear Security Administration;
- lands from the U.S. Air Force's Nevada Test and Training Range; and
- lands managed by BLM's Southern Nevada District Office's Pahrump Field Office.

⁷The Blue Ribbon Commission also delivered interim reports, with draft recommendations from its three subcommittees in the spring of 2011.

Figure 1: Regional Location of Yucca Mountain Site



Sources: GAO analysis of GAO, BLM, and DOE data.

Yucca Mountain Has Geographical, Structural, and Geophysical Characteristics

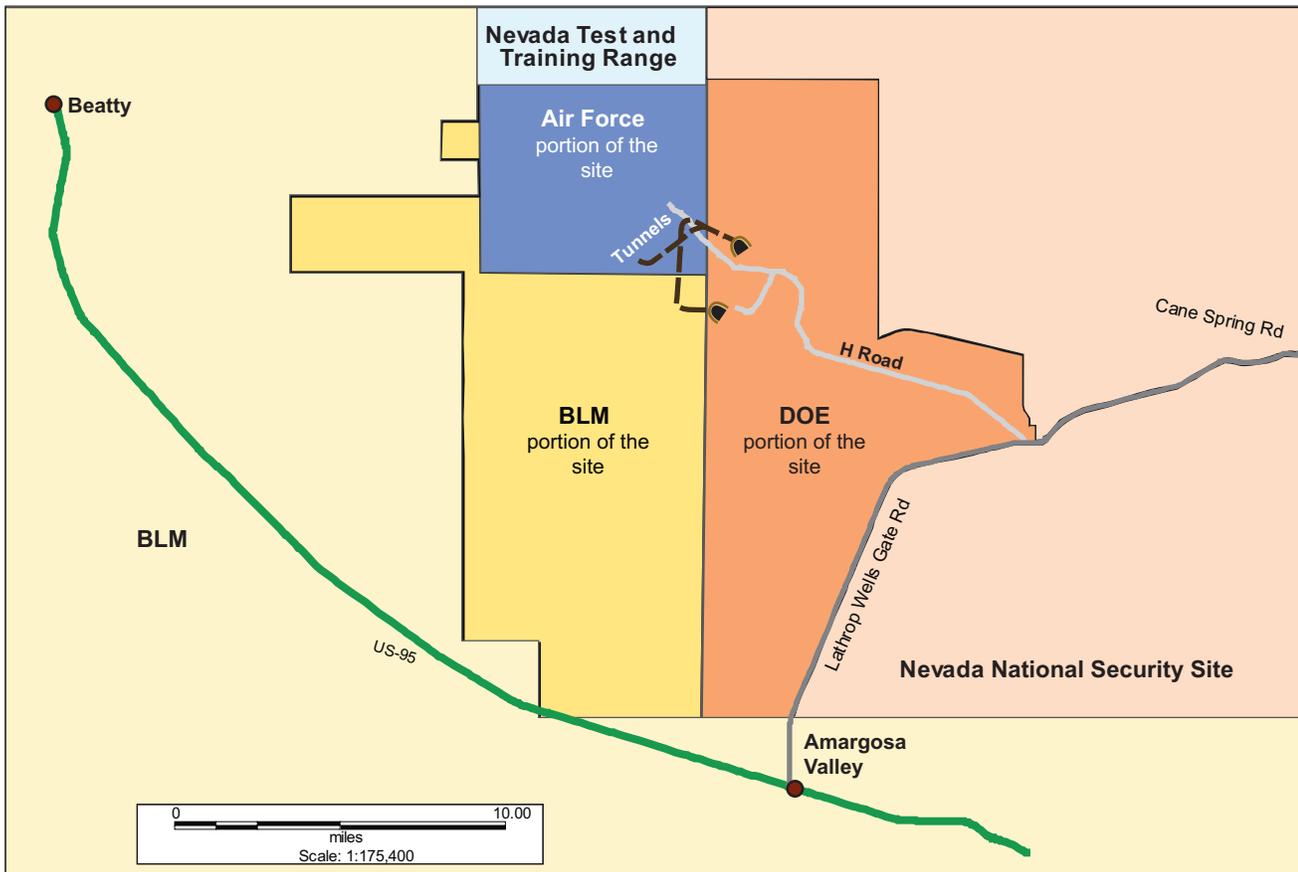
The Yucca Mountain site's geography, structures, and geophysical characteristics could offer benefits or pose challenges to proposed future alternative uses of the site.⁸ Geographical characteristics of the Yucca Mountain site include a remote location and the potential to be made highly secure. Structural site features include two large tunnels, several permanent and temporary buildings, and access to some utilities. Geophysically, the decades of study of the Yucca Mountain site have determined that the site has little surface water or groundwater, structurally stable volcanic rock, and low levels of seismic activity.

Geographical Characteristics Include a Remote Location and Potential for High Security

The 230-square-mile Yucca Mountain site is in a remote area in Nye County, Nevada. The closest major city, Las Vegas, Nevada, is about 100 miles away and the nearest town, the unincorporated Amargosa Valley—estimated population 1,000—is located about 14 miles from the tunnel entrances (see fig. 2).

⁸For the purposes of this report, geophysical characteristics refer to geology, seismology, hydrology, and other natural processes related to the physics of the earth.

Figure 2: Map of Location of Yucca Mountain Site and Agency Land Management



Sources: GAO analysis of GAO, BLM, and DOE data.

Because the site partially includes some of the lands of DOE’s Nevada National Security Site and DOD’s Nevada Test and Training Range, the experts we spoke with told us it has the potential to be made highly secure, which could be relevant to some proposed future alternative uses of the site.⁹ Security is in place at both of these sites, but there is no active

⁹Activities on these sites include nonnuclear testing of nuclear bomb components to support DOE’s stockpile stewardship responsibilities; nuclear device inspection and storage; pilot training, including dropping of live bombs; and testing of radar and other military equipment.

security perimeter around the Yucca Mountain site. However, the tunnel entrances are currently accessible by a few paved roads through the Nevada National Security Site via the main gate in Mercury, Nevada, which does have stringent security requirements.¹⁰ Before the Yucca Mountain repository program was terminated, another gate provided more direct access to the Yucca Mountain site and is about 12 miles closer, but it is currently closed. DOE officials told us there are some other paved roads on the Yucca Mountain site but these roads are no longer maintained and may have deteriorated. Use of the airspace over the DOE- and DOD-controlled portions of the site is restricted, according to a DOE document, although the airspace over the BLM-controlled portion is not.

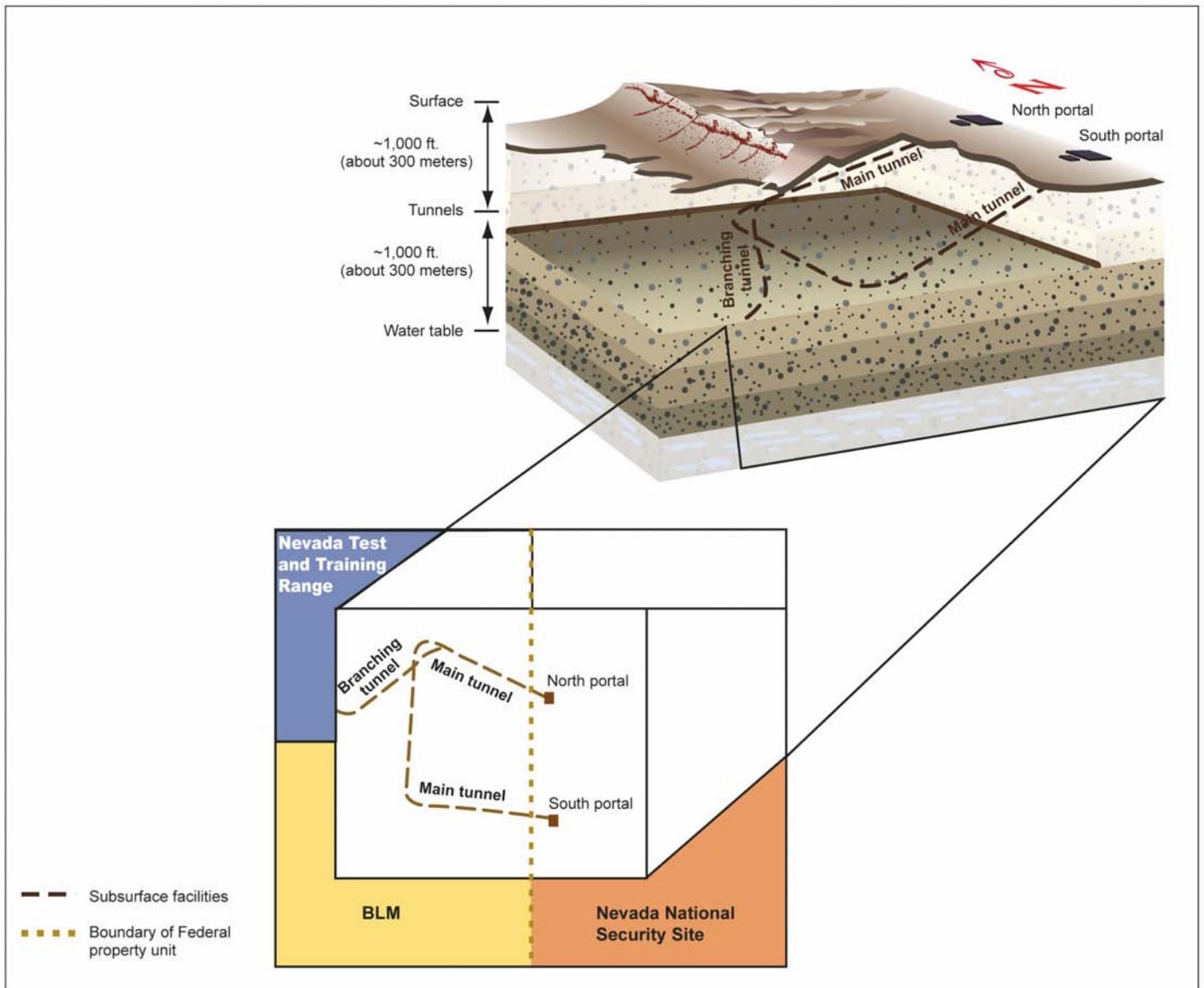
Site Features Include Two Tunnels, Several Buildings, and Access to Some Utilities

The primary feature on the Yucca Mountain site consists of two large tunnels that DOE bored into and underneath Yucca Mountain (see fig. 3).¹¹ The main tunnel is U-shaped with two entrances—the north portal and the south portal—and is about 5 miles long and 25 feet in diameter. Another 2-mile tunnel branches off of the main tunnel. Each of these tunnels includes minor spurs and alcoves used to house equipment and conduct experiments. A DOE report indicates that the rock surrounding the tunnel has high structural integrity enabling the tunnel to be self-supported by the existing rock structure, whereas most tunnels require additional support. There are railroad tracks inside the tunnel designed to move equipment and personnel along the length of the tunnel, but these tracks may need repair before they can be used again. DOE officials told us the tunnels are subject to some radon gas emissions and silica dust, which requires use of a ventilation system. Figure 3 is a schematic of the tunnel, and figure 4 shows the north portal entrance with the piping used in the ventilation system and the inside of the tunnel with the ventilation piping overhead.

¹⁰Mercury, Nevada, is a town in Nye County 65 miles northwest of Las Vegas, Nevada. As part of the Nevada National Security Site, the town is not accessible to the general public. As of October 1, 2010, responsibility for security of the Yucca Mountain site has been transferred to the National Nuclear Security Administration; see [GAO-11-229](#), 19.

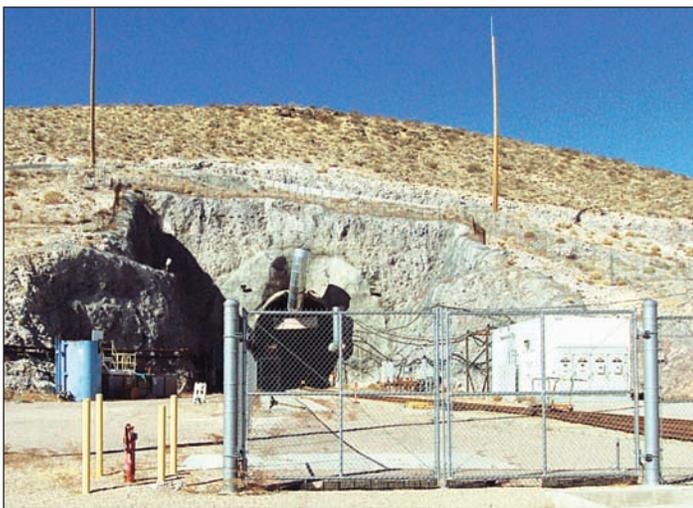
¹¹The construction of the main Yucca Mountain tunnel was estimated at about \$400 million between fiscal years 1994 and 1997, in then-year dollars.

Figure 3: Schematic of Yucca Mountain Tunnels



Sources: GAO analysis of GAO and DOE data.

Figure 4: Photos of the Yucca Mountain North Portal Tunnel Entrance and the Interior of the Main Tunnel



Source: GAO.



Source: DOE.

Some buildings used during investigations of the site as a nuclear waste repository still remain. The north portal area was a key center of activity during these investigations and retains several structures. In particular, there is one large permanent building that housed administrative offices, changing facilities for the workers, and other services. In addition, there are several temporary buildings used for offices and warehouses that, according to DOE officials, may have exceeded their expected lifespans. There are also several temporary storage containers that contain equipment and spare parts. In addition to the facilities at the north portal area, there are two permanent buildings located several miles from the tunnels that contain, among other things, drilling samples and other equipment. As we recently reported, when the repository program was terminated, DOE transferred most of its office equipment, computers, and some other equipment to other locations.¹² DOE officials said that most of the above-ground facilities and infrastructure at the Yucca Mountain site were constructed more than 20 years ago and were intended to be temporary and have not been maintained. In addition, according to a DOE official, some of the buildings on the site do not currently meet Occupational Safety and Health Administration or other codes and may

¹²GAO reported on the impacts of the termination of the Yucca Mountain project in April 2011; see [GAO-11-229](#).

require modifications to comply. Appendix IV provides a list of buildings and infrastructure on the site.

There are limited utilities available at the Yucca Mountain site, including electrical, water, and telecommunications infrastructure. However, according to DOE officials, much of this infrastructure is 30 or more years old, is not currently operational, and would require investment to be placed back into service. Parts of the site are connected to the Nevada National Security Site's electricity grid. Since DOE terminated the Yucca Mountain project and the proposed elimination of funding, power has been cut off to the site; however, according to DOE officials, power could be restored to some areas while service to other areas has been completely shut down. DOE officials told us that any future use of the site would probably require the existing power infrastructure to be replaced. The north portal area and other parts of the site have limited water service, provided by wells that draw groundwater—generally enough for operation of the restrooms, kitchen, and limited domestic services. However, the wells serving this system have failed in recent years and water service has been shut down. Moreover, according to a Nevada official, the current permit for use of water applies only to the work done to evaluate the site for a repository and any alternative uses of the Yucca Mountain site may require new water permits from the state of Nevada. In addition, two large tanks that can store potable water are on the site and are kept full during fire season. DOE officials told us they do not plan to drain the tanks this year but noted that since they are not winterized, the pipes could freeze and damage this infrastructure. A basic telecommunications infrastructure is in place on the site to provide for voice and data services and was replaced in 2006. However, the system is currently inactive, and the solar power system that operates the system's telecommunications towers has been disconnected. There is fiber-optic cable in some areas of the site as well, but the contract for service and maintenance has been cancelled.

Geophysical Characteristics Include Limited Surface and Groundwater, Structurally Stable Rock and Little Seismic Activity

As a result of three decades of study, much is known about the site's geophysical characteristics, particularly its hydrologic, geologic, and seismic characteristics. The site's hydrology is related to its location in a semiarid environment, with little surface or groundwater. Annual rainfall is less than 6 to 8 inches. There are a few seasonal streams and other surface water bodies at or near Yucca Mountain, but these are rarely flowing. There is groundwater beneath the site, residing several thousand feet below the surface in most locations.

Geologically, the top layer of the site is made up of welded volcanic tuff—thermally bonded volcanic rock from ancient eruptions about 12 to 14 million years ago—at least 6,000 feet thick. This rock is believed to have low permeability to water but contains fractures where water could migrate through it. According to DOE’s license application to use the site as a nuclear repository, based on the agency’s studies, the site has few, if any, valuable minerals. However, according to older studies and Nevada state government officials, the potential for valuable mineral resources may exist.

According to DOE’s license application, Yucca Mountain lies in an area of low seismicity and earthquake potential. The site shows evidence of some earthquake events during its geologic history, but according to DOE documents, past earthquakes have occurred infrequently with tens of thousands of years between events, although small earthquakes have occurred since measurement began in recent decades. However, some uncertainty exists about the sources of seismic signals recorded near the Yucca Mountain site over the decades of study because activities at adjacent sites—including underground nuclear explosions at the Nevada National Security Site prior to the 1992 decision to stop underground testing of nuclear weapons, airborne bombing at the Nevada Test and Training Range, and surface drilling and detonations using seismic charges to support geophysical investigations at Yucca Mountain and nearby—may produce earthquake-like signals.

**Stakeholders
Proposed Various
Alternative Uses but
Experts Cited
Significant Challenges
to Some Uses and
Noted that Many
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Stakeholders we contacted proposed 30 alternative uses of the Yucca Mountain site. We found no broad consensus among the experts we consulted about the benefits and challenges of these uses, many of whom told us that many of these uses would be costly and may require federal assistance, and that some may face significant challenges. Several experts noted that many proposed alternative uses could be undertaken elsewhere.

Stakeholders Proposed Alternative Uses that Fell into Five Categories, and We Found No Consensus among Experts about Their Benefits and Challenges

Stakeholders we contacted proposed 30 alternative uses of the Yucca Mountain site spanning five broad categories, which include: (1) nuclear or radiological uses, (2) defense or homeland security activities, (3) information technology, (4) energy development or storage, and (5) scientific research. The proposed alternative uses were at varying levels of development and specificity, with some having had more consideration and others in the conceptual phase. A full list of the proposed alternative uses and a description of each can be found in appendix II. We contacted experts in each of the five categories to provide comments on the uses in their areas of expertise. Overall, no broad consensus emerged among these experts about the benefits and challenges of these proposed alternative uses. Some experts identified some as good or great uses of the Yucca Mountain site, while other experts identified those same uses as poor or very poor uses of the site for varying reasons, as discussed in the following paragraphs.

Nuclear or radiological uses. Stakeholders proposed 10 nuclear or radiological uses of the Yucca Mountain site, including the production of medical isotopes,¹³ reprocessing of spent nuclear fuel,¹⁴ temporary or interim nuclear or radioactive waste storage, and several uses related to nuclear power generation. Several nuclear experts we contacted identified interim storage of nuclear waste as a good or great potential use of the site, since it is similar to the original proposed use and could therefore build on past efforts and studies. On the other hand, one nuclear expert identified use of the site for interim storage as very poor, noting that it is impractical to transport high-level nuclear waste more than once.¹⁵ Similarly, two stakeholders proposed producing medical isotopes on the site, and nuclear experts differed on the benefits and challenges of this use. As some experts acknowledged a need to increase production of medical isotopes in the United States, they, however, noted multiple challenges related to isotope production at the Yucca Mountain site. For example, one expert questioned the viability of the technologies stakeholders proposed to

¹³Medical isotopes are materials containing radioactive atoms that have useful applications in medical imaging and cancer treatment, among other things.

¹⁴Reprocessing spent fuel requires that a reprocessing plant break apart the used fuel assemblies and separate the reusable materials from the remaining waste. The reusable materials are then fabricated into recycled fuel for reactors.

¹⁵In its technical comments on this report, DOE noted that the Blue Ribbon Commission on America's Nuclear Future recommended establishing centralized interim storage for high-level waste and spent nuclear fuel, in addition to developing a nuclear repository.

produce medical isotopes—the use of electron accelerators or neutron generators. Stakeholders also proposed two additional alternative uses related to nuclear research—a nuclear technologies research facility and a research reactor—that also received mixed responses from experts we consulted. Some experts noted that such research is already conducted at other locations, such as DOE’s Idaho National Laboratory, and that another research location is not necessary; further, some experts said that they did not believe that there would be an adequate workforce in Nevada to support such a facility. Moreover, one expert noted that a research reactor would “only realize moderate benefit from historical investments and infrastructure at Yucca Mountain.”

Defense or homeland security activities. Stakeholders proposed six alternative uses for the Yucca Mountain site related to defense or homeland security, including testing and training of the Active Denial System, a nonlethal weapon;¹⁶ a training site for first responders; and a command center for unmanned aerial vehicles. Some defense experts we contacted identified some defense uses of the Yucca Mountain Site as good or great uses. In particular, these experts noted that the site may be well-suited for homeland security activities, including using the site to test instruments to detect radioactive and nuclear material. According to these experts, the Yucca Mountain site would offer security, and the tunnels could provide shielding for radioactive and nuclear materials as well as the ability to test and train in both open and confined environments. One expert stated that the Yucca Mountain tunnel could be used to simulate a wide range of threats, including chemical, biological, radiological, nuclear, and explosive. For example, according to this expert, the shielding provided by Yucca Mountain would prevent any radiation “signature” from being detected above ground, which—coupled with the potential of strong physical security of the site—would allow the federal government to test classified systems and materials. Moreover, any accidental release of hazardous or radioactive material used in testing could be easily contained on site, according to one expert. Some experts also told us that the site may offer benefits for first responder training activities. For example, one expert noted that the main tunnel could simulate a subway tunnel for training first responders in underground environments. Moreover, the shielding and containment of the tunnel could allow nuclear

¹⁶The Active Denial System is a nonlethal, directed-energy, crowd-control device which works by beaming microwave radiation, causing intense pain—but no damage—in people.

or other hazardous materials to be used in training exercises, according to one expert. On the other hand, some experts identified challenges associated with proposed defense uses. For example, one expert noted that the enclosed space of the Yucca Mountain tunnel may limit testing and training activities. In particular, the tunnel would not effectively simulate open or urban environments, where most actual responses would take place, according to this expert. Currently, unmanned aerial vehicles are operated at other sites not originally built for this purpose—including Creech Air Force Base in Indian Springs, Nevada, about 40 miles from the Yucca Mountain site—and which some have noted could be vulnerable to an attack. One stakeholder suggested that such operations could be moved or centralized to Yucca Mountain, which would provide a more secure site. One expert stated that having a highly secure command and control facility for unmanned aerial vehicles will be essential in the future and identified this as a great use of the site. On the other hand, another expert cited the limited infrastructure at the site as a shortcoming to this use and noted that it was not a very good fit for the unique characteristics of Yucca Mountain.

Information technology. Stakeholders we contacted proposed three alternative uses related to information technology, including using the site for public emergency communications, secure electronic data, or paper document storage. For example, one stakeholder proposed locating a secure electronic data center at the Yucca Mountain site to house classified federal data. According to some experts, some of the benefits that the site may offer include potentially strong physical security and proximity to a major internet hub that runs through Las Vegas, Nevada, which could provide a great deal of flexibility in managing and transmitting data. In addition, one expert noted that locating a secure data center on-site could lead to some cost savings if classified datasets that are currently managed in separate locations could be consolidated. However, some experts told us that using the site for a data center would require significant upgrades to the data and communications infrastructure at the site to connect it to existing infrastructure in Las Vegas. In particular, one expert noted that securing communications infrastructure—including measures to physically secure the communications links, along with efforts to ensure adequate cybersecurity—can be expensive. Moreover, one expert cited physical challenges to housing information technology in the Yucca Mountain tunnels. For example, environmental controls would likely need to be added to manage the environment within the tunnel. DOE and state officials told us that humidity levels may be high in the tunnels without an operating ventilation system due to condensation of water from the air. As a result, U.S. Geological Survey officials said that

ventilation fans may be required to operate in the tunnels in order to house computer servers or other electronic equipment. In addition, the stakeholder proposing use of the tunnels for data storage told us that heat emitted by servers may require substantial cooling.

Energy development. Stakeholders we contacted proposed seven alternative uses of Yucca Mountain related to energy development or storage. Three of the proposed uses concerned production of renewable energy, while three other proposed uses support renewable energy development, and one stakeholder proposed using the site as a strategic petroleum reserve for the western states.¹⁷ One expert noted that research into geothermal energy development is needed and cited advantages for this use at Yucca Mountain, but another expert stated that this was a poor use of the site and that the site did not provide any unique advantages for this use. Other experts identified benefits to using the site for solar energy development, since the area is rich in sunlight, but one cited the ruggedness of the terrain as a challenge. Stakeholders also proposed using the site for research into renewable energy sources, including solar, wind, and geothermal energy, and carbon capture. Two experts identified this as a good or great use of the site, noting that more research into renewable energy technologies is needed, but some experts identified challenges related to this use, including challenges related to building transmission lines. Three other uses—compressed air storage, hydroelectric energy storage, and a renewable energy storage laboratory—would use the main tunnel to store renewable energy for later use. For these uses, stakeholders proposed sealing the main tunnel and using it to store energy—either as compressed air or pumped water. Such systems work by storing energy produced when production is high (e.g., during the day when solar energy is produced) by compressing air or pumping water upstream and releasing the air or water to produce energy when demand is high. A few experts noted that more research into compressed air storage in tunnels is needed and cited a demonstration project as a great use of the Yucca Mountain site. One expert stated that the Yucca Mountain site was “critical” to use as a renewable energy storage laboratory, noting that the tunnel and related infrastructure were unique assets that could provide a commercial-scale demonstration project. On the other hand, some experts identified the proposed uses related to renewable energy storage as poor

¹⁷The Strategic Petroleum Reserve, which currently holds about 700 million barrels of crude oil, was created in 1975 to help insulate the U.S. economy from oil supply disruptions.

or very poor uses, noting that there are a number of challenges to these uses at the site, such as the permeability of the site's geology.¹⁸ One stakeholder proposed using the site as a strategic petroleum reserve for the western part of the country, but several experts identified this as a poor use of the site for a number of reasons. For example, one expert noted that there already is adequate strategic petroleum reserve capacity elsewhere in the United States.

Scientific research. Stakeholders we contacted proposed four alternative uses related to scientific research, including using the site for a geological laboratory and storage site for geological samples, as a center for research into highly-infectious diseases, for mining research, or for other scientific and university research. According to one scientific expert, the site could be used to store geological samples at a cost that would be relatively low compared to other uses for the site, but another expert noted that this use was not of much value at the site, since it would not take advantage of the large investment into site characterization made in the past. Regarding the proposal for a center for disease research, one expert stated that this research would be of "vital interest to scientists as well as those concerned with national security," and other experts identified some of the site's characteristics, such as its remoteness, as benefits to this use. However, one expert stated that a subsurface facility would not be ideal for this use, given the need for ventilation and access. One expert identified mining education as a good use of the site, noting that the physical infrastructure, history of the construction, and continued exploration of Yucca Mountain present an "unmatched opportunity" for students of mining or geology in general. Other experts also saw benefits to using the site for this use, but one stated that, overall, this was not an optimal use given the substantial past investment in the site. One stakeholder proposed using the site for scientific research to explore a variety of research areas, including the atomic structure of matter.¹⁹ This stakeholder noted that research at such a facility may address a wide variety of current challenges, including improving the conversion of solar energy, efficiency and durability of battery storage, and pollution control

¹⁸As noted previously, DOE's investigation of the Yucca Mountain site indicated that while the rock itself is believed to be impermeable to water, it contains fractures where water could migrate through it.

¹⁹This use also relates to the nuclear and radiological uses category, but we categorized it into the scientific research category because it addresses a broad range of research interests.

from energy production. According to one expert, using the site as a research center may be a good use, but other experts identified this as a poor or very poor use and cited multiple challenges, such as accessibility to the site, given its remoteness.

Many Proposed Alternative Uses May Be Costly or Face Significant Challenges

Many of the proposed alternative uses of Yucca Mountain may be costly—requiring federal funding to make them economically viable—or face major challenges, according to many of the 16 experts we contacted. In particular, many of the proposed nuclear uses would be costly to implement, according to some nuclear experts, and would only be feasible with financial support from the federal government. For example, the stakeholder who proposed using the site for the reprocessing of spent nuclear fuel, as well as several nuclear experts, acknowledged that reprocessing using current technologies is very expensive and not economically viable at this time. One expert noted that an industry estimate of the cost to build a nuclear reprocessing facility in the United States is \$25 billion. Similarly, two experts stated that it would be costly to build nuclear reactors for power generation at the Yucca Mountain site, with one noting that doing so would require federal funding. It would also be expensive to use the site for production of medical isotopes, according to two experts, both in terms of capital and operating costs, and one expert said that this use would also require federal funds. Moreover, several experts said that many of the nuclear uses may face other significant challenges, including local public resistance. For example, one expert noted that opposition to using Yucca Mountain for any nuclear or radioactive waste disposal, including interim waste storage, would be a challenge, especially if there was no long-term plan for addressing the waste. In addition, one expert noted that some individuals fear that allowing interim storage of nuclear waste at the site would preserve the option to allow it to be used for permanent storage of such waste. Moreover, some experts noted that several of the proposed alternative nuclear uses, including nuclear power generation and reprocessing, require significant amounts of water, which may be a significant challenge at the site, given the scarcity of water in Nevada.²⁰

²⁰According to an official from the Nevada Division of Water Resources, the agency responsible for managing the state's water resources, the state of Nevada grants water rights in part based on whether the water will be used for a "beneficial use." This official also noted that it may be difficult to get sufficient water rights for an industrial use that requires a large amount of water.

Some defense experts we contacted also said that some of the proposed defense or homeland security uses would be costly to implement or face other significant challenges. For example, some experts cited the high cost of using Yucca Mountain as a command and control center for the military, which would require significant upgrades to data communications, water infrastructure, and infrastructure within the tunnel. In particular, one expert noted that the requirement to develop survivable communications infrastructure for command and control would be significant. Two experts also noted that it would be costly to use the Yucca Mountain site as a command center for unmanned aerial vehicles. According to one expert, there are already sites in place that serve these purposes, and it would be costly to move them.

Several of the proposed uses in the energy category may also be expensive to implement or face major challenges, according to some energy experts. For example, using the site for compressed air storage may not be cost-effective on its own and would require significant investment of outside funds, according to one expert. This expert also noted that it was unlikely that the application would result in large-scale commercial deployment. Two other experts identified sealing and reconfiguring the tunnel for this use as also being costly. Similarly, some experts identified high costs related to using the tunnel for hydrological energy storage or as a renewable energy storage laboratory. One expert said that outside funding would also be required for solar energy development at the site, since there is not currently a well-developed market for solar electricity, and a few other experts identified high costs associated with this use, including the cost to build transmission lines to the site and other infrastructure. Using the site as a strategic petroleum reserve may also face significant challenges, according to some experts. One expert stated that the amount of petroleum that could be stored in the Yucca Mountain tunnels is insignificant when considering the nation's current rate of consumption and storage capacity elsewhere. Moreover, this expert noted that transporting the petroleum would be a challenge, since it would have to be transported from U.S. petroleum sources or coastal delivery ports.

According to some of the experts we contacted, some of the proposed scientific uses may also be costly or face other significant challenges. For example, using the site for a research center on the atomic structure of matter would be very expensive to build and operate, according to some experts. Research in this area would require a large, advanced accelerator, which one expert stated would cost billions of dollars to build. In addition, such an accelerator may require a particular shape, according

to one expert, which the Yucca Mountain tunnels may not match, thus requiring additional excavation. Construction started on a similar facility in Texas in the 1980s—the Superconducting Super Collider—but the project was shut down due to high costs, among other concerns. Building a research center to study highly infectious diseases would also be costly, according to one expert, and may generate controversy and local resistance.

Experts Noted that Many Proposed Alternative Uses Could be Undertaken Elsewhere

Several experts stated that Yucca Mountain’s characteristics would not be critical to many of the alternative uses proposed by stakeholders, with some noting that other locations might offer some of the same benefits while posing fewer challenges. For example, nuclear experts we contacted identified a number of nuclear uses that could be undertaken elsewhere. One expert told us that interim waste disposal could happen “anywhere in the country”—DOE has reported that spent nuclear fuel and high-level radioactive waste that had been planned to be disposed of at Yucca Mountain is currently stored at 121 sites in 39 states.²¹ In addition, some experts said that they did not believe that the remoteness or level of security at the site was critical for production of medical isotopes, with two experts stating that medical isotopes should be produced closer to the locations in which they will be used—hospitals and research facilities—especially considering their short half-lives.²² Likewise, as one expert cited the remoteness of Yucca Mountain as an advantage in the reprocessing of nuclear waste, another expert stated that other locations would be better suited—including DOE’s Idaho National Laboratory or Savannah River Site, which both have an existing infrastructure and workforce. And several experts noted that nuclear power plants would be better sited closer to population centers that could use the power.

Similarly, the defense experts we contacted told us that characteristics of the Yucca Mountain site were not critical to some of the defense and homeland security uses stakeholders proposed. For example, testing of the Active Denial System could be safely done in any remote location,

²¹This includes high-level waste and spent nuclear fuel at five sites managed by DOE and several sites that have only research reactors that generate small amounts of waste.

²²Medical isotopes, like all radioactive materials, decay at a known rate. A half-life refers to the interval at which half of the radioactivity has decayed. Isotopes with short half-lives, like those used in medical applications, decay during shipping, requiring higher quantities of the material to be shipped than may be needed at the facility using them.

according to one expert, who noted that the shielding that Yucca Mountain provides would not be critical to this use. Moreover, another expert stated that there are likely many other military test ranges in the United States where testing and training of this weapon could take place. In addition, two experts stated that using the Yucca Mountain site as a command and control center or a command center for unmanned aerial vehicles could both be done elsewhere and with potentially fewer challenges. For example, it would cost significantly more to use the Yucca Mountain site as a command center for these vehicles rather than using an existing military base that already has infrastructure to support personnel, such as housing, in place.

Some of the proposed information technology uses could also be undertaken elsewhere, according to some experts. For example, the stakeholder that proposed using Yucca Mountain for secure data storage told us that, while Yucca Mountain would offer some advantages to this use, it could be undertaken at other locations, noting in particular that some underground facilities on the adjacent Nevada National Security Site would also provide a high level of security as well as other benefits similar to those offered by the Yucca Mountain site. In addition, one expert stated that the use of the site for storage of highly secure electronic data would benefit from the potentially strong physical security of the site, but another expert stated that the characteristics at Yucca Mountain were not central to the proposed concept. In particular, the second expert noted that the site's isolation may pose challenges for making the needed data capacity upgrades and consolidating data in one location could make it more susceptible to cyber attacks. Similarly, one expert stated that the proposed public emergency communications site would be better located closer to Las Vegas, Nevada, where most of the first responders are located. Moreover, this expert noted that it may be difficult to broadcast emergency messages from a submerged rock tunnel.

For the proposed energy uses, some experts stated that there are many other sites that would be suitable for solar and geothermal development. One expert noted that there are many areas in the Southwest that are well-suited for solar power, and another expert stated that Yucca Mountain's remote location would present some disadvantages in that it is far from a customer base that could use and finance the power and would require construction of adequate transmission lines to move the electricity to population centers. Similarly, one expert pointed out that there are many locations in the Southwest with high levels of geothermal activity, and another expert stated that most of Nevada's geothermal activity is in the northern part of the state. Some experts said that some of the Yucca

Mountain site's characteristics would be critical for renewable energy storage, but others noted that other locations may be better suited. For example, one expert stated that compressed air energy storage may face challenges in any area with seismic activity, since even a small tremor may rupture an airtight seal. Another expert identified Yucca Mountain as a unique location for studying tunnel-based storage but noted that other sites could be used for hydrological energy storage. One expert stated that a strategic petroleum reserve would be better placed elsewhere, such as in an abandoned mine that is much bigger and closer to existing petroleum sources and distribution infrastructure.

Some experts said that Yucca Mountain's location was not critical to some scientific uses either. According to one scientific expert, storing geological samples could be done elsewhere at a lower cost, including in surface warehouses. Similarly, while one expert identified the remoteness of the Yucca Mountain site as offering advantages to a research center to explore the atomic structure of matter, two experts also identified this as a challenge, with one noting that the remoteness of the site may prevent federal and academic scientists from the collaboration that is critical to multidisciplinary research projects. Experts cited similar concerns regarding use of the site as a center for research into highly-infectious diseases, with one noting that the site's location may make it difficult to hire a skilled workforce.

Pursuing Alternative Uses of the Yucca Mountain Site Could Face Legal and Administrative Challenges

Alternative uses of Yucca Mountain could face a number of legal and administrative challenges if they were to be pursued. These challenges include legal proceedings regarding the site's original planned use as a repository, potential litigation related to mining claims on the site, federal agencies' divided control over the site, and activities on adjacent federal lands. In addition, any proposed uses of Yucca Mountain would be subject to applicable federal and state regulations.

Resolution of Legal Proceedings Could Preclude or Significantly Delay Alternative Uses

The outcome of legal proceedings concerning whether the Yucca Mountain site will be used as a nuclear waste repository could significantly delay or preclude the pursuit of alternative uses of the Yucca Mountain site. Specifically, two separate but related legal proceedings—one before the NRC and another before a federal appellate court—were unresolved as of September 9, 2011, when this report was being prepared for publication. Specifically,

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- After DOE submitted a motion in March 2010 to an NRC Atomic Safety and Licensing Board to withdraw its application to license Yucca Mountain as the nation's first repository for spent fuel and high-level nuclear waste, the licensing board denied DOE's motion to withdraw its licensing application in June 2010, and stated that the Nuclear Waste Policy Act of 1982, as amended, mandates progress toward a decision on the construction permit. However, NRC issued an order inviting parties to file briefs addressing whether the NRC commissioners should review the board's decision and, if so, whether the commissioners should uphold or reverse it. On September 9, 2011, the commissioners considered whether or not to overturn or uphold the board's decision. However, they were evenly divided and unable to take a final action on the matter. Instead, the commissioners directed the licensing board, consistent with budgetary limitations, to complete all necessary and appropriate case management activities, including disposing of the matters before the board, by September 30, 2011. Continued NRC proceedings or challenges in federal court could delay or preclude alternative uses.
 - In response to DOE's attempt to withdraw its license application, several states and private parties sued DOE and NRC in the U.S. Court of Appeals for the District of Columbia Circuit.²³ These petitioners contended that DOE had no authority to terminate the proposed Yucca Mountain repository. On July 1, 2011, the court dismissed the case, finding that the court lacked jurisdiction over the petitioners' claims because the Yucca Mountain licensing proceeding remained pending before the NRC. In addition, the court stated that if the NRC fails to rule on the license application within the period provided in the Nuclear Waste Policy Act of 1982, as amended,²⁴ the petitioners would have a new cause of action. On July 29, 2011, the same petitioners, joined by Nye County, Nevada, filed a petition against NRC asking the court to, among other things, compel NRC to provide a proposed schedule with milestones and a date certain for approving or disapproving the license application. If the court finds for

²³The parties included South Carolina and Washington state; Aiken County, South Carolina; and individuals from the state of Washington. DOE's Hanford Site and one commercial nuclear power reactor are located in Washington state, DOE's Savannah River Site and four commercial nuclear power stations are located in South Carolina, and the Savannah River Site is located in Aiken County.

²⁴The four-year period in the Nuclear Waste Policy Act of 1982, as amended, includes three years plus an additional year, if needed, for review of the license application.

the petitioners, the license application review process may resume and alternative uses could be delayed or precluded.

A ruling by the NRC or the court may reopen the possibility of Yucca Mountain again being considered for a permanent nuclear waste repository, although fully reinstating these efforts could require Congress to take several steps, including appropriating funds. In the event that the site is developed into a repository, it would preclude use of the site for alternative uses. Even without a ruling, potential alternative uses will almost certainly be delayed until the legal issues surrounding the original use of Yucca Mountain have been resolved.

Potential Litigation Related to Mining Claims Could Affect Alternative Uses of the Site

DOE's access to the BLM portion of the Yucca Mountain site has changed. During DOE's study of the Yucca Mountain site, Interior provided DOE the right to use lands managed by BLM. Specifically, BLM granted a right-of-way in 1988 to allow DOE to have access to the entire BLM portion of the Yucca Mountain site (see fig. 5), which comprises a total of about 81 square miles.²⁵ According to DOE and Interior officials, the right-of-way allowed for other uses of the site lands, including mining, as long as they did not interfere with DOE's study of the Yucca Mountain site for a potential repository.²⁶ Within the lands covered by the right-of-way, Interior issued a public land order in 1990 that established additional restrictions on the BLM portion of the land nearest to and directly above the tunnel.²⁷ This public land order withdrew 6.6 square miles of the BLM portion of the site's land within the 81 square miles covered by the right-of-way from location under the mining laws and from leasing under the mineral leasing laws. The order effectively prevented new mining claims

²⁵This right-of-way (ROWR 47748) has been extended twice—in 2001 and 2007—and is now scheduled to expire on December 31, 2014. The right-of-way does not extinguish existing valid rights—such as any mining claims—that existed before the right-of-way was granted in 1988.

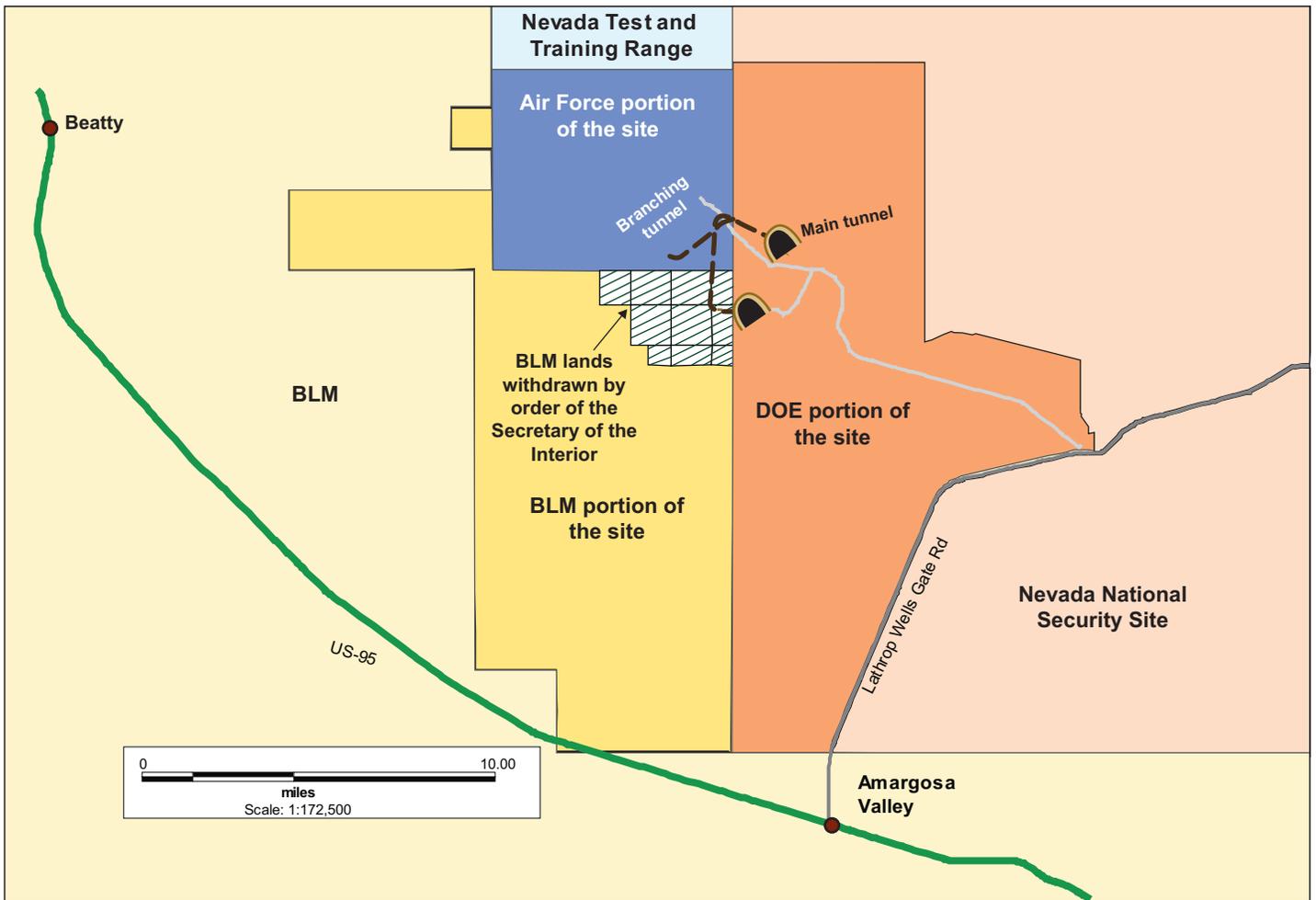
²⁶Under the General Mining Act of 1872, an individual or corporation can establish a claim to certain valuable mineral deposits—including gold, silver, cinnabar, lead, tin, and copper—generally known as hardrock deposits, on public land. Upon recording a mining claim with BLM, the claimant must pay an initial \$34 location fee and a \$140 maintenance fee annually per claim; the claimant is not required to pay royalties on any hardrock minerals extracted.

²⁷This land withdrawal order, Public Land Order 6802, 55 Fed. Reg. 39,152 (Sept. 25, 1990), was extended by Public Land Order 7534, 67 Fed. Reg. 53,359 (Aug. 15, 2002), until January 31, 2010.

in the area above the tunnel as well as the area expected to be where waste would be stored underground, according to DOE documents, as well as the lands in the immediate vicinity (see fig. 5).²⁸ In 2008, DOE asked the Secretary of the Interior to extend the land withdrawal order beyond its scheduled expiration date in January 2010, but the Secretary did not grant the extension. However, the right-of-way covering the BLM portion of the site still applies to these lands until its scheduled expiration date in 2014.

²⁸According to Interior officials, the order withdrew the lands from the location of new claims and entry under the mining laws and leasing under the mineral leasing laws, subject to valid existing rights.

Figure 5: Map Showing Federal Management Status of the Yucca Mountain Site



Sources: GAO analysis of DOE and BLM data.

After the scheduled expiration of the public land order, private parties filed 35 mining claims on the 6.6 square-mile area covered by the land withdrawal, which the BLM Nevada State Office recorded and

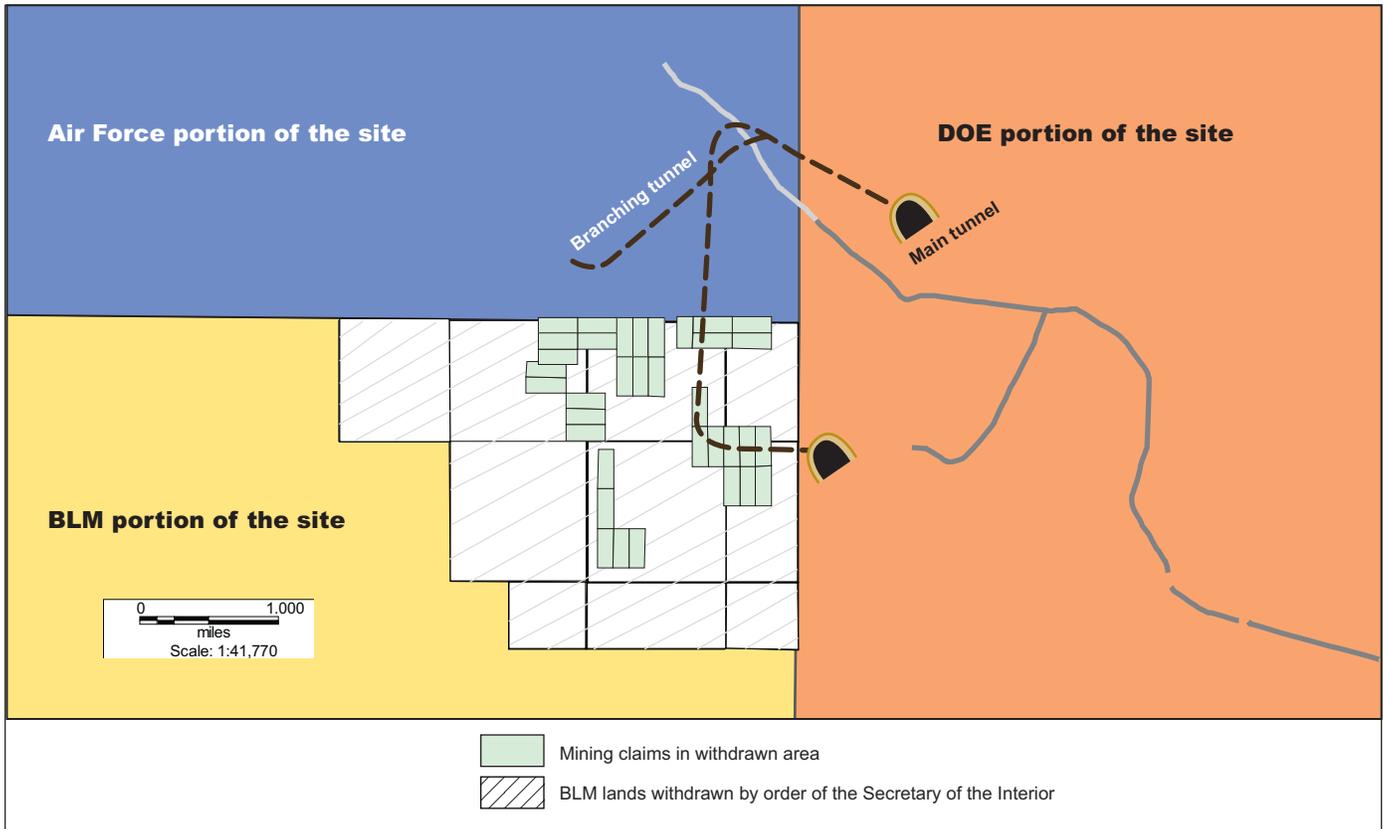
processed.²⁹ As of July 2011, BLM had initially determined that almost all of these 35 mining claims were “active,” or in good standing; that is, the claims were on lands open to mineral entry and were properly filed.³⁰ Based on our analysis, 8 of these 35 mining claims directly overlay a section of the existing main Yucca Mountain tunnel and others appeared to be located above the planned nuclear waste storage areas (see fig. 6). In August 2011, however, Interior officials told us that as a result of our inquiry and subsequent discussions with agency officials, BLM, in consultation with Interior’s Office of the Solicitor, which performs the legal work of Interior’s bureaus and offices, determined that the 35 mining claims were filed on lands not open for mineral location. In making this determination, BLM and Interior officials told us that, although the public land order withdrawing the lands from location under the mining laws and leasing under mineral leasing laws had expired, the Secretary of the Interior had not issued an “opening order” to formally reopen the land, and the lands would therefore remain closed until such an order had been issued. As a result, BLM officials told us that they declared the claims to be “*void ab initio*,” that is void from the start, in August 2011.³¹ BLM plans to refund about \$8,000 to the private parties who held the 35 claims. If they disagree with BLM’s declaration, the parties have 30 days to appeal the decision to Interior. Separately, private entities had filed 83 additional mining claims on the land covered by the right-of-way outside the lands subject to the public land order. According to BLM officials, these 83 claims are active, but the owners of these claims would have to work with BLM and DOE to begin significant mining activities. Most of these claims are located near the southern and western boundaries of the site.

²⁹As part of its regular evaluation of mining claims on public lands, BLM determines whether the lands are open to location under the mining laws and potential mining activities, and whether claims were properly filed, which is referred to as “minerals adjudication.” BLM officials told us that, prior to August 2011, they had determined that the expiration of the land withdrawal had automatically resulted in opening of the lands for mineral entry.

³⁰For these claims, BLM accepted payment, updated its electronic records system used to track uses of federal lands, and took other administrative steps to acknowledge the claims. At least two of the claims lacked complete documentation when they were submitted and BLM provided the claimants with an opportunity to correct these errors. As a result of the time allowed for these corrections, BLM officials told us that they had not yet completed their review of the claims but told us that BLM could still have determined that these two claims were active.

³¹See 43 C.F.R. § 2091.6.

Figure 6: Map Showing Locations of Mining Claims in Relation to Yucca Mountain Tunnel



Sources: GAO analysis of DOE and BLM data.

Even though BLM has declared the 35 mining claims *void ab initio*, Interior officials acknowledged that the claims' status could ultimately be the subject of litigation, which may present challenges or cause delays to future uses of the site. For example, if mining claims that include the tunnel are recognized as active and in good standing following litigation, future potential alternative users might have to negotiate with the holder of the mining claim in order to make use of portions of the tunnel included in the claims, or seek to buy out the mining claim. Similarly, if mining

operations were allowed, some officials noted that activities on the claims, such as blasting, could pose risks to the integrity of the tunnel.³²

Federal Agencies' Divided Control of the Yucca Mountain Site May Present Challenges to Alternative Uses

Because the Yucca Mountain site and the tunnels are within lands managed by three separate federal agencies, potential alternative uses of the site may face challenges related to the management of the site's lands. Currently, DOE has use of all three portions of the Yucca Mountain site through its right-of-way agreement with BLM and an additional right-of-way agreement with BLM and the U.S. Air Force to access lands controlled by the Air Force. These right-of-way agreements were provided to DOE for site investigation activities and are scheduled to expire in 2014. After 2014, full control of the lands and tunnel will revert to the Air Force, BLM, and DOE.³³ As noted, the tunnels' portals open onto DOE's Nevada National Security Site, but the tunnels also underlie BLM and Air Force land.

Any potential future user of the site would have to coordinate with all three agencies, absent a change in the management or ownership of the land. Agency officials and stakeholders discussed three possible scenarios under which the Yucca Mountain site's land could be managed if an alternative use were pursued as well as some potential outcomes of these scenarios, as follows:

³²BLM officials told us that parties that hold mining claims can initiate limited mining exploration, including using earth-moving equipment, drilling and blasting, if claimants file a notice and pay a bond intended to guarantee that there are financial means to restore public land after mining exploration activities are finished. These activities are called "notice level activities" under BLM regulations. If BLM finds the bond to be acceptable, claimants may use mechanical equipment, including earth movers and explosives, but may not affect more than 5 surface acres of land per year. As of July 2011, BLM officials were not aware of any mining activities near the tunnel.

³³The lands historically controlled by DOE were provided through land withdrawal orders without expiration dates for specific purposes. The lands now comprising the Nevada National Security Site were provided to DOE's predecessor agency in 1952 for weapons testing, with subsequent withdrawals adding additional lands to the site. The lands now comprising the Nevada Test and Training Range were provided to DOD's predecessor agency in 1940 for use as an aerial bombing and gunnery range. The Military Lands Withdrawal Act of 1999, Pub. L. No. 106-65, tit. XXX, subtit. A, § 3011(b), 113 Stat. 512, 886, superseded the earlier withdrawals and withdrew the land from appropriation under all public land laws for a number of defense related activities.

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- *Site remains federally managed.* DOE, BLM, and the U.S. Air Force could continue to manage the site's lands under the control of each agency. As a result, a potential user might have to hold negotiations and come to agreements with each agency separately, as was done by the managers of DOE's Yucca Mountain repository project. In this case, the user would likely be subject to current DOE rules, such as restrictions placed on foreign nationals' access to the Nevada National Security Site and the payment of service fees that DOE charges for use of the DOE portion of the site.³⁴ Similarly, each of the other agencies may have unique concerns that may need to be addressed individually.
 - *Sale of site lands to a private landowner.* Any private acquisition of land would have to address acquisition of lands currently held by DOE, BLM, and possibly the U.S. Air Force; this may require significant legal steps. For example, Air Force lands have been legislatively withdrawn to serve its mission, so congressional action may be required before Air Force lands could be sold. In addition, to give users access to the site, DOE would at least have to grant rights-of-way through the Nevada National Security Site, or congressional action may have to be taken. In addition, if there are any existing mining claims, the potential user that acquired the lands could take title of the land subject to the existing mining claims or could buy out the claims.
 - *Congressional land withdrawal for a specific use.* If it chooses to do so, Congress has the power to set aside land for specific federal agencies through legislative action, including by withdrawal of lands, such as the Yucca Mountain site lands, for specific purposes from the public land laws. In addition, Congress could specify conditions or restrictions associated with the land withdrawal, such as to what extent other land management laws or regulations apply.

³⁴DOE's cost accounting procedures direct its contractor to charge other users operating on the site for a share of the costs of managing the site, and these costs could be high. For example, officials of the DOE contractor in charge of the site told us that electricity costs would be expensive—approximately double the cost of electricity charged by a nearby provider for local service, not taking into account the cost of supplying this electricity to the site from an external source. This cost would reflect the expense of providing and maintaining electrical service in the vast area of the site.

Activities on Adjacent Federal Lands May Limit Some Alternative Uses

Potential future uses of the site may be limited by the highly sensitive national security activities that take place on adjacent federal lands. At the Nevada National Security Site, DOE activities include subcritical testing of nuclear bomb components to support DOE's stockpile stewardship mission, nuclear device assembly and storage, and other activities. At the U.S. Air Force's Nevada Test and Training Range, activities include training pilots, dropping live bombs, and testing of radar and other military equipment, among other things. Air Force officials we spoke with told us that an important part of what makes the Nevada Test and Training Range an asset to the Air Force is that it provides a unique opportunity for pilots and others to test equipment and train personnel in a large area of "pristine" airspace without any electromagnetic interference. Some potential uses may create electromagnetic or other interference. For example, wind turbines would be of concern because the spinning blades of wind turbines, even if they are miles away, can create reflective radar effects that could seriously impede the testing of new sensing equipment. In addition, Air Force officials told us that they may have concerns about other uses as well—such as proposed uses that would increase civilian or aviation activity on the border of the Nevada Test and Training Range—but that each use would have to be evaluated on a case-by-case basis.³⁵ Similarly, the Nevada National Security Site conducts some activities that are highly sensitive and that DOE requires to be secure from outside observation. As such, DOE officials noted that some uses, particularly those that could provide observation of key portions of the Nevada National Security Site, would not be consistent with the site's mission.

In addition to these restrictions, the U.S. Air Force and the Federal Aviation Administration regulate the use of airspace over most of the site. In particular, the DOE and Air Force portions are restricted from all civilian air traffic. However, the airspace above the BLM portion of the site is unrestricted, according to DOE documents.

³⁵Such evaluations are done by the Nellis Air Force Base's Office of Public Partnerships, which evaluates and attempts to mitigate cases of potential interference. In addition, U.S. Air Force officials told us that future uses of the site would likely involve interagency agreements between the U.S. Air Force and the entities operating on the site.

Any Proposed Use of the Site Will Require Addressing a Range of Regulatory Requirements

Any proposed alternative use of the site will require the use to comply with applicable federal and state regulations, as with any activity. For example, alternative uses that result in air emissions, such as emissions from any gas-powered generators or dust if there is construction on the site, would require operators to obtain air permits from Nevada. Similarly, construction of some buildings may require permits and steps to address Occupational Safety and Health Administration and other building-specific requirements. In addition, The National Environmental Policy Act of 1969, as amended requires that proposed major federal actions that significantly affect the quality of the human environment must be accompanied by a detailed statement which includes the environmental impacts of the proposed action, adverse environmental effects that cannot be avoided, and alternatives to the proposed action. The specific regulatory requirements needed for a specific alternative use would depend on the nature of the use.

Agency Comments and Our Evaluation

We provided Interior, DOE, the U.S. Air Force, and NRC with a draft of this report for their review and comment. Interior did not provide written comments on our draft report. However, in e-mails, the Interior liaison stated that Interior concurred with the findings in the report. Interior also provided written technical comments, which we incorporated as appropriate. We received written comments on the draft report from DOE, which are reproduced in appendix V. DOE neither agreed with nor disagreed with our findings and also provided technical comments, which we incorporated as appropriate. The U.S. Air Force did not provide written comments but provided technical comments, which we have incorporated as appropriate. We received written comments on the draft report from NRC, which are reproduced in appendix VI. NRC neither agreed nor disagreed with the findings in the report and also provided technical comments, which we incorporated as appropriate.

As agreed with your office, unless you publicly announce the contents of this report earlier, we plan no further distribution until 30 days from the report date. At that time, we will send copies to the appropriate congressional committees, the Secretary of the Interior, the Secretary of Defense, the Secretary of Energy, the Chairman of NRC, and other interested parties. In addition, this report will be available at no charge on the GAO website at <http://www.gao.gov>.

If you or your staff members have any questions about this report, please contact me at (202) 512-3841 or ruscof@gao.gov. Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this report. Key contributors to this report are listed in appendix VII.

Sincerely yours,

A handwritten signature in black ink that reads "Frank Rusco". The signature is written in a cursive style with a long, sweeping horizontal line extending to the right from the end of the name.

Frank Rusco
Director, Natural Resources
and Environment

Appendix I: Scope and Methodology

For this report, we examined (1) the characteristics of the Yucca Mountain site; (2) alternative uses stakeholders have proposed that may utilize these characteristics, and experts' evaluations of those uses; and (3) challenges, if any, in pursuing alternative uses.

For the purposes of this report, we have defined the Yucca Mountain site to include the lands that were withdrawn or reserved from lands historically managed by the Department of Energy (DOE), Bureau of Land Management (BLM), and the U.S. Air Force when the site was being investigated for use as a nuclear waste repository, as well as lands authorized by the BLM for such use. To examine the characteristics of the Yucca Mountain site, we inspected several portions of the site to assess its conditions and conduct a limited assessment of existing assets. During our site inspection, we visited both tunnel portals as well as the site's permanent and temporary structures. Our assessment of the site did not include an inspection of the tunnels because of the costs to reopen them and make them safe for inspection. As a result of the proposed elimination of federal funding for the Yucca Mountain Project, DOE discontinued most activities at the site in 2010 and took steps to close the site,¹ including closing access to the tunnels and turning off utilities, including the power for the ventilation system. DOE determined that reopening the tunnels, because of the steps that had been taken to close the site, would cost \$20,000-\$50,000 for one day. In addition to our site inspection, we reviewed documents, including DOE's license application, environmental impact statements, public land orders, and relevant laws and regulations. We also interviewed officials with knowledge of the site, including officials from DOE, the Department of Defense, and the Department of the Interior's BLM and U.S. Geological Survey, as well as other experts with knowledge of the site. Finally, we worked with agency officials familiar with Geographical Information Systems to create maps of the site encompassing various data layers.

To examine proposed alternative uses of the Yucca Mountain site, we contacted federal, state, and local government agencies; national laboratories; private firms; nonprofit agencies; and others to identify stakeholders with ideas for alternative uses of the Yucca Mountain site. We

¹In April 2011, Congress passed a continuing resolution to provide funding for federal departments and agencies for fiscal year 2011. In that legislation, Congress appropriated \$0 under the heading "Department of Energy, Energy Programs, Nuclear Waste Disposal."

also asked each stakeholder we identified, in addition to gathering information on the proposed alternative uses, whether he or she knew of any other such proposals. Using this snowball methodology, we attempted to uncover all reasonably plausible ideas for uses that have been put forward, from those in the early stages of formation and discussion to more fully developed proposals. However, in part because the site has long been expected to be the future site of a permanent nuclear waste repository and has not been the subject of widespread consideration for other purposes, it is important to note that the alternative uses discussed in this report may not reflect all of the potential alternative uses for the site. We asked stakeholders to describe their proposed alternative uses using a structured data collection instrument. We then consolidated proposed uses in order to avoid duplication; for example, we received two proposals related to first responder training activities, which we consolidated into one. We then sorted the proposed uses into five broad categories: (1) nuclear uses, (2) defense or homeland security activities, (3) information technology, (4) energy development or storage, and (5) scientific research. The complete list of proposed alternative uses for the Yucca Mountain site that are considered in this report is given in appendix II.

In order to identify experts to comment on the stakeholders' proposed uses in each of the five broad categories, we approached experts within nationally recognized organizations, including the National Academy of Sciences, the RAND Corporation, and the Brookings Institution, as well as other experts we knew of from our work in these areas, for their recommendations on names of experts we should include in this effort. We did not attempt to snowball a complete list of experts in each of these categories, but rather to ensure we had at least a few well-respected experts within each category of expertise, who could provide informed comments on the proposed alternative uses. We also took steps to ensure that all of these experts could provide independent and objective opinions on the proposed uses, including ensuring that none of them had any financial or nonfinancial interests in any of the potential uses, and that they did not represent, advocate for, or benefit from any of the stakeholders' proposed alternative uses of the site. From the list of experts generated, we then selected a nonprobability sample of 16 experts to comment on the stakeholders' proposed uses in each of the five broad categories. Specifically, there were five expert perspectives in the nuclear category, three in the defense category, three in the information technology category, five in the energy category, and three in the research category. (Since some of the experts could provide expertise in more than one category, these sum up to more than 16.) We created and used a structured data collection instrument to elicit comments from the experts on each proposed

alternative use. Specifically, we asked experts to provide information on whether the proposed alternative uses would utilize the site's characteristics; the benefits of, challenges to, and costs of the uses; the criticality of Yucca Mountain's characteristics to the uses; and the experts' overall opinions on the uses. We compiled and analyzed the provided information. Appendix III lists the experts we consulted. The scope of our work did not include asking experts to evaluate the benefits of not using the site for any use; moreover, no one we contacted for proposals documented a proposal that the site not be used.

To identify the statutory, regulatory, and other challenges that would have to be addressed to pursue alternative uses, we reviewed relevant laws, regulations, and guidance. We interviewed agency officials from DOE, including officials from the Nevada Site Office, the former Office of Civilian Radioactive Waste Management, and the Office of General Counsel. We also interviewed federal officials from the U.S. Nuclear Regulatory Commission, BLM, U.S. Fish and Wildlife Service, the Department of the Interior's Solicitor's Office, and the General Services Administration; state officials from Nevada, including officials from the Nevada Attorney General's office, the State of Nevada Agency for Nuclear Projects, Nevada Division of Environmental Protection, Nevada Department of Wildlife, and the Nevada State Engineer; and local officials from Nye and Clark Counties. We also consulted officials from federal agencies operating at the adjacent Nevada National Security Site, Nevada Test and Training Range, and BLM land to evaluate the extent to which any of the potential uses could conflict with current or anticipated missions at the sites. We used Geographic Information Systems data to determine the locations of mining claims on the Yucca Mountain site and compared them to the locations of the tunnels and other infrastructure on the site.

We conducted our work from October 2010 to September 2011 in accordance with all sections of GAO's Quality Assurance Framework that are relevant to our objectives. The framework requires that we plan and perform the engagement to obtain sufficient and appropriate evidence to meet our stated objectives and to discuss any limitations in our work. We believe that the information and data obtained, and the analysis conducted, provide a reasonable basis for any findings and conclusions in this product.

Appendix II: Concepts Proposed for Potential Alternative Uses of the Yucca Mountain Site Documented by GAO

Tables 1 through 5 provide a complete list of the alternative uses that were proposed by stakeholders we contacted, as well as examples of their benefits and challenges identified by experts we contacted.

Table 1: Proposed Alternative Uses of Yucca Mountain in the Nuclear Category

Proposed use	Description provided by stakeholder	Examples of potential benefits noted by experts	Examples of challenges noted by experts
Energy park	A commercial energy park for nuclear, solar, and wind power generation could be built on the site.	<ul style="list-style-type: none"> • Would help meet electricity demand • Would provide energy sources with low greenhouse gas emissions 	<ul style="list-style-type: none"> • High cost • Lack of water at site • Licensing and regulatory challenges
Interim storage of nuclear waste	The site could be used for centralized interim retrievable storage of spent nuclear fuel.	<ul style="list-style-type: none"> • Would benefit from past site characterization and licensing efforts • Would allow for underground storage of nuclear waste, which may be safer than above-ground storage 	<ul style="list-style-type: none"> • Issues and costs related to transporting waste to site • Public acceptance of use
Medical isotope production, using an accelerator	The site could be used to create medical isotopes through the use of electron accelerators.	Would help meet national need for medical isotopes	<ul style="list-style-type: none"> • Lack of proximity to hospitals or other locations where isotopes would be used; transportation time given the short half-lives of medical isotopes • High capital and operating cost
Medical isotope production, using a neutron generator	The site could be used to create medical isotopes through the use of neutron generators coupled with uranium blankets.	Would help meet national need for medical isotopes	<ul style="list-style-type: none"> • Lack of proximity to hospitals or other locations where isotopes would be used; transportation time given the short half-lives of medical isotopes • Questions about viability of technology; more proof of concept needed
Mixed waste treatment facility	The site could be used as a mixed waste treatment and research facility to conduct research into treating low- and mixed-level waste.	<ul style="list-style-type: none"> • Would help meet national need for waste disposal • Would benefit from some past site characterization efforts 	<ul style="list-style-type: none"> • Public acceptance of use • Licensing and regulatory challenges
Nuclear power generation	Nuclear power could be generated on the site.	<ul style="list-style-type: none"> • Would help meet electricity demand in country • Would provide an energy source with reduced greenhouse gas emissions 	<ul style="list-style-type: none"> • Lack of water at site • High cost to build facility and transmission lines • Licensing and regulatory challenges

**Appendix II: Concepts Proposed for Potential
Alternative Uses of the Yucca Mountain Site
Documented by GAO**

Proposed use	Description provided by stakeholder	Examples of potential benefits noted by experts	Examples of challenges noted by experts
Nuclear technologies research facility	The site could be used as a research facility for advanced nuclear technologies.	Some research needs would benefit from remote location	<ul style="list-style-type: none"> • May be difficult to staff facility with appropriate workforce • Redundant facilities are currently located elsewhere, such as Idaho National Laboratory
Nuclear waste reprocessing	The site could be used for nuclear waste reprocessing and research, with the existing facilities used for temporary storage of nuclear waste throughout reprocessing.	<ul style="list-style-type: none"> • Would benefit from some past site characterization efforts • Would make use of underground infrastructure for interim waste storage 	<ul style="list-style-type: none"> • Extremely high cost • Lack of water at site • Public acceptance of use
Research reactor	A high-temperature nuclear reactor for research and power could be built on the site.	<ul style="list-style-type: none"> • Would provide new energy sources of potential benefit to the country • Would benefit from some past site characterization and modeling efforts 	<ul style="list-style-type: none"> • New custom design for reactor would be needed, which is currently only in the conceptual phase • Cost • Public acceptance of use
Underground nuclear reactor	An air-cooled underground nuclear reactor could be built on the site.	<ul style="list-style-type: none"> • Would provide new energy sources of potential benefit to the country • In the event of a nuclear accident, underground location may be safer than above-ground 	<ul style="list-style-type: none"> • Cost • Licensing and regulatory issues • Limited applicability at other sites

Source: GAO summary of information provided by stakeholders and experts.

**Appendix II: Concepts Proposed for Potential
Alternative Uses of the Yucca Mountain Site
Documented by GAO**

Table 2: Proposed Alternative Uses of Yucca Mountain in the Defense and Homeland Security Category

Proposed use	Description provided by stakeholder	Examples of Potential Benefits noted by Experts	Examples of Challenges noted by Experts
Command and control facility	The site could house a command and control or communications facility for continuity of operations.	<ul style="list-style-type: none"> • Would provide redundancy for command and control facilities throughout the country • Would benefit from the security and remoteness of site, which could help prevent security breaches • In the event of a large-scale nuclear attack, underground location could increase survivability 	<ul style="list-style-type: none"> • Would need significantly more infrastructure than currently available at the site • Limited water, data, and communications infrastructure currently available at the site would limit use • Remote location would be a challenge for continuous staffing of such a facility
Command center for unmanned aerial vehicles	The U.S. Air Force's command center for unmanned aerial vehicles could be relocated from Creech Air Force Base.	Would benefit from security of site, which will be important in the future given that use of unmanned aerial vehicles is likely to increase	<ul style="list-style-type: none"> • High cost • Redundant facilities are currently located elsewhere at existing military bases
Homeland security activities	The site could be used for homeland security activities, such as a Center of Excellence, training facility, or demonstration facility.	<ul style="list-style-type: none"> • Would provide the ability to test in both confined and open spaces • Would provide national security benefits • Would allow multiple tests to be carried out simultaneously 	<ul style="list-style-type: none"> • Remote location would be a challenge for staffing of facilities • Costs of additional tunneling for geophysical experiments
Testing and training of the Active Denial System weapon	The site could be used for testing and training of the Active Denial System, a nonlethal, directed-energy weapon. The weapon may be used as a crowd-control device, which works by beaming microwave radiation, causing intense pain—but no damage—to people.	<ul style="list-style-type: none"> • The tunnel would provide a controlled way to test numerous constrained conditions with low risk • Due to the extensive tunnels and shielding of the surrounding rock, multiple tests could be run 	<ul style="list-style-type: none"> • Potential risks associated with use of such a device represent a significant risk of liability, as the system can be lethal in some situations • Depending on the characteristics of the beam and interaction with the tunnel, the human effects might be more damaging than in an open environment

**Appendix II: Concepts Proposed for Potential
Alternative Uses of the Yucca Mountain Site
Documented by GAO**

Proposed use	Description provided by stakeholder	Examples of Potential Benefits noted by Experts	Examples of Challenges noted by Experts
Testing of active interrogators	The site could be used to operate linear accelerators to characterize and test active interrogation systems, which generate x-rays, neutrons, or other types of particles to detect and identify nuclear or other dense materials. These systems would generate x-rays, neutrons, or other types of particles to detect and identify nuclear or radioactive materials or other highly dense materials within target objects, such as shipping containers or trailers.	<ul style="list-style-type: none"> • Would provide national security benefits, including combating weapons of mass destruction and improving tracking of nuclear material • The shielding provided by the mountain would provide for the safety of the testing organization and offer the necessary security given the sensitive nature of the operation 	<ul style="list-style-type: none"> • Issues and costs related to transportation of materials to site • Some additional infrastructure would be needed
Training site for first responders	The site could be used for training and testing for first responder and emergency management activities, such as using the site for training the chemical, biological, radiological, and high explosive units from the Las Vegas, Nevada, metropolitan police.	<ul style="list-style-type: none"> • Would provide security and emergency response benefits • The shielding and containment offered by tunnel could facilitate training with nuclear materials • Would allow responses that take place in an underground environment, such as a subway, to be simulated 	<ul style="list-style-type: none"> • The enclosed space limits some testing/training options • Challenges with extrapolating the experience in the tunnels to other more open or urban settings, which is where most first responses take place

Source: GAO summary of information provided by stakeholders and experts.

**Appendix II: Concepts Proposed for Potential
Alternative Uses of the Yucca Mountain Site
Documented by GAO**

Table 3: Proposed Alternative Uses of Yucca Mountain in the Information Technology Category

Proposed use	Description provided by stakeholder	Examples of potential benefits noted by experts	Examples of challenges noted by experts
Public emergency communications site	The site could house public emergency communications for public entities in the western states, or a private branch exchange switching site for emergency responders, in the case that commercial stations in Las Vegas, Nevada, or the western states were lost.	<ul style="list-style-type: none"> • The potential for high security of site could allow a facility to be quickly established • Proximity to a major internet hub in Las Vegas could provide more flexible data transmission options 	<ul style="list-style-type: none"> • Distance from Las Vegas, where presumably most first responders would be • Challenges in trying to broadcast from within a submerged rock tunnel
Secure data storage	The site could be used as a data center/colocation facility to house classified digital material from the federal government.	<ul style="list-style-type: none"> • Would benefit from the security of site, which would meet the needs of a facility housing classified digital material • Proximity to a major internet hub could provide more flexible data transmission options • Would provide cost savings if classified data sets that are now managed separately could be consolidated 	<ul style="list-style-type: none"> • Risks and vulnerabilities should the infrastructure fail or be attacked • Minimal data and communications infrastructure at the site would need to be significantly upgraded
Secure paper document storage	The site could be used for storing and protecting critical paper documents, as well as critical electronic data, to ensure that they are not lost in an emergency.	Would benefit from the security and remoteness of site	Unclear whether the physical environment of the tunnel is appropriate for long-term document storage

Source: GAO summary of information provided by stakeholders and experts.

**Appendix II: Concepts Proposed for Potential
Alternative Uses of the Yucca Mountain Site
Documented by GAO**

Table 4: Proposed Alternative Uses of Yucca Mountain in the Energy Development or Storage Category

Proposed use	Description provided by stakeholder	Examples of potential benefits noted by experts	Examples of challenges noted by experts
Compressed air storage	The tunnel on the site could be used for storage of air compressed using solar- or wind-generated power during times of surplus electricity generation. The compressed air would later be released through a turbine to generate electricity when demand increases.	<ul style="list-style-type: none"> • Would help meet need for research into compressed air storage • Would benefit from the controlled and controllable nature of the site's cavities, which likely make it one of the only sites where research like this could be performed in a relatively controlled and modular environment 	<ul style="list-style-type: none"> • Unclear how applicable the research would be to other sites in the world, given the site's uniqueness • Permeability of the rock in the tunnel would require sealing • Seismic concerns may affect this use, since the tunnel would need to be airtight
Facility to support renewable energy	The site could be used for research into renewable energy sources or carbon capture.	<ul style="list-style-type: none"> • Would help meet need for additional research on renewable energy technologies and commercial advancement • Would provide abundant space for solar energy and other equipment 	<ul style="list-style-type: none"> • High cost to build transmission lines • No benefits of site over other sites for carbon capture research
Geothermal energy development	The site could be used for geothermal energy development in hot dry rock.	<ul style="list-style-type: none"> • Would help meet need for additional research into geothermal energy, and hot dry rock in particular • Would benefit from the site's remoteness because of the substantial drilling operations that would need to occur for this use 	<ul style="list-style-type: none"> • Site is not located in an area of major geothermal activity • Remoteness would limit utility of site • High upfront costs
Pumped hydroelectric energy storage	The site could be used for pumped hydroelectric energy storage. Water would be pumped from a lower reservoir to an upper reservoir when there is surplus electricity; the water would then be released back through a turbine to generate electricity when demand increases.	<ul style="list-style-type: none"> • Would provide a unique demonstration project for a technology • Would make use of the tunnel, which could serve as the lower reservoir 	<ul style="list-style-type: none"> • Access to water • Significant environmental impacts of application • Requires nearby renewable energy production

**Appendix II: Concepts Proposed for Potential
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Proposed use	Description provided by stakeholder	Examples of potential benefits noted by experts	Examples of challenges noted by experts
Renewable energy storage laboratory	The site could be used for research into compressed air and pumped hydroelectric energy storage. The tunnel could serve as a pressurized chamber for compressed air technologies or a reservoir for pumped hydroelectric storage.	<ul style="list-style-type: none"> • Would help meet a need for research into storage of renewable energy • Would benefit from past site characterization efforts on water flow through volcanic tuff 	<ul style="list-style-type: none"> • High costs • Experimental technology with limited application
Solar energy development	The site could be used to generate power from solar energy.	<ul style="list-style-type: none"> • Would benefit from the availability of land at the site • Would contribute to research and development of solar energy 	<ul style="list-style-type: none"> • Ruggedness of terrain may not be well-suited for solar energy development • Lack of transmission lines and distance from population base to use electricity
Strategic petroleum reserve	The site could be used as a strategic petroleum reserve for the western part of the country.	<ul style="list-style-type: none"> • Would enhance nation's energy security • May provide a buffer against supply fluctuations in the petroleum market 	<ul style="list-style-type: none"> • Tunnel is not large enough to hold a significant amount of petroleum, given current rates of consumption • Transporting petroleum to the site

Source: GAO summary of information provided by stakeholders and experts.

**Appendix II: Concepts Proposed for Potential
Alternative Uses of the Yucca Mountain Site
Documented by GAO**

Table 5: Proposed Alternative Uses of Yucca Mountain in the Scientific Research Category

Proposed use	Description provided by stakeholder	Examples of potential benefits noted by experts	Examples of challenges noted by experts
Geological laboratory and sample storage	The tunnel on the site could be used as a geologic laboratory to manage geologic samples.	<ul style="list-style-type: none"> • Would benefit from underground areas' large storage capacity • Rare, valuable, or delicate samples would benefit from the site's security 	Remoteness of site would make it difficult to transport and access samples
Highly-infectious disease research facility	The site could serve as a center for research into highly infectious disease.	<ul style="list-style-type: none"> • Would help meet the need for research in this area, which is of vital interest to scientists and those concerned with national security • Would benefit from remoteness and security of facility 	<ul style="list-style-type: none"> • Remote location would present challenges to collaboration among scientists as well as finding a skilled workforce • Public reaction to use
Mining research and education	The site could be used by a university to teach mining techniques.	<ul style="list-style-type: none"> • Would make use of the tunnel, which would provide large and accessible entry to a subsurface environment • Would provide an excellent environment for mining education and training 	<ul style="list-style-type: none"> • Little need for mining education and training • Remote location would be a challenge for access to the site
Scientific and university research	The tunnel and surrounding area could house large accelerators that would be used to explore the electronic and atomic structure of matter. This research could apply to a variety of areas, including conversion of solar energy, battery efficiency and storage, and pollution control.	<ul style="list-style-type: none"> • Would help meet a substantial research need • Shielding of tunnel and remote location could offer benefits to this use 	<ul style="list-style-type: none"> • Tunnels may not offer the specific geometry needed for accelerators • Remote location would present challenges to collaboration • High cost

Source: GAO summary of information provided by stakeholders and experts.

Appendix III: List of Experts GAO Consulted

- Thomas B. Cochran, Ph.D.
Senior Scientist, Nuclear Program, Natural Resources Defense Council
- John S. Crockett, Ph.D.
Director, Research Project Development, San Diego State University Research Foundation
- Pamela Drew, Ph.D.
Senior Vice President, TASC
- Donald Gibson, Ph.D.
Vice President, TASC
- Herb Hayden, PE
Chief Technical Officer, Southwest Solar Technologies, Inc.
- Andrew C. Kadak, Ph.D.
Director, Nuclear Services, Exponent, Inc.
- Joel Kurtzman, M.S.
Executive Director, Center for a Sustainable Energy Future, Milken Institute
- Tom LaTourrette, Ph.D.
Senior Physical Scientist, RAND Corporation
- Herb Lin, Ph.D.
Chief Scientist, Computer Science and Telecommunications Board, National Research Council of the National Academies
- Jane C. S. Long, Ph.D.
Associate Director at Large, Lawrence Livermore National Laboratory
- Brian B. Looney, Ph.D.
Senior Advisory Engineer, Savannah River National Laboratory
- S. Andrew Orrell
Director, Nuclear Energy & Fuel Cycle Programs, Sandia National Laboratories
- Don Steeples, Ph.D.
McGee Distinguished Professor of Geophysics, University of Kansas

- Ben K. Sternberg, Ph.D.
Professor, Geological & Geophysical Engineering and Electrical & Computer Engineering, and Director, Laboratory for Advanced Subsurface Imaging, University of Arizona
- Darrell M. West, Ph.D.
Vice President and Director of Governance Studies, and Director of the Center for Technology Innovation, Brookings Institution
- Chris G. Whipple, Ph.D.
Principal, Environ

Appendix IV: Description of Buildings and Facilities on the Yucca Mountain Site

Table 6 lists the buildings and facilities that are currently at the Yucca Mountain site.

Table 6: Description of Buildings and Facilities at the Yucca Mountain Site

Facility	Description	Year built	Dimensions
Change House, Exploratory Studies Facilities North Portal	Steel frame with interior shear walls	1997	12,250 square feet
Switchgear Exploratory Studies Facilities North Portal	Light frame steel	1998	7,750 square feet
Booster Station Pump Enclosure	Steel braced frame	2007	804 square feet
Office Trailer, Management and Operating Contractor Complex	Light steel frame	1987	10,080 square feet
Office Trailer, Quality Control Field Office	Light steel frame	1993	1,440 square feet
Office trailer for construction team	Light steel frame	1983	3,600 square feet
Booster Tank, Yucca Mountain Project water supply	Water supply for pumping and treatment	1999	20,000 gallons
Booster Tank, Yucca Mountain Project water supply	Water supply for pumping and treatment	1999	20,000 gallons
Exile Hill Water tank	Water supply for pumping and treatment	1999	200,000 gallons
Potable Water tank	Water supply for pumping and treatment	1999	50,000 gallons
Warehouse, tent #1	Sprung Instant Structures	1995	13,290 square feet
Craft shops, tent #2	Rupp Instant Structure	1996	13,500 square feet
Sub Surface Power Center	Substation, transmission, and distribution	1995	25,918 KVA
Access roads	Roads, walks, and paved areas	1990	30 miles
Sanitary sewer system	Effluent disposal system with piping	1996	6,092 feet
Surface electrical system	Electrical transmission and distribution	1990	1 system
Water distribution	Water supply, pumping, treatment, and distribution	1996	35,948 feet

Source: GAO analysis of DOE data.

Appendix V: Comments from the Department of Energy



Department of Energy
National Nuclear Security Administration
Washington, DC 20585



September 8, 2011

Mr. Gene Aloise
Director
Natural Resources and Environment
Government Accountability Office
Washington, DC 20458

Dear Mr. Aloise:

The Department of Energy (Department) and National Nuclear Security Administration (NNSA) appreciates the opportunity to review the Government Accountability Office's (GAO) report, *YUCCA MOUNTAIN Information on Alternative Uses of the Site and Related Challenges*, GAO-11-847. At the request of Senator Harry Reid, GAO was asked to examine (1) the characteristics of the Yucca Mountain site; (2) stakeholders' proposed alternative uses, and experts' evaluations of those potential alternative uses; and (3) challenges, if any, in pursuing alternative uses.

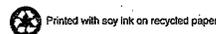
We are providing comments that we believe will help clarify and improve the report in areas that may be confusing or misleading.

If you have any questions concerning this response, please contact JoAnne Parker, Director, Office of Internal Controls, at 202-586-1913.

Sincerely,

Kenneth W. Powers
Associate Administrator
for Management and Budget

Enclosure



Appendix VI: Comments from the U.S. Nuclear Regulatory Commission



UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

September 8, 2011

Jon Ludwigson
Assistant Director
Natural Resources and Environment
U.S. Government Accountability Office
Denver Field Office
1244 Speer Blvd, Suite 800
Denver, CO 80204-3581

Dear Mr. Ludwigson:

Thank you for the opportunity to comment on the September 2011 draft of the U.S. Government Accountability Office (GAO) report "Yucca Mountain: Information on Alternative Uses of the Site and Related Challenges" (GAO-11-847). The U.S. Nuclear Regulatory Commission (NRC) has no significant comments regarding the technical accuracy of the GAO statement of facts as they relate to the NRC's role or activities. However, we have enclosed a few minor changes, which will clarify descriptions of NRC hearing activities and will correct the use of technical terminology. If we can be of further assistance, please do not hesitate to contact us.

Sincerely,

A handwritten signature in black ink that reads "R. W. Borchardt".

R. W. Borchardt
Executive Director
for Operations

Enclosure:
As stated

Appendix VII: GAO Contact and Staff Acknowledgments

GAO Contact

Frank Rusco, (202) 512-3841 or ruscof@gao.gov

Staff Acknowledgments

In addition to the individual named above, Jon Ludwigson, Assistant Director; Nabajyoti Barkakati; Kevin Bray; Lee Carroll; John Mingus; Alison O'Neill; Anne Rhodes-Kline; Lesley Rinner; Jena Sinkfield; and Jacqueline Wade made key contributions to this report. Also contributing to this report were Debra Cottrell, Anne Hobson, Richard P. Johnson, Thomas Laetz, and Jennifer Leone.

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