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2

Proposed Action and No-Action Alternative

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2. PROPOSED ACTION AND NO-ACTION ALTERNATIVE

Under the Proposed Action, the U.S. Department of Energy (DOE) would construct, operate and monitor, and eventually close a geologic repository for the disposal of spent nuclear fuel and high-level radioactive waste at Yucca Mountain (see Section 2.1). The Proposed Action includes transportation of spent nuclear fuel and high-level radioactive waste from commercial and DOE sites to the Yucca Mountain site (see Figure 2-1).

Under the No-Action Alternative (see Section 2.2), DOE would end site characterization activities at Yucca Mountain, and the commercial and DOE sites would continue to manage their spent nuclear fuel and high-level radioactive waste (see Figure 2-1). The No-Action Alternative assumes that spent nuclear fuel and high-level radioactive waste would be treated and packaged as necessary for its safe onsite management. DOE does not intend to represent the No-Action Alternative as a viable long-term solution but rather to use it as a baseline against which the Proposed Action can be evaluated.

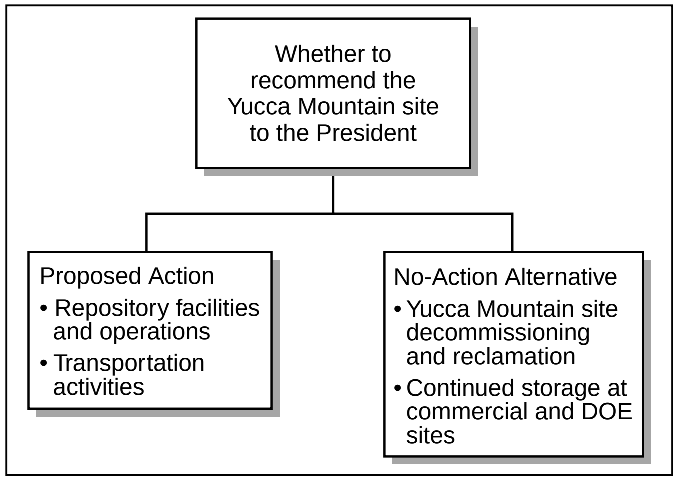


Figure 2-1. General activity areas evaluated under the Proposed Action and No-Action Alternative.

Section 2.3 discusses the alternatives that DOE considered but eliminated from detailed study in this environmental impact statement (EIS). Section 2.4 summarizes findings from the EIS and compares the potential environmental impacts of the Proposed Action and the No-Action Alternative. Section 2.5 addresses the collection of information and analyses performed for the EIS. Section 2.6 identifies the preferred alternative.

DOE has developed the information about the potential environmental impacts that could result from either the Proposed Action or the No-Action Alternative to inform the Secretary of Energy's determination whether to recommend Yucca Mountain as the site of this Nation's first monitored geologic repository for spent nuclear fuel and high-level radioactive waste.

As part of the Proposed Action, the EIS analyzes the impacts of transporting spent nuclear fuel and high-level radioactive waste to the Yucca Mountain site from 77 sites across the United States. This analysis includes information on such matters as the comparative impacts of truck and rail transportation, alternative intermodal (rail to truck) transfer station locations, associated heavy-haul truck routes, and alternative rail transport corridors in Nevada. Although it is uncertain at this time when DOE would make any transportation-related decisions, DOE believes that the EIS provides the information necessary to make decisions regarding the basic approaches (for example, mostly rail or mostly truck shipments), as well as the choice among alternative transportation corridors. However, follow-on implementing decisions, such as selection of a specific rail alignment within a corridor, or the specific location of an intermodal transfer station or the need to upgrade the associated heavy-haul routes, would require additional field surveys, state and local government consultations, environmental and engineering analyses, and National Environmental Policy Act reviews.

2.1 Proposed Action

DOE proposes to construct, operate and monitor, and eventually close a geologic repository at Yucca Mountain for the disposal of spent nuclear fuel and high-level radioactive waste. About 600 square kilometers (230 square miles or 150,000 acres) of land in Nye County, Nevada, could be permanently withdrawn from public access for DOE use for the repository (see Figure 2-2 for location of area). DOE would dispose of spent nuclear fuel and high-level radioactive waste in the repository using the inherent, natural geologic features of the mountain and engineered (manmade) barriers to ensure the long-term isolation of the waste from the human environment. DOE would build the repository inside Yucca Mountain between 200 and 425 meters (660 and 1,400 feet) below the surface and between 175 and 365 meters (570 and 1,200 feet) above the water table.

Under the Proposed Action, DOE would permanently place approximately 10,000 to 11,000 waste packages containing no more than 70,000 metric tons of heavy metal (MTHM) of spent nuclear fuel and high-level radioactive waste in the repository. Of the 70,000 MTHM to be emplaced in the repository, 63,000 MTHM would be spent nuclear fuel assemblies from boiling-water and pressurized-water reactors (Figure 2-3) that DOE would ship from commercial nuclear sites to the repository. The remaining 7,000 MTHM would consist of about 2,333 MTHM of DOE spent nuclear fuel and 8,315 canisters (4,667 MTHM) containing solidified high-level radioactive waste (see Figure 2-3) that the Department would ship to the repository from its facilities. The 70,000 MTHM inventory would include 50 metric tons (55 tons) of surplus weapons-usable plutonium as spent mixed-oxide fuel or immobilized plutonium. Appendix A contains additional information on the inventory and characteristics of spent nuclear fuel, high-level radioactive waste, and other materials that DOE could emplace in the proposed repository. For this EIS, a connected action includes the offsite manufacturing of the containers that DOE would use for the transport and disposal of spent nuclear fuel and high-level radioactive waste.

**DEFINITION OF
METRIC TONS OF HEAVY METAL**

Quantities of spent nuclear fuel are traditionally expressed in terms of *metric tons of heavy metal* (typically uranium), without the inclusion of other materials such as cladding (the tubes containing the fuel) and structural materials. A metric ton is 1,000 kilograms (1.1 tons or 2,200 pounds). Uranium and other metals in spent nuclear fuel (such as thorium and plutonium) are called *heavy metals* because they are extremely dense; that is, they have high weights per unit volume. One metric ton of heavy metal disposed of as spent nuclear fuel would fill a space approximately the size of a typical household refrigerator.

Figure 2-4 is an overview of components or activities associated with the Proposed Action. The implementing alternatives and scenarios analyzed in this EIS, as described in Section 2.1.1, represent the potential range of variables associated with implementing the Proposed Action that could affect environmental impacts. The Proposed Action would require surface and subsurface facilities and operations for the receipt, packaging, and emplacement of spent nuclear fuel and high-level radioactive waste (see Section 2.1.2) and transportation of these materials to the repository (see Section 2.1.3). Section 2.1.4 summarizes the estimated cost of the Proposed Action. Chapters 4, 5, and 6 evaluate potential environmental impacts from the Proposed Action. As part of the process to develop implementing concepts, mitigation techniques have been designed into the Proposed Action through the use of best engineering and management practices, as applicable.

The Proposed Action would use two types of institutional controls—active and passive. Active institutional controls (monitored and enforced limitations on site access; inspection and maintenance of waste packages, facilities, equipment, etc.) would be used through closure. Passive institutional controls (markers, engineered barriers, etc., that are not monitored or maintained) would be put in place during closure and used to minimize inadvertent exposures to members of the public in the future.

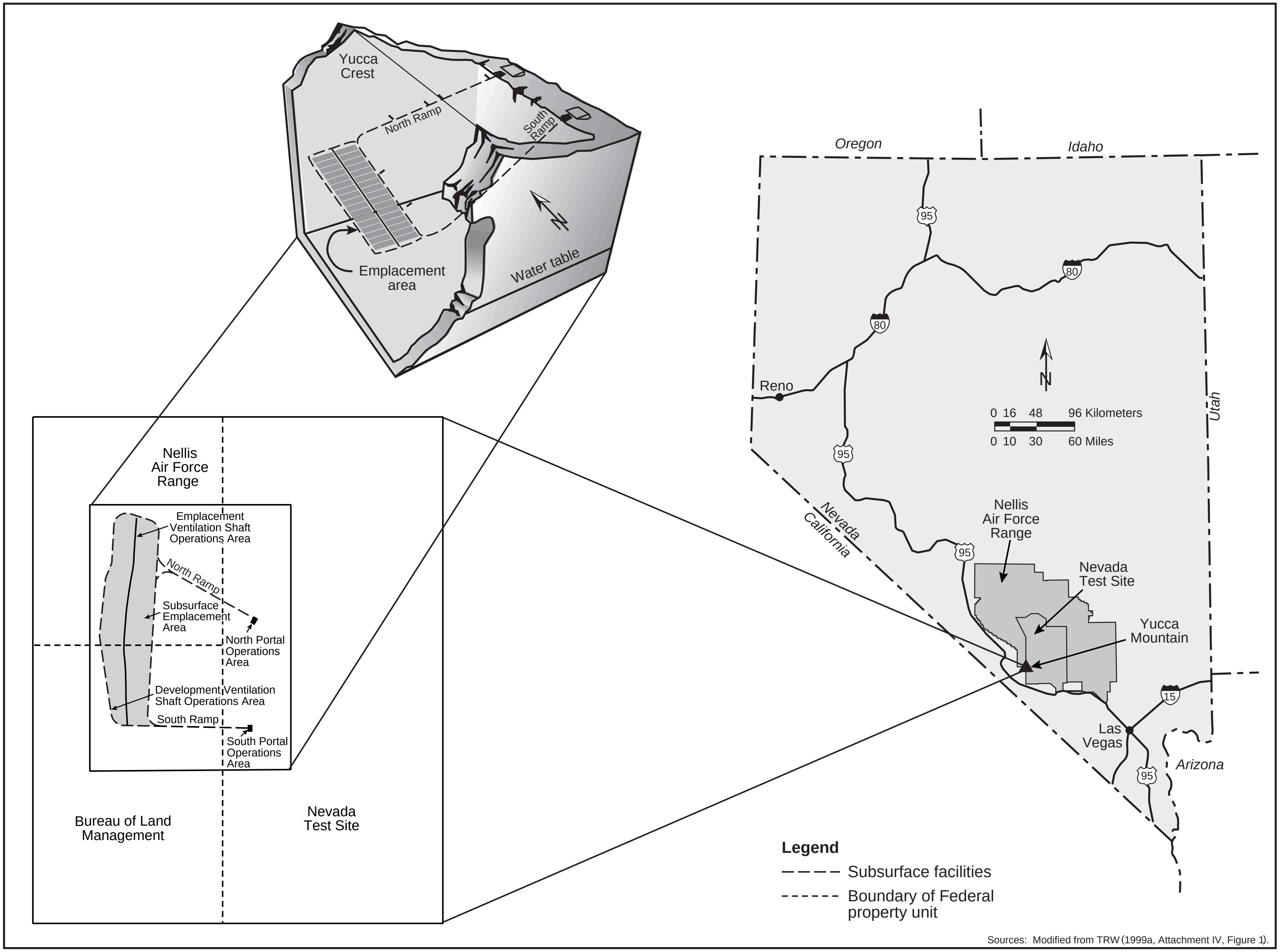
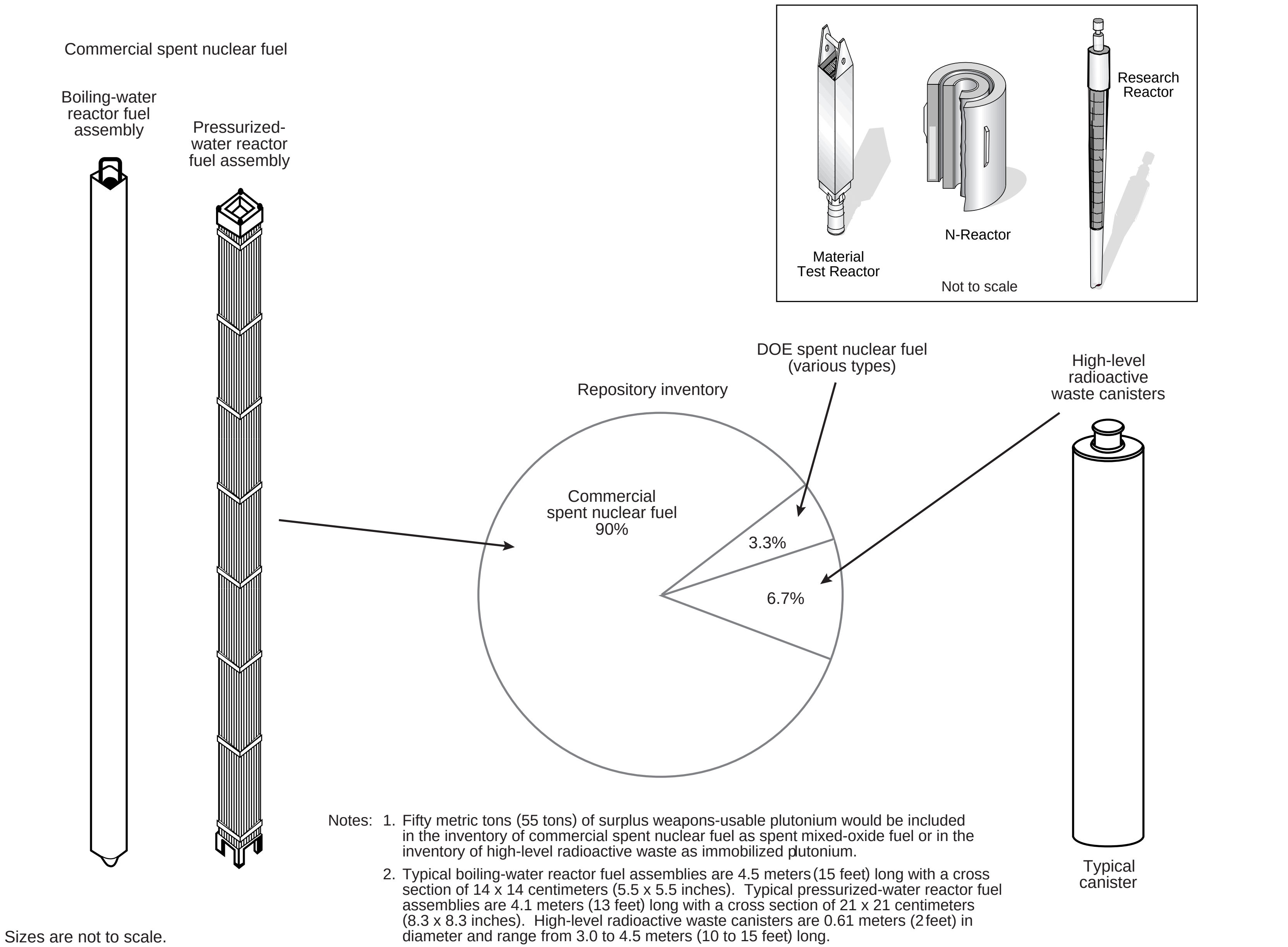


Figure 2-2. Diagram and location of the proposed repository at Yucca Mountain.



Notes: 1. Fifty metric tons (55 tons) of surplus weapons-usable plutonium would be included in the inventory of commercial spent nuclear fuel as spent mixed-oxide fuel or in the inventory of high-level radioactive waste as immobilized plutonium.

2. Typical boiling-water reactor fuel assemblies are 4.5 meters (15 feet) long with a cross section of 14 x 14 centimeters (5.5 x 5.5 inches). Typical pressurized-water reactor fuel assemblies are 4.1 meters (13 feet) long with a cross section of 21 x 21 centimeters (8.3 x 8.3 inches). High-level radioactive waste canisters are 0.61 meters (2 feet) in diameter and range from 3.0 to 4.5 meters (10 to 15 feet) long.

Figure 2-3. Sources of spent nuclear fuel and high-level radioactive waste proposed for disposal at the Yucca Mountain Repository.

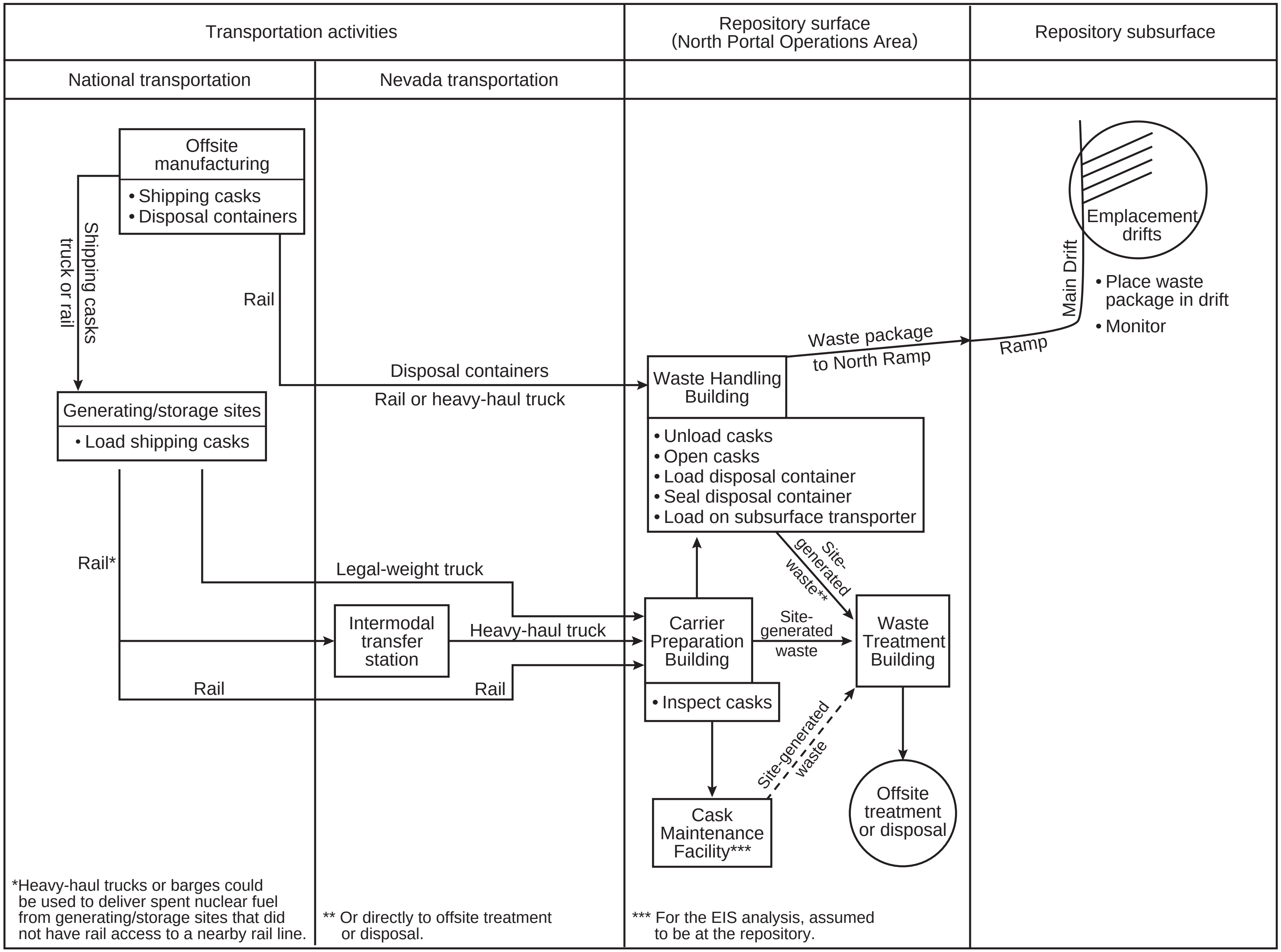


Figure 2-4. Overview flowchart of the Proposed Action.

2.1.1 OVERVIEW OF IMPLEMENTING ALTERNATIVES AND SCENARIOS

This EIS describes and evaluates the current preliminary design concept for repository surface facilities, subsurface facilities, and disposal containers (waste packages), and the current plans for the construction, operation and monitoring, and closure of the repository. DOE recognizes that plans for the repository would continue to evolve during the development of the final repository design and as a result of the U.S. Nuclear Regulatory Commission licensing review of the repository. In addition, decisions on how spent nuclear fuel and high-level radioactive waste would be shipped to the repository (for example, truck or rail) and how spent nuclear fuel would be packaged (uncanistered or in disposable or dual-purpose canisters) would be part of future transportation planning efforts.

For these reasons, DOE developed implementing alternatives and analytical scenarios to bound the environmental impacts likely to result from the Proposed Action (see Figure 2-5). The Department selected the implementing alternatives and scenarios to accommodate and maintain flexibility for potential future revisions to the design and plans for the repository. Because of uncertainties, DOE selected implementing alternatives and scenarios that incorporate conservative assumptions that tend to overstate the risks to address those uncertainties.

The following paragraphs describe the packaging scenarios, thermal load scenarios, national transportation scenarios, Nevada transportation scenarios, and implementing rail and intermodal alternatives evaluated in the EIS. In addition, these paragraphs discuss the continuing investigation of options DOE is considering for the repository design at the next major program milestones (that is, Site Recommendation and License Application).

DOE will evaluate future repository design revisions in accordance with its regulations for implementing the National Environmental Policy Act (10 CFR 1021.314) to determine if there are substantial changes in the proposal or significant new circumstances or information relevant to environmental concerns. Based on these regulations, DOE will determine whether it will conduct further National Environmental Policy Act reviews.

2.1.1.1 Packaging Scenarios

DOE operations at repository surface facilities would differ depending on how the spent nuclear fuel in shipping casks was packaged. Commercial spent nuclear fuel could be received either uncanistered or in disposable or dual-purpose canisters.

The EIS assumes that DOE spent nuclear fuel and high-level radioactive waste would be shipped to the repository in disposable canisters. In addition, it evaluates the following packaging scenarios for commercial spent nuclear fuel to cover the potential range of environmental impacts from repository surface facility construction and operation:

- A mostly uncanistered fuel scenario
- A mostly canistered fuel scenario that includes:
  - Disposable canisters
  - Dual-purpose canisters

Table 2-1 summarizes these scenarios.

DISPOSAL CONTAINERS AND WASTE PACKAGES

A *disposal container* is the vessel consisting of the barrier materials and internal components in which the spent nuclear fuel and high-level radioactive waste would be placed. The filled, sealed, and tested disposal container is referred to as the *waste package*, which would be emplaced in the repository.

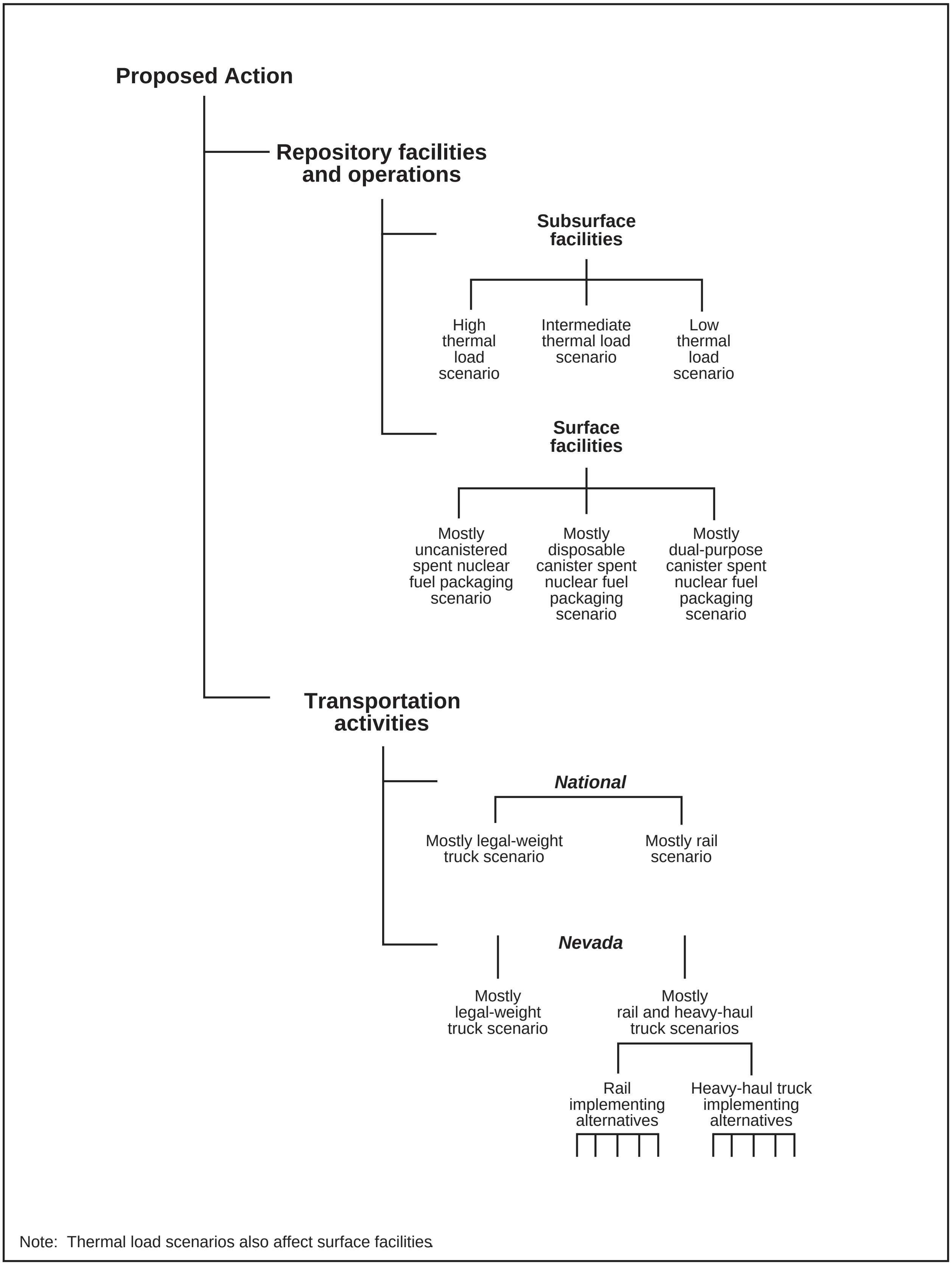


Figure 2-5. Analytical scenarios and implementing alternatives associated with the Proposed Action.

Table 2-1. Packaging scenarios (percentage based on number of shipments).

Material[a]	Mostly uncanistered fuel	Mostly canistered fuel: Disposable canister	Mostly canistered fuel: Dual-purpose canister
Commercial SNF	100% uncanistered fuel	About 80% disposable canisters; about 20% uncanistered fuel	About 80% dual-purpose canisters; about 20% uncanistered fuel
HLW	100% disposable canisters	100% disposable canisters	100% disposable canisters
DOE SNF	100% disposable canisters	100% disposable canisters	100% disposable canisters

a. SNF = spent nuclear fuel; HLW = high-level radioactive waste.

DEFINITIONS OF PACKAGING TERMS

Shipping cask: A thick-walled vessel that meets applicable regulatory requirements for shipping spent nuclear fuel or high-level radioactive waste.

Canister: A thin-walled metal vessel used to hold spent nuclear fuel assemblies or solidified high-level radioactive waste.

Dual-purpose canister: A canister suitable for storing (in a storage facility) and shipping (in a shipping cask) spent nuclear fuel assemblies. At the repository, dual-purpose canisters would be removed from the shipping cask and opened. The spent nuclear fuel assemblies would be removed from the canister and placed in a disposal container. The opened canister would be recycled or disposed of offsite as low-level radioactive waste.

Disposable canister: A canister for spent nuclear fuel assemblies or solidified high-level radioactive waste suitable for storage, shipping, and disposal. At the repository, the disposable canister would be removed from the shipping cask and placed directly in a disposal container.

Uncanistered spent nuclear fuel: Fuel placed directly into storage canisters or shipping casks without first being placed in a canister. At the repository, spent nuclear fuel assemblies would be removed from the shipping cask and placed in a disposal container.

Disposal container: A container for spent nuclear fuel and high-level radioactive waste consisting of the barrier materials and internal components. The filled, sealed, and tested disposal container is referred to as the *waste package*, which would be emplaced in the repository.

Waste package: The filled, sealed, and tested disposal container that would be emplaced in the repository.

2.1.1.2 Thermal Load Scenarios

The heat generated by spent nuclear fuel and high-level radioactive waste (the thermal load) could affect the long-term performance of the repository (that is, the ability of the engineered and natural barrier systems to isolate the emplaced waste from the human environment). Different thermal loads would have a direct effect on internal and external waste package temperatures, thereby potentially affecting the corrosion rate and integrity of the waste package. The heat generated by the waste packages would also affect the geochemistry, hydrology, and mechanical stability of the emplacement drifts, which in turn would influence the flow of groundwater and the transport of radionuclides from the engineered and natural barrier systems to the environment. The thermal load would depend on factors related to the design of the repository including, but not limited to, the age of the spent nuclear fuel at the time of emplacement, the spacing of the emplacement drifts and the waste packages in them, the repository ventilation, and the decision on whether to backfill the emplacement drifts.

DOE evaluated three thermal load scenarios. These scenarios include a relatively high emplacement density of spent nuclear fuel and high-level radioactive waste (high thermal load – 85 MTHM per acre), a relatively low emplacement density (low thermal load – 25 MTHM per acre), and an emplacement density between the high and low thermal loads (intermediate thermal load – 60 MTHM per acre). The additional spacing required for the lower thermal loads would increase the subsurface area and the amount of excavation. In addition, the different thermal loads would affect the area requirements for the excavated rock pile on the surface.

2.1.1.3 National Transportation Scenarios

The national transportation scenarios evaluated in this EIS encompass the transportation options or modes (legal-weight truck and rail) that are practical for DOE to use to ship spent nuclear fuel and high-level radioactive waste from the commercial and DOE sites to the Yucca Mountain site. DOE would use both legal-weight truck and rail transportation, and would determine the number of shipments by either mode as part of future transportation planning efforts. Therefore, the EIS evaluates two national transportation scenarios (mostly legal-weight truck and mostly rail) that cover the possible range of transportation impacts to human health and the environment.

TERMS ASSOCIATED WITH TRANSPORTATION

Legal-weight trucks have a gross vehicle weight (both truck and cargo weight) of less than 36,300 kilograms (80,000 pounds), which is the loaded weight limit for commercial vehicles operated on public highways without special state-issued permits. In addition, the dimensions, axle spacing, and, if applicable, axle loads of these vehicles must be in compliance with Federal and state regulations.

An **intermodal transfer station** is a facility for transferring freight from one transportation mode to another (for example, from railcar to truck). In this EIS, intermodal transfer station refers to a facility DOE would use to transfer rail shipping casks containing spent nuclear fuel or high-level radioactive waste from railcars to heavy-haul trucks, and to transfer empty rail shipping casks from heavy-haul trucks to railcars.

Heavy-haul trucks are overweight, overdimension vehicles that must have permits from state highway authorities to use public highways. In this EIS, heavy-haul trucks refers to vehicles DOE would use on public highways to move spent nuclear fuel or high-level radioactive waste shipping casks designed for a railcar.

2.1.1.4 Nevada Transportation Scenarios and Rail and Intermodal Implementing Alternatives

The transportation of spent nuclear fuel and high-level radioactive waste to the proposed repository would affect all the states through which the shipments would travel, including Nevada. However, to highlight the impacts that could occur in Nevada, DOE has chosen to discuss them separately. DOE is looking at three transportation scenarios for Nevada. These scenarios include legal-weight truck and rail, which are the same as the national scenarios but highlight the Nevada portion of the transportation, and heavy-haul truck. The heavy-haul truck scenario includes the construction of an intermodal transfer station with associated highway improvements for heavy-haul trucks in the State. DOE has identified five potential rail corridors leading to Yucca Mountain and three potential intermodal transfer station locations with five associated potential highway routes for heavy-haul trucks. Section 2.1.3.3 describes these implementing alternatives.

2.1.1.5 Continuing Investigation of Design Options

As noted, this EIS describes and evaluates the current preliminary design concept for the repository and current plans for repository construction, operation and monitoring, and closure (see Section 2.1.2). DOE continues to investigate design options for possible incorporation in the final repository design; Appendix E identifies design features and alternative design concepts that DOE is considering for the final design (for example, smaller waste packages, a waste package design using two corrosion-resistant materials, and a long-term ventilated repository). The criteria for selecting these design options are related to improving or reducing uncertainties in repository performance (the potential to provide containment and isolation of radionuclides) and operation (for example, worker and operational safety, ease of operation).

DOE has assessed each of the design options still being considered for the expected change it would have on short- and long-term environmental impacts and has compared these impacts to the potential impacts determined for the packaging, thermal load, and transportation scenarios evaluated in the EIS. This assessment, which is described in Appendix E, found that the changes in environmental impacts for the design options would be relatively minor in relation to the potential impacts evaluated in this EIS. Therefore, DOE has concluded that the analytical scenarios and implementing alternatives evaluated in this EIS provide a representative range of potential environmental impacts the Proposed Action could cause. Chapter 9 discusses mitigation from design options that could be beneficial in reducing impacts associated with repository performance or operation.

2.1.2 REPOSITORY FACILITIES AND OPERATIONS

This section describes proposed repository surface and subsurface facilities and operations (Sections 2.1.2.1 and 2.1.2.2), repository closure (Section 2.1.2.3), and the performance confirmation program (Section 2.1.2.4). The description is based on TRW (1999a, all), TRW (1999b, all), and TRW (1999c, all), unless otherwise noted. The following paragraphs contain an overview of the repository facilities and operations and the sequence of planned repository construction, operation and monitoring, and closure. DOE would design the repository based on the extensive information collected during the Yucca Mountain site characterization activities. These activities are summarized in semiannual site characterization reports. [See the semiannual Site Characterization Progress Reports that the Department prepares in accordance with Section 113(b)(3) of the NWPA (for example, DOE 1991a, all).] The facilities used for site characterization activities at Yucca Mountain would be incorporated in the repository design to the extent practicable. (See Chapter 3, Section 3.1, for additional information on existing facilities at Yucca Mountain developed during site characterization activities.)

DOE would construct surface facilities at the repository site to receive, prepare, and package spent nuclear fuel and high-level radioactive waste for underground emplacement. In addition, surface facilities would support the construction of subsurface facilities. These facilities include the following primary surface operations areas:

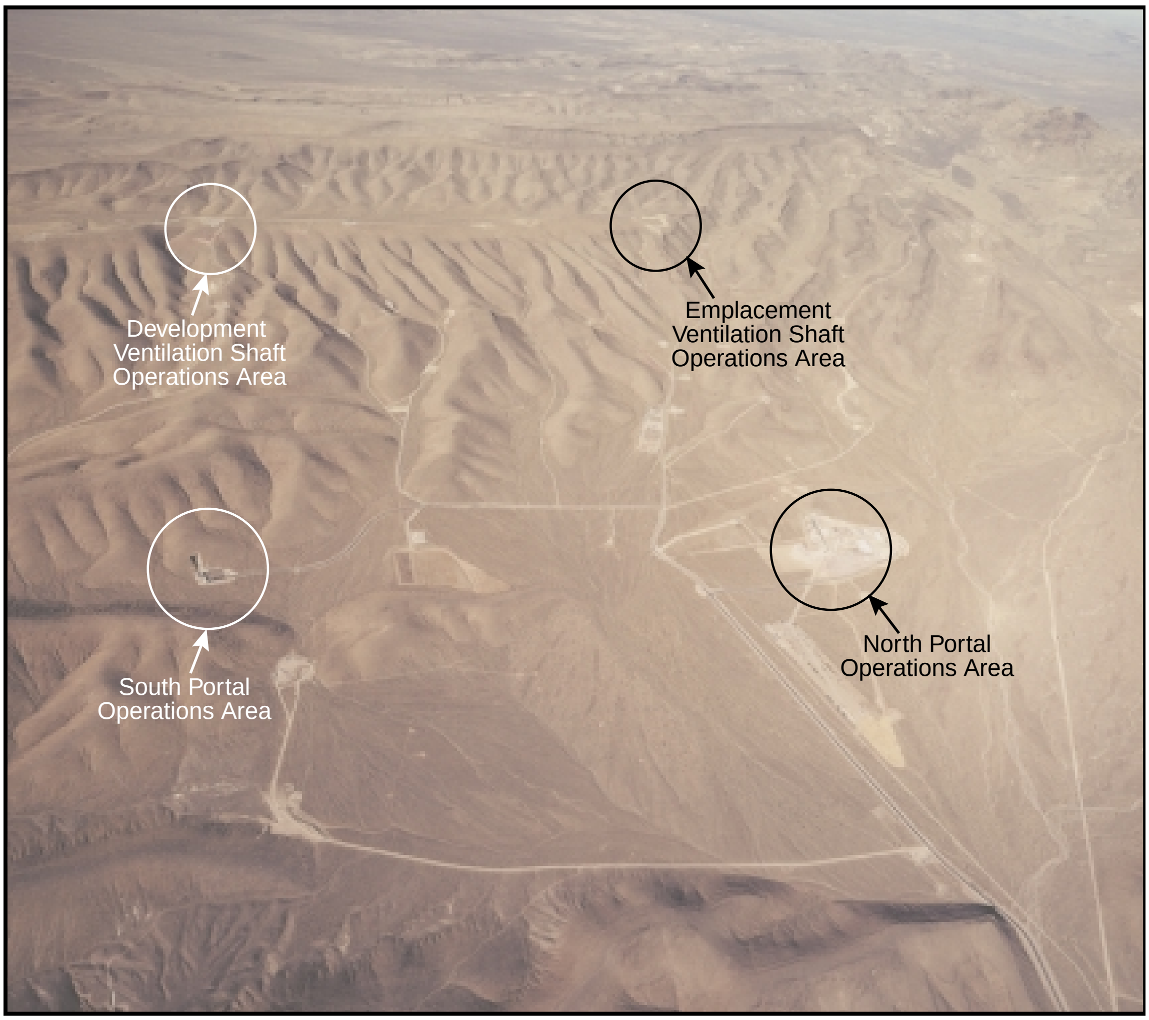
- North Portal Operations Area – Receive, prepare, and package spent nuclear fuel and high-level radioactive waste for underground emplacement

- South Portal Operations Area – Support the construction of subsurface facilities

- Emplacement Ventilation Shaft Operations Area – Exhaust air from the subsurface facilities where waste packages would be emplaced (emplacement side)

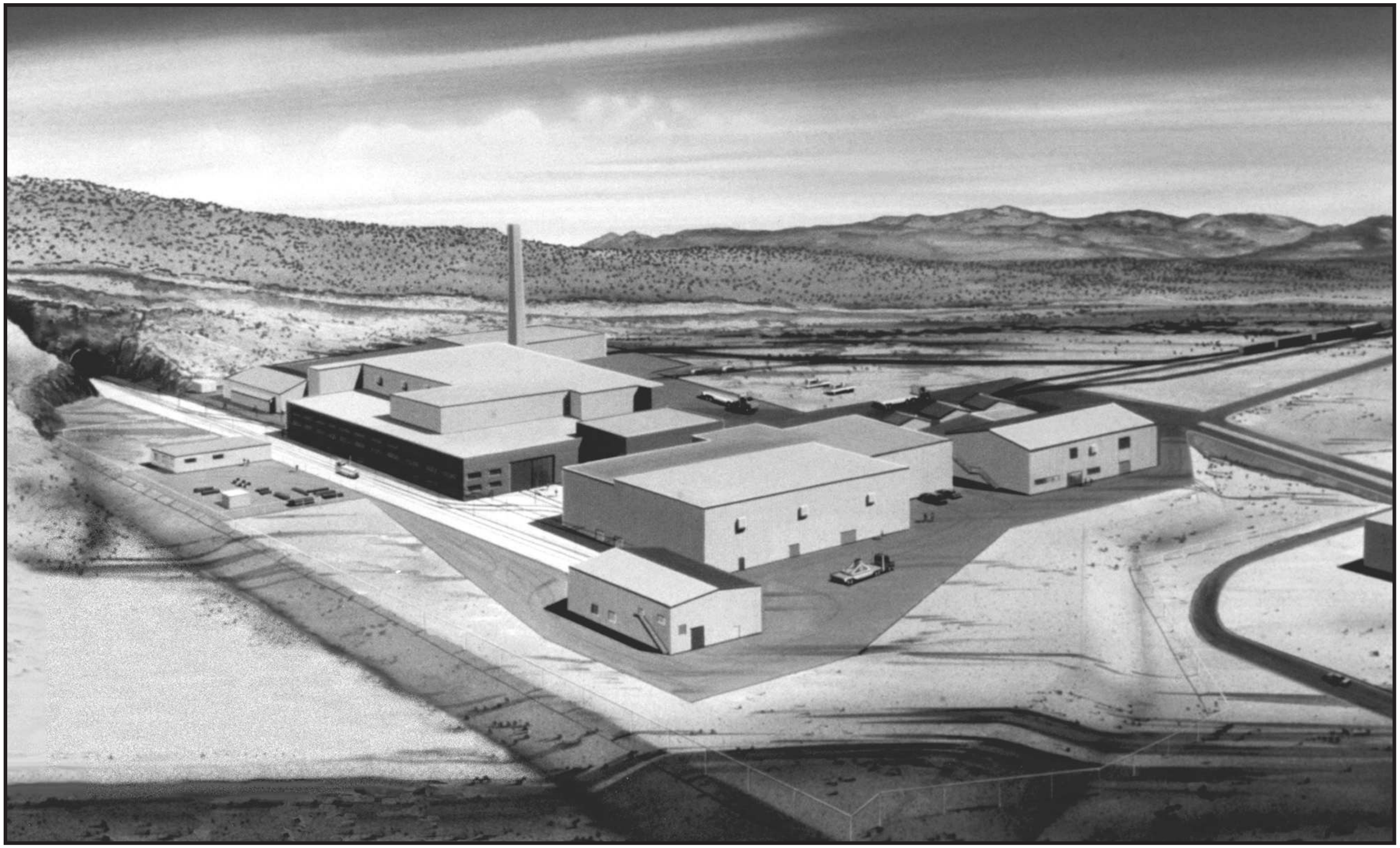
- Development Ventilation Shaft Operations Area – Supply air to subsurface facilities where construction activities would occur (development side)

Figure 2-6 is an aerial photograph of the Yucca Mountain site showing the locations of these surface facilities. Figure 2-7 is an illustration of the repository surface facilities at the North Portal Operations Area. The spent nuclear fuel and high-level radioactive waste would be handled remotely with workers shielded from exposure to radiation using design and operations practices in use at licensed nuclear facilities to the maximum extent practicable. The repository operations areas and supporting areas, utilities, roads, etc., would require the active use of about 3.5 square kilometers (870 acres) of land. Of this total area, about 1.5 square kilometers (370 acres) have been disturbed by previous activities.



Note: The North and South Portal Operations Areas are approximately 2.7 kilometers (1.7 miles) apart.

Figure 2-6. Surface facilities at the proposed Yucca Mountain Repository.



Source: DOE (1998a, Overview, page 13).

Figure 2-7. Artist's conception of proposed repository surface facilities at the North Portal Operations Area.

Figure 2-8 shows the subsurface layout of the repository, which would consist of tunnels (called *drifts*) and vertical ventilation shafts that DOE would excavate in the mountain. Along with the main drifts, gently sloping ramps from the surface to the subsurface facilities would move workers, equipment, and waste packages. Waste packages of spent nuclear fuel and high-level radioactive waste would be placed in the emplacement drifts. The ventilation systems would move air for workers and would cool the repository.

Figure 2-9 shows the expected timing for construction, operation and monitoring, and closure of the proposed repository at Yucca Mountain. If a recommendation was made to proceed with the development of the repository, DOE would continue performance confirmation activities to support a License Application to the Nuclear Regulatory Commission. Preconstruction performance confirmation activities at and in the vicinity of the Yucca Mountain site would be similar to those performed during site characterization. These activities could require surface excavations, subsurface excavations and borings, and in-place testing of rock characteristics.

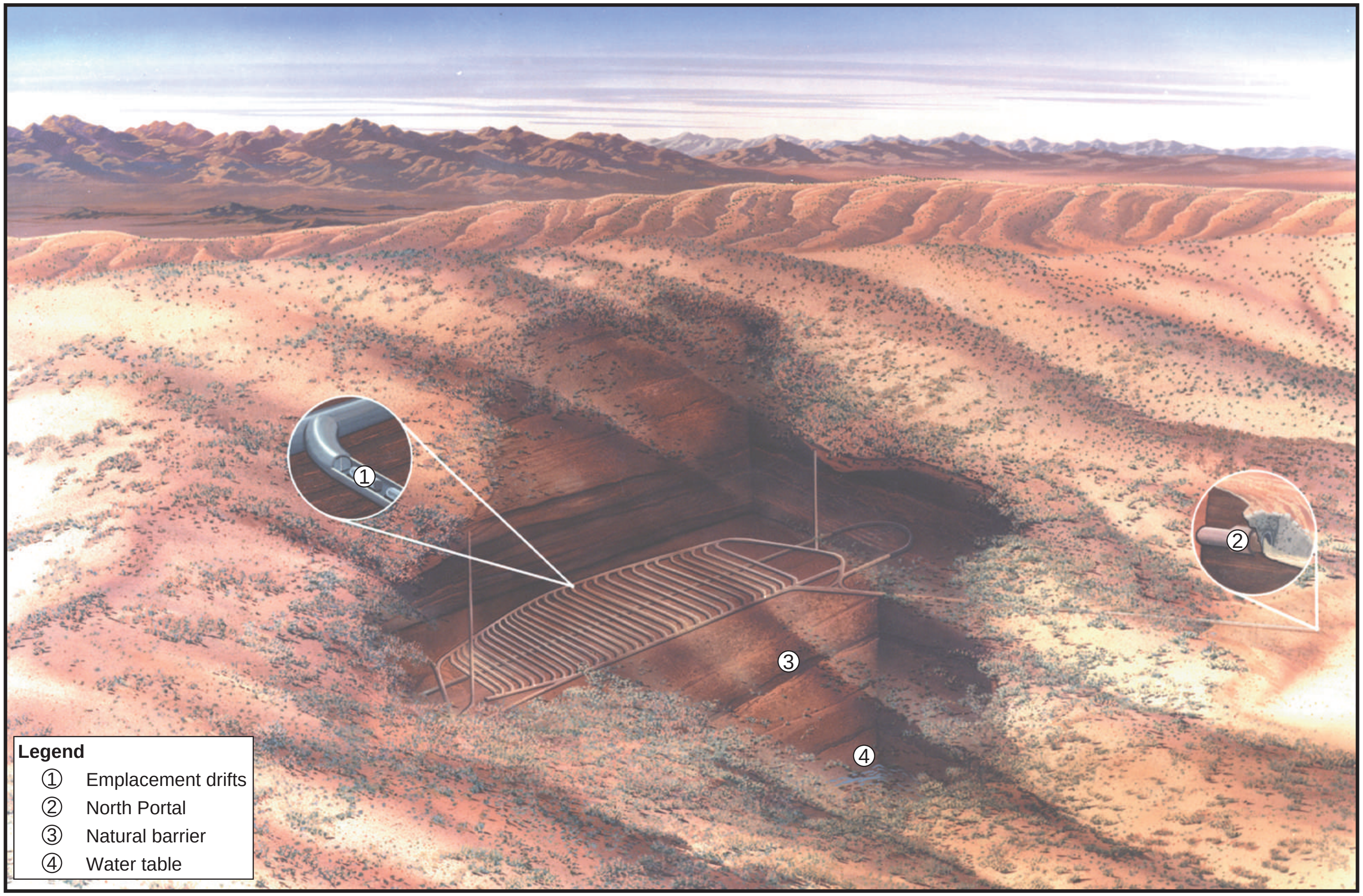
The construction of repository facilities for the handling of spent nuclear fuel and high-level radioactive waste could begin only after the receipt of construction authorization from the Nuclear Regulatory Commission. For this EIS, DOE assumed that construction would begin in 2005. The repository surface facilities, the main drifts, ventilation system, and initial emplacement drifts would be built in approximately 5 years, from 2005 to 2010.

Repository operations would begin after DOE received a license from the Nuclear Regulatory Commission to receive and possess spent nuclear fuel and high-level radioactive waste. For this EIS, DOE assumed that the receipt and emplacement of these materials would begin in 2010 and that emplacement would occur over a 24-year period ending in 2033, based on the emplacement of 70,000 MTHM at approximately 3,000 MTHM per year.

The construction of emplacement drifts would continue during emplacement and would end in about 2032. The repository design would enable simultaneous construction and emplacement operations, but it would physically separate activities on the construction or development side from activities on the emplacement side.

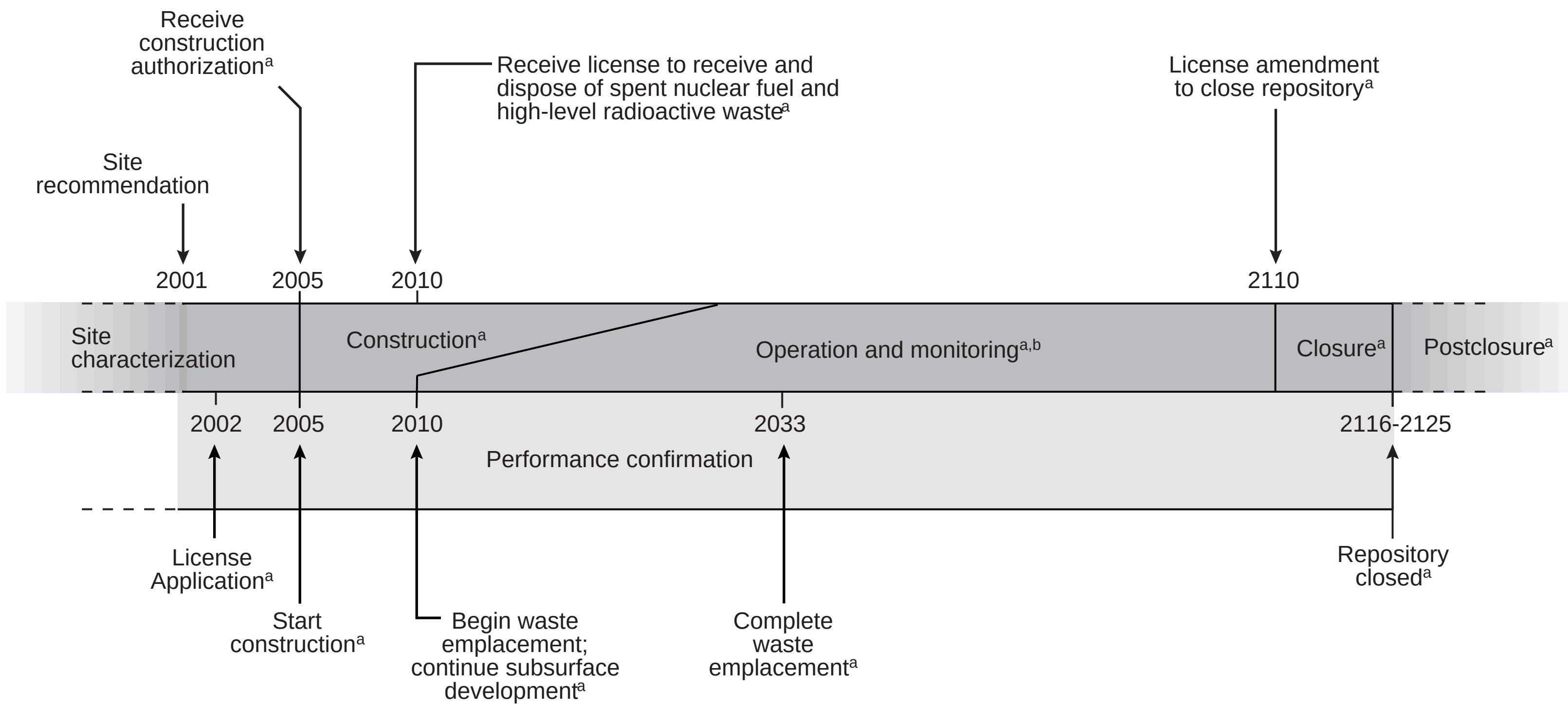
Monitoring and maintenance activities would start with the first emplacement of waste packages and would continue through repository closure. After the completion of emplacement, DOE would maintain those repository facilities, including the ventilation system and utilities (air, water, electric power) that would enable continued monitoring and inspection of the emplaced waste packages, continued investigations in support of predictions of long-term repository performance, and the retrieval of waste packages if necessary. Immediately after the completion of emplacement, DOE would decontaminate and close the facilities that handled nuclear materials on the surface to eliminate a potential radioactive material hazard. However, DOE would maintain an area of the Waste Handling Building for the possible recovery and testing of waste packages as a quality assurance contingency in the performance confirmation program (see Section 2.1.2.4). Future generations would decide whether to continue to maintain the repository in an open monitored condition or to close it. To ensure flexibility to future decisionmakers, DOE is designing the repository with the capability for closure as early as 50 years or as late as 300 years after the start of emplacement. This EIS assumes that closure would begin 100 years after the start (76 years after the completion) of emplacement, but assesses impacts (in Chapter 4) for closure beginning 50 and 300 years after the start of emplacement.

Repository closure would occur after DOE received a license amendment from the Nuclear Regulatory Commission. The period to accomplish closure would range from about 6 years for the high thermal load scenario to about 15 years for the low thermal load scenario. The closure of the repository facilities



Source: Modified from DOE (1998a, Overview, page 9).

Figure 2-8. Artist's conception of proposed repository subsurface layout.



a. If Yucca Mountain is approved.
b. The EIS analysis assumed that waste emplacement would occur over a 24-year period ending in 2033.

Source: Modified from TRW (1999b, Figure 1.5-1, page 1-3).

Figure 2-9. Expected monitored geologic repository milestones.

would include closing the subsurface facilities, decontamination and decommissioning the surface facilities, reclaiming the site, and establishing long-term institutional barriers, including land records and warning systems to limit or prevent intentional or unintentional activity in and around the closed repository (see Section 2.1.2.3).

The performance confirmation program would continue some site characterization activities through repository closure, including various types of tests, experiments, and analytical procedures. DOE would conduct performance confirmation activities to evaluate the accuracy and adequacy of the information it used to determine with reasonable assurance that the repository would meet the performance objectives for the period after permanent closure (see Section 2.1.2.4).

2.1.2.1 Repository Surface Facilities and Operations

Surface facilities at the repository site would be used to receive, prepare, and package spent nuclear fuel and high-level radioactive waste for subsurface emplacement. Surface facilities would also support the construction of the subsurface facilities. DOE would upgrade some facilities built for site characterization, but most surface facilities would be new. Most facilities would be in four areas—the North Portal Operations Area, the South Portal Operations Area, the Emplacement Ventilation Shaft Operations Area(s), and the Development Ventilation Shaft Operations Area(s)—as shown on Figure 2-10. Facilities to support waste emplacement would be concentrated near the North Portal, and facilities to support subsurface facility development would be concentrated near the South Portal.

2.1.2.1.1 *North Portal Operations Area*

This area, shown in Figure 2-11, would be the largest of the primary operations areas, covering about 0.6 square kilometer (150 acres) at the North Portal. It would include two areas: a Restricted Area for receipt of spent nuclear fuel and high-level radioactive waste handling and packaging for emplacement, and a Balance of Plant Area for support services (administration, training, emergency, and general maintenance). The Restricted Area (called the *Radiologically Controlled Area* in other DOE documents) would be enclosed by a fence and monitored to ensure adequate safeguards and security for radioactive materials. The two principal facilities in the Restricted Area would be the Carrier Preparation Building and the Waste Handling Building. Other support facilities planned for the North Portal Operations Area include basic facilities for personnel support, warehousing, security, and transportation (motor pool).

When a legal-weight truck or railcar hauling a cask containing spent nuclear fuel or high-level radioactive waste arrived at the repository site, it would move through the security check into the Restricted Area parking area or to the Carrier Preparation Building. Rail casks arriving on heavy-haul trucks might be transferred to a railcar outside the Restricted Area before entering it. Operations in the Carrier Preparation Building would include performing inspections of the vehicle and cask, removing barriers from the vehicle that protected personnel during shipment, and removing impact limiters from the cask. The vehicle would then move to the Waste Handling Building for unloading or to a storage yard until space became available for unloading. In the Waste Handling Building shipping casks would be removed from the vehicle and placed on carts (see Figure 2-12). The carts would move through the Waste Handling Building airlock to cask preparation areas, where the casks would be checked for contamination and the interior gases sampled. The casks would then be vented and cooled, and the cask lids would be unbolted.

After cask preparation operations, receipt and packaging operations would begin; the nature of these operations would depend on how the spent nuclear fuel in the shipping cask was packaged. The following paragraphs describe the different receipt and packaging operations for different types of packages.

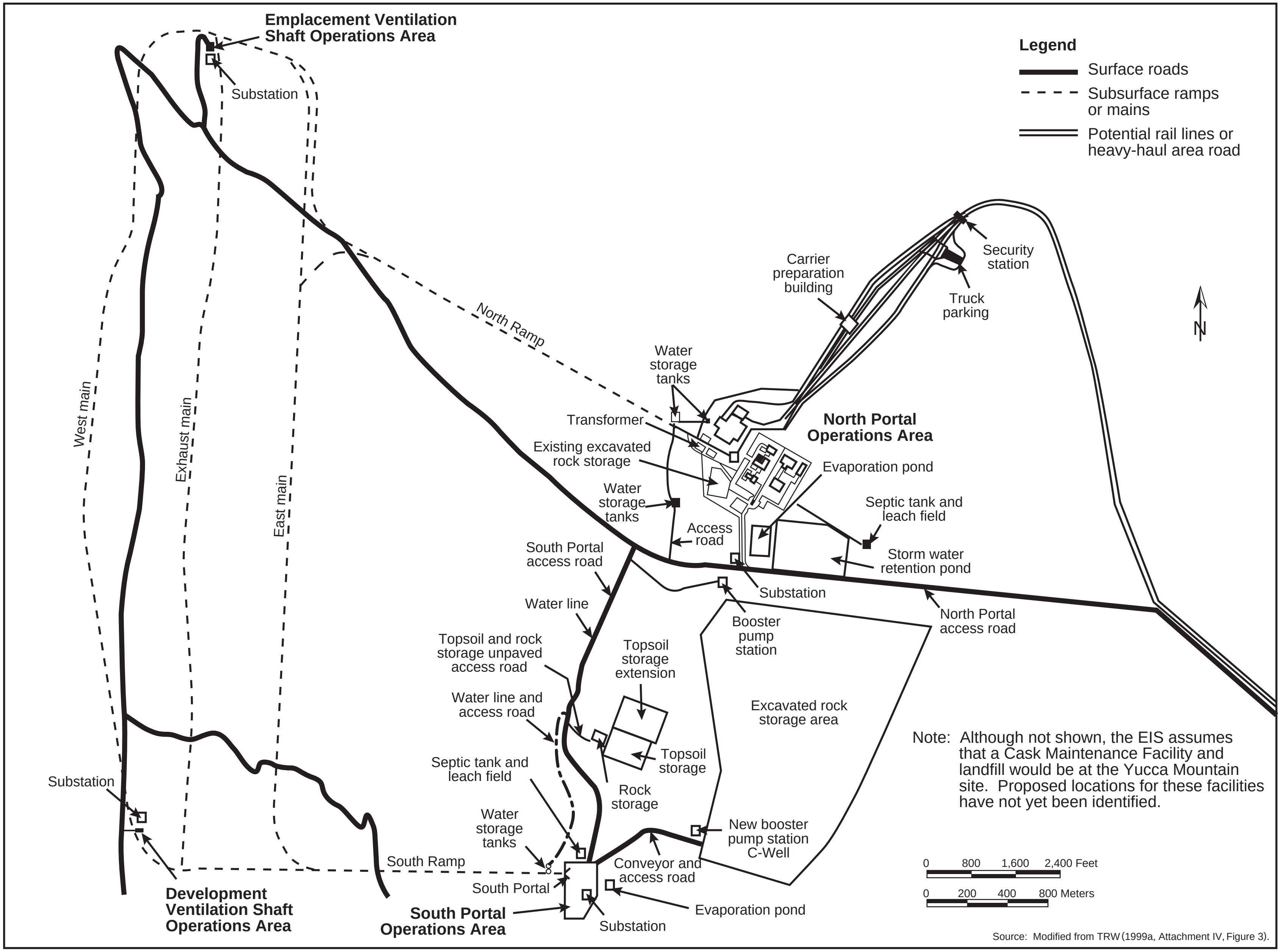


Figure 2-10. Repository surface facilities site plan.

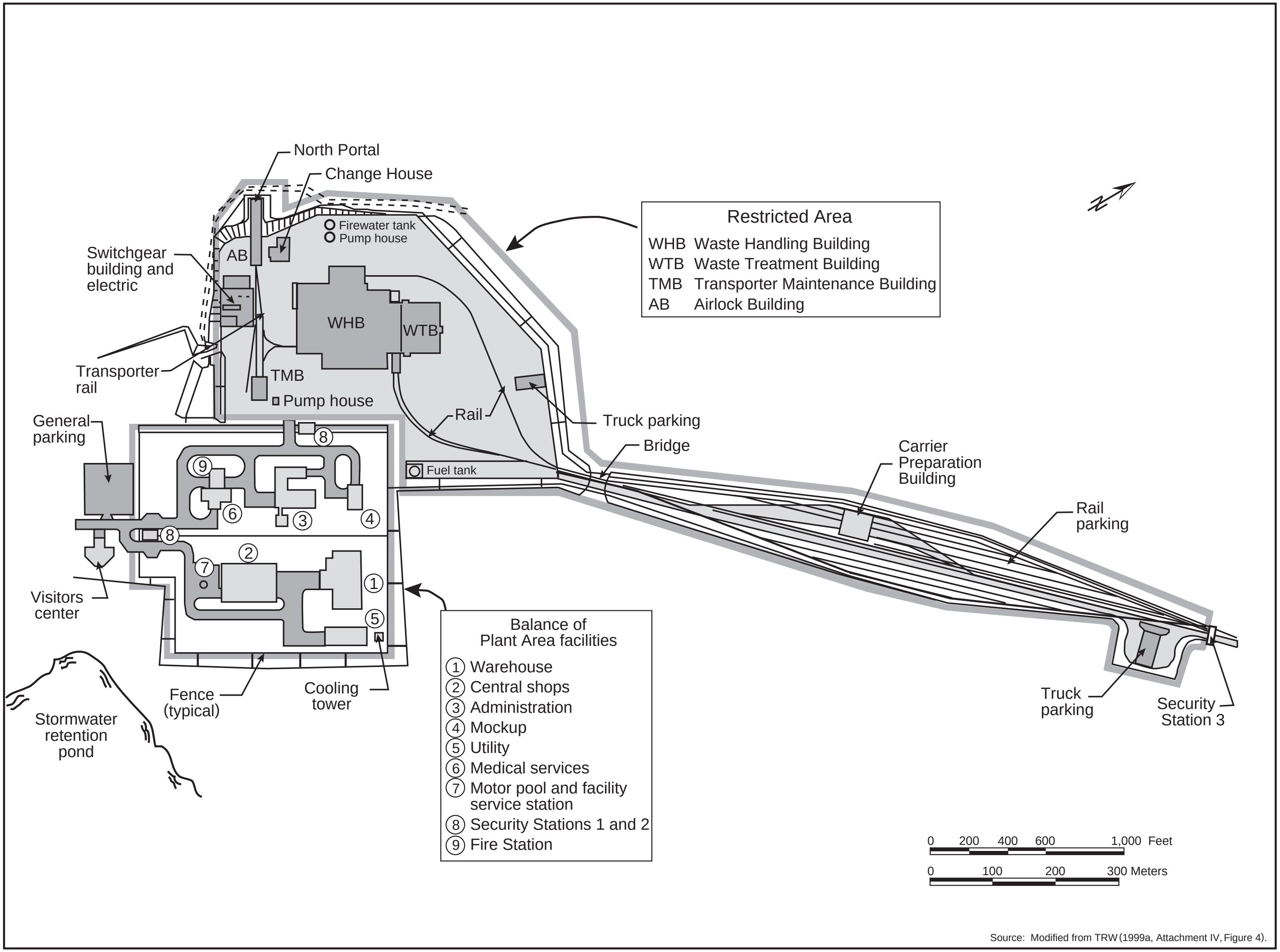


Figure 2-11. North Portal Operations Area site plan.

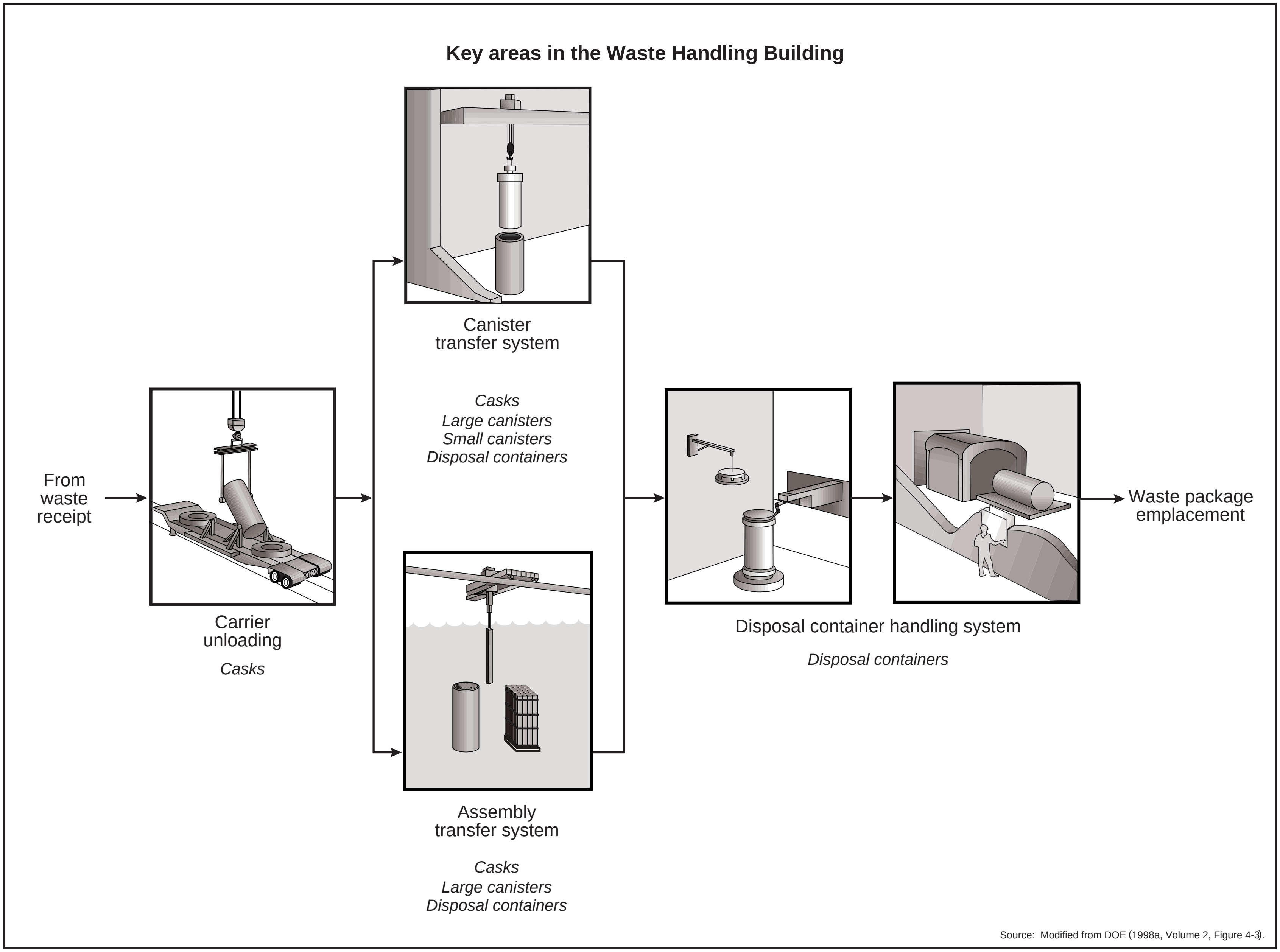


Figure 2-12. Key components of the waste handling operations.

Uncanistered spent nuclear fuel in a cask would be placed in a water transfer pool in the Waste Handling Building. The cask lid would be removed and each fuel assembly would be removed and placed in a transfer basket. When the transfer basket was loaded, it would be *staged* or moved from the pool to an assembly transfer cell and dried. The dried assemblies would be loaded in a disposal container, which would be decontaminated, and either transferred directly to a welding area or stored temporarily until a welding area was available. Welding operations would include installing and welding the inner and outer lids of the disposal container. The disposal container would be filled with an inert gas such as helium after the inner lid was welded. Each welding operation would be followed by nondestructive weld examination and certification. After weld certification, the loaded disposal container is called a *waste package* (see Section 2.1.2.2). Each waste package would be decontaminated and loaded in a shielded waste package transporter for transfer to the repository or held in the Waste Handling Building until a transporter became available.

Shipping casks containing spent nuclear fuel or high-level radioactive waste in disposable canisters would be moved directly to a dry canister transfer handling area. The shipping cask lid would be removed and the disposable canisters would be staged, or transferred directly into a disposal container. The disposal container sealing and welding process would be similar to that described for uncanistered spent nuclear fuel.

Shipping casks containing spent nuclear fuel assemblies in dual-purpose canisters would be placed in a water transfer pool. The shipping cask lid would be removed, the canister inside would be removed and opened, and the assemblies would be unloaded to a transfer basket. Once the assemblies were in the basket, the process would be the same as that described for uncanistered fuel.

DOE would decontaminate empty canisters, shipping casks, and related components as required in the Waste Handling Building. After decontamination, the empty canisters and shipping casks would be loaded on truck or rail carriers, sent to the Carrier Preparation Building for processing, and shipped off the site.

Waste generated at the repository from the decontamination of canisters and shipping casks and from other repository housekeeping activities would be collected, processed, packaged, and staged in the Waste Treatment Building before being shipped off the site for disposal at permitted facilities. Waste minimization and pollution prevention measures would reduce the amount of site-generated waste requiring such management. For example, decontamination water could be treated and recycled to the extent practicable. Site-generated wastes would include low-level radioactive waste, hazardous waste, and industrial solid waste. Operations would not be likely, but that could occur, could produce small amounts of mixed wastes (wastes containing both radioactive and hazardous materials). The repository design would include provisions for collecting and storing mixed waste for offsite disposal.

The ventilation systems for the Waste Handling Building and the Waste Treatment Building would provide confinement of radioactive contamination by using pressure differentials to ensure that the air would flow from areas free of contamination to areas potentially contaminated to areas that are normally contaminated. The monitored exhaust air from both buildings would pass through high-efficiency particulate air filters before being released through a single exhaust stack.

2.1.2.1.2 *South Portal Operations Area*

The South Portal Operations Area would cover about 0.15 square kilometer (37 acres) immediately adjacent to the South Portal of the subsurface facility. The structures and equipment in this area, which would support the development of subsurface facilities, would include a concrete plant for fabricating and curing precast components and supplying concrete for in-place casting, and basic facilities for personnel support, maintenance, warehousing, material staging, security, and transportation. From this area, overland conveyors would transport excavated rock from the repository to the excavated rock pile.

2.1.2.1.3 *Emplacement Ventilation Shaft Operations Areas*

DOE would develop these areas where ventilation shafts from the emplacement side of the subsurface reached the surface. The number of shafts required to ventilate the subsurface would depend on the thermal load scenario for the repository. A repository design with a high or intermediate thermal load would require a single ventilation shaft with a corresponding surface operations area for the emplacement side. A design with a low thermal load would require three emplacement ventilation shafts with corresponding surface operations areas because of the increased area to be ventilated. Two of these operations areas would contain fans to pull air from the emplacement area; the other would not contain fans but would supply air to the emplacement area.

An Emplacement Ventilation Shaft Operations Area would cover about 12,000 square meters (3 acres) and would normally be unstaffed. An emplacement side ventilation system would contain two fans, each driven by a 2,000-horsepower electric motor with a capacity of about 17,000 cubic meters (600,000 cubic feet) per minute. One fan would be in continuous operation and the other would be on standby. Section 2.1.2.2 contains a description of the subsurface ventilation design.

2.1.2.1.4 *Development Ventilation Shaft Operations Areas*

Development ventilation shafts would supply air to the development side of the repository. A repository design with a high or intermediate thermal load would require a single development ventilation shaft with a corresponding surface operations area. A design with a low thermal load would require two development ventilation shafts with corresponding surface operations areas because of the increased area to be ventilated. Each Development Ventilation Shaft Operations Area would be similar in size to the Emplacement Ventilation Shaft Operations Areas, and would contain two fans, each with a capacity of about 17,000 cubic meters (600,000 cubic feet) per minute and driven by a 2,000-horsepower electric motor. One fan would be in continuous operation, forcing air into the repository, and the other fan would be on standby. Section 2.1.2.2 contains a description of the subsurface ventilation design.

2.1.2.1.5 *Support Equipment and Utilities*

Repository support equipment and utilities would be on the surface in the general vicinity of the North and South Portal Operations Areas (see Figure 2-10). The storage area for excavated rock would be the largest support area. For the high or intermediate thermal load scenario, the excavated rock storage area would be between the North and South Portals, as shown in Figure 2-10, and would require about 1.0 and 1.2 square kilometers (250 and 300 acres), respectively. For the low thermal load scenario, the excavated rock storage area would be about 5 kilometers (3 miles) east of the South Portal Operations Area, as shown on Figure 2-13. Because the excavated rock pile would be higher at this location, the area required would be about 1.1 square kilometers (270 acres).

The repository site would have two evaporation ponds for industrial wastewater, one at the North Portal and one at the South Portal. Sources of industrial wastewater would include water used for dust suppression during construction, water used for cooling tower operations at the North Portal, and water used for concrete mixing and for form cleanup at the South Portal. Heavy plastic sheets would line both ponds to prevent water migration into the soil. The North Portal pond would cover about 24,000 square meters (6 acres). The evaporation pond at the South Portal would be about 2,300 square meters (0.6 acre). The North Portal area would also include an approximately 130,000-square-meter (32-acre) stormwater retention pond to control stormwater runoff from the North Portal Operations Area.

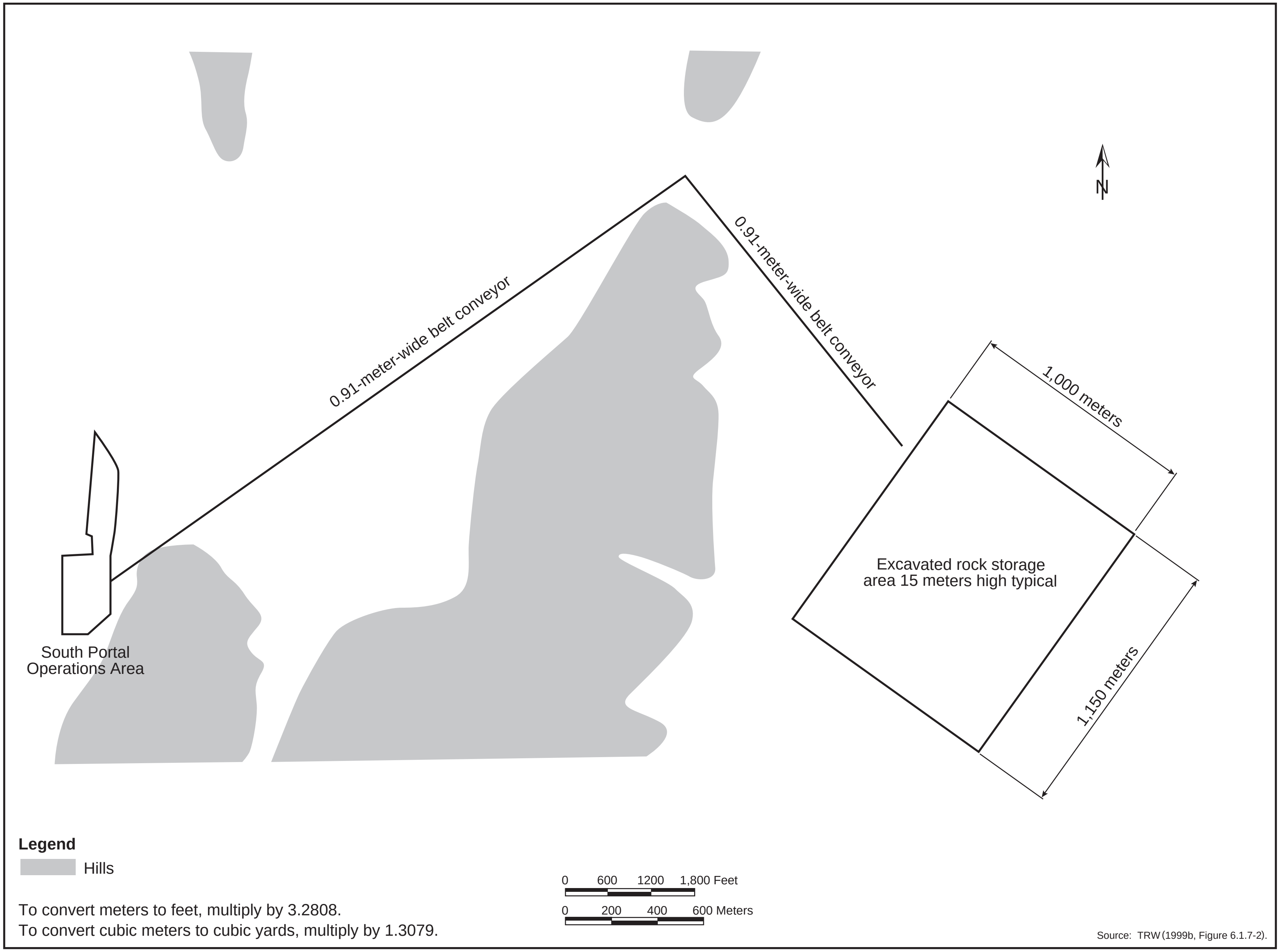


Figure 2-13. Location of excavated rock storage area for low thermal load scenario.

DOE would develop an appropriately sized landfill [approximately 0.036 square kilometer (9 acres)] at the repository site for nonhazardous and nonradiological construction and sanitary solid waste and for similar waste generated during the operation and monitoring and closure phases. The South Portal Operations Area would have a septic tank and leach field for the disposal of sanitary sewage. The North Portal Operations Area has an existing septic system that would be adequate for use during repository operations.

At present, electric power is obtained from the Nevada Test Site power distribution system. For the repository, electric power would be distributed throughout the surface and subsurface areas and to remote areas such as the Ventilation Shaft Operations Areas, construction areas, environmental monitoring stations, transportation lighting and safety systems, and water wells. To accommodate the expected demand for the repository, DOE would upgrade existing electrical transmission and distribution systems. Backup equipment and uninterruptable electric power would be provided to ensure personnel safety and operations requiring electric power continuity. Diesel generators and associated switchgear would provide the backup power capability.

DOE would use existing wells about 5.6 kilometers (3.5 miles) southeast of the North Portal Operations Area to supply water for repository activities. These wells have supplied water for site characterization activities at Yucca Mountain. Water would be pumped to a booster pump station and then to potable and nonpotable water systems that would distribute the water to the Restricted and Balance of Plant Areas and to the subsurface.

Fuel supply systems would include fuel oil for a central heating (hot water) plant, which would consist of a 950,000-liter (250,000-gallon) main tank and a 57,000-liter (15,000-gallon) day tank. In addition, there would be fuel supply systems for generating steam to cure precast concrete, for fire water system tank heaters, for diesel-powered standby generators and air compressors, and for backup fire pumps. Diesel fuel and gasoline would also be provided to fuel vehicles during the construction, operation and monitoring, and closure of the repository.

2.1.2.2 Repository Subsurface Facilities and Operations (Including Waste Packages)

DOE would construct the subsurface facilities of the repository and emplace the waste packages above the water table in a mass of volcanic rock known as the Topopah Spring Formation (welded tuff) (see Chapter 3, Section 3.1.3.1). The specific area in this formation where DOE would build the repository would satisfy several criteria. The primary criteria would be to (1) be within select portions of the Topopah Spring formation that have desirable properties, (2) avoid major faults for reasons related to both hydrology and seismic hazard (see Section 3.1.3.2), (3) be at least 200 meters (660 feet) below the surface, and (4) be at least 100 meters (330 feet) above the water table (TRW 1993, pages 5-99 to 5-101).

Figures 2-14, 2-15, and 2-16 show the repository footprint for the emplacement of spent nuclear fuel and high-level radioactive waste for the high, intermediate, and low thermal load scenarios, respectively. DOE would develop a high thermal load repository in the upper emplacement block, using 3 square kilometers (740 acres), with two ventilation shafts to the surface, one on the emplacement side and one on the development side (Figure 2-14). An intermediate thermal load repository would also be in the upper emplacement block, would have an area of 4.25 square kilometers (1,050 acres), and would require two ventilation shafts to the surface (Figure 2-15). A low thermal load repository would be in the upper and lower emplacement blocks and in Area 5, would use an area of approximately 10 square kilometers (2,500 acres), and would require three emplacement and two development ventilation shafts (Figure 2-16).

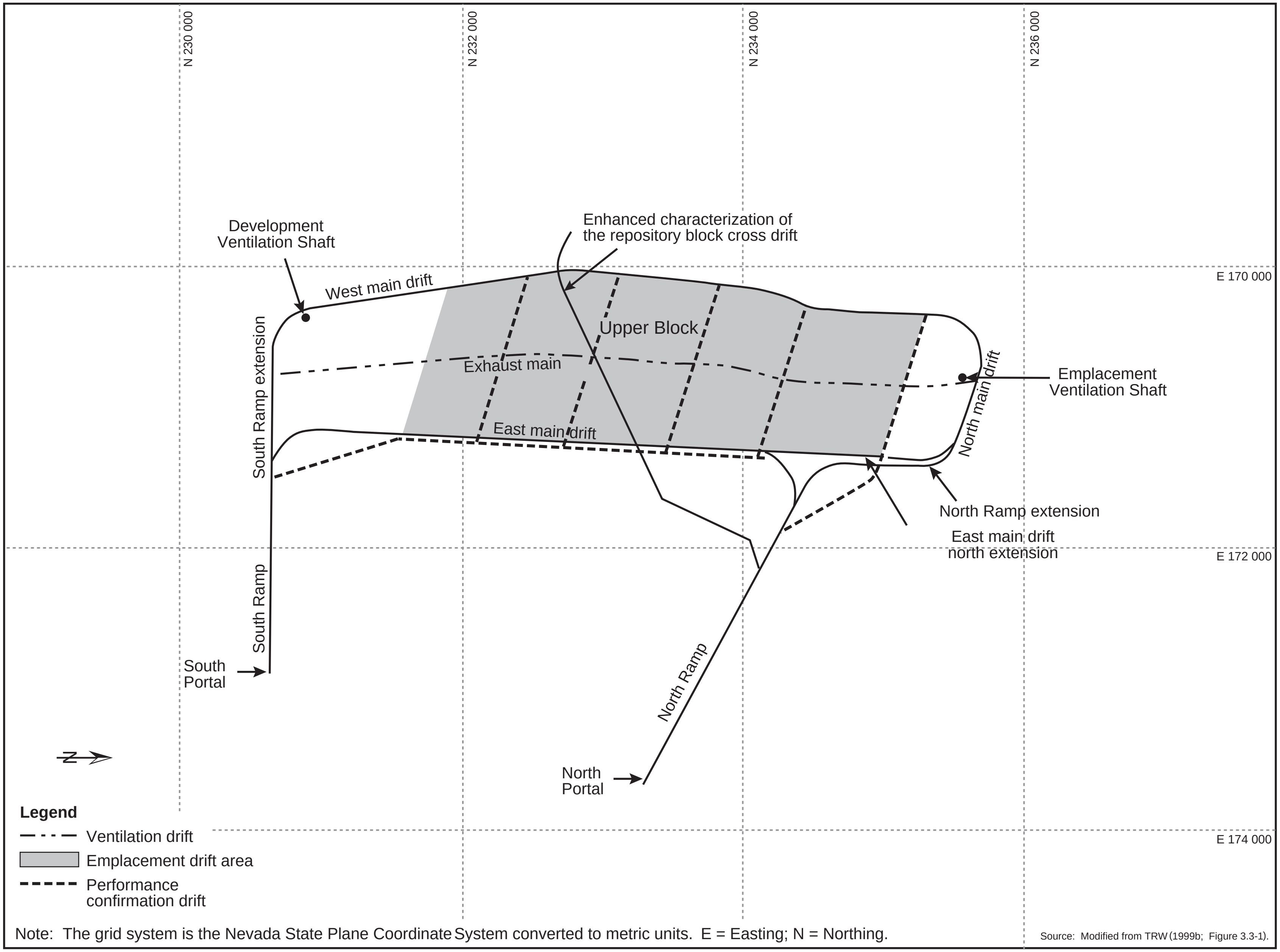


Figure 2-14. High thermal load repository layout.

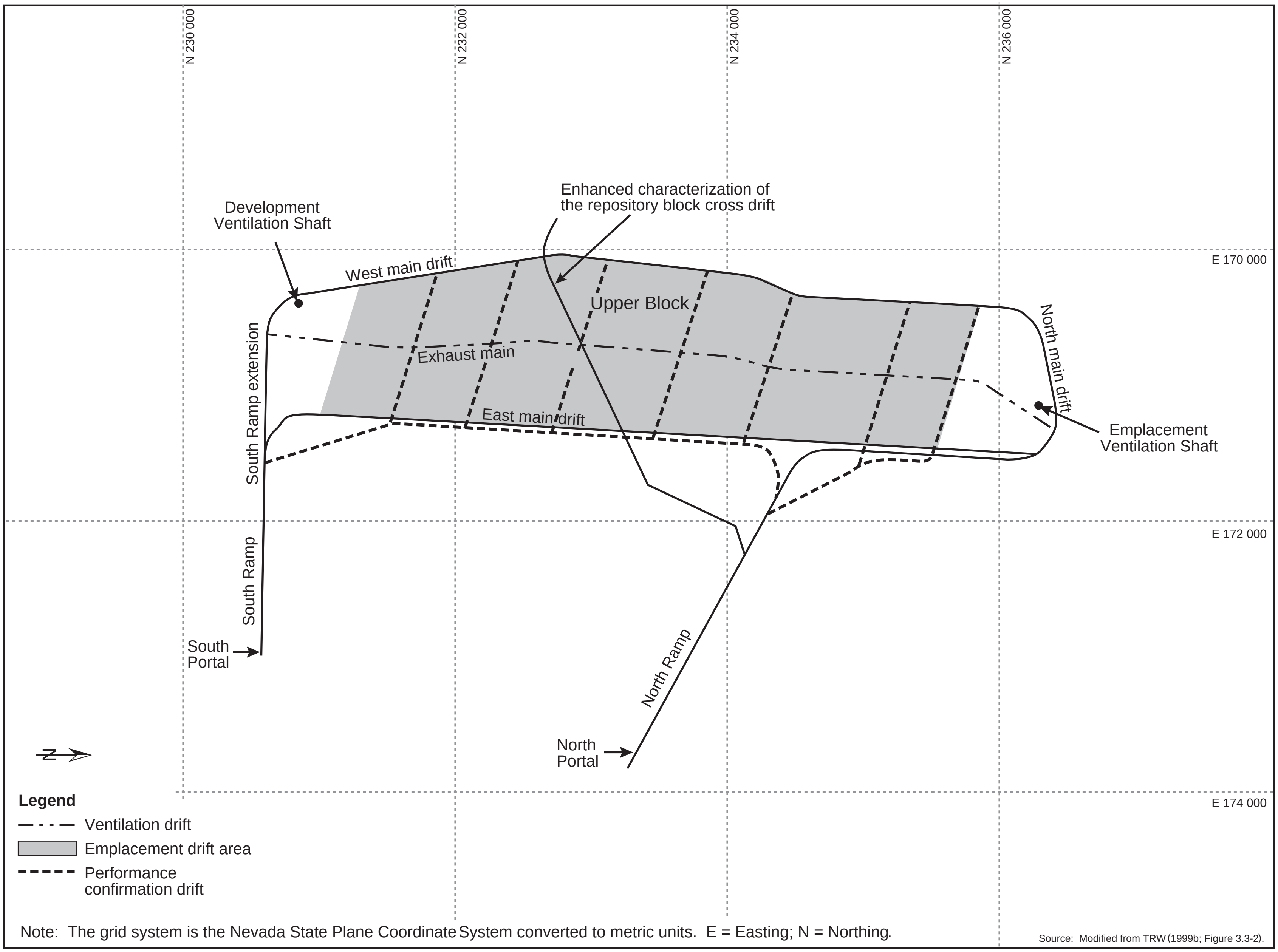


Figure 2-15. Intermediate thermal load repository layout.

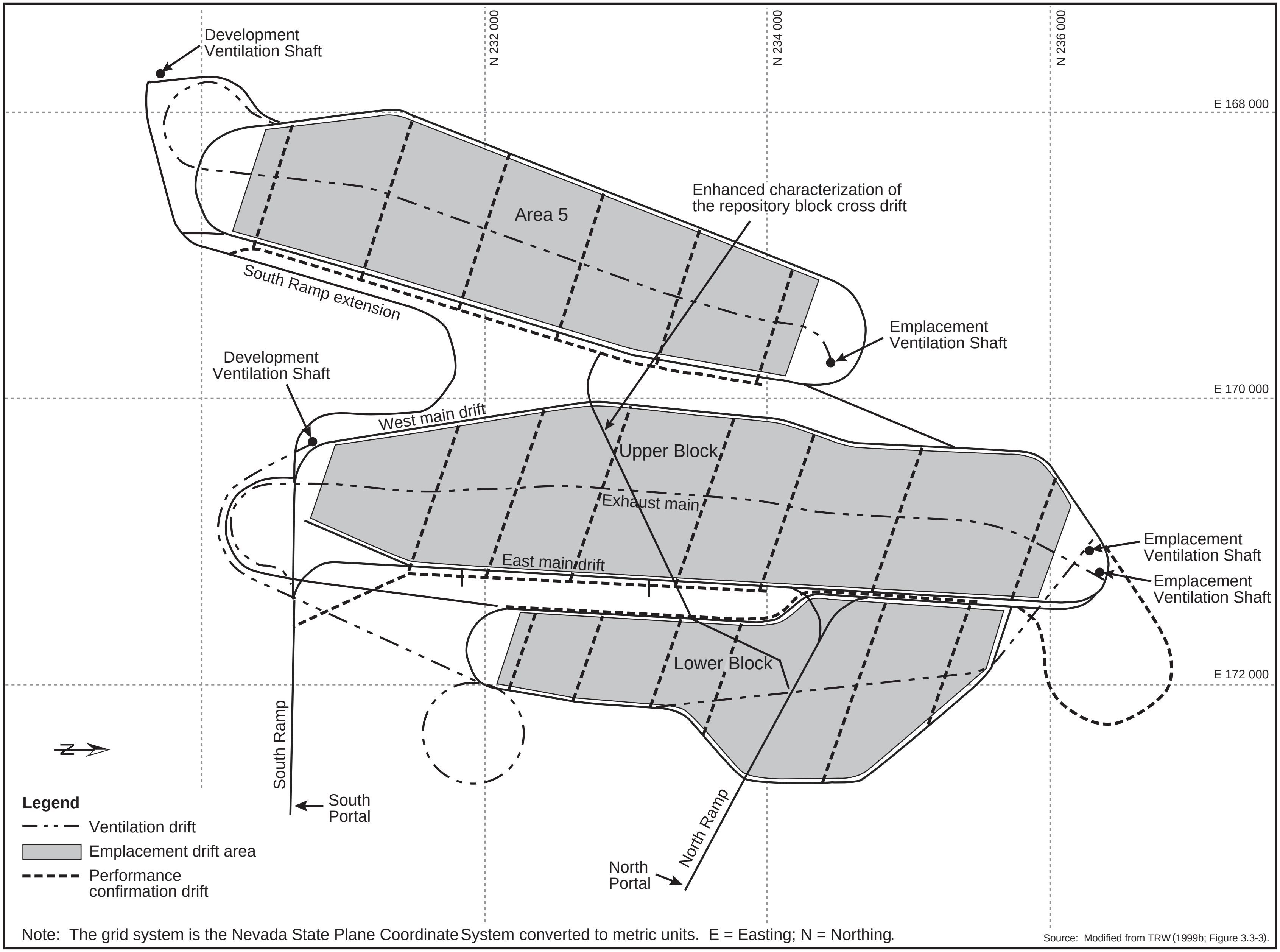


Figure 2-16. Low thermal load repository layout.

The following paragraphs describe the subsurface facility design and construction (including the ventilation system), the design of the waste packages, and waste package emplacement operations.

2.1.2.2.1 *Subsurface Facility Design and Construction*

The subsurface design would incorporate most of the drifts developed during the site characterization activities. Other areas would be excavated during the repository construction phase. Excavated openings would include gently sloping access ramps to enable rail-based movement of construction and waste package handling vehicles between the surface and subsurface, subsurface main drifts to enable the movement of construction and waste package handling vehicles, emplacement drifts for the placement of waste packages, exhaust mains to transfer air in the subsurface area, and ventilation shafts to transfer air between the surface and the subsurface. There would also be performance confirmation drifts for the placement of instrumentation to monitor emplaced waste packages (see Figures 2-14, 2-15, and 2-16).

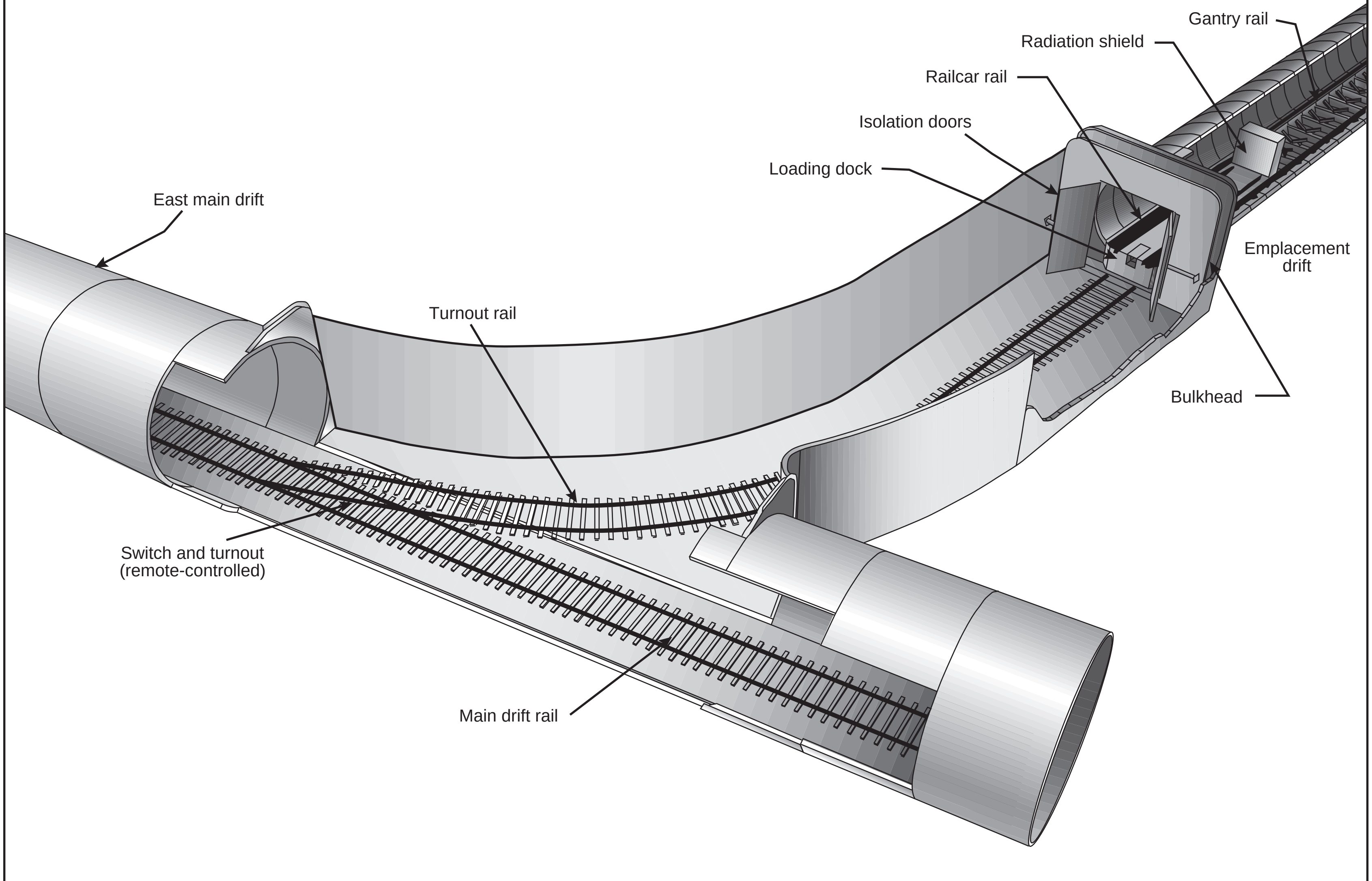
Access ramps connecting the surface and subsurface would be concrete-lined, 7.6-meter (25-foot)-diameter tunnels excavated by electric-powered tunnel boring machines (see Figure 2-17). Rail lines and an overhead trolley system would enable the movement of electric-powered construction and waste package handling vehicles. The North and South Ramps were developed during site characterization and would become part of the proposed repository. The North Ramp begins at the North Portal Operations Area on the surface (see Section 2.1.2.1) and extends through the subsurface to the edge of the repository area. It would support waste package emplacement operations. The South Ramp originates at the South Portal Operations Area on the surface (see Section 2.1.2.1) and extends through the subsurface to the edge of the repository area. It would support subsurface construction activities.

The main drifts for a high thermal load, shown in Figure 2-14, would include the East Main, the West Main, and the North Main. These drifts would be extended for the intermediate or low thermal load scenario. Additional main drifts would be excavated for the low thermal load scenario to provide access to other emplacement areas. Main drifts would be concrete-lined, 7.6-meter (25-foot)-diameter tunnels excavated by tunnel boring machines. Rail lines and an overhead trolley system in the main drifts would enable the movement of electric-powered construction and waste package handling vehicles. The East Main drift was excavated as part of site characterization activities but was not lined with concrete. During the operation and monitoring phase, the main drifts would support both subsurface construction and waste package emplacement, which would occur simultaneously. Ventilation barriers creating airlocks would separate the emplacement and development sides of the repository, and the ventilation system would be designed to maintain the emplacement side at a lower pressure than the development side. This would ensure that any air leakage would be from the development side to the emplacement side.

Emplacement drifts would be 5.5-meter (18-foot)-diameter tunnels connecting the main drifts; they could have steel ribbing or be lined with concrete. These drifts would be excavated by an electrically powered tunnel boring machine. An emplacement drift would be large enough to permit the movement of waste packages over emplaced packages in the drift. Steel isolation doors at the emplacement drift entrances would prevent unauthorized human access and reduce radiation exposure to personnel. In addition, radiation shields would be placed at the ends of emplacement drifts that contained waste packages. The isolation doors would be opened and closed remotely. Figure 2-18 shows an emplacement drift branching off the East Main drift.

Exhaust main drifts would ventilate the emplacement side of the repository; they would be roughly perpendicular to and at a level below the emplacement drifts (see Figure 2-19). The exhaust main drift would connect with the emplacement drifts through a ventilation raise and would connect with an emplacement ventilation shaft. For a high thermal load configuration, a 6.7-meter (22-foot) exhaust main

Figure 2-17. Tunnel boring machine.



Source: Modified from TRW (1999b, Figure 4.3.2.8-1).

Figure 2-18. Artist's conception of emplacement drift branching from main drift.

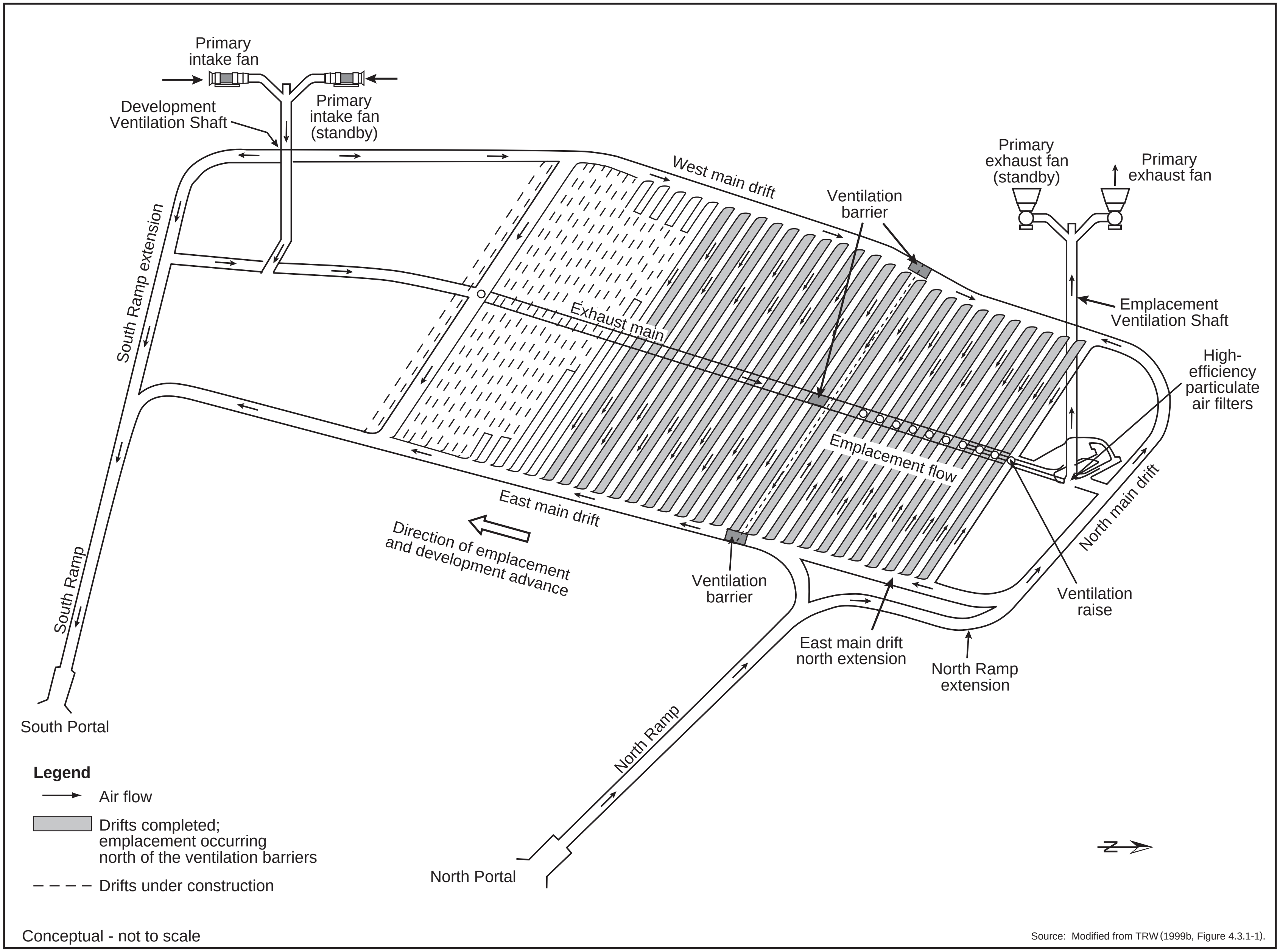


Figure 2-19. Subsurface conceptual design for ventilation air flow during construction and operations.

drift would be excavated approximately 10 meters (33 feet) below the emplacement drift. This drift would be extended for the intermediate and low thermal load scenarios. For the low thermal load scenario, other exhaust main drifts would be excavated to ventilate the additional emplacement areas. For a high thermal load configuration, DOE would excavate two 6.7-meter (22-foot)-diameter shafts for repository ventilation, an emplacement ventilation shaft at the north end and a development ventilation shaft at the south end of the upper emplacement block. An intermediate thermal load configuration would also require two shafts. These vertical shafts would extend from approximately 10 meters (33 feet) below the repository to the surface of the mountain. The emplacement ventilation shaft shown in Figure 2-19 would connect to the north end of the exhaust main drift and provide the only route for emplacement side air to leave the repository. It would be the primary ventilation exhaust airway for emplacement and monitoring activities before closure; as such, it would contain continuous radiation detection and monitoring equipment. During emplacement and monitoring operations, fans on the surface would pull air up the emplacement ventilation shaft. If the monitors detected a radioactive material leak from an emplacement drift, the exhaust air would be diverted automatically through the high-efficiency particulate air filters installed at the bottom of the emplacement ventilation shaft. Fresh air would be pulled into the repository through the North Ramp.

The development ventilation shaft, shown in Figure 2-19, would supply fresh air to the construction side of the repository. It would be the primary ventilation intake airway for subsurface development activities. Fans at the development ventilation shaft operations area would force air down to the development side of the repository. The South Ramp would be the exhaust path for air in the development side.

For a low thermal load configuration, DOE would excavate five ventilation shafts—three on the emplacement side of the repository and two on the development side. Two of the shafts on the emplacement side would contain fans to pull the air from the subsurface; the third would be an intake air shaft with no fans. Air would be pulled into the subsurface from this shaft and the North Ramp. An additional ventilation shaft would force air into the development side.

As noted above, electrically powered tunnel boring machines would excavate the emplacement drifts and most main drifts. DOE would use other mechanical excavators in areas where tunnel boring machines were impractical (for example, excavating turnouts and small alcoves) or industry-standard drill and blast techniques in limited applications where mechanical excavators were impractical. No drill and blast operations are currently envisioned, but if they were needed, care would be taken to ensure that the waste isolation properties of the mountain were not compromised. Ventilation shafts would be bored from the surface to the repository. Specialized equipment would move excavated rock in the subsurface to the conveyor system, which would move the rock from the subsurface to the excavated rock storage area on the surface. During drift excavation, water supplied to the subsurface in pipelines would be used for dust control at the excavation location and along the conveyor carrying excavated rock. Some of the water would be removed from the subsurface with the excavated rock, some would evaporate and be removed in the ventilation air, and the remainder would be collected in sumps near the point of use and pumped to the evaporation pond at the South Portal. DOE could recycle the water discharged to the evaporation pond for surface dust suppression activities. Controls would be established, as necessary, to ensure that water application for subsurface (and surface) dust control would not affect repository performance.

2.1.2.2.2 *Waste Package Design*

The function of the waste package changes over the repository lifetime. During the operation and monitoring phase, the disposal containers or waste packages would function as the vessels for safely handling, emplacing, and retrieving (if necessary) their contents. After closure, the waste packages would be the primary engineered barrier to inhibit the release of radioactive material to the environment.

DOE is developing specific waste package designs for uncanistered spent nuclear fuel assemblies, canistered spent nuclear fuel assemblies, and high-level radioactive waste canisters (Figure 2-20). The waste packages would be cylindrical containers and, in the preliminary conceptual design, range from 3.7 meters (12 feet) to 6.2 meters (20 feet) long and 1.25 to 2.0 meters (4.1 to 6.6 feet) in diameter. The waste packages of commercial spent nuclear fuel would hold as many as 21 pressurized-water reactor fuel assemblies or 44 boiling-water reactor fuel assemblies. There would be two general waste package designs for other types of spent nuclear fuel. These two designs would hold either a canister containing assemblies of naval spent nuclear fuel, or several canisters containing DOE spent nuclear fuel assemblies. There would be two general co-disposal waste package loading options, which would hold either five high-level radioactive waste canisters with an additional canister containing DOE spent nuclear fuel assemblies, or five canisters containing both high-level radioactive waste and immobilized plutonium waste forms. In addition, there would be waste packages that would contain only high-level radioactive waste.

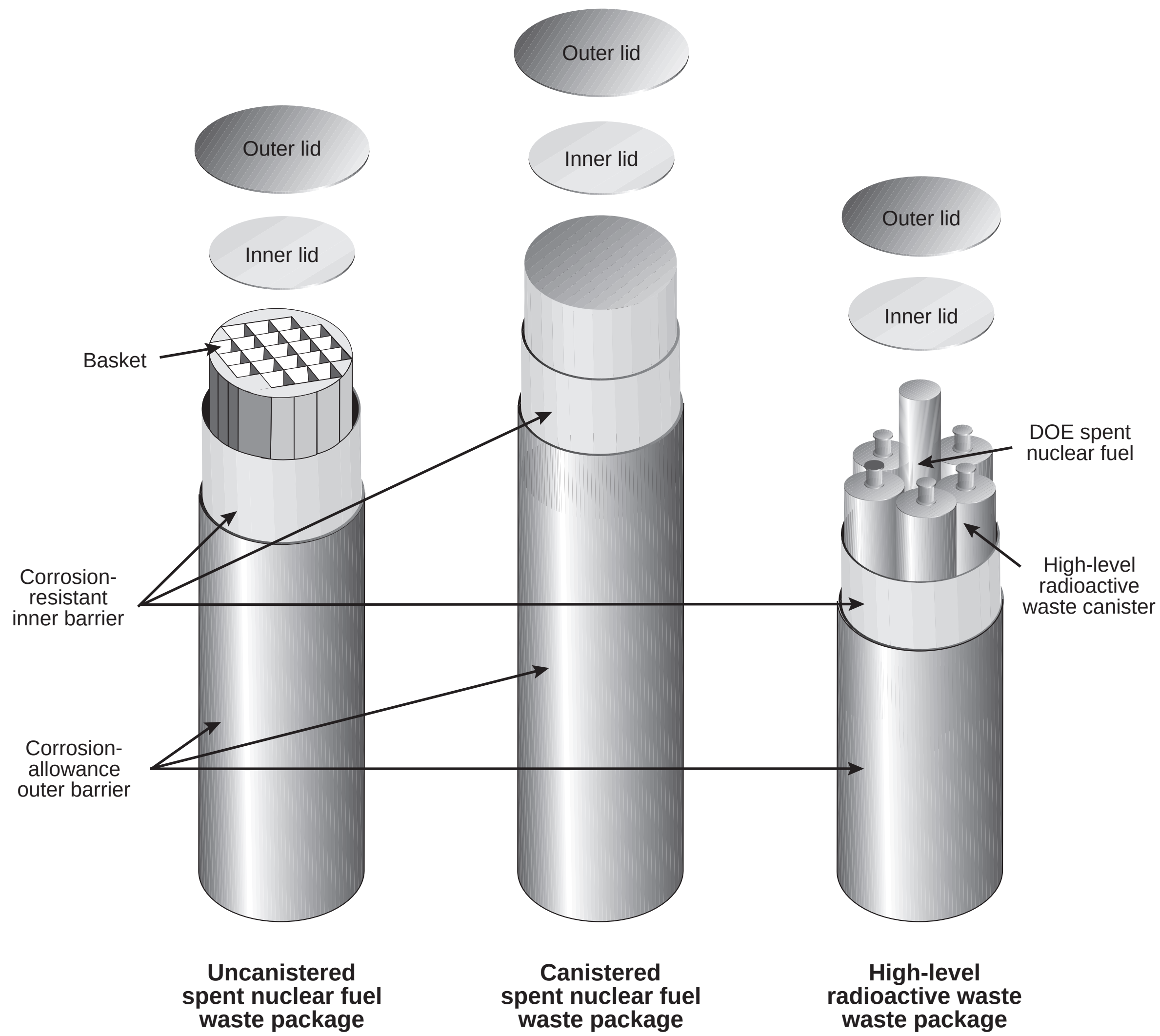
The preliminary conceptual design of the waste packages would have two layers: a structurally strong outer layer of carbon steel about 10 centimeters (4 inches) thick, and a corrosion-resistant inner layer of high-nickel alloy (Alloy 22) about 2 centimeters (0.79 inch) thick. These two layers would work together to preserve the integrity of the waste package for thousands of years.

Commercial spent nuclear fuel, DOE spent nuclear fuel, and immobilized plutonium contain *fissile material,* which is material capable, in principle, of sustaining a fission chain reaction. For a self-sustaining chain reaction to take place, a critical mass of fissile material—uranium-233 or -235 or one of several plutonium isotopes—must be arranged in a critical configuration. Waste packages are loaded with fissile material and neutron absorbers, if needed, so criticality cannot occur even in the unlikely event that the waste package somehow became full of water.

The waste packages would be placed horizontally on supports in the emplacement drifts (Figure 2-21). The supports would be steel and concrete structures that would hold the waste packages above the drift floor. DOE would place approximately 10,000 to 11,000 waste packages, which would include both spent nuclear fuel and high-level radioactive waste, in the repository. For the high thermal load scenario, the emplacement drifts would be spaced approximately 28 meters (92 feet) apart; for the intermediate thermal load scenario, they would be spaced approximately 28 to 40 meters (92 to 130 feet) apart; and for the low thermal load scenario, they would be spaced approximately 38 meters (125 feet) apart. In the emplacement drifts, DOE would then use the optimum spacing of waste packages based on their actual heat load; therefore, spacing would be greatest for the low thermal load scenario.

2.1.2.2.3 *Waste Package Emplacement Operations*

The transport of each waste package to the subsurface would start after the loading of a waste package on a reusable railcar and the loading of that railcar in a shielded waste package transporter in the Waste Handling Building (Figure 2-22). The transporter would be coupled at its closed end to a primary electric powered locomotive (trolley). A secondary electric powered locomotive would be coupled to the door end of the waste package transporter outside the Waste Handling Building. All waste packages would be transported underground through the North Ramp to the emplacement area main drift (Figure 2-23). On arrival at the emplacement drift, the secondary locomotive would be uncoupled from the transporter, and the transporter would be pushed into the emplacement drift turnout by the primary locomotive and stopped short of the isolation doors and loading dock. The doors would be opened remotely, as would the transporter doors. The transporter would be moved to align with the loading dock. The waste package would be moved on the railcar to the emplacement drift loading dock. The gantry would lift the waste package from the railcar and carry it to its emplacement location. The empty railcar would be returned to



Note: Waste packages would range in size from 3.7 to 6.2 meters (12 to 20 feet) long and 1.25 to 2.0 meters (4.1 to 6.6 feet) in diameter. They would range in weight from 35,000 kilograms (77,000 pounds) to 83,000 kilograms (183,000 pounds).

Source: Modified from DOE (1998a, Volume 3, Figure 2-3).

Figure 2-20. Potential waste package designs for spent nuclear fuel and high-level radioactive waste.

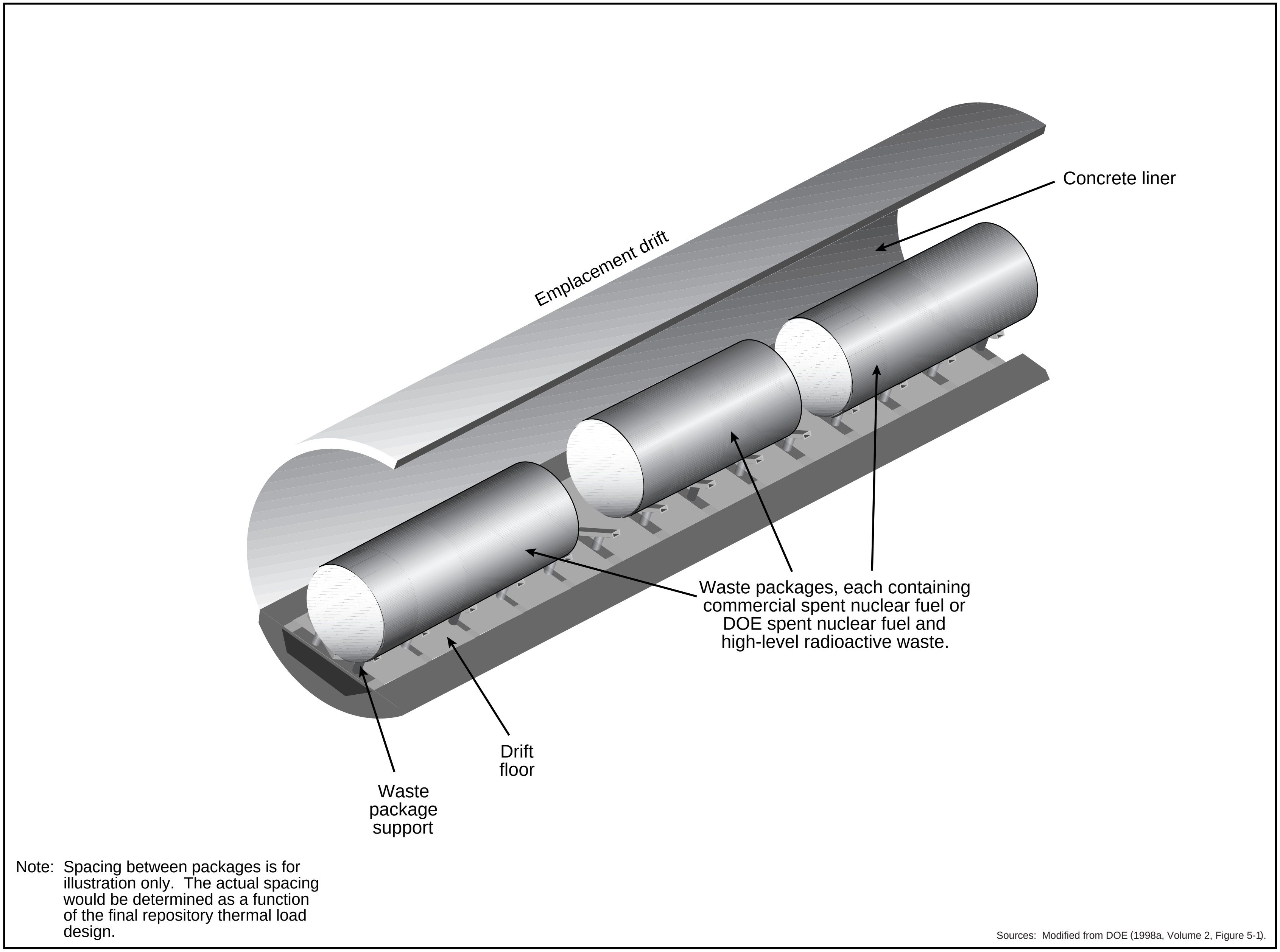
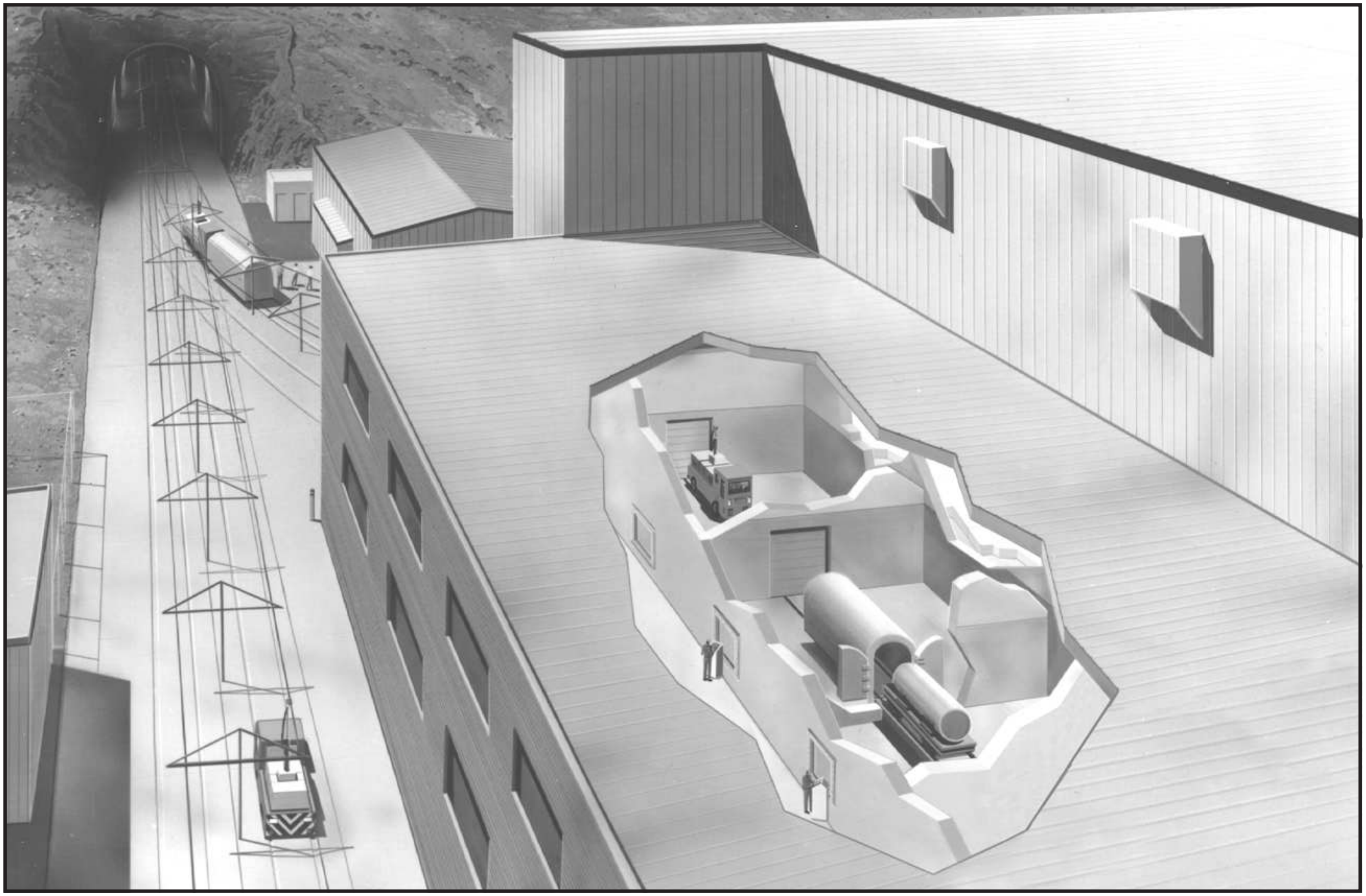


Figure 2-21. Conceptual design of waste packages in emplacement drift.



Source: DOE (1998a, Overview, page 28).

Figure 2-22. Artist's conception of operations to move waste underground (view of Waste Handling Building and North Portal).

① Emplacement drift
② Emplacement drift isolation door
③ Waste package transporter (waste package waiting for gantry)
④ Electric-powered locomotive (trolley)
⑤ Turnout

Sources: Modified from DOE (1998a, Overview, page 14).

Figure 2-23. Artist's conception of repository underground facilities and operation.

the transporter, the isolation doors would be closed remotely, and the empty transporter with locomotives coupled front and rear would be returned to the surface for reuse.

2.1.2.3 Repository Closure

Permanent closure of the proposed repository would include closing the subsurface facilities, decontaminating and decommissioning the surface facilities, reclaiming the site, and establishing institutional barriers. This EIS assumes that repository closure would begin 100 years after the start of emplacement (76 years after the completion of emplacement). The time to complete repository closure would vary from about 6 years for the high and intermediate thermal load scenarios to about 15 years for the low thermal load scenario.

The closure of the subsurface repository facilities would include the removal and salvage of equipment and materials; filling of the main drifts, access ramps, and ventilation shafts; and sealing of openings, including ventilation shafts, access ramps, and boreholes. Filling operations would require surface operations to obtain fill material from the excavated rock pile or other source, and processing (screening, crushing, and possibly washing) the material to obtain the required particle size. Fill material would be transported on the surface in trucks and underground in open gondola railcars. A fill placement system would place the material in the underground main drifts and ramps. Seals for shafts, ramps, and boreholes would be strategically located to reduce radionuclide migration over extended periods, and so that they could not become pathways that could compromise the repository's postclosure performance. Seal materials and placement methods would be selected to reduce, to the extent practicable, the creation of preferential pathways for groundwater to contact the waste packages and the migration of radionuclides through existing pathways.

Decommissioning surface facilities would include decontamination activities, if required, and facility dismantlement and removal. Equipment and materials would be salvaged, recycled, or reused, if possible. Site reclamation would include restoring the site to as near its preconstruction condition as practicable. Reclamation could require the recontouring of disturbed surface areas, surface backfill, soil buildup and reconditioning, site revegetation, site water course configuration, and erosion control.

DOE would use institutional controls, including land records and warning systems, to limit or prevent intentional and unintentional activities in and around the closed repository. The repository area would be identified by monuments that would be designed, fabricated, and placed to be as permanent as practicable. Provisions could be added for postclosure monitoring.

2.1.2.4 Performance Confirmation Program

Performance confirmation refers to the program of tests, experiments, and analyses that DOE would conduct to evaluate the accuracy and adequacy of the information used to determine with reasonable assurance that long-term performance objectives have been met. The performance confirmation program, which would continue through the closure phase, would include elements of site testing, repository testing, repository subsurface support facilities construction, and waste package testing. Some of these activities would be a continuation of activities that began during site characterization. The data collection focus of the performance confirmation program initially would be to collect additional information to support enhanced confidence in the data used in the License Application. After the granting of licenses, the activities primarily would focus on monitoring and data collection for parameters important to terms and conditions of the license. The types of data important in the performance confirmation programs could include:

- Thermal response of the rock mass
- Air temperature and relative humidity in the emplacement drifts

- Possible emanation of radioactive gases from the emplacement drifts
- Condition of the waste packages and emplacement drifts
- Placement and recovery of test amounts of sample materials in the emplacement drifts
- Saturated zone monitoring
- Possible groundwater flow into the emplacement drifts and evidence of standing water accumulating in the emplacement drifts
- Air permeability, stress, and deformation and displacement of the rocks around the emplacement drifts
- Soil and rock temperature around the repository
- Moisture content, vapor content and humidity, fluid temperature, and air pressure in the rock adjacent to the emplacement drifts that would be most strongly affected by the presence of the emplaced waste

Performance confirmation drifts would be built about 15 meters (50 feet) above the emplacement drifts (see Figures 2-14, 2-15, and 2-16). DOE would drill boreholes from the performance confirmation drifts that would approach the rock mass near the emplacement drifts; instruments in these boreholes would gather data on the thermal, mechanical, hydrological, and chemical characteristics of the rock after waste emplacement. DOE would acquire performance confirmation data by sampling and mapping, from instruments in performance confirmation drifts or along the perimeter mains, ventilation exhaust monitoring, remote inspection systems in emplacement drifts, and possible recovery of waste packages for testing.

The performance confirmation program data would be used to evaluate total system performance and to confirm predicted system response. If the data determined that actual conditions differed from those predicted, the results could support further evaluation of the impacts of actual conditions on the long-term performance of the repository system.

2.1.3 TRANSPORTATION ACTIVITIES

Under the Proposed Action, DOE would transport spent nuclear fuel and high-level radioactive waste from commercial and DOE sites to the repository. The Naval Nuclear Propulsion Program would transport naval spent nuclear fuel from the Idaho National Engineering and Environmental Laboratory to the repository. Transportation activities would include the loading of these materials for shipment at generator sites (Section 2.1.3.1), transportation of the materials to the Yucca Mountain site by truck, rail, or possibly barge [see Sections 2.1.3.2 (National) and 2.1.3.3 (Nevada)], and shipping cask manufacturing, maintenance, and disposal (Section 2.1.3.4).

2.1.3.1 Loading Activities at Commercial and DOE Sites

This EIS evaluates the loading of spent nuclear fuel and high-level radioactive waste at commercial and DOE sites for transportation to the proposed repository at Yucca Mountain. Activities would include removing the spent nuclear fuel or high-level radioactive waste from storage, loading it in a shipping cask, and placing the cask on a vehicle (see Figures 2-24 and 2-25) for shipment to the repository. This EIS assumes that at the time of shipment the spent nuclear fuel and high-level radioactive waste would be in a form that met approved acceptance and disposal criteria for the repository.

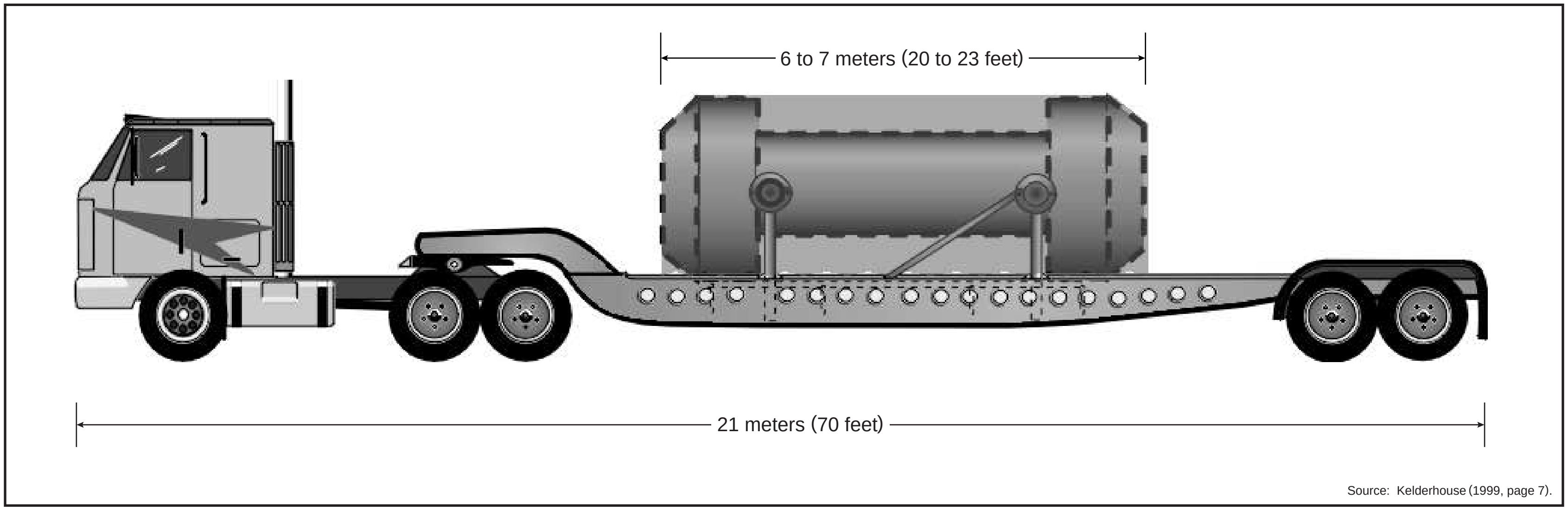


Figure 2-24. Artist's conception of a truck cask on a legal-weight tractor-trailer truck.

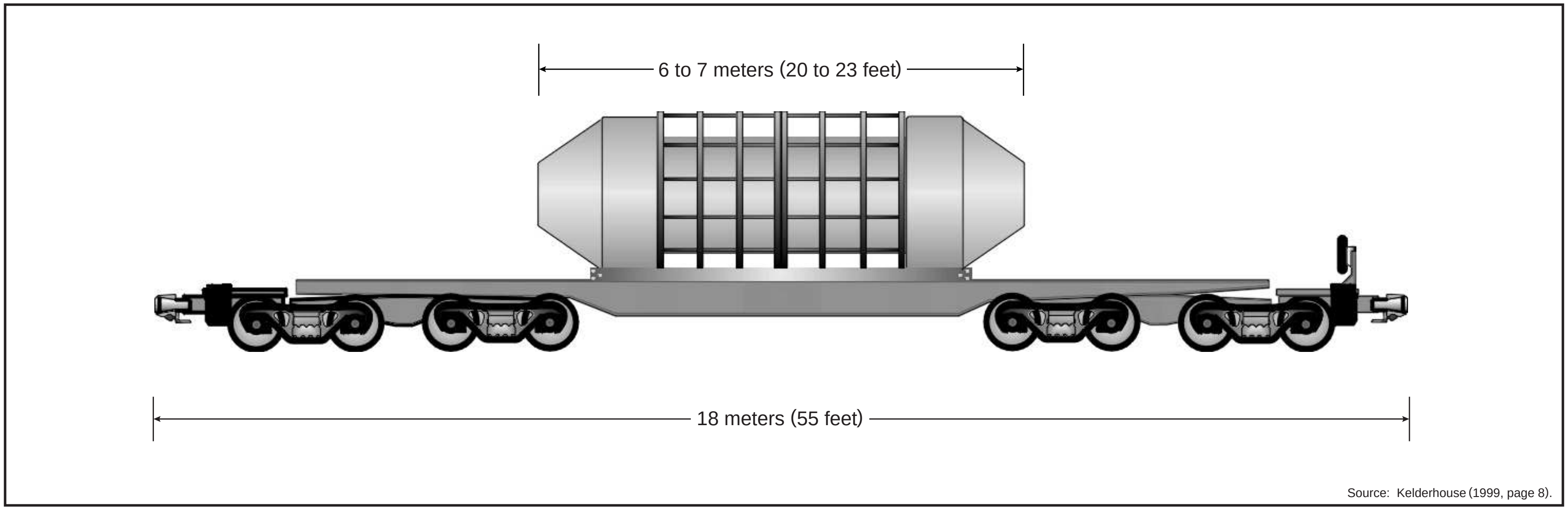


Figure 2-25. Artist's conception of a large rail cask on a railcar.

2.1.3.2 National Transportation

National transportation includes the transport of spent nuclear fuel and high-level radioactive waste from the commercial and DOE sites to the Yucca Mountain site using existing highways (see Figure 2-26) and railroads (see Figure 2-27). Heavy-haul trucks could be used to transport spent nuclear fuel from commercial sites that did not have rail access to a nearby rail access point. Such sites on navigable waterways could use barges to deliver spent nuclear fuel to a nearby rail access point. The transportation of spent nuclear fuel and high-level radioactive waste to the repository would comply with applicable regulations of the U.S. Department of Transportation and the Nuclear Regulatory Commission, as well as applicable state and local regulations.

DOE has developed TRANSCOM, a satellite-based transportation tracking and communications system, to track current truck and rail shipments. Using the TRANSCOM system, DOE would monitor shipments of spent nuclear fuel and high-level radioactive waste to the repository at frequent intervals. This or a similar system could provide users (for example, DOE, the Nuclear Regulatory Commission, and state and tribal governments) with information about shipments to the repository and would enable communication between the vehicle operators and a central communication station. In heavily populated areas, armed escorts would be required for highway and rail shipments (10 CFR 73.37).

Section 180(c) of the Nuclear Waste Policy Act requires DOE to provide technical and financial assistance to states and tribes for training public safety officials in jurisdictions through which it plans to transport spent nuclear fuel and high-level radioactive waste. The training is to include procedures for the safe routine transportation of these materials and for emergency response situations. DOE is developing the policy and procedures for implementing this assistance and has started discussions with the appropriate organizations. The Department would institute these plans before beginning shipments to the repository. In the event of an incident involving a shipment of spent nuclear fuel or high-level radioactive waste, the transportation vehicle crew would notify local authorities and the central communications station monitoring the shipment. DOE would make resources available to local authorities as appropriate to mitigate such an incident.

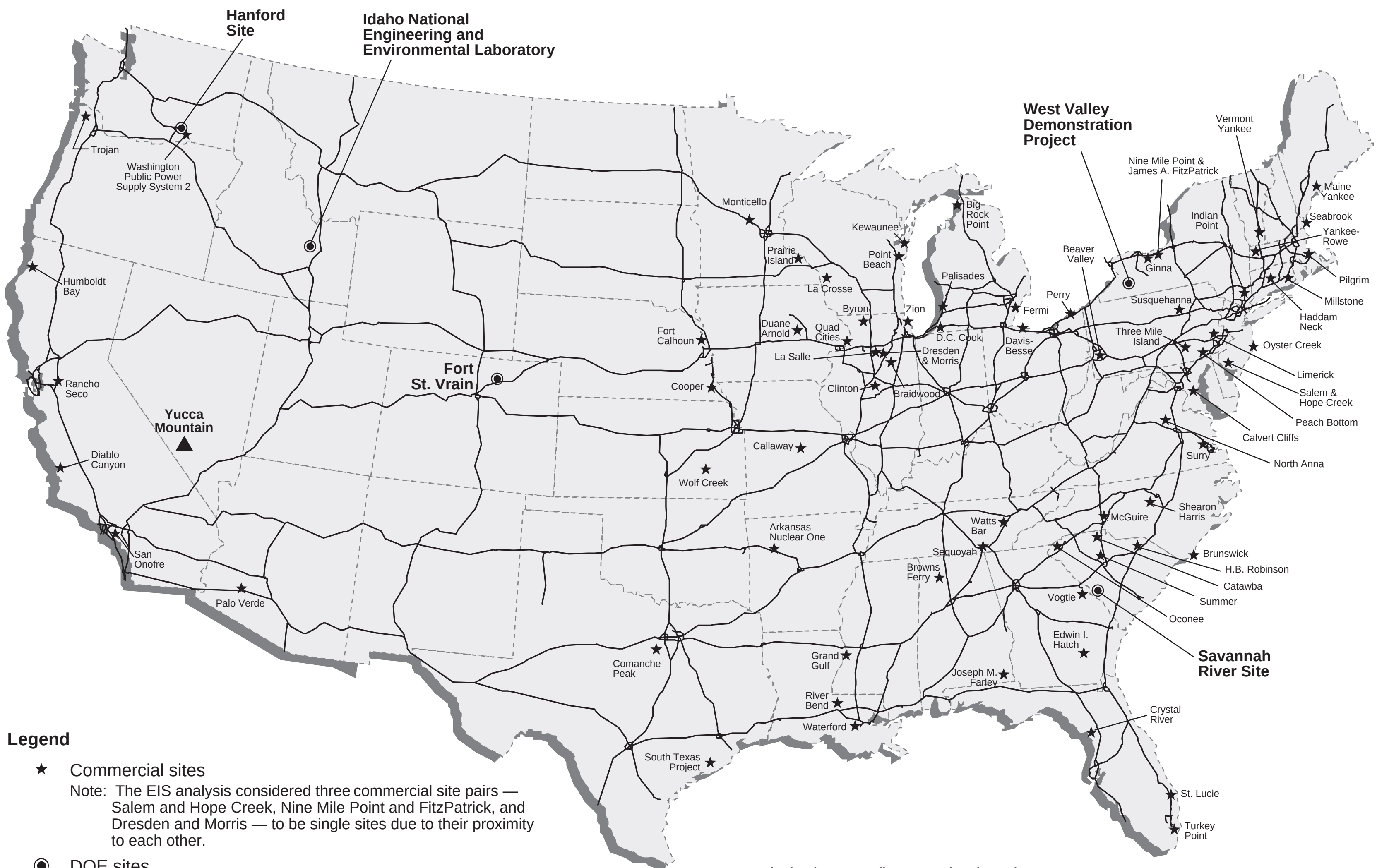
2.1.3.2.1 *National Transportation Shipping Scenarios*

DOE would ship spent nuclear fuel and high-level radioactive waste from commercial and DOE sites in some combination of legal-weight truck, rail, heavy-haul truck, and possibly barge. This EIS considers two national transportation scenarios, which for simplicity are referred to as the mostly legal-weight truck scenario and the mostly rail scenario. These scenarios illustrate the broadest range of operating conditions relevant to potential impacts to human health and the environment. Table 2-2 summarizes these scenarios, and Appendix J provides additional details.

Table 2-2. National transportation scenarios (percentage based on number of shipments).[a]

Material	Mostly legal-weight truck	Mostly rail
Commercial SNF	100% by legal-weight truck	About 80% by rail; about 20% by legal-weight truck
HLW	100% by legal-weight truck	100% by rail
DOE SNF	Mostly legal-weight truck; includes about 300 naval SNF shipments from INEEL to Nevada by rail	100% by rail

a. SNF = spent nuclear fuel; HLW = high-level radioactive waste; INEEL = Idaho National Engineering and Environmental Laboratory.



Legend

★ Commercial sites

Note: The EIS analysis considered three commercial site pairs — Salem and Hope Creek, Nine Mile Point and FitzPatrick, and Dresden and Morris — to be single sites due to their proximity to each other.

◉ DOE sites

Note: The EIS analysis included the high-level radioactive waste and spent nuclear fuel at West Valley. The State of New York owns the high-level radioactive waste and the site. Under the West Valley Demonstration Project Act, DOE is responsible for solidifying and transporting the high-level radioactive waste off the West Valley site. DOE owns and is responsible for the spent nuclear fuel at the site.

—— Interstate highway

Symbols do not reflect precise locations.

Source: Modified from DOE (1998a, Overview, page 5), and Barrett (1998, page 12).

Figure 2-26. Commercial and DOE sites and Yucca Mountain in relation to the U.S. Interstate Highway System.

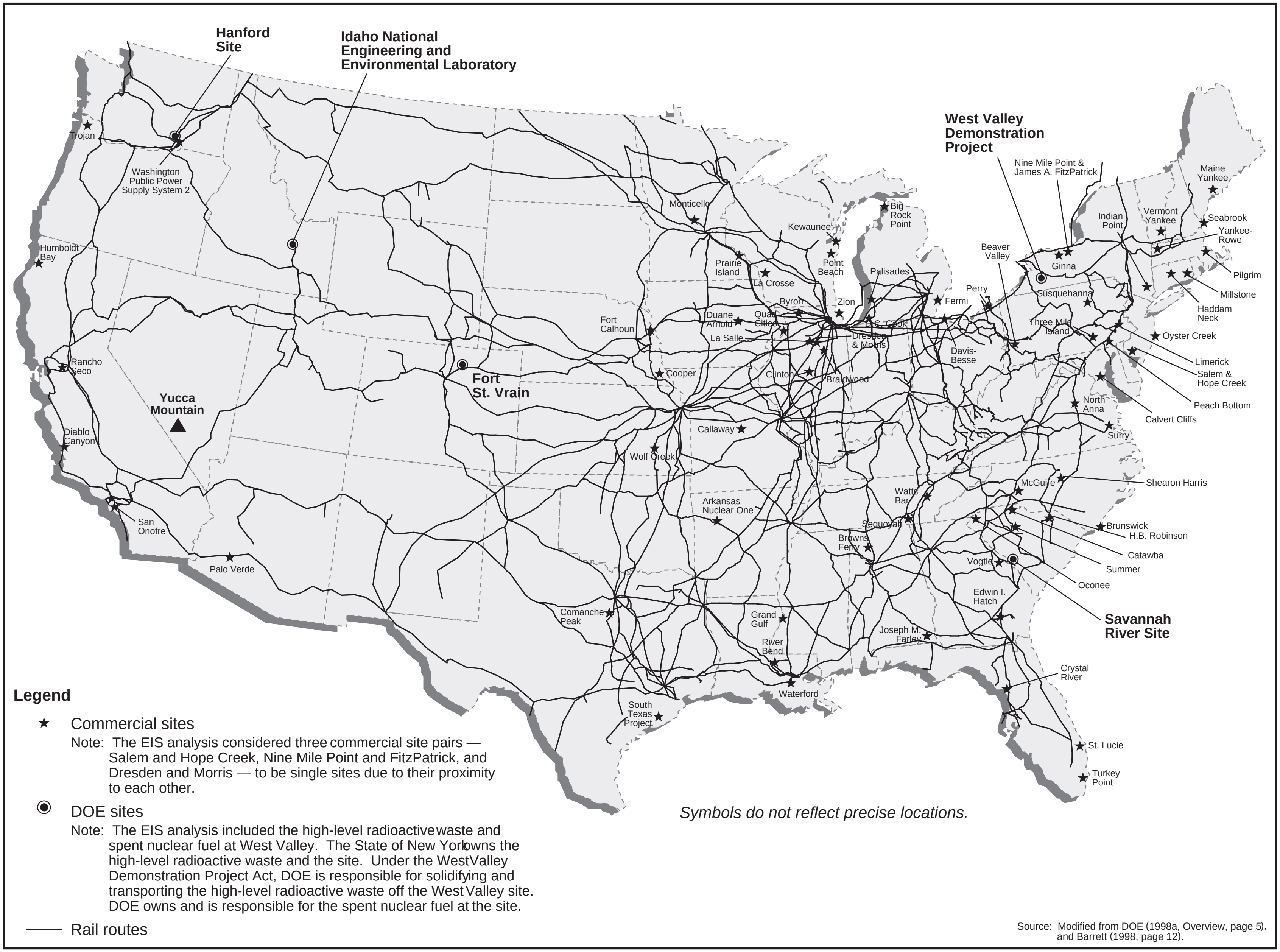


Figure 2-27. Commercial and DOE sites and Yucca Mountain in relation to the U.S. railroad system.

2.1.3.2.2 *Mostly Legal-Weight Truck Shipping Scenario*

Under this scenario, DOE would ship all high-level radioactive waste and most spent nuclear fuel from commercial and DOE sites to the Yucca Mountain site by legal-weight truck. About 50,000 shipments of these materials would travel on the Nation's Interstate Highway System during a 24-year period. There would be about 38,000 commercial spent nuclear fuel shipments and about 12,000 shipments of DOE spent nuclear fuel and high-level radioactive waste. The exception would be about 300 shipments of naval spent nuclear fuel that would travel from the Idaho National Engineering and Environmental Laboratory to Nevada by rail. [The Navy prepared an EIS (USN 1996a, all) and issued two Records of Decision (62 *FR* 1095, January 8, 1997; 62 *FR* 23770, May 1, 1997) on its spent nuclear fuel.]

Truck shipments would use Nuclear Regulatory Commission-certified, reusable shipping casks secured on legal-weight trucks (Figure 2-24). With proper labels and vehicle placards (hazard identification) and vehicle and cask inspections, a truck carrying a shipping cask of spent nuclear fuel or high-level radioactive waste would travel to the repository on highway routes selected in accordance with U.S. Department of Transportation regulations (49 CFR 397.101), which require the use of preferred routes. These routes include the Interstate Highway System, including beltways and bypasses. Alternative routes could be designated by states and tribes following Department of Transportation regulations (49 CFR 397.103) that require consideration of the overall risk to the public and prior consultation with affected local jurisdictions and with any other affected states.

Shipments of naval spent nuclear fuel would travel by rail in reusable shipping casks certified by the Nuclear Regulatory Commission. These shipments would use applicable and appropriate placards and inspection procedures.

2.1.3.2.3 *Mostly Rail Shipping Scenario*

Under this scenario, DOE would ship most spent nuclear fuel and high-level radioactive waste to Nevada by rail, with the exception of material from commercial nuclear sites that do not have the capability to load large-capacity rail shipping casks. Those sites would ship spent nuclear fuel to the repository by legal-weight truck. Commercial sites that have the capability to load large-capacity rail shipping casks but not rail access could use heavy-haul trucks or barges to transport their spent nuclear fuel to a nearby rail line. Under this scenario, about 11,000 railcars of spent nuclear fuel and high-level radioactive waste would travel on the nationwide rail network over a period of 24 years. Rail shipments would consist of Nuclear Regulatory Commission-certified, reusable shipping casks secured on railcars (see Figure 2-25). In addition, there would be about 2,600 legal-weight truck shipments. All shipments would be marked with the appropriate labels and placards and would be inspected in accordance with applicable regulations.

Some of the logistics of rail transportation to the repository would depend on whether DOE used general or dedicated freight service. General freight shipments of spent nuclear fuel and high-level radioactive waste would be part of larger trains carrying other commodities. A number of transfers between trains could occur as a railcar traveled to the repository. The basic infrastructure and activities would be similar between general freight and dedicated trains. However, dedicated train service would contain only railcars destined for the repository. In addition to railcars carrying spent nuclear fuel or high-level radioactive waste, there would be buffer and escort cars, in accordance with Federal regulations. DOE would use a satellite-based system to monitor all spent nuclear fuel shipments (see Section 2.1.3.2).

TERMS RELATED TO RAIL SHIPPING

General freight rail service: A train that handles a number of commodities. Railcars carrying spent nuclear fuel or high-level radioactive waste could switch in railyards or on sidings to a number of trains as they traveled from commercial and DOE sites to Nevada.

Dedicated freight rail service: A train that handles only one commodity (in this case, spent nuclear fuel or high-level radioactive waste). Use of a separate train with its own crew carrying spent nuclear fuel or high-level radioactive waste would avoid switching railcars between trains.

Buffer cars: Railcars placed in front and in back of those carrying spent nuclear fuel or high-level radioactive waste to provide additional distance from possibly occupied railcars. Federal regulations (49 CFR 174.85) require the separation of a railcar carrying spent nuclear fuel or high-level radioactive waste from a locomotive, occupied caboose, or carload of undeveloped film by at least one buffer car. These could be DOE railcars or, in the case of general freight service, commercial railcars.

Escort cars: Railcars in which escort personnel (for example, security personnel) would reside on trains carrying spent nuclear fuel or high-level radioactive waste.

2.1.3.3 Nevada Transportation

Nevada transportation is part of national transportation, but the EIS also discusses it separately. Depending on how a shipment was transported, DOE could use one of three options or modes of transportation in Nevada: legal-weight trucks, rail, or heavy-haul trucks. Legal-weight truck shipments arriving in Nevada would travel directly to the Yucca Mountain site. Two Interstate highways cross Nevada—I-80 in the north and I-15 in the south. I-15, the closest Interstate highway to the proposed repository, travels through Salt Lake City, Utah, to southern California, passing through Las Vegas. Figure 2-28 shows the existing highway infrastructure in southern Nevada. The EIS analysis assumed that the proposed Interstate bypass around the urban core of Las Vegas (the Las Vegas Beltway) would be operational before 2010.

Shipments arriving in Nevada by rail would travel to the repository site by rail or heavy-haul truck (legal-weight trucks could not be used due to the size and weight of the rail shipping casks). Existing rail lines in the State include two northern routes and one southern route; the Southern Pacific Railroad owns one of the northern routes and the Union Pacific Railroad owns the other northern route and the southern route. The northern routes pass through or near the cities of Elko, Carlin, Battle Mountain, and Reno. The southern route runs through Salt Lake City, Utah, to Barstow, California, passing through Caliente, Las Vegas, and Jean, Nevada. Figure 2-29 shows the Nevada rail infrastructure. Rail access is not currently available to the Yucca Mountain site, so DOE would have to build a branch rail line from an existing mainline railroad to the site or transfer the rail cask to a heavy-haul truck at an intermodal transfer station for transport to the repository.

To indicate distinctions between available transportation options or modes in Nevada and to define the range of potential impacts associated with transportation in the State, this EIS analyzes three transportation scenarios: the first, associated with the national legal-weight truck scenario, is a Nevada legal-weight truck scenario; the second and third, both associated with the national rail scenario, are rail transport directly to the Yucca Mountain site, and an intermodal transfer from railcar to heavy-haul truck for travel to the site. Table 2-3 summarizes the Nevada transportation scenarios.

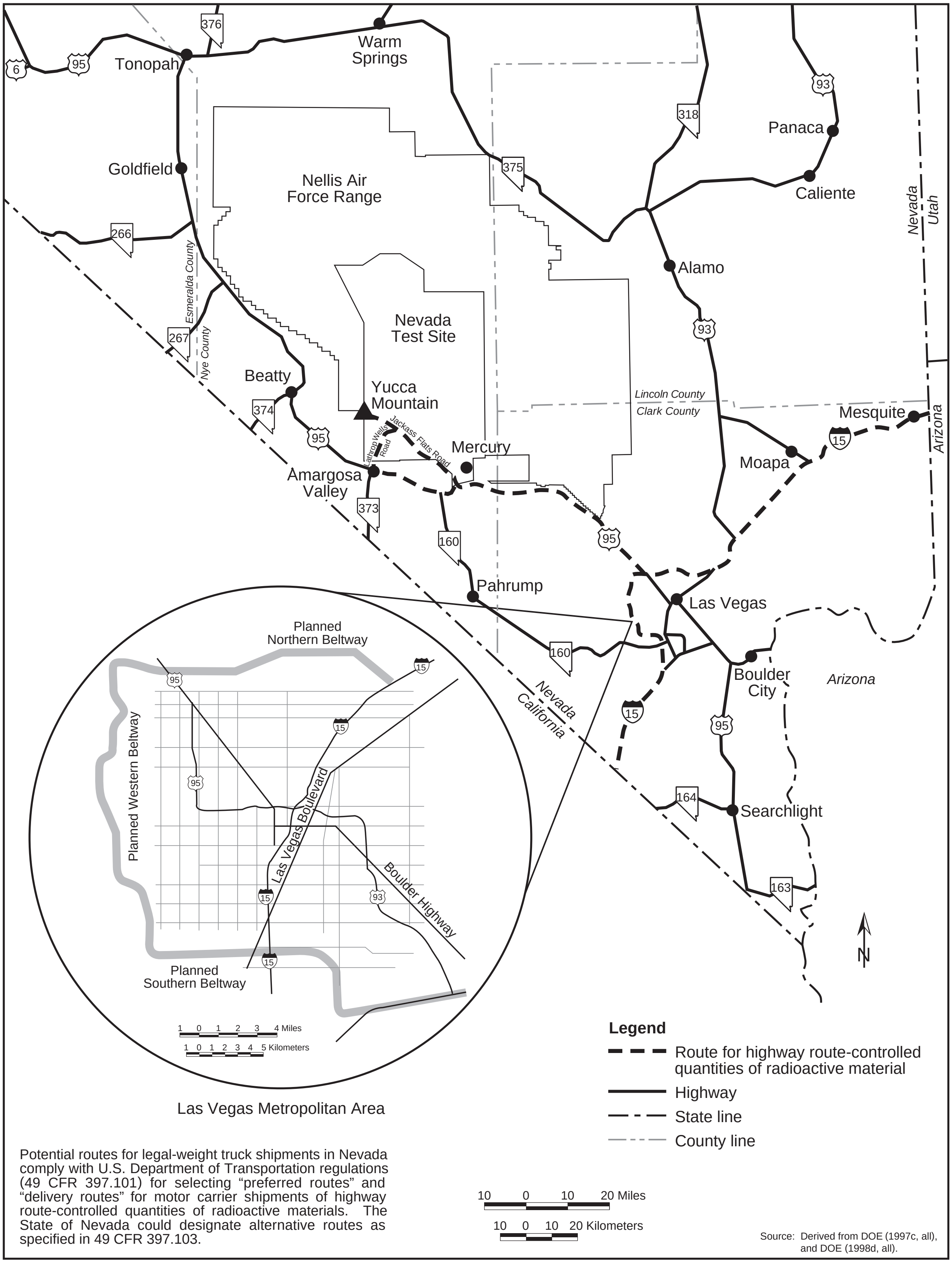


Figure 2-28. Southern Nevada highways.

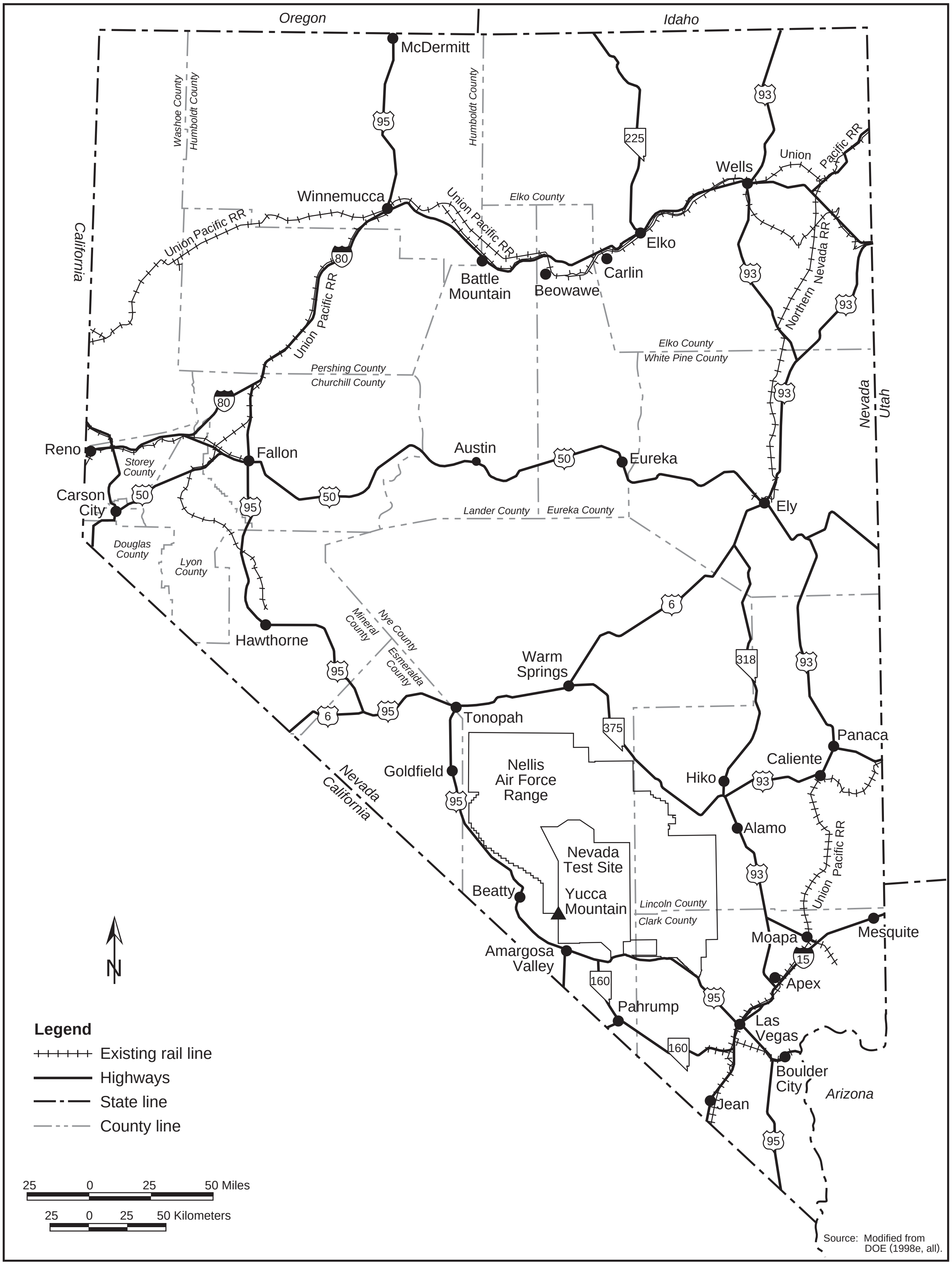


Figure 2-29. Existing Nevada rail lines.

Table 2-3. Nevada transportation shipping scenarios (percentage based on number of shipments).[a]

Material	Mostly legal-weight truck	Mostly rail	Mostly heavy-haul truck[b]
Commercial SNF	100% by legal-weight truck	About 80% by rail; about 20% by legal-weight truck	About 80% by heavy-haul truck; about 20% by legal-weight truck
HLW	100% by legal-weight truck	100% by rail	100% by heavy-haul truck
DOE SNF	Mostly by legal-weight truck; includes about 300 naval SNF shipments by rail and heavy-haul truck	100% by rail	100% by heavy-haul truck

a. SNF = spent nuclear fuel; HLW = high-level radioactive waste.
b. Rail shipment to intermodal transfer station, and heavy-haul truck shipment from intermodal transfer station to the repository.

The following sections describe the Nevada transportation scenarios and the implementing alternatives DOE is considering for a new branch rail line or a new intermodal transfer station and associated highway route for heavy-haul trucks. Detailed engineering descriptions are based on TRW (1999d, all), unless otherwise noted.

2.1.3.3.1 *Nevada Legal-Weight Truck Scenario*

Under this scenario, DOE would use legal-weight trucks in Nevada to transport spent nuclear fuel and high-level radioactive waste to the repository. Naval spent nuclear fuel would be transported to Nevada by rail. In Nevada, DOE would use heavy-haul trucks to transport these 300 shipments. DOE would establish an intermodal transfer capability and an associated heavy-haul shipment capability (see Section 2.1.3.3.3).

Legal-weight truck shipments would use existing routes that satisfy regulations of the U.S. Department of Transportation for the shipment of highway route-controlled quantities of radioactive materials (49 CFR 397.101). Legal-weight trucks would enter Nevada on I-15 from the north or south, bypass the Las Vegas area on the proposed beltway, and travel north on U.S. 95 to the Nevada Test Site and then to the Yucca Mountain site (Figure 2-28).

2.1.3.3.2 *Nevada Rail Scenario*

Under this scenario, DOE would construct and operate a branch rail line in Nevada. Based on previous studies (described in Section 2.3), DOE has narrowed its consideration for a new branch rail line to five potential rail corridors—Caliente, Carlin, Caliente-Chalk Mountain, Jean, and Valley Modified. These rail corridors are shown on Figure 2-30 and are described in the following paragraphs. DOE would need to obtain a 0.4-kilometer (0.25-mile)-wide right-of-way to construct a rail line and an associated access road. As shown in Figure 2-30, there are possible alignment variations, which are described further in Appendix J.

- *Caliente Rail Corridor Implementing Alternative.* The Caliente corridor originates at an existing siding to the Union Pacific mainline railroad near Caliente, Nevada (Figure 2-30). The corridor is 513 kilometers (319 miles) long from the Union Pacific line connection to the Yucca Mountain site.

- *Carlin Rail Corridor Implementing Alternative.* The Carlin corridor originates at the Union Pacific main line railroad near Beowawe in north-central Nevada (Figure 2-30). The Carlin and Caliente corridors converge near the northwest boundary of the Nellis Air Force Range (also known as the Nevada Test and Training Range). Past this point, they are identical. The corridor is 520 kilometers (323 miles) long from the tie-in point with the Union Pacific line to the Yucca Mountain site.

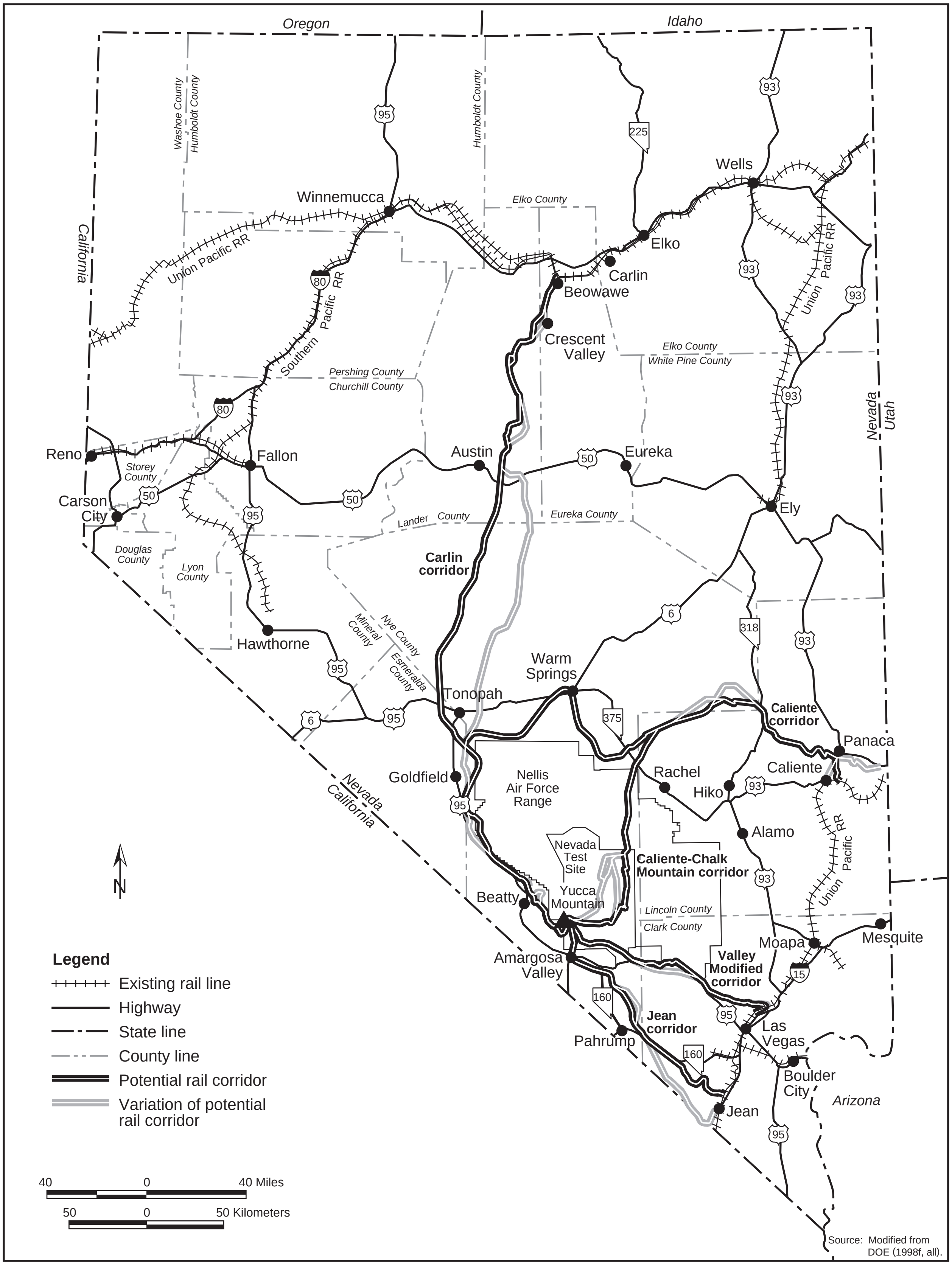


Figure 2-30. Potential Nevada rail routes to Yucca Mountatin.

- *Caliente-Chalk Mountain Rail Corridor Implementing Alternative.* The Caliente-Chalk Mountain corridor is identical to the Caliente corridor until it approaches the northern boundary of the Nellis Air Force Range. At that point the Caliente-Chalk Mountain corridor turns south through the Nellis Air Force Range and the Nevada Test Site to the Yucca Mountain site (Figure 2-30). The corridor is 345 kilometers (214 miles) long from the tie-in point at the Union Pacific line to the Yucca Mountain Site.

- *Jean Rail Corridor Implementing Alternative.* The Jean corridor originates at the existing Union Pacific mainline railroad near Jean, Nevada (Figure 2-30). The corridor is 181 kilometers (112 miles) long from the tie-in point at the Union Pacific line to the Yucca Mountain site.

- *Valley Modified Rail Corridor Implementing Alternative.* The Valley Modified corridor originates at an existing rail siding off the Union Pacific mainline railroad northeast of Las Vegas. The corridor is about 159 kilometers (98 miles) long from the tie-in point with the Union Pacific line to the Yucca Mountain site.

2.1.3.3.2.1 Rail Line Construction. The selected rail line would be designed and built in compliance with Federal Railroad Administration safety standards. In addition, a service road along the rail line would be built and maintained. Rail line construction along any of the corridors would take an estimated 2.5 years. Construction would start after the selection of a route, completion of engineering studies, completion of the rail line design, and land acquisition.

Construction activities would include the development of construction support areas; construction of access roads to the rail line construction initiation points and to major structures to be built, such as bridges; and movement of equipment to the construction initiation points. The number and location of construction initiation points would be based on such variables as the route selected, the length of the line, the construction schedule, the number of contractors used for construction, the number of structures to be built, and the locations of existing access roads adjacent to the rail line.

RAILROAD CONSTRUCTION TERMS

Borrow areas: Areas outside the rail corridor where construction personnel could obtain materials to be used in the establishment of a stable platform (subgrade) for the rail track. Aggregate crushing operations could occur in these areas.

Spoils areas: Areas outside the rail corridor for the deposition of excavated materials from rail line development.

Construction support areas: Areas along the rail route that could be used as temporary residences for construction crews, material and equipment storage areas, and concrete production areas. Such camps probably would be for the construction of routes far from population centers.

The construction of a rail line would require the clearing and excavation of previously undisturbed lands in the corridor and the establishment of borrow and spoils areas outside the corridor. To establish a stable platform for the rail track, construction crews would excavate some areas and fill (add more soil to) others, as determined by terrain features. To the extent possible, material excavated from one area would be used in areas that required fill material. However, if the distance to an area requiring fill material was excessive, the excavated material would be disposed of in adjacent low areas, and a borrow area would be established adjacent to the area requiring fill material. Access roads to spoils and borrow areas would be built during the track platform construction work.

Typical heavy-duty construction equipment (front-end loaders, power shovels, and other diesel-powered support equipment) would be used for clearing and excavation work. Trucks would spray water along graded areas for dust control and soil compaction. The fill material used along the rail line to establish a stable platform for the track would be compacted to meet design requirements. Water could be shipped from other locations or obtained from wells drilled along the route.

Railroad track construction would consist of the placement of railbed material, ties, rail, and ballast (support and stabilizing materials for the rail ties) over the completed railbed platform. Other activities would include the following:

- Installation of at-grade crossings (which would require rerouting existing utility lines in some areas)
- Installation of fences along the rail line, if requested by other agencies (for example, the Bureau of Land Management or the Fish and Wildlife Service)
- Installation of the train control system (monitoring equipment, signals, communications equipment)
- Final grading of slopes, installation of rock-fall protection devices, replacement of topsoil, revegetation and installation of other permanent erosion control systems, and completion of the adjacent maintenance road

2.1.3.3.2.2 Rail Line Operations. Branch rail line operations from the junction with the main line to the proposed repository at Yucca Mountain would meet Federal Railroad Administration standards for maintenance, operations, and safety. Current plans for the branch rail line anticipate a train with two 3,000-horsepower, diesel-electric locomotives; from one to five railcars containing spent nuclear fuel and high-level radioactive waste; buffer cars; and escort cars.

The operational interface between the Union Pacific and the branch rail line would be determined by whether the waste was shipped to Nevada by dedicated rail service or by general freight rail service. With dedicated rail service to Nevada, the railcars would be transferred to the branch rail line and shipped immediately to the repository. With general freight service, the railcars carrying spent nuclear fuel or high-level radioactive waste could be parked on a side track (off the main rail line) at the connection point until a train could be assembled to travel to the repository site. A small secure railyard off the main rail line would be established for switching operations. Railcars with spent nuclear fuel or high-level radioactive waste would have to be moved within 48 hours in accordance with U.S. Department of Transportation regulations (49 CFR 174.14).

This EIS assumes there would be about four trains per week for shipments of spent nuclear fuel and high-level radioactive waste to the repository. In addition, the rail line would enable the transport of other material to the repository, including empty disposal containers, bulk concrete materials, steel, large equipment, and general building materials. The EIS assumes one train per week for this other material for a total of about five trains per week to the repository from about 2010 to 2033.

2.1.3.3.3 *Nevada Heavy-Haul Truck Scenario*

Under this scenario, rail shipments to Nevada would go to an intermodal transfer station where the shipping cask would transfer from the railcar to a heavy-haul truck. The heavy-haul truck would travel on existing roads to the repository. The following sections describe the implementing alternatives (the intermodal transfer station locations and associated highway routes for heavy-haul trucks) that the EIS analyzes.

2.1.3.3.3.1 Intermodal Transfer Stations. To enable intermodal transfers and heavy-haul shipments to the repository, an intermodal transfer station would be built and operated in Nevada. DOE is considering three potential locations for intermodal transfer operations: near Caliente, northeast of Las Vegas (Apex/Dry Lake), and southwest of Las Vegas (Sloan/Jean) (Figure 2-31). DOE has identified general areas at these three locations where it could build and operate an intermodal transfer station:

- *Caliente Intermodal Transfer Station Implementing Alternative.* The Caliente siting areas are south of Caliente in the Meadow Valley Wash. DOE has identified two possible areas along the west side of the wash.

- *Apex/Dry Lake Intermodal Transfer Station Implementing Alternative.* The potential areas northeast of Las Vegas are between the Union Pacific rail sidings at Dry Lake and Apex. Two large contiguous areas are available for intermodal transfer station siting near the Apex/Dry Lake sidings. The first area is directly adjacent to the Dry Lake siding along the west side of the Union Pacific line. The second area is on the east side of I-15 adjacent to the Union Pacific line and south of where the main Union Pacific line crosses I-15. Because this area is between the Dry Lake and Apex sidings, the construction of an additional rail siding would be necessary.

- *Sloan/Jean Intermodal Transfer Station Implementing Alternative.* The potential areas for an intermodal transfer station southwest of Las Vegas are between the existing Union Pacific rail sidings at Sloan and Jean. One area is on the west side of I-15, north of the Union Pacific rail underpass at I-15. The second is south of the Sloan rail siding along the east side of the rail line. A third area is south of the second, directly north of the Jean interchange on I-15.

The intermodal transfer station would be a fenced area of about 250 meters (820 feet) by 250 meters and a rail siding that would be about 2 kilometers (1.2 miles) long (see Figure 2-32). The estimated total area occupied by the facility and support areas would be about 0.2 square kilometer (50 acres). It would include rail tracks, two shipping cask transfer cranes (one on a gantry rail, and one on a backup rubber-tired vehicle), an office building, and a maintenance and security building. It would also have connection tracks to the existing Union Pacific line and storage and transfer tracks inside the station boundary. The maintenance building would provide space for routine service and minor repairs to the heavy-haul trailers and tractors. The station would have power, water, and other services. Diesel generators would provide a backup electric power source. Construction of an intermodal transfer station would take an estimated 1.5 years.

Intermodal transfer station operations would depend on whether the railcars that carried spent nuclear fuel and high-level radioactive waste arrived on dedicated or general freight trains. A dedicated train would enter the intermodal transfer station, passing the opened security gate and parking on a track for cask inspection. After inspection, the train would proceed to a loading and unloading track or a designated storage track (if the loading and unloading tracks were occupied).

General freight trains would switch from the main Union Pacific track to an existing or newly constructed passing track. The railcars carrying casks of spent nuclear fuel or high-level radioactive waste would be uncoupled from the freight train and switched to the intermodal transfer station track. The freight train would return to the main Union Pacific line and continue its trip. A railyard locomotive would move the cars containing the casks to the station.

The loading and unloading process would begin with the return of a heavy-haul truck from the repository. The empty cask returning from the repository would be lifted from the truck, loaded on an empty railcar, and secured. The gantry or mobile crane would then remove a loaded cask from another railcar and transfer it to the same truck, where it would be secured and inspected before shipment to the repository.

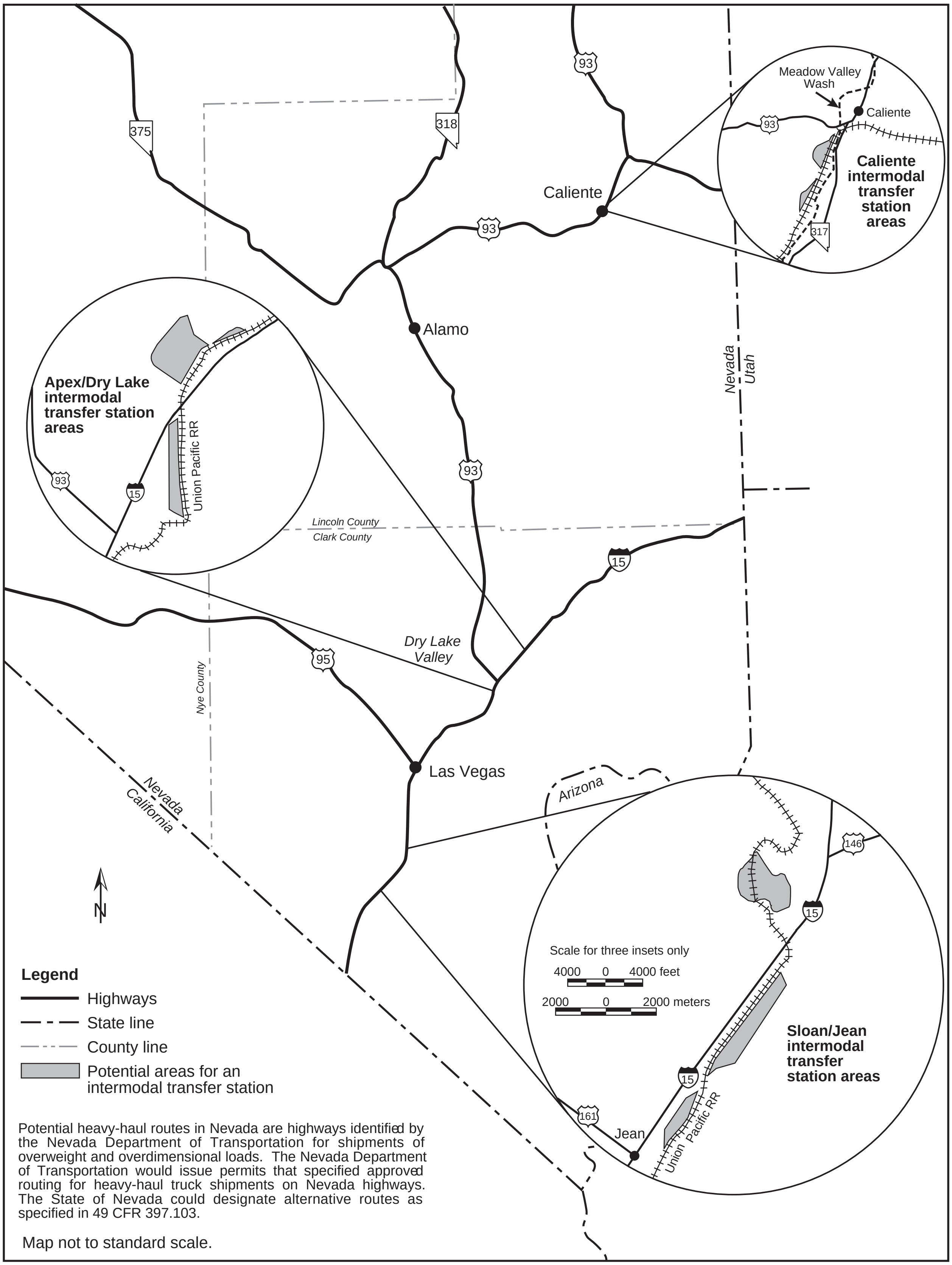


Figure 2-31. Potential intermodal transfer station locations.

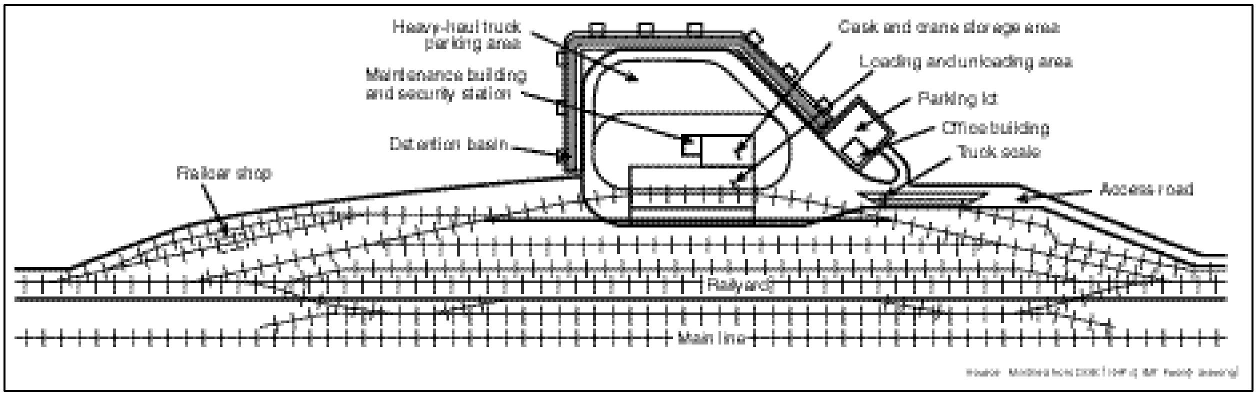


Figure 2-32. Conceptual diagram of intermodal transfer station layout.

The station would accept railcars as they arrived (24 hours a day, 7 days a week), but it would normally dispatch heavy-haul trucks during early morning daylight hours on weekdays, consistent with current Nevada heavy-haul shipment regulations.

At the completion of the 24 years of shipping, the intermodal transfer station would be decommissioned and, if possible, reused.

2.1.3.3.3.2 Highway Routes for Heavy-Haul Shipments. Figure 2-33 is an illustration of a heavy-haul truck that DOE could use to transport spent nuclear fuel and high-level radioactive waste to the repository. The heavy-haul truck would weigh about 91,000 kilograms (200,000 pounds) unloaded and would be up to 67 meters (220 feet) long. It would be custom-built for repository shipments. Average trip speeds would be 32 to 48 kilometers (20 to 30 miles) per hour.

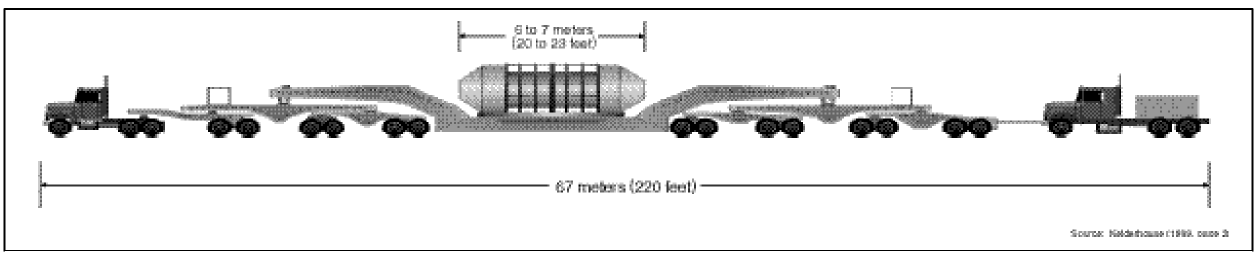


Figure 2-33. Artist's conception of a heavy-haul truck carrying a rail shipping cask.

Heavy-haul truck shipments from an intermodal transfer station to the repository would comply with U.S. Department of Transportation requirements for shipments of highway route-controlled quantities of radioactive materials (49 CFR Part 177) and with State of Nevada permit requirements for heavy-haul shipments. Nevada permits heavy-haul shipments on Monday through Friday (excluding holidays) but only in daylight hours.

Road upgrades for candidate routes, if necessary, would involve four kinds of construction activities: (1) widening the shoulders and constructing turnouts and truck lanes, (2) upgrading intersections that are inadequate for heavy-haul truck traffic, (3) increasing the asphalt thickness (overlay) of some sections, and (4) upgrading engineered structures such as culverts and bridges. The overlay work would include upgrades needed to remove frost restrictions from some road sections.

Shoulder widening and the construction of turnouts and truck lanes would occur as needed along the side of the existing pavement. Shoulders would be widened from 0.33 or 0.66 meter (1 or 2 feet) to 1.2 meters (4 feet). Widening would build the existing shoulder up to pavement height. Truck lanes would be built on roadways with grades exceeding 4 percent. Turnout lanes would be built approximately every 8 to 32 kilometers (5 to 20 miles) depending on projected traffic. The truck lanes and turnouts would require land clearing and soil excavation or fill to establish the roadway. Culverts under the roadway would be lengthened. Most borrow material for construction could come from existing Nevada Department of Transportation borrow areas, if the State agreed. Asphalt could be produced at a portable plant in the borrow areas. Appendix J contains descriptions of the specific highway improvements for the five routes.

The following paragraphs describe the potential highway routes for heavy-haul trucks DOE is considering for the intermodal transfer station location and unique operational considerations for each route.

- *Caliente Intermodal Transfer Station Highway Routes.* Heavy-haul trucks leaving the Caliente intermodal transfer station could travel on one of three potential routes: (1) Caliente, (2) Caliente-Chalk Mountain, and (3) Caliente-Las Vegas (see Figure 2-34).

  The Caliente route would be approximately 533 kilometers (331 miles) long. Heavy-haul trucks leaving an intermodal transfer station in the Caliente area would travel directly from the station to U.S. Highway 93. The trucks would travel west on U.S. 93 to State Route 375, then on State Route 375 to the intersection with U.S. Highway 6. The trucks would continue on U.S. 6 to the intersection with U.S. 95 in Tonopah, then into Beatty on U.S. 95, where an alternate truck route would be built because the existing intersection is too constricted to allow a turn. Heavy-haul trucks would then travel south on U.S. 95 to the Lathrop Wells Road exit, which accesses the Yucca Mountain site. Because of the estimated travel time associated with the Caliente route and the restriction on nighttime travel for heavy-haul vehicles, DOE would construct a parking area along the route to enable these vehicles to park overnight. This parking area would be near the U.S. 6 and U.S. 95 interchange at Tonopah.

  The Caliente-Chalk Mountain route would be approximately 282 kilometers (175 miles) long. Heavy-haul trucks leaving an intermodal transfer station in the Caliente area would travel directly from the station to U.S. 93. The trucks would travel on U.S. 93 to State Route 375, on State Route 375 to Rachel, and head south through the Nellis Air Force Range to the Nevada Test Site.

  The Caliente-Las Vegas route would be approximately 377 kilometers (234 miles) long. Heavy-haul trucks leaving an intermodal transfer station in the Caliente area would travel directly from the station to U.S. 93. The trucks would travel south on U.S. 93 to the intersection with I-15, northeast of Las Vegas. The trucks would travel south on I-15 to the exit for the proposed northern Las Vegas Beltway, then would travel west on the beltway. They would leave the beltway at U.S. 95, and head north on U.S. 95 to the Nevada Test Site. The trucks would travel on Jackass Flats Road on the Nevada Test Site to the Yucca Mountain site.

- *Apex/Dry Lake Intermodal Transfer Station Highway Route.* Heavy-haul trucks would leave the intermodal transfer station at the Apex/Dry Lake location and enter I-15 at the Apex interchange. The trucks would travel south on I-15 to the exit to the proposed northern Las Vegas Beltway, and would travel west on the beltway. The trucks would leave the beltway at U.S. 95, and travel north on U.S. 95 to the Nevada Test Site. They would then travel on Jackass Flats Road on the Nevada Test Site to the Yucca Mountain site. This route is about 183 kilometers (114 miles) long (see Figure 2-34).

- *Sloan/Jean Intermodal Transfer Station Highway Route.* Heavy-haul trucks leaving a Sloan/Jean intermodal transfer station would enter I-15 at the Sloan interchange. The trucks would travel on I-15 to the exit to the southern portion of the proposed Las Vegas Beltway, and then travel northwest on the beltway. They would leave the beltway at U.S. 95, and travel to the Nevada Test Site. They would then travel on Jackass Flats Road to the Yucca Mountain site. This route would be approximately 188 kilometers (117 miles) long (see Figure 2-34).

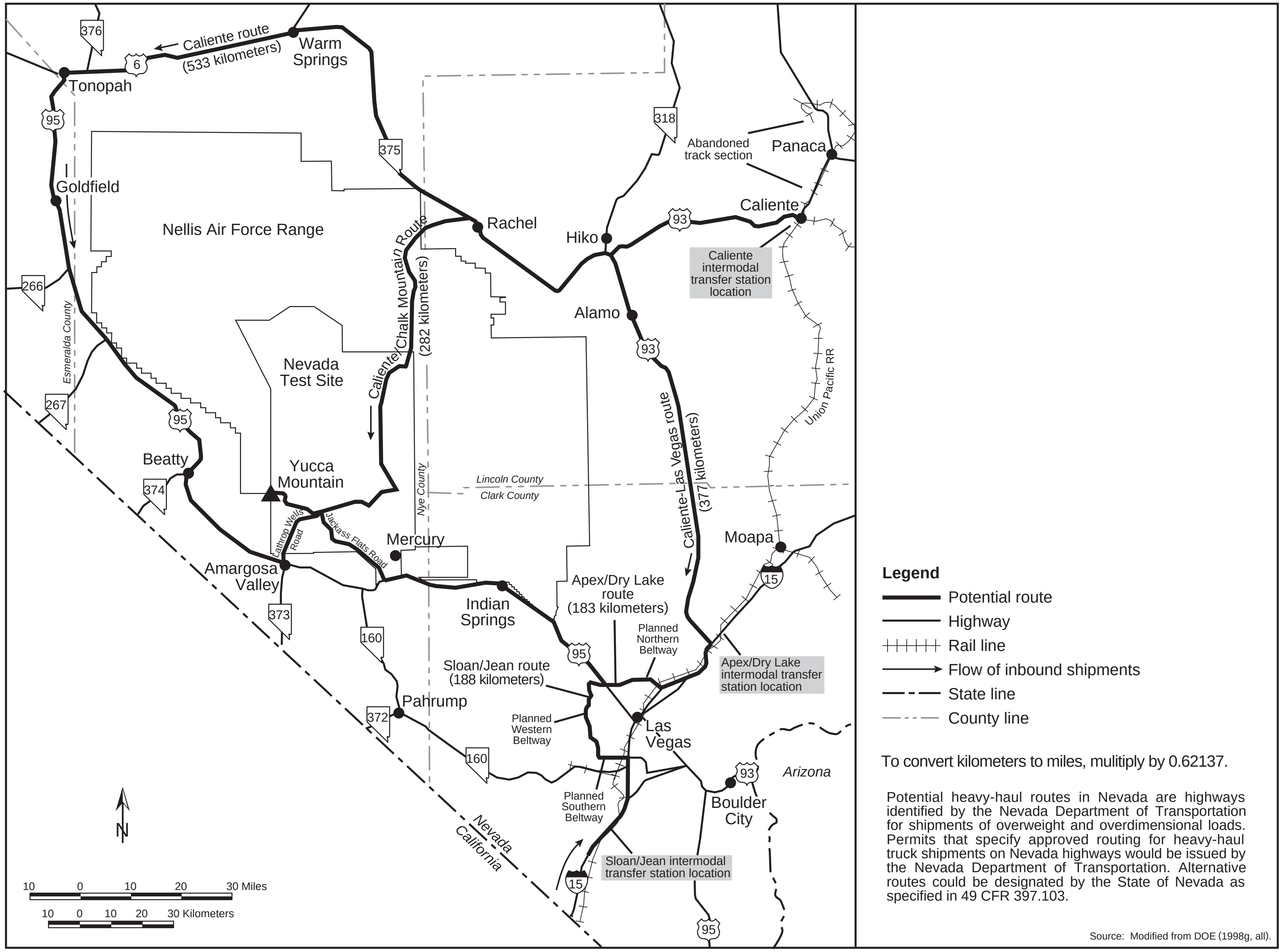


Figure 2-34. Potential routes in Nevada for heavy-haul trucks.

2.1.3.4 Shipping Cask Manufacturing, Maintenance, and Disposal

To transport spent nuclear fuel and high-level radioactive waste to the repository, DOE would use existing or new shipping casks that met Nuclear Regulatory Commission regulations (10 CFR Part 71). One or more qualified companies that provide specialized metal structures, tanks, and other heavy equipment would manufacture new shipping casks. The number and type of shipping casks required would depend on the predominant mode of transportation.

DOE would remove casks from service periodically for maintenance and inspection. These activities would occur at a cask maintenance facility(s) where cask functions and components would be checked and inspected in compliance with Nuclear Regulatory Commission requirements and preventive maintenance procedures. The major operations involved in cask maintenance would include decontamination, replacement of limited-life components such as O-rings, and verification of radiation shielding integrity, structural integrity, and heat transfer efficiency.

The large number of repository shipments would require new facilities for cask maintenance. DOE has not decided where in the United States it would locate a cask maintenance facility(s), but this EIS assumes that such a facility would be at the repository inside the Restricted Area at the North Portal on approximately 0.01 square kilometer (2.5 acres). Minor cask maintenance activities could occur at commercial or DOE sites.

2.1.4 ALTERNATIVE DESIGN CONCEPTS AND DESIGN FEATURES

The EIS analyzed thermal load and packaging scenarios to identify the range of potential short- and long-term impacts of a repository at Yucca Mountain. This analysis used conceptual designs, which is typical for an EIS. However, the level of design is insufficient to meet information needs for a License Application to the Nuclear Regulatory Commission. Therefore, the repository design will continue to evolve through the submittal of the License Application.

As part of this evolving design process, DOE is evaluating various design features and alternatives. The purpose of the evaluation is to determine if these features and alternatives would reduce uncertainties in the long-term performance of the repository, reduce costs, or improve operations. Other construction materials could be evaluated in the future. The License Application Design Selection project is considering a variety of design alternatives and features, as described in Appendix E. In addition, DOE has made preliminary identification of five combinations of design features and alternatives, called Enhanced Design Alternatives, as part of this process (Table 2-4). The EIS analysis categorized the design features and alternatives into three groups, based on their primary function, which are intended to:

- Limit the release and transport of radionuclides
- Control the thermal/moisture environment in the repository
- Support operational and cost considerations

The following sections summarize the design approaches for the three groups DOE is considering within the scope of the design features and alternatives.

2.1.4.1 Design Features and Alternatives To Limit Release and Transport of Radionuclides

The features related to improving the barriers that limit the release and transport of radioactive material focus on two areas of the design. Some of the features focus on improvements in the long-term integrity

Table 2-4. Design features and alternatives used to form Enhanced Design Alternatives.

Category	Enhanced Design Alternative I	II	III	IV	V
Barriers to limit release and transport of radionuclides					
Drip shields	X[a]	X	X	X	X
Backfill to protect waste package and drip shield from rockfall		X		X	
Waste package corrosion-resistant barrier	X	X	X		X
Additives and fillers				X	
Ground support options			X		
Repository design to control thermal/moisture environment					
Low thermal alternative evaluation	X	X			
Aging and blending of waste	X	X			X
Continuous postclosure ventilation	X	X	X	X	X
Drift diameter	X				
Waste package spacing and drift spacing	X	X	X	X	X
Higher thermal load					X
Repository designs to support operational and cost considerations					
Enhanced access design	X	X	X	X	X
Timing of repository closure	X	X	X	X	X
Maintenance of underground design features and ground support			X		

a. X specifies what is used in each Enhanced Design Alternative.

of the waste packages; others focus on limiting the transport of radioactive material released from a waste package to the environment. Examples of designs include the following:

- Designs to improve the long-term integrity of waste packages, including coating the package with a ceramic or using multiple types of corrosion-resistant materials, which should directly reduce waste package failure due to corrosion.

- Designs to reduce the potential of structural damage to waste packages from rockfall, such as backfilling the drifts or providing mechanical support to the drift wall (concrete or steel liner).

- Designs to limit the transport of radionuclides, including additives and fillers to the waste packages or getters under the waste packages; these substances would capture radionuclides chemically to limit transport.

Some features provide the potential to limit both the release and transport of radionuclides, and to modify the temperature environment. For instance, backfill could protect against the release and transport of contaminants by capturing corrosive salts in the water and retarding flow and by increasing the emplacement drift temperature to decrease the relative humidity. For convenience of presentation, each feature is listed in only one category.

2.1.4.2 Design Features and Alternatives To Control the Thermal/Moisture Environment in the Repository

Potentially the most effective repository design would provide an environment in the emplacement drifts that would accommodate the heat discharge from the waste packages, maintain the materials and contents of the packages at low temperatures, and maintain low ambient moisture. Several alternatives and features focus on these goals. An example of a design to control the repository drift environment would be continuous postclosure ventilation of the drifts to provide both heat and moisture removal.

Many designs use an integrated approach to control the drift environment. The high thermal load designs, for example, provide ambient temperatures above 100°C (212°F) through portions of the repository so moisture would vaporize and disperse. Designs involving the diameter and spacing of drifts and the loading of waste packages consider similar integrated effects to control the heat load. Some designs focus only on moisture control, such as those that involve surface modifications directly above the repository to retard or eliminate any infiltration of moisture.

2.1.4.3 Design Features and Alternatives To Support Operational and Cost Considerations

In general, these design features and alternatives focus on repository operation and cost, so they would not usually affect long-term (postclosure) performance but could have short-term (preclosure) impacts. Designs to enhance access to the drifts and to facilitate performance monitoring incorporate approaches that would reduce occupational exposure. Modular design and phased construction would result in slightly increased short-term impacts but would accommodate incremental funding of repository construction.

The final design of the repository is likely to evolve from the current design (as described in Section 2.1 and analyzed in this EIS), combinations of the design features and alternatives, and other design concepts that evolve from the DOE License Application Design Selection process (that is, Enhanced Design Alternatives). The identification and evolution of the features and alternatives was underway as DOE was preparing the Draft EIS. The evolution of the repository design is likely to incorporate some of the features and alternatives discussed in this section and Appendix E. After incorporating modifications in the design, DOE will evaluate the environmental impacts associated with the updated design in the Final EIS.

The design features and alternatives are functionally equivalent to potential mitigation measures because they have the potential to improve long-term (postclosure) performance (that is, they would reduce risk), reduce operational impacts, or reduce costs. Chapter 9 summarizes the mitigation aspects of these design features and alternatives and Appendix E describes them more fully. However, there are tradeoffs associated with many of these features and alternatives that could have negative short-term (preclosure) or long-term impacts that could be greater than the impacts associated with the basic design under the thermal load and packaging scenarios evaluated as part of the Proposed Action. Appendix E contains qualitative descriptions of the features and alternatives, including the reasons for their consideration (potential benefits) and potential negative environmental considerations.

2.1.5 ESTIMATED COSTS ASSOCIATED WITH THE PROPOSED ACTION

DOE has estimated the total cost of the Proposed Action to construct, operate and monitor, and close a geologic repository at Yucca Mountain, including the transportation of spent nuclear fuel and high-level radioactive waste to the repository (TRW 1999e, all). The estimate is based on acceptance and disposal of about 63,000 MTHM of commercial spent nuclear fuel, 2,333 MTHM of DOE spent nuclear fuel, and 8,315 canisters of solidified high-level radioactive waste (4,667 MTHM). Table 2-5 lists the estimated costs. The costs would total about $29 billion. This is representative and would vary

Table 2-5. Proposed Action costs.[a,b]

Description	Costs
Monitored geologic repository	$18.7
Waste acceptance, storage, and transportation	4.5
Nevada transportation	0.8
Program integration	2.1
Institutional	2.7
Total	**$28.8**

a. Source: TRW (1999e, all).

b. Adjusted to constant 1998 dollars, in billions.

somewhat, depending on the thermal load, packaging, and transportation scenarios and on the Nevada transportation implementing alternative selected.

2.2 No-Action Alternative

This section describes the No-Action Alternative, which provides a baseline for comparison with the Proposed Action. Under the No-Action Alternative and consistent with the Nuclear Waste Policy Act, as amended [Section 113(c)(3) (the EIS refers to the amended Act as the NWPA)], DOE would end site characterization activities at Yucca Mountain and undertake site reclamation to mitigate adverse environmental impacts from characterization activities. Commercial nuclear power utilities and DOE would continue to manage spent nuclear fuel and high-level radioactive waste at 77 sites in the United States (see Figure 2-35).

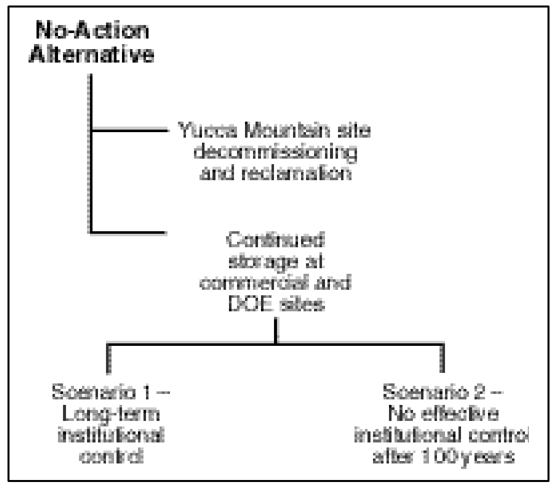


Figure 2-35. No-Action Alternative activities and analytical scenarios.

Under the NWPA, if DOE decided not to proceed with the development of a repository at Yucca Mountain, it would prepare a report to Congress with its recommendations for further action to ensure the safe permanent disposal of spent nuclear fuel and high-level radioactive waste, including the need for new legislative authority. Furthermore, DOE intends to comply with the terms of existing consent orders and compliance agreements regarding the management of spent nuclear fuel and high-level radioactive waste. However, the future course that Congress, DOE, and the commercial nuclear power utilities would take if Yucca Mountain were not recommended as a repository remains uncertain. A number of possibilities could be pursued, including continued storage of the material at its current locations or at one or more centralized location(s); the study and selection of another location for a deep geologic repository (Chapter 1 discusses alternative sites previously selected by DOE for technical study); development of new technologies (for example, transmutation); or reconsideration of other disposal alternatives to deep geologic disposal (Section 2.3.1 discusses other disposal options previously evaluated by DOE). The environmental considerations related to continued storage at current locations or at one or more centralized location(s) have been analyzed in other contexts for both commercial and DOE spent nuclear fuel and high-level radioactive waste in several documents (see Chapter 7, Table 7-1 for a description of representative studies). Under any future course that would include continued storage, both commercial and DOE sites would have an obligation to continue managing spent nuclear fuel and high-level radioactive waste in a manner that protected public health and safety and the environment.

In light of the uncertainties described above, DOE decided to illustrate one set of possibilities by focusing its analysis of the No-Action Alternative on the potential impacts of two scenarios:

- Long-term storage of spent nuclear fuel and high-level radioactive waste at the current storage sites with effective institutional control for at least 10,000 years (Scenario 1)

- Long-term storage at the current storage sites with no effective institutional control after approximately 100 years (Scenario 2)

DOE recognizes that neither of these scenarios is likely to occur in the event there is a decision not to develop a repository at Yucca Mountain. However, these two scenarios were chosen for analysis because they provide a baseline for comparison to the impacts from the Proposed Action and they reflect a range of the impacts that could occur. Scenario 1, which includes an analysis of impacts under effective institutional controls for at least 10,000 years, is consistent with the portion of the analysis of the Proposed Action that includes an analysis of effective institutional controls for the first 100 years after closure. Scenario 2, in which the analyses do not consider institutional controls after approximately 100 years, is consistent with the portion of the analysis of the Proposed Action in which long-term performance after 100 years also does not include institutional controls.

The following sections describe expected Yucca Mountain site decommissioning and reclamation activities (Section 2.2.1), and further describe the scenarios for continued spent nuclear fuel and high-level radioactive waste management at the commercial and DOE sites (Section 2.2.2). Chapter 7 describes the potential environmental impacts of the No-Action Alternative.

2.2.1 YUCCA MOUNTAIN SITE DECOMMISSIONING AND RECLAMATION

Under the No-Action Alternative, site characterization activities would end at Yucca Mountain and decommissioning and reclamation would begin as soon as practicable and could take several years to complete. Decommissioning and reclamation would include removing or shutting down surface and subsurface facilities, and restoring lands disturbed during site characterization.

INSTITUTIONAL CONTROL

Monitoring and maintenance of storage facilities to ensure that radiological releases to the environment and radiation doses to workers and the public remain within Federal limits and DOE Order requirements.

Portable and prefabricated buildings would be emptied of their contents, dismantled, and removed from the site. Other facilities could be shut down without being removed from the site. DOE would remove and salvage such equipment as electric generators and tunneling, ventilation, meteorological, and communications equipment. Foundations and similar materials would remain in place.

DOE would remove equipment and materials from the underground drifts and test rooms. Horizontal and vertical drill holes extending from the subsurface would be sealed. Subsurface drifts and rooms would not be backfilled, but would be left with the concrete inverts in place. The North and South Portals would be gated to prohibit entry to the subsurface.

Excavated rock piles would be stabilized. Topsoil previously removed from the excavated rock pile area and stored in a stockpile would be returned and the areas would be revegetated. Areas disturbed by surface studies (drilling, trenching, fault mapping) or used during site characterization (borrow areas, laydown pads, etc.) would be restored. Fluid impoundments (mud pits, evaporation ponds) would be backfilled or capped as appropriate and reclaimed. Access roads throughout the site (paved or graveled) and parking areas would be left in place and would not be restored.

2.2.2 CONTINUED STORAGE OF SPENT NUCLEAR FUEL AND HIGH-LEVEL RADIOACTIVE WASTE AT COMMERCIAL AND DOE SITES

Under the No-Action Alternative, spent nuclear fuel and high-level radioactive waste would be managed at the 72 commercial and 5 DOE sites (the Hanford Site, the Idaho National Engineering and Environmental Laboratory, the Savannah River Site, Fort St. Vrain, and the West Valley Demonstration Project) (see Figure 1-1). The No-Action Alternative assumes that the spent nuclear fuel and high-level radioactive waste would be treated, packaged, and stored. The amount of spent nuclear fuel and high-level radioactive waste considered in this analysis is the same as that in the Proposed Action—70,000 MTHM, including 63,000 MTHM of commercial spent nuclear fuel, 2,333 MTHM of DOE spent nuclear fuel, and 8,315 canisters of solidified high-level radioactive waste (4,667 MTHM). This EIS assumes that the No-Action Alternative would start in 2002.

2.2.2.1 Storage Packages and Facilities at Commercial and DOE Sites

A number of designs for storage packages and facilities at the commercial and DOE sites would provide adequate protection to the environment from spent nuclear fuel and high-level radioactive waste. Because specific designs have not been identified for most locations, DOE selected a representative range of commercial and DOE designs for analysis as described in the following paragraphs.

Spent Nuclear Fuel Storage Facilities

Most commercial nuclear utilities currently store their spent nuclear fuel in water-filled basins (fuel pools) at the reactor site. Some utilities have built *independent spent fuel storage installations* in which they store spent nuclear fuel dry, above ground, in metal casks or in weld-sealed canisters inside reinforced concrete storage modules. Some utilities are planning to build independent spent fuel storage installations so they can proceed with decommissioning their nuclear plants and terminating their operating licenses (for example, the Rancho Seco and Trojan plants). Because utilities could elect to continue operations until their fuel pools are full and then cease operations, the EIS analysis originally considered ongoing wet storage in existing fuel pools to be a potentially viable option for spent nuclear fuel storage. However, dry storage is the preferred option for long-term spent nuclear fuel storage at commercial sites for the following reasons (NRC 1996, pages 6-76 and 6-85):

- Dry storage is a safe economical method of storage.
- Fuel rods in dry storage are likely to be environmentally secure for long periods.
- Dry storage generates minimal, if any, amounts of low-level radioactive waste.
- Dry storage units are simpler and easier to maintain.

Accordingly, this EIS assumes that all commercial spent nuclear fuel would be in dry storage at independent spent fuel storage installations at existing locations. This includes spent nuclear fuel at sites that no longer have operating nuclear reactors. Figure 2-36 shows a photograph of the independent spent fuel storage installation at the Calvert Cliffs commercial nuclear site. Although most utilities and DOE have not constructed independent spent fuel storage installations or designed dry storage containers, this analysis evaluated the impacts of storing all commercial and most DOE spent nuclear fuel in horizontal concrete storage modules (see Figure 2-37) on a concrete pad at the ground surface. Concrete storage modules have openings that allow outside air to circulate and remove the heat of radioactive decay. The analysis assumed that both pressurized-water reactor and boiling-water reactor spent nuclear fuel would have been loaded into a dry storage canister that would be placed inside the concrete storage module. Figure 2-38 shows a typical dry storage canister, which would consist of a stainless-steel outer shell, welded end plugs, pressurized helium internal environment, and criticality-safe geometry for 24 pressurized-water or 52 boiling-water reactor fuel assemblies.

The combination of the dry storage canister and the concrete storage module would provide safe storage of spent nuclear fuel as long as the fuel and storage facilities were properly maintained. The reinforced concrete storage module would provide shielding against the radiation emitted by the spent nuclear fuel. The concrete storage module would also provide protection from damage from such occurrences as aircraft crashes, earthquakes, and tornadoes.

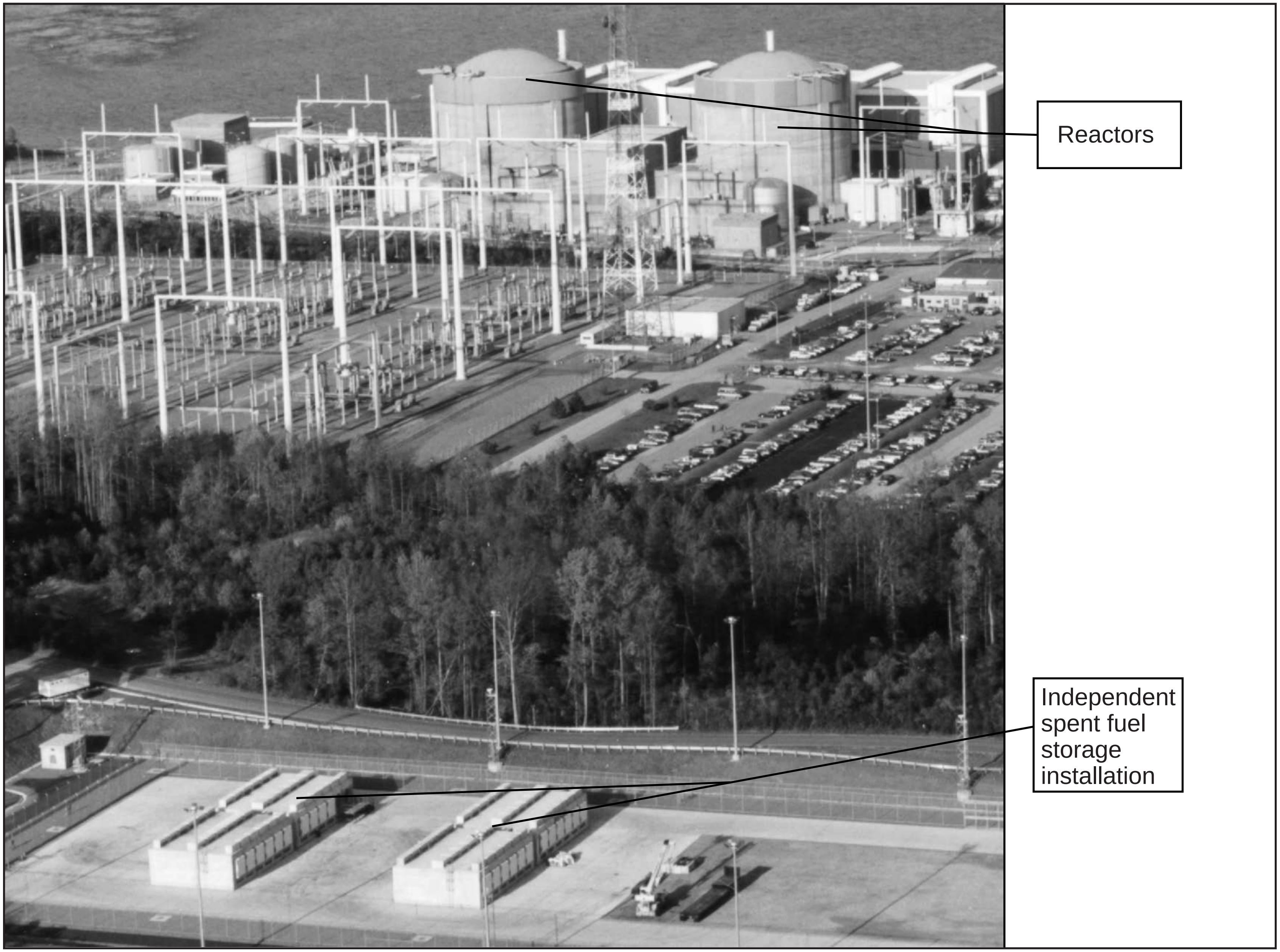
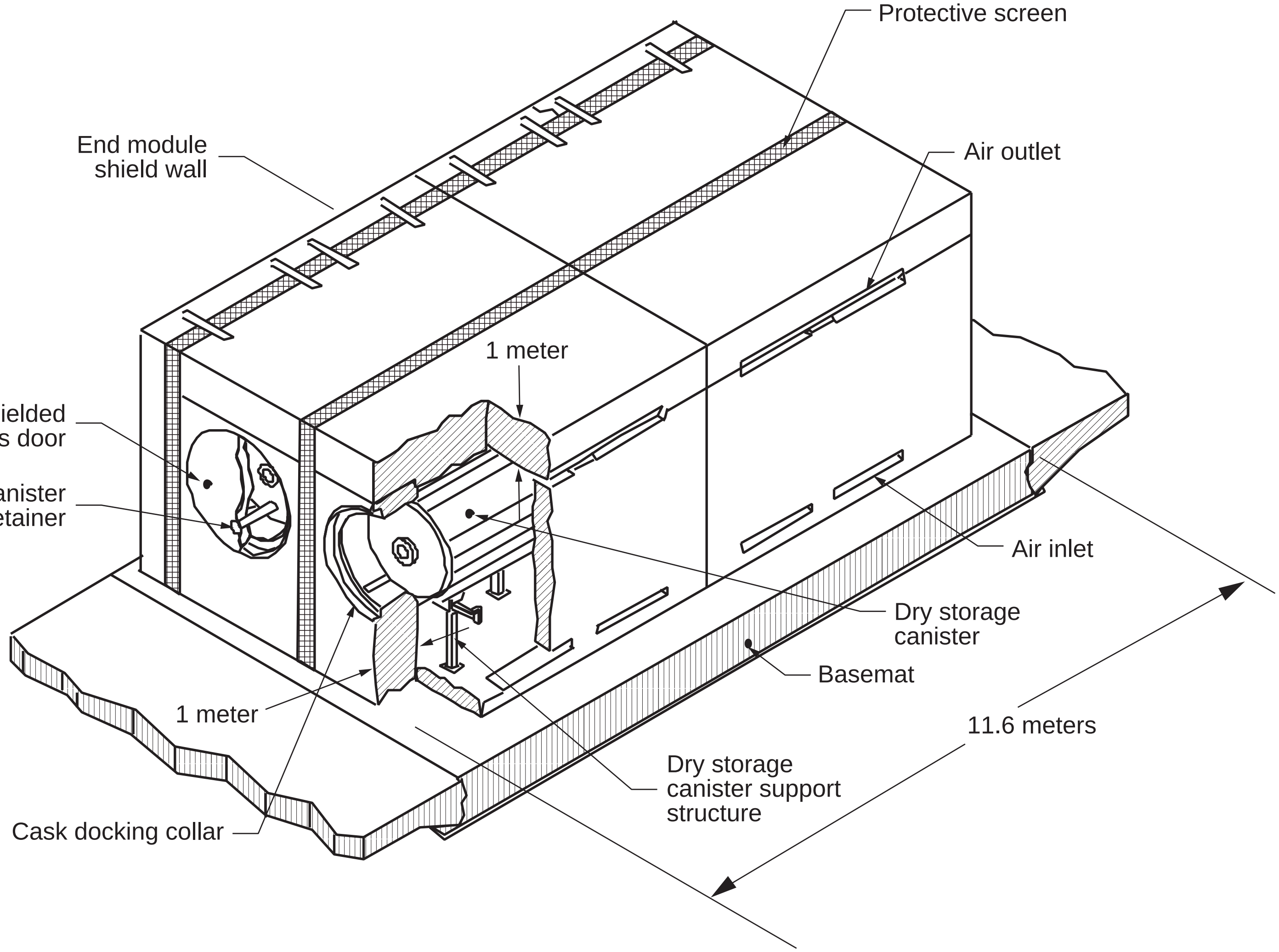


Figure 2-36. Calvert Cliffs independent spent fuel storage installation and reactors.

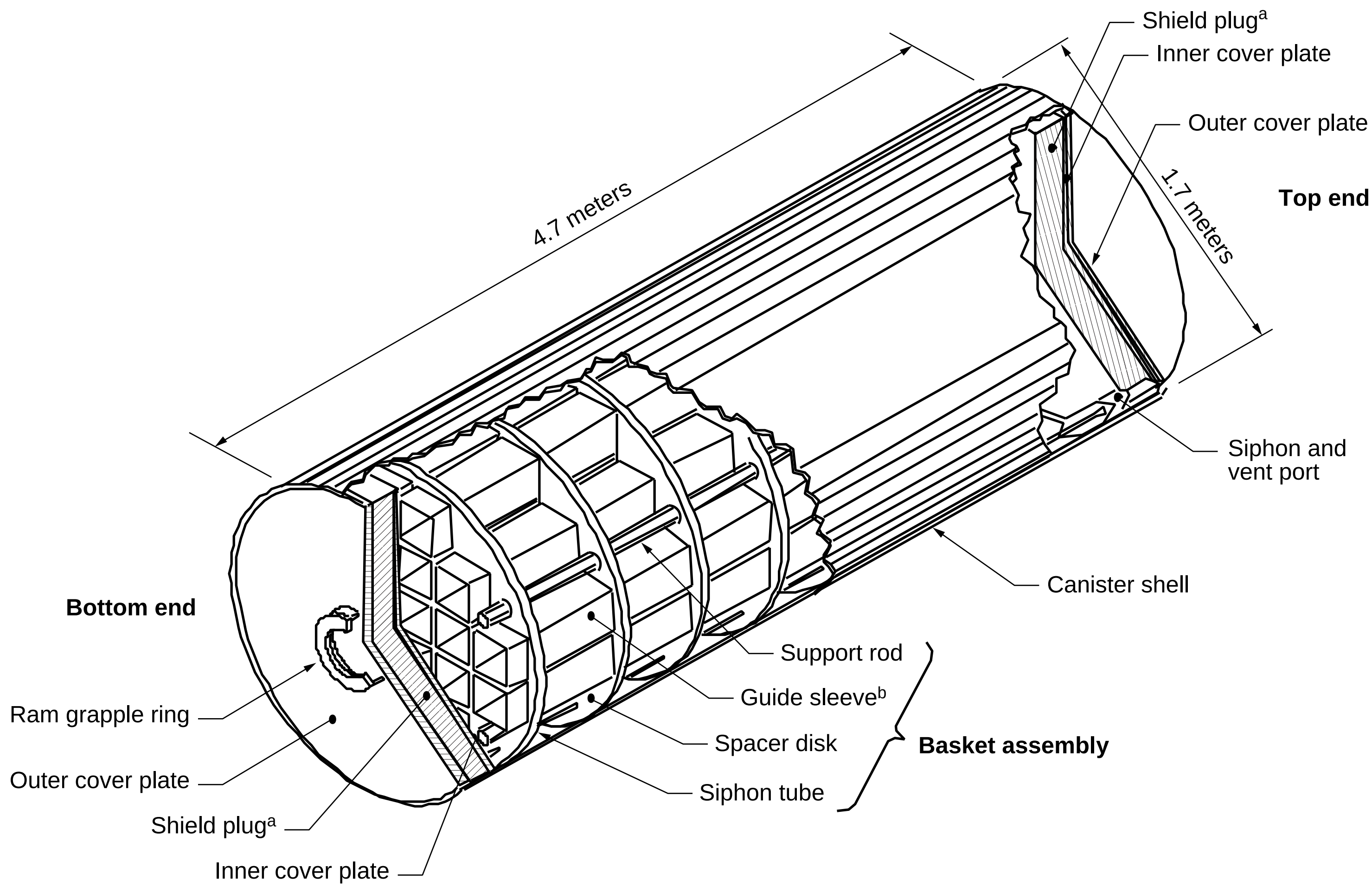


To convert meters to feet, multiply by 3.2808.

Note: Arrangement shown is a row of two storage modules with two canisters in each module.

Source: Modified from Poe (1998a, page 1-2).

Figure 2-37. Spent nuclear fuel concrete storage module.



All materials 304 stainless steel except as noted.

a. Shield plug would be lead.

b. Borated neutron absorber plate for boiling-water reactor spent nuclear fuel assemblies.

To convert meters to feet, multiply by 3.2808.

Source: Modified from Poe (1998a, page 1-5).

Figure 2-38. Spent nuclear fuel dry storage canister.

This analysis assumed that DOE spent nuclear fuel at the Savannah River Site, Idaho National Engineering and Environmental Laboratory, and Fort St. Vrain would be stored dry, above ground in stainless-steel canisters inside concrete casks. In addition, it assumed that the design of DOE above-ground spent nuclear fuel storage facilities would be similar to the independent spent fuel storage installations at commercial nuclear sites.

The analysis assumed that DOE spent nuclear fuel at Hanford would be stored dry in below-grade storage facilities. The Hanford N-Reactor fuel would be stored in the Canister Storage Building, which would consist of three below-grade concrete vaults with air plenums for natural convective cooling. Storage tubes of carbon steel would be installed vertically in the vaults. Each storage tube, which would be able to accommodate two spent nuclear fuel canisters, would be closed and sealed with a shield plug. The vaults would be covered by a structural steel shelter.

High-Level Radioactive Waste Storage Facilities

With one exception, this analysis assumed that high-level radioactive waste would be stored in a below-grade solidified high-level radioactive waste storage facility (Figure 2-39). At the West Valley Demonstration Project, it was assumed that DOE would use a dry storage system similar to a commercial spent nuclear fuel storage installation for high-level radioactive waste storage.

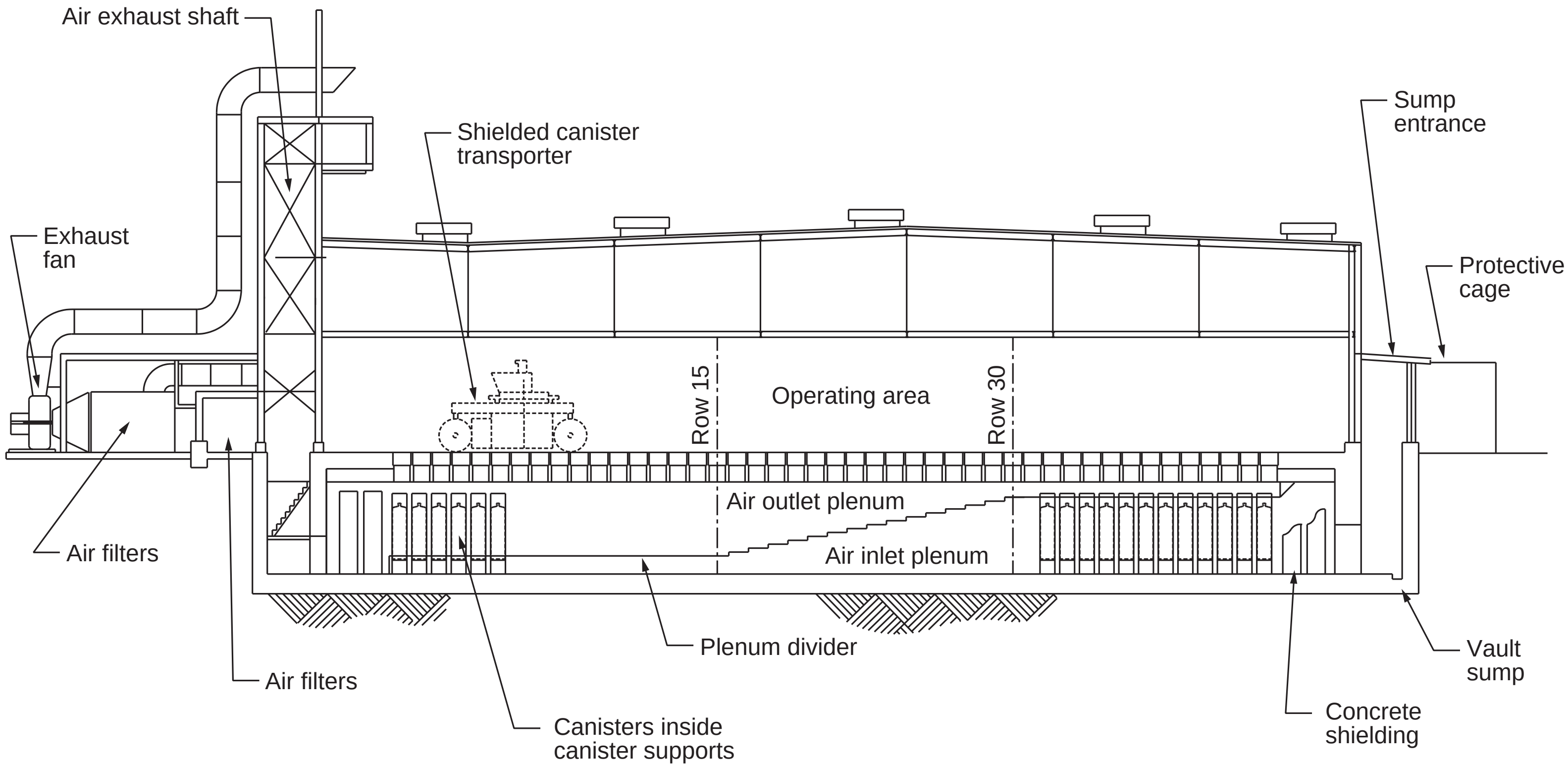
The high-level radioactive waste storage facility has four areas: below-grade storage vaults, an operating area above the vaults, air inlet shafts, and air exhaust shafts. The canister cavities are galvanized-steel large-diameter pipe sections arranged in a grid. Canister casings are supported by a concrete base mat. Space between the pipes is filled with overlapping horizontally stepped steel plates that direct most of the ventilation air through the storage cavities.

The below-grade storage vault would be below the operating floor, which would be slightly above grade. The storage vault would be designed to withstand earthquakes and tornadoes. In addition, the operating area would be enclosed by a metal building, which would provide weather protection and prevent the infiltration of precipitation. The storage vault would be designed to store the canisters and protect the operating personnel, the public, and the environment as long as the facilities were maintained. Radiation shielding would be provided by the surrounding earth, concrete walls, and a concrete deck that would form the floor of the operating area. Canister cavities would have individual precast concrete plugs.

Each vault would have an air inlet, air exhaust, and air passage cells. The heat of radioactive decay would be removed from around the canisters by the facility’s forced air exhaust system. The exhaust air could be filtered with high-efficiency particulate air filters before it was discharged to the atmosphere through a stack, or natural convection cooling could be used with no filter. The oversize diameter of the pipe storage cavities would allow air passage around each cavity.

2.2.2.2 No-Action Scenario 1

In No-Action Scenario 1, DOE would continue to manage its spent nuclear fuel and high-level radioactive waste in above- or below-grade dry storage facilities at five sites around the country. Commercial utilities would continue to manage their spent nuclear fuel at 72 sites. The commercial and DOE sites would remain under effective institutional control for at least 10,000 years. Under institutional control, these facilities would be maintained to ensure that workers and the public were protected adequately in accordance with current Federal regulations (10 CFR Parts 20 and 835) and the requirements in DOE Order 5400.5, *Radiation Protection of the Public and the Environment*. DOE based the 10,000-year analysis period on the generally applicable Environmental Protection Agency regulation for the disposal of spent nuclear fuel and high-level radioactive waste (40 CFR Part 191), even though the regulation would not apply to disposal at Yucca Mountain.



Source: Derived from Poe (1998a, pages 4-7, 4-8, and 4-11).

Figure 2-39. Conceptual design for solidified high-level radioactive waste storage facility.

Under Scenario 1, the storage facilities would be completely replaced every 100 years. They would undergo one major repair during the first 100 years, because this scenario assumes that the design of the first storage facilities at a site would include a facility life of less than 100 years. The 100-year lifespan of future storage facilities is based on analysis of concrete degradation and failure in regions throughout the United States (Poe 1998a, all). The facility replacement period of 100 years represents the assumed useful lifetime of the structures. Replacement facilities would be built on land adjacent to the existing facilities. After the spent nuclear fuel and high-level radioactive waste had been transferred to the replacement facility, the older facility would be demolished and the land prepared for the next replacement facility, thereby minimizing land-use impacts. The top portion of Figure 2-40 shows the conceptual timeline for activities at the storage facilities for Scenario 1. Only the relative periods shown on this figure, not the exact dates, are important to the analysis.

2.2.2.3 No-Action Scenario 2

In No-Action Scenario 2, spent nuclear fuel and high-level radioactive waste would remain in dry storage at commercial and DOE sites and would be under effective institutional control for approximately 100 years (the same as Scenario 1). Beyond that time, the scenario assumes no effective institutional control. Therefore, after about 100 years and up to 10,000 years, the analysis assumed that the spent nuclear fuel and high-level radioactive waste storage facilities at 72 commercial and 5 DOE sites would begin to deteriorate and that the radioactive materials in them could eventually be released to the environment. DOE based the choice of 100 years on a review of generally applicable Environmental Protection Agency regulations for the disposal of spent nuclear fuel and high-level radioactive waste (40 CFR Part 191, Subpart B), Nuclear Regulatory Commission regulations for the disposal of low-level radioactive material (10 CFR Part 61), and a National Research Council report on standards for the proposed Yucca Mountain Repository that generally discounts the consideration of institutional control for longer periods in performance assessments for geologic repositories (National Research Council 1995, Chapter 4). The lower portion of Figure 2-40 shows the conceptual timeline for activities at the storage facilities for Scenario 2.

2.2.3 NO-ACTION ALTERNATIVE COSTS

The total estimated cost of the No-Action Alternative includes costs for the decommissioning and reclamation of the Yucca Mountain site, and for the storage of spent nuclear fuel at 72 commercial sites (63,000 MTHM), storage of DOE spent nuclear fuel (2,333 MTHM) at 4 sites (there would be no spent nuclear fuel at the West Valley Demonstration Project), and storage of solidified high-level radioactive waste (8,315 canisters) at 4 sites (there is no high-level radioactive waste at Fort St. Vrain). As listed in Table 2-6, the estimated cost of both Scenarios 1 and 2 for the first 100 years ranges from $51.5 billion to $56.7 billion, depending on whether the dry storage canisters have to be replaced every 100 years. The estimated cost for the remaining 9,900 years of Scenario 1 ranges from $480 million to $529 million per year. There are no costs for Scenario 2 after the first 100 years because the scenario assumes no effective institutional control.

2.3 Alternatives Considered but Eliminated from Detailed Study

This section addresses alternatives that DOE considered but eliminated from detailed study in this EIS. These include alternatives that the NWPA states this EIS need not consider (Section 2.3.1); design alternatives that DOE considered but eliminated during the evolution of the repository design analyzed in this EIS (Section 2.3.2); and alternative rail corridors and highway routes for heavy-haul trucks and associated intermodal transfer station locations that DOE considered but eliminated during the transportation studies that identified the 10 Nevada implementing rail and intermodal alternatives analyzed in this EIS (Section 2.3.3).

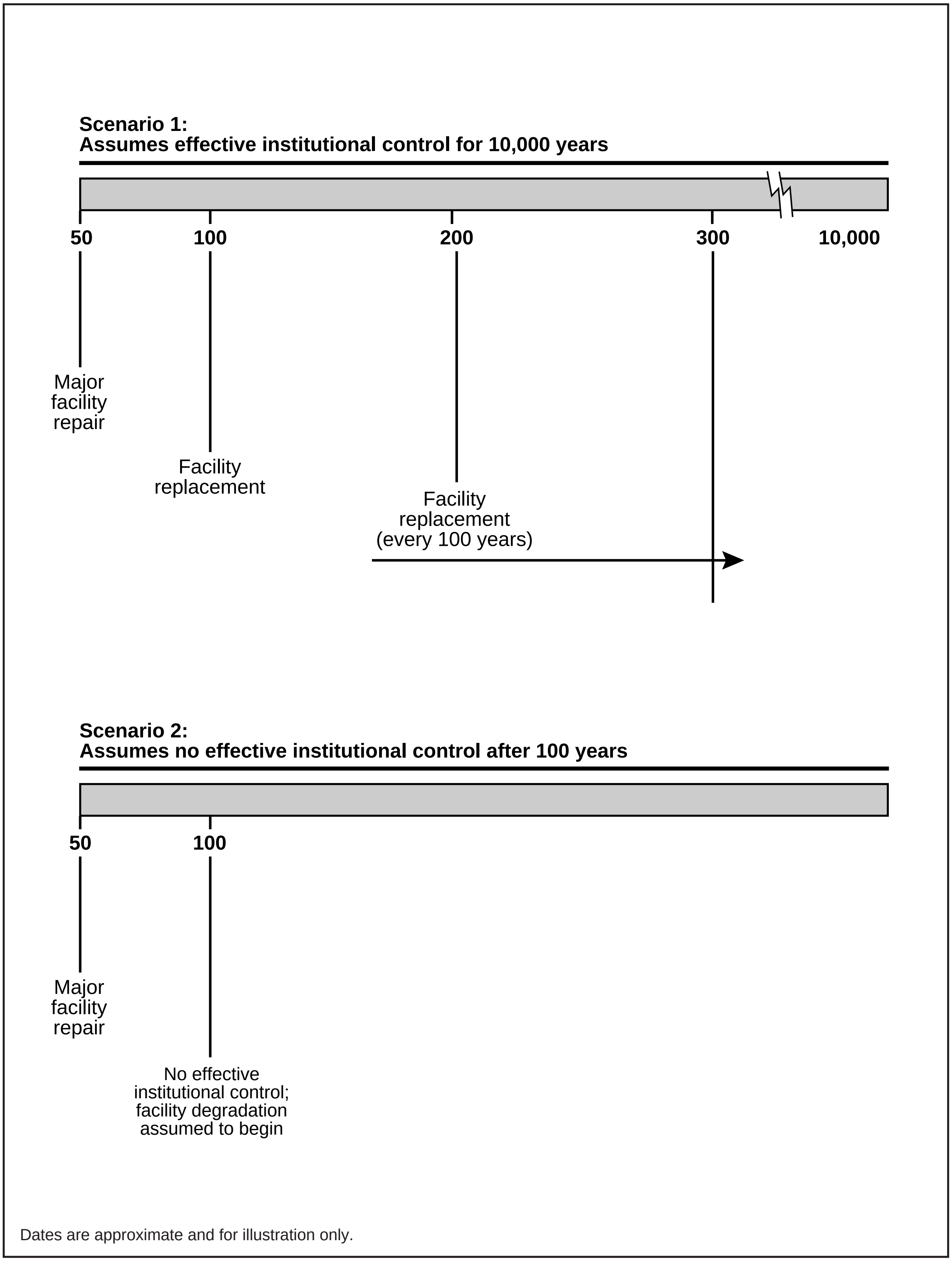


Figure 2-40. Facility timeline assumptions for No-Action Scenarios 1 and 2.

Table 2-6. No-Action Alternative life-cycle costs (in billions of 1998 dollars).[a]

Factor	First 100 years	Remaining 9,900 years (per year)	
	Scenarios 1 and 2[b]	Scenario 1[b,c]	Scenario 2[d]
72 commercial sites (63,000 MTHM)	$40.3 - 45.5	$0.376 - 0.425	$0
DOE spent nuclear fuel storage sites (2,333 MTHM)	7.4	0.069	0
High-level radioactive waste storage sites (8,315 canisters)	3.8	0.035	0
Decommissioning and reclamation of the Yucca Mountain site	(e)	NA[f]	0
Totals	**$51.5 - 56.7**	**$0.480 - 0.529**	**$0**

a. Source: TRW (1999e, all).
b. The range of costs for commercial sites is based on the assumption that the spent nuclear fuel would either be placed in dry storage canisters that would not need to be replaced over the 10,000-year period (low cost) or would have to be placed in new dry storage canisters every 100 years (high cost).
c. Stewardship costs are expressed in average annual disbursement costs (constant year 1998 dollars) only.
d. Costs are not applicable.
e. The costs for decommissioning and reclamation of the Yucca Mountain site would contribute less than 0.1 percent to the total life-cycle cost of continued storage.
f. NA = not applicable.

2.3.1 ALTERNATIVES ADDRESSED UNDER THE NUCLEAR WASTE POLICY ACT

The NWPA states that, with respect to the requirements imposed by the National Environmental Policy Act, compliance with the procedures and requirements of the NWPA shall be deemed adequate consideration of the need for a repository, the time of the initial availability of a repository, and all alternatives to the isolation of spent nuclear fuel and high-level radioactive waste in a repository [Section 114(f)(2)]. The geologic disposal of radioactive waste has been the focus of scientific research for more than 40 years. Starting in the 1950s, the Atomic Energy Commission and the Energy Research and Development Administration (both predecessor agencies to DOE) investigated different geologic formations as potential hosts for repositories and considered different disposal concepts, including deep-seabed disposal, disposal in the polar ice sheets, and rocketing waste into the sun. After extensive discussion of the options in an EIS (DOE 1980, all), DOE decided in 1981 to pursue disposal in an underground mined geologic repository (46 *FR* 26677, May 14, 1981). A panel of the National Academy of Sciences noted in 1990 that there is a worldwide scientific consensus that deep geologic disposal, the approach being followed by the United States, is the best option for disposing of high-level radioactive waste (National Research Council 1990, all).

Chapter 1 of this EIS summarizes the process that led to the 1987 amendments to the Nuclear Waste Policy Act of 1982, in which Congress directed DOE to study only Yucca Mountain to determine if it is suitable for a repository. Consistent with this approach, the NWPA states that, for purposes of complying with the requirements of the National Environmental Policy Act, DOE need not consider alternative sites to Yucca Mountain for the repository [Section 114(f)(3)].

Under the Proposed Action, this EIS does not consider alternatives for the emplacement of more than 70,000 MTHM of spent nuclear fuel and high-level radioactive waste in a repository at Yucca Mountain because the NWPA prohibits the Nuclear Regulatory Commission from approving the emplacement in the first repository of a quantity of spent nuclear fuel containing more than 70,000 MTHM or a quantity of solidified high-level radioactive waste resulting from the reprocessing of such a quantity of spent nuclear fuel until a second repository is in operation [Section 114(d)]. However, Chapter 8 of this EIS analyzes the cumulative impacts from the disposal of all projected spent nuclear fuel and high-level radioactive waste, as well as Greater-Than-Class-C waste and Special-Performance-Assessment-Required waste in the proposed Yucca Mountain Repository.

2.3.2 REPOSITORY DESIGN ALTERNATIVES ELIMINATED FROM DETAILED STUDY

The preliminary design concept for the proposed Yucca Mountain Repository analyzed in this EIS is the result of a design process that began with early site characterization activities. The design process identified design alternatives (options) that DOE considered. Some of the design options were eliminated from further detailed study during the design evolution. Examples include placement of the emplacement drifts in the saturated zone (rather than the unsaturated zone); vertical shafts (rather than the gently sloping North and South Ramps); use of drilling and blasting methods for emplacement drift construction (rather than mechanical excavation methods such as tunnel-boring machines); and use of diesel-powered vehicles for waste package emplacement (rather than electrically powered, rail-based vehicles).

DOE recently undertook a comprehensive review and examination of possible design options to provide information for use in support of the suitability recommendation and License Application. Appendix E discusses the design options that DOE considered in this review, and Section 2.1.1 discusses their consideration in this EIS.

2.3.3 NEVADA TRANSPORTATION ALTERNATIVES ELIMINATED FROM DETAILED STUDY

Because rail access is not currently available to the Yucca Mountain site, DOE would have to build a branch rail line from an existing mainline railroad to the repository or transfer rail shipping casks to heavy-haul trucks at an intermodal transfer station to make effective use of rail transportation for shipping spent nuclear fuel and high-level radioactive waste to the repository. Section 2.1.3 describes the 10 implementing rail and intermodal alternatives for Nevada transportation that this EIS evaluates. DOE selected these implementing alternatives based on transportation studies that identified, evaluated, and eliminated other potential Nevada transportation rail and intermodal alternatives (Tappen and Andrews 1990, all; TRW 1995a, all; TRW 1996, all). This section identifies the potential rail and highway routes for heavy-haul trucks and associated intermodal transfer station locations that DOE considered but eliminated from further detailed study.

2.3.3.1 Potential Rail Routes Considered but Eliminated from Further Detailed Study

In the *Preliminary Rail Access Study* (Tappen and Andrews 1990, all), DOE identified 10 potential branch rail line routes to the Yucca Mountain site (Valley, Arden, Jean, Crucero, Ludlow, Mina, Caliente, Carlin, Cherry Creek, and Dike). Figure 2-41 shows these potential rail routes, each named for the area where it would connect to the mainline railroad. Alternatives within each route were developed wherever possible. The routes were chosen to maximize the use of Federal lands, provide access to regional rail carriers, avoid obvious land-use conflicts, and meet current railroad engineering practices. After the development of these rail routes, Lincoln County and the City of Caliente identified three additional routes (identified as Lincoln County Routes A, B, and C).

DOE evaluated these 13 potential rail routes in Tappen and Andrews (1990, all) and reevaluated them in the *Nevada Potential Repository Preliminary Transportation Strategy, Study 1* (TRW 1995a, all). One new route, Valley Modified, was added in the 1995 study based on updated information from the Bureau of Land Management on the status of two Wilderness Study Areas that represent possible land-use conflicts for the Valley route in the original evaluation. Three additional alignments—Caliente-Chalk Mountain, Elgin/Rox, and Hancock Summit—were evaluated in the Nevada Potential Repository Preliminary Assessment of the Caliente-Chalk Mountain Rail Corridor. The evaluations reviewed each potential rail corridor to identify land-use compatibility issues (the presence or absence of land-use conflicts, and the potential for mitigation of a conflict if one exists) and for access to regional rail carriers. The evaluations also compared other factors of the routes, including favorable topography (gently sloping rather than rugged terrain) and avoidance of lands withdrawn from public use by Federal action. Based

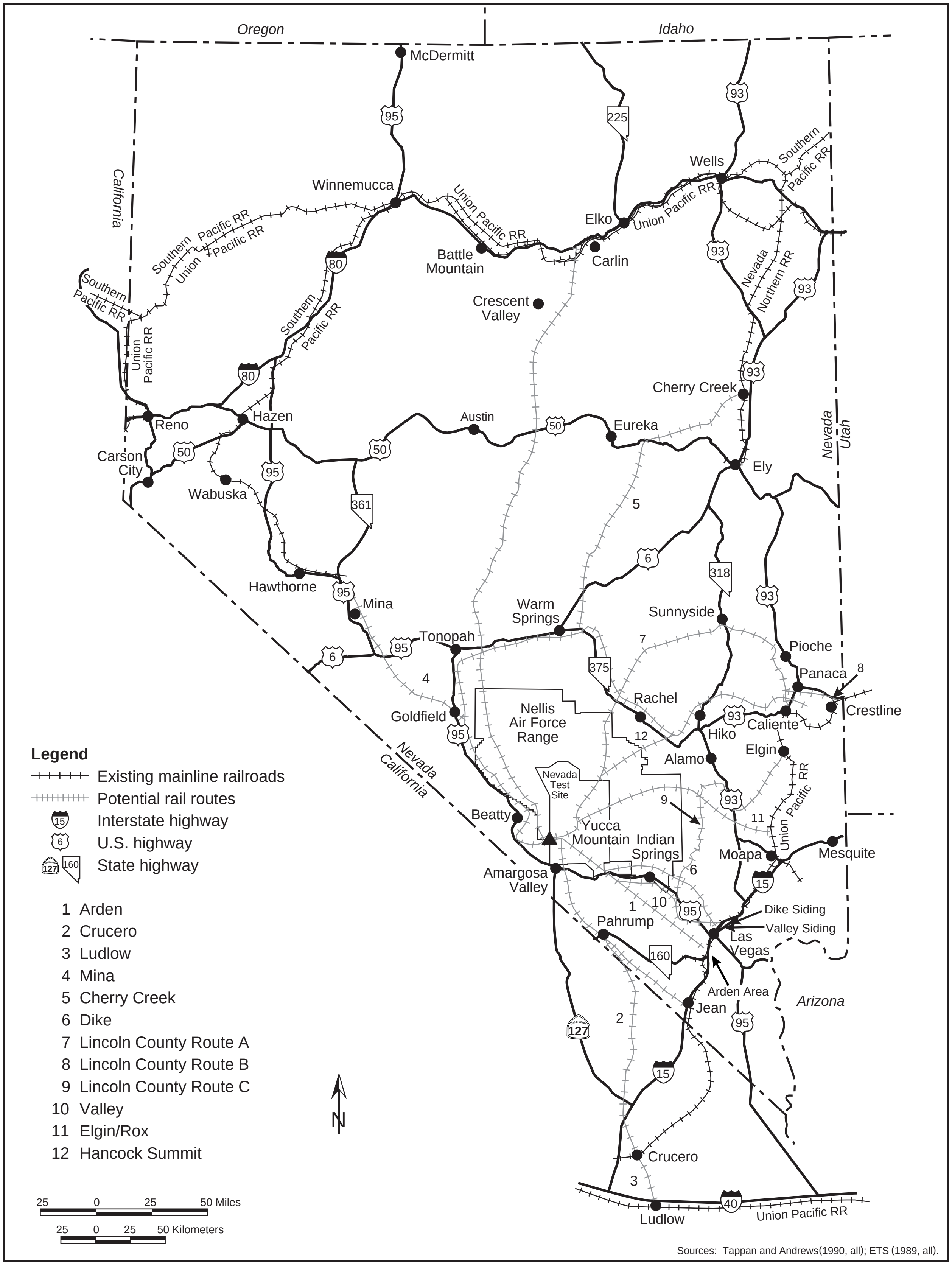


Figure 2-41. Potential rail routes to Yucca Mountain, Nevada, considered but eliminated from detailed study.

on these evaluations, DOE eliminated the Valley, Arden, Crucero, Ludlow, Mina, Cherry Creek, Dike, Elgin/Rox, Hancock Summit, and Lincoln County A, B, and C rail routes from further study.

2.3.3.2 Potential Highway Routes for Heavy-Haul Trucks and Associated Intermodal Transfer Station Locations Considered but Eliminated from Further Detailed Study

DOE identified and evaluated potential highway routes for heavy-haul trucks from existing mainline railroads to the Yucca Mountain site (TRW 1995a, all; TRW 1996, all; TRW 1999d, all). The Department identified highway routes for heavy-haul trucks and associated intermodal transfer station locations to provide reasonable access to existing mainline railroads, to minimize transport length from an existing mainline rail interchange point, and to maximize the use of roads identified by the Nevada Department of Transportation for the highest allowable axle load limits. In addition to the five implementing intermodal alternatives selected for analysis in this EIS (see Section 2.1.3), Figure 2-42 shows highway routes for heavy-haul trucks and associated intermodal transfer station locations that DOE considered but eliminated from further detailed study. The eliminated alternatives include four routes named for the location of the intermodal transfer station—Apex, Arden, Baker, and Apex/Dry Lake (Las Vegas Bypass)—and three that are representative of routes from the northern Union Pacific mainline railroad (Northern Routes 1, 2, and 3).

DOE considered the development of new roads for dedicated heavy-haul truck shipments. The analysis assumed those routes would be within the corridors identified for potential rail routes, because the selection criteria for heavy-haul routes and rail routes (land-use compatibility issues, access to regional rail carriers, etc.) would be similar (TRW 1996, page 6-3). DOE also considered routes for heavy-haul trucks in the potential rail corridors that could use portions of the existing road system for part of the route length. DOE eliminated the development of a new road for heavy-haul trucks from further detailed evaluation, because the construction of a new branch rail line would be only slightly more expensive and transportation by rail would be safer (no intermodal transfers) and more efficient (TRW 1996, page 6-7).

2.4 Summary of Findings and Comparison of the Proposed Action and the No-Action Alternative

This section summarizes and compares the potential environmental impacts of the Proposed Action and the No-Action Alternative (Section 2.2). Detailed descriptions of the impact analyses are contained in the following chapters:

- Chapter 4 describes the short-term environmental impacts associated with construction, operation and monitoring, and closure of the repository and includes the manufacture of waste disposal containers and shipping casks.
- Chapter 5 describes long-term (postclosure) environmental impacts from the disposal of spent nuclear fuel and high-level radioactive waste in the repository.
- Chapter 6 describes the impacts associated with the transportation of spent nuclear fuel, high-level radioactive waste, other materials, and personnel to and from the repository.
- Chapter 7 describes the short-term and long-term impacts associated with the No-Action Alternative.

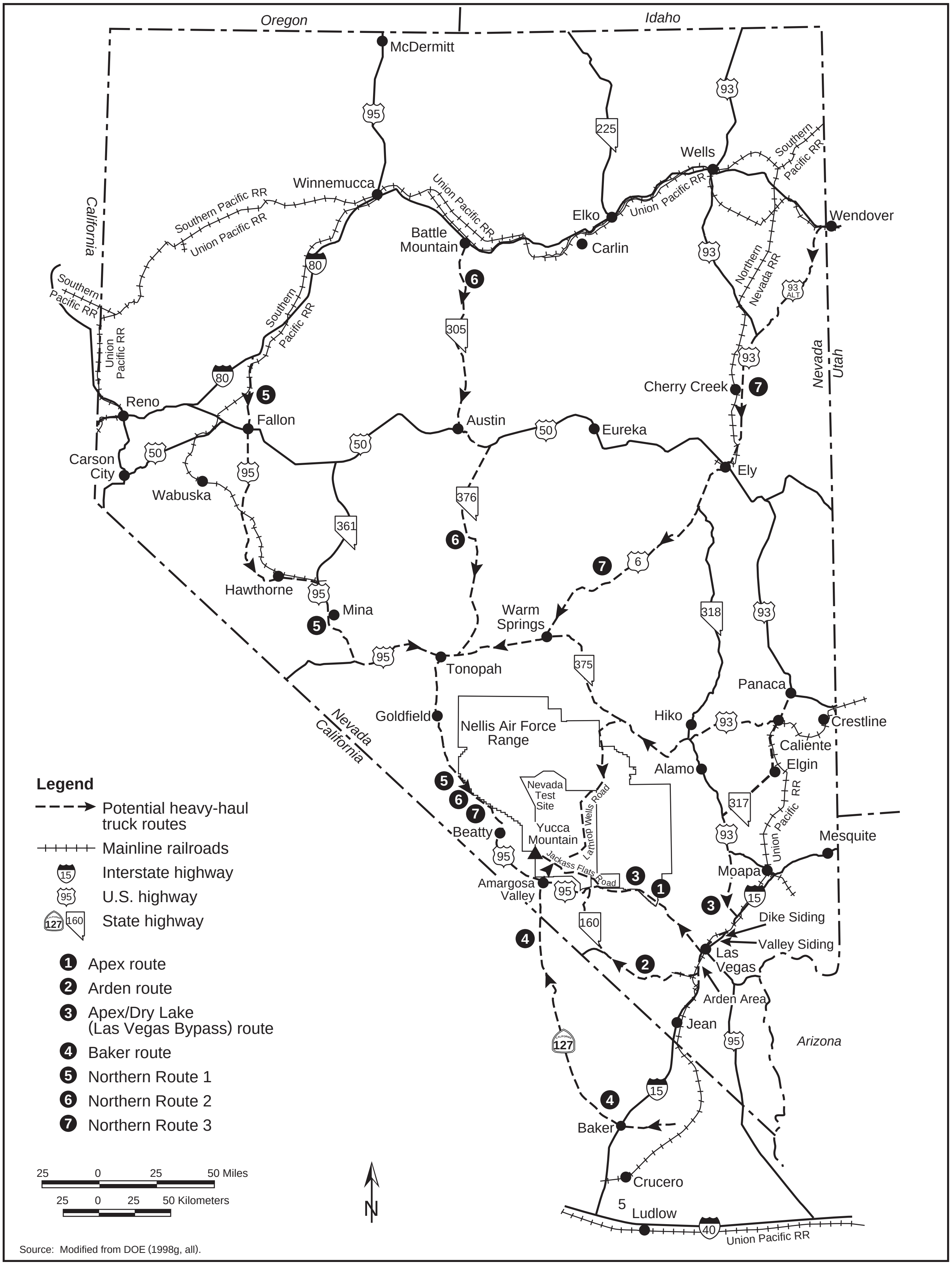


Figure 2-42. Potential highway routes for heavy-haul trucks to Yucca Mountain, Nevada, considered but eliminated from detailed study.

This EIS defines *short-term impacts* as those that would occur until and during the closure of the repository (approximately 100 years following the start of emplacement) and *long-term impacts* as those that would occur after repository closure (after 100 years) and for as long as 10,000 years.

This section summarizes the findings of the EIS analyses and contains a general comparison of the Proposed Action and No-Action Alternative (Section 2.4.1), potential short-term impacts (Section 2.4.2), long-term impacts (Section 2.4.3), and transportation impacts (Section 2.4.4).

2.4.1 PROPOSED ACTION AND NO-ACTION ALTERNATIVE

In general, the EIS analyses showed that the environmental impacts associated with the Proposed Action would be small, as described in Chapters 4, 5, 6, and 8. For some of the resource areas specifically analyzed in this study, there would be no impacts. Table 2-7 provides an overview approach to comparing the Proposed Action and the No-Action Alternative.

Although generally small, environmental impacts would occur under the Proposed Action. DOE would reduce or eliminate many such impacts with mitigation measures or implementation of standard Best Management Practices. Under the No-Action Alternative, the short-term impacts would be the same under Scenarios 1 or 2. Under Scenario 1, DOE would continue to manage spent nuclear fuel and high-level radioactive waste facilities at 5 DOE sites, and commercial utilities would continue to manage their spent nuclear fuel at 72 sites on a long-term basis and to isolate the material from human access with institutional control. Under Scenario 2, with the assumption of no effective institutional control after 100 years, the spent nuclear fuel and high-level radioactive waste storage facilities would begin to deteriorate and radioactive materials could escape to the environment, contaminating the local atmosphere, soils, surface water, and groundwater, thereby representing a considerable human health risk.

2.4.2 SHORT-TERM IMPACTS OF REPOSITORY CONSTRUCTION, OPERATION AND MONITORING, AND CLOSURE

DOE analyzed short-term impacts (about 100 years) for the Proposed Action and No-Action Alternative in various resource areas. The information presented in Table 2-7 shows that the short-term environmental impacts for the Proposed Action and the No-Action Alternative would generally be small and do not differentiate dramatically between the two alternatives. The analyses also included cost estimates for the two alternatives. Estimated short-term (to 100 years) costs for the Proposed Action would be about $29 billion, and those for the No-Action Alternative would be as much as $57 billion for the same period.

2.4.3 LONG-TERM IMPACTS OF THE PROPOSED ACTION AND THE NO-ACTION ALTERNATIVE

In addition to the short-term impacts described above, DOE assessed the impacts from radiological and nonradiological hazardous materials released over a much longer period (100 years to as long as 10,000 years) after the closure of the repository. Because these projections are based essentially on best available scientific techniques, DOE focused the assessment of long-term impacts on human health, biological resources, surface-water and groundwater resources, and other resource areas for which the analysis determined the information was particularly important and could establish estimates of impacts.

The EIS also examined possible biological impacts from the long-term production of heat by the radioactive materials disposed of in Yucca Mountain. Because there would be no repository activity after approximately 100 years, there would be no changes in land use, employment of workers, and use of water or utilities. The analysis determined that there would be no impacts to land use, noise, socioeconomic resources, cultural resources, surface-water resources, aesthetics, utilities, or site services

Table 2-7. Impacts associated with the Proposed Action and No-Action Alternative (page 1 of 4).

	Proposed Action			No-Action Alternative		
	Short-term (through closure, about 100 years)		Long-term (after closure, about 100 to 10,000 years)	Short-term	Long-term (100 to 10,000 years)	
Resource area	Repository	Transportation		(100 years)	Scenario 1	Scenario 2
Land use and ownership	Withdraw about 600 km^2[a] of land now under Federal control; active use of about 3.5 km^2	0 to about 20 km^2 of land disturbed for new transportation routes; Air Force identified conflicts for some routes; Valley Modified rail corridor would pass near the Las Vegas Paiute Indian Reservation; some rail corridors could overlap with potential Las Vegas growth; heavy-haul trucks could slow traffic flow; some heavy-haul routes would pass near or through the Moapa and Las Vegas Paiute Indian Reservations	Potential for limited access into the area; the only surface features remaining would be markers	Small; storage would continue at existing sites	Small; storage would continue at existing sites	Potential contamination of 0.04 to 0.4 km^2 surrounding each of the 72 commercial and 5 DOE sites
Air quality	Releases and exposures well below regulatory limits (less than 5 percent of limits)	Releases and exposures below regulatory limits; pollutants from vehicle traffic and trains would be small in comparison to other national vehicle and train traffic	No air releases	Releases and exposures well below regulatory limits	Releases and exposures well below regulatory limits	Increases in airborne radiological releases and exposures (potentially exceeding current regulatory limits)
Hydrology (groundwater and surface water)	Water demand well below Nevada State Engineer's ruling on perennial yield (250 to 480 acre-feet[b] per year)	Withdrawal of up to 710 acre-feet[b] from multiple wells and hydrographic areas over 2.5 years	Low-level contamination of groundwater in Amargosa Valley after a few thousand years (estimated concentration would be below drinking water standards)	Small; usage would be small in comparison to other site use	Small; usage would be small in comparison to other site use	Potential for radiological contamination of groundwater around 72 commercial and 5 DOE sites
	Small; minor changes to runoff and infiltration rates; floodplain assessment concluded impacts would be small	Small; minor changes to runoff and infiltration rates; additional floodplain assessments would be performed in the future as necessary	Small; minor changes to runoff and infiltration rates	Small; minor changes to runoff and infiltration rates	Small; minor changes to runoff and infiltration rates	Potential for radiological releases and contamination of drainage basins downstream of 72 commercial and 5 DOE sites (concentrations potentially exceeding current regulatory limits)

Table 2-7. Impacts associated with the Proposed Action and No-Action Alternative (page 2 of 4).

Resource area	Proposed Action: Short-term (through closure, about 100 years) — Repository	Proposed Action: Short-term (through closure, about 100 years) — Transportation	Proposed Action: Long-term (after closure, about 100 to 10,000 years)	No-Action Alternative: Short-term (100 years)	No-Action Alternative: Long-term (100 to 10,000 years) — Scenario 1	No-Action Alternative: Long-term (100 to 10,000 years) — Scenario 2
Biological resources and soils	Loss of about 3.5 km^2 of desert soil, habitat, and vegetation; adverse impacts to threatened desert tortoise (individuals, not the species as a whole); reasonable and prudent measures to minimize impacts; impacts to other plants and animals and habitat small; wetlands assessment concluded impacts would be small	Loss of 0 to about 20 km^2 of desert soil, habitat, and vegetation for heavy-haul routes and rail corridors; adverse impacts to threatened desert tortoise (individuals, not the species as a whole); reasonable and prudent measures to minimize impacts; impacts to other plants and animals and habitat small; additional wetlands assessments would be performed in the future as necessary	Slight increase in temperature of surface soil directly over the repository for 10,000 years resulting in a potential temporary shift in plant and animal communities in this small area (about 8 km^2)	Small; storage would continue at existing sites	Small; storage would continue at existing sites	Potential adverse impacts at each of the 77 sites from subsurface contamination of 0.04 to 0.4 km^2
Cultural resources	Repository development would disturb about 3.5 km^2; damage to and illicit collecting at archaeological sites; programs in place to minimize impacts; opposing Native American viewpoint	Loss of 0 to about 20 km^2 of land disturbed for new transportation routes; damage to and illicit collecting at archaeological sites; programs in place to minimize impacts; opposing Native American viewpoint	Potential for limited access into the area; opposing Native American viewpoint	Small; storage would continue at existing sites; limited potential of disturbing sites	Small; storage would continue at existing sites; limited potential of disturbing sites	No construction or operation activities; no impacts
Socioeconomics	Estimated peak employment of 1,800 occurring in 2006 would result in less than a 1 percent increase in direct and indirect regional employment; therefore, impacts would be low	Employment increases would range from less than 1 percent to 5.7 percent (use of intermodal transfer station or rail line in Lincoln County, Nevada) of total employment by county; therefore, impacts would be low	No workers, no impacts	Small; population and employment changes would be small compared to totals in the regions	Small; population and employment changes would be small compared to totals in the regions	No workers; no impacts
Occupational and public health and safety						
Public						
Radiological (LCFs[c])						
MEI[c]	1.9×10^{-5} to 5.1×10^{-5}	1.6×10^{4} to 1.2×10^{-3}	1.9×10^{-8} to 4.4×10^{-5}	4.3×10^{-6}	1.3×10^{-6}	(d)
Population	0.14 to 0.41	3 to 18	5.5×10^{-5} to 5.3×10^{-4}	0.41	3	3,300[e]
Nonradiological	Exposures well below regulatory limits	Exposures below regulatory limits; pollutants from vehicle traffic and trains	Exposures well below regulatory limits or guidelines	Exposures well below regulatory limits or guidelines	Exposures well below regulatory limits or guidelines	Increases in releases of hazardous substances in the spent nuclear fuel and high-level radioactive waste and exposures to the public

Table 2-7. Impacts associated with the Proposed Action and No-Action Alternative (page 3 of 4).

	Proposed Action			No-Action Alternative		
	Short-term (through closure, about 100 years)		Long-term (after closure, about 100 to 10,000 years)	Short-term (100 years)	Long-term (100 to 10,000 years)	
Resource area	Repository	Transportation			Scenario 1	Scenario 2
Occupational and public health and safety (continued)						
Workers (involved and noninvolved)						
Radiological (LCFs)	3 to 4	3 to 11	No workers, no impacts	16	12	No workers, no impacts
Nonradiological fatalities (includes commuting traffic fatalities)	1 to 2	11 to 16[f]	No workers, no impacts	9	1,080	No workers, no impacts
Accidents						
Probability (frequency per year)	8.6×10^{-7} to 1.1×10^{-2}	1.4×10^{-7} to 1.9×10^{-7}	No credible accidents	3.2×10^{-6}	3.2×10^{-6}	3.2×10^{-6}
Public						
Radiological (LCFs)						
MEI	2.9×10^{-13} to 2.1×10^{-6}	0.002 to 0.013	Not applicable	No impacts	No impacts	Not applicable
Population	1.0×10^{-11} to 7.8×10^{-5}	0.02 to 0.07	Not applicable	No impacts	No impacts	3 to 13
Workers	For some accident scenarios workers would likely be severely injured or killed	For some accident scenarios workers would likely be severely injured or killed	No workers; no impacts	For some accident scenarios workers would likely be severely injured or killed	For some accident scenarios workers would likely be severely injured or killed	No workers; no impacts
Noise	Impacts to public would be low due to large distances to residences; workers exposed to elevated noise levels – controls and protection used as necessary	Transient and not excessive, less than 90 dBA[g]	No activities, therefore, no noise	Transient and not excessive, less than 90 dBA	Transient and not excessive, less than 90 dBA	No activities, therefore, no noise
Aesthetics	Low adverse impacts to aesthetic or visual resources in the region	Low, temporary, and transient; possible conflict with visual resource management goals for Jean rail corridor	Small; only surface features remaining would be markers	Small; storage would continue at existing sites; expansion as needed	Small; storage would continue at existing sites; expansion as needed	Small; aesthetic value decreases as facilities degrade
Utilities, energy, materials,	Use of materials would be very small in comparison to amounts used in the region; electric power delivery system to the Yucca Mountain site would have to be enhanced.	Use of materials and energy would be small in comparison to amounts used nationally	No use of materials or energy	Small; materials and energy use would be small compared to total site use	Small; materials and energy use would be small compared to total site use	No use of materials or energy
and site services						

Table 2-7. Impacts associated with the Proposed Action and No-Action Alternative (page 4 of 4).

	Proposed Action			No-Action Alternative		
	Short-term (through closure, about 100 years)		Long-term (after closure, about 100 to 10,000 years)	Short-term (100 years)	Long-term (100 to 10,000 years)	
Resource area	Repository	Transportation			Scenario 1	Scenario 2
Management of site-generated waste and hazardous materials	Radioactive and hazardous waste generated would be a few percent of existing offsite capacity; other wastes would be managed offsite and some waste potentially at an onsite landfill	Radioactive and hazardous waste generated would be a few percent of existing offsite capacity; other wastes would be managed offsite and some waste potentially at an onsite landfill	No waste generated or hazardous materials used	Small; waste generated and materials used would be small compared to total site generation and use	Small; waste generated and materials used would be small compared to total site generation and use	No waste generated or hazardous materials used
Environmental justice	No disproportionately high and adverse impacts to minority or low-income populations; opposing Native American viewpoint	No disproportionately high and adverse impacts to minority or low-income populations; opposing Native American viewpoint	No disproportionately high and adverse impacts to minority or low-income populations; opposing Native American viewpoint	No disproportionately high and adverse impacts to minority or low-income populations	No disproportionately high and adverse impacts to minority or low-income populations	Potential for disproportionately high and adverse impacts to minority or low-income populations

a. km^2 = square kilometers; to covert to acres, multiply by 247.1.
b. To convert acre-feet to cubic meters, multiply by 1233.49.
c. LCF = latent cancer fatality; MEI = maximally exposed individual.
d. The maximally exposed individual could receive a fatal dose of radiation within a few weeks to months. Death would be caused by acute direct radiation exposure.
e. Downstream exposed population of approximately 3.9 billion over 10,000 years.
f. As many as 8 of these fatalities could be members of the public; fatalities include commuting traffic fatalities.
g. dBA = A-weighted decibels, a common sound measurement. A-weighting accounts for the fact that the human ear responds more effectively to some pitches than to others. Higher pitches receive less weighting than lower ones.

from the Proposed Action and limited impacts from the No-Action Alternative, depending on the scenario. The analysis led to the following conclusions:

- From 0.04 to 0.4 square kilometer (10 to 100 acres) of land could be contaminated to the extent it would not be usable for long periods near each of the 77 sites for No-Action Scenario 2. There could be accompanying impacts on biological resources, socioeconomic conditions, cultural resources, and aesthetic resources for long periods. Such impacts for the Proposed Action and No-Action Scenario 1 would be very small.

- For No-Action Scenario 2, there could be low levels of contamination in the surface watershed and high concentrations of contaminants in the groundwater downstream of the 77 sites for long periods. There would be no such impacts for No-Action Scenario 1. For the Proposed Action, there could be low levels of contamination in the groundwater in the Amargosa Desert for a long period.

- Projected radiological impacts to the public for the first 10,000 years for the Proposed Action would be low (0.000055 to 0.00053 latent cancer fatality per year) compared to No-Action Scenario 2 (3,300 latent cancer fatalities).

- Radionuclides would be released for a long period of time under the Proposed Action and peak doses would occur hundreds of thousand years after closure of the repository.

- Projected long-term fatalities associated with No-Action Scenario 1 would be about 1,000, primarily to the workforce at the storage sites.

- Risks associated with sabotage and materials diversion in relation to the fissionable material stored at the 77 sites would be much greater than they would be if the fissionable material were in a monitored deep geologic repository.

The projected cost associated with No-Action Scenario 1 would be approximately $600 million a year (1998 dollars) for 9,900 years. Projected long-term costs for the Proposed Action would be very low while there would be none for No-Action Scenario 2 due to the lack of institutional control.

2.4.4 IMPACTS OF TRANSPORTATION SCENARIOS

2.4.4.1 National Transportation

This section summarizes and compares transportation-related environmental impacts for the movement of spent nuclear fuel and high-level radioactive waste from the 77 sites to the Yucca Mountain site. Table 2-8 compares the environmental impacts for the two national transportation scenarios analyzed, mostly rail and mostly legal-weight truck (see Section 2.1.3.2). Because DOE does not know the actual mix for these potential national transportation modes, the analyses used these two scenarios to bound the impacts from transportation activities that would move spent nuclear fuel and high-level radioactive waste to the Yucca Mountain site. In addition, Table 2-8 lists estimates of the environmental impacts associated with transportation activities in Nevada.

The values listed in Table 2-8 are limited to radiological impacts. As discussed in more detail in Chapter 6, shipments of spent nuclear fuel and high-level radioactive waste to Yucca Mountain would be a small fraction of the overall railroad and highway shipping activity in the United States. Thus, the incremental impacts from shipments to Yucca Mountain for the resource areas would be small in comparison to background impacts from all shipping activities, with the exception of potential radiological impacts.

Table 2-8. National transportation impacts for the transportation of spent nuclear fuel and high-level radioactive waste for the mostly rail and mostly legal-weight truck scenarios.

Group	Impact	Mostly legal-weight truck scenario	Mostly rail scenario
Worker	*Incident-free health impacts, radiological*		
	Maximally exposed individual (rem)	48	48
	Individual latent cancer fatality probability	0.02	0.02
	Collective dose (person-rem)	11,000	1,900 - 2,300[a]
	Latent cancer fatality incidence	4.5	0.8 - 0.9[a]
Public	*Incident-free health impacts, radiological*		
	Maximally exposed individual (rem)	2.4	0.31
	Individual latent cancer fatality probability	0.001	0.00016
	Collective dose (person-rem)	35,000	3,300 - 5,000[a]
	Latent cancer fatality incidence	18	1.6 - 2.5[a]
	Incident-free vehicle emissions impacts		
	Fatalities	0.6	0.3
Public	*Radiological impacts from maximum reasonably foreseeable accident scenario*		
	Probability (per year)	1.9 in 10,000,000	1.4 in 10,000,000
	Maximally exposed individual (rem)	3.9	26
	Individual latent cancer fatality probability	0.002	0.013
	Collective dose (person-rem)	9,400	61,000
	Latent cancer fatality incidence	4.7	31
Public and transportation workers	*Fatalities from vehicular accidents*	3.9	3.6

a. Range for the 10 rail and heavy-haul truck implementing alternatives in Nevada.

The following conclusions can be drawn from the analysis results summarized in Table 2-8:

- Radiological impacts from maximum foreseeable accident scenarios during the transportation of spent nuclear fuel and high-level radioactive waste would be lower for the mostly legal-weight truck case.
- Impacts from the transportation of spent nuclear fuel and high-level radioactive waste from the commercial and DOE sites to the Yucca Mountain site would be low for either national shipping mode.
- Radiological impacts to the public and to workers for normal transportation activities would be lower for the mostly rail scenario.

Most of the occupational and public health and safety impacts to the public and to workers would occur during the repository operating and monitoring phase.

Incremental differences in short-term impacts for the thermal load scenarios would be small, generally by less than a factor of about 2. Short-term impacts would generally be largest for the low thermal load and lowest for the high thermal load.

2.4.4.2 Nevada Transportation

For shipments coming into the State of Nevada by rail, there is no rail line to connect the national rail routes with the Yucca Mountain site (see Section 2.1.3.3). As a consequence, DOE evaluated the impacts in Nevada of moving spent nuclear fuel and high-level radioactive waste to the site using 10 implementing alternatives. These included five potential corridors for a new branch rail line (see Section 2.1.3.3.2) and five potential combinations of intermodal transfer stations and highway routes for heavy-haul trucks (see Section 2.1.3.3.3).

Tables 2-9 and 2-10 compare the impacts from transportation activities in potential Nevada rail corridors and heavy-haul truck corridors, respectively. In addition, they list impacts associated with engineering attributes for each implementing alternative. These engineering factors include cost, institutional acceptability of the route, construction and schedule risk, and operational compatibility. Additional attributes could affect a decision on the choice of a transportation mode or route in Nevada.

The following conclusions can be drawn from the information in Tables 2-9 and 2-10:

- Environmental impacts for each of the 10 implementing alternatives would be small.
- With the exception of collective dose, the environmental impacts for shipment by legal-weight truck in Nevada would be smaller than those from the 10 implementing alternatives associated with incoming shipments by rail. However, even for shipment by rail or heavy-haul truck in Nevada, the projected collective dose impacts would be small (approximately 2 latent cancer fatalities to both the public and transportation workers).
- With the exception of land use, differences in environmental impacts for the 10 implementing alternatives related to incoming shipments by rail would be small, so environmental impacts do not appear to be a major factor in the selection of transportation mode, route, or corridor in Nevada for incoming rail shipments.
- For land use, the Caliente-Chalk Mountain routes for a rail corridor and for a highway route for heavy-haul trucks would have conflicts with ongoing national defense activities at the Nellis Air Force Range.
- Impacts to cultural resources for any of the potential implementing alternative routes or corridors cannot be fully assessed until more detailed archaeological and ethnographic studies are conducted, but they are likely to be similar to one another. Impacts to Native American values could occur from the use of any of the routes including the use of highways in Nevada by legal-weight trucks that would pass through the Moapa and Las Vegas Paiute Indian reservations.

2.5 Collection of Information and Analyses

DOE conducted a broad range of studies to obtain or evaluate the information needed for the assessment of Yucca Mountain as a monitored geologic repository for spent nuclear fuel and high-level radioactive waste. The Department used the information from these studies in the analyses described in this EIS. Because some of these studies are ongoing, some of the information is incomplete.

The complexity and variability of the natural system at Yucca Mountain, the long periods evaluated, and factors such as the use of incomplete information or the unavailability of information have resulted in a certain degree of uncertainty associated with the analyses and findings in this EIS. DOE believes that it is important that the EIS identify the use of incomplete and unavailable information and uncertainty to enable an understanding of its findings. It is also important to understand that research can produce results or conclusions that might disagree with other research. The interpretation of results and conclusions has resulted in the development of views that differ from those that DOE presents in this EIS. DOE has received input from a number of organizations interested in the Proposed Action or No-Action Alternative or from potential recipients of impacts from those actions. These organizations include among others the State of Nevada, local governments, and Native American groups. Their input includes documents that present research or information that in some cases disagrees with the views that DOE presents in this EIS. The Department reviewed these documents and evaluated their findings for inclusion as part of the EIS analyses. If the information represents a substantive view, DOE has made every effort to incorporate that view in the EIS and to identify its source.

Table 2-9. Comparison of impacts for Nevada rail implementing alternatives and for legal-weight truck shipments (page 1 of 2).

Impact	Caliente	Carlin	Caliente-Chalk Mountain	Jean	Valley Modified	Mostly legal-weight truck
Land use and ownership						
Disturbed land (square kilometers)[a]	18	19	12	9	5	None
Private land (square kilometers)	0.9	7	0.8	3.6	0	None
Nellis Air Force Base land (square kilometers)	20	19	22	0	10	None
Air quality						
PM_{10} (construction)	Areas in attainment of air quality standards - branch rail line construction not a significant source of pollution	Areas in attainment of air quality standards - branch rail line construction not a significant source of pollution	Areas in attainment of air quality standards - branch rail line construction not a significant source of pollution	Except in Clark County, areas in attainment of air quality standards - branch rail line construction would not be a significant source of pollution	Clark County is in nonattainment of air quality standards for PM_{10} - branch rail line construction would not be a significant source of pollution	No construction
CO (operations)	93% of General Conformity Rule threshold	93% of General Conformity Rule threshold	93% of General Conformity Rule threshold	93% of General Conformity Rule threshold	93% of General Conformity Rule threshold	93% of General Conformity Rule threshold
Hydrology						
Surface water	Low	Low	Low	Low	Low	None
Groundwater						
Water use (acre-feet)[b]	710	660	480	410	320	None
Water use (number of wells)	64	67	43	23	20	None
Biological resources and soils	Low	Low	Low	Low	Low	None
Cultural resources	None identified to archaeological, historical, or cultural resources	None identified to archaeological, historical, or cultural resources	None identified to archaeological, historical, or cultural resources	None identified to archaeological, historical, or cultural resources	None identified to archaeological or historical resources. Route passes close to the Las Vegas Paiute Indian Reservation	Since shipments would use existing highways, none to archaeological or historical resources. Shipments from the northeast would pass through the Moapa Indian Reservation. All shipments would pass through the Las Vegas Paiute Indian Reservation
Noise	Moderate	Low	Moderate	Moderate	Moderate	Low
Utilities and resources						
Diesel (million liters)[c]	42	39	33	26	13	Low
Steel (thousand metric tons)[d]	71	72	48	26	22	None

Table 2-9. Comparison of impacts for Nevada rail implementing alternatives and for legal-weight truck shipments (page 2 of 2).

Impact	Caliente	Carlin	Caliente-Chalk Mountain	Jean	Valley Modified	Mostly legal-weight truck
Concrete (thousand metric tons)[e]	420	400	280	150	130	None
Aesthetics	Very low	Very low	Very low	Potential small area of conflict	Very low	None
Socioeconomics						
New jobs (percent of workforce in affected counties	1,200 (< 1% to 4%)	1,100 (< 1%)	910 (< 1% to 5.7%)	720 (< 1%)	350 (< 1%)	Low
Peak real disposable income (million dollars)	27	25	19	16	7	Low
Peak incremental Gross Regional Product (million dollars)	49	44	35	29	14	NA[f]
Waste management	Limited quantity	Limited quantity	Limited quantity	Limited quantity	Limited quantity	None
Environmental justice (disproportionately high and adverse impacts)	None	None	None	None	None	None
Incident-free health and safety						
Industrial hazards						
Total recordable incidents	250	240	220	170	130	NA
Lost workday cases	130	120	110	90	70	NA
Fatalities	1.3	1.2	1	0.9	0.5	NA
Collective dose (person-rem [LCFs])						
Workers	430 [0.17]	470 [0.19]	390 [0.16]	400 [0.16]	380 [0.15]	1,600 [0.63]
Public	390 [0.20]	420 [0.21]	380 [0.19]	430 [0.21]	380 [0.19]	2,800 [1.4]
Fatalities from vehicle emissions	0.0019	0.0025	0.0017	0.014	0.0018	0.005
Traffic accident fatalities						
Construction and operations workforce	1.9	1.8	1.5	1.2	0.9	NA[f]
SNF[g] and HLW[h] shipping	0.13	0.15	0.11	0.11	0.1	0.5
Radiological impacts, accident scenarios						
Maximum exposed individual (rem)	26	26	26	26	26	3.9
Individual latent cancer fatality probability	0.02	0.02	0.02	0.02	0.02	0.002
Collective dose	0.09	0.1	0.09	0.15	0.09	0.5
Latent cancer fatalities	0.00005	0.00005	0.00004	0.00008	0.00004	0.0002

a. To convert square kilometers to acres, multiply by 247.1.
b. To convert acre-feet to gallons, multiply by 325,850.1.
c. To convert liters to gallons, multiply by 0.26418.
d. To convert metric tons to tons, multiply by 1.1023.
e. To convert cubic feet to cubic meters, multiply by 0.028317.
f. NA = not applicable.
g. SNF = spent nuclear fuel.
h. HLW = high-level radioactive waste.

Table 2-10. Comparison of impacts for Nevada heavy-haul truck implementing alternatives and for legal-weight truck shipments (page 1 of 2).

Impact	Caliente	Caliente-Chalk Mountain	Caliente-Las Vegas	Sloan/Jean	Apex/Dry Lake	Mostly legal-weight truck
Land use and ownership						
Disturbed land (square kilometers)[a]	0.28	0.24	0.24	0.2	0.2	None
Private land (square kilometers)	0	0	0	0	0	None
Nellis Air Force Base land (square kilometers)	0	0	0	0	0	None
Air quality						
PM_{10} (construction)	Areas in attainment of air quality standards - highway upgrades not a significant source of pollution	Areas in attainment of air quality standards - highway upgrades not a significant source of pollution	Except Clark County, areas in attainment of air quality standards - highway upgrades not a significant source of pollution	48% of GCR Threshold for IMT construction	48% of GCR Threshold for IMT construction	No construction
CO (operations)	93% of General Conformity Rule threshold	93% of General Conformity Rule threshold	93% of General Conformity Rule threshold	93% of General Conformity Rule threshold	93% of General Conformity Rule threshold	
Hydrology						
Surface water	Low	Low	Low	Low	Low	None
Groundwater						
Water use (acre-feet)[b]	100	60	44	8	8	None
Water use (number of wells)	16	5	7	Truck water	Truck water	None
Biological resources and soils	Low	Low	Low	Low	Low	None
Cultural resources	None identified to archaeological, historical, or cultural resources	None identified to archaeological, historical, or cultural resources	None identified to archaeological, historical, or cultural resources; route near Moapa Indian Reservation and passes across 1.6-kilometer (1-mile) corner of the Las Vegas Paiute Indian Reservation	None identified to archaeological, historical, or cultural resources; route passes across 1.6-kilometer (1-mile) corner of the Las Vegas Paiute Indian Reservation	None identified to archaeological, historical, or cultural resources; IMT[c] and route near the Moapa Indian Reservation and passes across 1.6-kilometer (1-mile) corner of the Las Vegas Paiute Indian Reservation	Since shipments would use existing highways, none to archaeological or historical resources. Shipments from the northeast would pass through the Moapa Indian Reservation. All shipments would pass through the Las Vegas Paiute Indian Reservation
Noise	Low	Low	Low	Low	Low	Low
Utilities and resources						
Diesel (million liters)[d]	13	4.7	5.5	1.7	1.6	Low
Steel (metric tons)[e]	49	14	21	2.3	2.3	None
Concrete (thousand metric tons)[f]	1.8	0.5	0.8	0.1	0.1	None
Aesthetics	Some potential near Caliente	Some potential near Caliente	Some potential near Caliente	Very low	Very low	None

Table 2-10. Comparison of impacts for Nevada heavy-haul truck implementing alternatives and for legal-weight truck shipments (page 2 of 2).

Impact	Caliente	Caliente-Chalk Mountain	Caliente-Las Vegas	Sloan/Jean	Apex/Dry Lake	Mostly legal-weight truck
Socioeconomics						
New jobs (percent of workforce in affected counties)	1,000 (< 1% to 2.3%)	830 (< 1% to 2.6%)	810 (< 1% to 2%)	720 (< 1%)	540 (< 1%)	Low
Peak real disposable personal income (million dollars)	25	20	20	20	15	Low
Peak incremental Gross Regional Product (million dollars)	42	35	35	34	26	Low
Waste management	Limited quantity	Limited quantity	Limited quantity	Limited quantity	Limited quantity	None
Environmental justice (disproportionately high and adverse impacts)	None	None	None	None	None	None
Incident-free health and safety						
Industrial hazards						
Total recordable incidents	340	330	300	180	180	NA[g]
Lost workday cases	190	180	160	100	100	NA
Fatalities	0.7	0.6	0.6	0.4	0.4	NA
Incident-free health and safety (continued)						
Collective dose (person-rem [LCFs])						
Workers	780 [0.31]	710 [0.29]	740 [0.30]	710 [0.29]	690 [0.28]	1,600 [0.63]
Public	2,100 [1.0]	1,200 [0.62]	1,600 [0.77]	1,000 [0.51]	940 [0.47]	2,800 [1.4]
Fatalities from vehicle emissions	0.0016	0.0012	0.0013	0.012	0.0012	0.005
Traffic accident fatalities						
Construction and operations workforce	5.6	2.9	3.4	2.0	2.0	NA[g]
SNF[h] and HLW[i] shipping	0.73	0.42	0.54	0.33	0.31	0.5
Radiological impacts, accident scenarios						
Maximum exposed individual (rem)	26	26	26	26	26	3.9
Individual latent cancer fatality probability	0.02	0.02	0.02	0.02	0.02	0.002
Collective dose	0.29	0.26	0.72	4.1	0.67	0.5
Latent cancer fatalities	0.0001	0.0001	0.0004	0.002	0.0003	0.0002

a. To convert square kilometers to acres, multiply by 247.1.
b. To convert acre-feet to gallons, multiply by 325,850.1.
c. IMT = intermodal transfer.
d. To convert liters to gallons, multiply by 0.26418.
e. To convert metric tons to tons, multiply by 1.1023.
f. To convert cubic feet to cubic meters, multiply by 0.028317.
g. NA = not applicable.
h. SNF = spent nuclear fuel.
i. HLW = high-level radioactive waste.

2.5.1 INCOMPLETE OR UNAVAILABLE INFORMATION

Some of the analyses in this EIS had to use incomplete information. To ensure an understanding of the status of its information, DOE has identified the use of incomplete information or the unavailability of information in the EIS in accordance with the Council on Environmental Quality regulations pertaining to incomplete and unavailable information (40 CFR 1502.22). Such cases describe the basis for the analyses, including assumptions, the use of preliminary information, or conclusions from draft or incomplete studies. DOE continues to study issues relevant to understanding what could happen in the future at Yucca Mountain and the potential impacts associated with its use as a repository. As a result, the Final EIS will include information that was not available for the Draft EIS. In addition, DOE might not complete some of the studies and design development for the repository until after it has issued the Final EIS. DOE believes, however, that sufficient information is currently available to assess the range of impacts that could result from either the Proposed Action or the No-Action Alternative.

2.5.2 UNCERTAINTY

The results and conclusions of analyses often have some associated uncertainty. The uncertainty could be the result of the assumptions used, the complexity and variability of the process being analyzed, the use of incomplete information, or the unavailability of information. To enable an understanding of the status of its findings, this EIS contains descriptions of the uncertainties, if any, associated with the results and conclusions presented.

2.5.3 OPPOSING VIEWS

In this EIS, opposing views are defined as differing views or opinions currently held by organizations or individuals outside DOE. These views are considered to be opposing if they include or rely on data or methods that DOE is not currently using in its own impact analysis. In addition, these views are reasonably based on scientific, regulatory, or other information supported by credible data or methods that relate to the impacts analyzed in the EIS.

DOE has attempted to identify and address the range of opposing views in this EIS. The Department identified potential opposing views by reviewing published or other information in the public domain. Sources of information included reports from universities, other Federal agencies, the State of Nevada, counties, municipalities, other local governments, and Native American groups. DOE reviewed the potential opposing views to determine if they:

- Address issues analyzed in the EIS
- Differ from the DOE position
- Are based on scientific, regulatory, or other information supported by credible data or methods that relate to the impacts analyzed in the EIS
- Have significant basic differences in the data or methods used in the analysis or to the impacts described in the EIS

DOE has included potential opposing views that met the above criteria in the EIS where it discusses the particular subject. For example, opposing views on the groundwater system are discussed in the sections on groundwater.

2.6 Preferred Alternative

DOE's preferred alternative is to proceed with the Proposed Action to construct, operate and monitor, and eventually close a geologic repository for the disposal of spent nuclear fuel and high-level radioactive waste at Yucca Mountain. The analyses in this EIS did not identify any potential environmental impacts that would be a basis for not proceeding with the Proposed Action. DOE has not chosen any transportation mode, corridor, or route as preferred at this time.

DOE recognizes that implementation of the preferred alternative would require the completion of a number of actions. As part of this process, the Secretary of Energy is to:

- Undertake (and complete) site characterization activities at Yucca Mountain to provide information and data required to evaluate the site.

- Prepare an EIS.

- Decide whether to recommend approval of the development of a geologic repository at Yucca Mountain to the President.

The NWPA also requires DOE to hold hearings to provide the public in the vicinity of Yucca Mountain with opportunities to comment on the Secretary's possible recommendation of the Yucca Mountain site to the President. If, after completing the hearings and site characterization activities, the Secretary decides to recommend that the President approve the site, the Secretary will notify the Governor and legislature of the State of Nevada accordingly. No sooner than 30 days after the notification, the Secretary may submit the recommendation to the President to approve the site for development of a repository.

If the Secretary recommends the Yucca Mountain site to the President, a comprehensive statement of the basis for the recommendation, including the Final EIS, will accompany the recommendation. This Draft EIS has been prepared now so that DOE can consider the Final EIS, including the public input on the Draft EIS, in making a decision on whether to recommend the site to the President.

If, after a recommendation by the Secretary, the President considers the site qualified for application to the Nuclear Regulatory Commission for a construction authorization, the President will submit a recommendation of the site to Congress. The Governor or legislature of Nevada may object to the site by submitting a notice of disapproval to Congress within 60 days of the President's action. If neither the Governor nor the legislature submits a notice within the 60-day period, the site designation would become effective without further action by the President or Congress. If, however, the Governor or the legislature did submit such a notice, the site would be disapproved unless, during the first 90 days of continuous session of Congress after the notice of disapproval, Congress passed a joint resolution of repository siting approval and the President signed it into law.

In determining whether to recommend the Yucca Mountain site to the President, DOE would consider not only the potential environmental impacts identified in this EIS, but also other factors. Those factors could include those identified through public input, as well as other available information. Examples of such other possible factors include the following:

- Ability to obtain necessary approvals, license and permits
- Ability to fulfill stakeholder agreements
- Consistency with DOE mission
- Assurance of safety
- Facility construction and operation flexibility

- Cost of implementation
- Ability to mitigate adverse impacts

As part of the Proposed Action, the EIS analyzes the impacts of transporting spent nuclear fuel and high-level radioactive waste to the Yucca Mountain site from 77 sites across the United States. As part of this analysis, the EIS includes information, such as the comparative impacts of truck and rail transportation, alternative intermodal (rail to truck) transfer station locations, associated heavy-haul truck routes, and alternative rail transport corridors in Nevada, that might not lead to near-term decisions. It is uncertain at this time when DOE would make these transportation-related decisions. If and when it is appropriate to make such decisions, DOE believes that the EIS provides the information necessary to make these decisions. However, measures to implement those decisions, such as selection of a specific rail alignment within a corridor, or the specific location of an intermodal transfer station, or the need to upgrade the associated heavy-haul routes, would require additional field surveys, state and local government consultations, environmental and engineering analyses, and National Environmental Policy Act reviews.