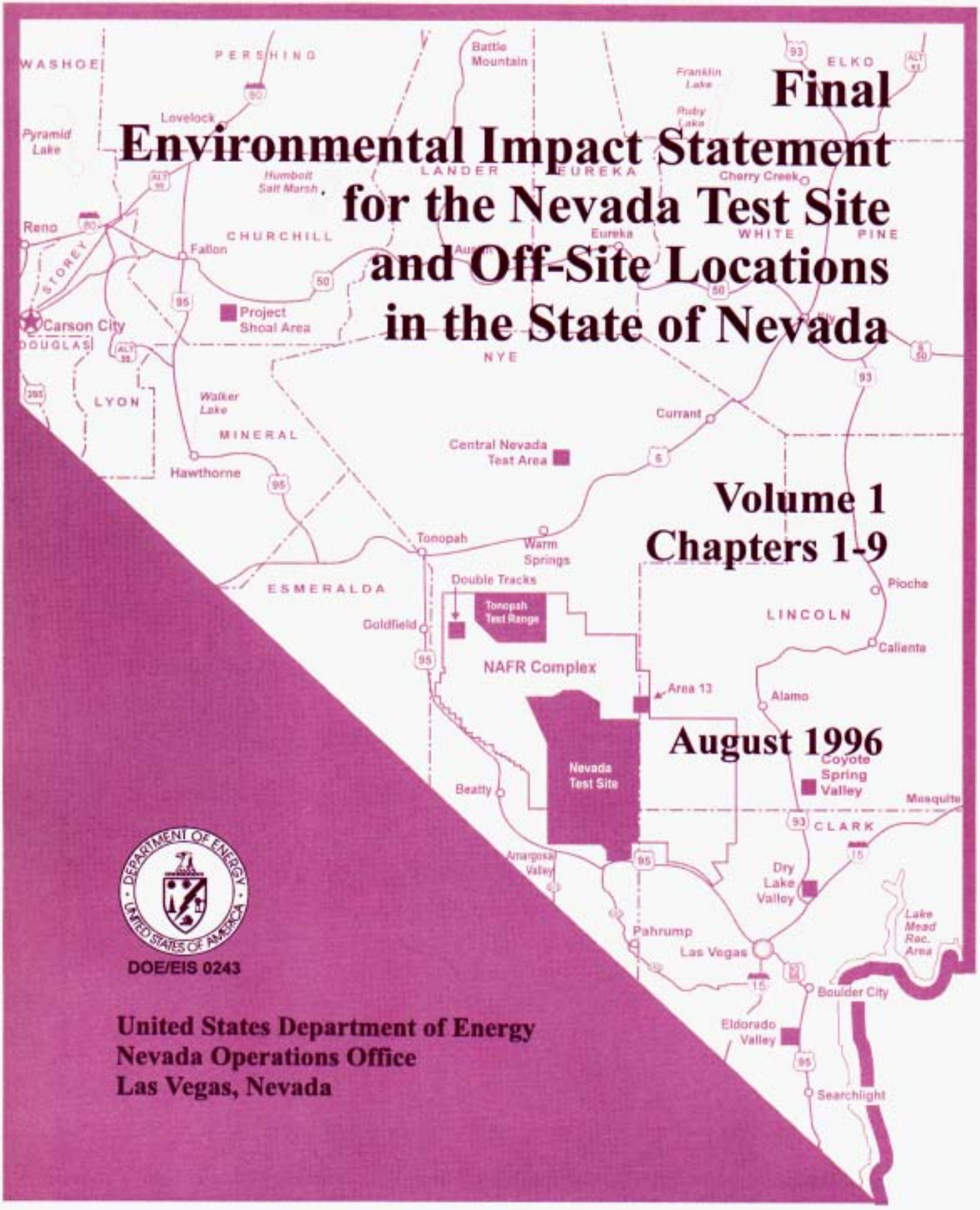
Final Environmental Impact Statement for the Nevada Test Site and Off-Site Locations in the State of Nevada

Volume 1
Chapters 1-9

August 1996



DOE/EIS 0243

United States Department of Energy
Nevada Operations Office
Las Vegas, Nevada

Department of Energy
Nevada Operations Office
P.O. Box 98518
Las Vegas, NV 89193-8518

Dear Interested Party

The Final Environmental Impact Statement (EIS) for the Nevada Test Site (NTS) and Off-Site Locations in the State of Nevada has been completed. This EIS examines existing and potential impacts to the environment that have resulted, or could result, from current and future Department of Energy activities in southern Nevada. The EIS analyzes four alternatives for managing the activities of Department of Energy programs at the NTS, the Tonopah Test Range, portions of the Nellis Air Force Range Complex, the Central Nevada Test Area, and the Project Shoal Area. In addition, proposed Solar Enterprise Zone facilities in Dry Lake Valley, Eldorado Valley, Coyote Spring Valley and the NTS are also examined.

The EIS identifies the Preferred Alternative as the Expanded Use Alternative (Alternative 3) plus the public education activities from Alternative 4, Alternate Use of Withdrawn Lands. This Preferred Alternative is the most comprehensive alternative in supporting statutory mission responsibilities while providing for a diversification of use to include nondefense, interagency, public, and private uses of the resources and capabilities available. Details on this preferred alternative can be found in the Summary and in Volume 1, Section 3.6, of this EIS. A framework for a Resource Management Plan is included as Volume 2 of this EIS and represents the development of an ecosystem management-based planning process closely integrated with the National Environmental Policy Act process.

The Department of Energy appreciates your participation in the development of this EIS and looks forward to your continued participation in the development of the Resource Management Plan and other activities of the Department of Energy.

Terry A. Vaeth
Acting Manager

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COVER SHEET

RESPONSIBLE AGENCY: U.S. Department of Energy

COOPERATING AGENCIES: Federal: U.S. Bureau of Land Management, U.S. Fish and Wildlife Service, Defense Nuclear Agency; and U.S. Air Force; Local Governments: Nye County, Nevada

TITLE: Final Environmental Impact Statement for the Nevada Test Site and Off-Site Locations in the State of Nevada (DOE/EIS-0243)

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ABSTRACT: This sitewide EIS evaluates the potential environmental impacts of four possible land-use alternatives being considered for the Nevada Test Site (NTS), the Tonopah Test Range, and the formerly operated DOE sites in the state of Nevada: the Project Shoal Area, the Central Nevada Test Area, and portions of the Nellis Air Force Range Complex. Three additional sites in Nevada—Eldorado Valley, Dry Lake Valley, and Coyote Spring Valley—are evaluated for colocation of solar energy production facilities. The four alternatives include **Continue Current Operations** (No Action, continue to operate at the level maintained for the past 3 to 5 years); **Discontinue Operations** (discontinue operations and interagency programs); **Expanded Use** (increased use of NTS and its resources to support defense and nondefense programs); and **Alternate Use of Withdrawn Lands** (discontinue all defense-related activities at NTS; continue waste management operations in support of NTS environmental restoration efforts; expand nondefense research). Environmental impacts were assessed for each alternative by analyzing, to the extent possible, the discrete and cumulative environmental impacts associated with Defense Waste Management, Environmental Restoration, Nondefense Research and Development, and Work for Others Programs. A framework for a Resource Management Plan is included as Volume 2 of this EIS and represents the development of an ecosystem based planning process closely integrated with the National Environmental Policy Act process. This EIS, among other things, analyzed the impacts of transportation of low level waste, and site characterization activities related to the Yucca Mountain Project but did not analyze the suitability of the site as a repository. This EIS does not analyze the suitability of the Yucca Mountain site as a repository as this is an action beyond the scope of the EIS. The **Preferred Alternative** is identified as **Expanded Use** plus the public education activities from **Alternate Use of Withdrawn Lands.** Volume 3 of this EIS contains the public comments and the responses to the comments.

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Final
Environmental Impact Statement

for
the Nevada Test Site and Off-Site Locations
in the State of Nevada

Volume 1

U.S. Department of Energy
Nevada Operations Office
Las Vegas, Nevada

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Chapter 1

INTRODUCTION

CHAPTER 1
INTRODUCTION

The U.S. Department of Energy (DOE) proposes to continue managing the Nevada Test Site (NTS) and its resources in a manner that meets evolving DOE missions and that responds to the concerns of affected and interested individuals and agencies.

This sitewide Environmental Impact Statement (EIS) is a type of programmatic EIS, in that it analyzes the impacts from DOE programs at the following sites: the NTS, the Tonopah Test Range, portions of the Nellis Air Force Range Complex (NAFR Complex), the Central Nevada Test Area, and the Project Shoal Area. These programs include ongoing activities for the stewardship of the nation's nuclear weapons stockpile, management of radioactive waste, and environmental restoration. Also examined in this EIS are newer programs, such as the proposed Solar Enterprise Zone facilities at the NTS, Eldorado Valley, Dry Lake Valley, and Coyote Spring Valley. In addition, Appendices F and J provide project specific analyses for the Big Explosives Experimental Facility and the activities conducted in the Lyner Complex, respectively.

This EIS examines existing and potential impacts to the environment that have resulted, or could result, from current and future DOE operations in Nevada during the next 10-year period. This 10-year planning period accounts for both short-term (0 to 5 years) and long-term (5 to 10 years) potential projects. However, it is a regulatory requirement of the DOE (10 CFR Part 1021) to review a sitewide EIS of multifacility sites at least every 5 years. The DOE Nevada Operations Office (DOE/NV), proposes to accomplish this review through the Resource Management Plan process. Although a framework for the *Resource Management Plan* is being published in conjunction with the NTS EIS, the *Resource Management Plan* will take longer to complete than the NTS EIS. In the future, it will be an integral part of the National Environmental Policy Act process on the NTS. The DOE is committed to completing the *Resource Management Plan*, which is estimated to take approximately 2 years. The 5-year sitewide review required by DOE policy will utilize the *Resource Management Plan* as part of the review of the EIS and in determining whether (1) the existing EIS remains adequate, or (2) a new EIS should be prepared or the existing EIS supplemented. A more detailed discussion on the relationship between the *Resource Management Plan* and the EIS is presented in the *Framework for the Resource Management Plan* (Volume 2, Section 1.4 of the EIS).

In September 1977, the *Final Environmental Impact Statement, Nevada Test Site, Nye County, Nevada*, a broadly scoped NTS EIS, was published (ERDA, 1977). Pursuant to the DOE's mission responsibilities at that time, the 1977 EIS focused on an evaluation of the environmental impacts of underground nuclear tests with yields of less than one megaton. An analysis of other intermittent nuclear and non-nuclear activities that were conducted—and continue to be conducted—at the NTS was included in this earlier EIS. In recent years, nuclear testing policy changes have occurred. These policy changes have caused significant changes in NTS programs. These changes, together with the favorable environmental and infrastructure characteristics at the NTS, have resulted in additional DOE and non-DOE activities being proposed for siting at the NTS. These proposed changes in operations at the NTS, and the DOE policy of reviewing sitewide National Environmental Policy Act documents, have resulted in the preparation of a new NTS EIS. Preparing an EIS at this time responds to public concern and allows for a full dialogue among the DOE and state, tribal, county and municipal governments; other federal agencies; and the general public.

Initially, the DOE/NV planned to prepare two EISs to be separated along programmatic lines. The DOE/NV Environmental Restoration and Waste Management EIS was to address restoration and waste management activities at the NTS and other off-site test areas within Nevada. The sitewide NTS EIS was to address the future mix of Defense Program missions/activities, stockpile stewardship, and alternative uses of the NTS.

The Manager, DOE/NV, decided on May 15, 1994, that one EIS should be prepared for the Defense, Environmental Restoration, and Waste Management Programs, and other potential activities considered for the NTS. Work then began on the preparation of a Notice of Intent (NOI) for this EIS. The NOI was subsequently published in the *Federal Register* on August 10, 1994.

On June 28, 1994, the state of Nevada filed a Complaint for Declaratory Judgment and Injunction against the DOE in the U.S. District Court in Nevada. In its complaint, the state of Nevada sought declaratory judgments that the DOE has failed to comply with National Environmental Policy Act requirements at the NTS, and that the DOE must initiate a single sitewide EIS for all major federal actions at the NTS. Nevada also sought orders to halt shipments of low-level waste from Fernald (a DOE site located in Ohio), as well as all other transportation, receipt, storage, and disposal of mixed waste, hazardous waste, and other DOE approved waste to the NTS. In its complaint, Nevada sought to stop the DOE from pursuing any "Weapons Complex" activities, including nuclear testing, research, and development that would significantly impact the environment, until publication of the NTS EIS.

On July 14, 1994, the state of Nevada amended its original complaint to focus on enjoining only the receipt, disposal, and waste management activities related to off-site waste. The U.S. District Court in Nevada issued an Order on January 12, 1995, that dismissed Nevada's claims regarding shipment of Fernald low-level waste to the NTS based on a pre-enforcement review bar under the Comprehensive Environmental Response, Compensation and Liability Act. The Court also dismissed claims regarding preparation of an Environmental Impact Statement because of mootness since this NTS EIS was underway. Claims regarding the contents of the new EIS were also dismissed as not yet ripe for adjudication. However, the Court did not dismiss Plaintiff's claims seeking injunctive relief from the disposal of low-level waste from other off-site disposal facilities.

On April 29, 1996 the parties filed a Joint Stipulation to Stay Proceedings requesting court approval of their agreement that the complaint should be administratively dismissed from the docket until thirty days following the issuance of the NTS Record of Decision. The DOE agreed to store and dispose of all low-level waste not originating from Fernald at Area 5, rather than Area 3, of the NTS until 30 days following the issuance of the Record of Decision for this EIS. The parties also agreed that, thirty days following issuance of the Record of Decision, they would develop a schedule for filing a Third Amended Complaint, responding to such complaint if one is filed, preparing the Administrative Record and filing summary judgement briefings to the court. At a Status Conference on May 15, 1996, the Court approved the joint Stipulation to Stay Proceedings and scheduled a further Status Conference for Friday, August 30, 1996.

1.1 Organization of This Environmental Impact Statement

This EIS is organized into three volumes. Volume 1 contains the EIS, and Volume 2 presents the framework within which a *Resource Management Plan* will be developed. Volume 3 contains a compilation of comments received on the Draft NTS EIS and responses to those comments.

Volume 1 is organized into 9 chapters and 10 appendices. Chapter 2 provides a description of the purpose and need for the action analyzed in this EIS. Chapter 3 provides a description of the four alternatives analyzed in this EIS and brief reviews of the alternatives eliminated from further consideration, and identifies the DOE's preferred alternative. Chapter 3 also provides a comparative summary of the impacts of the alternatives on the local communities and the natural environment. Chapter 4 contains a description of the affected environments under current conditions, and provides a baseline for analyzing the impacts of the alternatives. The results of the environmental impact analysis are presented in Chapter 5. Chapter 6 contains the cumulative impacts discussions. Chapter 7 presents mitigation measures. Chapter 8 contains the list of individuals and organizations consulted during the preparation

of this EIS. Chapter 9 contains the list of NTS EIS preparers and contributors. References are listed at the end of the chapter in which they are cited. A glossary and an index follow Chapter 9.

In addition to the body of this EIS, the following appendices are included:

- Appendix A - Detailed Project and Activity Information
- Appendix B - Notice of Intent
- Appendix C - Relevant Regulatory Requirements
- Appendix D - Distribution of the Final EIS
- Appendix E - Impact Assessment Methods
- Appendix F - Project-Specific Environmental Analysis (Big Explosives Experimental Facility)
- Appendix G - American Indian Assessments: Final Environmental Impact Statement for the Nevada Test Site and Off-Site Locations in the State of Nevada
- Appendix H - Human Health Risk and Safety Impacts Study
- Appendix I -Transportation Study
- Appendix J - Classified Supplement: Project-Specific Information for Activities Conducted at the Lyner Complex.

As part of the process for this EIS, guidance on addressing American Indian concerns, provided in an Executive Policy Memorandum (DOE, 1994), was considered. For this EIS, the DOE implemented the executive policy by inviting representatives of the Consolidated Group of Tribes and Organizations to write sections of the document so that their concerns and viewpoints regarding the alternatives and the technical analyses would be presented. In many instances, viewpoints of the American Indians differ widely from the DOE's. To facilitate review, the viewpoints of the Consolidated Group of Tribes and Organizations are included in the text of the NTS EIS as italicized sections. The full text of American Indian concerns related to the alternatives evaluated in this EIS is located in Appendix G.

Two additional studies were undertaken in support of this EIS: the Human Health Risk and Safety Impacts Study, and the Transportation Study. These studies are published as Appendices H and I of this EIS and contain the detailed information and analyses that led to the transportation, human health effects, and safety impacts conclusions contained in this EIS.

As part of this EIS the DOE prepared two project-specific appendices. Appendix F is a project-specific environmental analysis for the Big Explosive Experimental Facility and Appendix J is a classified appendix containing information on the activities conducted at the Lyner Complex. The Big Explosive Experimental Facility is an existing facility in Area 4 of the NTS and has appropriate National Environmental Policy Act compliance review for its ongoing bunker-certification tests and shaped-charge experiments (described as Alternative 1 in Appendix F). The project-specific impact analysis in Appendix F has been incorporated into Chapter 5 of the NTS EIS. This EIS is intended to complete the National Environmental Policy Act requirements for the Big Explosive Experimental Facility by evaluating the potential impacts resulting from the alternatives of ongoing or expanded use of the facility.

The classified appendix was completed concurrently with the unclassified portion of this NTS EIS. It discusses the potential for adverse impacts to the environment under routine operating conditions during experiments with special nuclear material at the Lyner Complex. The classified appendix contains information on material quantities and design concepts that are classified by the DOE for nonproliferation and national security reasons. The environmental impacts and public safety and health risks associated with these experiments are not classified and are included in Chapter 5, Environmental Consequences, under Defense Program activities.

1.2 Alternatives Analyzed

This EIS analyzes the environmental impacts associated with managing the NTS and its resources. The alternatives are structured to provide scenarios of current and future uses of the DOE facilities in Nevada that range from discontinued use to expanded use. The use alternatives have been designed to allow the DOE to analyze and compare the potential environmental effects of a wide range of use options. The use the DOE ultimately selects, however, may not be one of the alternatives described in its entirety, but a hybrid created by selecting specific options from within the alternatives analyzed.

This EIS identifies the impacts of past, current, and potential programs of the DOE. The programs are included in one or more of the four alternatives and fall into three basic levels: (1) current activities, (2) planned projects, and (3) proposed projects. Current activities are those that are presently part of the normal operations of the NTS, the Tonopah Test Range, portions of the NAFR Complex, and other areas considered in this EIS, such as the Area 5 Radioactive Waste Management Site. Planned projects are those that are within the 5-year planning cycle and are likely to be implemented, such as a Solar Enterprise Zone facility. These projects are not yet included in the 5-year planning window, but have undergone sufficient conceptual development to allow a reasonable assessment. The most reliable data are clearly derived from ongoing activities. Planned projects would present slightly less reliable data. Data for proposed projects would be the least defined, but were determined to be essential to a full and open evaluation and disclosure of the potential effects of the alternative. To provide an adequate analysis, conservative assumptions and parameter values were used to evaluate potential impacts of the less-defined activities.

Four alternatives are presented in this EIS:

- Alternative 1 - Continue Current Operations (No Action) - Ongoing DOE and interagency programs and activities at the NTS and other associated areas in Nevada would be continued under this alternative
- Alternative 2 - Discontinue Operations - All current and planned program activities and NTS operations would be discontinued under this alternative. Only the environmental monitoring and site-security functions necessary for human health, safety, and security would be maintained
- Alternative 3 - Expanded Use - The NTS and its resources would be made available for increased use to support national programs of both a defense and nondefense nature
- Alternative 4 - Alternate Use of Withdrawn Lands - All defense-related activities and most Work for Others Program activities would be discontinued at the NTS. Certain programs and activities that are not currently included in NTS mission responsibilities are also evaluated. This alternative could include other activities, such as the relinquishment of portions of the NTS, that would be dependent upon future land-use designations and withdrawal status.

1.3 Laws and Regulations

This document was prepared in accordance with the National Environmental Policy Act of 1969; the Council on Environmental Quality (CEQ) regulations, which implement the Act (Title 40 Code of Federal Regulations [CFR] Parts 1500-1508), and the DOE's implementing regulations for the National Environmental Policy Act (10 CFR Part 1021).

Appendix C identifies and summarizes the primary federal and state laws, regulations, executive orders, and DOE orders that may apply to the proposed action and alternatives at the NTS. It also provides information on the current status of permits and regulatory compliance for the NTS and DOE off-site locations in Nevada.

1.4 Relationship of This Environmental Impact Statement and Other Statements

The DOE is preparing several other National Environmental Policy Act documents that may affect the scope of this EIS because they include the

NTS as an alternative location for the action under consideration. The documents are discussed in the remainder of this section. In addition, Section 3.2.6.1 addresses the EIS that the DOE plans to prepare for the Yucca Mountain Repository Project.

The NTS EIS is a sitewide EIS. A sitewide EIS is intended to support decisionmaking at a given geographic location; this EIS addresses environmental impacts that occur as a result of past, present, and reasonably foreseeable future activities at the site. In some circumstances, a sitewide EIS must take into account proposals originating elsewhere (such as in other DOE program-level documents) that may affect facilities management or land use planning at the site. Such external proposals would be subject to separate National Environmental Policy Act review and decisionmaking processes, but would be identified, and their impacts incorporated in the sitewide EIS.

When the NTS has been proposed and analyzed as an alternative in one of these DOE program-level documents, the impact of additional activities is included as part of the Alternative 3, Expanded Use impacts of this sitewide EIS. The discussion of cumulative impacts in this EIS incorporates the analysis presented in other geographically-related environmental documents, and is intended to reflect the maximum expected impacts for each of the four alternatives considered in this EIS. The National Environmental Policy Act reviews considered for analysis in the NTS EIS include those discussed in the following paragraphs.

Waste Management Programmatic EIS—The Waste Management Programmatic EIS provides a department-wide evaluation of management alternatives for treating, storing, and disposing of radioactive and hazardous waste. The NTS is a site considered for the central or regional management for DOE wastes; 13 other sites are also being considered. Under other options, the NTS would manage only its own wastes or ship some, or all, of its wastes to another DOE site. The Final Waste Management Programmatic EIS, which is in preparation, will more clearly define the role of the NTS within the DOE Waste Management Complex.

Stockpile Stewardship and Management Programmatic EIS—The Stockpile Stewardship and Management Programmatic EIS addresses the activities required to ensure the safety and reliability of the nation's nuclear weapons stockpile and the maintenance, evaluation and repair or replacement of weapons and associated components. This programmatic EIS provides information to assess the environmental impacts of alternatives for conducting the stockpile stewardship and management program, assist with decisions to identify specific capabilities and facilities for conducting the program, and help determine the configuration (or sites for facilities) of the nuclear weapons complex that would most efficiently implement the program.

Stockpile stewardship activities for which the NTS has been identified as an alternative, although not as part of the Preferred Alternative, include the National Ignition Facility and the next generation of nuclear weapons simulators. The next generation of simulators cannot be defined to the degree necessary to perform meaningful environmental analysis. However, two conceptual facilities are analyzed in this EIS for land-use planning purposes only: (1) Next Generation Radiographic Facility and (2) Next Generation Magnetic Flux Compression Generation Facility. In the Stockpile Stewardship and Management Programmatic EIS, these facilities are described as the Advanced Hydrotest Facility and the High-Explosive Pulsed Power Facility, respectively. Under stockpile management activities, the NTS Device Assembly Facility, and the P-Tunnel, located on Rainier Mesa, are proposed as alternative sites for weapons assembly and disassembly. The DOE began the Stockpile Stewardship and Management Programmatic EIS in June 1995 (60 FR 31291), and issued the Draft Programmatic EIS in February 1996. The Final NTS EIS is currently being prepared.

Disposition of Surplus Highly Enriched Uranium EIS—The Disposition of Surplus Highly Enriched Uranium EIS evaluates the disposition alternatives of surplus highly enriched uranium. The NTS is a candidate for receipt of low-level waste generated by blending high-enriched uranium with low-enriched uranium. The Draft Highly

Enriched Uranium EIS was issued in October 1995; the final Highly Enriched Uranium EIS was issued in June, 1996. There are no functions or facilities for the NTS identified in the Preferred Alternative of this EIS. Decisions related to the disposal of any low-level waste generated by blending will be consistent with the Record of Decision issued after completion of the Waste Management Programmatic EIS.

Storage and Disposition of Weapons-Usable Fissile Materials Programmatic EIS—The Storage and Disposition of Weapons-Usable Fissile Materials Programmatic EIS evaluates sites for the storage and several technologies considered for the dispositioning of plutonium and other weapons-usable fissile materials, except the surplus of highly enriched uranium. This programmatic EIS included consideration of strategic reserves of special nuclear materials; because the storage of strategic reserves is covered in both the Storage and Disposition of Weapons-Usable Fissile Materials Programmatic EIS and the Stockpile Stewardship and Management Programmatic EIS, the decision for location of storage of the strategic reserves will not be made until completion of both EIS documents, in a Record of Decision which will jointly consider both proposals.

The NTS is a candidate site for two of the storage alternatives considered in the Storage and Disposition of Weapons-Usable Fissile Materials Programmatic EIS; Consolidation of Plutonium Alternative and Collocation of Plutonium and Highly Enriched Uranium Alternative. The programmatic EIS also evaluates the technology or technology mix to be employed for achieving the Spent Fuel Standard for disposal. For the purpose of analysis, the programmatic EIS considered the NTS as a location for a disposal technology or technology mix including Pit Disassembly/ Conversion Facility, Mixed Oxide Fuel Fabrication Facility, and an Evolutionary Light Water Reactor. However, the record of decision for the Storage and Disposition of Weapons-Usable Fissile Materials Programmatic EIS would only select the technology, not the site. This Draft Programmatic EIS was issued in February 1996. The Final Programmatic EIS is currently being prepared.

Continued Operation of the Pantex Plant and Associated Storage of Nuclear Weapons and Components Draft EIS—The Pantex Sitewide EIS addresses continued operations of the DOE's Pantex Plant, located near Amarillo, Texas, as well as the possible relocation of the interim storage of these plutonium pits. A decision on the interim storage of pits is being considered as a contingency and will not be necessary if a decision on the long-term storage and disposition of plutonium is made following the Fissile Materials Programmatic EIS. An expanded Device Assembly Facility and the P-Tunnel, both located on the NTS, have been proposed as candidate sites for the interim relocation of up to 20,000 pits although not as part of the Preferred Alternative. The DOE began this EIS in May 1994 (59 FR 26635). The Draft NTS EIS was issued for review in 1996.

Los Alamos National Laboratory Sitewide EIS—The Los Alamos National Laboratory Sitewide EIS addresses continued operations of the Los Alamos National Laboratory in New Mexico. The EIS may also evaluate the use of the NTS facilities for disposal in the waste management section of the document. The DOE began this EIS in May 1995 (60 FR 25697).

Medical Isotopes Production Project: Molybdenum-99 and Related Isotopes. In the Final NTS EIS, the DOE proposed to create a domestic source for the production of medical isotopes for maintaining a stable supply to the United States' health care community. These isotopes would be produced in concert with the DOE's national laboratories. The NTS was identified as the preferred location for the disposal of approximately 100 drums of low-level waste generated each year under this proposed medical isotope production project. The Final Molybdenum-99 and Related Isotopes EIS was issued in May 1996.

Nellis Air Force Range Legislative EIS—In addition to the National Environmental Policy Act documents that the DOE is preparing, the U.S. Air Force will be preparing a legislative EIS for the NAFR Complex. This document will include a discussion of all activities on the Tonopah Test Range. The Tonopah Test Range will be evaluated

as part of the 2001 land withdrawal review of the NAFR Complex. Under Public Law 99-606 (which consolidated the NAFR Complex under one withdrawal order) over 3 million acres of land in Clark, Nye, and Lincoln counties were withdrawn. The withdrawal and reservation terminates on November 6, 2001. Renewal actions require an EIS to address the environmental impacts of continued land withdrawal. The land withdrawal alternatives evaluated in the NAFR Complex Legislative EIS may result in proposed changes that could affect DOE operations, such as the use of Pahute Mesa by the DOE . It is anticipated that the NTS EIS will provide baseline information and will be used in the cumulative impact analysis section for the NAFR Complex Legislative EIS.

1.5 Public Comment Process on the Draft NTS Environmental Impact Statement

The Draft NTS EIS was developed after a series of public scoping meetings. The scoping process and issues raised during the scoping phase are described in the Final Implementation Plan (DOE/NV, 1995). This Draft EIS was distributed for review and comment to congressional members and committees; the state of Nevada; tribal governments; several county governments; other federal agencies; and the general public. The DOE invited comments to correct factual errors or to provide insights on any other matter related to this environmental analysis. During the comment period, public hearings were held in St. George, UT; Reno, Pahrump, and Las Vegas, NV; and additional workshops were held in Caliente, Tonopah, Boulder City, and North Las Vegas, NV. In addition, the public was encouraged to provide comments via mail, fax, e-mail, and telephone (toll-free 800 number).

In response to public feedback critical of DOE's traditional hearing format, the public hearings and workshops held on the Draft NTS EIS were conducted using various formats selected by representatives of the host community. The formats chosen allowed for a two-way interaction between the DOE and the public; increased public awareness and understanding on project-related impacts discussed in the Draft NTS EIS; and encouraged informed public input and comments on the document. Community facilitators were present at the workshops to direct and clarify discussions and comments.

All public hearing and workshop comments received by mail, fax, e-mail, or telephone during the public comment period are presented in Volume 3 of this EIS, the comment response document. Volume 3 describes the public comment process in detail, presents broad issue summaries and responses, and includes copies of all comments received.

The DOE provided the draft classified Appendix J, "Classified Supplement: Project-Specific Environmental Impact Analysis (Lyner Complex)," for review by appropriately cleared parties. The parties included the EPA and the state of Nevada. Neither party had any recommendations for changes to the classified supplement.

1.6 Changes from the Draft Sitewide Environmental Impact Statement

The DOE has revised the Draft NTS EIS in response to comments received from the state of Nevada, the Consolidated Group of Tribes and Organizations and Indian Tribes, local governments and federal agencies (including the Department of the Interior and the Environmental Protection Agency), nongovernmental organizations, the general public, and the DOE and laboratory reviewers. The text of the NTS EIS has been changed in some areas to provide additional environmental baseline information, to correct inaccuracies and make editorial corrections, and provide additional discussion of technical considerations to respond to comments and to clarify text. In addition, the DOE has updated coverage due to events or decisions made in other documents since the Draft NTS EIS was provided for public comment in January, 1996. Finally, the DOE has identified a preferred alternative. New and changed text has been identified by a side-bar on the modified text.

1.6.1 Alternatives

DOE has provided additional information to clarify the alternatives, including repeating material from Alternative 1 in Alternative 3.

1.6.2 Preferred Alternative

Alternative 3 has been identified as the DOE's Preferred Alternative, with the addition of public education options from Alternative 4. This Preferred Alternative is viewed as the alternative which best meets the objectives of the DOE, and addresses comments from the public regarding other uses for the NTS. The Preferred Alternative satisfies the purpose and need cited as the reason DOE needs to take action. The Record of Decision may select this alternative or a combination of this alternative and the other alternatives for DOE's future activities at the Nevada Test Site and off-site locations in the state of Nevada.

1.6.3 Summary of Significant Changes

Volume 3 of this EIS, the comment response volume, contains responses to individual comments. The comments can be grouped based on their content, and the changes resulting from them can be summarized. Below is a summary of changes made in Volumes 1 and 2 as a result of the comments and other considerations cited above:

With regard to the Defense Program, there were comments which questioned the rationale for conducting subcritical experiments, as well as the characterization of subcritical experiments as part of the No-Action Alternative. Information has been added that explains the historical basis for having conducted the tests in the past and defines the program for the future. The relationship to current Comprehensive Test Ban Treaty negotiations is also clarified. Changes have been made in various sections of Chapters 2, 3 and 4 to clarify the nature of these experiments.

With regard to waste management, many comments noted the differences in waste volume numbers cited in this EIS and in other DOE documents. The waste volume numbers have been updated and clarified. Changes in the waste volumes have resulted in changes in the values used in the Transportation Study (Appendix I) and the Human Health Risk and Safety Impacts Study Assessment (Appendix H) as well. Questions about waste categories and what is disposed on the NTS have been addressed and clarifying language has been added to the text. Changes have been made in various sections of Chapters 2, 3, 4, and 5 and Appendices A, H, and I of the NTS EIS.

Commentors raised questions about the radioactive source term data discussed in the groundwater and public health impacts sections. Additional information has been provided about the development of the source term and the models used in the evaluation of groundwater contaminant transport. This information has also been referenced in the Human Health Risk and Safety Impacts Study Assessment (Appendix H) to better clarify the results of consequence and impact assessments in the public environment off the NTS/NAFR Complex controlled lands. Changes have been made in Section 4.1.4.2 of the NTS EIS.

Comments regarding the impacts to biological resources have been addressed by adding clarifying information to the text. The recently completed Biological Opinion provided by the U.S. Fish and Wildlife Service has been referenced as well. Changes have been made in the text in various sections of Chapters 5 and 8 of the NTS EIS.

The Consolidated Group of Tribes and Organizations have continued their evaluation of the NTS EIS and development of their information pertaining to the DOE activities and conclusions. The American Indian Assessments: Final Environmental Impact Statement for the Nevada Test Site and Off-Site Locations in the State of Nevada (Appendix G), has been revised and additional assessments have been incorporated. These assessments have been added, in italics, to the text of the NTS EIS.

There were many comments on the cumulative impacts assessment. Chapter 6 has been revised to incorporate more information and to better reflect the role of DOE activities as contributing to the overall impacts of the region.

Many comments were received on DOE's waste transportation activities and transportation-related issues. These issues have been addressed through revisions to the Transportation Study, and by fully incorporating and assessing the full scope of transporting defense program materials as well as

hazardous materials in relation to activities at the NTS. The concerns of the local governments and the public have been addressed as well. American Indian concerns will be identified and addressed through a recently initiated American Indian Transportation Study and continued government-to-government consultation. The DOE will continue all dialogue initiated through the transportation study development.

1.7 Next Steps

The Record of Decision will explain all factors, including environmental impacts, that the DOE considered in reaching its decision (see inside back cover). The Record of Decision will also identify the environmentally preferred alternative, or alternatives. If mitigation measures, monitoring, or other conditions are adopted as part of the DOE's decision, these will be summarized in the Record of Decision, as applicable, and will be included in a Mitigation Action Plan that would be prepared following the issuance of the Record of Decision. The Mitigation Action Plan would explain how and when mitigation measures would be implemented and how the DOE would monitor the mitigation measures over time to judge their effectiveness. The Record of Decision and the Mitigation Action Plan will also be placed in the DOE Reading Room in Las Vegas and made available to interested parties upon request.

The DOE is committed to completing the *Resource Management Plan* in accordance with the Final Framework as described in Volume 2 of this Final EIS. During the *Resource Management Plan* process, consultation with federal agencies and sovereign nations, and interaction with local governments and interested members of the public will continue.

1.8 References

REGULATION, ORDER, LAW

10 CFR Part 1021 — U.S. Department of Energy (DOE), "Energy: Compliance with the National Environmental Policy Act," *Code of Federal Regulations*, Office of the Federal Register, National Archives and Records Administration, U.S. Government Printing Office, Washington, DC, 1992.

40 CFR Part 1500-1508 — Council on Environmental Quality (CEQ), "Protection of the Environment: Regulations for Implementing the Procedural Provisions of the National Environmental Policy Act," *Code of Federal Regulations*, Office of the Federal Register, National Archives and Records Administration, U.S. Government Printing Office, Washington, DC, 1993.

59 FR 26635 — DOE, "Preparation of an Environmental Impact Statement for the Continued Operation of the Pantex Plant and Associated Storage of Nuclear Weapon Components, Notice of Intent," *Federal Register*, Washington, DC, 1994.

60 FR 25697 — DOE, "Notice of Intent to Prepare a Sitewide Environmental Impact Statement for the Los Alamos National Laboratory," *Federal Register*, Washington, DC, 1995.

60 FR 31291 — DOE, "Stockpile Stewardship and Management Programmatic Environmental Impact Statement, Notice of Intent," *Federal Register*, Washington, DC, June 14, 1995.

GENERAL

DOE, 1994 — DOE, Memorandum for the Heads of Executive Departments and Agencies, Government-to-Government Relations with Native American Tribal Governments, Washington, DC, 1994.

DOE/NV, 1995 — U.S. Department of Energy, Nevada Operations Office (DOE/NV), *Implementation Plan for the Nevada Test Site Environmental Impact Statement* Revision O, DOE/NV-390, pp. 3 and 4, 3-14, Las Vegas, NV, 1995.

ERDA, 1977 — U.S. Energy Research and Development Administration (ERDA), *Nevada Test Site, Nye County, Nevada Final Environmental Impact Statement*, Report No. ERDA-1551, Washington, DC, 1977.

MLWA, 1986 — Military Lands Withdrawal Act of 1986, Public Law 99-606.

NEPA, 1969 — National Environmental Policy Act (NEPA), Public Law 91-190, 42 U.S.C. 4341, et seq., amended by Public Laws 94-52 and 94-83, 1969.

Chapter 2

PURPOSE AND NEED FOR DOE ACTION

CHAPTER 2
PURPOSE AND NEED FOR DOE ACTION

Among the major responsibilities of the DOE are the continued stewardship of the nation's nuclear weapons stockpile and the maintenance of a testing capability. The purpose and need for the proposed actions analyzed in this EIS arise in part from those responsibilities. The DOE proposes to continue managing the NTS and its many resources in a manner consistent with national needs during a period in which the missions of the DOE and the NTS continue to evolve.

2.1 Background

Historically, the primary mission of the NTS was to conduct nuclear weapons tests. Since the current moratorium on testing began in October 1992, this mission has changed to maintain a readiness to conduct tests, if so directed, in the future. The NTS, because of its favorable environment and infrastructure, has also supported DOE waste management, as well as other national-security-related research, development, and testing programs. With the end of the Cold War, the United States is now challenged with a complete re-evaluation of its national security needs and priorities in a way that emphasizes the nation's commitment to a comprehensive ban on nuclear weapons testing and reduction of the global nuclear danger.

This EIS is being prepared pursuant to DOE regulations (10 CFR Part 1021) and is part of a long-term management process. The first step in this process is evaluating all actions planned for the NTS, defining the baseline environment, and identifying potential impacts that might occur as a result of the planned actions. Beyond these elements common to all EISs, this document also serves as the framework for developing a long-term *Resource Management Plan* for the NTS.

This EIS represents one level of a tiered management process. Tiering refers to the coverage of general matter in broader environmental impact statements, such as national program statements,

Evolution of National Policy

The alternatives considered in this EIS reflect the importance of the NTS within the overall national defense policy. Over the last 4 years, major shifts in policy have occurred. These shifts are highlighted below.

DATE	*EVENT/POLICY CHANGE*
September 1991	**The President made the first of three announcements on significant reductions in the nuclear weapons stockpile.**
September 1992	**The last underground nuclear test was performed at the NTS.**
October 1992	**The President signed a 9-month moratorium, stopping all nuclear testing until July 1993.**
July 1993	**The President announced an extension of the moratorium and directed the DOE to develop alternative means for a stockpile stewardship program.**
November 1993	**Congress, through the National Defense Authorization Act (Public Law 103-160) instructed the Secretary of Energy to "establish a stewardship program to ensure the preservation of the core intellectual and technical competencies of the United States in nuclear weapons."**
May 1995	**The Nonproliferation Treaty was extended indefinitely.**
August 1995	**The President announced the decision to seek a zero-yield Comprehensive Test Ban Treaty and established the conduct of a science-based stockpile stewardship program as a condition of the United States' entry into the treaty. Maintenance of a safe and reliable stockpile is considered "a supreme national interest of the United States."**

with subsequent narrower environmental statements or analyses, such as project or site-specific statements. The narrower statement incorporates by reference the general discussions of the broader statement and concentrates solely on the issues specific to the statement subsequently prepared. For the NTS EIS, such documents as the Waste Management Programmatic EIS or the Stockpile Stewardship and Management Programmatic EIS address broader national issues and include the NTS as a potential location for implementing an action considered in the program. The NTS EIS evaluates the impacts of those potential decisions. Similarly, actions considered in the NTS EIS may, at a later time, be more explicitly analyzed in an environmental assessment which could address only the narrower topic being considered without restating information contained in the NTS EIS.

Between the issuance of this EIS as a final document and the first planned review, there will, no doubt, be new activities identified that were not considered. Each of these actions will be evaluated on a case-by-case basis, and a tiered National Environmental Policy Act document will be prepared if necessary. Tiered documents include supplemental EISs and environmental assessments. As a hypothetical example, during the planned investigations of the Underground Testing Area's Corrective Action Unit, it might be necessary to conduct some type of land-disturbing test that was not considered in this EIS. If the hypothetical test required the collection of deep seismic data using shallow boreholes and high explosives, the specific impacts and consequences of performing the seismic study would be evaluated and documented in a tiered report. If the environmental consequences were projected to be significant, a supplemental EIS might be prepared that would address only the specific proposed test and its alternatives.

On the other hand, some new actions could trigger a National Environmental Policy Act review as a result of regulatory requirements, and a tiered National Environmental Policy Act document might not be sufficient. In such instances, a National Environmental Policy Act compliance review would be performed and, if necessary, a separate EIS prepared. In other instances, the new action might be included in future reviews and updates of this EIS.

This EIS provides tiered project-specific National Environmental Policy Act documentation for two facilities at the NTS. Appendix F analyzes the continued and potential expanded use of the Big Explosives Experimental Facility. Appendix J presents classified information for activities conducted at the Lyner Complex. The environmental impacts of the activities are not classified and are discussed in the appropriate sections of Chapter 5.

In addition to National Environmental Policy Act documents, other analyses that deal with the human environment are used to support DOE decisionmaking and public participation processes. These other documents include Safety Analysis Reports, Safety Evaluation Reports, Hazard Analyses, Human Health Risk Assessments, Transportation Studies, Environmental Restoration Assessments, Performance Evaluations, and Performance Assessments. Some of these studies perform very focused and specific functions with respect to decisionmaking, and are triggered when an appropriate stage of the project is reached. When these other studies precede or are concurrent with a National Environmental Policy Act document and are relevant to the analysis, their findings are incorporated into the National Environmental Policy Act document. These analytical processes and their relationship to the NTS EIS are discussed further in Section 2.5 with the exception of the Safety Analysis Reports, Safety Evaluation Reports, and Hazard Analysis. These three analyses are designed to identify and resolve sources of potential injury to workers and are disclosed in National Environmental Policy Act documents.

2.2 Policy Considerations

In responding to the nation's need to ensure the safety, security, and reliability of the nuclear weapons stockpile, the DOE must consider national deterrence and stockpile stewardship policies. The NTS plays an integral part in helping the DOE meet this mission, and the policies outlined below are a major factor in developing the long-term management framework for the NTS.

A moratorium on nuclear weapons testing is currently in effect. In September 1992, Congress imposed a 9-month moratorium on underground nuclear

weapons testing. President Clinton has extended the moratorium on three occasions. The latest extension occurred in January 1995, and continues the moratorium through September 1996. Under the moratorium, President Clinton directed the DOE to maintain the capability to conduct nuclear tests. On August 11, 1995, President Clinton reaffirmed this commitment and announced his intention to seek a zero-yield Comprehensive Test Ban Treaty. A zero-yield Comprehensive Test Ban Treaty would ban any nuclear weapon test explosion or any other nuclear explosion. President Clinton also established specific safeguards that define the conditions under which the United States can enter into a Comprehensive Test Ban Treaty. These safeguards are as follows:

- The conduct of a science-based stockpile stewardship program to ensure a high level of confidence in the safety and reliability of nuclear weapons in the active stockpile, including the conduct of a broad range of effective and continuing experimental programs
- The maintenance of modern nuclear laboratory facilities and programs in theoretical and exploratory nuclear technology that would attract, retain, and ensure the continued application of our human scientific resources to those programs upon which continued progress in nuclear technology depends
- The maintenance of the basic capability to resume nuclear test activities prohibited by the Comprehensive Test Ban Treaty should the United States cease to be bound to adhere to such a treaty
- The continuation of a comprehensive research and development program to improve treaty-monitoring capabilities and operations
- The continuing development of a broad range of intelligence gathering and analytical capabilities and operations to ensure accurate and comprehensive information on worldwide nuclear arsenals, nuclear weapons development programs, and related nuclear programs
- The understanding that if the President of the United States is informed by the Secretary of Defense and the Secretary of Energy, advised by the Nuclear Weapons Council, the Directors of DOE's nuclear weapons laboratories, and the Commander of the U.S. Strategic Command, that a high level of confidence in the safety and reliability of a nuclear weapon type that the two Secretaries consider to be critical to our nuclear deterrent could no longer be certified, the President, in consultation with Congress, would be prepared to withdraw from the Comprehensive Test Ban Treaty under the standard "supreme national interest" clause in order to conduct whatever testing might be required.

The NTS has a demonstrated or potential role in implementing each of these Comprehensive Test Ban Treaty safeguard elements. For example, the NTS's role in the implementation of the first of these safeguards is to participate in full partnership, for a common purpose, with the scientific and academic communities, business and industry, and stakeholders to advance the NTS as a valued national resource. The NTS provides the modern nuclear laboratory platform for theoretical and exploratory nuclear technology that can attract and retain the human scientific resources required for continued progress in nuclear technology development. As the nation moves away from full-scale nuclear testing, the DOE must enhance its capability to use other tools to predict weapons safety, performance, and reliability. In particular, the DOE must enhance its capability to perform zero-yield science-based stockpile stewardship. Uncertainty in the behavior of aging stockpiled weapons will continue to increase with time and in the absence of testing (Thorn and Westervelt, 1987). To ensure continued confidence in the safety and reliability of the United States' nuclear weapons stockpile, the DOE needs to maintain the basic capability to conduct underground nuclear testing activities should a situation arise from unanticipated technical problems in the enduring stockpile. To maintain this capability, the National Laboratories have identified 33 already drilled vertical holes, which are an inventory of potential sites for stockpile stewardship exercises and experiments. The DOE also needs to enhance its

capability to perform dynamic experiments (including subcritical experiments involving special nuclear materials) and hydrodynamic tests to assess the condition and behavior of nuclear weapons.

The NTS, through its Work for Others Program, has supported the stewardship programs since their inception. For example, in support of improved treaty-monitoring capabilities, chemical explosions at the NTS are being used to develop and calibrate seismic and hydrodynamic detection and analysis techniques (e.g., Chemical Kiloton and Kuchen experiments). Sensitive isotope analysis techniques, derived from nuclear chemistry applications to tests, are being developed for treaty monitoring and intelligence analysis. Development is being advanced by analysis of underground test residue and environmental studies at the NTS. Ongoing NTS activities that support the development of intelligence gathering and analytic capabilities include projects conducted at the Spill Test Facility, a demonstrated test bed for developing remote sensors for nonproliferation, environmental, and other national security programs. Non-nuclear high-explosive experiments at the NTS support design calculations for technologies that would disarm improvised nuclear devices, thereby preventing nuclear yield (see Appendix F).

In its Programmatic EIS for the Stockpile Stewardship and Management Program, the DOE is examining the future missions and configurations of the nuclear weapons complex (60 FR 31291). The Programmatic EIS will address the long-term capabilities required to carry out the DOE's Stockpile Stewardship and Management Program, as well as site the locations of these activities. Under this Programmatic EIS, the NTS is a candidate for future increased missions, as well as continuing operations. Until the Record of Decision for that Programmatic EIS is issued and the decisions are implemented, the DOE must continue its defense mission in light of the changes in stockpile stewardship and the continued moratorium on nuclear weapons testing.

Environmental restoration and waste management have been part of NTS operations since the beginning of the nation's nuclear testing program. Early restoration efforts were focused on cleaning detonation locales in order to reuse them for subsequent tests. The generated debris was disposed of through the on-site Waste Management Program. A formalized Waste Management Program commenced at the NTS in 1961. An inventory of radioactive waste has accumulated at numerous sites throughout the DOE complex through several decades of the Cold War. Beginning in 1976, some Defense Program radioactive waste generated at the Mound, Ohio, site was disposed of at the NTS. Increasing attention to the complexwide inventory brought more waste from a greater number of DOE sites to the NTS for disposal. Low-level waste has been generated through the weapons development, testing, and production activities at DOE facilities as well as the environmental cleanup and restoration programs. As DOE missions have changed, there has been an increasing volume of waste generated through the environmental restoration activities. This increase will continue into the future.

While the NTS does not currently accept transuranic or mixed waste from other sites, the management of low-level, mixed, and transuranic wastes generated at the NTS and other DOE-approved facilities across the United States has been an ongoing mission of the NTS. Wastes have been and are now generated as a result of a variety of DOE activities, including nuclear energy research, defense projects, and, more recently, as a result of environmental restoration activities. This waste must be disposed of in accordance with applicable regulations and DOE orders. The DOE has a need to continue providing the practical, cost-effective, and environmentally sound means of low-level waste disposal offered by the NTS.

Another change in NTS mission priorities is evidenced by an increase in environmental restoration efforts. Environmental restoration activities are planned for various sites at the NTS and other test locations in Nevada. Through 1992, there have been 928 nuclear tests conducted on the NTS; no nuclear tests have been conducted since entering into the moratorium. Defense research and weapons-test verification activities were also conducted at the

Project Shoal Area and the Central Nevada Test Area. From 1957 to 1963, several safety tests were conducted at sites at the NTS, the NAFR Complex, and the Tonopah Test Range to test the safety of nuclear weapons in accident situations. Because these tests were not contained and used special nuclear materials and chemical explosives, they resulted in the release of radioactive materials and surface contamination. The DOE must develop site remediation goals and cleanup levels for the NTS and off-site test areas based on future land use and management goals for the protection of environmental resources. The DOE is working in cooperation with other agencies to define remediation and cleanup levels to ensure that the disposition of withdrawn lands is consistent with the controlling agencies' existing land-use or resource management plans.

2.3 Purpose and Need for DOE Action

As a result of the changing mission priorities discussed in the preceding sections, the DOE has a need to focus on new national security, energy, and environmental issues challenging the nation and to redefine the role of the NTS within the DOE complex.

Other changes in DOE policy regarding land and facility use require the DOE to manage all its land and facilities as valuable national resources, with stewardship based on the principles of ecosystem management and sustainable development. This policy has resulted in the need for a comprehensive plan for the NTS that will guide land- and facility-use decisions and integrate mission, economic, ecologic, social, and cultural factors. As the first step in the development of such a comprehensive plan, the DOE has developed the framework of a *Resource Management Plan* for the NTS that will benefit from the public participation and review afforded by the National Environmental Policy Act process (see Volume 2).

The purpose of the *Resource Management Plan* document is to publicize how the DOE/NV proposes to develop and use a *Resource Management Plan* for the NTS so the public can comment on and assist with:

- Developing the methods for creating and using the plan
- Identifying the values people place on manmade and natural resources found on the NTS
- Developing the goals DOE/NV will use to guide the conservation and use of those resources
- Identifying the management actions needed to meet constraints and resource management goals
- Incorporating the principles of ecosystem management into land and resource management on the NTS.

The framework for the *Resource Management Plan* is being developed in conjunction with the NTS EIS to take advantage of the extensive data collection and public participation activities associated with the National Environmental Policy Act. Following receipt of public information during the comment period for the Draft NTS EIS, the DOE/NV revised this description of the *Resource Management Plan* in order to publish the revision with the Final NTS EIS. The revision includes the goals the DOE/NV has developed for managing resources and land-use constraints. The revision also includes the final plans for developing the *Resource Management Plan*. These plans will guide the DOE/NV as it develops a *Resource Management Plan* in the coming years.

2.4 Nevada Test Site Programs

For review purposes, the projects and activities at the NTS have been categorized into five programs: Defense, Waste Management, Environmental Restoration, Nondefense Research and Development, and Work for Others. Services, such as fire protection and communications, for each of these programs are provided through the NTS support services infrastructure. Brief summaries of each program are presented in this section.

Programs Conducted at the NTS

The DOE accomplishes its mission at the NTS through the management of activities that are organized into five programs:

Defense - The primary mission of this program is stockpile stewardship, including the maintenance of readiness to conduct underground nuclear tests, if directed.

Waste Management - This program provides for the safe and permanent disposal of waste through either disposal on the NTS or to off-site commercial waste treatment or disposal facilities.

Environmental Restoration - The goal of this program is to identify contaminated areas and clean-up those areas, as appropriate.

Nondefense Research and Development - This program includes original research efforts by the DOE, universities, industry, and other federal agencies.

Work for Others - This program provides for the use of NTS areas and facilities by other groups and agencies for activities such as military training exercises.

2.4.1 Defense Program

The primary mission of the Defense Program at the NTS is to help ensure the safety and reliability of the nation's nuclear weapons stockpile. The NTS has a long history of participating in the Stockpile Stewardship Program. This stewardship program includes maintaining the readiness and capability to conduct underground nuclear weapons tests and conducting such tests if so directed by the President or Congress. Other aspects of stockpile stewardship include conventional high-explosive tests, dynamic experiments (including subcritical experiments), and hydrodynamic testing. Although the term "subcritical" was not used in previous EISs for the NTS, some tests or experiments conducted over the past decades, as well as the impacts of those tests or experiments, are substantially the same as those contemplated by the new terminology. The term "subcritical experiments," rather than defining a new form of activity, is intended instead to clarify the fact that such experiments involving the use of special nuclear material would not achieve the condition of criticality.

Historically, the nation's nuclear emergency response capability has been based at the NTS. The Nuclear Emergency Search Team maintains the readiness to respond to any type of nuclear emergency, including search and identification for lost or stolen weapons, and conducts training exercises related to nuclear bomb threats and radiation dispersal threats.

The NTS has also been a key site for past efforts in the areas of nuclear nonproliferation and verification of international treaties. This work was exemplified recently by the Joint Treaty Verification Project, a cooperative effort between the United States and the former Soviet Union.

2.4.2 Waste Management Program

The NTS presently serves as a disposal site for low-level waste generated by DOE defense-related facilities and also as a storage site for a limited amount of transuranic mixed wastes pending opening of the Waste Isolation Pilot Plant in New Mexico. Waste Management Program activities are conducted in four primary NTS areas: Areas 3, 5, 6, and 11. Areas 3 and 5 are the two existing radioactive waste management sites at the NTS.

- The Area 3 Radioactive Waste Management Site accepts bulk and packaged low-level waste for disposal.
- The Area 5 Radioactive Waste Management Site accepts low-level waste and NTS-generated mixed waste for disposal, and packaged transuranic and NTS generated transuranic mixed waste for storage.
- Area 6 includes a waste accumulation building for polychlorinated biphenyl (PCB) wastes and a landfill. Area 6 is also the identified site for the Liquid Waste Treatment System. (See Appendix A for a detailed description.)
- The Area 11 Explosive Ordnance Disposal Unit is not a disposal unit. It is a thermal treatment unit where explosive wastes are detonated or

treated. (See Appendix A for a detailed description.)

Radioactive waste disposal operations began at the NTS in 1961. Radioactive (low-level, transuranic, mixed, and classified low-level) wastes were disposed of in selected pits, trenches, landfills, and greater confinement (deeper) disposal boreholes on the NTS. Near-surface burial (3 to 18 meters [m] deep [10 to 60 feet (ft)]) of low-level waste and low-level mixed waste in subsidence craters, pits, and trenches has been the historical practice at the NTS (Areas 3 and 5 Radioactive Waste Management Sites). In 1981, the DOE adopted the concept of greater confinement burial (21 to 37 m deep [70 to 120 ft]) for wastes that are not appropriate for near-surface disposal because of their radioactive exposure levels. Specifically, these waste types include a waste similar to greater-than-Class C low-level waste; certain high-specific activity low-level waste (for example, fuel rod claddings and sealed sources); transuranic waste; and some classified wastes. The term "similar to greater-than-Class C low-level waste" indicates that the waste disposed of at the Area 5 Radioactive Waste Management Site was DOE-generated, not commercially generated waste subject to Nuclear Regulatory Commission (NRC) regulations.

The Low-Level Radioactive Waste Policy Amendments Act of 1985 (Public Law 99-240) made the federal government responsible for the disposal of greater-than-Class C waste generated by licensees of the NRC. Such disposal must be performed in a facility licensed by the NRC. Implementation of this provision may not occur for 20 years or more, and although the DOE is currently studying possible approaches for disposal of this waste, the DOE has not yet formulated a proposal for action. Therefore, disposal of greater-than-Class C waste is not addressed in this EIS.

Questions were raised in comments on the Draft EIS regarding DOE's handling of "special case wastes." "Special case waste" is not a formal technical waste category in the same sense as

Waste Definitions

Radioactive Waste — Solid, liquid, or gaseous material that contains radioactive nuclides regulated under the Atomic Energy Act of 1954, as amended, and of negligible economic value considering costs of recovery.

Specific Activity — The concentration of radioactivity, given as the number of Becquerels (Bq) or curies (Ci) per unit mass.

Transuranic Waste — Radioactive waste containing alpha-emitting radionuclides having an atomic number greater than 92 and half-lives greater than 20 years, in concentrations greater than 100 nanocuries (nCi) per gram.

Low-Level Waste — Radioactive waste not classified as high-level waste, transuranic waste, or spent nuclear fuel, or the tailings or wastes produced by the extraction or concentration of uranium or thorium from any ore processed primarily for its source material content. Test specimens of fissionable material irradiated for research and development only, and not for the production of power or plutonium, may be classified as low-level waste, provided the concentration of transuranic elements is less than 100 nCi per gram.

High-Level Waste — The highly radioactive waste material that results from the reprocessing of spent nuclear fuel, including liquid waste produced directly in reprocessing of and any solid waste derived from the liquid, that contains a combination of transuranic waste and fission products in concentrations requiring permanent isolation.

Byproduct Waste — Tailings or waste produced by the extraction or concentration of uranium or thorium from any ore processed primarily for its source material content.

Greater-Than-Class C Waste — Low-level waste that is generated by the commercial sector and that exceeds U.S. Nuclear Regulatory Commission concentration limits for Class-C low-level waste as specified in 10 CFR Part 61. DOE is responsible for the disposal of greater-than-Class C wastes from commercial sources.

Hazardous Waste — Wastes that are designated as hazardous by the Environmental Protection Agency (EPA) or State of Nevada regulations. Hazardous waste, defined under the Resource Conservation and Recovery Act, is waste from production or operation activities that poses a potential hazard to human health or the environment when improperly treated, stored, or disposed. Hazardous wastes that appear on special EPA lists or possess at least one of the following characteristics: (1) ignitability, (2) corrosivity, (3) reactivity, and (4) toxicity.

Waste Definitions (Cont.)

Mixed Waste — Waste containing both radioactive and hazardous components, as defined by the Atomic Energy Act and the Resource Conservation and Recovery Act, respectively. Mixed waste intended for disposal must meet the Land Disposal Restrictions as listed in Title 40 CFR Part 268. Mixed waste is a generic term for specific types of mixed waste such as low-level mixed waste, and transuranic mixed waste.

Low-Level Mixed Waste — Low-level waste that also includes hazardous components, as identified in 40 CFR Part 261, Subparts C and D.

Transuranic Mixed Waste — Waste containing both transuranic and hazardous components, as identified in 40 CFR Part 261, Subparts C and D.

Radioactive Waste Management Site — Designated location where radioactive waste handling, storage, or disposal operations are conducted under management control.

Classified Waste — Although not a regulatory term, includes weapons components and assemblies designated by the U.S. Government, pursuant to Executive Order, statute, or regulation, that require protection against unauthorized information or material disclosure for reasons of national security. Additional security and safeguards management activities are required in the handling of these materials.

"transuranic waste" or "low-level waste"; rather, "special case waste" is a temporary, informal designation used by the generator to identify wastes that exhibit characteristics which indicate that greater analysis may be necessary to properly categorize it, or which may require special handling, storage, or disposal methods. For this reason, the term "special case waste" is not included in the sidebar definitions of the various waste types. The DOE intends to clarify its use of the term "special case waste" in the Final Waste Management Programmatic Environmental Impact Statement. This clarification will update the use of the term to reflect the dynamic nature of DOE's special case waste inventory. It will also reflect the DOE's intent to manage this waste within existing waste categories as options arise and plans are developed.

Since the 1980s, hazardous waste generated on the NTS has been shipped off site to commercial facilities. Receipt of transuranic waste for disposal at the NTS ceased in 1988; receipt of mixed waste for disposal from off-site generators ceased in 1990. Certain mixed waste generated from activities on the NTS can be disposed of at the disposal facilities on the NTS while others must be stored on the state-authorized storage pad, pending identification of treatment technologies for the hazardous constituents (see definition). Historically (since the mid-1960s), the Area 3 Radioactive Waste Management Site was used primarily for the disposal of contaminated waste generated from the NTS Atmospheric Testing Debris Disposal Program, which involved the cleanup of atmospheric testing sites. Today, Area 3 is used for the disposal of bulk and packaged low-level waste from on-site and off-site DOE-approved generators. Current waste disposal cells at the Area 3 Radioactive Waste Management Site comprise four subsidence craters (U-3ax, U-3bl, U-3ah, and U-3at), with areas between craters U-3ax and U-3bl and between craters U-3ah and U-3at excavated to make two oval-shaped landfill units. Conventional landfill methods are used to dispose of waste in each cell; each layer of waste is covered with 1 m (3 ft) of fill before additional waste materials are disposed. The U-3ax/bl disposal cell contains low-level mixed waste; this cell is inactive, temporarily covered, and awaiting closure. The U-3ah/at cell is currently being used for low-level waste disposal; mixed waste is not accepted. Three additional subsidence craters have been reserved for use as low-level waste cells: U-3bh, U-3bg, and U-3az.

In 1961, the Area 5 Radioactive Waste Management Site was established for the disposal of low-level waste and classified low-level waste from both on-site and off-site DOE generators. The developed waste area within the Area 5 Radioactive Waste Management Site consists of 17 landfill cells (pits and trenches), 13 greater confinement disposal boreholes, and the transuranic waste storage pad. The low-level waste and low-level mixed waste disposal units within the Area 5 Radioactive Waste Management Site include the following:

- Pits for the disposal of low-level waste and on-site generated low-level mixed waste
- Trenches for the disposal of low-level waste and classified low-level waste.

The 13 greater confinement disposal boreholes contain low-level waste, low-level mixed waste, waste similar to greater-than-Class C low-level waste, high-specific-activity low-level waste, transuranic waste, transuranic mixed waste, and classified waste. The transuranic waste storage pad is a Resource Conservation and Recovery Act compliant unit for the storage of mixed waste (low-level and transuranic). Additional information can be found in Chapter 4, Affected Environments. Section 4.1.1.5 contains a description of existing Waste Management Program activities, and Section 4.1.2.3 identifies out-of-state waste generators.

DOE is committed to preventing pollution and reducing waste generation at the NTS. This is accomplished through establishing partnerships with private industry, and complying with local, state, and federal regulations. The elements of the DOE/NV Waste Minimization/Pollution Prevention Program addresses reporting requirements, compliance costs, waste reduction costs, employee concerns, environmental liability, training, and the reduction, recycle, and reuse of commodities. Appendix C.6 provides a description of the DOE/NV Waste Minimization/Pollution Prevention Program.

2.4.3 Environmental Restoration Program

As noted previously, the Environmental Restoration Program and its predecessors have been effectively working toward the decontamination of the NTS since the inception of testing. Prior to the early 1980s, the major focus of environmental restoration was the decontamination of testing areas for future use and the identification of contaminated areas that required restricted access.

Starting in the 1980s, environmental restoration at the NTS grew significantly. Characterization, remediation, and closures were primarily driven by the Resource Conservation and Recovery Act. Abandoned underground storage tanks and PCBs were removed. Hazardous waste disposal trenches were closed using the Resource Conservation and Recovery Act process.

The DOE is committed to the goal of remediating contaminated sites in accordance with the requirements of the responsible agencies. Current operations will comply with environmental regulations, and the health and safety of employees and the public will be safeguarded. An ongoing assessment to identify and remediate contamination will continue in pursuit of these goals.

The goal of the Environmental Restoration Program (a detailed discussion of which can be found in Appendix A) is to ensure that risks to the environment and to human health and safety, as posed by inactive and surplus facilities and sites, are either eliminated or reduced to protective levels. Protective levels are determined through site conditions, risk assessments, and consultation with federal and state regulatory authorities.

Specific investigations and risk assessments are being conducted for each corrective action unit (grouping of environmental restoration sites) to determine the levels and extent of contamination, to ascertain the potential human health or environmental exposure to that contamination, and to compare that exposure to established standards for protection of human health and the environment.

Factors Related to Prioritization of Environmental Restoration Program Activities:

- **Risk Assessment**
- **Available Technology**
- **Cost (Funding Appropriated by Congress)**
- **Future Land and Resources Use**
- **Geographic Location**
- **Interdependency of Actions**
- **Optimization of Resources**
- **DOE, Defense Nuclear Agency, State Priorities**
- **Presence of Cultural Resources or Sensitive Species**
- **Regulatory Requirements**
- **Scheduling (Optimizing Labor and Equipment)**
- **Stakeholder Concerns**
- **Time Required to Complete Action**
- **Waste Management Concerns (Adequate Facilities)**

Based on the information gathered and in consideration of the factors listed in the sidebar, the DOE/NV will prioritize environmental restoration activities through interaction with the state of Nevada and interested members of the public. A major driver for this process is the Federal Facility Agreement and Consent Order (State of Nevada, 1996), which has been signed.

2.4.4 Nondefense Research and Development Program

The DOE has historically supported a variety of research and development activities at the NTS and at other locations in Nevada in cooperation with universities, industry, and other federal agencies. The DOE continues to support ongoing nondefense research and development projects. The National Environmental Research Park Program supports environmental research activities at the NTS. Research on the safety aspects of handling, shipping, and storing hazardous fluids and liquefied gaseous fuels are conducted at the Spill Test Facility. The Corporation for Solar Technology and Renewable Resources, with development funding provided by the DOE, continues to study the feasibility of locating and constructing a solar energy facility in Nevada; it is proposed that these solar power generating facilities should be collocated at the NTS and at one or more of the three other Nevada locations under evaluation: Eldorado Valley, Dry Lake Valley, or Coyote Spring Valley.

The Environmental Management and Technology Development project continues to conduct research and development focused on overcoming major obstacles to progress in cleaning up the DOE sites. The principal mission of the Tonopah Test Range is to provide research and development test support for DOE-funded weapons projects. However, the Tonopah Test Range represents a unique test environment, both in location and capabilities, and is available for use by other government agencies and their contractors. The Tonopah Test Range management schedules a broad spectrum of tests to make effective use of range capabilities for multiple users.

2.4.5 Work for Others Program

The Work for Others Program is hosted by the DOE and includes the shared use of certain facilities and resources. Historically, the DOE has hosted projects by other federal agencies, especially the Department of Defense (DoD), that require the large, remote, and secured areas offered by the NTS. Typical past uses under this program have included co-use of NTS airspace, training exercises, and research and development projects.

2.5 Evaluation of Environmental Impacts and Risk

In addition to the NTS EIS, several DOE studies are in progress that address the consequences and risks associated with the DOE's operations at the NTS and other Nevada locations. Although all of these studies relate to the risk or the consequences of DOE activities, each of these studies has a unique scope and purpose. It is important to understand the differences in study scopes, how these different studies relate to each other, and how the information gained from them has been used in this EIS. Several of these other studies are discussed in the following sections. Figure 2-1 illustrates the scope and purpose of each of these studies and describes their relationship to the NTS EIS.

2.5.1 Nevada Test Site Environmental Impact Statement

The NTS EIS identifies the environmental consequences or impacts that could occur as a result of implementing various resource management alternatives at the NTS. These alternatives encompass a range of resource uses, including current level of operation (Alternative 1), minimum resource use (Alternative 2), maximum use of resources (Alternative 3), and alternative uses of NTS resources (Alternative 4). Consequences resulting from the various alternatives are described as physical impacts (e.g., surface disturbance, degradation of air quality, and availability of water resources). These impacts are assessed and reported for each alternative to inform the decisionmakers of

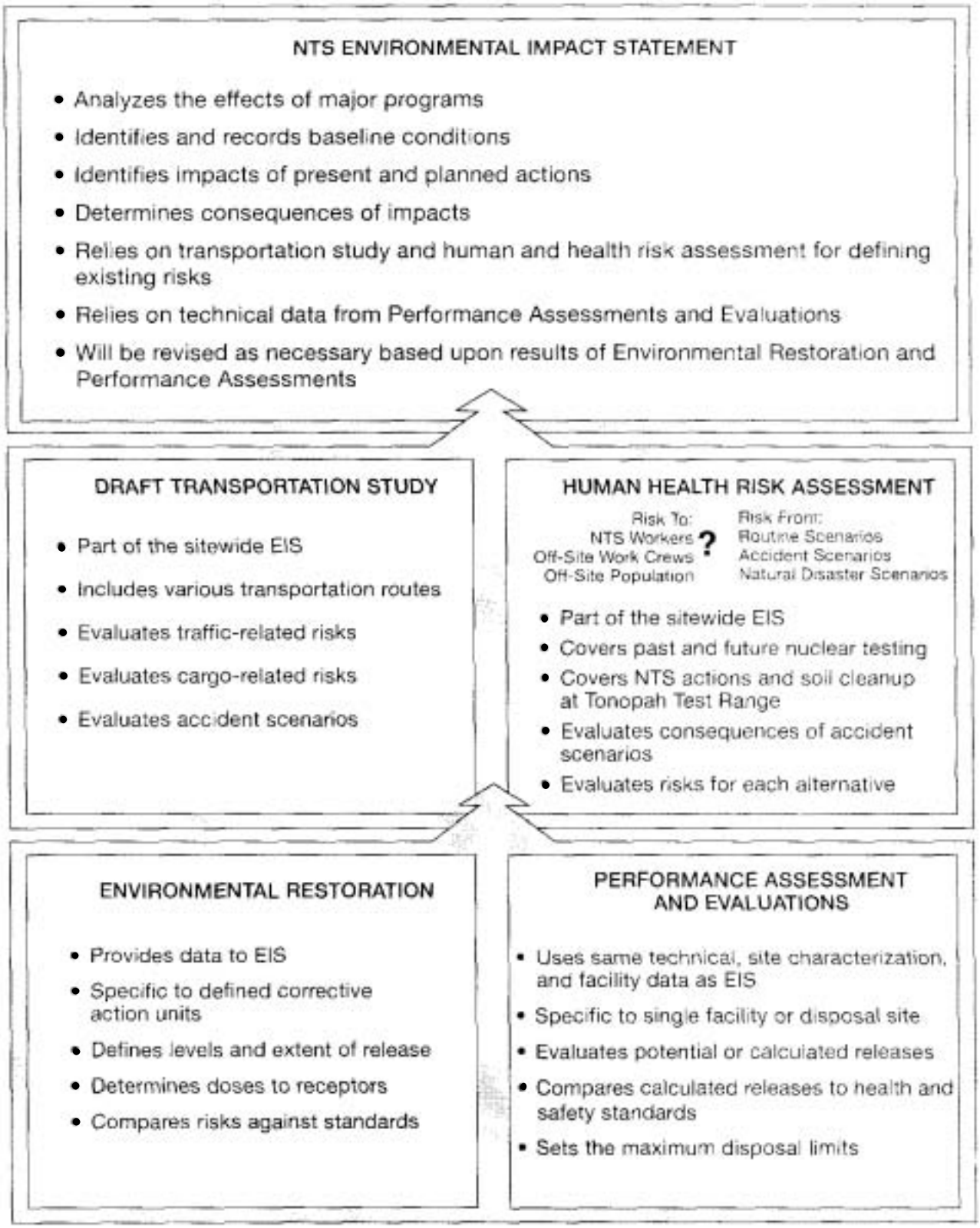


Figure 2-1. NTS studies that were used in the EIS analysis

the associated environmentalimpacts and any potential actions that may be required to mitigate those impacts.

The foundation for the impact analysis conducted in this EIS is the technical data developed and used in the studies and reports noted above and discussed later in this section. Site characterization data, facility information, environmental data, and other information from these other studies, as well as the most current technical information about site uses, were used to perform the impact analyses reported in this EIS.

2.5.2 Human Health Risk Assessment

In addition to describing the physical impacts to the environment that have resulted from past NTS operations and could result from a range of future NTS uses, the NTS EIS includes a human health risk assessment (see Appendix H). The risk assessment quantifies the potential chance of occupational injuries and facilities, cancer deaths, and detriment to workers and the public that could result from the overall operation of the NTS as defined in each alternative. Underlying the assessment of each alternative are the historical operations and their consequences that contribute to the current environmental conditions, or baseline, of the NTS. Thus, the risk assessment encompasses risks contributed from past operations and the risk potentially contributed from each of the future-use alternatives. This EIS considered the consequences of events that have a low probability of occurrence but have high consequences should they occur. There are many events or scenarios that have a very low probability of occurring, but the consequences of such an event are so high that even remotely credible scenarios are considered and evaluated. The results of these analyses provide additional information that was used in this EIS.

2.5.3 Transportation Study

Of utmost importance to the DOE's stakeholders and the sovereign nations regarding the transportation of radioactive material are the human health risks associated with exposure to ionizing radiation. The health risks of transporting low-level

Performance Assessment and Risk Evaluation Terms

Receptors – Plants, animals, and people that may be exposed to contamination. A receptor can be exposed via the air and soil pathways (for example, by inhalation, ingestion, and contact), and the surface and groundwater pathways (by contact and ingestion).

Pathway – The route by which a contaminant reaches a human receptor. Common pathways considered in performance assessments include, but are not limited to, air, groundwater, and surface water.

Limiting Concentrations – The radioactivity that remains in a waste after treatment, that poses a limitation or bounding condition to disposal options. The radionuclide that tends to be most mobile, or has the highest potential to affect human health and the environment, becomes the limiting factor for the disposal facility.

Residuals – The composition and form of a waste after treatment. For example, solidified incineration ash would be a residual.

Carbon-14 – An isotope of carbon that occurs both naturally and from the decay of certain radioactive isotopes. Carbon-14 is a well-known tool used to date archaeological finds. Carbon-14 can be generated from wastes as a gas and can rise upward to the surface if precautions are not taken.

Human Intruder – A hypothetical individual (in a future scenario) who unknowingly contacts the waste(s) in a disposal unit(s) after the loss of institutional control and with no prior knowledge of the waste disposal activities at the site. Intrusion scenarios include, but are not limited to, drilling into the waste or farming on or near the waste disposal facility.

Groundwater Recharge – Water that infiltrates the land surface and is not lost to evaporation or consumed by plants can percolate downward and replenish the groundwater aquifers. This deep percolation is called recharge. Much of the recharge at the NTS is from mountainous areas as much as 48 km (30 mi) away.

Infiltration – Water that falls on the land surface that does not run off but percolates into the ground. Some of this water evaporates, some is used by plants, and some percolates downward to the groundwater.

Unsaturated Zone – The subsurface zone between the land surface and the top of the groundwater. The unsaturated zone at the NTS is thick, ranging from 160 m (525 ft) to almost 914 m (3,000 ft) in some areas.

waste, mixed waste, and nuclear material to and on the NTS were evaluated in a transportation risk analysis (see Appendix I). The transportation study identifies the risks to the public resulting from traffic deaths and exposure to radiation from the shipments along the various routes. The transportation study uses current and future projections of the sources and movements of materials and wastes to the NTS. The results of the transportation analyses are incorporated in the appropriate impact analysis section of this EIS.

2.5.4 Environmental Restoration Assessments

A different type of risk assessment is performed as part of studies conducted for the Environmental Restoration Program. First, a risk assessment that defines the nature and extent of the release of contaminants from a source area is performed for each corrective action unit. Next, the pathways whereby the contamination could lead to an exposure to a worker or off-site resident are identified. The doses to these potential receptors are then estimated for each pathway, and the risk associated with that dosage is evaluated. If the dose exceeds a regulatory standard, some action could be required either to remediate the contamination or otherwise protect the receptor. The available technical information used in these types of assessments is used as appropriate in the NTS EIS and forms the basis for the larger restoration program assessments that are discussed in this EIS. Because these assessments are performed on a project or Corrective Action Unit basis, the assessments will be developed by the DOE in cooperation with the state of Nevada to identify the preferred closure actions. The results will also be incorporated into the National Environmental Policy Act document that analyzes the closure proposal.

2.5.5 Performance Evaluation

The Federal Facility Compliance Act of 1992 requires the DOE to work with its regulators and with members of the public to establish plans for treatment of DOE's low-level mixed waste. Although the Federal Facility Compliance Act does not specifically address the disposal of treated low-level mixed waste, both the DOE and the States recognize that disposal issues are an integral part of treatment discussions. The performance evaluation concept was developed by the DOE and the States to address this concern. The performance evaluation process started by identifying DOE sites across the defense complex which were managing mixed waste, and then developed a screening process that eliminated all but 15 sites from consideration as a disposal site. The NTS is one of the remaining sites. The Performance Evaluation of the Technical Capabilities of DOE Sites For the Disposal of Mixed Low-Level Waste, prepared by Sandia National Laboratories (SNL, 1996) contains a description of how sites were eliminated, and contains information on the results of the performance evaluation for the NTS.

The process and technical approach for the performance evaluations were presented to State regulators at several joint State and DOE meetings facilitated by the National Governors' Association. The technical process, methodology, and data used for the performance evaluations have been continuously reviewed by an independent senior review panel made up of nongovernment experts from academia and industry. The principal goal in developing the performance evaluation was to determine the limiting concentrations of radionuclides in residuals resulting from treatment of low-level mixed waste that can be disposed of at various DOE sites.

A performance evaluation is a screening tool. Its objective is to estimate permissible concentrations of radionuclides in low-level mixed waste disposal facilities so that releases of radionuclides to the environment would not result in exposures to humans at levels greater than some predetermined performance measures. Calculations of release for three pathways (water, atmospheric, and hypothetical inadvertent intruder) form the foundation of the performance evaluation. The technical data and information used in performance evaluations is the same information available for the analyses reported in the NTS EIS. The performance evaluation is not intended to be a substitute for the detailed analysis of a performance assessment, nor is it intended for siting or permitting.

Based on the results of the performance evaluation analysis (SNL, 1996), low-level mixed waste disposal at the NTS is almost exclusively limited by the intrusion scenario. Only the radionuclide carbon-14 shows more restrictive waste limits from the atmospheric pathway. The extremely dry conditions at the NTS, where infiltration is negligible and distance to the groundwater is great, inhibit the migration of radionuclides by means of the water pathway.

Transport of radionuclides downward along a groundwater pathway does not appear to be a mechanism for movement in the subsurface at the NTS Radioactive Waste Management Sites. This conceptual model is based on hydrologic studies performed at the NTS which concluded that groundwater recharge at the Area 5 Radioactive Waste Management Site is negligible. In addition, the performance assessment for disposal of low-level waste at Area 5 demonstrates and concludes a "no groundwater pathway" conceptual model for the site hydrologic conditions during the 10,000-year performance period considered in the performance evaluation.

The performance evaluation is a means for the DOE and the States to begin evaluating options for disposal of low-level mixed waste treatment residuals that have been treated pursuant to the requirements of the Federal Facility Compliance Act of 1992. The ultimate identification of sites that might host low-level mixed waste disposal activities will follow state and federal regulations for siting and permitting, and will include public involvement in the decisionmaking. Site-specific performance assessments for the two existing Radioactive Waste Management Sites at the NTS, as described in the following sections, will also be completed.

2.5.6 Performance Assessment and Composite Analysis

The DOE orders for low-level waste and EPA regulations for transuranic waste disposal require that each radioactive waste disposal site prepare and maintain a site-specific radiological performance assessment. A performance assessment is a systematic analysis of potential risks, posed by waste management systems, to the public and to the environment and a comparison of those risks to established performance objectives. A performance assessment is an iterative process that proceeds sequentially from site characterization to conceptual model development, to outcome modeling, and back to site characterization, as necessary. The results of performance assessment analyses are used to guide site characterization activities and to refine subsequent analyses. The process ends when further site characterization would not yield information that could change the decision regarding safety of the site.

The site characterization data used in the performance assessments conducted for the NTS facilities have been used in the impact analyses performed for this EIS. The technical data and information used in the preparation of these performance assessments have also been used in the preparation of the NTS EIS. The technical conclusions of both documents are the same, and the technical data and information used remain relevant to both documents.

The DOE is responsible for disposing of a variety of radioactive wastes, including low-level, transuranic, and high-level waste. Low-level waste disposal is governed by DOE Order 5820.2A, which establishes policies and guidelines for the disposal of radioactive waste in general. The U.S. Nuclear Regulatory Commission regulations in 10 CFR Part 61 include similar requirements for performance assessment of shallow-land burial of commercial radioactive waste. Most low-level waste is disposed of using near-surface burial techniques. Disposal operations at the NTS are described in greater detail in Chapter 4, Section 4.1.1.5. Disposal of transuranic waste must meet the standards established by the EPA in 40 CFR Part 191. While transuranic waste is planned for disposal generally at the Waste Isolation Pilot Plant near Carlsbad, New Mexico, a few tens of cubic meters of transuranic waste were disposed of in the past at the NTS, and the DOE is in the process of assuring that this disposal is consistent with 40 CFR Part 191. Congress has directed the DOE to study the suitability of Yucca Mountain as a potential permanent repository for spent nuclear fuel and high-level radioactive waste from commercial and DOE-owned sources.

The DOE/NV has conducted, and continues to conduct, performance assessments of low-level waste disposal units at the NTS. The first performance assessment conducted on NTS disposal units was a draft for the Area 5 Radioactive Waste Management Sites prepared by Idaho National Engineering Laboratory (dated August 1, 1988). This performance assessment was prepared prior to the issuance of DOE Order 5820.2A, which contains the requirement for preparing a performance assessment. The performance assessment has been, and continues to be, revised; the next publication is scheduled for the fall of 1996. The first draft performance assessment for the Area 3 Radioactive Waste Management Sites was prepared by Oak Ridge National Laboratory/Grand Junction and was completed in September 1991. Several revisions of the Area 3 performance assessment have occurred, and a major revision is scheduled for completion in 1998.

The performance assessments for the Areas 3 and 5 RWMSs address the post-1988 low-level radioactive waste disposal source term (Shott et al., 1995) for each respective facility, as required under DOE Order 5820.2A. The Order specifies that performance assessments are required only for waste disposed after the effective date of the Order, September 26, 1988. In response to the Defense Nuclear Facilities Safety Board Recommendation 94-2, that the scope of performance assessments be expanded to account for past, present, and future inventories of low-level radioactive waste at the site, the DOE is developing a comprehensive environmental management systems approach to ensure long-term protection from all sources of radioactive materials left in the ground after remediation and disposal programs are completed. The comprehensive approach will include requirements that integrate DOE's land-use planning, facility decommissioning, environmental restoration, and waste disposal efforts.

Specifically, the long-term radioactive impact of the disposal operations will be analyzed by combining performance assessments under DOE Order 5820.2A for the post-1988 waste source term, with a composite analysis of the pre-1988 waste source terms, as well as other sources of radioactive contamination in the ground that are potentially interactive with the low-level waste facility (DOE, 1996). The composite analysis guidance and review criteria are to include 100 millirem (mrem) and 30 mrem in a year as criteria for evaluating results at site-determined compliance points and boundaries. The composite analysis serves as a long-term management planning tool.

Two types of performance assessments are conducted at the NTS: (1) low-level waste performance assessments pursuant to DOE Order 5820.2A for the Areas 3 and 5 Radioactive Waste Management Sites, and (2) transuranic waste performance assessments in the Area 5 Radioactive Waste Management Site pursuant to the EPA's regulations at 40 CFR Part 191. The following is a brief description of the low-level waste performance assessments and composite analysis in peer review or under development, their purpose, and the tentative schedule for completion. The transuranic waste performance assessments are discussed in Appendix A, Section A.2.

2.5.6.1 Low-Level Waste Performance Assessments

Two low-level waste performance assessments are in review or preparation stages: (1) the Area 5 Radioactive Waste Management Site Performance Assessment and (2) the Area 3 Radioactive Waste Management Site Performance Assessment. Each performance assessment must evaluate facility operation based on four performance objectives (DOE Order 5820.2A):

1. Protect public health and safety in accordance with standards specified in applicable environmental health orders and DOE orders, specifically DOE Order 5400.5, Radiation Protection of the Public and the Environment.

2. Assure that external exposure to the waste and concentrations of radioactive material that might be released into surface water, groundwater, soil, plants, and animals result in an effective dose equivalent that does not exceed 25 mrem per year (mrem/yr) to any member of the public. Releases to the atmosphere must meet the requirements of 40 CFR Part 61, the National Emission

Standards for Hazardous Air Pollutants. Releases of radioactivity in effluent to the general environment must be maintained using the "as-low-as-reasonably-achievable" process. (NV/YMP Radiological Control Manual, DOE/NV, 1994.)

3. Assure that the committed effective dose equivalents received by individuals who inadvertently intrude into the waste after loss of institutional control (100 years) will not exceed 100 mrem/yr for continuous exposure or 500 mrem for a single acute exposure (a 10,000-year compliance period).

4. Protect groundwater resources consistent with federal, state, and local regulations and requirements.

Area 5 Radioactive Waste Management Site Performance Assessment—The Area 5 Radioactive Waste Management Site Performance Assessment (Shott et al., 1995) addresses the post-1988 waste source term for the facility and was submitted to the DOE peer review panel in August 1995 for technical review and recommendation. Panel review is now concluding and a final publication is scheduled for submittal to DOE Headquarters by January 1997 (DOE, 1996). Depending on the extent of the panel's review comments and recommendations, the Area 5 report should be published by January 1997 or earlier. The next update of the Area 5 Radioactive Waste Management Site Performance Assessment will include the pre-1988 waste source-term and composite analysis, as stated in the Draft Implementation Plan, Defense Nuclear Facilities Safety Board Recommendation 94-2 (DOE, 1995).

The total estimated dose to the general public from all pathways was predicted to be approximately 0.6 mrem/yr. This estimate was obtained through analysis of several scenarios and represents an increase in annual dose of one-sixth of one percent. This compares favorably to the 25 mrem/yr performance objective dose limit for members of the general public set in DOE Order 5820.2A. Appendix A provides additional details on this and other on-going NTS performance assessments.

Area 3 Radioactive Waste Management Site Performance Assessment—The Area 3 Radioactive Waste Management Site Performance Assessment will address the post-1988 waste disposal source term and is scheduled for submittal to DOE/HQ in March 1998 (DOE, 1996). Site characterization of the facility is ongoing to acquire additional subsurface information to support performance assessment analyses in Fiscal Year 1997.

Site characterization of Area 3 in 1996 focuses on completion of exploratory boreholes beneath subsidence craters U-3bh (a reserve low-level waste cell at the Area 3 Radioactive Waste Management Site), U-3ah/at, and U-3ax/bl. The primary objective of the exploratory borehole in Area 3 is to characterize the physical and hydrologic properties of the chimney and to assess the potential for downward groundwater movement and radionuclide transport. The underground shot cavity beneath the subsidence craters at approximately 189 m (620 ft) is much deeper than active hydrologic surface processes (infiltration, redistribution, and evapotranspiration) operating beneath the waste unit, from the ground surface to a depth of approximately 30 m (100 ft). Current scientific hypotheses suggest that the rubble chimney beneath the low-level waste unit does not enhance or promote vertical groundwater flow between the waste unit (subsidence crater) and the deep shot cavity (see Chapter 4, Section 4.1.5.2). This conceptual model was confirmed by recent hydrologic data (Van Cleave, 1996). Given the proximity of Area 5 to Area 3 (23 km [14 mi]) and very similar hydrogeologic conditions, the defensible conceptual hydrogeologic model for Area 5 will be tested and validated for the Area 3 Radioactive Waste Management Site.

2.5.6.2 Composite Analyses

The long-term impact of the disposal operations at the Areas 3 and 5 Radioactive Waste Management Sites will be analyzed by combining the site-specific performance assessments for the post-1988 waste source term with complementary composite analyses taking into account the pre-1988 waste source terms, and other sources of proximal radioactive contamination in the ground (DOE, 1996). The Area 3 Radioactive Waste Management Site

Composite Analysis is scheduled to be submitted to DOE Headquarters together with the Performance Assessment by March 1998. The corresponding Area 5 Radioactive Waste Management Site Composite Analysis is due to DOE Headquarters by September 1999.

2.6 Summary

The purpose of the actions addressed in this sitewide EIS is to provide a management framework for the continued operation of the NTS. The actions are influenced by policy considerations, history, and the ongoing activities of the various programs as discussed in this chapter.

The NTS is a critical facility in the DOE's efforts to meet the nation's need to safely maintain the nuclear weapons stockpile, to retain the capability to conduct underground tests, and to focus on new and challenging issues of national security, energy, and the environment.

The DOE has historically performed rigorous evaluations of any actions that pose a threat to worker safety, public health, or the environment. The results of these studies have been used in the impact analyses conducted for this EIS. These evaluations will continue to be conducted as appropriate, and their results will be disclosed and incorporated in future National Environmental Policy Act documents. These evaluations include the detailed safety analysts done by the Defense Program, the comprehensive performance assessments developed in conjunction with the operation of waste management facilities, and the safety planning and risk assessments performed by the Environmental Restoration Program during the characterization and remediation of sites on the NTS. These activities were summarized in Section 2.4.

This sitewide EIS is not the "final word" and is not designed to cover all potential future activities at the NTS. Rather, this EIS includes only those actions and alternatives that are reasonably foreseeable at this time. Any new actions or projects will receive National Environmental Policy Act reviews prior to their implementation and will be supported through an additional tiered National Environmental Policy Act document. These reviews will include updated information on the various ongoing studies and assessments, as appropriate.

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Chapter 3

DESCRIPTION OF ALTERNATIVES

CHAPTER 3
DESCRIPTION OF ALTERNATIVES

This chapter contains the descriptions of the alternatives that are being evaluated for the NTS, Project Shoal Area, Central Nevada Test Area, Tonopah Test Range, and the DOE sites located on the NAFR Complex. Solar Enterprise Zone projects proposed for the NTS, Eldorado Valley, Dry Lake Valley, and Coyote Spring Valley are also described. Section 3.1 contains the alternatives and the associated land-use descriptions. Specific projects and activities included under each alternative are described in greater detail in Appendix A. Section 3.2 lists the alternatives the DOE is no longer considering and the reasons for their elimination. Section 3.3 provides a comparison of the alternatives and their environmental impacts based on analyses from the remainder of the NTS EIS. Sections 3.4 and 3.5 are the American Indian overview of Environmental Impacts and Responses to the NTS Action Alternatives. Section 3.6 identifies the DOE Preferred Alternative.

Chapters 4 and 5 of this EIS identify the impacts of past, present, and proposed future programs, projects and activities of the DOE/NV. Projects and activities are included in one or more of the four alternatives and fall into three basic levels: (1) current activities, (2) planned projects, and (3) proposed projects. Current activities are those that are presently part of the normal operations of the NTS, the Tonopah Test Range, portions of the NAFR Complex, and other areas considered in this EIS. Planned projects are those that are within the 5-year planning cycle and are likely to be implemented. Projected projects are not yet included within the 5-year planning window, but have undergone sufficient conceptual development to allow a reasonable assessment. The most reliable data are clearly derived from ongoing activities. Planned projects would present slightly less reliable data. Data for projected projects would be the least defined, but were determined to be essential to a full and open evaluation and disclosure of the potential effects of the alternative. To provide an adequate analysis, conservative assumptions and parameter values were used to evaluate potential impacts of the less-defined activities. In addition, site-support activities are analyzed for each of the environmental resources and resource elements.

3.1 Alternatives

Four use alternatives are evaluated in this EIS: Alternative 1, Continue Current Operations (No Action Alternative); Alternative 2, Discontinue Operations; Alternative 3, Expanded Use; and Alternative 4, Alternate Use of Withdrawn Lands. Each alternative is described with respect to the five program categories representing DOE/NV's primary mission: Defense, Waste Management, Environmental Restoration, Nondefense Research and Development, and Work for Others (defense-related research, development, and testing).

These alternatives are structured to provide scenarios of current and future uses of DOE facilities in Nevada that range from discontinued use to expanded use. The use alternatives have been designed to allow the DOE to analyze and compare the potential environmental effects of a wide range of use options.

The Tonopah Test Range has been managed by DOE/Albuquerque and operated by Sandia National Laboratories as a remote research and testing facility since the 1950s. In 1995, the DOE/NV and the DOE/Albuquerque entered into a memorandum of agreement, transferring the management of Environmental, Safety and Health responsibilities of the Tonopah Test Range to the DOE/NV. This action also transferred some of the operational management of the Tonopah Test Range to the DOE/NV with the exception of DOE/Albuquerque Stockpile Stewardship and Management Program and other weapons-related responsibilities for the DOE's mission.

Following the description of each alternative are the site and zoning category definitions and a land-use map that illustrates the zoning that would be implemented for each alternative. The land-use maps identify the locations of waste management, industrial, research, and support sites and define the general physical and political boundaries of

activities conducted on the NTS. These zones can include compatible defense and nondefense research development and testing projects and activities as well. The Continue Current Operations Alternative (Alternative 1) is considered as the baseline land-use condition. Alternatives 2, 3, and 4 are variations developed to represent and support the uses described in each alternative.

3.1.1 Alternative 1, Continue Current Operations (No Action Alternative)

Alternative 1 is defined as the continuation of the DOE/NV and interagency programs and operations in the five program categories of: Defense, Waste Management, Environmental Restoration, Nondefense Research and Development, and Work for Others. Under Alternative 1, these activities would continue in the same manner and degree as they have within the past 3 to 5 years. Site-support activities would also continue in the same manner and degree as they have for the past 3 to 5 years. Current institutional controls would continue.

3.1.1.1 Defense Program under Alternative 1. Defense Program operations would continue at the NTS under the conditions of the ongoing nuclear testing moratorium and the negotiations of the Comprehensive Test Ban Treaty as described in Chapter 2. Two scenarios were evaluated. In the first scenario, the President would not direct any nuclear testing and the DOE's nuclear testing-related activities would be limited to maintaining a readiness to test. This scenario emphasizes the NTS's science-based stockpile stewardship experiments and operations. In the second scenario, which the DOE believes unlikely but consistent with the site's historical mission, there is a contingent possibility that the President, through an end of the moratorium or through the "supreme national interest" clause of a test ban treaty, would direct the DOE to conduct one or more nuclear tests in order to achieve a high level of confidence in the safety and reliability of the weapon type in question. These types of stockpile tests would be conducted on Pahute Mesa or on Yucca Flat, which are the only nuclear testing locations considered in this EIS. The first scenario would comprise the following current Defense Program operations at the NTS. The second scenario would include the same operations, plus the contingent possibility of conducting underground nuclear tests.

- Stockpile stewardship, including the following:

  First Scenario:

  - Maintaining readiness to conduct underground nuclear tests
  - Performing treaty compliant and permitted dynamic experiments (including subcritical experiments)[1] and hydrodynamic tests (subcritical experiments would be conducted only where containment is assured)
  - Conducting high explosive tests and experiments
  - Destroying damaged nuclear weapons.

  Second Scenario:

  - Conducting underground nuclear testing if directed by the President. This contingent possibility would occur only under the second scenario.

- Nuclear Emergency Response. The Site provides widespread flexible support to the following programs for training and exercises:
  - Nuclear Emergency Search Team
  - Federal Radiological Monitoring and Assessment Center
  - Aerial Measuring System
  - Accident Response Group
  - Radiological Assistance Program
  - Internal Emergency Management Program.

The primary mission of Defense Program activities at the Tonopah Test Range is to ensure that the

[1] The term "Subcritical Experiments," does not define a new form of activity. It is intended instead to clarify the fact that dynamic experiments that involve the use of special nuclear materials do not achieve the condition of criticality.

nation's nuclear weapons systems meet the highest standards of safety and reliability. The primary activities include:

- Stockpile stewardship:

  Assess the surety condition of existing systems, verifying required modification to existing systems, and verifying and maintaining surety of systems

  Conducting experiments with special nuclear materials where containment is assured.

All testing activities are non-nuclear.

3.1.1.2 Waste Management Program under Alternative 1. Radioactive waste has been generated by the weapons development, testing, and production activities at DOE facilities as well as the environmental cleanup and restoration of these facilities. As DOE missions have changed, there has been an increasing volume of waste generated through the environmental restoration activities. This increase will continue into the future. Although no new initiatives or projects would be pursued or added under Alternative 1, the following ongoing waste management activities, as described in Chapter 2, would continue at the NTS:

- Providing low-level and mixed waste disposal capability to the NTS generators and low-level waste disposal capability to currently approved waste generators. This includes disposal in existing cells as well as creating new cells. Low-level waste includes those waste streams that may be inappropriate for shallow land disposal
- Continuing to study and pursue capabilities that lead to the development of disposal units
- Storing transuranic and existing transuranic mixed waste, pending the development of DOE off-site treatment, certification, handling, and disposal facilities
- Accepting no off-site transuranic mixed waste for storage
- Storing hazardous waste pending off-site shipment for treatment, storage, and/or disposal
- Storing mixed waste, pending development of treatment options and/or certification for disposal
- Continuing closure activities of inactive waste sites, as planned
- Storing PCB waste, pending off-site shipment for treatment, storage, and/or disposal
- Treating explosives at the Explosive Ordnance Disposal Unit
- Providing disposal capability for on-site generated solid waste
- Continuing the Waste Minimization/Pollution Prevention Program.

3.1.1.3 Environmental Restoration Program under Alternative 1. Environmental Restoration Program activities would continue in the form of characterization and remediation of contaminated areas or facilities, as identified in the recently completed site inventory (DOE, 1994). Environmental restoration is not considered a land use, but an activity necessary for reuse or disposition of land and facilities. The Environmental Restoration Program projects in Nevada that would continue under Alternative 1 are as follows:

- Underground Test Area Corrective Action Unit
- Soils Media Corrective Action Unit (including portions of the NAFR Complex)
- Industrial Sites Corrective Action Unit
- Decontamination and decommissioning facilities
- Tonopah Test Range

- Central Nevada Test Area
- Project Shoal Area
- Defense Nuclear Agency sites.

The Defense Nuclear Agency sites are being identified as part of the Environmental Restoration Program activities because Defense Nuclear Agency site activities are environmental remediations. However, it should be noted that the Defense Nuclear Agency is responsible for the operation and the funding. In this sense, it is a Work for Others project.

3.1.1.4 Nondefense Research and Development Program under Alternative 1. The DOE would continue supporting ongoing program operations, but no new program initiatives would be pursued. Ongoing and planned nondefense research and development operations and activities at the NTS that would continue under this alternative are as follows:

- Support for the Solar Enterprise Zone concept
- Demonstration projects
- Spill Test Facility activities
- Environmental Management and Technology Development Programs
- National Environmental Research Park Program activities.

3.1.1.5 Work for Others Program under Alternative 1. The Work for Others Program is hosted by the DOE and includes the shared use of certain facilities and resources at the NTS and the Tonopah Test Range. Under Alternative 1, the DOE would continue to host the projects and activities of other federal agencies (for example, DoD) at activity levels not exceeding those of the past 3 to 5 years.

Work for Others Program activities that would be expected to continue include the following:

- Treaty verification
- Nonproliferation projects
- Counterproliferation
  - researching, developing, and characterizing counterproliferation technologies
- Conventional weapons demilitarization
- Defense research and development, land navigation training, exercises, and use of air space.

3.1.1.6 Land Use and Zones under Alternative 1. The following information describes the site and zone categories (for the NTS) under Alternative 1. The zone categories are depicted on the land use map in Figure 3-1.

Industrial, Research, and Support Site—An industrial site is used for the manufacturing, processing, and/or fabrication of any article, substance, or commodity. A research site is used for projects and conventional laboratory operations for the development, quality assurance, or reliability of materials and equipment under controlled conditions to verify theories or concepts. Support sites are used for office space, training, equipment storage, maintenance, security, feeding and housing, fire protection services, and health services.

Waste Management Site—These sites are used for the disposal, storage, and/or treatment of wastes.

Nuclear Test Zone—This land area is reserved for dynamic experiments, hydrodynamic tests, and underground nuclear weapons and weapons-effects tests.

Nuclear and High Explosive Test Zone—This land area is designated within the Nuclear Test Zone for additional underground and surface high-explosive tests or experiments.

Research, Test, and Experiment Zone—This land area is designated for small-scale research and development projects for the development, quality assurance, or reliability of materials and equipment under controlled conditions.

Radioactive Waste Management Zone—This land area is designated for the management of radioactive waste.

Critical Assembly Zone—This land area is used for conducting nuclear explosives operations. Operations generally include assembly, disassembly or modification, staging, storage, repair, retrofit, and surveillance.

Spill Test Facility Impact Zone—This downwind geographic area, or footprint, would define the impacts of the largest planned tests of any material released.

Reserved Zone—This land area includes areas and facilities that provide widespread flexible support for diverse short-term testing and experimentation. The Reserved Zone is also used for short-duration exercises and training, such as the Nuclear Emergency Search Team and Federal Radiological Monitoring and Assessment Center training and DoD land-navigation exercises and training.

No designated land-use zones currently exist at the Tonopah Test Range. Activities on this range are conducted in industrial and testing areas.

3.1.2 Alternative 2, Discontinue Operations

Alternative 2 is defined as the discontinuation of the DOE/NV and interagency programs and operations at the NTS. Site-support activities would be maintained, but would be limited to environmental monitoring and security functions necessary for human health and security. Control of the NTS would be maintained by the DOE, but no activities would take place. All facilities, after decommissioning operations have ceased, would be placed in cold standby.

3.1.2.1 Defense Program under Alternative 2. Under Alternative 2, the DOE/NV would not maintain a state of readiness for nuclear testing, and there would be an overall discontinuation of other defense-related activities at the NTS. The Tonopah Test Range would continue hosting Stockpile Stewardship activities as described under Alternative 1.

3.1.2.2 Waste Management Program under Alternative 2. Under Alternative 2, the DOE/NV would maintain only minimum low-level and mixed waste disposal capability until NTS waste-generating activities are completely shut down. After shutdown, monitoring and security functions on the NTS would be reduced and become part of the sitewide monitoring activity. Transuranic and transuranic mixed waste would be shipped to other DOE facilities for certification, handling, and disposal. Active waste sites would be covered with approximately 3 m (10 ft) of soil prior to shutdown.

3.1.2.3 Environmental Restoration Program under Alternative 2. Under Alternative 2, the currently inventoried Environmental Restoration Program sites would be discontinued and left abandoned as is. All reports, studies, field investigations, characterization, and decommissioning and/or decontamination would cease. All remediation projects under way would be discontinued, with the goal of progressing to a suitable conclusion within one calendar year of the decision to pursue this alternative.

3.1.2.4 Nondefense Research and Development Program under Alternative 2. Under Alternative 2, the DOE would discontinue support of ongoing program operations. The National Environmental Research Park Program would be terminated. The Spill Test Facility would be abandoned. The Environmental Management and Technology Development Program would be discontinued at the NTS. New DOE projects, such as a Solar Enterprise Zone facility, would not be sited on the NTS.

3.1.2.5 Work for Others Program under Alternative 2. Under Alternative 2, the DOE would not host the projects and activities of other federal agencies. The use of NTS airspace and certain lands by branches of the military would be discontinued. Any subsequent airspace restrictions

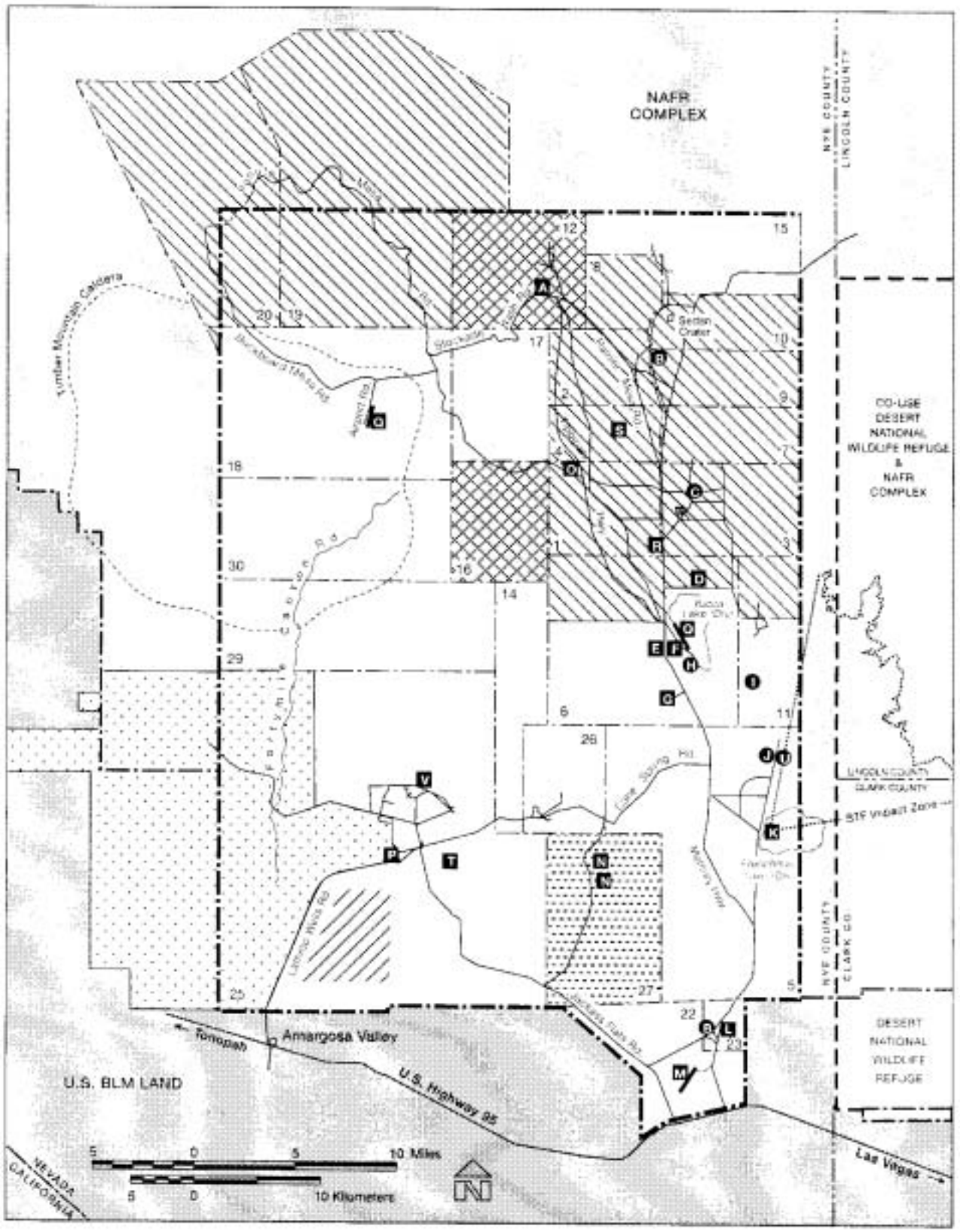


Figure 3-1. NTS Alternative 1 land use map

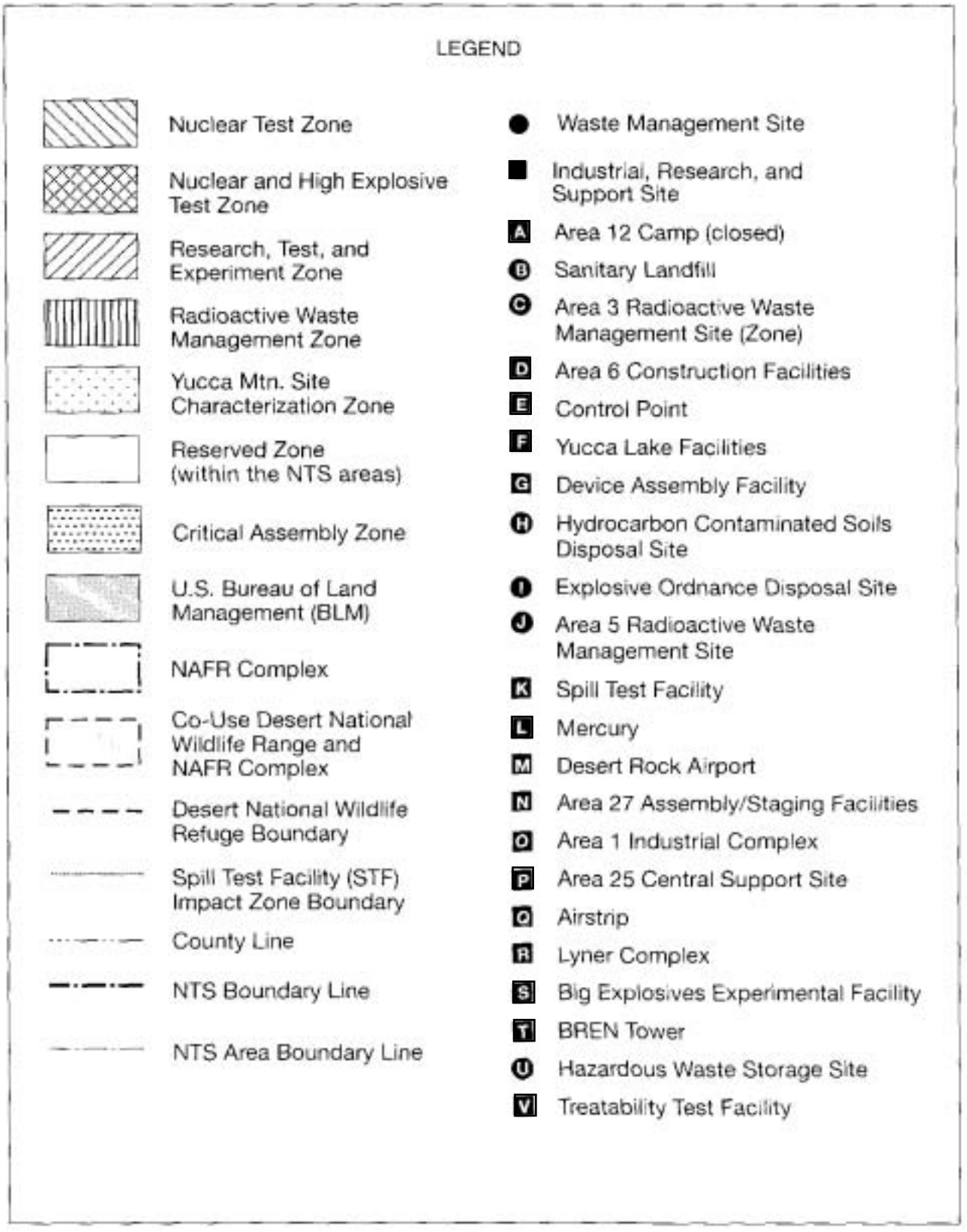


Figure 3-1 (continued). Legend for NTS Alternative 1 land use map

would be required to allow for overflights and inspections of the NTS in accordance with international arms control treaties, such as the Open Skies Treaty.

3.1.2.6 Land Use and Zones under Alternative 2. The following information describes the site and zone categories depicted on the land use map (Figure 3-2) under Alternative 2.

Security and Monitoring Operations Control Point—The site is used as the base of operations location for environmental monitoring and security patrols.

Industrial, Research, and Support Sites—An industrial site is used for manufacturing, processing, and/or fabricating any article, substance, or commodity. A research site is used for projects and conventional laboratory operations for the development, quality assurance, or reliability of materials and equipment under controlled conditions to verify theories or concepts. Support sites are used for office space, training, equipment storage, maintenance, security, feeding and housing, fire protection services, and health services.

Closed Site—These sites are industrial, research, or support sites that are no longer in use or maintained.

Closed Waste Management Site—This site is a waste management site that is no longer in use or maintained.

Monitored and Restricted Zone –Public access to this land area is restricted. Visits, patrols, and/or data collection on a periodic basis is conducted to provide for human health and safety and for the protection of assets and the environment.

3.1.3 Alternative 3, Expanded Use

The scope of Alternative 3 (Expanded Use) in this EIS is defined as including all currently planned and proposed projects, and all currently ongoing DOE/NV and interagency programs and operations described in Alternative 1, Continue Current Operations (No Action Alternative) and the potential project activities resulting from other DOE EISs. These additional project activities include the modification and/or expansion of existing facilities, and the construction of new facilities. In the case of potential activities resulting from other DOE EISs, this alternative identifies the action to reserve land and infrastructure pending a programmatic decision. An analysis of the environmental impacts associated with siting these potential projects is included in the consequences analysis (Chapter 5) for this alternative.

The following is a program-by-program description under Alternative 3, Expanded Use. To clarify the differences between Alternative 1 and Alternative 3 activities, asterisks are used to identify those activities that represent the expanded uses described by Alternative 3.

3.1.3.1 Defense Program under Alternative 3. Defense Program operations would continue at the NTS under the conditions of the ongoing nuclear testing moratorium and the negotiations of the Comprehensive Test Ban Treaty. These operations would emphasize NTS science-based stockpile stewardship experiments and operations to maintain the safety and reliability of the stockpile without underground nuclear testing. In addition, because there can be no absolute guarantee of the complete success in the development of enhanced experimental and computational capabilities, this alternative includes those activities necessary to maintain the capability to conduct nuclear tests under a "supreme national interest" provision in the anticipated Comprehensive Test Ban Treaty. These activities include maintaining the necessary infrastructure, and more importantly, exercising the research and engineering disciplines of the nation's nuclear weapons programs to assure the continued competence of its technical staff. Defense Programs activities would include:

- Stockpile Stewardship and Management
  - Performing treaty compliant and permitted dynamic experiments (including subcritical experiments)[2], and

[2] The term "Subcritical Experiments," does not define a new form of activity. It is intended instead to clarify the fact that dynamic experiments which involve the use of special nuclear materials do not achieve the condition of criticality.

hydrodynamic tests (subcritical) experiments would be conducted only where containment is assured)

- Maintaining readiness to conduct underground nuclear tests
- Conducting high explosive tests and experiments to include hydrodynamic tests and pulse power experiments. These tests and experiments may contain potentially hazardous materials such as beryllium, depleted uranium, deuterium, and tritium. At the Big Explosives Experimental Facility no experiments utilizing special nuclear materials would be performed
- Disposition of damaged nuclear weapons
- * Reserve land and infrastructure for a large, heavy-industrial facility
- Conducting underground nuclear testing if directed by the President under a "supreme national interest" provision in the anticipated Comprehensive Test Ban Treaty
- * Reserve land and infrastructure for next generation nuclear weapons simulators pending programmatic decisions
- * Reserve land and infrastructure for nuclear weapon assembly/disassembly operations and associated storage of strategic reserves of special nuclear materials as proposed in the Pantex Sitewide EIS. Interim storage of nuclear weapons components (pits) as proposed as an alternative in the Pantex Sitewide EIS, pending programmatic decisions.

- Materials Disposition
  - * Reserve land and infrastructure for long-term storage and facilities for the disposition of weapons-usable fissile material pending programmatic decisions

- Nuclear Emergency Response

Although no land area is specifically dedicated to Nuclear Emergency Response activities, the NTS provides a broad support base for the National Emergency Response Programs. The NTS provides an excellent test bed for training and exercise activities, and provides technical, operational, and logistical expertise in planning and deployment operations of the following programs.

- Nuclear Emergency Search Team
- Federal Radiological Monitoring and Assessment Center
- Aerial Measuring System
- Accident Response Group
- Radiological Assistance Program
- Internal Emergency Management Program.

The primary mission of Defense Program activities at the Tonopah Test Range is to ensure that the nation's nuclear weapons systems meet the highest standards of safety and reliability. These activities include several activities:

- Stockpile Stewardship
  - Assess surety conditions of existing systems, verifying required modification to existing systems, and verifying and maintaining surety of systems
  - Conducting experiments with special nuclear materials where containment is assured.

3.1.3.2 Waste Management Program under Alternative 3. Waste Management operations would continue to support DOE research and environmental cleanup and restoration programs. The DOE's Waste Management objective for the NTS would be to conduct proper disposal and monitoring of wastes generated from the NTS and other DOE sites. The specific waste management

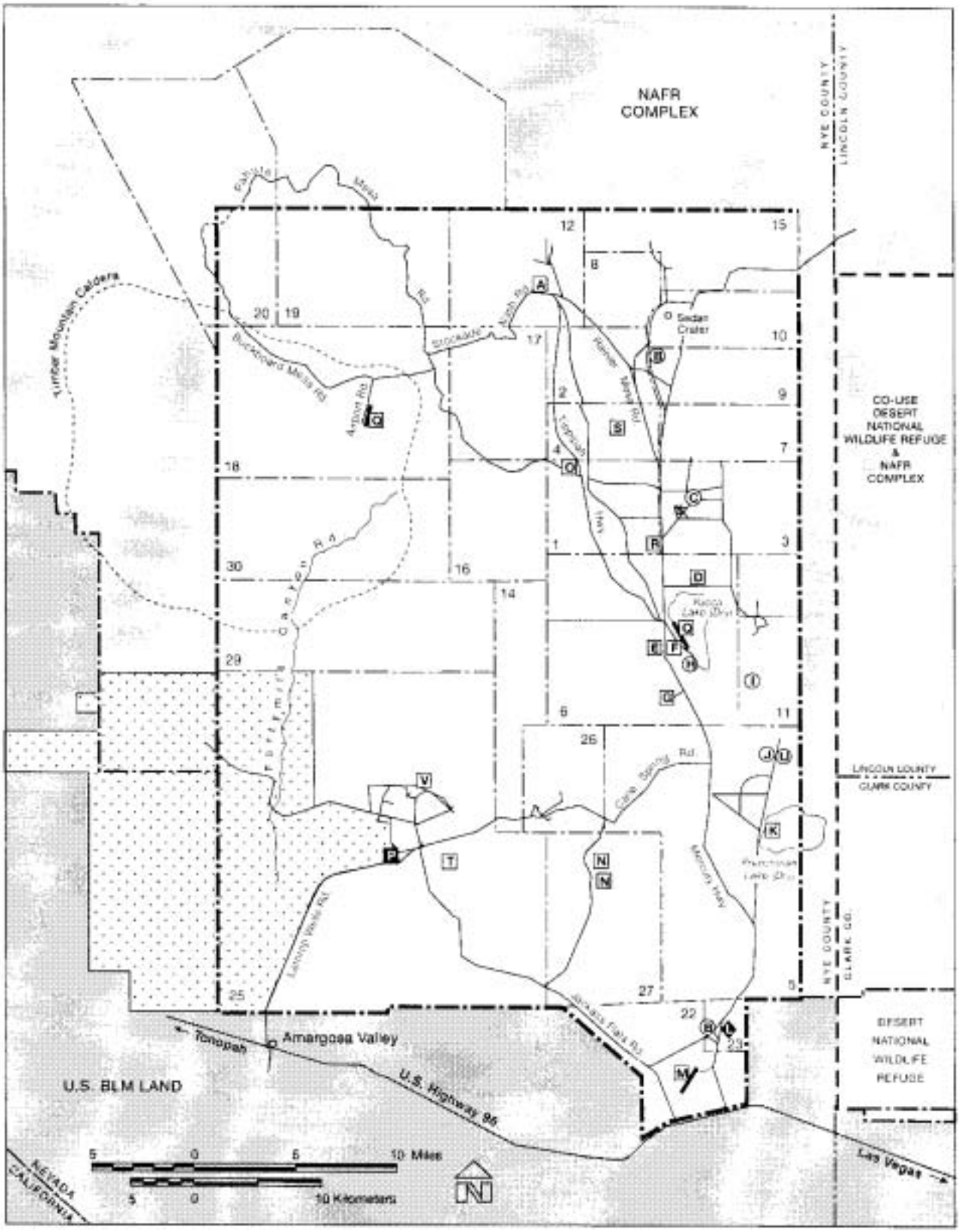


Figure 3-2. NTS Alternative 2 land use map

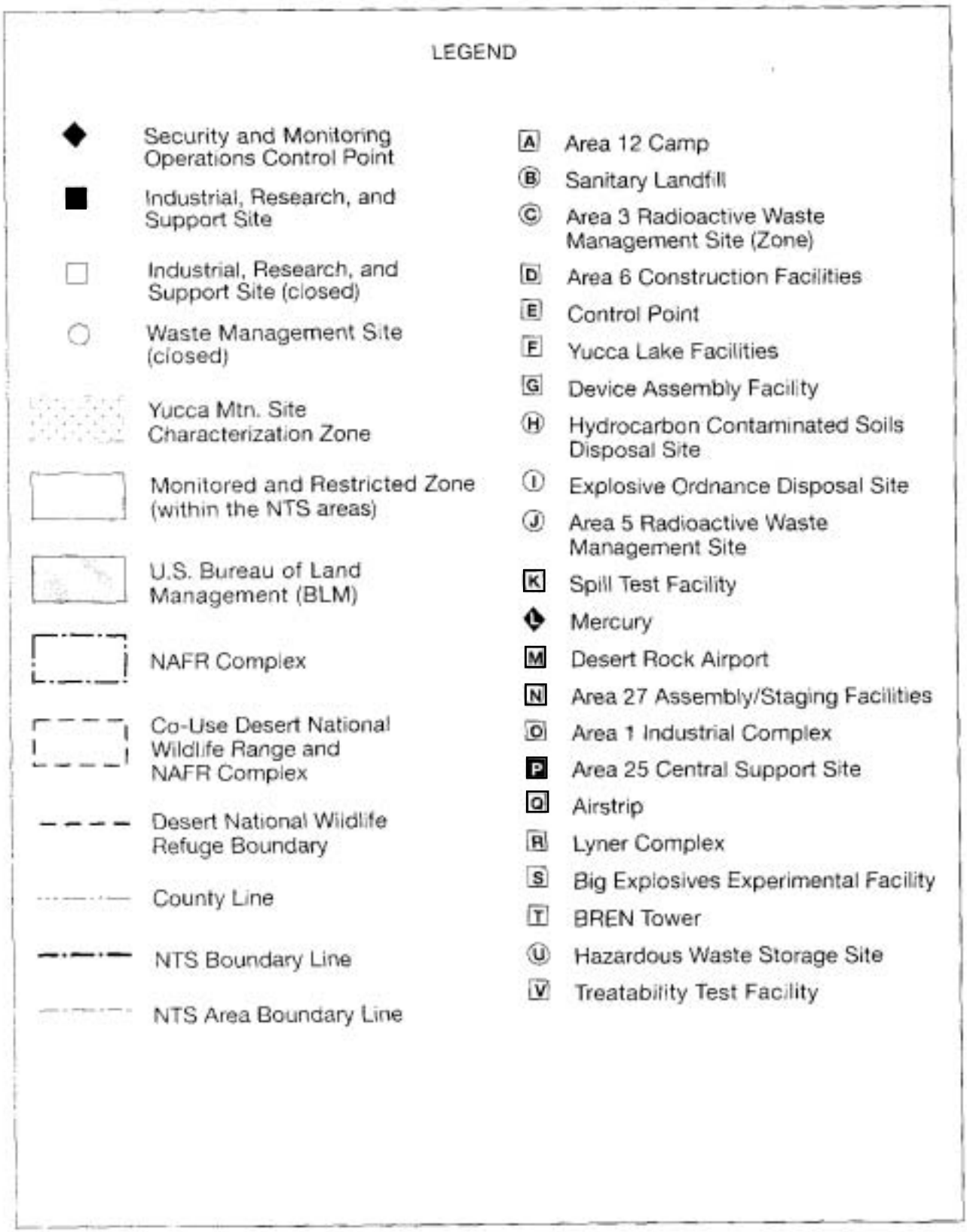


Figure 3-2 (continued). Legend for NTS Alternative 2 land use map

activities proposed in Alternative 3 are listed in Table 3-4. The following Waste Management activities would occur in appropriately designated Waste Management zones or sites:

- Providing low-level and mixed waste disposal capability to approved waste generators. This includes expanding and creating new disposal units. Low-level waste includes waste streams inappropriate for shallow land burial.
- Storing transuranic and transuranic mixed waste, pending the development of the DOE off-site treatment and disposal facilities
- Construct and operate on-site facilities for the certification and handling of transuranic and transuranic mixed waste for off-site treatment and disposal
- Expanding the existing capacity for the storage of hazardous waste pending off-site disposal
- Storing mixed waste, pending development of treatment options and/or certification for disposal
- Constructing and operating a mixed waste storage pad
- Continuing closure activities of inactive waste sites, as planned
- Storing PCB waste pending off-site disposal
- Constructing and providing storage capability for low-level waste
- Constructing and operating treatment facilities for on-site generated low-level and mixed waste
- Treating explosives at the Explosive Ordnance Disposal Unit
- Constructing and operating additional disposal facilities for solid waste generated on the NTS and in adjacent rural counties.

3.1.3.3 Environmental Restoration Program under Alternative 3. Environmental Restoration Program activities would continue in the form of characterization and remediation of contaminated areas or facilities, as identified in the recently completed site inventory. Environmental Restoration is not considered a land use, but an activity necessary for reuse or disposition of land and facilities. The Environmental Restoration Program subprojects in Nevada that would continue under Alternative 3 include:

- Underground Test Area Corrective Action Unit
- Soils Median Corrective Action Unit (including sites on the NAFR Complex)
- Industrial Sites Corrective Action Unit
- Decontamination and decommissioning facilities
- Tonopah Test Range
- Central Nevada Test Area
- Project Shoal Area
- Defense Nuclear Agency sites.

3.1.3.4 Nondefense Research and Development Program under Alternative 3. Under Alternative 3, the DOE would continue supporting ongoing program operations and pursue new initiatives. New initiatives would include constructing and operating a solar power production facility and siting an Alternative Fuels Demonstration Project at the NTS. Alternative 3 reserves land and infrastructure for public and private institutions to use portions of the NTS for compatible research, development, and testing activities. For example, the Kistler Aerospace Corporation identified during the public comment period of this EIS their interest in a commercial satellite delivery system as a future activity in this program area. Nondefense research, development, and testing activities that would continue or be pursued at the NTS would include:

- Supporting the Solar Enterprise Zone facility concept
- Reserve land on the NTS as a Solar Enterprise Zone facility. Construct and operate a solar power generation facility on the selected site
- Increased Spill Test Facility (Hazardous Materials Spill Center) activities
- Increased Environmental Management and Technology Development Programs
- National Environmental Research Park Program activities
- Additional demonstration projects.

Solar Enterprise Zone facility land use area is proposed under Alternative 3. In addition to a facility at the NTS, three sites in southern Nevada are being considered: Eldorado Valley, Dry Lake Valley, and Coyote Spring Valley.

The Tonopah Test Range activities that would be pursued include programs in the field of robotics technology, infrastructure maintenance, and transportation.

3.1.3.5 Work for Others Program under Alternative 3. Use of NTS airspace and certain lands by branches of the military for training and for defense-related research and development would increase under Alternative 3. The DOE would continue to host projects and activities of other federal agencies (for example, DoD) and share use of certain facilities and resources at the NTS and the Tonopah Test Range. This alternative reserves land and infrastructure for other federal agencies to use portions of the NTS for compatible activities. Work for Others Program activities that would continue include the following:

- Treaty verification
- Increased nonproliferation projects
- Expanded counterproliferation projects
  - Researching, developing, and characterizing counterproliferation technologies
- Additional conventional weapons demilitarization projects
- Expanded defense-related research and development, land navigation training, exercises, and use of airspace.

Furthermore, under Alternative 3, various facilities at the NTS would be used to conduct research and development of advanced conventional weapons technologies, including the Big Explosives Experimental Facility (see Section A.1.1.1.3 and Appendix F).

Tonopah Test Range airspace and the use of certain lands by the military for training and defense-related research and development would increase.

3.1.3.6 Land Use and Zones under Alternative 3. The following information describes the site and zone categories depicted on the land use map (Figure 3-3) under Alternative 3.

Waste Management Site—These sites are used for the disposal, storage, and/or treatment of wastes.

Industrial, Research, and Support Site—An industrial site is used for manufacturing, processing, and/or fabricating any article, substance, or commodity. A research site is used for projects and conventional laboratory operations for the development, quality assurance, or reliability of materials and equipment under controlled conditions to verify theories or concepts. Support sites are used for office space, training, equipment storage, maintenance, security, feeding and housing, fire protection services, and health services.

Nuclear Test Zone—This land area is reserved for dynamic experiments, hydrodynamic tests, and underground nuclear weapons and weapons-effects tests. This zone includes compatible defense and nondefense research, development and testing projects and activities.

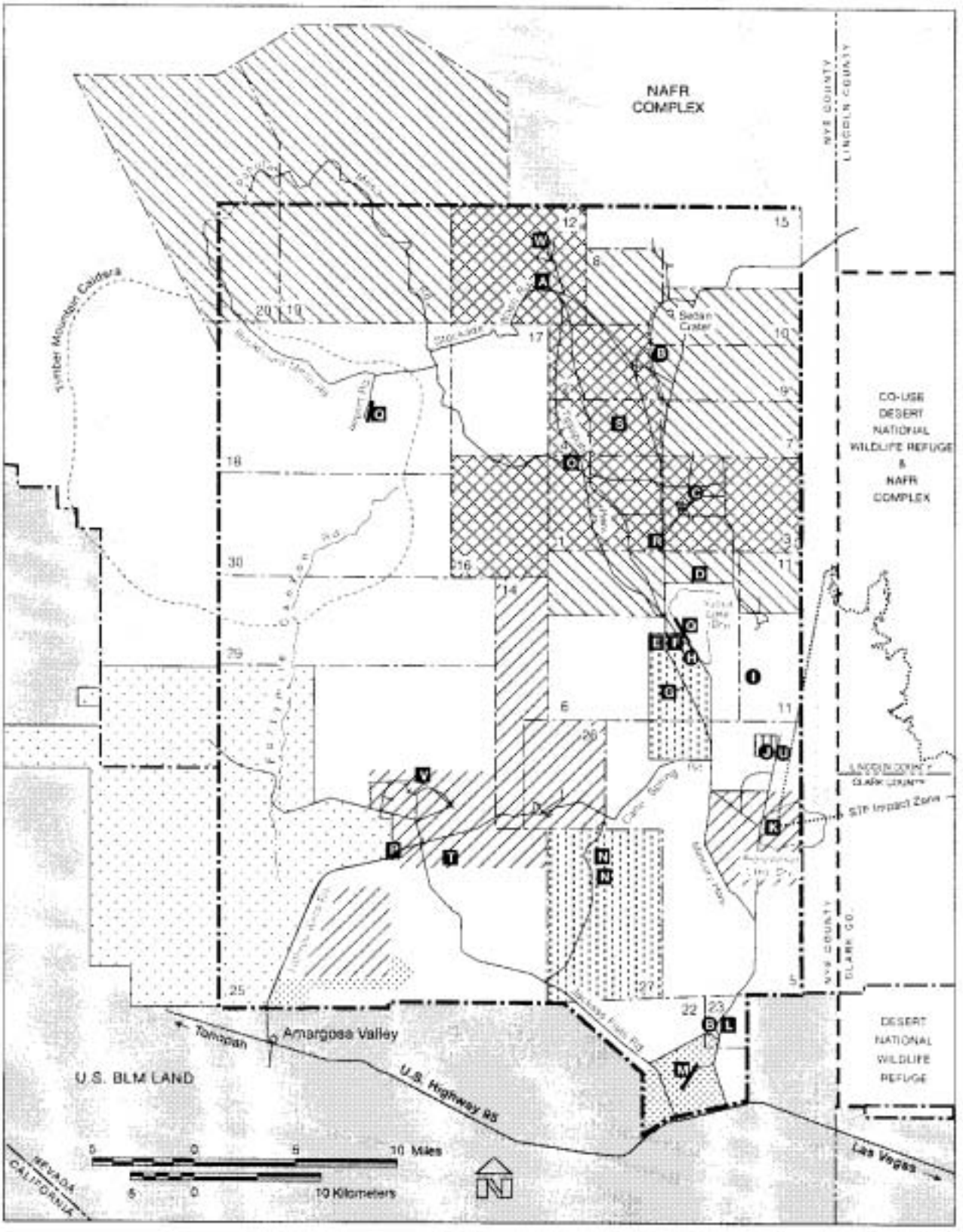


Figure 3-3. NTS Alternative 3 land use map

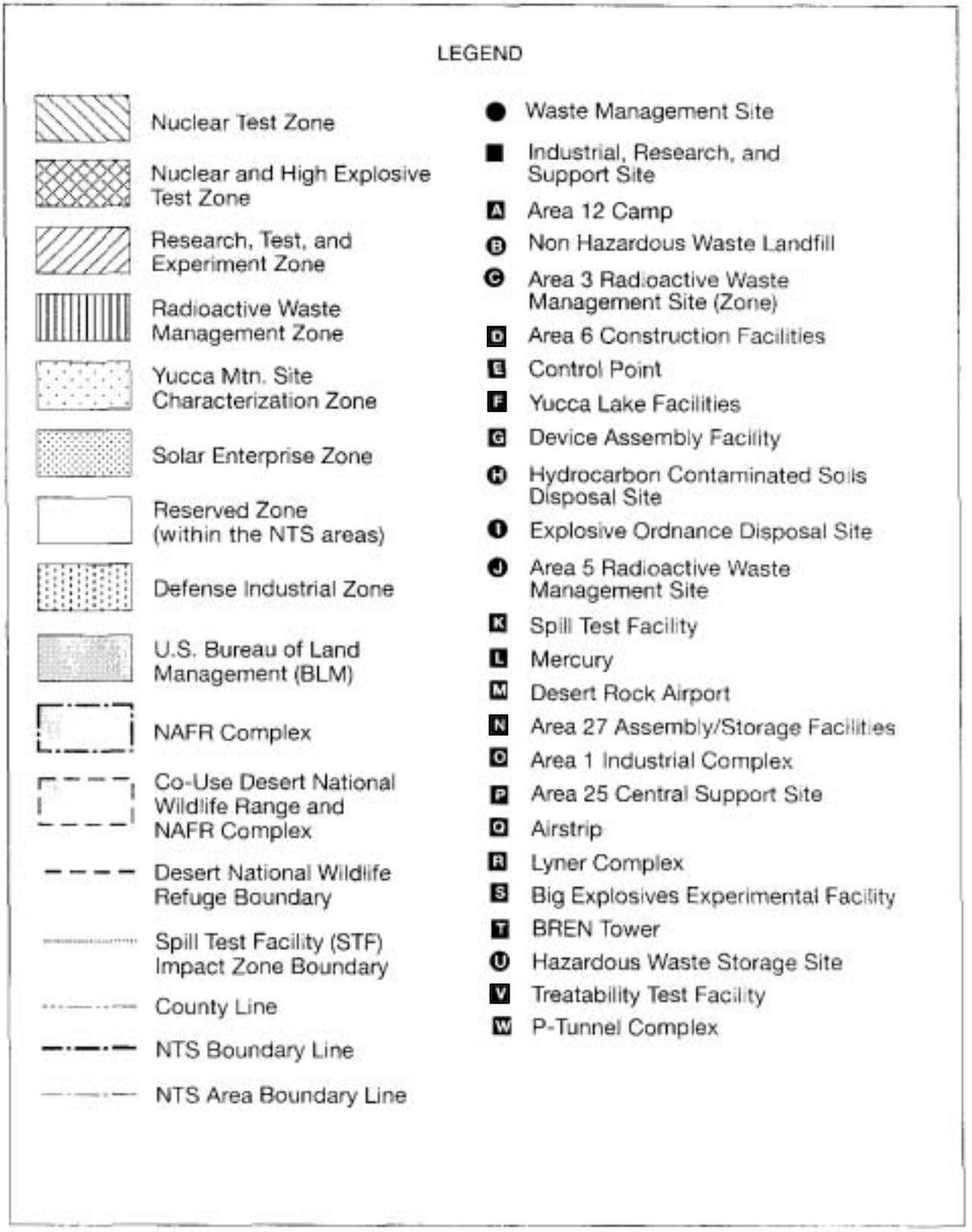


Figure 3-3 (continued). Legend for NTS Alternative 3 land use map

Nuclear and High Explosive Test Zone—This land area is designated within the Nuclear Test Zone for additional underground and outdoor high-explosive tests or experiments. This zone includes compatible defense and nondefense research, development and testing projects and activities.

Research, Test, and Experiment Zone—This land area is designated for small-scale research and development projects, demonstrations, pilot projects; outdoor tests; and experiments for the development, quality assurance, or reliability of materials and equipment under controlled conditions. This zone includes compatible defense and nondefense research, development and testing projects and activities.

Radioactive Waste Management Zone—This land area is designated for the management of radioactive wastes.

Solar Enterprise Zone—This land area is designated for the development of a solar energy power-generation facility, and light industrial equipment and commercial manufacturing capability.

Spill Test Facility Impact Zone—This downwind geographic area would confine the impacts of the largest planned tests of any material released.

Defense Industrial Zone—This land area is designated for stockpile management of weapons, including production, assembly, disassembly or modification, staging, repair, retrofit, and surveillance. Also included in this zone are permanent facilities for stockpile stewardship operations involving equipment and activities such as radiography, lasers, materials processing, and pulsed power.

Reserved Zone—This land area includes areas and facilities that provide widespread flexible support for diverse short-term testing and experimentation. The reserved zone is also used for short-duration exercises and training, such as the Nuclear Emergency Search Team and Federal Radiological Monitoring and Assessment Center training and DoD land-navigation exercises and training.

3.1.4 Alternative 4, Alternate Use of Withdrawn Lands

Under Alternative 4, the DOE would discontinue all defense-related activities at the NTS and most Work for Others Program activities. The U.S. Air Force could increase its use of airspace. The continuation of waste management operations in support of NTS environmental restoration and waste-generating activities associated with projects sited at the NTS would be the primary activities under this alternative.

3.1.4.1 Defense Program under Alternative 4. The DOE would not maintain a state of readiness for nuclear testing, and there would be an overall down scaling and discontinuation of other defense-mission activities. However, the DOE would be required to provide for overflights and inspections of the NTS in accordance with international arms control treaties. Tonopah Test Range activities associated with maintaining readiness would be in accordance with treaty requirements consistent with the Tonopah Test Range mission.

3.1.4.2 Waste Management Program under Alternative 4. Waste Management Program operations and construction would include all the activities listed under Alternative 3, with the restriction that these services be provided solely for DOE waste generated within Nevada.

3.1.4.3 Environmental Restoration Program under Alternative 4. The Environmental Restoration Program would continue at current or accelerated rates. More stringent remediation levels greater than protection of human health and the environment may be implemented (where applicable), based on designated land use and/or the potential return of some lands to public domain.

3.1.4.4 Nondefense Research and Development Program under Alternative 4. Under Alternative 4, Nondefense Research and Development Program activities would include those described under Alternative 3, but with a reduction in the scope of the Alternative Fuels Demonstration Projects.

3.1.4.5 Work for Others Program under Alternative 4. Under Alternative 4, it is anticipated that portions of the restricted NTS airspace would be relinquished. Conventional weapons demilitarization activities would not be sited at the NTS under this alternative, and defense-related research and training by other government agencies would not be conducted at the NTS. The DOE would be required to provide for overflights and inspections of the NTS and the Tonopah Test Range in accordance with international arms control treaties such as the Open Skies Treaty.

3.1.4.6 Potential Public Uses of NTS Lands under Alternative 4. The activities described in the following sections are other potential public uses of the NTS.

- Public Education:

  Educational tour routes would be established for the public. Tours would allow the public to see firsthand some of the history of the Nuclear Era and impacts of past nuclear testing. A Nuclear Era museum at the NTS that highlights the testing activities would be an important contribution to understanding the nation's nuclear history.

  Educational field trips to the NTS have occurred to a limited extent. This type of education would allow students to see firsthand some of the impacts of nuclear testing and contrast this destruction to the pristine and relatively undisturbed ecosystems that exist on the NTS.

- Public Recreation:

  Recreation on the NTS could focus on natural scenic areas, such as Timber Mountain and the isolated forested areas. The Timber Mountain Caldera is a national natural landmark and, with all its associated volcanic features, is one of the best examples of a caldera. This area is also the location of American Indian petroglyphs.

  The road system on the NTS would provide a location for such events as foot races, marathons, closed-circuit bicycle and car races, and other similar activities. The desert terrain and the existing facilities make Alternative 4 attractive.

  Deer herds and other game animals on the NTS have not been actively hunted for many decades. Consequently, a limited trophy deer hunt could be established similar to the bighorn sheep trophy hunt, as on the NAFR Complex, with a drawing to select a limited number of hunters. Each hunter must attend a one-day training session. The Nevada Division of Wildlife manages the bighorn sheep trophy hunt.

3.1.4.7 Land Use and Zones under Alternative 4. The following information describes the site and zone categories depicted on the land use map (Figure 3-4) under Alternative 4:

Waste Management Site—These sites are used for the disposal, storage, and/or treatment of wastes.

Industrial, Research, and Support Sites—An industrial site would be used for the manufacturing, processing, and/or fabrication of any article, substance, or commodity. A research site would be used for projects and conventional laboratory operations for the development, quality assurance, or reliability of materials and equipment under controlled conditions to verify theories or concepts. Support sites are used for office space, training, equipment storage, maintenance, security, feeding and housing, fire protection services, and health services.

Closed Site—These are closed industrial, research, and support sites that are no longer in use or maintained.

Radioactive Waste Management Zone—This land area is designated for the management of radioactive waste.

Spill Test Facility Impact Zone—This downwind geographic area would confine the impacts of the largest planned tests of any material released at the Spill Test Facility.

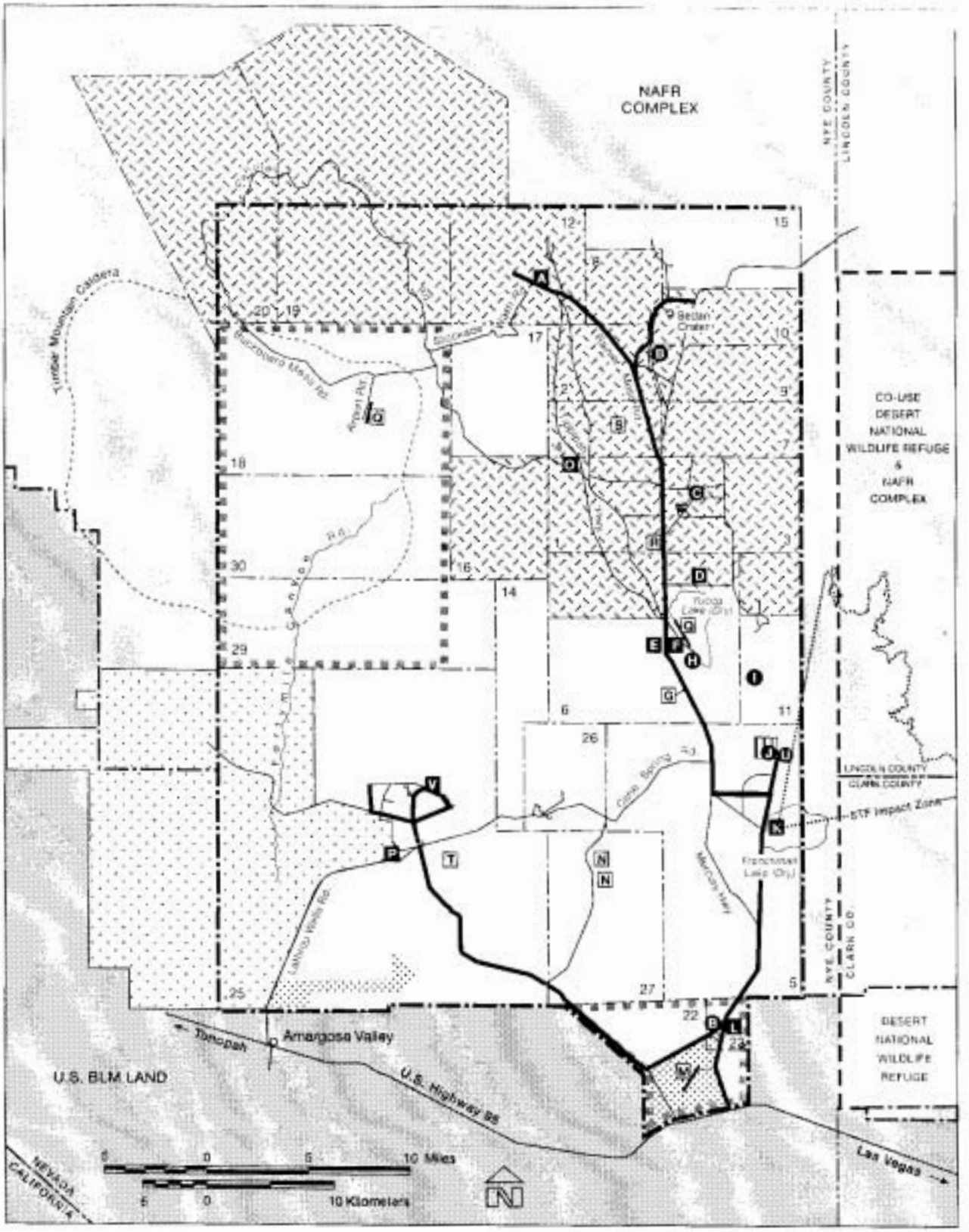


Figure 3-4. NTS Alternative 4 land use map

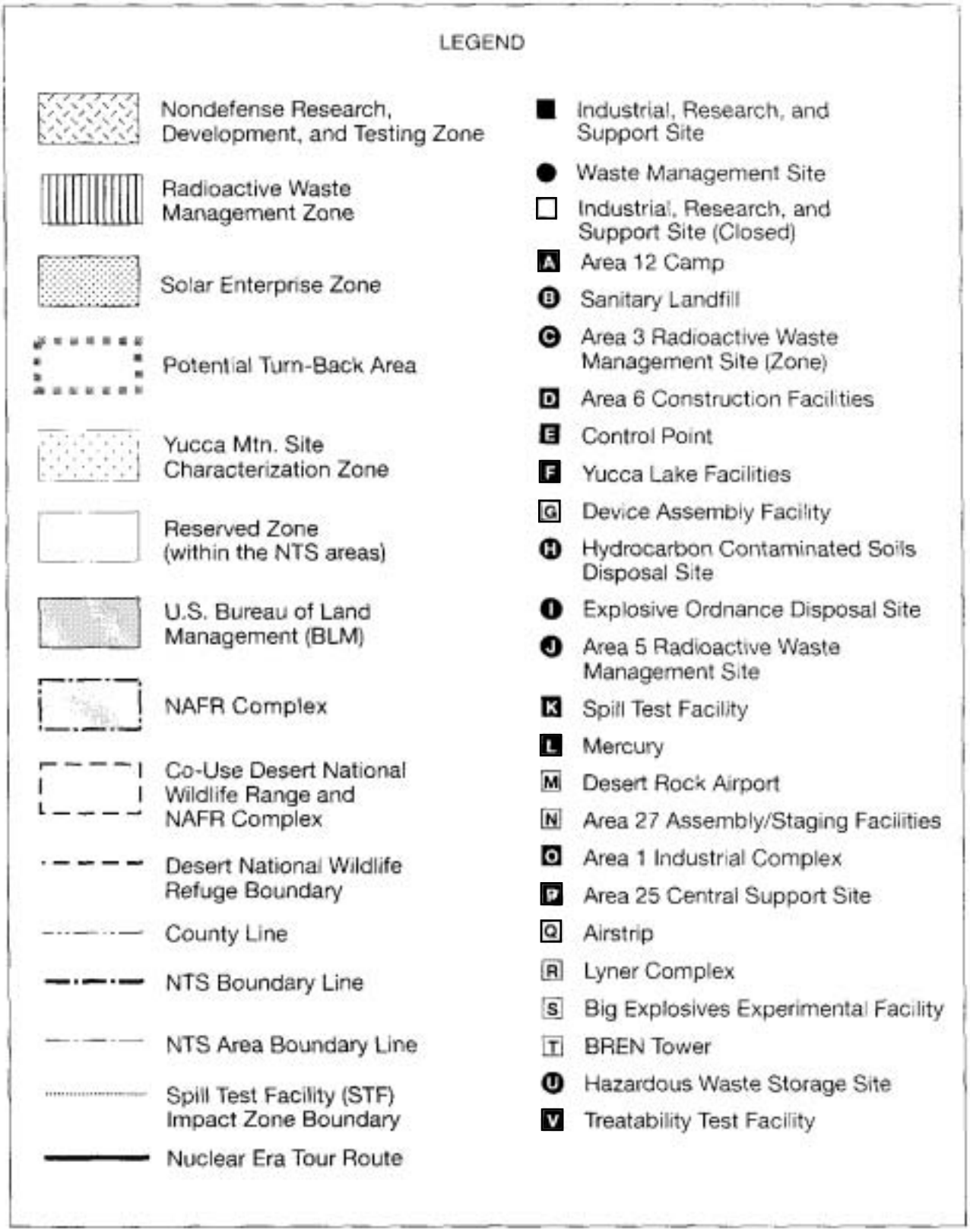


Figure 3-4 (continued). Legend for NTS Alternative 4 land use map

Reserved Zone—The reserved zone includes areas and facilities that provide widespread flexible support for diverse short-term nondefense research, testing, and experimentation.

Nondefense Research, Development, and Testing Zone—This monitored restricted-access land area has been designated for nondefense-related research, development, and testing activities.

Potential Turn Back Area—This zone encompasses the land area designated for potential return to the U.S. Bureau of Land Management who would determine the proper management prescription for the land consistent with area land use policies.

3.2 Alternatives Eliminated from Further Consideration

A National Environmental Policy Act review specifies the purpose and need for an agency to take action, describes the action that the agency proposes to meet for that purpose and need, and identifies reasonable alternatives to meet all or part of the purpose and need. A potential alternative might be eliminated from detailed consideration if the alternative would take too long to implement, or would be prohibitively expensive, or highly speculative in nature and thus is considered unreasonable. During scoping for the NTS EIS, commentors suggested several alternatives that could be considered in the document. The DOE considered those alternatives, but did not analyze them in detail in this EIS. This section identifies the alternatives that were eliminated from further consideration and provides a brief explanation of the reason for elimination. These alternatives include the following:

- Site uses defined by the program
- Site closure with full environmental restoration
- Site closure with direct turn back of surplus lands to the sovereign nations, public, county, and state
- No Action Alternative that excludes receipt of waste from out-of-state waste generators
- Other alternatives within the range of alternatives considered
- Alternatives including rail routes for waste transport.

3.2.1 Site Uses Defined by Program

As an alternative to managing the NTS to support multiple programs, the DOE considered, but dismissed as unreasonable, the alternatives that would dedicate the NTS to a single program. The most commonly cited alternatives included the five programs evaluated in this EIS: Defense, Environmental Restoration, Waste Management, Nondefense Research and Development (including alternative energy research), and Work for Others. In each alternative, only one program would be conducted at the NTS, with the NTS being fully dedicated to conducting the program under consideration. The NTS has historically been a multipurpose facility because of its remote location, arid climate, controlled access, and size. For these reasons, this alternative fails to meet the DOE's need for a site that can support evolving DOE missions.

3.2.2 Site Closure with Complete Environmental Restoration

The DOE considered, but dismissed as too speculative, the alternative to fully remediate and close the NTS in the next 10-year period. In accordance with the DOE's National Environmental Policy Act EIS policy, the NTS EIS evaluates site uses for the next 5- to 10-year period and because of the unique nature of past NTS activities (nuclear weapons tests), complete site characterization and subsequent remediation activities could not be completed before the year 2035. Additionally, technologies to fully and economically remediate certain areas of the NTS (such as the underground testing areas) do not currently exist and are not anticipated to be available in the next 10-year period.

3.2.3 Site Closure with Direct Relinquishment of Surplus Lands to the Sovereign Nations, the Public, Nye County, or the state of Nevada following Remediation

The DOE considered, but dismissed as unreasonable, the alternative of relinquishing the withdrawn NTS land directly to the sovereign nations, the state of Nevada, Nye County, or the public. This alternative would require a redirection of the policies of the U.S. Bureau of Land Management, which administers the federal lands that are withdrawn for use by the DOE. Current U.S. Bureau of Land Management policies and regulations require lands that were formerly withdrawn from the public domain, and are no longer needed, to be relinquished to the U.S. Bureau of Land Management. For this reason, this alternative was considered too speculative and outside the scope of the NTS EIS. Alternative 4 addresses, to the extent reasonable, the identification of possible surplus land within the NTS and the return of that land to the U.S. Bureau of Land Management for public use.

3.2.4 Other Alternatives within the Range of Alternatives Considered

Several alternatives were identified by sovereign nations, stakeholders, and the public that fall within the range of the four alternatives being evaluated in this EIS. Such alternatives involved varying combinations of the five major programs (Defense, Environmental Restoration, Waste Management, Nondefense Research and Development, and Work for Others). Such alternatives included expanding nondefense research and development and minimizing waste management; continuing current operations except excluding receipt of waste from outside generators; and, expanding defense activities to include all stockpile stewardship and management functions. The DOE believes that the range of alternatives considered in this EIS bounds these other suggested alternatives. At one end of the spectrum, the alternatives include site closure with no activities other than monitoring; the opposite extreme is the expanded use of NTS resources. Encompassed within these extremes are the continuation of current operations (no action) and a reduced level of resource use that eliminates all defense-related activities and that limits waste management activities to support the environmental restoration of the NTS.

3.2.5 Alternatives Including Rail Routes for Waste Transport

Several stakeholders urged that rail routes for the transport of all waste types, including high-level waste and spent nuclear fuel, should be included in one or more of the alternatives. The DOE considered the inclusion of rail routes as part of the alternatives. As stated earlier, no action to construct rail access to the NTS is considered in this EIS or in the Record of Decision. The DOE/NV recognizes, however, that a rail option would be a feasible alternative should the NTS be named the sole low-level waste disposal site for the DOE complex and defers any decision to such time that a decision is made in the Waste Management Programmatic Environmental Impact Statement. The Transportation Study undertaken to support this EIS presents and analyzes, for purposes of comparison, the rail routes and highway truck transportation routes that could support low-level waste shipments only (see Appendix I).

The Yucca Mountain Project Repository EIS will evaluate the potential consequences associated with the construction and operation of a rail spur to ship spent nuclear fuel and high-level waste. The implications of such a spur for the NTS will be addressed as part of the cumulative impacts analysis in the Repository EIS. Should the DOE decide to construct and operate a rail spur, the DOE/NV would perform additional evaluations associated with the use of this resource by low-level waste generators.

3.2.6 Alternatives Considered But Eliminated from Consideration Prior To Scoping

Prior to the public scoping period, the DOE determined that a number of issues would not be considered in this EIS. The eliminated alternatives are considered to be outside the scope of this EIS because they will be evaluated in other EISs or because they represent policy decisions on actions defined by mechanisms outside the DOE/NV or the

DOE control including the Yucca Mountain Repository construction, operation, and closure.

3.2.6.1 Yucca Mountain Repository Construction, Operation, and Closure. The NTS EIS addresses operations and activities at the Nevada Test Site that could potentially occur over a 10-year period. These proposed operations and activities are the responsibility of the DOE Nevada Operations Office (DOE/NV). The Yucca Mountain Project is governed by the provisions of the Nuclear Waste Policy Act of 1982, as amended, and is under the Office of Civilian Radioactive Waste Management, a separate DOE office whose mission is distinct from that of the DOE/NV. The Yucca Mountain Project is currently engaged in activities which characterize the mountain to determine its suitability for development as a repository. The evaluations include analyzing the anticipated performance of such a repository, if it were constructed, over many thousands of years. Even if Yucca Mountain is eventually found suitable for development as a repository, and Congress authorizes such development, construction would not begin within the 10-year timeframe addressed in the NTS EIS.

The Council on Environmental Quality's National Environmental Policy Act regulation, Title 40 CFR Part 1501.7(a)(5), instructs the DOE, as lead agency, to indicate any public EISs that will be prepared and that are related to, but are not part of, the scope of the impact statement under consideration. The Office of Civilian Radioactive Waste Management is currently preparing an EIS, the Yucca Mountain Project Repository EIS, to evaluate the potential environmental impacts from the construction, operation, and eventual closure of a repository at Yucca Mountain for the geologic disposal of commercial and DOE-owned spent nuclear fuel and high-level radioactive waste (60 FR 40164, August 7, 1995).

During the scoping process for the Yucca Mountain Project Repository EIS, the DOE identified the construction, operation, and closure of a Yucca Mountain spent nuclear fuel and high-level radioactive waste repository as outside the scope of this EIS. Section 113 of the Nuclear Waste Policy Act, (NWPA, 1983) as amended, categorizes the current site characterization activities at Yucca Mountain as "preliminary activities" and specifically excludes them from the requirement of preparing an EIS. However, the NTS EIS includes these activities as part of the description of the existing environment at the NTS (see Chapter 4) as well as in the discussion of cumulative impacts (in Chapter 6). The Repository EIS will consider other relevant information and analyses, including the NTS EIS and other EISs prepared by the DOE to address other proposed actions. The Repository EIS will incorporate information from the NTS EIS, as appropriate, in its description of the existing environment as well as in its analysis of cumulative impacts. The analysis of cumulative impacts will include the combined effects of transporting waste to the repository and to the NTS. In this way, DOE will ensure that the cumulative effects from all activities taking place or contemplated at the NTS are considered in its decisionmaking process, along with the public's comments on these activities.

3.2.6.2 Monitored Retrievable Storage of Spent Nuclear Fuel and High-Level Radioactive Waste at the NTS or in Lincoln County, Nevada. The Nuclear Waste Policy Act of 1982, as amended, directed the DOE to work with interested states and sovereign nations to identify a host for the monitored retrievable storage facility. However, that provision has now expired. In addition, the Nuclear Waste Policy Act of 1982, as amended, prohibits the siting by the Secretary of a monitored retrievable storage facilty for the interim storage of spent nuclear fuel in the state of Nevada (Section 145(g)). Although bills have been introduced into Congress that may eliminate or nullify this prohibition, attempting to predict the outcome of such legislative proposals would be highly speculative, at best. Therefore, the DOE considered the inclusion of a facility for the interim storage of spent nuclear fuel within any of the NTS EIS sitewide alternatives to be beyond the scope of this EIS.

3.2.6.3 Claims for Past Damages Resulting from Atmospheric Testing. In accordance with the provisions of the Radiation Exposure Compensation Act of 1990, as amended, which is administered by the Department of Justice, members of the public who reside within the geographic boundaries and

time period therein defined may be eligible for monetary benefits as compensation for illness or damage related to specific diseases and death.

Historical dose estimates for past activities at the NTS, such as atmospheric weapons testing and belowground weapons testing, are available from a variety of sources (Church et al., 1990; Gesella and Voilleque, 1990). It is not within the scope of this assessment to recalculate the current information available on dose reconstruction at the NTS and the surrounding communities. Because none of the alternatives considered in the NTS EIS involve the resumption of atmospheric weapons testing, the risks for those activities are not assessed here. The risk to human health due to underground weapons testing is assumed to be similar to the past venting event detailed in the Special Nevada Report (SAIC/DRI, 1991). A wealth of information is available from the Off-site Radiation Exposure Review Project that was initially established by the DOE to collect historical exposure estimates and reconstruct the doses received by individuals off the NTS due to fallout.

To better understand the human health and safety issues posed by each of the alternatives, the DOE conducted a human health risk assessment as part of this EIS (see Appendix H). The human health risk assessment incorporates information on waste inventories, radioactive materials associated with nuclear weapons testing and defense program activities, and other hazardous materials that are used at the NTS under each of the alternatives considered. Risks that are examined include both fatal and non-fatal health effects that could result from transportation or other work-related accidents and from exposures to hazardous and radioactively contaminated materials.

3.3 Comparison of Alternatives and Environmental Impacts

The NTS EIS presents the discussion of environmental impacts of four alternatives for five DOE programs and site-support activities at the NTS and six other sites within Nevada. Tables 3-1 through 3-4 show site programs and projects for each alternative. Chapter 4 describes the affected environments of each of these sites by resource area, addressing, where applicable, the following resource areas: land use, airspace, transportation, socioeconomics, geology and soils, water resources, biology, air quality, noise, visual quality, cultural resources, occupational and public health and safety, and Environmental Justice. Chapter 5 describes the potential impacts of each of the alternatives on each of the resource areas. The discussion of impacts is arranged by resource area within each site so that the reader may find a discussion of the impact of a specific program for each alternative at a particular site. The following section presents a brief qualitative summary of the major impacts of each of the five programs. For each of the programs, there are resource areas that are of more interest than others. These major areas are summarized here. For further detail on these areas or for discussions of other resource areas, the reader should consult the relevant sections in Chapters 4 and 5.

Defense Program. Evaluation of the alternatives in this EIS for the Defense Program does not identify significant physical environmental impacts that would change the environmental baseline established by past activities. This would include Alternatives 1 and 3, which address a scenario to conduct one or more underground nuclear tests if directed by the President. Stockpiled holes for potential underground tests are isolated from other NTS activities. The construction of new facilities would have a minor, localized impact to the physical environment of the site but would not lead to off-site impacts. The most significant impacts would be the loss of income and jobs resulting from the elimination of the Defense Program activities under Alternatives 2 and 4.

Based on the more than 40 years of operations and information, many of the consequences of past Defense Program activities and other activities have been documented. Additional Defense Program impacts resulting from the alternatives considered in this EIS are significant, although small, compared to the impacts of previous testing. More than 800 underground nuclear tests have been conducted at the NTS. As discussed in the *Final Environmental Impact Statement, Nevada Test Site, Nye County, Nevada* (ERDA, 1977), underground testing has resulted in unavoidable adverse impacts to portions

Table 3-1. Comparison of Defense Program Activities for the Alternatives

Alternative 1	Alternative 2	Alternative 3	Alternative 4
Stockpile Stewardship - Maintain Readiness to Test - Conduct Underground Nuclear Weapons Testing (if directed) - Conduct Dynamic Experiments, including Subcritical Experiments, and Hydrodynamic Tests - Conduct Conventional High-Explosive Testing - Destroy Damaged Nuclear Weapons **Nuclear Emergency Response** - Nuclear Emergency Search Team - Federal Radiological Monitoring and Assessment Center - Aerial Measuring System - Accident Response Group - Radiological Assistance Program - Internal Emergency Management Program **Tonopah Test Range** - Impact Tests - Passive Tests - Chemical Tests	**Stockpile Stewardship** - Discontinue All Activities **Tonopah Test Range** - Impact Tests - Passive Tests - Chemical Tests	**Stockpile Stewardship** - Maintain Readiness to Test - Conduct Underground Nuclear Weapons Testing (if directed) - Conduct Dynamic Experiments, including Subcritical Experiments, and Hydrodynamic Tests - Conduct Conventional High-Explosive Testing - Construct Nuclear Weapons Simulators - National Ignition Facility (if selected in Stockpile Stewardship and Management Programmatic EIS) - Destroy Damaged Nuclear Weapons **Stockpile Management** - Store Nuclear Weapons - Disassemble Nuclear Weapons - Assemble Nuclear Weapons - Modify and Maintain Nuclear Weapons - Test Weapons Components for Quality Assurance - Provide Interim Storage of Pits **Nuclear Emergency Response** - Nuclear Emergency Search Team - Federal Radiological Monitoring and Assessment Center - Aerial Measuring System - Accident Response Group - Radiological Assistance Program - Internal Emergency Management Program **Storage and Disposition of Weapons-Usable Fissile Materials** - Store Weapons-Usable Fissile Material - Disposition Weapons-Usable Fissile Material - Construct New or Modify Tunnel Complexes - Increase Robotic Technology Experiment - Construct New or Modify Existing Structures - Heavy Industrial Facility **Tonopah Test Range** - Impact Tests - Passive Tests - Chemical Tests	**Stockpile Stewardship** - Discontinue All Activities **Tonopah Test Range** - Impact Tests - Passive Tests - Chemical Tests

Table 3-2. Comparison of Waste Management Program Activities for the Alternatives

Alternative 1	Alternative 2	Alternative 3	Alternative 4
Area 3 Disposal: - Nevada Generated Low-Level Waste - Non-Nevada Generated Low-Level Waste Closure: - Disposal Crater Complex UE3as/bl - Disposal Crater Complex UE3ah/at **Area 5** Disposal: - Nevada Generated Low-Level Waste - Non-Nevada Generated Low-Level Waste - Nevada Generated Mixed Waste - Greater Confinement Waste Storage: - Nevada Generated Mixed Waste - Transuranic Waste - Mixed Transuranic Waste - Hazardous Waste Closure Activities: - Close Designated Low-Level Waste Disposal Units - Close Designated Mixed Waste Disposal Units - Close Designated Greater Confinement Disposal Units **Area 6** Storage Activities: - PCB Waste Disposal Activities: - Hydrocarbon Landfill **Area 11** Treatment Activities: - Explosive Ordnance Disposal Unit	No Activity	**Area 3** Disposal: - Nevada Generated Low-Level Waste - Non-Nevada Generated Low-Level Waste Closure: - Disposal Crater Complex UE3as/bl - Disposal Crater Complex UE3ah/at Construction: - Future Low-Level Waste Disposal Pit - Building 3-302 (expansion) - Area 3 Truck Decon Station **Area 5** Disposal: - Nevada Generated Low-Level Waste - Non-Nevada Generated Low-Level Waste - Nevada Generated Mixed Waste - Greater Confinement Waste Storage: - Nevada Generated Mixed Waste - Transuranic Waste - Mixed Transuranic Waste - Hazardous Waste Facility Construction Activities: - Breaching and Sampling Facility - Real-Time Radiography - Transuranic Waste Certification Facility - Transuranic Waste Handling and Loading Facility - Mixed Waste Storage Pad - Mixed Waste Disposal Units - Low-Level Waste Disposal Units - Greater Confinement Disposal Units - Hazardous Waste Storage Pad (expansion) - Water Supply Line - Access Control Building - Maintenance Building - 5-01 Road Reconstruction (may not be necessary) - 5-07 Road Reconfiguration (may not be necessary) - 500-Year Flood Protection - Low-Level Waste Storage Facility - Fire Protection Utilities - Telephone System Closure Activities: - Close Designated Low-Level Waste Disposal Units - Close Designated Mixed Waste Disposal Units - Close Designated Greater Confinement Disposal Units Treatment Facility: - Cotter Concentrate Mixed Waste **Area 6** Storage Activities: - PCB Waste Treatment Activities: - Low-Level Liquid Waste Treatment Facility - Mixed Liquid Waste Treatment Facility Disposal Activities: - Hydrocarbon Landfill **Area 11** Treatment Activities: - Explosive Ordnance Disposal Unit	**Area 3** Disposal: - Nevada Generated Low-Level Waste Closure: - Disposal Crater Complex UE3as/bl - Disposal Crater Complex UE3ah/at **Area 5** Disposal: - Nevada Generated Low-Level Waste Storage: - Transuranic Waste - Mixed Transuranic Waste - Hazardous Waste Closure Activities: - Close Designated Low-Level Waste Disposal Units - Close Designated Mixed Waste Disposal Units - Close Designated Greater Confinement Disposal Units Facility Construction Activities: - Water Supply Line - Access Control Building - Maintenance Building - 5-07 Road Reconfiguration - 500-Year Flood Protection - Fire Protection Utilities - Telephone System Treatment Facility: - Cotter Concentrate Mixed Waste **Area 6** Storage Activities: - PCB Waste Treatment Activities: - Low-Level Liquid Waste Treatment Facility Disposal Activities: - Hydrocarbon Landfill **Area 11** Treatment Activities: - Explosive Ordnance Disposal Unit

Table 3-3. Comparison of Environmental Restoration Program Activities for the Alternatives

Alternative 1	Alternative 2	Alternative 3	Alternative 4
Underground Test Area Corrective Action Unit - Continue Groundwater Monitoring - Continue Drilling Characterization Wells - Evaluate and Implement Remediation Strategies **Soils Media Corrective Action Unit and Part of NAFR Complex** - Continue Studies to Identify, etc. Alternate Remedial Measures - Remove Contaminated Soils on NTS and Nellis Lands - Dispose of Contaminated Soils in Permitted Facilities - Select Alternate Remedial Action Method and Implement **Industrial Sites Corrective Action Unit** - Characterize and Dispose of Environmental Restoration Sites - Continue Field Program to Identify Sites - Dispose of Waste in Approved Facilities - Continue to Characterize and Remediate the Resource Conservation and Recovery Act Industrial Sites **Decontamination and Decommissioning Facilities** - Continue Remediation Action and Planning **Defense Nuclear Agency Sites** - Continue Operations to Stop Contaminant Migration Characterize and Remediate Contaminated Muck Piles and Ponds - Select and Implement Alternate Remedial Action or Redesign **Tonopah Test Range** - Continue Characterization and Remediation **Central Nevada Test Area** - Continue Characterization and Remediation **Project Shoal Area** - Continue Characterization and Remediation	No Activity	**Underground Test Area Corrective Action Unit** - Continue Groundwater Monitoring - Continue Drilling Characterization Wells - Evaluate and Implement Remediation Strategies - Intensify Groundwater Monitoring - Accelerate, Evaluate, and Implement Remediation Strategies - Alternate Uses May Require Stricter Cleanup Levels **Soils Media Corrective Action Unit and Part of NAFR Complex** - Continue Studies to Identify, etc. Alternate Remedial Measures - Remove Contaminated Soils on NTS and Nellis Lands - Dispose of Contaminated Soils in Permitted Facilities - Activities Would Accelerate Above Present Levels - After Studies, Select Alternate Remedial Action Method and Implement - Alternate Uses May Require Stricter Cleanup Levels **Industrial Sites Corrective Action Unit** - Characterize and Disposition of Environmental Restoration Sites - Continue Field Program to Identify Sites - Continue to Characterize and Remediate the Resource Conservation and Recovery Act Industrial Sites - Activities Would Accelerate Above Present Levels - Alternate Uses May Require Stricter Cleanup Levels **Decontamination and Decommissioning Facilities** - Accelerate Remedial Actions - Alternative May Require Clean Closure, Not Closure In Place **Defense Nuclear Agency Sites** - Accelerate Operations to Stop Radiation and Hazardous Contaminated Migration - Select and Implement Alternate Remedial Action or Redesign - Alternate Uses May Require Stricter Cleanup Levels - Characterize and Remediate Contaminated Muck Piles and Ponds **Tonopah Test Range** - Accelerate Characterization and Remediation of Site **Central Nevada Test Area** - Accelerate characterization and remediation **Project Shoal Area** - Continue Characterization and Remediation - Accelerate Characterization and Remediation of Site	**Underground Test Area Corrective Action Unit** - Continue Groundwater Monitoring - Continue Drilling Characterization Wells - Evaluate and Implement Remediation Strategies - Intensify Groundwater Monitoring - Accelerate, Evaluate, and Implement Remediation Strategies - Alternate Uses May Require Stricter Cleanup Levels **Soils Media Corrective Action Unit and Part of NAFR Complex** - Continue Studies to Identify, etc. Alternate Remedial Measures - Remove Contaminated Soils on NTS and Nellis Lands - Dispose of Contaminated Soils in Permitted Facilities - Activities Would Accelerate Above Present Levels - After Studies, Select Alternate Remedial Action Method and Implement - Alternate Uses May Require Stricter Cleanup Levels **Industrial Sites Corrective Action Unit** - Characterize and Disposition Environmental Restoration Sites - Continue Field Program to Identify Sites - Continue to Characterize and Remediate the Resource Conservation and Recovery Act Industrial Sites - Activities Would Accelerate Above Present Levels - Alternate Uses May Require Stricter Cleanup Levels **Decontamination and Decommissioning Facilities** - Accelerate Remedial Actions - Alternative May Require Clean Closure, Not Closure In Place **Defense Nuclear Agency Sites** - Accelerate Operations to Stop Radiation and Hazardous Contaminated Migration - Select and Implement Alternate Remedial Action or Redesign - Alternate Uses May Require Stricter Cleanup Levels - Characterize and Remediate Contaminated Muck Piles and Ponds **Tonopah Test Range** - Accelerate Characterization and Remediation of Site **Central Nevada Test Area** - Accelerate characterization and remediation **Project Shoal Area** - Continue Characterization and Remediation - Accelerate Characterization and Remediation of Site

Table 3-4. Comparison of Nondefense Research and Development, Work for Others, and Site Support Activities for the Alternatives

Nondefense Research and Development Program			
Alternative 1	**Alternative 2**	**Alternative 3**	**Alternative 4**
- Establish Solar Enterprise Zone - Spill Test Facility - Alternate Fuel Demonstration Project (16 vehicles) - Technology Development (normal) - Environmental Research Park	- No Activity	- Establish Solar Enterprise Zone - Construct and Operate Solar Production Facilities - Spill Test Facility - Alternate Fuel Demonstration Project (16 vehicles plus fueling station) - Technology Development (expanded) - Environmental Research Park	- Establish Solar Enterprise Zone - Construct and Operate Solar Production Facilities - Spill Test Facility - Alternate Fuel Demonstration Project (16 vehicles) - Technology Development (expanded) - Environmental Research Park
Work for Others Program			
Alternative 1	**Alternative 2**	**Alternative 3**	**Alternative 4**
Treaty Verification - Threshold Test Ban Treaty - Peaceful Nuclear Explosion Treaty - Chemical Weapons Convention Treaty - Treaty on Open Skies **Nonproliferation Projects** **Counterproliferation Research and Development** - Dipole Hail - Big Explosives Experimental Facility - Cut and Cover **Conventional Weapons Demilitarization** **Nondefense Research and Development** - Conduct Munitions Research and Development - Training Exercises	- No Activity	**Increased activity levels for:** **Treaty Verification** - Threshold Test Ban Treaty - Peaceful Nuclear Explosion Treaty - Chemical Weapons Convention Treaty - Treaty on Open Skies **Nonproliferation Projects** **Counterproliferation Research and Development** - Dipole Hail - Big Explosives Experimental Facility - Cut and Cover **Conventional Weapons Demilitarization** **Nondefense Research and Development** - Conduct Munitions Research and Development - Training Exercises	**Treaty Verification** - Treaty on Open Skies No Activity - Increased Use of Airspace by DoD
Site Support Activities			
Alternative 1	**Alternative 2**	**Alternative 3**	**Alternative 4**
No change in: - Facilities - Services - Utilities - Communications	- Facilities (cold standby) - Services (minimal) - Utilities (minimal) - Communications (minimal) **Tonopah Test Range** - Maintain Site Support for Stockpile Stewardship	**Expand as necessary:** - Facilities - Services - Utilities - Communications	**Modify as Necessary:** - Facilities - Services - Utilities - Communications

of the land, geologic, and groundwater resources, making them unusable for most purposes. Formation of craters, surface subsidence, and the release of radioactivity into the environment have been the most significant impacts to the physical environment as a result of historical testing operations at the NTS. Pockets of radioactive contamination surround each expended underground test location. The quantity of radioactivity remaining in the subsurface media can be estimated, based on the half-life of the fission products. From data on the number and dates of the underground tests at the NTS, a total quantity of radioactivity remaining underground is estimated to be 3.0×10^8 curies (Ci). Much of this radioactivity, exclusive of tritium, remains captured in the original cavity, and thus is not available to leach into the groundwater.

The impacts of conducting subcritical experiments underground would be much less than those for nuclear testing since no self-sustaining fission chain reactions occur and much less radioactivity is deposited to the geologic environment. As in the case of nuclear testing, the radioactivity is captured underground.

Radioactively-contaminated surface areas on the NTS resulted primarily from atmospheric testing of nuclear weapons from 1951 to 1962. Additionally, safety tests conducted at the surface from 1954 to 1963 resulted in the radioactive contamination of the soil. More than 200 radiation-contaminated controlled areas have been identified and mapped on the NTS.

The DOE has established a monitoring program on and off the NTS to detect radionuclides in air and in groundwater. To date, no radioactive contamination attributable to DOE activities has been detected in monitoring wells off the NTS. Detection of significant contamination is limited to underground testing areas on the NTS. Potable supply wells on the NTS utilize quality groundwater, meeting Safe Drinking Water Act Standards.

In addition to the historic and ongoing monitoring, the DOE has developed groundwater models, which continue to be refined, for addressing the concerns for potential groundwater transport of radionuclides. Health effects to the public from subsurface radioactivity have been modeled, based on predictions of future tritium concentrations in well water, even though predicted concentrations are well below current regulatory limits. Any public exposure to elevated tritium concentrations resulting from underground nuclear testing would necessarily occur outside the boundaries of DOE/DoD controlled areas. Modeling results to date consistently indicate that any such tritium levels would be below the U.S. Environmental Protection Agency guidelines for drinking water. The most recent model results from the Nevada Environmental Restoration Program (GeoTrans, 1995) predict that no tritium above natural background levels would appear outside of NTS/NAFR Complex controlled areas. The earlier screening study by Daniels et al., (1993) predicts a tritium peak of 4000 pCi/L. Therefore, calculations of the lifetime dose to a maximally exposed member of the public in the uncontrolled area around the time of peak tritium concentration indicate a lifetime probability of contracting a fatal cancer between 8×10^{-13} (about one in one trillion) and 1×10^{-5} (about one in 100,000).

Waste Management. The incremental environmental impacts over baseline conditions from waste management activities under Alternatives 1 and 3 would be negligible. Under Alternative 3, some new facilities would create a slight increase beyond the impacts under Alternative 1. Under Alternatives 2 and 4, little change in impact would be seen over present conditions because most of the land clearing, waste transportation, and geologic disturbance have already occurred.

Waste management has been an integral part of the NTS operations since the establishment of the NTS in 1951. The environmental impacts related to the Waste Management Program are minor compared to those of the other programs. The issues related to waste management are waste transportation and protection of the hydrologic, geologic, and biologic resources. A summary of the issues and impacts related to these topics is presented.

Impacts from waste management activities are mostly a result of transportation of waste from other

sites to the NTS. The majority of the postulated injuries and fatalities would be a result of normal traffic accidents and not a result of exposure to the transported waste. Accident scenarios that involve release of radioactive waste were factored into the risk evaluation. The DOE is committed to continue working with stakeholders and the American Indian Sovereign Nations into the future as issues arise.

Low-level waste at the Area 3 Radioactive Waste Management Site is disposed of in subsidence craters formed from past underground nuclear tests. Underground nuclear detonations create underground cavities into which the overlying soil and rock above the cavity then collapse. The final result is a crater on the surface. The craters that are and would continue to be used at the Area 3 Radioactive Waste Management Site represent the unavoidable adverse impacts that resulted from past underground nuclear tests. Use of the craters for waste disposal is a beneficial use of lands that have been significantly and unavoidably impacted by past actions. These craters have significantly altered the topography and have significantly impacted the surface drainage. Emplacement of waste in the craters and subsequent engineered closure of the cells would return portions of the surface topography to a natural grade, help to partially restore drainage patterns, and prevent the downward migration of precipitation into the waste. Additionally, recent hydrologic data support the current conceptual hydrogeologic model that no groundwater pathway exists beneath the Area 3 UE3ax/bl disposal craters.

Waste Management Program operations in Area 5 are more diverse and include facilities for hazardous and mixed waste management in addition to low-level waste management facilities. After 30 years of waste disposal operations, groundwater monitoring in wells recently completed near the Area 5 Radioactive Waste Management Site has not detected any contamination. In addition, field studies conducted to support the performance assessment models, which include monitoring of soil moisture and chloride ion concentrations, indicate that water falling on the surface (precipitation) in Frenchman Flat does not reach the groundwater. These studies and the absence of contamination support the conclusion that no groundwater pathway exists beneath the Area 5 Radioactive Waste Management Site. Thus, no impact to groundwater from waste management operations would be expected to occur. Cultural resource surveys will be performed prior to construction or expansion of any facility.

The long-term effects of waste disposal operations have been evaluated as a part of the performance assessment process. Scenarios developed in the performance assessment process are used to evaluate the potential for public exposure to radionuclides from the disposed waste. These scenarios consider transport of radionuclides by surface water and groundwater, by air, and by human intrusion pathways. Preliminary results of the Area 5 Radioactive Waste Management Site Performance Assessment (Shott et al., 1995) indicate that the risk of potential exposure to the public from waste disposal activities through surface water is not significant. Based on results of field studies, the groundwater pathway and air pathways are not considered credible transport mechanisms.

The limiting scenarios identified in the Area 5 performance assessment are the inadvertent intruder scenarios, which are postulated to occur thousands of years in the future when areas previously used for waste disposal would be inadvertently mined or farmed. The significant exposure would result from a person living on the former waste disposal site consuming food and water (assumed to be contaminated) for a lifetime. The results of this very conservative approach to estimating exposure are then used to establish design, operation, closure, and waste acceptance criteria for the waste management facilities. The performance assessment is a continuous process used to improve the design and operation of DOE waste management facilities.

Environmental Restoration Program. Environmental restoration activities would continue at varying levels of intensity under all but Alternative 2. Approximately 10,000 acres of land would be disturbed during the restoration activities under Alternatives 1, 3 and 4. After the corrective action, which would be based on potential future land uses as determined through the

Federal Facility Agreement and Consent Order process, these lands would be available for uses which may range from unrestricted public uses to various levels of restriction. Under Alternative 2, the environmental restoration activities would cease. This would result in a condition of noncompliance with environmental requirements (i.e., the Resource Conservation and Recovery Act) and limit the future use of the land.

Nondefense Research and Development. Historic environmental impacts from this program have been minimal. The most significant impact from Nondefense Research and Development would occur under Alternatives 3 and 4 and would result from the siting and construction of a Solar Enterprise Zone facility. This facility would disturb over 2,000 acres of disturbed and undisturbed habitat and require 6.2 x 10^6 m^3/yr (5,000 acre feet/yr) of water and would provide a net positive increase in terms of jobs and economic stability.

Work for Others. The Work for Others Program under Alternatives 1 and 3 is similar to historic activities and not expected to have significant impacts. Under Alternative 2, the program is discontinued, and under Alternative 4, the program is minimal.

A comparison of the environmental impacts of the four alternatives is summarized by resource or issue in Table 3-5. The alternatives, as described in Section 3.1, are Alternative 1, Continue Current Operations (No Action Alternative); Alternative 2, Discontinue Operations; Alternative 3, Expanded Use; and, Alternative 4, Alternate Use of Withdrawn Lands.

3.4 American Indian Overview of Environmental Impacts

As part of the consultation with the Consolidated Group of Tribes and Organizations, summary assessments and recommendations were prepared by the American Indian Writers Subgroup. The DOE has taken these CGTO recommendations under consideration. This section provides a summary of each project and a general response by the CGTO that includes at least one recommended action.

This section contains the overall and integrated responses of the Consolidated Group of Tribes and Organizations (CGTO) to five categories of actions as contained in the (1) Defense Program, (2) Waste Management Program, (3) Environmental Restoration Program, (4) Nondefense Research and Development Program, and (5) Work for Others Program. The CGTO recommends that funding be provided so that American Indians can conduct systematic studies of waste management and environmental restoration activities, and develop an American Indian public education program for the NTS.

Defense Program. *The Defense Program involves actions that range from complying with the nuclear weapons test moratorium of 1992, that precludes new underground nuclear testing, to maintaining a state of readiness to resume nuclear tests if so instructed by the President or Congress. The CGTO believes that any future nuclear testing will continue to adversely impact American Indian cultural resources. Studies have shown that nuclear testing has caused rockshelters and petroglyph panels to be destroyed when the edges of rock outcrops break off due to ground vibrations generated by the test (Stoffle, et al., 1994). Studies have also shown that plants have been removed so that roads, power lines, drill pads, and water ponds can be built as part of constructing the underground test chambers. American Indians express the opinion that some plants have been polluted due to releases of radioactivity from underground tests. American Indians also express the opinion that some plants are dying or do not flourish because they are not being prayed for ("talked to") and used in a traditional manner by American Indian people. American Indian people express concern that future underground tests will continue to crack the earth, thereby releasing radioactivity into the large underground water systems who are themselves alive, as well as being a basis for all other life and a part of the earth itself. Many American Indian people indicated that they were emotionally and spiritually troubled by ground-disturbing activities and underground nuclear tests. Even in areas where American Indian studies have occurred, there have not been studies of petroglyphs, power places, or cultural landscapes. Some areas have not been studied at*

Table 3-5. Summary comparison of environmental impacts of the alternatives (Page 1 of 7)

Alternative 1	Alternative 2	Alternative 3	Alternative 4
Land Use, Site Support Activities, Airspace			
Minimal land-use impacts would occur from continuation of current operations. All land uses would be consistent with current site and zone designations. Because of the location of the sites analyzed, and because similar land uses generally would be located on the borders of the sites, surrounding land uses would not be affected by this alternative.	Surrounding land-use impacts would be the same as those listed under Alternative 1. Closure without environmental restoration would not meet requirements of federal and state laws and signed agreements and memorandums.	Surrounding land-use impacts would be the same as those listed under Alternative 1. There would be minimal land-use impacts on site from increased intensity of operations and land-use conditions. Land uses at the Tonopah Test Range, Project Shoal Area, and Central Nevada Test Area would be similar to Alternative 1. The new Solar Enterprise Zone facility could result in up to 2,402 acres of new land disturbance.	Potential public uses of relinquished NTS lands would be located in designated areas surrounded by buffer zones. Current defense-related designated areas would be redesignated for nondefense activities. Land uses at the Tonopah Test Range, Project Shoal Area, and Central Nevada Test Area would be similar to those listed under Alternative 1. New Solar Enterprise Zone facility activities could occur at the NTS, Eldorado Valley, Dry Lake Valley, or Coyote Spring Valley; these activities would be compatible with existing land uses. Surrounding land-use impacts would be the same as those listed under Alternative 1. Land-use designations and zones would be incompatible with existing designations and zones.
Site support activities would continue at current levels. Airspace activities would be maintained at the current level of air traffic, navigational aid services, and airspace structure.	Site support activities would decrease and facilities would be closed. The NTS and Tonopah Test Range would experience reduced flight operations; otherwise, there would be no impacts to airspace.	Site support activities and structures would be modified and expanded, as needed. Impacts to NTS airspace would be the same as those listed under Alternative 1. Minimal impacts would be experienced at the Tonopah Test Range, Central Nevada Test Area, Project Shoal Area, Eldorado Valley, Dry Lake Valley, and Coyote Spring Valley.	Site support activities would be reduced and facilities would be closed. Airspace impacts would be the same as those listed under Alternative 1.
Land Disturbance[a]			
10,000 acres	0 acres	21,000 acres	15,500 acres

[a]The total amount of land currently disturbed on the NTS is approximately 60,000 acres. Numbers shown represent additional estimated disturbed acreage under each alternative after 10 years (acres to be reclaimed are not included).

Table 3-5. Summary comparison of environmental impacts of the alternatives (Page 2 of 7)

Alternative 1	Alternative 2	Alternative 3	Alternative 4
Transportation (On-site, Off-site, Transportation of Materials and Waste, Other Transportation)			
Minimal on-site impacts would exist at the NTS, Tonopah Test Range, Project Shoal Area, and Central Nevada Test Area. The NTS would average 3,370 trips per day. This would not change the level of service on affected highways and roads.	A total of 60 one-way vehicle trips per day would occur on the site. This would not change the level of service on affected highways and roads.	A total of 16,310 on-site vehicle trips per day are estimated under this alternative. No roadway would experience any significant traffic congestion. All key NTS roadways would have a capacity exceeding 2,000 vehicles per hour. Minimal impacts would be felt at the Tonopah Test Range, Project Shoal Area, Central Nevada Test Area, Eldorado Valley, Dry Lake Valley, and Coyote Spring Valley.	A total of 12,180 on-site vehicle trips per day are estimated. No roadway would experience any significant traffic congestion. All key NTS roadways have a capacity exceeding 2,000 vehicles per hour. Minimal impacts would be experienced at the Tonopah Test Range, Project Shoal Area, Central Nevada Test Area, Eldorado Valley, Dry Lake Valley, and Coyote Spring Valley.
A total of 1,480 one-way vehicle trips per day would occur off site by 2005. All key roads in the vicinity of the site would continue to operate at level of service C or better. However, while NTS-generated traffic would be relatively minimal, segments of I-15, U.S. Hwy. 95, and U.S. Hwy. 93 within metropolitan Las Vegas could deteriorate to unacceptable levels of service by 2000 because of cumulative traffic growth without state and local governmental transportation improvement projects. Minimal impacts to off-site traffic would be experienced at the Tonopah Test Range, Central Nevada Test Area, and Project Shoal Area.	A decrease over Alternative 1 of 1,480 one-way vehicle trips per day would occur off site by 2005. All key roads in the vicinity of the site would continue to operate at level of service C or better.	An increase over Alternative 1 of 1,030 one-way vehicle trips off site per day would occur by 2005. Most key roads in the vicinity of the site would continue to operate at level of service C or better. While the NTS-generated traffic would be relatively minimal, segments of I-15, U.S. Hwy. 95, and U.S. Hwy. 93 within metropolitan Las Vegas could deterinrate to unacceptable levels of service by 2000 because of cumulative traffic growth without state and local governmental transportation improvement projects.	A decrease from Alternative 1 of 610 one-way vehicle trips off site per day would be experienced by 2005. All key roads in the vicinity of the site would continue to operate at level of service C or better. However, while the NTS-generated traffic would be relatively minimal, segments of I-15, U.S. Hwy. 95, and U.S. Hwy. 93 within metropolitan Las Vegas could deteriorate to unacceptable levels of service by 2000 because of cumulative traffic growth without state and local governmental transportation improvement projects.
Approximately 350,000 m^3 (457,783 yd^3) of low-level waste and 50,000 m^3 (65,398 yd^3) of mixed waste would be generated on and off the site in a 10-year period.	Minimal generation of materials and waste would occur under Alternative 2.	Approximately 100,000 m^3 (130,795 yd^3) low-level waste and 300,500 m^3 (393,039 yd^3) of mixed waste would be generated on and off the site in a 10-year period.	Approximately150,000 m^3 (196,193 yd^3) of low-level waste and 500 m^3 (654 yd^3) of mixed waste would be generated on and off the site in a 10-year period.
Transportation risks along the entire route for low-level radioactive and mixed waste during the 10-year study period from vehicular accidents is expected to be 2 fatalities and 27 injuries. Latent cancer fatalities associated with this level of radioactive waste transport for the 10-year study period would be 0.0025. There would be no impact on direct use of local railroads, air transportation, or other modes of transportation.	There would be no impact on direct use of local railroads, air transportation, or other modes of transportation.	Risks associated with transporting radioactive waste would increase to 8 vehicle-related fatalities, 103 injuries, and 0.075 latent cancer fatality over the 10-year period of study. Minimal impacts would occur on direct use of local railroads, air transportation, or other modes of transportation.	No off-site transportation of radioactive materials and waste would occur. There would be minimal impacts on direct use of local railroads, air transportation, or other modes of transportation.

Table 3-5. Summary comparison of environmental impacts of the alternatives (Page 3 of 7)

Alternative 1	Alternative 2	Alternative 3	Alternative 4
Socioeconomics (Economic Activity, Population, and Housing)			
Total direct employment would be approximately 6,600 in 2005. Unemployment rate: Clark County, 5.8% Nye County, 5.2%. Total personal income in 2005: Clark County, $32,280,885,000 Nye County, $780,701,000. Population in 2005: Clark County, 1,380,920 Nye County, 38,516. Housing demand in 2005: Clark County, 539,422 Nye County, 14,435	A decrease from Alternative 1 of 6,490 direct jobs in 2005 would occur under Alternative 2. Unemployment rate increase over Alternative 1 in 2005: Clark County, +1.9% Nye County, +2.5%. Total personal income decrease in 2005 from Alternative 1: Clark County, ($884,676,000) Nye County, ($44,609,000). Population decrease from Alternative 1 in 2005: Clark County, -7,946 Nye County, -583. Housing demand decrease from Alternative 1 in 2005: Clark County, -2,928 Nye County, -218.	An increase over Alternative 1 of approximately 4,550 direct jobs in 2005 would occur under Alternative 3. Unemployment rate decrease from Alternative 1 in 2005: Clark County, -1.1% Nye County, -0.05%. Total personal income increase in 2005 over Alternative 1: Clark County, +$632,638,000 Nye County, +$31,457,000. Population increase over Alternative 1 in 2005: Clark County, +10,020 Nye County, +656. Housing demand increase over Alternative 1 in 2005: Clark County, +3,914 Nye County, +246.	A decrease from Alternative 1 of approximately 2,750 direct jobs in 2005 would occur under Alternative 4. Unemployment rate increase over Alternative 1 in 2005: Clark County, +1.1% Nye County, +1.7%. Total personal income decrease in 2005 from Alternative 1: Clark County, ($374,608,000) Nye County, ($18,833,000). No substantial employment level would be triggered; therefore, population and housing demand would not change when compared to Alternative 1.
Geology and Soils			
Testing impacts would include ground motion hazards and secondary seismic effects, soil contamination, alteration of natural drainage paths, and decreased surface stability. Impacts from other activities would include dust creation, soil contamination, and an increase in erosion potential. There would be minimal impacts at the Tonopah Test Range, Project Shoal Area, and Central Nevada Test Area.	Discontinuing operations would result in no additional impacts to geology and soils. However, the media that have been contaminated or altered by underground nuclear test would as in alternatives remain unavailable for unrestricted use. No surface areas contaminated by past activities would be remediated and any present access restrictions based on contamination would continue.	Impacts would be the same as those listed under Alternative 1. Minimal impacts would be experienced at the Tonopah Test Range, Project Shoal Area, Central Nevada Test Area, Eldorado Valley, Dry Lake Valley, and Coyote Spring Valley.	Impacts would include dust creation, soil contamination, and an increase in erosion potential. Minimal impacts would occur at the Tonopah Test Range, Project Shoal Area, Central Nevada Test Area, Eldorado Valley, Dry Lake Valley, and Coyote Spring Valley.

Table 3-5. Summary comparison of environmental impacts of the alternatives (Page 4 of 7)

Alternative 1	Alternative 2	Alternative 3	Alternative 4
Hydrology (Surface Hydrology and Groundwater)			
There would be minimal potential impact from the alteration of existing drainage paths caused by testing.	There would be no new impacts to surface hydrology.	There would be minimal potential impacts from alteration of natural drainage paths caused by new construction.	There would be minimal potential impacts from alteration of natural drainage paths caused by new construction.
Total effects from continuing groundwater withdrawals are expected to be minor. Local effects to the Yucca Flat Basin could be substantial if the annual water demand exceeds the basin's perennial yield.	Water demand would be reduced to that required for environmental monitoring and for potable water for the caretaker workforce.	Because of new program activities other potential impacts would be increased slightly over those listed under Alternative 1. However, the Solar Enterprise Zone has been estimated to require up to 6.8 x 10^6 m^3/yr (5,550 ac-ft/yr) of water. Local effects to the affected basin such as those near Dry Lake Valley could be substantial if the annual water demand exceeds the perennial yield of the basin. Increased waste quantities would not result in impacts.	Other potential impacts generally would be the same as those listed under Alternative 1 except at a decreased level. However, the Solar Enterprise Zone has been estimated to require up to 6.8 x 10^6 m^3/yr (5,550 ac-ft/yr) of water. Local effects to the affected basin such as those near Dry Lake Valley could be substantial if the annual water demand were to exceed the perennial yield of the basin.
There could be localized impacts related to underground tests conducted under or near the water table. Monitoring has revealed few instances of migration of radionuclides beyond the near test environment. No impacts are anticipated from waste management activities. Other potential quality impacts would be minimal. Minimal impacts would occur at the Tonopah Test Range, Project Shoal Area, and Central Nevada Test Area.	Contaminated areas would not be restored, resulting in continued possibility of groundwater contamination.	Minimal impacts would be experienced at the Tonopah Test Range, Project Shoal Area, Central Nevada Test Area, Eldorado Valley, Dry Lake Valley, and Coyote Spring Valley.	Minimal impacts are expected at the Tonopah Test Range, Project Shoal Area, Central Nevada Test Area, Eldorado Valley, Dry Lake Valley, and Coyote Spring Valley.
Biological Resources			
Approximately 7,360 acres of generally undisturbed habitat would be disturbed, primarily in support of the Environmental Restoration Program at the NTS, Tonopah Test Range, and Central Nevada Test Area. This would represent approximately 1 percent of total undisturbed habitat in these areas. There would be minimal impact to desert tortoise population viability and on biodiversity or ecosystem functions.	There would be no effect on undisturbed natural habitat. Discontinuation of man-made water sources would change the distribution of horses, deer, and chukar. However, there would be no sitewide ecosystem impacts.	Approximately 10,420 acres of generally undisturbed habitat would be disturbed, primarily in support of the Environmental Restoration Program at the NTS, Tonopah Test Range, Project Shoal Area, and Central Nevada Test Area. This would represent an increase of 3,060 acres over Alternative 1. A portion of this area (3,015 acres) could be desert tortoise habitat. The Solar Enterprise Zone could minimally impact biodiversity or ecosystem functions at Eldorado Valley, Dry Lake Valley, and Coyote Spring Valley. Coyote Spring Valley lies within critical habitat for the desert tortoise.	Approximately 9,275 acres of generally undisturbed habitat would be disturbed, primarily for the Environmental Restoration Program and the Solar Enterprise Zone at NTS. The NTS, Tonopah Test Range, Central Nevada Test Area, and Project Shoal Area impacts would generally be the same as those listed under Alternative 1. The Solar Enterprise Zone could minimally impact biodiversity or ecosystem functions at all sites and areas. Coyote Spring Valley lies within critical habitat for the desert tortoise.

Table 3-5. Summary comparison of environmental impacts of the alternatives (Page 5 of 7)

Alternative 1	Alternative 2	Alternative 3	Alternative 4
Air Quality and Radiological Air Quality			
Pollutant emissions from stationary and mobile sources would be generated on site and off site. These emissions would be dispersed over a wide area. No major air emission sources are planned. Pollutant concentrations related to NTS activities would be well below ambient air quality standards. No substantial increases in air pollution are expected by 2005 and Nye County would continue its prevent attainment designation for all criteria pollutants. No additional violations of air quality standards would be provided in the nonattainment area of Clark County. The region is expected to conform with the applicable State Implementation Plan for all National Ambient Air Quality Standards (NAAQS). Radiological air quality impacts would not reach the maximum CAP-88 air dose assessment modeled dose. Impacts would be minimal.	Pollutant emissions associated with stationary sources would be essentially eliminated following discontinuance of operations, and mobile source emissions would be substantially reduced. Radiological air quality impacts would be the same as those listed under Alternative 1.	Impacts would be the same as those listed under Alternative 1. Pollutant concentrations related to NTS activities, though higher than the Alternative 1, would remain below ambient air quality standards. Selected values for two pollutants of concern are PM_{10}: 600 tons/ year; less than one percent of regional burden. CO_2 : 224 tons/year of which 90 tons/year would be in the Las Vegas Valley; less than 0.2 percent of Clark County emissions.	Impacts would be the same as those listed under Alternative 1. Pollutant concentrations related to NTS activities would be lower than those of Alternative 1. All pollutants would remain below ambient air quality standards.
Noise			
Transportation noise levels on site would be minimal and would not produce any noise impacts off site. Temporary noise impacts from construction-related noise would occur within the immediate vicinity of construction sites. Noise impacts would be negligible because the sites are located within remote areas. No sensitive receptors are close to construction areas. Noise from other activities would decrease with distance and would be barely distinguishable from background noise levels.	A minor amount of noise would result from operations vehicles. Other noise levels would be a result of noises typically found in uninhabited desert areas.	Impacts would be the same as those listed under Alternative 1.	Impacts would be the same as those listed under Alternative 1, except for the Defense Program, which would have the same impacts as Alternative 2.
Visual Resources			
New land disturbance would be located in areas of scenic quality common to the region, but none would be visible from any public viewpoints. Although there would be short-term, local adverse effects because of environmental restoration, there would be long-term beneficial effects because of revegetation.	There would be little change in the overall appearance of the existing landscape.	Most new land disturbance would be located in areas of scenic quality common to the region. However, the areas proposed for the Solar Enterprise Zone facility in Eldorado Valley, Dry Lake Valley, or Coyote Spring Valley have a high visual sensitivity because they cross major highways. Furthermore, Coyote Spring Valley has extensive panoramic views of linear mountain ranges and valleys.	There would be slight changes in the overall appearance of the existing landscape. New ground disturbance would be located in areas of scenic quality common to the region, but none of these areas would be visible from any public viewpoints. The impacts of the Solar Enterprise Zone would be the same as those listed under Alternative 3.

Table 3-5. Summary comparison of environmental impacts of the alternatives (Page 6 of 7)

Alternative 1	Alternative 2	Alternative 3	Alternative 4
Cultural Resources			
There would be impacts to cultural resources as a result of ground disturbing activities resulting from construction of new facilities, utilities, road upgrades, and decommissioning of existing buildings. Continued visitation and vehicular traffic could indirectly affect recorded archaeological sites and archaeologically sensitive areas. The precise location of these resources is unknown until archaeological survey is conducted. Surveys will be conducted prior to any ground disturbing activities. Modification of existing buildings would include an evaluation of their historic significance, especially in relation to Cold War/nuclear development themes, to minimize impacts. According to the CGTO, under Alternative 1, access to American Indian culturally significant places would continue to be reduced. The potential would exist for unauthorized artifact collection and culturally inappropriate environmental restoration techniques.	Discontinuance of activities would eliminate most impacts to cultural resources. The degree of impact to American Indian cultural sites, as stated by the CGTO, would be less than that associated with Alternative 1.	The amount of acreage disturbed as a result of activities described for Alternative 3 would double as compared to Alternative 1. Approximately 20,930 acres of ground disturbance are anticipated. Construction of new facilities, wells, utilities roads, and burial of contaminated soils may affect cultural resources. Large-scale activities associated with the Solar Enterprise Zone facility could affect cultural resources. Modification of existing buildings would include an evaluation of their historic significance, especially in relation to Cold War/nuclear development themes, to minimize impacts. According to the CGTO, under Alternative 3, access to American Indian culturally significant places would continue to be reduced. Increased visits by students and researchers who collect artifacts, visit sacred areas, and remove plants or animals, and the scraping of land would affect American Indian cultural resources.	Most impacts would be the same as those listed under Alternative 3. Access impacts, according to the CGTO, for American Indians would be less than that experienced under Alternative 1. However, the potential for unauthorized artifact collection would be increased from Alternative 1 because of increased public access.
Land Use Land Zone Areas			
1. Nuclear Test Zone (includes Areas 19 and 20) - 1,120 km^2 (435 mi^2) 2. Nuclear and High Explosive Zone - 180 km^2 (70 mi^2) 3. Research, Test, and Experiment Zone - 45 km^2 (20 mi^2) 4. Radioactive Waste Management Zone - 5 km^2 (2 mi^2) 5. Yucca Mountain Site Characterization Zone (within NTS boundary) - 225 km^2 (90 mi^2) 6. Critical Assembly Zone - 130 km^2 (50 mi^2) 7. Spill Test Impact Zone (within NTS boundary - 15 km^2 (5 mi^2) 8. Reserved Zones on NTS (within NTS boundary) - 1,775 km^2 (685 mi^2)	1. Yucca Mountain Site Characterization Zone (within NTS boundary) 225 km^2 (87 mi^2) 2. Monitored/Restricted Zone (within NTS boundary) - 3,255 km^2 (1,260 mi^2)	1. Nuclear Test Zone (includes Areas 19) - 705 km^2 (275 mi^2) 2. Nuclear and High Explosive Zone - 381 km^2 (147 mi^2) 3. Research, Test, and Experiment Zone - 575 km^2 (222 mi^2) 4. Radioactive Waste Management Zone - 5 km^2 (2 mi^2) 5. Yucca Mountain Site Characterization Zone (within NTS boundary) - 225 km^2 (90 mi^2) 6. Solar Enterprise Zone - 34 km^2 (13 mi^2) 7. Spill Test Impact Zone (within NTS boundary - 15 km^2 (5 mi^2) 8. Defense Industrial Zone - 170 km^2 (65 mi^2) 9. Reserved Zones on NTS (within NTS boundary) - 1,375 km^2 (530 mi^2)	1. Non-Defense Research/Development/Testing Zone (includes Areas 19 and 20) - 1,295 km^2 (500 mi^2) 2. Radioactive Waste Management Zone - 5 km^2 (2 mi^2) 3. Yucca Mountain Site Characterization Zone (within NTS boundary) - 225 km^2 (90 mi^2) 4. Solar Enterprise Zone - 35 km^2 (13 mi^2) 5. Spill Test Impact Zone (within NTS boundary) - 15 km^2 (5 mi^2) 6. Reserved Zones (within NTS boundary) - 1,310 km^2 (505 mi^2) 7. Potential Turnback Area (includes Area 22 Solar Enterprise Zone) - 610 km^2 (235 mi^2)

NOTE: CGTO = Consolidated Group of Tribes and Organizations.

Table 3-5. Summary comparison of environmental impacts of the alternatives (Page 7 of 7)

Alternative 1	Alternative 2	Alternative 3	Alternative 4
Occupational and Public Health and Safety (Routine and Accident Operations)			
The health impacts to workers due to occupational exposure and accidents could result in a probability of 1 in 8 of a single latent cancer fatality and 1 in 21 of a single other detrimental health effect in the worker population. The risk of life-threatening noncarcinogenic effects on workers involved with an accidental release of hazardous chemicals has a hazard index of 0.58.	The health impacts to workers due to occupational exposure and accidents could result in a probability of 1 in 47 of a single latent cancer fatality and 1 in 120 of any other detrimental health effect in the worker population. The risk of life-threatening noncarcinogenic effects on workers involved with an accidental release of hazardous chemicals has a hazard index of 0.48.	The health impacts to workers due to occupational exposure and accidents could result in a probability of 1 in 8 of a single latent cancer fatality and 1 in 20 of any other detrimental health effect in the worker population. The risk of life-threatening noncarcinogenic effects on workers involved with an accidental release of hazardous chemicals has a hazard index of 2.4.	The health impacts to workers due to occupational exposure and accidents could result in a probability of 1 in 13 of a single latent cancer fatality and in 1 in 30 of any other detrimental health effect in the worker population. The risk of life-threatening noncarcinogenic effects of workers involved with an accidental release of hazardous chemicals has a hazard index of 0.58.
Health impacts to the public from accidental release of radionuclides could result in a probability of 1 in 18,000 of a single latent cancer fatality and 1 in 40,000 of any other detrimental health effect in the population within 50 miles. Potential public exposure to accident release of hazardous chemicals could result in a probability of 1 in 4,000 of a single incidence of cancer in the population. No noncarcinogenic detrimental health effects are expected.	Health impacts to the public from accidental release of radionuclides could result in a probability of 1 in 20,000 of single latent cancer fatality and 1 in 50,000 of any other detrimental health effect in the population within 50 miles. Potential public exposure to accidental release of hazardous chemicals could result in probability of 1 in 50,000 of a single incidence of cancer in the population. No noncarcinogenic detrimental health effects are expected.	Health impacts to the public from accidental release of radionuclides could result in a probability of 1 in 18,000 of a single latent cancer fatality and 1 in 40,000 of any other detrimental health effect in the population within 50 miles. Potential public exposure to accidental release of hazardous chemicals could result in a probability of 1 in 4,000 of a single incidence of cancer in the population. No noncarcinogenic detrimental health effects are expected.	Health impacts to the public from accidental release of radionuclides could result in a probability of 1 in 20,000 of a single latent cancer fatality and 1 in 43,000 of a single other detrimental health effect in the population within 50 miles. Potential public exposure to accidental release of hazardous chemicals could result in a probability of 1 in 4,000 of a single incidence of cancer in the population. No noncarcinogenic detrimental health effects are expected.
Potential accidental venting of radionuclides from an underground test could result in a probability of 1 in 180 of a single latent cancer fatality and 1 in 400 of any other detrimental health effect in the population within 50 miles.		Potential accidental venting of radionuclides from an underground test could result in a probability of 1 in 180 of a single latent cancer fatality and 1 in 400 of a single other detrimental health effect in the population within 50 miles.	
The maximum reasonably foreseeable radiological accident has a probability of 1 in 10 million years and involves a non-nuclear explosion in a nuclear weapons storage bunker at Area 27. This accident could result in public impacts of 3 to 55 latent cancer fatalities and 1 to 25 other detrimental health effects.	The maximum reasonably foreseeable radiological accident has a probability of 1 in 10 million years and involves a failure of an artillery-fired test assembly at the Tonopah Test Range. This accident would result in only small fractional increases in the probability of latent cancer fatality or other detrimental health effects in the offsite population.	The maximum reasonably foreseeable radiological and chemical accidents are the same as for Alternative 1.	The maximum reasonably foreseeable radiological accident has a probability of 1 in 2 million years and involves an airplane crash into the Area 5 transuranic waste storage unit. This accident could result in public impacts of 1 to 13 latent cancer fatalities and 0 to 6 other detrimental health effects.
The maximum reasonably foreseeable chemical accident has a probability of 1 in 10 million years and involves an airplane crash into the Spill Test Facility. This accident could result in 0 to 3 latent cancers in the offsite population, but no noncancer health effects would be expected.	The maximum reasonably foreseeable chemical accident has a probability of 1 in 13,000 years and involves a multi-container fire at the Area 5 hazardous waste storage unit. This accident would result in only small fractional increases in the probability of latent cancer in the offsite population, and no noncancer health effects would be expected.		The maximum reasonably foreseeable chemical accident is the same as for Alternative 1.
Environmental Justice			
American Indian impacts would only consider American Indian groups and would, therefore, be disproportionately high according to the CGTO's method of defining impacts.	Impacts would be the same as those listed under Alternative 1.	Impacts would be the same as those listed under Alternative 1.	Impacts would be the same as those listed under Alternative 1.

all. It is not possible to completely assess the potential impacts of future underground tests on these cultural resources.

Another major component of the Defense Program involves expanding stockpile management responsibility, storage and disposal of weapons-useable fissile materials, and counterproliferation research and development. The CGTO believes American Indians lack sufficient information and understanding of these issues to make a complete assessment of their impacts on cultural resources. Some observations can be made at this time. The NTS is a holy area that is central to these American Indian people. In general, the more fearful activities that occur here and the more ground disturbance that occurs, the more cultural risks will be involved if American Indian people use these lands. The more such activities occur on these lands, the longer and more difficult it will be to restore these lands to their natural condition.

Waste Management Program. *The storage of low-level and mixed waste generated by the DOE will be an ongoing responsibility regardless of which EIS alternative is selected. This program minimally involves the storage of existing waste and waste generated during the environmental restoration of NTS lands. Under Alternative 3, waste could be received from any DOE-approved facility, which would cause current NTS waste disposal locations to be filled and new waste facilities to be sited and operated. American Indian people hold both traditional and scientific views of radioactivity. The former builds on the view that rocks are alive; radioactive rocks are powerful, but they can become "angry rocks" if they are removed without proper ceremony, used in a culturally inappropriate way, disposed of without ceremony, and placed where they don't want to be (Stoffle, et al., 1989; Stoffle, et al., 1990). Another issue is the ethics of agreeing to receive radioactive waste from other Native American lands so those people can live without fear of radioactivity (see Project Chariot, DOE/NV, 1994). In general, after properly removed rocks have been used, they are either returned to their place of origin or to a place of cultural significance. The practice of dealing with "bad medicine" or neutralizing negative forces was a part of the traditional culture. So, the question of "how to dispose of radioactive waste in a culturally appropriate manner" could be resolved if the time and resources were provided for American Indian people to participate in a formal study of this issue. American Indian people have not studied the cultural impacts of siting any of the existing waste facilities. So, American Indian people would like to become a part of a retrospective assessment of these facilities, as well as to participate in the assessment of siting all new waste facilities.*

Environmental Restoration Program. *The Environmental Restoration Program involves actions that would return disturbed land to its natural condition. Up to 1,800 monitoring wells and access roads are a part of this effort. All alternatives involve some environmental restoration and monitoring; however, Alternative 3 would require more restoration because it would disturb more land. American Indian people believe that the natural condition of the land existed before 1492 when the Europeans arrived. The land was in a natural condition when it was managed and used by American Indian people. For example, American Indian plant management techniques involved spiritual interactions like praying and conducting ceremonies for the plants, as well as physical actions like selective burning, transplanting cuttings and seeds, pruning of plants like Tumar (Stanleyappinnata) and willow, and "whipping" pine nut trees to make them fuller. American Indian water management techniques involved spiritual interactions that satisfied the water and its occupants like Water Babies, who need to know why American Indian people are using the water. Water ceremonies assured both rain and snowfall, for example, by praying for a continued relationship between wet snow and the little black bugs who are responsible for making the snow become wet. Generally, American Indian people managed the land according to religious teachings. From the American Indian perspective, environmental restoration should proceed according to American Indian culture and with the participation of American Indian people.*

Nondefense Research and Development Program. *There is a variety of planned actions considered within this category. Many of these are related to*

the National Environmental Research Park, which permits universities and other federal agencies to conduct research. Other projects involve testing alternative vehicle fuels, testing techniques for handling chemical spills, and building alternative energy generators like solar collectors. American Indian people view each of these as potentially impacting cultural resources. More cars potentially endanger the desert tortoises. University students studying biology may find and collect arrowheads or remove plants that are significant to American Indian people. Solar collectors involve scraping the land. American Indian people believe they should be involved in assessing the impacts of all these proposed actions.

Only American Indian people know which places are appropriate for visits by non-Indian people and how to collect plants, animals, and soil samples so they do not disrupt the land and its associated spirituality. Only American Indian people can provide guidance for proper behavior; however, a guidance document has not been collectively produced and approved by the CGTO. On the other hand, with proper guidance by American Indian people, university students and other members of the public may learn about the beauty and cultural significance of these lands and begin to change national perceptions of these lands from one as a wasteland to one as an American Indian holy land.

Work for Others Program. *This program contains two major subcategories of activities: the Conventional Weapons Demilitarization Program and Defense-related Research and Development Program. The first program involves the shipment, storage, disposal, and destruction of conventional weapons. The second program involves military training exercises and weaponry tests.*

The CGTO, in principle, approves of the Conventional Weapons Demilitarization Program, because world peace will reduce the need to use the NTS for nuclear weapon production, storage, assembly, and testing. On the other hand, the CGTO believes that if the NTS becomes the place where most or all weapons are stored, disassembled, and disposed, then the NTS lands will be polluted. The presence of conventional and nuclear weapons defines the NTS as a place of destruction, which promotes an image that is inappropriate for a place for peaceful relations between American Indian ethnic groups.

The CGTO knows from past experience, but not formal study, that military training exercises and weaponry tests can adversely impact cultural resources. Military people move across the land on foot and in vehicles without either the time or the purpose to pay attention to the plants that are being crushed, the animals that are being dislocated, or the archaeology materials underfoot. Cultural resources are damaged when conventional weapons are fired nearby. Often, geographically distinctive power places, like the big white rock near Rattlesnake Ridge, are targeted without regard or knowledge of their cultural significance. Without a formal study, the exact impacts of military training exercises will not be fully understood.

3.5 Summary of American Indian Responses to the NTS Action Alternatives

The response of the CGTO to the four alternatives proposed for NTS and discussed site-by-site in the previous paragraphs can be summarized as follows:

Alternative 1: Continue Current Operations. *Under this alternative, the DOE will continue with its current operations and interagency project activities in each of the programs listed above. There will be little or no change planned for the future mission of NTS. To this effect, the CGTO opposes Alternative 1 because of our strong cultural ties to the land. NTS operations have adversely impacted the land, causing irreparable damage to traditional resources. If NTS operations continue, it is expected that damage will be increased and more land will be wasted. Access to culturally significant spiritual places and use of animals, plants, water, and lands may cease because Indian people's perception of health and spiritual risks will increase if nuclear weapon testing, assembly, storage, disassembly, and disposal continues. Nondefense programs are expected to cause adverse impacts if these produce*

more ground disturbance or if they bring people who trample and destroy traditional resources.

Alternative 2: Discontinue Operations and Decommission. *Under this alternative, all current and planned programs, activities, and operations would be discontinued. Only activities conducted in support of decommissioning, radiation monitoring, and security functions necessary for human health, safety, and security would be maintained. Environmental restoration would not be done. All defense and nondefense programs would be discontinued. Inactive waste disposal sites would be abandoned. Only a minimum of low-level radioactive and mixed waste disposal capacity would be maintained to support closure of the NTS.*

The CGTO supports Alternative 2 because it would allow the land to heal and perhaps return to its natural condition. The CGTO recommends that an evaluation of areas that can be restored for human use be made and that environmental restoration activities be included in this alternative. Access to culturally significant places should be allowed. The DOE should continue to protect all cultural resource sites.

Alternative 3: Expanded Use. *Under this alternative, expanded use of the NTS and its resources would be made to support national programs for both defense and nondefense. Current defense programs would continue, and a variety of defense-related projects currently under consideration would be pursued. Waste management operations would increase and storage/disposal areas expanded. Waste transportation would be increased as well. Environmental restoration and research and development activities would continue and expand. A solar-energy production facility would be built.*

The CGTO opposes Alternative 3 because of our strong cultural ties to the land. Under expanded use, it is expected that the continuation and expansion of current operations as well as the implementation of additional defense and nondefense project activities and programs would irreparably damage American Indian cultural resources present at the NTS. Expansion of NTS operations would conceivably require use of land that is yet untouched, and would worsen the risk of radioactive contamination. Potentially, Native American access to resources and sacred sites would be even more restricted. Expanded use would be detrimental for the socioeconomic development and health of Indian communities.

Alternative 4: Alternate Use of Withdrawn Lands. *This alternative will evaluate the impacts associated with locating new programs and project activities at the NTS, including nondefense research and development programs, expansion of the liquefied gaseous fuel spill test facility in Area 5, and various types of personnel training for locating, containing, handling, or transporting hazardous material, radioisotopes, fuels, explosives, and other material. Under this alternative, waste management operations, waste-generating operations, and ongoing NTS environmental restoration activities would continue. However, the DOE would not maintain a state of readiness for nuclear testing at the NTS. The NTS would be opened for unprecedented public access to some of the most remote areas, including areas that contain American Indian rock shelters, archaeological sites, and petroglyphs. Education and recreational activities would be pursued. The potential for turning back lands to the public domain would depend upon the ability to achieve established clean up and safety levels.*

The CGTO tentatively supports Alternative 4 with reservations regarding certain components of this alternative. Aside from the concerns already expressed regarding waste-related pollution and ground disturbance, the CGTO expects that opening the NTS to the public will adversely impact traditional resources, particularly petroglyphs, archaeological sites, and rock shelters, because of their appeal as tourist attractions. Heavy traffic will trample plants, hurt animals, limit American Indian access to sacred sites and power places, and interfere with traditional practices.

The CGTO would like to have the right of first refusal in the event that the NTS lands are turned back to public use.

3.6 Identification of the Preferred Alternative

The DOE Preferred Alternative is Alternative 3, Expanded Use, plus the public education activities from Alternative 4. The Expanded Use Alternative represents a continuation of the multipurpose, multi-program use of the site, and further represents a continuation and diversification of the DOE/NV and interagency programs and operations at the NTS. The Expanded Use Alternative includes support for ongoing DOE/NV program categories defined in Alternative 1, Continue Current Operations (No Action), and also provides for increased use of the NTS and its resources and capabilities. This alternative would also make the NTS more available to both public and private institutions for purposes of demonstrating new technologies.

Public education activities from Alternative 4 include establishing educational tour routes on the NTS and promoting the concept of creating a nuclear era museum that highlights the NTS testing activities. Tours would allow the public to see firsthand some of the history and impacts of past nuclear testing. These activities would be an important contribution to public understanding of the nation's nuclear testing and Cold War history.

The Draft NTS EIS pointed out that the use the DOE ultimately selected as the Preferred Alternative might not be a single NTS EIS alternative in its entirety, but rather a hybrid created by selecting specific options from among the various alternatives described. This approach was the starting point in the process of identifying the Preferred Alternative. Initially, the universe of activities included under any of the alternatives, by program, were combined and subjected to a process of elimination. This Preferred Alternative identification process began concurrently with the public hearings on the Draft EIS and continued through the comment response process and review of the Final NTS EIS.

The criteria used for eliminating various activities from the combined alternatives were: inconsistency with strategic planning, failure to fulfill statutory mission responsibilities, public concern and perceptions, incompatibility of uses, and consideration of pending programmatic analyses and decisions. Appendix A, *Descriptions of Projects and Activities*, was used extensively in this process for detailed descriptive information. The result of this process was the identification of Alternative 3, Expanded Use, as the most comprehensive alternative in terms of supporting statutory mission responsibilities and providing for a diversification of use to include nondefense, interagency, public and private uses. The Expanded Use Alternative was generically identified in the original Notice of Intent for the NTS EIS; however, the specific nature of the Expanded Use Alternative was not fully realized, nor was its comprehensiveness appreciated by the DOE, until this systematic process was applied.

The Preferred Alternative identification process also led to better programmatic definition of the alternatives in general. In the case of potential activities resulting from other DOE Programmatic EISs, Alternative 3 now states clearly that the specific action contemplated under this alternative is to reserve land and infrastructure pending a programmatic decision. This realistically identifies the nature of the decisions to be made based on the NTS EIS with respect to activities that are currently under programmatic review. Other clarifications include the description of potential public uses of NTS lands in Alternative 4. This concept, in the Draft NTS EIS, was incorrectly described as limited to potential uses of relinquished NTS lands. However, the lands analyzed for potential return to the public were not the only lands on which public education or recreation activities could occur. In the Preferred Alternative process, public education activities were identified as another form of public use. Although this activity is not included in the Expanded Use Alternative, this aspect of Alternative 4 was chosen for inclusion in the Preferred Alternative.

In the Preferred Alternative identification process, the land use zones and maps in the Draft NTS EIS were also considered. Several rezoning concepts were considered in response to concerns that the land use maps would restrict nondefense research use of the site. Rather than adjust boundaries and create additional land use zones and definitions, the definitions of land use categories were amended

slightly to include compatible defense and nondefense use in almost every zone of the NTS. As defined in Alternative 3, Expanded Use, only the Defense Industrial Zone is restricted to defense-related activities.

The process of DOE approval of the Preferred Alternative began with the recommendation of the Nevada Operations Office to DOE Headquarters. The DOE continued to consider the Preferred Alternative process, public comments, and comment responses in the preparation of the Final NTS EIS. In this stage of the Preferred Alternative identification process, the various affected program offices considered public comments received with regard to their statutory mission responsibilities. Only after the program offices had concluded that the comments were adequately addressed in the comment response document did they recommend approval of the preferred alternative and the Final NTS EIS to the Secretary of Energy.

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Chapter 4

AFFECTED ENVIRONMENTS

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AFFECTED ENVIRONMENTS

This chapter contains the description of the existing environmental conditions of the Nevada Test Site (NTS), the Tonopah Test Range, portions of the Nellis Air Force Range (NAFR) Complex, the Project Shoal Area, the Central Nevada Test Area, Eldorado Valley, Dry Lake Valley, and Coyote Spring Valley (Figure 4-1). During Environmental Impact Statement (EIS) preparation, the most up-to-date and accurate information available was used to describe existing environments, facilities, activities, and projects. The information serves as a baseline from which to identify and evaluate environmental changes resulting from the proposed alternatives. The baseline conditions, for the purposes of analysis, are the conditions that currently exist. The regions of influence vary, as dictated by the resources under consideration. For some discussions, such as site-support activities, the regions of influence are limited to the areas circumscribed by each U.S. Department of Energy (DOE) administrative boundary. For other topics, such as transportation, groundwater, and air quality, the regions of influence are much larger and may include all of southern Nevada, as well as portions of Utah, Arizona, and California.

The environmental resources discussed in this chapter include land use, geology and soils, hydrology, biology, air quality, noise, and visual and cultural resources. Where applicable, this chapter also describes existing waste management facilities and other resource elements, including airspace, site-support activities, transportation, socioeconomics, occupational and public health and safety, radiological conditions, and Environmental Justice.

The discussions of the DOE administrative units are organized according to their relative geographic proximity to one another. Because the NTS and the NAFR Complex share a boundary and because the units of interest are within 97 km (60 mi) of each other, they are discussed together in the next section. The Tonopah Test Range, Project Shoal Area, Central Nevada Test Area, Eldorado Valley, Dry Lake Valley, and Coyote Spring Valley are discussed separately in subsequent sections.

4.1 Nevada Test Site and Surrounding Areas

The existing environmental conditions of the NTS and portions of the NAFR Complex are described in this section. The portion of the NAFR Complex that is described is limited to Area 13.

The NTS, a unique national resource managed by the U.S. Department of Energy, Nevada Operations Office (DOE/NV), is located about 105 km (65 mi) northwest of Las Vegas. The 3,496 km^2 (1,350 mi^2) site features desert and mountainous terrain and is larger than Rhode Island, making it one of the largest secured areas in the United States. The NTS is in a remote and arid region, surrounded by federal installations, with strictly controlled access, and public lands that are open to public entry.

The following information pertaining to the NTS is provided by the American Indian Writers Subgroup of the Consolidated Group of Tribes and Organizations (CGTO). Information provided by the American Indians is italicized in this EIS to distinguish it from DOE text.

For many centuries, the NTS has been a central place in the lives of American Indian tribes. The NTS and nearby lands contain traditional gathering, ceremonial, and recreational areas for the American Indian people. From antiquity to contemporary times, this area has been used continuously by many tribes. It contains numerous ceremonial resources and power places that are crucial for the continuation of American Indian culture, religion, and society. Until the mid-1900s, traditional festivals involving religious and secular activities attracted American Indian people to the area from as far as San Bernardino, California. Similarly, groups came to the area from a broad region during the hunting season and used animal

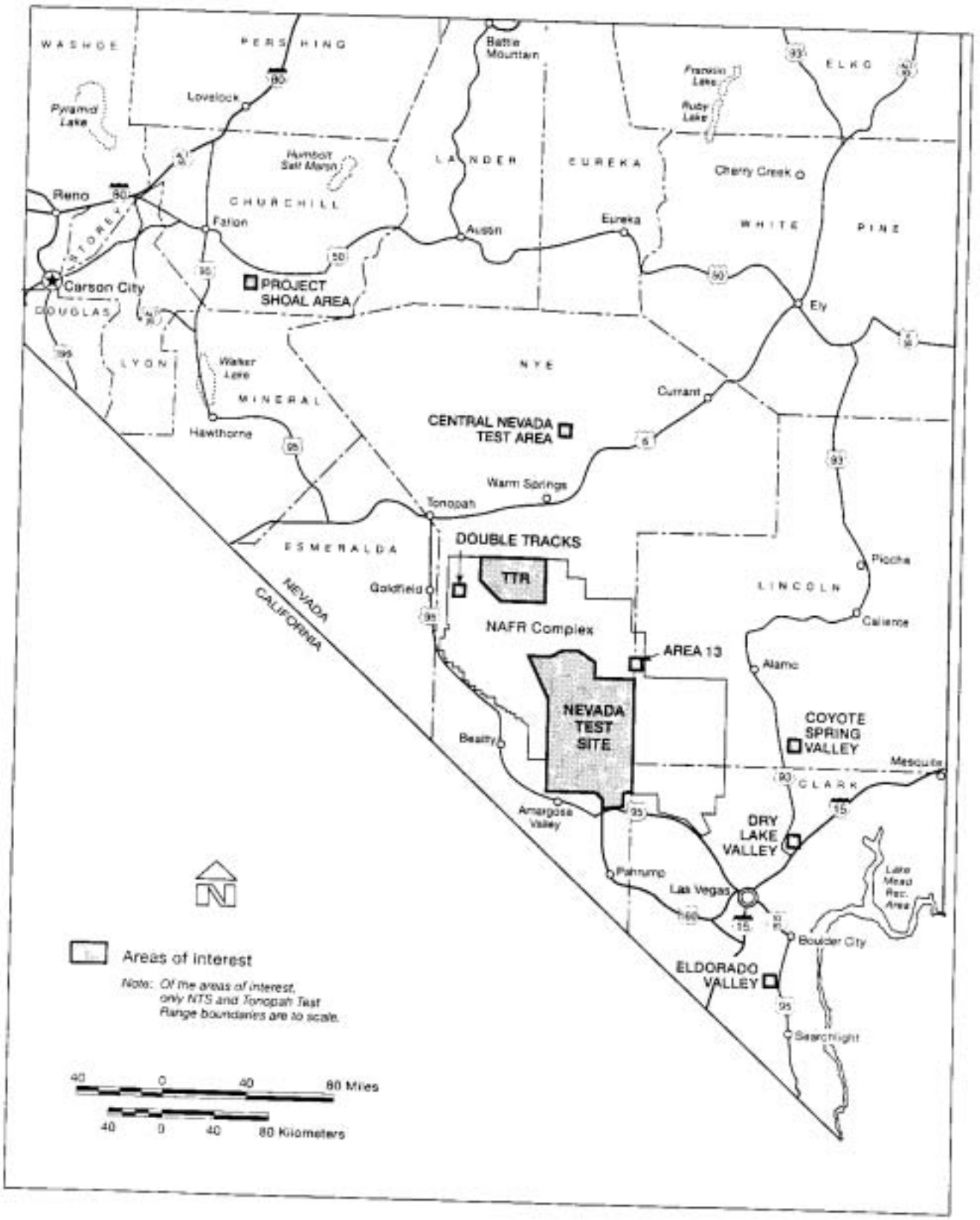


Figure 4-1. NTS and selected areas of interest

and plant resources that were crucial for their survival and cultural practices.

Despite the loss of some traditional lands to pollution and reduced access, the American Indian people have neither lost their ancestral ties to nor have forgotten their cultural resources on the NTS. There is continuity in the American Indian use of and broad cultural ties to the NTS. American Indian people have cared for the NTS resources and will continue to do so.

4.1.1 Land Use

Land resources are important considerations for decisions regarding site use. The land-use analysis determines if there is enough land available for the proposed facilities and required buffers, and identifies conflicts between the proposed project and existing or projected on- and off-site land use. These analyses are necessary to determine whether public lands would be managed in a manner consistent with existing and projected land uses. To make decisions with respect to locating facilities at the NTS, the DOE must consider several issues, particularly the constraints and opportunities related to land resources. These include whether conflicts exist with the administrative framework and whether adequate resources are available and viable.

The known land-use constraints and opportunities at the NTS are outlined in this section and described throughout this chapter. Land-use constraints include those features of the NTS, either natural or manmade, that preclude or limit the future activities that can be conducted in a specific location or area. Opportunities are the best and highest uses of the land that can be accomplished within the constraints. Further definition of land-use opportunities and constraints is planned as part of the *Framework for the Resource Management Plan* (see Volume 2).

Many of the constraints identified throughout Chapter 4 are those resulting from historic land uses, primarily nuclear weapons, rocket and related nuclear testing activities, and to a lesser extent, radioactive waste management activities. Many of these constraints on land use were identified in the *Final Environmental Impact Statement, Nevada Test Site, Nye County, Nevada* (ERDA, 1977) as unavoidable adverse impacts or irreversible actions with irretrievable commitments of resources. Because of the nature of many historic activities and their consequences, specifically the introduction of radionuclides into environmental media, land use will continue to be constrained in some areas of the NTS during the 10-year period covered by this EIS, and likely well into the future. These constraints, and the specific environmental media that are affected, are summarized at the end of this section.

Natural constraints, such as unstable soils or ecologically sensitive areas, are described in the appropriate sections of Chapter 4 (i.e., Geology and Soils and Biological Resources). Land-use opportunities under baseline (i.e., existing environmental and administrative) conditions are presented throughout the remainder of Chapter 4, beginning in Section 4.1.1.1. The remainder of this section summarizes the constraints to land use resulting from the fulfillment of the DOE's missions at the NTS.

Based upon the more than 40 years of operations and information gathered, many of the consequences of past weapons testing and other activities are well understood and documented. Many of the consequences described in this chapter were previously presented in the *Final Environmental Impact Statement, Nevada Test Site, Nye County, Nevada* (ERDA, 1977). While not all of the consequences of historic actions at the NTS and adjacent areas have been fully defined, this section presents an overview of their resulting constraints and establishes a baseline of current conditions. The baseline serves as a basis for evaluating the potential impacts of future actions. Because of the complexity of some issues, a full understanding that removes all uncertainty may never be achieved. Nonetheless, the DOE continues, through many of the programs and actions described in this EIS, to address the remaining data deficiencies and uncertainties.

For purposes of discussion, the past activities at the NTS have been grouped into eight categories. In this section, a brief historical overview is provided, and the known consequences and resulting

constraints on use of the physical environment are presented.

Eight historic activities, and their consequences, are included in the baseline discussion within this chapter:

Atmospheric Weapons Testing—A total of 100 atmospheric detonations were conducted before the Limited Test Ban Treaty was signed in August 1963. Atmospheric tests include tests conducted at ground level, from towers or balloons, or by airdrops. Of the 100 atmospheric tests, 16 were safety tests. By design, these safety tests produced little or no nuclear yield.

Underground Nuclear Testing—Approximately 800 underground nuclear tests have been conducted at the NTS. The types of tests conducted include deep underground tests used to study weapons effects, designs, safety, and reliability, and shallow borehole tests used to study the peaceful application of nuclear devices for cratering. The 70 underground safety tests conducted on the NTS, by design, produced little or no nuclear yield.

Safety Tests—Between late 1954 and June 1963, 16 tests were conducted aboveground to test the vulnerability of certain weapon designs to possible accidents. At a location in Area 5, 24 experiments, utilizing relatively small quantities of plutonium, were conducted between 1954 and 1956. These experiments, known as the GMX Project, were so-called "equation-of-state" studies where "instantaneous" changes in the physical properties of plutonium materials subjected to detonations from conventional explosives were measured. By design, these experiments produced little or no nuclear yield.

Safety tests are no longer conducted aboveground; all such tests are performed underground in emplacements that are designed so that radioactive materials will not reach aboveground environments (AEC, 1972; AEC, 1973a; ERDA, 1976; ERDA, 1977). Impacts to soils that resulted from these historic activities are described further in Chapter 4, Section 4.1.4.3.

Nuclear Rocket Development Station—Twenty-six experimental tests of reactors, nuclear engines, ramjets, and nuclear furnaces were conducted between 1959 and 1973.

Shallow Land Radioactive Waste Disposal—Some wastes generated during the testing program, and as a result of nuclear projects, were disposed of in shallow cells, pits, and trenches. Because of the site's characteristics, notably the absence of a groundwater pathway, shallow burial continues to be an important waste disposal activity.

Crater Disposal—Contaminated soils and equipment collected during the decontamination of atmospheric testing areas and the consolidation of radioactively contaminated structures, and other bulk wastes, were disposed of in subsidence craters in Yucca Flat.

Greater Confinement Disposal—In 1981, greater confinement disposal of waste was initiated at Area 5 for certain radioactive low-level wastes not suitable for shallow land disposal.

Site-Support—Like any large facility, the NTS has a large infrastructure that provides all site-support services. Food and housing services, paint shops, vehicle maintenance facilities, machine shops, road maintenance, and other on-site facilities all produce more common short-term impacts, such as localized land disturbance, air emissions, and noise. Site-support facilities are associated with NTS land-use opportunities.

Table 4-1 and Figure 4-2 provide information on the key characteristics of the historic activities that have occurred on the NTS and now constrain the future use of certain NTS land areas. Figure 4-2 summarizes the historical activities and identifies the media of concern in the physical environment that could constrain their future use. Table 4-1 lists information on the nature of the source, the type of area involved, the media affected, the principal contaminants, the depth, and the best available estimate of the remaining inventory of radioactivity. It should be noted that in some cases only approximate values are available; these values are presented solely to illustrate the general

characteristics of each source group and to highlight the differences between the groups.

More detailed information for each affected resource is included in the specific resource discussions in this chapter. Section 4.1.1.5, Waste Management Program, describes the existing waste management operations at the NTS, including the locations, types of materials managed, and the quantities of radioactive and nonradioactive wastes that have been disposed. Section 4.1.2.3, Transportation of Materials and Wastes, identifies the out-of-state waste generators that ship low-level waste to the NTS for disposal.

In Section 4.1.4.2, the baseline geological conditions are described. The geology baseline documents the physical disturbances to the subsurface environment that have resulted from 35 years of underground nuclear testing.

Section 4.1.4.3, Soils, identifies the historical activities, such as atmospheric nuclear testing, safety tests, and nuclear rocket and reactor experiments that have resulted in contamination of surface soils. The extent and degree of contamination is also explained.

4.1.1.1 Public Land Orders and Withdrawals. The NTS encompasses 3,496 km^2 (1,350 mi^2) of land area reserved to the jurisdiction of the DOE. Figure 4-3 shows the land area as it has been withdrawn through all forms of appropriation under the public land laws, including mining and mineral-leasing laws through the public land orders and a Memorandum of Understanding. Under Public Land Order 805 (February 12, 1952), approximately 435,000 acres of land were reserved for use by the Atomic Energy Commission as a weapons testing site. Under Public Land Order 1662 (June 20, 1958), 38,400 acres were reserved for the use of the Atomic Energy Commission in connection with the NTS. The lands described under this Public Land Order are not considered in any alternative use by the DOE and are, therefore, not addressed in this EIS. Under Public Land Order 2568 (December 19, 1961), 318,000 acres of land previously reserved for use by the U.S. Air Force were transferred to the jurisdiction of the Atomic Energy Commission for use in connection with the NTS for test facilities, roads, utilities, and safety distances. Under Public Land Order 3759 (August 3, 1965), 21,108 acres of land were reserved for the jurisdiction of the Atomic Energy Commission for use in connection with the NTS. Pahute Mesa, located in the northern portions of Areas 19 and 20, which encompasses 106,240 acres, is managed by the DOE as a part of the NTS in accordance with a 1963 Memorandum of Understanding with the U.S. Air Force. This memorandum was superseded by a Memorandum of Understanding between the U.S. Air Force and DOE/NV in 1982 (DoD, 1982).

In 1983, the U.S. Bureau of Land Management, in accordance with the Federal Land Policy and Management Act of 1976, conducted a review of the existing four land withdrawals that comprise the NTS. The U.S. Bureau of Land Management District Manager concurred with the review's conclusion that the lands were still being used for the purpose for which they were withdrawn. Furthermore, in recognition of a potential end of testing in future years, the U.S. Bureau of Land Management recommended that the land withdrawals again be reviewed in 100 years.

4.1.1.2 Land-Use Designations. The NTS is located in Nye County in southern Nevada; its southernmost point is located about 105 km (65 mi) northwest of Las Vegas, Nevada. The site varies from 46 to 56 km (28 to 35 mi) in width and 64 to 88 km (40 to 55 mi) in length (north to south).

The DOE is in the process of developing a *Resource Management Plan*. The goal of the *Resource Management Plan* will be to establish a process for managing the facilities and national resources of the NTS to ensure long-term diversity and productivity of natural ecosystems and sustain the use of land and facilities at the NTS. The DOE will use this process to evaluate the selection, design, and location of existing and proposed activities. This process will identify the criteria for evaluating the compatibility of these activities with public values, ongoing missions, existing infrastructure, cultural and natural resources, human health and safety, and other resources and land-use constraints on the NTS.

Table 4-1. Summary of radioactivity on the NTS as of January 1996

Source of Radioactivity	Type of Area	Environmental Media	Major Known Isotopes or Wastes	Depth Range	Amount (curies)
Atmospheric & Tower Tests	Above Ground Nuclear Weapon Proving Area	Surficial Soils & Test Structures	Americium Cesium Cobalt Plutonium Europium Strontium	At Land Surface	Approximately 20
Safety Tests	Above Ground Experimental Areas	Surficial Soils	Americium Cesium Cobalt Plutonium Strontium	Less than 0.9 m (3 ft)	Approximately 35
Nuclear Rocket Development Area	Nuclear Rocket Motor, Reactor, & Furnace Testing Area	Surficial Soils	Cesium Strontium	Less than 3 m (10 ft)	Approximately 1
Shallow Borehole Tests	Underground Nuclear Testing Areas	Soils & Alluvium	Americium Cesium Cobalt Europium Plutonium Strontium	Less than 61 m (200 ft)	Approximately 2,000 at land surface; unknown at depth
Shallow Land Disposal	Waste Disposal Landfills	Soils & Alluvium	Dry Packaged Low-level & Mixed Wastes	Less than 9 m (30 ft)	Approximately 500,000[a]
Crater Disposal	Test induced subsidence crater with sidewalls, cover, & drainage	Soils & Alluvium	Bulk contaminated soils & equipment	Less than 30 m (100 ft)	Approximately 1,250[b] (Approximately 205,000 m^3 [7,250,000 ft^3])[b]
Greater Confinement Disposal	Monitored Underground Waste Disposal Borehole	Soils & Alluvium	Tritium Americium	37 m (120 ft)	Approximately 9.3 million[a] (Approximately 300 m^3 [10,000 ft^3])[a]
Deep Underground Tests	Underground Nuclear Testing Areas	Soils, Alluvium, & Consolidated Rock	Tritium, fission, & activation products	Typically less than 640 m (2,100 ft), but may be deeper	Greater than 300 million

[a] Inventory at time of disposal (not corrected for decay)
[b] Amount of waste that was considered for inventory.

Existing land use on the NTS is divided into two site categories and seven zone categories. The site and zone category definitions are as follows:

Industrial, Research, and Support Site—An industrial site is used for the manufacturing, processing, and/or fabrication of articles, substances, or commodities. A research site is used for projects to verify theories or concepts under controlled conditions. Support sites are used for office space, training, equipment storage, maintenance, security, feeding and housing, fire protection services, and health services.

Waste Management Site—A site used for the disposal, storage, and/or treatment of wastes.

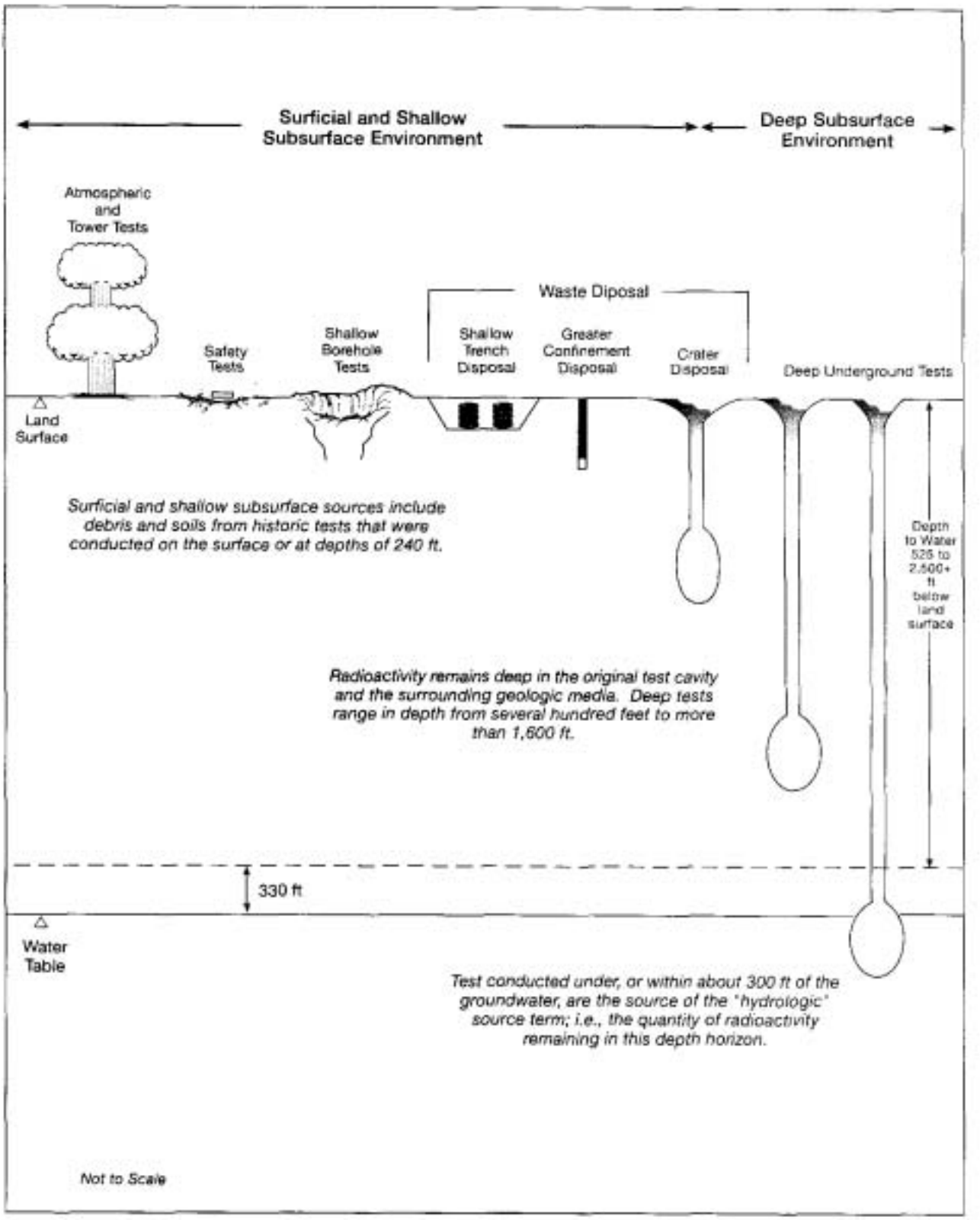


Figure 4-2. Types and depth horizons of radioactivity that remains on the NTS

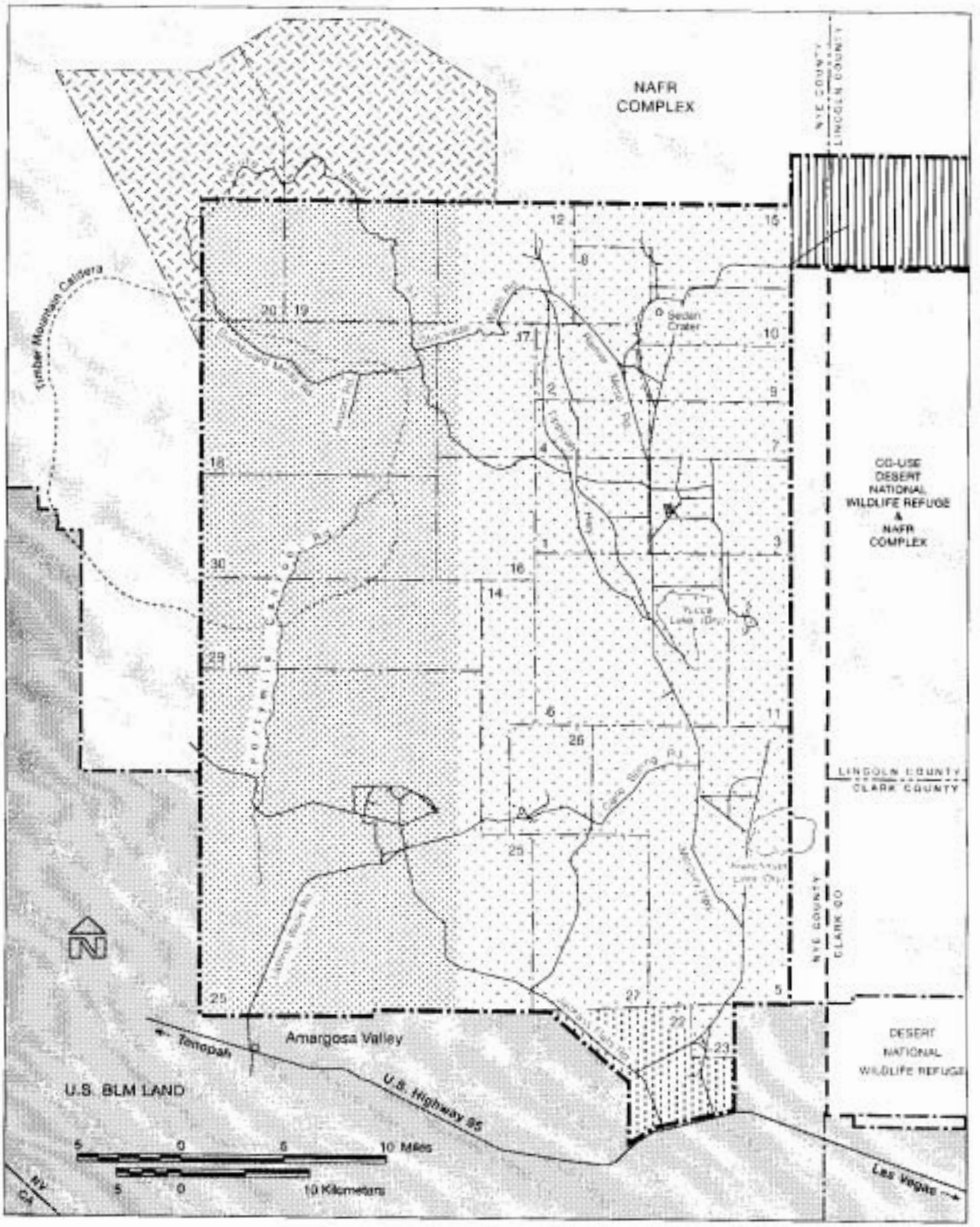


Figure 4-3. NTS land withdrawals and Memorandum of Understanding

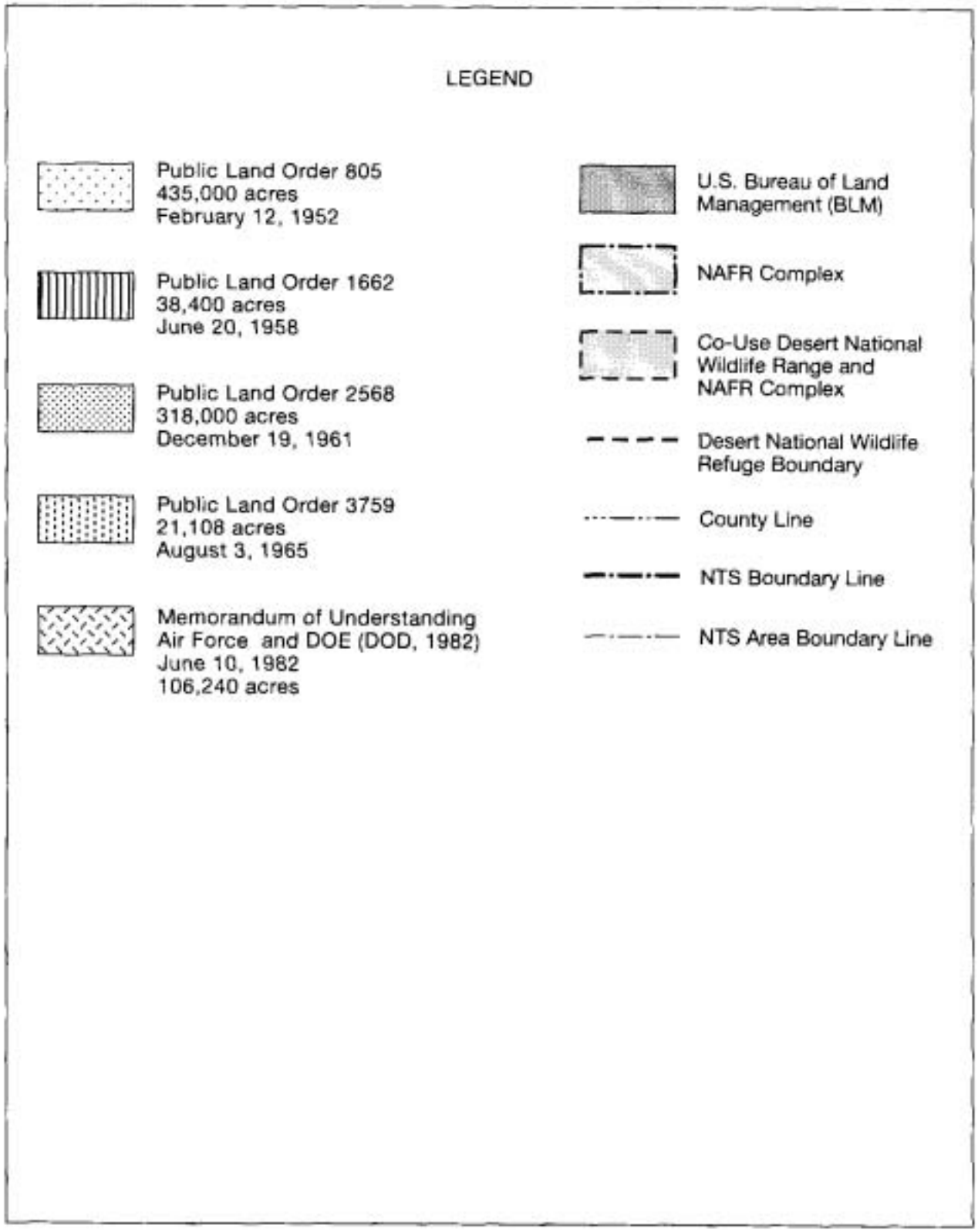


Figure 4-3 (continued). Legend for NTS land withdrawals and Memorandum of Understanding

Nuclear Test Zone—Land area reserved for underground hydrodynamic tests, dynamic experiments, and underground nuclear weapons and weapons effects tests. The stockpile stewardship emplacement hole inventory is located within this zone (Appendix A, Figure A-1).

Nuclear and High Explosive Test Zone—Land area designated within the Nuclear Test Zone for additional underground and aboveground high-explosive tests or experiments.

Research, Test, and Experiment Zone—Land area designated for small-scale research, development projects, pilot projects, and outdoor tests and experiments for the development, quality assurance, or reliability of materials and equipment under controlled conditions.

Radioactive Waste Management Zone—Land area designated for the shallow land burial of low-level and mixed wastes.

Critical Assembly Zone—Land area used for conducting nuclear explosive operations. Operations generally include assembly, disassembly or modification, staging, repair, retrofit, and surveillance. The potential for weapons storage also exists in this zone.

Spill Test Facility Impact Zone—A downwind geographic area that would confine the impacts of the largest planned tests of materials released at the Spill Test Facility.

Reserved Zone—Controlled-access land area that provides a buffer between nondefense research, development, and testing activities. The Reserved Zone includes areas and facilities that provide widespread flexible support for diverse short-term nondefense research, testing, and experimentation. This land area is also used for short-duration exercises and training, such as Nuclear Emergency Search Team and Federal Radiological Monitoring and Assessment Center training, and U.S. Department of Defense (DoD) land navigation exercises and training.

To simplify the distribution, use, and control of resources, the NTS is also divided into numbered areas. The following pages contain an area-by-area description of land use on the NTS. Refer to Chapter 3, Figure 3-1.

Area 1—As a part of the Nuclear Test Zone, this area occupies 70 km^2 (27 mi^2) near the center of the Yucca Flat weapons test basin. Four atmospheric nuclear tests were conducted here between 1952 and 1955. Three underground nuclear tests have also been detonated in Area 1, one in 1971 and two in 1990.

Buildings and structures associated with aboveground nuclear testing are discussed in Section 4.1.10 and listed in Table 4-37 as NT (Nuclear Testing). Although many of these structures are believed to be eligible, no official evaluation or determination of eligibility has been conducted. Should any of these structures be affected by project activities, an evaluation would be completed, eligibility determined, and consultation with the Nevada State Historic Preservation Office (SHPO) would be conducted prior to initialing the project. The project would be conducted in accordance with SHPO recommendations.

The Lyner Complex is a mined underground complex in Area 1 that is available for dynamic experiments (including subcritical experiments involving special nuclear material) and hydrodynamic tests that cannot be conducted aboveground because they may contain hazardous materials. Initial work on what is now known as the Lyner Complex began in the late 1960s with the mining of the U1a shaft to a depth of 305 meters (m) (1,000 feet [ft]) for a nuclear test. It was not used. Further work took place in the 1980s and early 1990s to develop a complex that could be used to perform intentionally designed low-yield tests or experiments, which included safety tests, and other experiments that would be expected to remain subcritical or produce negligible nuclear energy release. The Ledoux nuclear test with a yield of less than 25 kilotons was conducted in 1990 in a drift within this tunnel complex. The Kismet experiment, involving high explosives, tritium, depleted uranium, and other materials, was a dynamic experiment conducted in the Lyner Complex in March 1995. Both Ledoux and Kismet

were contained to prevent radiological releases to the rest of the Lyner Complex and the surface environment.

The Area 1 Industrial Complex, at the intersection of Pahute Mesa Road and Tippipah Highway, is the maintenance and storage area for an over $20-million inventory of large-hole drilling equipment and miscellaneous supplies. Typical day-to-day operations include replacing worn cutters on a drill bit with new or rebuilt cutters, straightening drill pipe and tubing, and other drilling tool maintenance tasks. A concrete batch plant and storage area for bulk construction material, as well as a shaker plant that produces stemming material and concrete aggregate, lie to the north of the drilling yard.

There is one stockpile stewardship emplacement hole within Area 1 (Appendix A, Figure A-1).

Area 2—This area, within the Nuclear Test Zone, occupies approximately 52 km^2 (20 mi^2) in the northern half of the Yucca Flat basin. The eastern portion of Area 2 was the site of seven atmospheric nuclear tests conducted between 1952 and 1957. The first in a series of underground nuclear tests in Area 2 took place in late 1962 and continued through 1990. A number of the 137 underground tests detonated in Area 2 were simultaneous detonations of multiple devices in the same emplacement hole; other underground tests involved the firing of two or more devices with the devices in separate emplacement holes.

There are eleven stockpile stewardship emplacement holes within Area 2 (Appendix A, Figure A-1).

Most of the structures that comprised a former construction base camp (consisting generally of Butler buildings, Quonset huts, and trailers) have been relocated to Area 6, and the facilities remaining in Area 2 are in the process of being moved to other locations or are being scrapped.

Area 3—This portion of the Nuclear Test Zone occupies 82 km^2 (32 mi^2) near the center of the Yucca Flat weapons test basin and was the site of 17 atmospheric tests conducted between 1952 and 1958. A total of 251 underground nuclear tests were conducted in Area 3 from 1958 through 1992. This is the largest number of tests of any of the NTS underground test areas. A number of these tests consisted of simultaneous device detonations, and nearly all of these simultaneous tests consisted of single devices in separate emplacement holes. Nine of the underground nuclear tests in Area 3 were conducted in unstemmed holes to minimize, but not eliminate, the release of radioactivity to the atmosphere. These unique tests were carried out between mid-1957 and late 1958.

There are four stockpile stewardship emplacement holes within Area 3 (Appendix A, Figure A-1).

Bulk low-level waste is disposed of in selected Area 3 subsidence craters that, collectively, comprise the Area 3 Radioactive Waste Management Site. This activity commenced in the mid-1960s when the DOE began removing scrap tower steel, vehicles, and other large objects that had been subjected to atmospheric testing. From 1979 to 1990, large amounts of contaminated soil and other debris from the NTS were added to the craters. There are seven disposal craters. Two craters are in use, two are full and temporarily capped, and three are in reserve for potential future use.

Area 4—This area, within the Nuclear Test Zone, occupies 41 km^2 (16 mi^2) near the center of the Yucca Flat basin. Area 4 was the site of five atmospheric nuclear tests conducted between 1952 and 1957. From the mid-1970s through 1991, a total of 35 underground nuclear tests were conducted in Area 4, mainly in the northeast corner. Two of these tests involved the simultaneous detonation of multiple devices in the same emplacement hole.

The Big Explosives Experimental Facility in Area 4 is being evaluated for its suitability as an operational complex for testing large charges of conventional high explosives. Comprised of two earth-covered, steel-reinforced concrete structures, one structure may serve as a manned operational control room facility, and the other may serve as an unmanned camera room with viewing ports to a gravel table where large charges of high explosives can be fired.

There are four stockpile stewardship emplacement holes in Area 4 (Appendix A, Figure A-1).

Area 5—This area, within the Reserved Zone, occupies some 246 km² (95 mi²) in the southeastern portion of the site and includes the Area 5 Radioactive Waste Management Site, the Hazardous Waste Storage Unit, and the Spill Test Facility.

From 1951 through early 1962, 14 atmospheric tests were conducted at Frenchman Flat, several of which were weapons effects tests. Among the remains of the structures tested in Frenchman Flat are simulated motel complexes, metal frames that supported a variety of roofing materials, a window test structure, cylindrical liquid storage vessels, reinforced concrete domes and aluminum domes, bridge pedestals, and a bank vault; all of these remains are of considerable historical interest. Five nuclear weapons tests were conducted underground at Frenchman Flat between 1965 and 1968. However, the presence of the carbonate aquifer makes this area less suitable for underground testing than other locations on the NTS.

In the GMX area, 24 experiments, some utilizing relatively small quantities of fissile materials, were conducted between 1954 and 1956. These experiments were so-called "equation-of-state" studies where "instantaneous" changes in the physical properties of plutonium materials subjected to detonations from conventional explosives were measured. These experiments were conducted on or very near one place, and the source can be considered to be at one site.

The Area 5 Radioactive Waste Management Site is located in a 732-acre Radioactive Waste Management Zone used for low-level waste disposal. Mixed waste, including transuranic mixed waste, has been disposed of at the site in the past, and transuranic wastes are currently being stored there pending disposal at the Waste Isolation Pilot Plant near Carlsbad, New Mexico. Disposal of waste at the NTS is discussed in Section 4.1.1.5.

The Hazardous Waste Storage Unit is an accumulation point for nonradioactive materials, such as paints, chemicals, unused or surplus fuels, and other items. Periodically, all hazardous wastes generated at the NTS are sent to permitted commercial facilities for recycling, incineration, or disposal.

The Spill Test Facility is a complex of fuel tanks, spill pads, meteorological and camera towers, equipment and control buildings, and a wind tunnel used for releasing hazardous materials and measuring their behavior in outdoor conditions.

Area 6—This area occupies 212 km² (82 mi²) between Yucca Flat and Frenchman Flat, straddling Frenchman Mountain. Only one atmospheric nuclear test was conducted in Area 6, and that was in 1957. Between 1968 and mid-1990, five underground nuclear tests were conducted at this location, two of which involved the simultaneous detonation of multiple devices in separate emplacement holes.

There are two stockpile stewardship emplacement holes in Area 6 (Appendix A, Figure A-1).

The Control Point complex serves as the command center, air operations center, and timing and firing center for the Yucca Flat weapons test basin, Frenchman Flat, Pahute Mesa, and surrounding areas. Augmenting facilities near the secured compound include a communications building, several radiological sciences and technical services buildings, a fire and first-aid station, and various maintenance and warehouse structures.

The Area 6 Construction Facilities provide craft and logistical support to activities in the forward areas of the NTS. This forward area complex replaces older construction base camps in Areas 2 and 3. Those elements comprising the Yucca Lake facilities include a variety of equipment storage facilities, a heavy- duty maintenance and equipment repair facility, and decontamination facilities. A 3,353 m (11,000 ft) airstrip and nearby weather station also are located on the Yucca Lake bed.

The Device Assembly Facility, when open, will be the primary location of all nuclear explosive operations at the NTS. Nuclear explosive operations include assembly, disassembly or modification, staging, transportation, testing, maintenance, repair, retrofit, and surveillance. The

Device Assembly Facility contains about 9,290 m^2 (100,000 ft^2) of interior floor space within a Critical Assembly Zone composed of approximately 22 acres.

The Hydrocarbon Contaminated Soils Disposal Site is an existing, state of Nevada-approved, Class III landfill. All non-Resource Conservation and Recovery Act-regulated hydrocarbon contaminated soils and materials generated on the NTS are disposed of at this landfill.

Area 7—This area, within the Nuclear Test Zone, occupies 52 km^2 (20 mi^2) in the northeast quadrant of the Yucca Flat weapons test basin. Twenty-six atmospheric tests were conducted in this area. From late 1964 through the fall of 1991, a total of 62 underground nuclear tests were carried out in Area 7, all consisting of a single nuclear device in a drilled emplacement hole.

There are three stockpile stewardship emplacement holes in Area 7 (Appendix A, Figure A-1).

Area 8—This area, within the Nuclear Test Zone, occupies 34 km^2 (13 mi^2) in the northeast quadrant of the Yucca Flat weapons test basin. Area 8 was the site of three atmospheric nuclear tests conducted in 1958. From mid-1966 through late 1988, 10 underground nuclear tests were carried out at this location. Two of the underground tests involved the simultaneous firing of multiple devices put in the same emplacement hole. Underground shelter structures were tested in the late 1950s, and in 1964 these shelters were used by the University of Florida for shelter habitability studies. Lawrence Livermore National Laboratory has conducted experiments in this area.

Area 9—This area, within the Nuclear Test Zone, occupies 52 km^2 (20 mi^2) in the northeast quadrant of the Yucca Flat weapons test basin. Seventeen atmospheric tests were conducted in this area between 1951 and 1958. Area 9 has been used extensively for underground nuclear testing; 100 such tests were carried out from late 1961 to mid-1992. Of the dozen underground tests involving the simultaneous detonation of multiple devices, most involved the use of separate emplacement holes (two or more holes, each with a single device).

There is one stockpile stewardship emplacement hole in Area 9 (Appendix A, Figure A-1).

The Area 9 sanitary landfill is located in a subsidence crater formed as a result of a subsurface nuclear detonation in the early 1960s. This Class II landfill is allowed to receive all types of nonhazardous waste. In October 1995, the landfill underwent partial closure and will reopen as a Class III construction and demolition debris landfill.

Area 10—This area, incorporated in the Nuclear Test Zone, occupies 54 km^2 (21 mi^2) in the northeast quadrant of the Yucca Flat weapons test basin. Area 10 was the selected location for the nation's first nuclear missile system test, an air-to-air rocket, detonated in mid-1957. This was the only nuclear rocket test ever conducted at the NTS. Two of the earliest shallow nuclear cratering experiments conducted at the NTS were detonated in 1951 and 1955 at this location. Resuming with the deeply buried Sedan cratering experiment in mid-1962 and extending through early 1991, a number of underground nuclear tests were conducted in Area 10. Counting both the cratering and contained underground tests, there were 57 nonatmospheric nuclear tests. A number of the underground tests detonated in Area 10 were simultaneous detonations of multiple devices in the same emplacement hole, while others involved the firing of multiple devices, but with each of the nuclear devices located in separate emplacement holes.

Area 10 is the site of Sedan Crater, which was formed by a thermonuclear device detonated in July 1962. It left a large throw-out crater with a diameter of 390 m (1,280 ft) and a depth of 98 m (320 ft). Sedan was the first in a series of 23 Plowshare experiments conducted at the NTS to develop peaceful uses of nuclear explosives. Sedan Crater is listed on the National Register of Historic Places, a file of cultural resources of national, state, regional, or local significance identified by the National Park Service. The Scooter Crater, also located in Area 10, is the result of a 500-ton conventional high-explosive experiment carried out in 1960.

Area 11- This area, which is split among the Nuclear Test and Reserved Zones, occupies 67 km^2 (26 mi^2) along the eastern border of the NTS. Four atmospheric plutonium-dispersal safety tests were conducted in the northern portion of Area 11 in 1954 and 1956 in what is now known as Plutonium Valley. Because of the radioactive residues that remain from the safety experiments, Area 11 continues to be used on an intermittent basis for realistic drills in radiological monitoring and sampling operations. In addition to the aboveground safety tests, five underground nuclear weapons effects tests were carried out in Area 11 between the spring of 1966 and early 1971.

An explosive ordnance disposal site is located in the southern portion of Area 11. This is a Resource Conservation and Recovery Act permitted treatment unit. The site consists of a detonation pit surrounded by an earthen pad, approximately 8 m (25 ft) by 30 m (100 ft), and supplemental equipment, which includes a bunker, electrical shot box, and electrical wire. Typically, up to six detonations of 45 kilograms (kg) (100 pounds [lb]) or less of explosives are conducted annually.

Area 12—This area, within the Nuclear or High Explosive Test Zone, occupies 104 km^2 (40 mi^2) at the northern boundary of the NTS known as Rainier Mesa. No atmospheric tests were conducted at this location. Rainier Mesa was the site of the nation's first fully contained underground nuclear detonation in the fall of 1957. Of the 61 underground nuclear tests carried out in Area 12 between late 1957 and the fall of 1992, only 2 were detonated in drilled holes, whereas all of the others were detonated in mined tunnels.

Today, there are a number of tunnels mined into Rainier Mesa, within which most DoD horizontal line-of-sight exposure experiments were conducted. In particular, N-, P-, and T-Tunnel complexes were extensively developed during the past several decades. N-Tunnel was also the location for a non-proliferation experiment, detonated in September 1993; this experiment involved 1.3×10^6 kg (2.9×10^6 lb) of conventional high explosives. The DoD currently operates a high-explosives research and development tunnel in Area 12. This reusable test bed supports programs involving the detonation of conventional or prototype explosives and munitions.

The Area 12 camp was used to support operations in the northern region of the NTS. The camp includes housing and feeding facilities; other support structures include a major maintenance building, various craft and repair shops, a first-aid facility, and a supply depot. The camp is currently closed.

Area 13—Officially, there is no Area 13 within the NTS boundary; however, there is a land plot on the NAFR Complex, known as NAFR Complex Area 13, which lies off the northeast corner of the NTS. This was the location for a plutonium-dispersal safety experiment conducted in early 1957. The only future DOE activities that would occur in this area would involve environmental restoration.

Area 14—This Reserved Zone area occupies 67 km^2 (26 mi^2) in the south-central portion of the NTS. Relatively isolated from the NTS's major operational and support facilities, no atmospheric or underground nuclear tests have ever been conducted in Area 14.

Area 15 –This Reserved Zone area occupies 96 km^2 (37 mi^2) at the northeast corner of the NTS, and no atmospheric tests were conducted at this location. However, between early 1962 to mid-1966, three underground nuclear tests were carried out in Area 15.

Two major complexes are located in Area 15, the Hardhat/Piledriver site and the U.S. Environmental Protection Agency (EPA) Farm Complex, both of which are now closed. The Piledriver experiment in mid-1966 was one of the most complex and expensive DoD underground nuclear tests ever carried out. The purpose of these tests was to investigate the simulated effects of a nuclear surface detonation on a deeply buried, superhard command and control center in a granite rock formation.

From 1978 to 1983, the Spent Fuel Test, Climax was carried out in a separately mined drift at the Hardhat/Piledriver site. The purpose of this study

was to learn more about how granite would react to heat and radiation from spent nuclear fuel.

As part of the nation's long-range health and safety program, an experimental 30-acre dairy farm was developed and operated in Area 15 between 1965 and 1981. The purpose of this extensive research program was to study the passage of airborne radionuclides through the soil-forage-cow-milk-food chain.

Area 16—This area, within the Nuclear or High Explosive Test Zone, occupies 73 km^2 (28 mi^2) in the west-central portion of the NTS. No atmospheric tests have ever been conducted at this location. Area 16 was established in 1961 for the DoD's exclusive use in support of a complicated nuclear effects experiment that required a tunnel location in an isolated area away from other active weapons test areas. From mid-1962 through mid-1971, six underground nuclear weapons effects tests (all in the same tunnel complex) were conducted at this location. Currently, the DoD uses this area for high-explosives research and development in support of programs involving the detonation of conventional or prototype explosives and munitions.

Area 17—This area, within the Reserved Zone, occupies 80 km^2 (31 mi^2) in the north-central portion of the NTS. This area has been used primarily as a buffer between other testing activities. No atmospheric tests or experimental activities of programmatic consequence have been conducted in Area 17.

Area 18—This area, within the Reserved Zone, occupies 231 km^2 (89 mi^2) in the northwest quadrant of the NTS. The inactive Pahute airstrip is located in the east-central portion of the area. When in operational status, the airstrip was primarily used for shipment of supplies and equipment for Pahute Mesa test operations.

Area 18 was the site of five nuclear weapons tests: four were conducted in mid-1962 and one underground test was conducted in 1964. Two of these were atmospheric tests, two were cratering experiments, and one was a stemmed underground nuclear test. In 1964, the Lawrence Livermore National Laboratory used the area for a Plowshare-sponsored test using chemical high explosives to investigate the potential use of nuclear explosives for ditch digging in dense hard rock.

Area 19—This area, within the Nuclear Test Zone, occupies 388 km^2 (150 mi^2) in the northwest corner of the NTS. Area 19 was developed for high-yield underground nuclear tests. No atmospheric nuclear tests were conducted in Area 19. From the mid-1960s through 1992, a total of 35 underground nuclear tests were conducted.

There are five stockpile stewardship emplacement holes in Area 19 (Appendix A, Figure A-1).

Area 20—This area, within the Nuclear Test Zone, occupies 259 km^2 (100 mi^2) and is in the extreme northwest corner of the NTS. Area 20, like Area 19, was developed in the mid-1960s as a suitable location for high-yield underground nuclear tests. No atmospheric nuclear tests were conducted in Area 20. Three underground nuclear tests in the megaton and greater yield range were carried out on Pahute Mesa between 1966 and 1976. These tests were the well-publicized Boxcar, Benham, and Handley events. From the mid-1960s through 1992, a total of 46 contained, underground nuclear tests were conducted in Area 20. All of these Pahute Mesa tests have consisted of single nuclear devices being detonated in drilled emplacement holes.

In addition to weapons development tests, one nuclear test detection experiment and three Plowshare tests were conducted on Pahute Mesa. The Plowshare tests in Area 20 included the nuclear cratering experiments Palanquin, Cabriolet, and Schooner. Palanquin, detonated in the spring of 1965, was the first nuclear test on Pahute Mesa.

There are two stockpile stewardship emplacement holes in Area 20 (Appendix A, Figure A-1).

Area 21—There is no Area 21 on the NTS.

Area 22—This area, within the Reserved Zone, occupies 83 km^2 (32 mi^2) in the southeastern corner of the NTS and serves as the main entrance area. Before 1958, this area included Camp Desert Rock, a Sixth Army installation used for housing troops

taking part in military exercises at the NTS. After 1958, the camp was essentially removed, with the exception of the Desert Rock Airport. In 1969, the runway was extended to a length of 2,286 m (7,500 ft). The airport currently is open, but provides no services.

Area 23—This area, within the Reserved Zone, occupies 13 km^2 (5 mi^2) in the southeastern portion of the NTS and is the location of the largest operational support complex. Mercury was established in 1951 and serves as the main administrative and industrial support center at the NTS. Permanent structures and services include housing and feeding, laboratory, maintenance, communication and support facilities, computer facilities, warehouses, storage yards, motor pools, and administrative offices. Mercury is located approximately 8 km (5 mi) from U.S. Highway 95.

The Area 23 Class II sanitary landfill, located just west of Mercury, is open to receive all types of nonhazardous solid waste. Wastes are compacted and covered to form layers. The Area 23 landfill receives approximately 830 tons of solid waste annually. The landfill is an open, rectangular pit with steep, nearly vertical sides. The current capacity of the landfill is approximately 4.5×10^5 cubic meters (m^3) (5.9×10^5 cubic yards [yd^3]).

Area 24—There is no Area 24 on the NTS. However, Las Vegas and North Las Vegas are sometimes referred to as Area 24.

Area 25—This is the largest area on the NTS. It occupies some 578 km^2 (223 mi^2) in the southwestern corner of the site and includes an entrance gate to the NTS.

Located roughly in the center of Area 25, Jackass Flats was the site selected for a series of ground tests of reactors, engines, and rocket stages as part of a program to develop nuclear reactors for use in the nation's space program. In the early 1960s, the Atomic Energy Commission and the National Aeronautics and Space Administration negotiated an interagency agreement to establish and manage a test area at the NTS, designated as the Nuclear Rocket Development Station. These facilities, inactive since 1973, remain today in various stages of disrepair. They consist of three widely separated reactor test stands; two maintenance, assembly, and disassembly facility buildings; a Control Point complex; an administrative area complex; and a radioactive materials storage area.

Area 25 is divided into multiple zone categories: Yucca Mountain Site Characterization Zone; Research, Test, and Experiment Zone; and Reserved Zone. The Yucca Mountain Site Characterization Zone within the boundaries of the NTS represents a land assignment area for site characterization activities. The former Nuclear Rocket Development Station administrative area complex in Area 25 has been rededicated as the Yucca Mountain Site Characterization Central Support Site. Limited Yucca Mountain characterization activities are also conducted off site and beyond Area 25. Similarly, the NTS has monitoring activities off site. The Research, Test, and Experiment Zone in Area 25 is used by the U.S. Army's Ballistic Research Laboratory for depleted uranium testing. Two classifications of tests are conducted under this program, open-air tests and X-tunnel tests. These tests include hazard classification and system tests. Research sites within the Reserved Zone include the Treatability Test Facility and Bare Reactor Experiment Nevada (BREN) Tower. The Treatability Test Facility was established in Area 25 for bench-scale testing of physical processes for separating plutonium and uranium from contaminated soils.

Area 25 was used in the early 1980s for MX (Peacekeeper) missile siting studies and canister ejection certification tests.

The 465-m (1,527-ft) BREN Tower has been used intermittently by a number of organizations to conduct sonic-boom research, meteorological studies, and free-fall/gravity-drop tests. More recently, the facility has been used in support of the Brilliant Pebbles program, as well as in studies to develop the technology and measurement techniques for advanced infrared imaging from space satellites. A Brilliant Pebble is a relatively small computer-operated, rocket-powered vehicle that uses sensors and a small laser to detect and

track an oncoming ballistic missile, which the Brilliant Pebble vehicle is designed to destroy by kinetic energy.

The Rock Valley Study Area, not shown on the map, is located south of Jackass Flats Road on the southern boundary of Area 25. This location was selected in 1960 for controlled studies relating to the effects of radiation on a desert ecosystem. During the past three decades, these fenced study plots have been used by a number of government-sponsored scientists, as well as students and others conducting environmental research projects and experiments.

Portions of the Area 25 Reserved Zone are used by the military for land navigation and training exercises.

Area 26—This area, within the Reserved Zone, occupies 57 km^2 (22 mi^2) in the south-central area of the NTS. The southern portions of this area were used in the past for nuclear-powered ramjet engine tests known as Project Pluto. The residual test facilities include a control point, test bunker, compressor house and air-storage facilities, and a disassembly building.

Area 27—This area, within the Critical Assembly Zone, occupies 130 km^2 (50 mi^2) in the south-central portion of the NTS. Area 27's principal assembly facilities include five assembly bays, four storage magazines, two combination assembly bay/storage magazines, and three radiography buildings. The Area 27's critical assembly facilities are an alternate to the Device Assembly Facility.

Area 27 was also used in the past for the Super Kukla Reactor Facility.

Area 28—No longer in existence, the Area 28 designation formerly applied to a portion of the NTS that has since been absorbed into Areas 25 and 27.

Area 29—This area, within the Reserved Zone, occupies 161 km^2 (62 mi^2) on the west-central border of the NTS. The site of a communications repeater station for the NTS is located in the Shoshone Mountains.

Area 30—This area, within the Reserved Zone, occupies 150 km^2 (58 mi^2) and, like Area 29, is on the western edge of the NTS. Area 30 also has fairly rugged terrain and includes the northern reaches of Fortymile Canyon. In the past, Area 30 has had limited use in support of the nation's nuclear testing programs, but in the spring of 1968 it was the site of Project Buggy, the first nuclear row-charge experiment in the Plowshare Program.

SURROUNDING LAND USE—Figure 4-4 shows the status and use of lands around the NTS. The NTS is surrounded by other federal lands. The NTS is bordered by the NAFR Complex on the north, east, and west and by U.S. Bureau of Land Management lands on the south and southwest.

Beyond the federal lands that surround the NTS, principal land uses in Nye County in the vicinity of the NTS include mining, grazing, agriculture, and recreation. Currently, Nye County does not have a land-zoning ordinance; however, measures are being reviewed by the Board of Supervisors for approval. Of the total land area within Nye County, only a small number of isolated areas are under private ownership and, therefore, subject to general planning guidelines. Urban and residential land uses occur beyond the immediate vicinity of the NTS, in fertile valley regions such as the Owens and San Joaquin to the west, the Virgin River to the east, Pahrump to the south, the Moapa River to the southeast, and Hike and Alamo to the northeast. The nearest population centers surrounding the NTS are Amargosa Valley, Indian Springs, Beatty, and Pahrump Valley. These are all rural communities, with Amargosa Valley being the closest to the NTS. Las Vegas is the closest major metropolitan area and is located about 105 km (65 mi) southeast of the NTS. Amargosa Valley (formerly Lathrop Wells) lies 3 km (2 mi) south of the NTS border.

Clark County, to the southeast, consists of 20,461 km^2 (7,900 mi^2), of which about 95 percent is owned by the federal government. The primary land uses of these federal lands include open grazing, mining, and recreation. The remaining 5 percent of the land in Clark County is used for state and local government, residential, industrial, and commercial purposes. Numerous

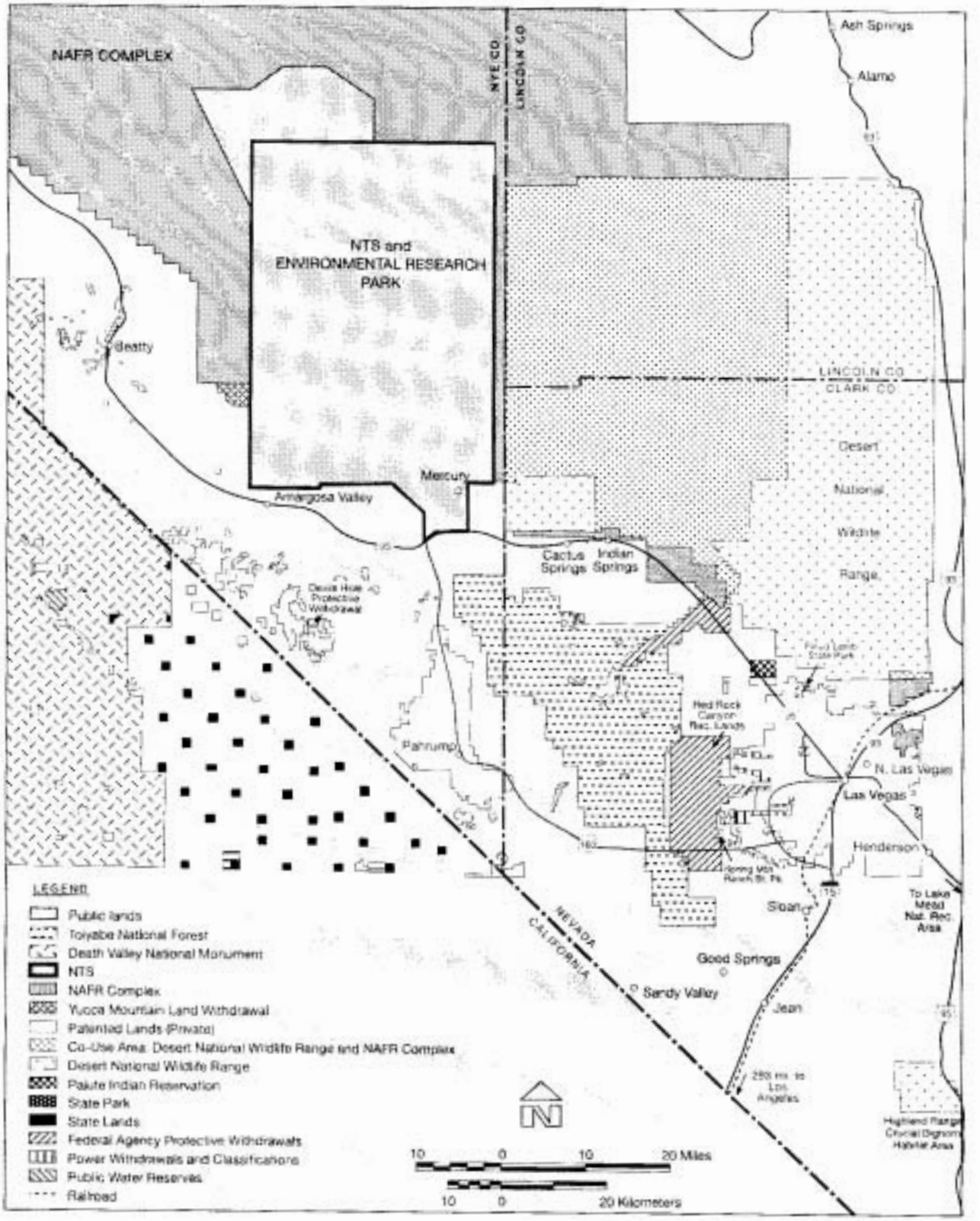


Figure 4-4. NTS and surrounding land use

national, state, and local public recreation areas exist within the region. Outdoor recreational areas include the Lake Mead National Recreation Area, located 121 km (75 mi) east; the Death Valley National Monument, located 19 km (12 mi) to the west-southwest; the Red Rock National Conservation Area, located 64 km (40 mi) to the southwest; and the Desert National Wildlife Range, located 5 km (3 mi) east. Portions of the Desert National Wildlife Range overlap the NAFR Complex and come within 3 km (2 mi) of the boundary of the NTS. State parks include Spring Mountain Ranch State Park, located 80 km (50 mi) southwest, and the Floyd R. Lamb State Park, located 72 km (45 mi) southwest. Other recreational areas include year-round campsites and picnic areas in the Toiyabe National Forest, located 40 km (25 mi) to the southwest. In addition, numerous camping and fishing sites that are used during the spring, summer, and fall months are located in the outlying areas north of the site.

The North Las Vegas Facility occupies approximately 80 acres in the city of North Las Vegas, Nevada. The North Las Vegas Facility is zoned for general industrial use and is bordered on the north, south, and east by general industrial zoning. The western border of the site is adjacent to a street, which acts as a buffer zone, separating the site from fully-developed, single family, residential-zoned property.

The North Las Vegas Facility is divided into three distinct areas. The first area covers 20 acres and houses support for the Lawrence Livermore National Laboratory test program. The second area covers 20 acres and houses support for the Los Alamos National Laboratory test program. The third area covers 38.3 acres and houses a computer center and administrative and engineering support functions.

4.1.1.3 Site-Support Activities. The following sections provide a brief discussion of the current NTS site-support services (infrastructure). Additional details regarding site support are provided in Section A.6 of Appendix A.

FACILITIES– The NTS contains approximately 1,500 buildings that provide approximately 269,419 m^2 (2.9 x 10^6 ft^2) of space. A breakdown of the types of facilities and their cumulative space is given in Table 4-2. Many of these facilities have been either mothballed or abandoned because of the reduction of program activities at the NTS.

SERVICES– Services available at the NTS include law enforcement and security, fire protection, and health care.

Law Enforcement and Security– Law enforcement on the NTS is provided by the Nye County Sheriff's Department through a substation located at Mercury. Security enforcement is the responsibility of Wackenhut Services, Inc. The NTS is a controlled-access area. Wackenhut Services, Inc., a private contractor, provides sitewide protective services following guidelines established by the DOE/NV Safeguards and Security Division.

The DOE currently contracts with the Nye County Sheriff's Department for five officers at the NTS substation to assist in civilian law enforcement. There is no holding facility at the NTS; most people arrested at the NTS are transported to Pahrump. If the individual cannot pay bail, he is sent to Tonopah, Nevada (Willen, 1995).

Security facilities at the main gate include a badging and security office. Other facilities include firing ranges, an ammunition dump, a security training facility, and an obstacle course. Mobile ground patrols provide security throughout the site. Helicopters and light aircraft are used to check perimeter barricades and other remote locations in the forward area. Teams of armed guards are available to respond to emergency situations and to escort the movement of nuclear explosives and special nuclear materials within the NTS. Response teams are equipped with all-terrain, high-speed armored vehicles (Raytheon Services Nevada, 1994b).

Fire Protection—The fire protection capacity of the NTS is structured to accommodate current mission requirements, with a self-contained fire-fighting department responsible for suppression and prevention. Other services include rescue, hazardous material response, training of fire personnel, fire prevention inspection, installation of all fire

Table 4-2. Building space on the NTS

Functional Unit	Square Meters	Square Feet
Administrative	72,081	775,874
Temporary Housing	22,499	242,178
Storage	68,886	741,483
Services	62,667	674,539
Research and Development	38,215	411,338
Reactor and Accelerator	305	3,286
Other Known Assets	101	1,088
Other Storage	3,713	39,971
Industrial/Production Process	3,290	35,418
Service Structures	205	2,208
Communication and Related Systems	797	8,575
Distribution Systems	36	390

extinguishers at the NTS, and fire prevention awareness programs (Raytheon Services Nevada, 1994).

A fire department staffed with support-contractor personnel provides 24-hour fire-fighting services for the NTS. In addition, fire protection and crash rescue services are provided for two airstrips, upon request. Within site boundaries, the fire department provides support during the transportation, transfer, and storage of toxic and flammable gases. The fire department maintains one fire station in Mercury. Support equipment used by the fire department include one engine company, one tanker truck, and one UNMOG used for wildlands support (Raytheon Services Nevada, 1994).

Health Care— An eight-bed dispensary in Mercury serves as a clinic for the NTS. Facilities include rooms for emergency care, examination and treatment, X-ray, and associated darkroom equipment, as well as offices and storage. The facility can respond rapidly to normal and emergency situations, including in-patient treatment, emergency surgery, and radiation accidents. First-aid stations are located near field activities so that personnel can be treated quickly. Ambulances are available for emergencies that occur on the site, in nearby communities, or on highways (Raytheon Services Nevada, 1994).

UTILITIES—The utilities at the NTS include water systems, wastewater systems, and electrical systems.

Water Systems—The NTS is presently served by a water system consisting of 11 operating wells for potable water, one well for non-potable water (Table 4-3), 27 usable storage tanks, 13 usable construction water sumps, and 6 water transmission systems (with 5 permitted water distribution systems). The wells are not being used to their full capacity and are capable of producing much more water if needed. Additional inactive wells are available (Table 4-4) or wells may be drilled and developed if increased water production is required. Wells, sumps, and storage tanks are used, as required, to support construction or operational activities. Five water storage tanks are currently under construction at the NTS. Domestic, construction, and fire protection water are supplied by this system through over 161 km (100 mi) of supply line. Potable water is trucked to support facilities that are not connected to the potable water

Table 4-3. Active water supply wells on the NTS

Well*	Water Service Areas	Area Served	Type	Status	Sumps & Reservoirs Storage Capacity		Flow Rate	
					L	gal	L/min	gal/min
U-20a	A	19, 20	Nonpotable	Active	154,400,000	40,780,000	1,060	280
8	B	2, 12	Potable	Active	2,100,000	553,000	2,045	540
UE-16d	B	1	Potable	Active	None	None	735	194
C	C	6, 3	Potable	Active	4,880,000	1,290,000	1,100	290
C-1	C	6, 3	Potable	Active	See Well C	See Well C	1,100	290
4 and 4a	C	6	Potable	Active	See Well C	See Well C	2,651	700
5b	C	5, 22, 23	Potable	Active	2,700,000	710,000	871	230
5c	C	5, 22, 23	Potable	Active	190,000	50,000	871	230
J-12	D	25	Potable	Active	13,510,000	3,555,000	2,878	760
J-13	D	25	Potable	Active	190,000	50,000	2,574	680
Army Well 1	C	22, 23	Potable	Active	None	None	371	98

* The locations of these wells are shown on Figure 4-5

Table 4-4. Inactive water supply wells on the NTS

Well[a]	Water Service Areas	Area Served	Type	Status	Sumps & Reservoirs Storage Capacity		Flow Rate	
					L	gal	L/min	gal/min
UE-19c	A	19, 20	Nonpotable	Inactive	13,984,000	2,900,000	1,363	360
UE-15d	B	15	Nonpotable	Inactive	56,781	15,000	1,022	270
2	B	2, 4, 7, 9, 10	Potable (chlorinator)	Inactive (pump failed)	3,293,308	870,000	643	170
UE-1r	B	1	Nonpotable	Inactive	None	None	1,022	270
UE-5c	C	5	Nonpotable	Active for environmental sampling only	None	None	1,325	350
5a	C	5	Potable	Abandoned	None	None	341	90
F	C	27	Nonpotable	Inactive	None	None	901	238
3	C	3	Nonpotable	Inactive	None	None	None	None
J-11	D	25	Potable	Abandoned	See Well J-12[b]	See Well J-12[b]	None	None

[a] The locations of these wells are shown on Figure 4-5.

[b] Table 4-3.

system. The NTS used approximately 1.7 billion liters (L) (457 million gallons [gal]) of water in 1994. Mercury was the primary user of this water, using 40 percent of the total water pumped. The forward areas of the NTS used approximately 7.0×10^7 L (1.9×10^7 gal).

For evaluation purposes, the NTS water system has been divided into four water service areas (A, B, C, and D) according to the location of the water system and support facilities (Figure 4-5). Water service area A includes NTS Areas 19 and 20; service area B covers Areas 2, 4, 7, 8, 9, 10, 12, 15, 17, and 18; service area C supplies Areas 1, 3, 5, 6, 11, 22, 23, 26, and 27; and service area D supplies water to the remaining areas of the NTS.

Non-potable water distribution in water service area A is through an aboveground 152 millimeter (mm) (6-inch [in.]) pipe line that runs along the Pahute Mesa Road between Well UE-19c, the Area 20 camp, and Well U-20a. Water in this system must maintain a constant flow to prevent freezing in the extreme temperatures.

Water service area B has two potable water distribution systems to serve water needs in this area. The Area 17 support facilities are supplied by the system from Well UE-16d. The other transmission system in this area feeds from Well 8 to the Area 12 camp through 152-mm (6-in.) pipe line and 102-mm (4-in.) pipe line and then into the Area 2 facilities through 152-mm (6-in.) pipe line connecting to Well 2.

The two distribution systems in water service area C feed several wells and use 203-mm (8-in.), 102-m (4-in.), and 152-mm (6-in.) underground pipelines. The Area 6 distribution system is supplied by Wells 4, C, C1, and 4a, and provides potable water service to the Device Assembly Facility, the Yucca Lake facilities, the Control Point, and the Well 3 yard. This system contains segments of old asbestos pipe. Area 5, Mercury, and Desert Rock facilities are supplied by a system connecting Wells 5b, 5c, and Army Well 1.

Wells J-12 and J-13 supply potable water to the single transmission system in water service area D. This system (in NTS Area 25) supplies several reservoirs and the former Nuclear Rocket Development Station facilities through 152 mm (6-in.), 203-mm (8-in.), and 304-mm (12-in.) pipe lines.

Wastewater Systems—Wastewater on the NTS is disposed of either by a combination septic tank and leach field system or by a lagoon system. At areas not serviced by a permanent wastewater system, portable sanitary units are provided. The size and type of wastewater systems used are determined by anticipated discharge and cost effectiveness.

Electrical System—Electric power is delivered to the NTS at the Mercury switching center in Area 22 by a primary 138-kilovolt (kV) supply line from the Nevada Power Company system near Las Vegas. A second Nevada Power Company-owned 138-kV line connects the Mercury switching center to the Jackass Flats substation in Area 25. Valley Electric Cooperative, serving the Pahrump, Nevada area also has a transmission connection to the Jackass Flats substation. The dual transmission and station connections provide the NTS with the ability to receive service from either transmission source depending on contractual arrangements. A DOE-owned 138-kV loop extends this primary power supply into the NTS forward areas where smaller, lower-voltage distribution lines feed power to individual facilities. During the last several years, the NTS has been provided power under contracts with Nevada Power Company and the Western Area Power Administration. Additionally, the DOE has periodically operated oil-fired diesel generators at Area 25 for peak and back-up power supply purposes (Raytheon Services Nevada, 1994).

Electric power on the NTS is carried over 426 km (265 mi) of transmission and subtransmission lines (Raytheon Services Nevada, 1994). The power subtransmission uses an extensive 34.5-kV system and two small 69-kV systems. These systems provide distribution voltages of 4.16 kV and 12.47 kV at various substations. Distribution voltages are transformed to both 480/277-volt and 208/120-volt three-phase systems for most NTS loads, with a few single-phase 120-volt services.

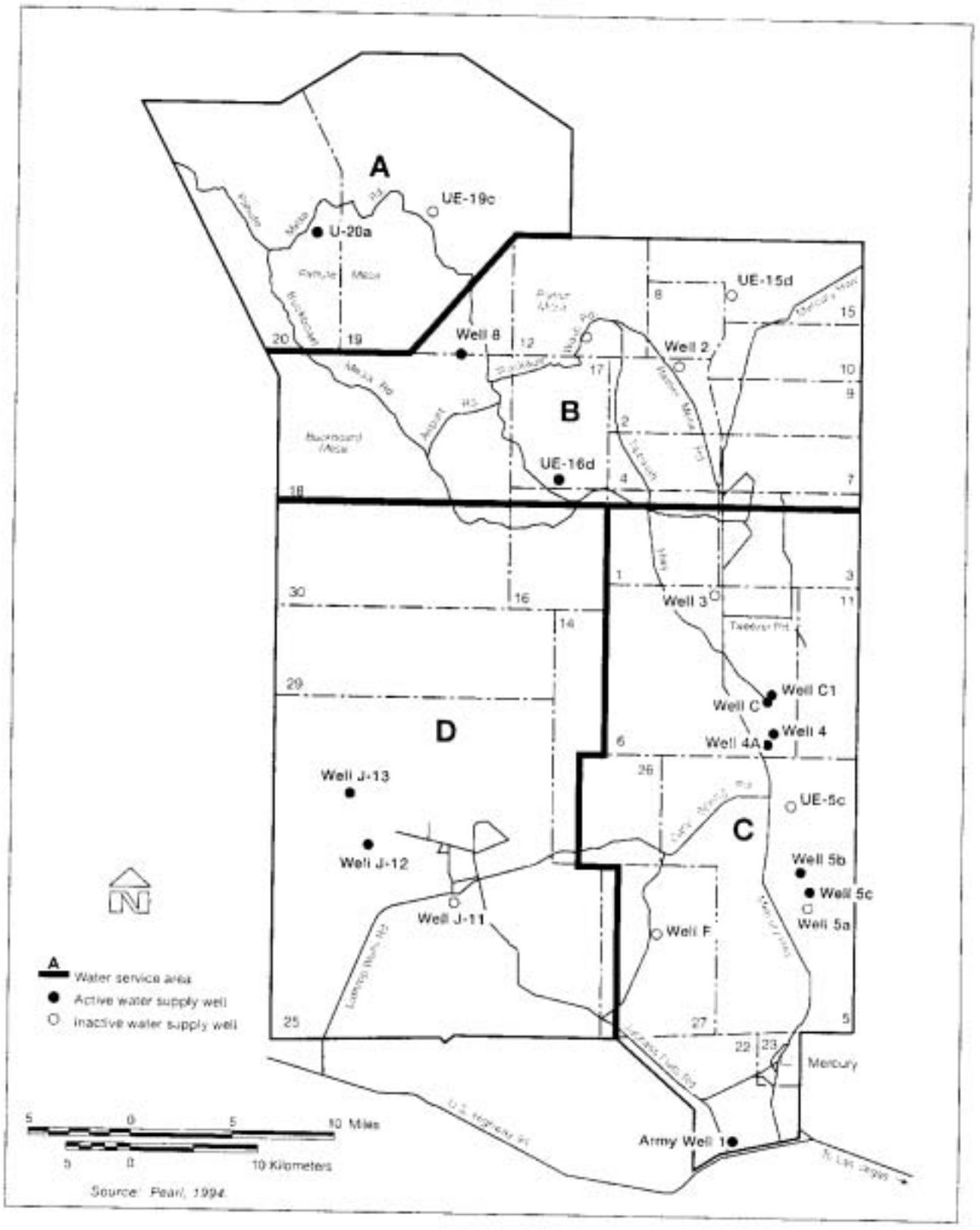


Figure 4-5. Existing water service areas and supply wells on the NTS

Power transmission/subtransmission lines and substations located on the NTS are shown on Figure 4-6.

COMMUNICATIONS—Communication systems cover not only the entire area of the NTS, but also reach far beyond its boundaries. The NTS telecommunications system employs digital telephone switching, fiber-optic transmission, microwave, two-way radio, voice privacy, data transmission systems, general- and special-purpose data communications, and teleconferencing services (secure as necessary).

Communications support also includes automated data processing equipment, automated office support systems, and information systems. Computer systems encompass general purpose, stand alone, data management, word processing, engineering, computer-aided drafting, and computer-aided manufacturing.

4.1.1.4 Airspace. Airspace must be managed and used in a manner that best serves the competing needs of commercial, general, and military aviation interests. The Federal Aviation Administration is responsible for the overall management of airspace and has established different airspace designations that are designed to protect aircraft during flights to or from an airport, transiting between airports, or operating within "special use" areas identified for defense-related purposes. Rules of flight and air traffic control procedures have been established to govern how aircraft must operate within each type of designated airspace. All aircraft operate under either instrument flight rules or visual flight rules.

The type and dimension of individual airspace areas established within a given region and their spatial and procedural relationship to one another are contingent upon the different aviation activities conducted in that region. When any significant change in airspace use is planned for a region, the Federal Aviation Administration will reassess the airspace configuration to determine if such changes will adversely affect (1) air traffic control systems and/or facilities, (2) movement of other air traffic in the area, or (3) airspace already designated and used for other purposes (i.e., military operating areas or restricted areas). Approximately 16,000 sorties were flown on the Tonopah Test Range by the DOE in Fiscal Year 1994. These sorties included employee transportation and activities associated with Defense and Work for Others Programs.

Airspace associated with the NTS and vicinity is shown on Figure 4-7. The NTS airspace is part of the NAFR Complex, which includes 4 restricted areas, the desert military operating areas/air traffic control assigned airspace, 2 low-altitude tactical navigation areas, 29 military training routes, and 3 air refueling routes. Greater detail of the airspace configuration is shown on Figure 4-8. Restricted area R-4808 is the airspace over the NTS. Airspace control over portions of the restricted areas and all desert military operating areas has been delegated to the Nellis Air Traffic Control Facility by the Federal Aviation Administration Air Route Traffic Control centers serving the surrounding airspace. The Nellis Air Traffic Control Facility controls the entry and exit of military aircraft in this airspace, while the Range Control Center monitors mission activities within this airspace. Because activities in restricted areas can be hazardous, nonparticipating aircraft are restricted from this airspace except when released by the controlling agency for joint use. The Nellis Air Traffic Control Facility may release and authorize use of R-4806 and R-4807 for nonparticipating aircraft when these areas are not required for defense-related activities. Restricted areas R-4808 and R-4809 are managed by the DOE and are never authorized for use by civilian aircraft.

The desert military operating areas comprise the eastern half and northern portion of the airspace associated with the NAFR Complex. The training conducted within the desert military operating areas consists of high-speed operations, including abrupt aircraft maneuvers and supersonic flight at or above 1,524 m (5,000 ft) above ground level. Within the military operating areas, military aircraft are exempted from the provisions of Federal Aviation Regulation 91.71, which normally restrict abrupt aircraft maneuvers or aerobatics within federal airways and control zones. The desert military operating areas are active during daylight hours Monday through Saturday and at other times by authorization.

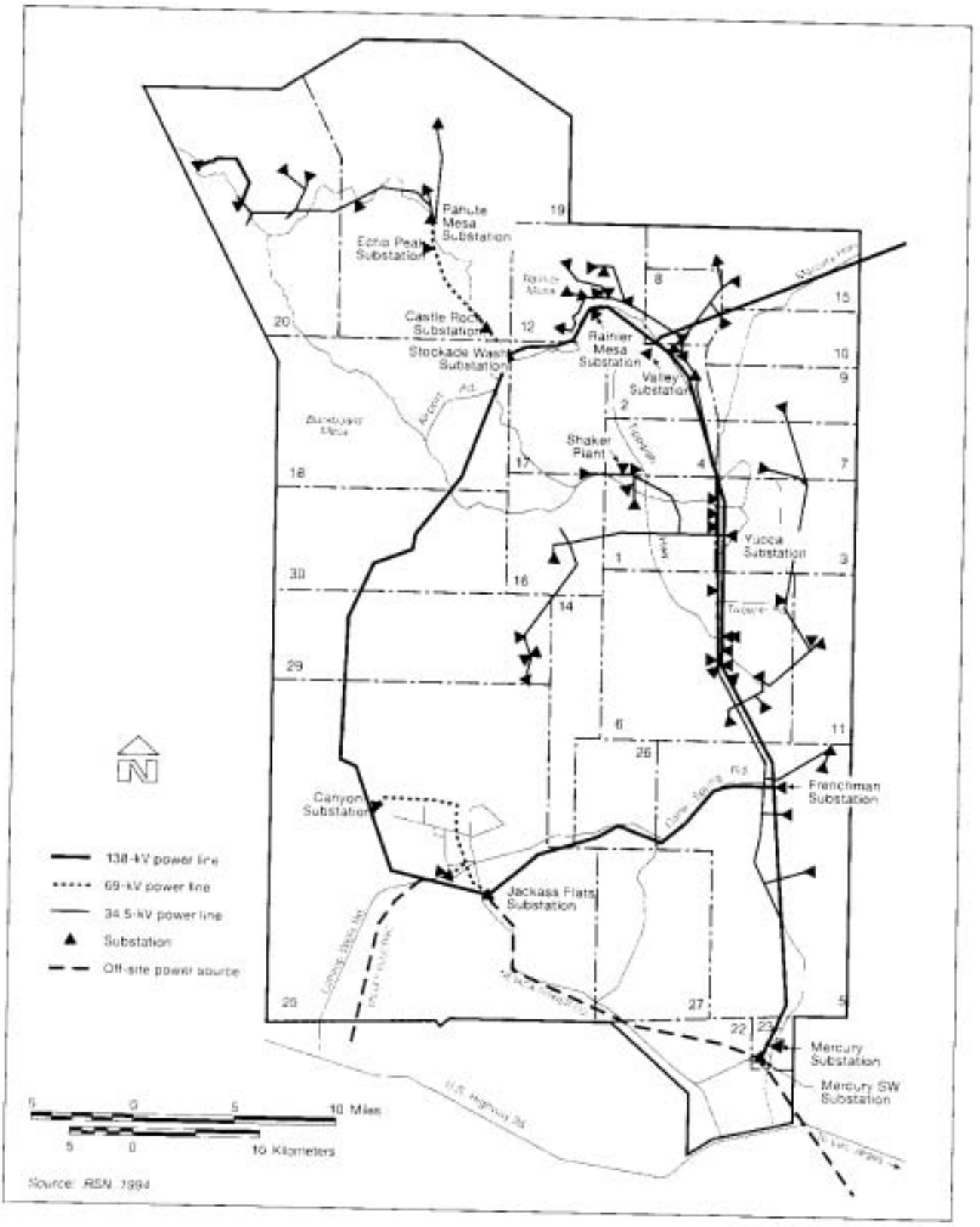


Figure 4-6. NTS sitewide power distribution.

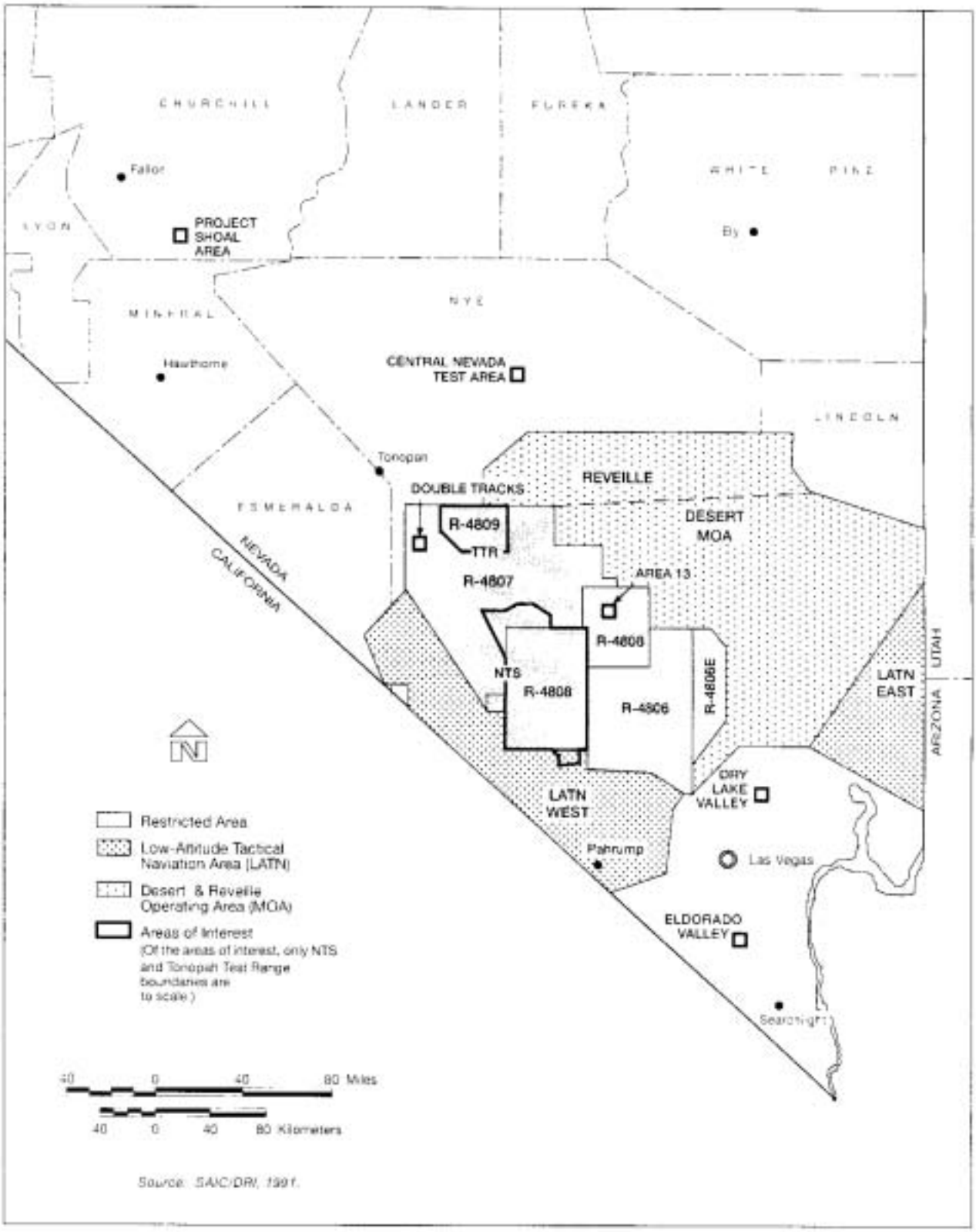


Figure 4-7. NTS and vicinity airspace

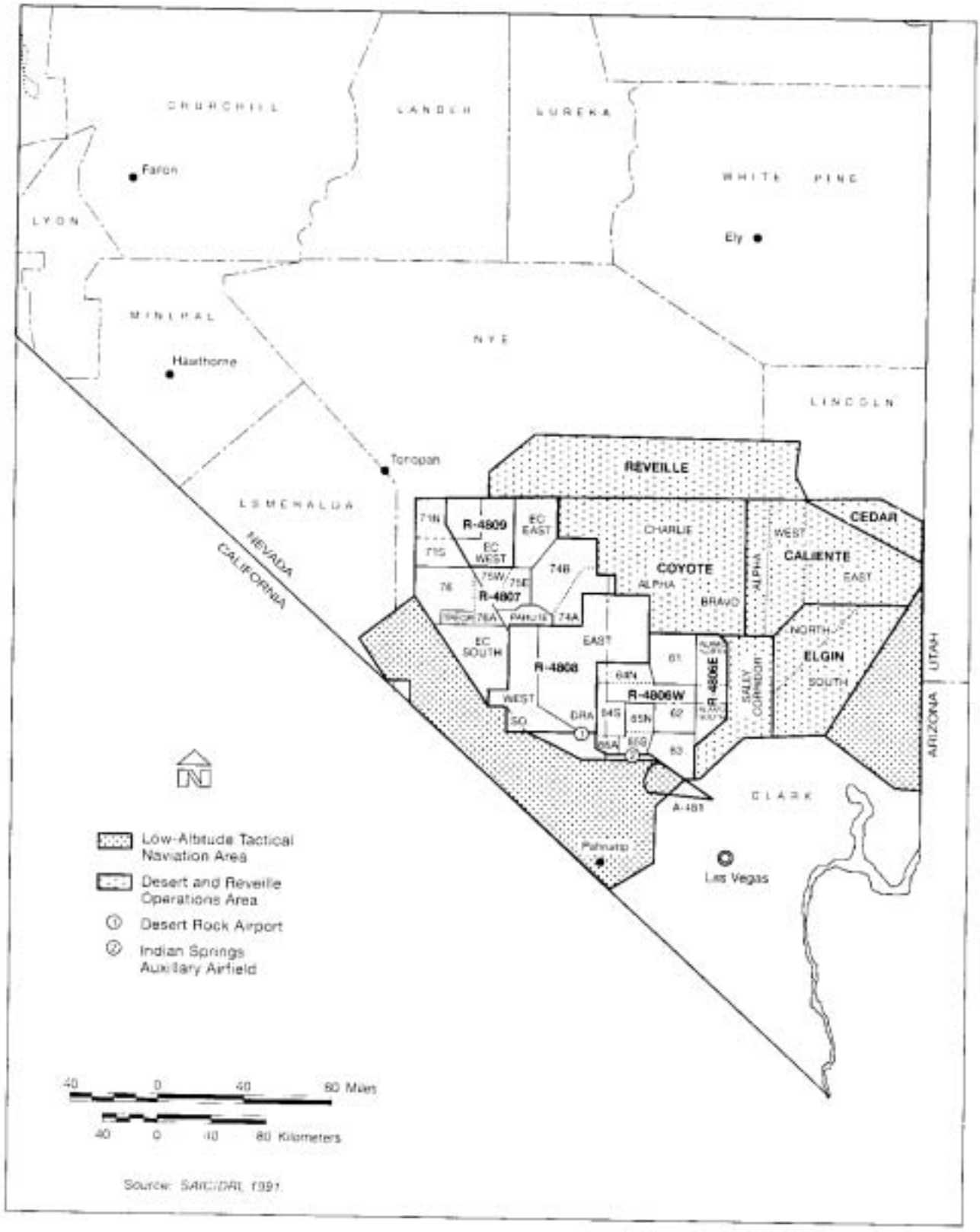


Figure 4-8. Detailed configuration of the NTS and vicinity airspace

Even though military aircraft are scheduled for flight activity within the military operating areas, civilian aircraft flying under visual flight rules can fly through the area. In addition, both military and civilian aircraft operating under instrument flight rules may be cleared through the military operating areas by Nellis Air Traffic Control Facility if in-flight separation can be provided.

The low-altitude tactical navigation areas are unrestricted airspace used intermittently by the military. These areas allow A-10 aircraft to practice random tactical navigation and formations between 30 m (100 ft) and 457 m (1,500 ft) above ground level at airspeeds at or below 250 knots (288 mi/hr).

These areas are normally used when no airspace is available for this type of training within the NAFR Complex.

The military training routes and air refueling routes are located within or at the boundaries of airspace associated with the NAFR Complex. Several of these military training routes overlap or are reversals of each other. Generally, military training routes are established below 3,048 m (10,000 ft) mean sea level for operations at speeds in excess of 250 knots (288 mi/hr). However, some military training route segments may be at higher altitudes because of terrain or climb and descent requirements. There are instrument-flight-rule military training routes and visual-flight-rule military training routes. The normal width of an instrument-flight-rule military training route from the centerline is 8 km (5 mi) and 8 to 16 km (5 to 10 mi) for visual-flight-rule military training routes, although some segments of these routes may be as narrow as 3 km (2 mi) and as wide as 32 km (20 mi). Figure 4-9 shows the complexity of military training routes.

There are several other types of designated airspace around the NAFR Complex/Las Vegas area. The following are brief descriptions of these types:

- Indian Springs Air Force Auxiliary Airfield Class D airspace encompasses a 8 km (5-statute mile) radius around the airfield from the surface to 914 m (3,000 ft) aboveground level within which aircraft are provided air traffic control service by the Indian Springs tower. The tower can advise civilian aircraft of military operations occurring at Indian Springs

- Desert Rock Airport is a controlled, but unmanned, airfield operated by the DOE, located southwest of Mercury along U.S. Highway 95 (Figure 4-8). Only periodic flights involving general-aviation single-engine to multi-engine jet aircraft occur at this airport

- Las Vegas Class B airspace encompasses Nellis Air Force Base and McCarran International Airport. All aircraft operating within the Class B airspace must be in contact with an air traffic control facility. In the northern portion of the Class B airspace, air traffic control is provided by the Nellis Approach Control. The southern portion is controlled by the Las Vegas Approach Control

- Alert Area 481 is a designated airspace extending from Nellis Air Force Base westward to advise civilian aviation of high-density military operation transiting between the base and the NAFR Complex. The alert area begins at 2,134 m (7,000 ft) mean sea level and extends to a ceiling of 5,791 m (19,000 ft) mean sea level.

The Nevada Airport System Plan (NDOT, 1995) indicates that in 1994 there were 824,570 civilian aircraft operations in Nevada. In 1994, there were 2,031 general aviation aircraft based at airports in Nevada, the locations of which are indicated in Figure 4-10.

Because of airspace restrictions associated with the NTS/NAFR Complex, commercial and general aviation aircraft must normally use routes of flight that remain clear of this range complex. With respect to commercial aviation (certificated air carrier operations), flight is generally conducted along an en route "highway" system defined by ground- or space-based radio navigational aids. In the NTS/NAFR Complex area, the federal airways (low altitude) (Figure 4-11) and jet route (high altitude) systems circumvent airspace used for defense-related purposes in a direct manner, or vertical separation is provided between military

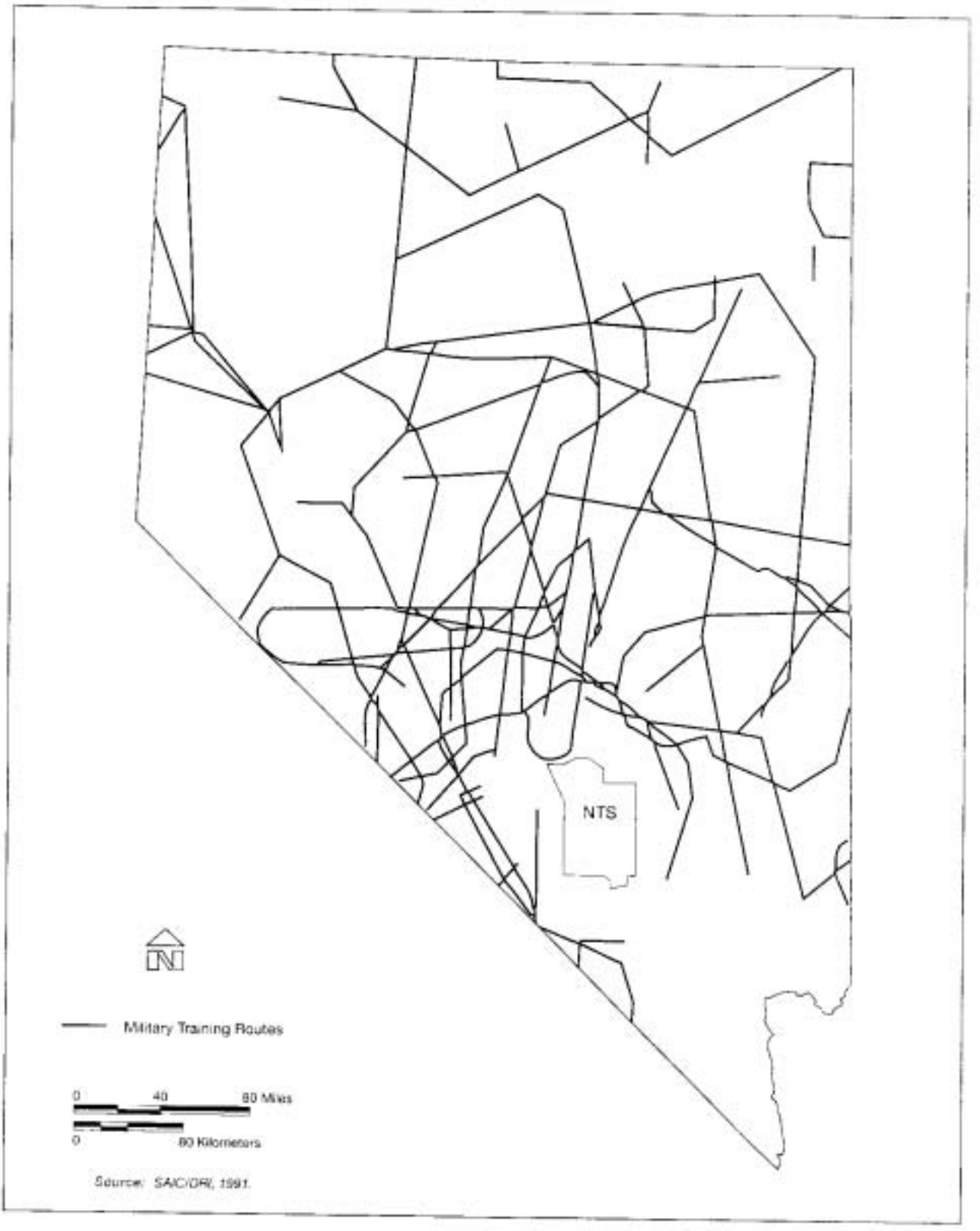


Figure 4-9. Military training routes in Nevada.

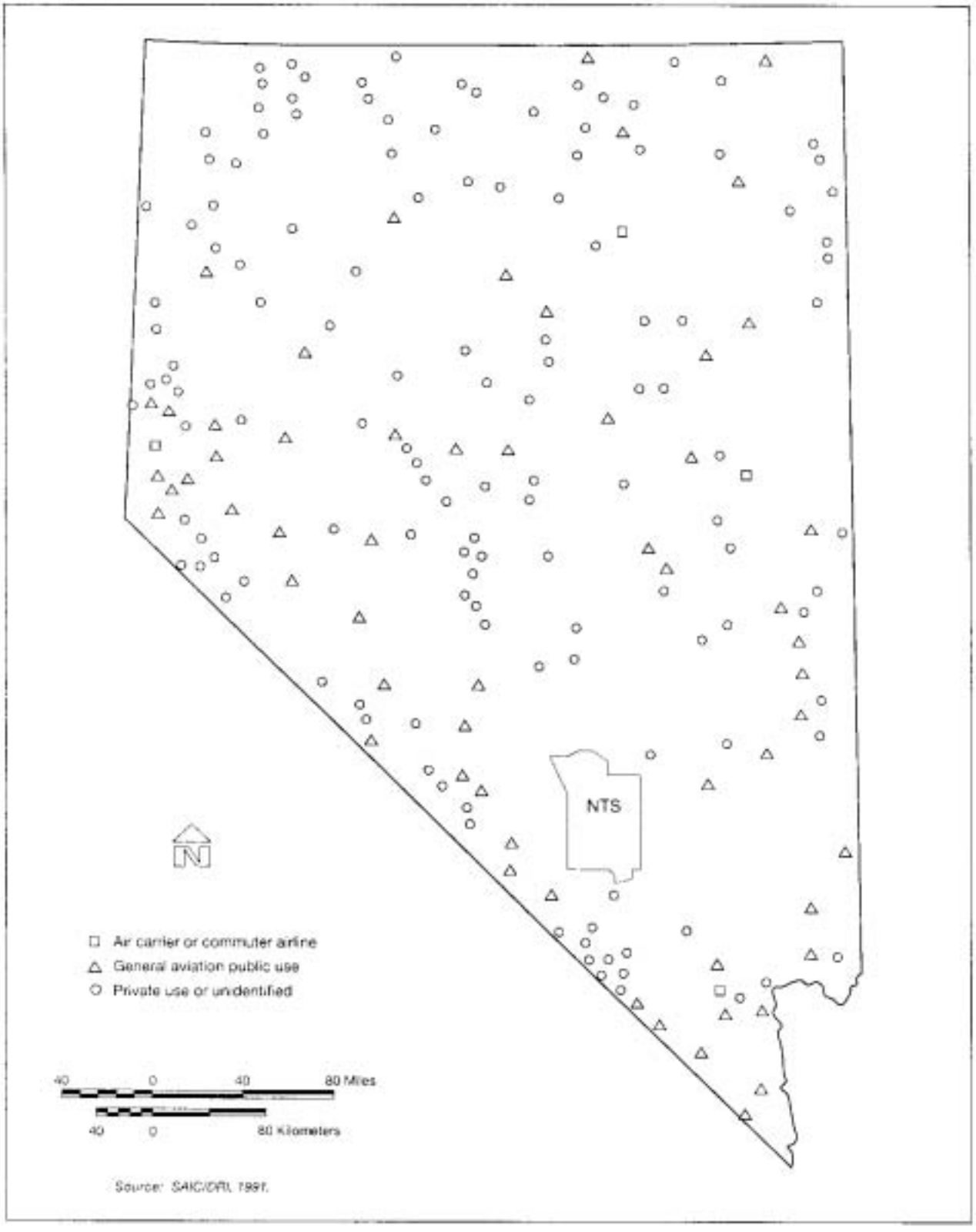


Figure 4-10. Commercial, general, and private aviation airports and airfields in Nevada

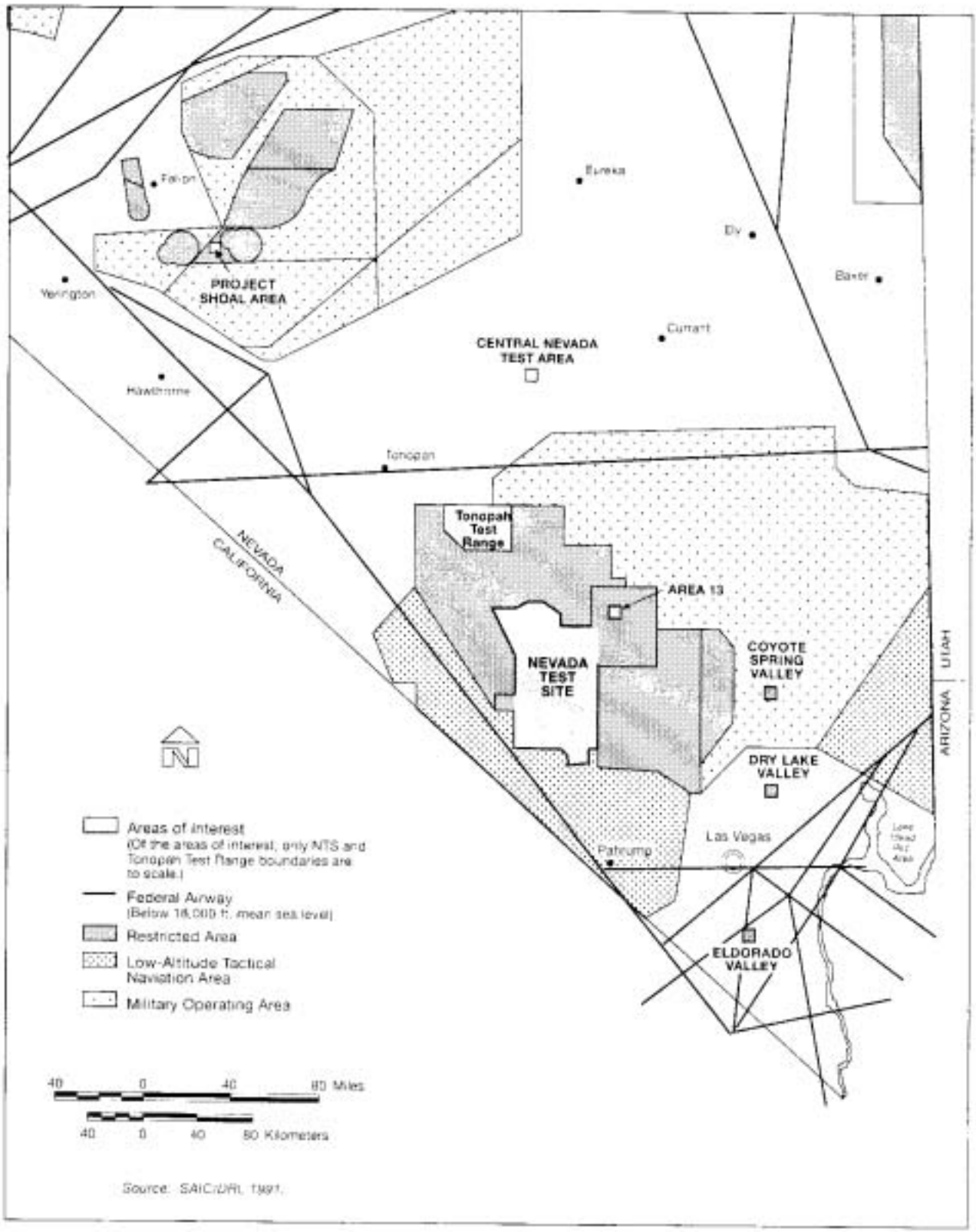


Figure 4-11. Federal low-altitude airways in southern Nevada

aircraft and the en route commercial traffic on these systems (Figure 4-12).

General aviation includes business or corporate air transportation and private, recreational, or training activities. General aviation aircraft operate within the framework of the en route airway system, as well as within the uncontrolled airspace outside the structured airway and terminal airspace. Recreational flying occurs on weekends when airspace is not normally used for defense-related training. However, occasional diversions around defense-related airspace that increase flying distance and fuel consumption may occur.

4.1.1.5 Waste Management Program. Waste Management Program activities include disposal, storage, treatment, closure operations and the activities of the Waste Minimization/Pollution Prevention Program. Each waste and operation type is discussed in this section; the waste Minimization/Pollution Prevention Program is discussed in Appendix C, Section C.6, and is summarized at the end of this section.

Wastes, such as nonhazardous, nonradioactive sanitary, and industrial wastes from the NTS programs are disposed of in several industrial landfills, sewage treatment systems, and septic tank systems located at the NTS. Five types of wastes are managed at the NTS: low-level waste, mixed wastes (transuranic and low-level), hazardous wastes, Toxic Substances Control Act wastes, and nonhazardous solid wastes.

The following sections summarize existing waste management operations by type: disposal, storage, treatment, and closure. Within the discussion of each type of operation, the different waste types managed and the locations of the facilities are identified. All of these wastes are managed in three types of management facilities: treatment facilities, storage facilities, and disposal facilities (Figure 4-13).

DISPOSAL OPERATIONS—In 1961, the Area 5 Radioactive Waste Management Site was established for the disposal of low-level waste from both on-site and off-site DOE generators. The developed area or unit within the Area 5 Radioactive Waste Management Site consists of 17 landfill cells (pits and trenches) and 13 greater confinement disposal boreholes. The operational mixed waste and low-level waste disposal cells within the Area 5 Radioactive Waste Management Site include the following.

- Pits for the disposal of on-site generated mixed waste and low-level waste
- Trenches for the disposal of low-level waste.

Approximately 500,000 Curies (Ci) of low-level waste have been disposed of in Area 5 pits and trenches. High-specific-activity wastes have been disposed of in greater confinement disposal units. Approximately 9.3×10^6 Ci of high-specific-activaty waste, primarily tritium, have been disposed of in greater confinement disposal units in Area 5.

Historically (since the mid-1960s), the Area 3 Radioactive Waste Management Site was used primarily for the disposal of contaminated waste generated from the NTS Atmospheric Testing Debris Disposal Program, which involved the cleanup of atmospheric testing sites. Total volume of waste disposed of in Area 3 as of September 1994 was 3.0×10^5 m^3 (1.1×10^7 ft^3) and consists of tower assemblies, metal cable, miscellaneous metal scrap, and soil from the blading (scraping) of the first few inches of the site to remove the surficial radioactive contamination.

Approximately half of the radioactive waste disposed of in the Areas 3 and 5 Radioactive Waste Management Sites is atmospheric testing debris generated during the cleanup of the NTS aboveground nuclear detonation areas. The remainder of the waste was received from other DOE and defense-related facilities conducting environmental restoration activities, research and development projects, and nuclear weapons production. This waste was generally in the form of soil, construction rubble, compactible trash, glass, plastics, filters, and process residues. Today, Area 3 is used for the disposal of bulk and packaged low-level waste from on-site and off-site DOE generators.

Current waste management disposal cells at the Area 3 Radioactive Waste Management Site are

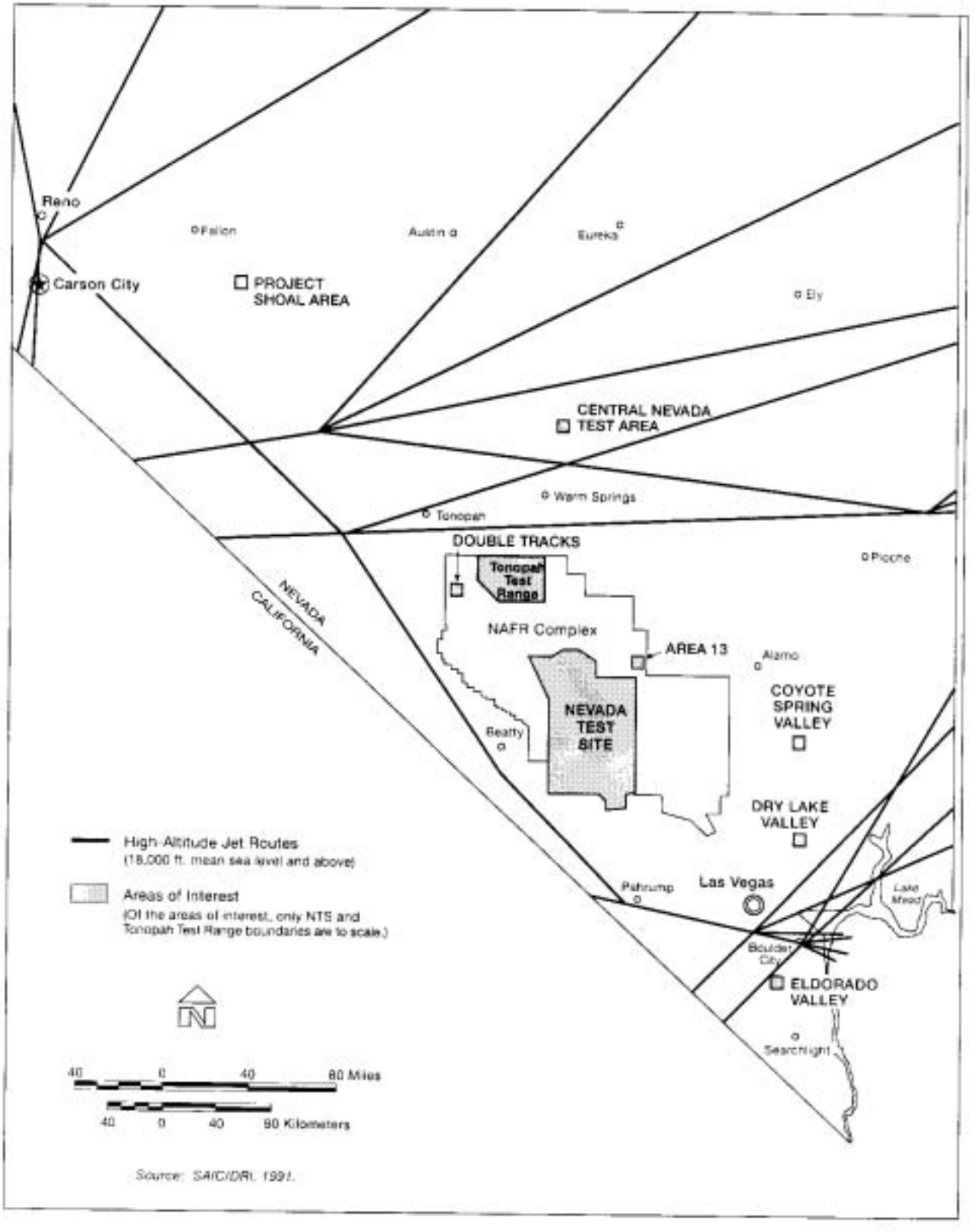


Figure 4-12. High-altitude jet routes in southern Nevada

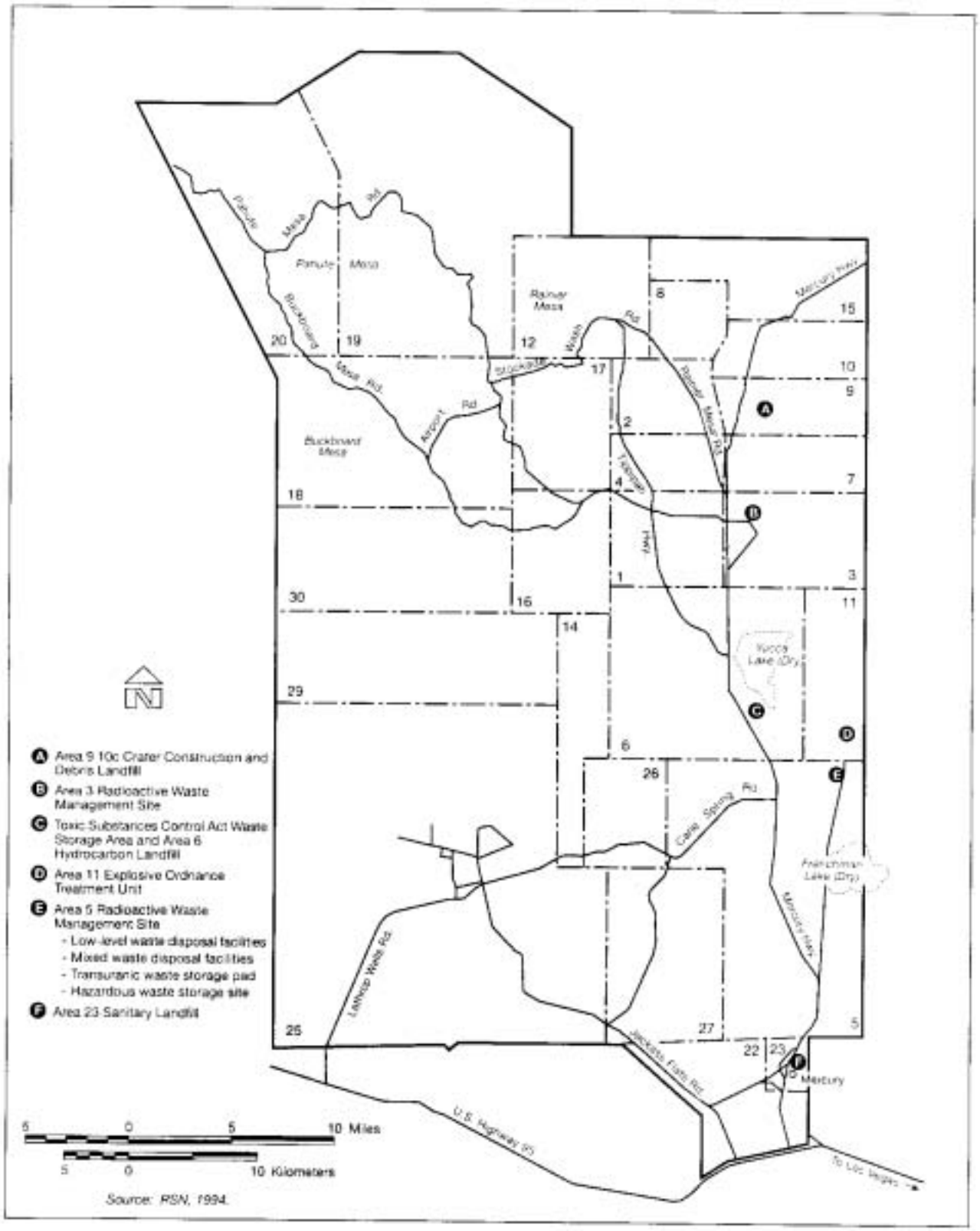


Figure 4-13. Existing treatment, storage, and disposal facilities on the NTS

comprised of four subsidence craters (U-3ax, U-3bl, U-3ah, and U-3at), with areas between craters excavated to make two oval-shaped landfill cells. Conventional landfill methods are used to dispose of waste in each cell; each layer of waste is covered with 1 m (3 ft) of fill before additional waste materials are disposed. The U-3ax/bl disposal cell contains mixed waste and low-level waste. It is inactive, temporarily covered, and awaiting closure. The U-3ah/at cell is currently being used for low-level waste disposal; mixed waste is not accepted. To date, approximately 1,250 Ci have been disposed of in the Area 3 subsidence craters. Three additional subsidence craters are reserved for low-level waste cells: U-3bh, U-3bg, and U-3az.

Several factors were considered in selecting subsidence craters for the disposal of waste. The degree of bulking, sometimes called compaction, that occurs during the collapse of the rubble chimney is an important consideration. Subsidence crater and cavity volumes were compared to establish the changes in the bulk density of the collapsed material. This was done to ensure that the resulting bulk density of the chimney rubble is equal to or greater than the density of the original, undisturbed geologic media. Such siting practices have ensured that additional compaction of the rubble below the waste management unit does not occur (Hawkins and Kunkle, 1996a).

The 13 greater confinement disposal boreholes contain mixed waste; low-level waste; waste similar to greater-than-Class C low-level waste; high-specific-activity low-level waste; and transuranic and transuranic mixed wastes. Limited quantities of transuranic waste were also disposed of in Trench 4C and in greater confinement units located in Area 5.

Since the 1980s, hazardous waste generated on the NTS has been shipped off site to commercial facilities. Receipt of transuranic waste for disposal at the NTS ceased in 1988; receipt of mixed waste for disposal from off-site generators ceased in 1990.

Low-level Waste—The NTS currently operates the Areas 3 and 5 Radioactive Waste Management Sites for the disposal of low-level waste from both the NTS and off-site defense generators. The Area 5 Radioactive Waste Management Site uses pits and trenches for shallow land burial of standard-packaged low-level waste. Included in the category of low-level waste is classified waste. Classified waste is low-level waste that is 'classified' because of the physical shape or specific composition of the material contained in the waste. Classification creates a need for the use of separate disposal units which are controlled with additional security measures. Area 3 uses subsidence craters generated during underground nuclear weapons testing for disposal of bulk low-level waste.

All waste coming to the NTS for disposal is subject to rigid waste acceptance criteria that mandate waste form, packaging, and certification. All generators are required to prepare a quality assurance program that ensures the NTS waste acceptance criteria are met; this program is audited by the DOE/NV for compliance. Only after all discrepancies are resolved does the generator receive permission to ship waste to the NTS. Once approved, generators are audited annually to ensure the continued adequacy of the program (DOE, 1992).

Mixed Waste—Pit 3, at the Area 5 Radioactive Waste Management Site, has Resource Conservation and Recovery Act interim status to accept mixed waste. Only NTS generators are currently allowed by the state of Nevada to dispose of waste in Pit 3, provided the mixed waste meets the requirements in the Resource Conservation and Recovery Act land disposal restrictions. No mixed waste has been certified or disposed of in Pit 3 in recent years, even though the capability exists.

The state of Nevada must approve the submitted Resource Conservation and Recovery Act Part B permit application for Mixed Waste Disposal Units prior to construction of the new units, which are intended for use as disposal units for off-site mixed waste primarily. The state of Nevada will defer review and comment on the application submitted until the completion of negotiations between all states and the DOE under the Federal Facility Compliance Act. Pit 3 at the Area 5 Radioactive Waste Management Site contains an inventory of 8,024 m^3 (283,372 ft^3) of mixed waste. Pit 3 currently has interim status under Resource Conservation and Recovery Act for disposal of mixed waste generated by the DOE/NV. The

disposal cell U-3ax/bl at the Area 3 Radioactive Waste Management Site also contains mixed waste. However, unlike Pit 3 in Area 5, this cell is completely filled and is awaiting closure. There are other disposal cells that contain constituents that would be considered hazardous according to current standards. The disposal cells at the Area 3 and Area 5 Radioactive Waste Management Sites will be closed with a Resource Conservation and Recovery Act-compliant closure cap, if required.

Nonhazardous Solid Waste –Currently, three nonhazardous solid waste landfills are being used for the disposal of solid waste at the NTS. The landfills are located in Areas 6, 9, and 23. The Area 6 landfill is a Class III landfill that accepts hydrocarbon-burdened soil and debris. The Area 9 and Area 23 landfills are currently considered Class II landfills because they each accept less than 20 tons per day of solid waste for disposal.

The Area 9 landfill is located in Crater U-10c. This landfill is an open, circular pit with steep, almost vertical sides which was formed from an underground nuclear test. The current capacity of the landfill is approximately 9.9×10^5 m^3 (3.5×10^7 million ft^3). Prior to the development in 1976 of Resource Conservation Recovery Act regulations governing the disposal of hazardous wastes, solid and liquid wastes were disposed of in the landfill. Since 1976, the Area 9 landfill has received construction and demolition waste, including paper, cardboard, vehicle parts, glass, concrete, gypsum board, nonsalvageable scrap metal and wood, and other materials. As a Class II landfill, the Area 9 landfill was allowed to receive all types of nonhazardous solid waste, excluding radioactive waste, free liquids, and asbestos. The Area 9 landfill receives an estimated 6,800 tons of solid wastes annually.

The Area 23 landfill is an open, rectangular pit with steep, nearly vertical sides. The current capacity of this landfill is approximately 4.5×10^5 m^3 (1.6×10^7 ft^3). The Area 23 landfill receives all types of nonhazardous solid waste. Nonpathogenic hospital waste, dead animals, and asbestos-containing materials are buried in separate cells that are identified by concrete markers. The Area 23 landfill receives approximately 830 tons of solid waste annually.

Although both landfills are currently classified as Class II landfills, changes in State regulatory requirements will cause the Area 9 landfill to undergo partial closure and reopen as a Class III construction and demolition landfill. The Area 23 landfill will remain in operation as a Class II landfill, but will be modified to comply with new State regulations. The modifications to both landfills and the associated potential impacts to the environment are presented in *Environmental Assessment for Solid Waste Disposal* (DOE, 1995a).

WASTE STORAGE OPERATIONS –Waste storage operations are discussed under separate subheadings for transuranic and transuranic mixed waste, mixed waste, low-level waste, hazardous waste, and polychlorinated biphenyl (PCB) waste.

Transuranic and Transuranic Mixed Waste –Currently, transuranic and transuranic mixed waste is stored on the Area 5 transuranic waste storage pad in accordance with a Settlement Agreement with the state of Nevada, signed June 23, 1992. Provisions of this agreement include permission to store transuranic mixed waste on the pad until the Waste Isolation Pilot Plant in New Mexico, or another DOE site, is available as a possible treatment, storage, or disposal destination. The agreement does not allow a volume increase for additional transuranic mixed waste to be received from outside of the state of Nevada. The agreement does not pertain to transuranic waste without hazardous components. A facility is planned to allow the DOE to characterize and certify that the existing transuranic waste meets the Waste Isolation Pilot Plant waste acceptance criteria and to prepare it for shipment to the Waste Isolation Pilot Plant. Facilities for staging and loading the transuranic waste into special containers will be in place. Some DOE/NV Environmental Restoration Program projects might generate a limited amount of transuranic waste; such waste will be stored on the pad and certified before it is transported to the Waste Isolation Pilot Plant.

Mixed Waste –Mixed waste is currently accepted for storage at the Area 5 transuranic waste storage pad under a Mutual Consent Agreement between the state of Nevada and the DOE that allows storage of incidental mixed waste discovered or generated during NTS cleanup activities. In accordance with this agreement, the DOE submitted a Resource Conservation and Recovery Act Part B permit application to the State in January 1995 for the construction of a Mixed Waste Storage Unit. Final disposition of this mixed waste is subject to the agreements reached between the DOE and the State under the Federal Facility Compliance Act. These agreements will cover the location and development of new facilities, the use of mobile units, and the transportation of mixed waste to specified facilities.

Low-level Waste—The NTS has a formal storage facility for NTS-generated low-level waste. This facility is located in Area 6 in the vicinity of the Decontamination Shop. The NTS-generated low-level waste is stored at this facility while characterization and certification activities are being completed prior to disposal at the Areas 3 or 5 Radioactive Waste Management Sites.

Hazardous Waste—The Resource Conservation and Recovery Act Part B permit for the Hazardous Waste Storage Unit does not allow for storage longer than one year. Therefore, the inventory of hazardous waste is stored for less than one year prior to shipment to an off-site permitted treatment or disposal facility.

PCB Waste—PCB waste disposal is regulated as hazardous by the state of Nevada. All other PCB activities are regulated under the Toxic Substances Control Act. This waste is accumulated and stored for up to nine months in the Area 6 Toxic Substances Control Act waste accumulation unit. This unit accepts only PCB and PCB-contaminated waste generated at the NTS. Accumulated PCB waste is shipped off site to a commercial Toxic Substance Control Act-permitted treatment, storage, and disposal facility.

WASTE TREATMENT OPERATIONS—Waste treatment operations are discussed under separate subheadings for low-level, mixed waste, and hazardous waste.

Low-level Waste—Currently, no radioactive waste treatment operations occur at the NTS.

Mixed Waste—Currently, no mixed waste treatment operations occur at the NTS.

Hazardous Waste—Currently, only the Explosive Ordnance Disposal Unit treats hazardous waste at the NTS. Operating under a Resource Conservation and Recovery Act Part B permit, the Explosive Ordnance Disposal Unit is capable of treatment by detonation of waste explosives, including damaged or expired conventional explosives. No other types of hazardous waste are treated at the unit.

CLOSURE OPERATIONS—The DOE/NV is developing a site-specific design for closure for the Area 5 Radioactive Waste Management Site that will take into consideration the climate, geology, surface water and regional hydrology, and waste forms. This project, part of the Integrated Closure Program, will investigate the optimum design for successful closure integrity in the arid NTS environment. Closure of the Area 5 Radioactive Waste Management Site will not occur until after the end of the active life of this area, beyond the year 2005. A number of alternatives are being considered, from one large closure cap for the entire Area 5 Radioactive Waste Management Site to caps for individual waste units. Closure performance standards include minimum maintenance requirements, provisions for protection of human health and the environment, provisions for minimizing or eliminating contaminant release, and complying with applicable regulations and DOE orders. The Area 3 low-level waste disposal cell, U-3ax/bl, will be closed under Resource Conservation and Recovery Act requirements because of the presence of hazardous waste components disposed of before the Resource Conservation and Recovery Act was implemented.

WASTE MINIMIZATION/POLLUTION PREVENTION PROGRAM—The DOE is committed to preventing pollution and reducing waste generation at the NTS. This is accomplished through establishing partnerships with private industry, and complying with federal, state, and local regulations. The elements of the DOE/NV Waste Minimization/Pollution Prevention Program

addresses reporting requirements, compliance costs, reduction costs, employee concerns, environmental liability, training, and the reduction, recycle, and reuse of commodities. Appendix C.6 provides a description of the DOE/NV Waste Minimization/ Pollution Prevention Program.

4.1.2 Transportation

The following sections address baseline transportation activities with respect to on-site traffic, off-site traffic, transportation of materials and wastes, and other transportation. Figure 4-14 illustrates the NTS transportation system.

4.1.2.1 On-Site Traffic. The main access to the NTS is the Mercury Highway, which originates at U.S. Highway 95, 105 km (65 mi) northwest of Las Vegas, Nevada, and accesses the main gate in Mercury. Eight kilometers (5 mi) to the west of Mercury is another entrance, which is a turnoff to Jackass Flats Road; however, this entrance is presently barricaded. The NTS has a restricted access into Area 25 from U.S. Highway 95 at Lathrop Wells Road, approximately 32 km (20 mi) west of Mercury. A fourth entrance, seldom used, is located in the northeast corner of the NTS and can be reached from State Route 375. Other existing roadways, although unpaved, could provide entrance or exit routes in case of an emergency. Access to the NTS is restricted, and guard stations are located at all entrances, as well as throughout the site.

The 1,127-km (700-mi) road network consists of 644 km (400 mi) of paved primary roads and 482 km (300 mi) of unpaved secondary roads. Most paved roadways are two-way and two-lane with 89 km per hour (kph) (55 mi per hour [mph]) speed limits unless posted otherwise. The speed limit in developed areas is 32 kph (20 mph). The maximum speed limit on dirt roads is 56 kph (35 mph). In addition, the NTS contains numerous event-related unpaved roads that are not maintained after a test has been conducted. Traffic flow and control throughout the NTS is maintained by conventional stop and yield signs at major intersections. Traffic regulations are enforced by the Nye County Sheriff's Department.

SOUTHERN ROAD NETWORK—The primary paved roads in the southern part of the NTS include Mercury Highway, Jackass Flats Road, Cane Spring Road, and Lathrop Wells Road (Figure 4-14).

Mercury Highway is the primary route from the interchange at U.S. Highway 95. Most of this road is 8 m (26 ft) wide; however, the shoulders vary from 1 to 2 m (4 to 6 ft) wide. Traffic consists of light- and heavy-duty trucks and cars, security vehicles, and emergency vehicles. The Mercury bypass is a well-constructed road and runs from just north of Gate 100, the main entrance to the NTS. This 8-m (26-ft)-wide road was built to enable rerouting of all traffic with a forward area destination.

Jackass Flats Road from Mercury to the Area 25 support area is a hot-mix asphalt road, which is in fair condition. Currently, some repair work is needed to meet current standards. The road system in Area 25 is made up of 7-m (22-ft)-wide roadways with 5-centimeter (cm) (2-in.) hot-mix asphalt surfaces. This roadway provides the principal access to the Area 25 support region. The Lathrop Wells Road provides access to Area 25 and the southwestern NTS from U.S. Highway 95. This plant-mix, oil-and-chip road with no shoulders extends to Guard Station 500 (east of the Area 25 support region) where it becomes Cane Spring Road. Cane Spring Road extends east to Mercury Highway, where it terminates. Cane Spring Road is also an oil-and-chip road, except for an asphalt-overlaid section 3 km (2 mi) west of Mercury Highway.

Vehicles delivering waste shipments to Area 5 use Road 5-01, which was not constructed to withstand the current or proposed Radioactive Waste Management Site traffic load. Road 5-01 branches off Mercury Highway approximately 8 km (5 mi) north of Mercury. It is the main access into Frenchman Flat where the Spill Test Facility, the Hazardous Waste Storage Unit, and the Radioactive Waste Management Site are located. Road 5-01 was constructed in 1965 to access the Defense Nuclear Agency weapons compound located northeast of the Area 5 Radioactive Waste Management Site. The road was built over the existing terrain without runoff drainage

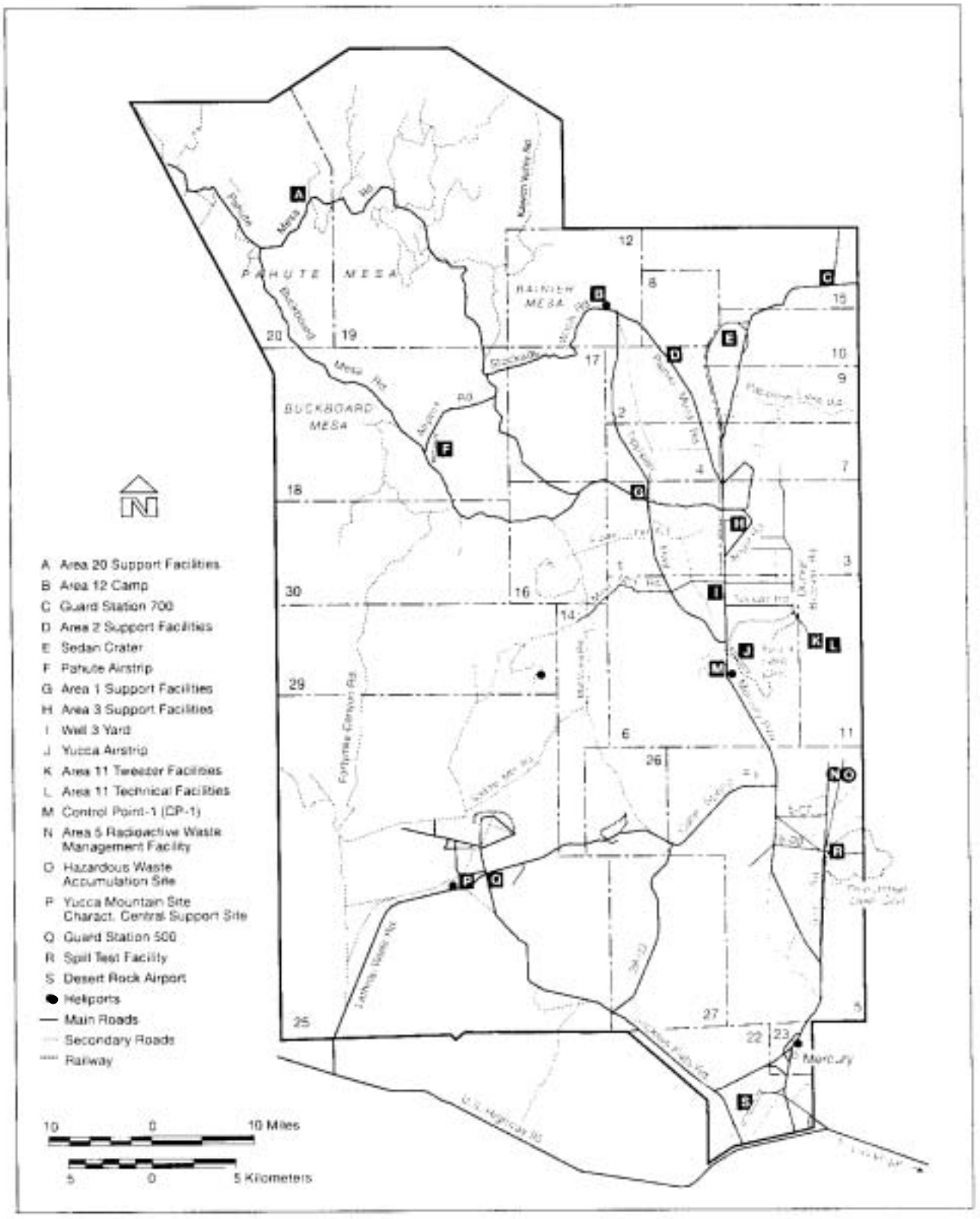


Figure 4-14. NTS transportation system

considerations and without formal design engineering. It is less than 6 m (20 ft) wide and has been used for five years beyond its expected 25-year service life. Road 5-07 provides a secondary access to this area, which is 8 km (5 mi) south of Control Point-1.

A new road will be constructed to provide access for waste shipments to the Area 5 Radioactive Waste Management Site. A new route from the Mercury Highway to the Radioactive Waste Management Site will be provided. The 5.0-km (3.1-mi) new roadway will be constructed by extending Cane Spring Road east from Mercury Highway to intersect with Road 5-01, 0.3 km (0.2 mi) south of the existing Radioactive Waste Management Site. In addition, improvements will be made to the Road 5-01 from this intersection into the Radioactive Waste Management Site.

Although Road 28-03 is a low-traffic road, it is adequately maintained because Area 27 is a high-security area. Tweezer, Angle, and Orange Blossom Roads are narrow, secondary, oil-and-chip roads with no shoulders. These roads require periodic maintenance. Orange Blossom Road has been abandoned, and signs have been posted warning drivers to use at their own risk.

Paved, local traffic streets in Mercury are approximately 6 m (18 ft) wide, which is sufficient for the current traffic loads. However, streets do not have curbs or gutters, and surface drainage is carried in ditches parallel with streets. Traffic flow through the numerous intersections in Mercury is controlled by the use of stop signs and yield signs. There is no real pathway system; pedestrians walk along the side of the roads or through open areas.

The remainder of the roadway network is composed of graded gravel roads and jeep trails. Gravel roads to event sites are maintained as requirements dictate. Gravel roads that remain in good condition include Mine Mountain and Mid-Valley/Saddle Mountain Roads.

NORTHERN ROAD NETWORK—The primary paved roads in the northern part of the NTS are Mercury Highway, Pahute Mesa Road, Buckboard Mesa Road, and Tippipah Highway. Other roads providing access to the northern areas are Rainier Mesa Road, Stockade Wash Road, and Circle Road. Pahute Mesa Road from Yucca Flat weapons test basin to the Area 20 camp is a typical hot-mix paved road. At the higher elevations, the road is winding and crosses rugged terrain, which is extremely hazardous under winter conditions. Chains or snow tires are essential when these conditions prevail. From the Area 20 camp to the intersection of Buckboard Mesa Road, Pahute Mesa Road consists of graded gravel.

Tippipah Highway extends from the Area 12 camp on Rainier Mesa Road south to Mercury Highway in Area 6. It is an adequately drained, all-weather highway that bypasses areas where testing has damaged Mercury Highway. This 8-m (26-ft)-wide road has 2.5-m (8-ft) compacted shoulders and was constructed with 7.5-cm (3-in.) hot-mix asphalt over a 30.5-cm (12-in.) base.

Rainier Mesa Road, which provides access to the Area 12 camp from Mercury Highway, was one of the first gravel roads on the NTS. Currently, this narrow oil-and-chip road with no shoulders requires minimum maintenance.

In the Yucca Flat weapons test basin, the segment of Mercury Highway from the intersection with Rainier Mesa Road north to Sedan Crater is not passable for normal traffic because of damage from numerous local underground nuclear weapons events. Although there are many detours and bypasses from Sedan Crater to Guard Station 700, the 6-m (20-ft)-wide road is in good condition.

Stockade Wash Road from Area 12 camp to Pahute Mesa Road is a hot-mix asphalt road in good condition; however, the mountain pass section through Eleana Ridge is weathered and requires maintenance.

Buckboard Mesa Road from Road 18-03 north to Pahute Mesa Road is a relatively new 18-km (11-mi)-long paved road that provides convenient access to the mesa testing areas.

Orange Road, which was constructed during the early development of the NTS, was abandoned in favor of the Tippipah Highway. Because this road

has not been maintained for a number of years, most of the paving has deteriorated.

NTS VEHICLES AND TRANSPORTATION SERVICES—The Maintenance and Operations contractor for the NTS maintains and repairs the fleet of 2,342 government-owned vehicles at the NTS. Vehicles include sedans, station wagons, ambulances, and light- and heavy-duty trucks. The vehicle fleet reached a peak of 3,370 vehicles in 1988. The total mileage of the fleet in 1994 was 2.5×10^7 km (1.6×10^7 mi). The peak mileage for the fleet was 4.9×10^7 km (3.1×10^7 mi) in 1985. Regular and compact pickup trucks, compact sedans, and 3/4-ton four-wheel drive trucks accumulated most of the mileage (Stowell, 1995).

Commuter buses provide daily passenger service to the NTS from Las Vegas and Pahrump by way of U.S. Highway 95. The number of buses entering the NTS varies daily, depending on the on-site activities in progress. Currently, there are 54 buses serving Las Vegas, and 5 buses serving Pahrump. The commuter bus service provides dedicated routes to the forward areas, and paved parking areas for the buses are located at the support facilities within Areas 6, 23 (Mercury), and 25. Limited bus parking is also available at other support facilities on the NTS. Parking for government and private commuter vehicles is available at most buildings on the NTS (Thomas, 1995).

4.1.2.2 Off-Site Traffic. Background traffic on key roads in the vicinity of the NTS has experienced rapid growth in the last ten years. This growth varied widely by location. An average annual growth ranging from 6 to 12 percent was experienced on Interstate 15, a 4- to 7-percent increase on Interstate 80, a 2- to 5-percent increase on U.S. Highway 95, a 4- to 7-percent increase on U.S. Highway 93, and less than 2 percent elsewhere on rural highways. While background traffic has increased in Nevada, traffic volumes at the Mercury interchange have decreased by approximately 2 percent per year during the last ten years because of reductions in the NTS workforce.

The region of influence for the transportation analysis includes principal road, air, and rail networks leading to the NTS, with emphasis on the immediate area surrounding the site. In the region of influence, continuous traffic counts available from automatic traffic recorders show seasonal peaks in traffic demand (i.e., highest volumes occur in August and September). Recreational routes, such as Interstate 15 to Las Vegas and Interstate 80 to Reno, Nevada, also experience weekend peaks. Daily morning and late afternoon peaks are apparent on all routes; however, the late afternoon peak is generally more intense than the morning peak.

Traffic volumes on a roadway vary; that is, during any particular hour, traffic volume may be greater in one direction than in the other. In the region of influence, for example, data show as much as a 2:1 imbalance on rural routes, but almost a 1:1 split on urban routes.

The potential for congestion and other problems of a roadway segment is generally expressed in terms of level of service. The level of service scale ranges from A to F, with each level defined by a range of volume-to-capacity ratios. Level of service A, B, and C are considered good operating conditions where minor or tolerable delays are experienced by motorists. Level of service D represents below average conditions. Level of service E corresponds to the maximum capacity of the roadway. Level of service F represents a jammed situation. The level of service designations and their associated volume-to-capacity ratios are presented in Table 4-5. These levels are based primarily on the *Highway Capacity Manual Special Report 209* (Transportation Research Board, 1994) and are adapted for local conditions.

The region surrounding the NTS is served by a network of interstate, U.S. and state highways and city streets. Figure 4-15 shows the general local road network now in place in the immediate vicinity of the NTS. For the purpose of this analysis, key roads are identified as those roads providing access to the site and most frequented by personnel, visitors, construction workers, vehicles carrying materials for construction, and radioactive waste delivery trucks. Key roads in the immediate vicinity of the site include Interstate 15; U.S. Highways 6, 93, and 95; and Nevada State Route 375. In addition, Interstate 80 and U.S. Highways 40 and 50 provide regional access to the site from the

Table 4-5. Road transportation levels of service

LOS[a]	Description	Criteria (Volume-to-Capacity)		
		Freeway[b]	Multilane Highway[c]	2-Lane Highway[d]
A	Free flow with users unaffected by presence of other users of roadway	0-0.35	0-0.33	0-0.12
B	Stable flow, but presence of users in traffic stream becomes noticeable	0.36-0.54	0.34-0.50	0.13-0.24
C	Stable flow, but operation of single users becomes affected by interactions with others in traffic stream.	0.55-0.77	0.51-0.65	0.25-0.39
D	High density but stable flow; speed and freedom of movement are severely restricted, poor level of comfort and convenience.	0.78-0.93	0.66-0.80	0.40-0.62
E	Unstable flow; operating conditions at capacity with reduced speeds, maneuvering difficulty, and extremely poor levels of comfort and convenience.	0.94-1.00	0.81-1.00	0.63-1.00
F	Forced or breakdown flow, with traffic demand exceeding capacity; unstable stop-and-go traffic.	>1.00	>1.00	>1.00

[a] Level of service
[b] Level of service for basic freeway sections, 113 kph (70 mph)
[c] Level of service for multilane highway, 97 kph (60 mph) design speed
[d] Level terrain, 20-percent no passing zones, design speed 97 kph (60 mph) or greater; also applicable to three-lane highways.

Source: Transportation Research Board, 1994.

northeast and south, respectively. The following paragraphs describe these major roadways.

Interstate 15 is the major regional access to the site. It runs north-south, connects San Diego, California, to Salt Lake City, Utah, and extends north to the Canadian border. Interstate 15 is generally a four-lane divided highway constructed to full freeway standards with full control of access. Within the Las Vegas metropolitan area, Interstate 15 becomes a six-lane freeway. Interstate 80 and U.S. Highway 50 are both major east-west freeways. They are generally four-lane highways with full control of access. U.S. Highway 40 is also an east-west freeway that does not intersect Nevada.

U.S. Highway 95 is a major north-south roadway extending south to the Mexican border and north to the Canadian border. U.S. Highway 95 is by far the most frequented direct access to the NTS and is used by over 95 percent of the employees working on site. It is the closest and most direct route to the site for hauling materials and waste, whether hauled directly by trucks or by rail. It is a four-lane roadway between Las Vegas and the Mercury interchange and within Las Vegas, and a two-lane rural highway beyond the Mercury interchange to the north. U.S. Highway 93 is a major north-south roadway across Nevada. It extends from Las Vegas to the Canadian border, intersecting Interstate 80 near the town of Wells, Nevada. It is an all-weather, two-lane paved roadway. U.S. Highway 6 is an east-west roadway, located to the north of the NTS and the Tonopah Test Range, and links U.S. Highways 93 and 95. It is also an all-weather, two-lane paved roadway.

Nevada State Route 375 provides vehicular access to the NTS via a connecting road. It runs northwest along the northeastern boundaries of the site. This stretch of two-lane highway links U.S. Highways 6 and 93.

On March 23, 1993, there were 1,375 vehicles of all categories entering or leaving the NTS via Gate 100; this number was found to be representative of the annual average daily traffic. The morning peak hour of the site (as a generator) occurs generally between 5:30 a.m. and 7:30 a.m. Traffic counts were performed during the morning peak hour in March 1995. There were 232 vehicles entering the site via Gate 100 between 6:25 a.m.

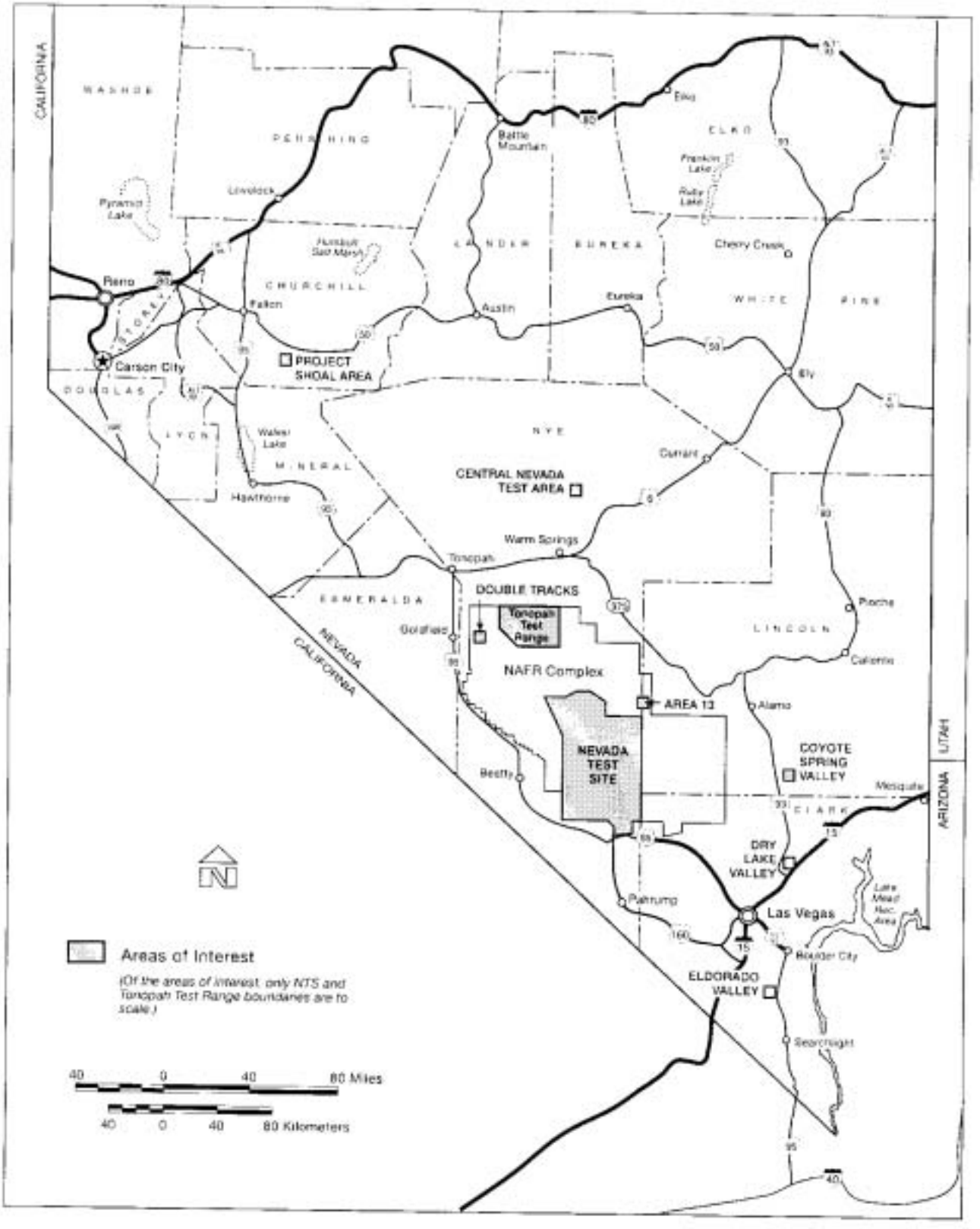


Figure 4-15. General local road network in southern Nevada

and 7:25 a.m. During the same time, there were only ten vehicles exiting the site. The 232 vehicles carried approximately 2,000 passengers (including drivers). The 232 total vehicles included 23 buses (10 percent), 152 one-person cars (66 percent), 47 two-person car pools (20 percent), 8 three-or-more-person car pools (3 percent), and only 2 trucks (less than 1 percent). Of all vehicles entering the site, 98 percent come from the east (Las Vegas area) and the remaining 2 percent from the west (Nye County) (Tetra Tech, Inc., 1995).

Volumes, peak-hour volumes, capacities, and the corresponding level of service on key regional and local roadways in the region of influence are shown in Table 4-6. Some segments of Interstates 15 and 80 and U.S. Highway 95 within the urban areas of Las Vegas and Reno, Nevada, already operate at level of service F because of heavy traffic volumes (recreational, local, and commuter traffic). U.S. Highway 93 at Hoover Dam operates at level of service F because of steep grades and sharp curves. Some segments of Interstate 15 and U.S. Highway 93 in Las Vegas operate at level of service D. All other key roads operate at level of service C or better due mainly to low traffic volumes.

The 1993 annual average daily traffic on key roads varied considerably in both space and time. Traffic volumes on Interstate 15 are highest within Las Vegas. As seen in Table 4-6, in 1993 there were 26,420 annual average daily traffic on Interstate 15 at the California/Nevada state line; 155,795 just north of the Sahara Avenue interchange (the maximum volume recorded on Interstate 15 within Nevada); 84,445 north of Washington Street; 33,770 north of Cheyenne Avenue; and only 11,530 at the Nevada/Utah state line. At the California/Nevada state line, August is the peak month of the year, representing 120 percent of the average month of the year, and Sunday is the peak day of the week, representing 140 percent of the average day of the week. Within Las Vegas, August remains the peak month, representing only 105 percent of the average month, and weekday volumes dominate rather than weekends.

The 1993 annual average daily traffic along Interstate 80 also varied considerably from a low of 5,000 in rural areas to a maximum of approximately 96,000 in urban areas. The highest volume is recorded in Reno, Nevada, at the U.S. Highway 395 junction, and the lowest recorded is at the Nevada/Utah state line. At the California/Nevada state line, August is the peak month, representing approximately 130 percent of the average month, and Saturdays and Sundays are the peak days of the week, representing 120 percent of the average day of the week. Within Reno and vicinity, August remains the peak month, representing only 109 percent of the average month, and weekday volumes dominate. In rural areas, August traffic is by far the highest, being 145 percent of the average month and having little daily variations (all days of the week handle the same amount of traffic).

The 1993 annual average daily traffic on U.S. Highway 95 shows a wide variation in traffic volumes between urban and rural sections. Within the urbanized area of Las Vegas, volumes varied between a low of 20,000 and a high of 145,580 recorded between Interstate 15 and Martin Luther King Boulevard. There were 116,675 vehicles at south Jones Boulevard. Elsewhere, the 1993 annual average daily traffic was well below 10,000.

At the Mercury interchange, the main access to the NTS, annual average daily traffic was 3,635 and 2,175, respectively, south and north of the interchange. West of the Mercury interchange and beyond, daily volumes decrease further to reach 1,720 north of Beatty, Nevada. There are little monthly variations in traffic volumes on this highway, although August remains the peak month with very little weekly variations.

In 1993, U.S. Highway 93 carried 1,160 annual average daily traffic just north of Nellis Air Force Base, and 1,210 farther north near Crystal Springs. In 1993, State Route 375 and U.S. Highway 6 in the vicinity of the site carried, in general, less than 500 annual average daily traffic.

4.1.2.3 Transportation of Materials and Waste. This section presents the types of materials and waste that are currently transported to and on the NTS. Refer to Chapter 2, Section 2.4.2 for definitions of the various waste types.

Table 4-6. Traffic volumes and level of service on key roads (Page 1of 2)

Roadway Segment	Two-Way[a] Capacity VPH[b]	1993 AADT[c]	1993 DDHV[d] One Direction	1993 Baseline LOS[e]
Regional				
I–15 at California/Nevada state line	6,800	26,420	2,403	D
I–15 north of Sahara Avenue interchange	10,200	155,795	6,050	F
I–15 north of the downtown expressway interchange	10,200	91,985	3,572	D
I–15 just north of the D Street and Washington Street interchange	10,200	84,445	3,280	C
I–15 north of the Cheyenne Avenue interchange	6,800	33,770	1,311	B
I–15 south of the Lamb Blvd. interchange	6,800	12,905	501	A
I–15 north of West Mesquite interchange (Nevada/Utah state line)	6,800	11,530	448	A
I–80 east of Apex interchange (California/Nevada state line)	6,800	22,825	1,568	B
I–80 west of the U.S. Hwy. 395 interchange (Reno)	6,800	95,955	4,423	F
I–80 west of the West Vista Blvd. interchange (east Reno)	6,800	26,445	1,219	B
I–80 east of Winnemucca interchange	6,800	6,495	408	A
I–80 east of U.S. 93 Hwy. interchange east of Wells	6,800	4,405	259	A
I–80 east of the West Wendover interchange (Nevada/Utah state line)	6,800	4,495	264	A
Local				
U.S. Hwy. 95 south of Jones Blvd. interchange	10,200	116,675	5,907	F
U.S. Hwy. 95 north of Sunset Road interchange (east Las Vegas)	6,800	41,770	2,092	C
Rancho Road, (SR[f] 599) east of the northern U.S. Hwy. 95/Rancho Road interchange	6,800	12,700	636	A
U.S. Hwy. 95 south of SR 157 north of Las Vegas	6,800	7,880	733	A
U.S. Hwy. 95 just east of Mercury interchange	6,800	3,635	338	A
U.S. Hwy. 95 interchange at Mercury				
Southbound off ramp	1,500	140	13	C
Southbound on ramp	1,500	560	52	C
Northbound off ramp	1,500	565	53	C
Northbound on ramp	1,500	145	13	C
Local				
SR 433, between U.S. Hwy. 95 and Mercury	2,000	1,375	128	B
U.S. Hwy. 95 3.8 miles north of Mercury interchange	2,000	2,715	253	C
U.S. Hwy. 95 from Amargosa Valley to Beatty	2,000	615	57	A
U.S. Hwy. 95 north of Beatty	2,000	1,720	160	B

Table 4-6. Traffic volumes and level of service on key roads (Page 2of 2)

Roadway Segment	Two-Way[a] Capacity VPH[b]	1993 AADT[c]	1993 DDHV[d] One Direction	1993 Baseline LOS[e]
U.S. Hwy. 93 south of the Nevada/Arizona state line (Hoover Dam)	1,500	747	695	F
U.S. Hwy. 93 east of Westbound off ramp of Railroad Pass interchange	6,800	24,605	2,289	D
U.S. Hwy. 93 north of I–15/U.S. Hwy. 93 interchange	2,000	1,160	108	A
U.S. Hwy. 93 south of SR 375 Junction near Crystal Springs	2,000	1,210	113	B
U.S.Hwy. 93 west of SR 375 Junction near Crystal Springs	2,000	440	41	A
SR 375 west of U.S. 93 Junction at Crystal Springs	1,500	195	29	A
SR 375 east of Warm Springs	1,500	85	13	A
U.S. Hwy. 6 east of Warm Springs at SR 375 Junction	1,700	145	15	A
U.S. Hwy. 6 west of Warm Springs at SR 375 Junction	1,700	210	20	A
U.S. Hwy. 6 east of Tonopah west of SR 376 Junction	1,700	1,095	105	B

[a] Based on 1985 Highway Capacity Manual
[b] Vehicles per hour
[c] Annual average daily traffic
[d] This is the directional design hourly volume per the 1985 Highway Capacity Manual. It considers the 30th peak hour of the year and the peaking and directional characteristics on various segments as supplied by the Nevada Department of Transportation, Annual Traffic Report 1993a. For two-lane highways, directional factors are applied, in general, a 70/30 split
[e] Level of service
[f] SR=State Route.

Source: NDOT, 1993a.

TRANSURANIC WASTE—The NTS expects no additional transuranic or transuranic mixed wastes to be transported to the NTS from off-site generators. It is expected that approximately 204,663 kg (451,201 lb), having a total volume of 612 m^3 (800 yd^3), of transuranic waste currently stored at the NTS would eventually be transported to the Waste Isolation Pilot Plant for disposal (DOE/NV, 1994a).

MIXED WASTE—On-site transportation of mixed waste to the Area 5 Radioactive Waste Management Site is anticipated because it will likely be generated during environmental restoration and decontamination projects at the NTS. Off-site transportation of mixed waste from the NTS is not anticipated.

LOW-LEVEL WASTE—Low-level waste may be generated during normal NTS operations. It is packaged and transported to one of two low-level waste disposal facilities in operation at the NTS: the Area 5 Radioactive Waste Management Site or the Area 3 Radioactive Waste Management Site (DOE/NV, 1992a). Low-level waste from other DOE facilities is transported to both sites for disposal. In addition, the DOE/NV accepts classified low-level waste from DoD facilities if DOE Headquarters has designated the activity to ship waste to the NTS. The total low-level waste transported to the Area 5 Radioactive Waste Management Site during 1961 to 1991 was 3.96×10^5 m^3 (1.4×10^7 ft^3). During Fiscal Year 1993, approximately 1.9×10^4 m^3 (6.71×10^5 ft^3) of low-level waste was transported from on-site and off-site generators to the NTS (DOE/NV, 1994a). As of August 10, 1995, the following generators are approved to ship low-level waste to the NTS for disposal:

- Aberdeen Proving Grounds, Aberdeen, Maryland (temporary suspension)
- Allied-Signal, Kansas City Plant, Kansas City, Missouri
- Ann Arbor Inertial Confinement Fusion Facility, Ann Arbor, Michigan
- Fernald Environmental Management Project, Cincinnati, Ohio
- General Atomics, San Diego, California
- Inhalation Toxicology Research Institute, Albuquerque, New Mexico
- Lawrence Livermore National Laboratory, Livermore, California, including Site 300
- Mound Plant, Miamisburg, Ohio
- Pantex Plant, Amarillo, Texas
- Bechtel Nevada Corporation (formerly Reynolds Electrical and Engineering Co., Inc.), NTS, Nevada (on site)
- Rocky Flats Plant, Golden, Colorado
- Reactive Metals Inc., Extrusion Plant, Ashtabula, Ohio
- Rockwell-Rocketdyne, Canoga Park, California
- Sandia National Laboratories, Livermore, California
- Sandia National Laboratories, Albuquerque, New Mexico.

The following generators are awaiting approval pending DOE Headquarters's concurrence:

- Oak Ridge National Laboratory, Oak Ridge, Tennessee (Melton Valley Waste Stream)
- Pinellas Plant, Largo, Florida.

The following generators are in the process of applying for approval to dispose of waste at the NTS:

- Babcock & Wilcox, Lynchburg, Virginia
- Defense Nuclear Agency, Johnston Atoll
- Defense Nuclear Agency, NTS, Nevada

- General Atomics, San Diego, California (new production reactor waste)
- Grand Junction Project Office, Grand Junction, Colorado
- IT Corporation, Las Vegas, Nevada (Project Chariot)
- U.S. Army Armament, Munitions and Chemical Command, Rock Island, Illinois.

These three sets of waste generators—approved, pending, and in process—represent the majority of waste generators who have historically shipped waste to the NTS.

Off-site shipments of low-level waste are made by commercial motor carriers. Transportation of low-level waste is performed in compliance with the packaging, loading, and driver training requirements of the U.S. Department of Transportation, the Nuclear Regulatory Commission, and the Nuclear Regulatory Commission Agreement State Regulation, and is subject to additional oversight by the DOE.

HAZARDOUS WASTE—Hazardous waste cannot be disposed of at the NTS landfill; therefore, it is transported to the Hazardous Waste Storage Unit where it is prepared for off-site shipment. Waste in this category includes, but is not limited to wastes that are ignitable, corrosive, toxic, or reactive. For example, hazardous waste may be generated on the NTS during drilling and tunneling operations and their support activities.

Waste from the use of explosive ordnance detonated by the Defense Nuclear Agency, the DOE Maintenance and Operations contractor, the Wackenhut Firing Range used by the NTS security force, and resident national laboratories is transported to the Area 11 Explosive Ordnance Disposal Facility for treatment. This facility is a Resource Conservation and Recovery Act miscellaneous unit (40 CFR Part 270.23) for conventional explosives.

HAZARDOUS MATERIALS—Live explosives, fuels, corrosives, compressed gas, and limited quantities of nuclear materials such as depleted special nuclear material uranium and radiological calibration source standards are transported onto and within the NTS for use in research, development, well-logging, and testing.

NONHAZARDOUS WASTE—Used petroleum products, uncontaminated tunnel muck, drilling fluids, cement and grout wastes, construction debris, refuse, sludge from wastewater lagoons, septic tank and chemical toilet sludge, and animal carcasses are transported for disposal at either a sanitary landfill, construction landfill, or sewage lagoon.

Sanitary solid waste generated on the NTS is transported via trucks to permitted landfills for disposal. The landfills are at various locations on the site. No off-site shipments of sanitary wastes are made to or from the NTS.

4.1.2.4 Other Transportation. Other modes of transportation are discussed in the following section. The transportation system includes buses, rail, and air. Greyhound Lines, Inc., provides intercity passenger service to and from Las Vegas. Citizens Area Transit provides bus service to most parts of Las Vegas.

OTHER ON-SITE TRANSPORTATION—No navigable waterways within the region of influence are capable of accommodating waterborne transportation of material shipments to the NTS. Air facilities consist of three airstrips and nine helicopter pads, which serve authorized aircraft. Two on-site rail systems, in Areas 25 and 26, were previously used to transport heavy, oversized, and hazardous payloads between facilities.

Railroads—There are no on-site mainline railroads. A 15-km (9-mi) standard-gauge railroad within Area 25 was abandoned in place. The former Nuclear Rocket Development Station facilities employed a remotely operated train engine to move flatbed cars carrying extremely heavy, large, and highly radioactive materials. A shorter, similar line once connected Project Pluto sites in Area 26. This line is abandoned, and much of the track and equipment have been removed.

Air Transportation—The southern area of the NTS is served by the Desert Rock Airport and Yucca Lake airstrip. Desert Rock Airport (a paved runway, 2 km [6,560 ft] long and 30 m [100 ft] wide) is the primary aircraft support facility at the NTS. It is located 5 km (3 mi) southwest of Mercury, Nevada, in Area 22. Existing features at Desert Rock Airport include an administration/control building, a fireman-standby trailer, an aircraft unloading pad, aircraft parking tie-down spurs, two lighted windsocks, and radio-activated runway lights. The airport also has a landing-arrester cable for use in the recovery of damaged aircraft that require emergency landing facilities. Desert Rock Airport is no longer manned, and no services are available because of funding and program cutbacks. However, Desert Rock Airport is still operational, and the use of this airstrip is controlled by the DOE.

Yucca Lake airstrip is a secondary NTS support facility for authorized aircraft. Features at this facility include an unpaved runway, an abandoned terminal building, and an aircraft refueling station. The runway is subject to flooding following local storms.

The only airstrip in the north is the Buckboard Mesa/Pahute airstrip in Area 18. Classified as a secondary support facility for authorized aircraft at the NTS, the Buckboard Mesa/Pahute airstrip has had minimal use in the last few years. Its primary purpose was to serve as a landing strip for aircraft carrying supplies and personnel to the Pahute Mesa sites. Occasional helicopters and approximately ten fixed-wing aircraft per year landed at the strip when the mesa was in use. Because the runway has no lights, use of the airstrip was restricted to prearranged times during daylight hours. The runway is relatively short. Its surface was unable to withstand the impact from high-speed takeoffs and landings of jet aircraft, so the largest aircraft that can be accommodated was the propeller-driven C-130. The Buckboard Mesa/Pahute airstrip is unusable and no longer serviceable.

Helipads equipped with windsocks, fire extinguishers, and painted markings are located in the following places:

- Area 5 Radioactive Waste Management Site (Inactive)
- Area 6 East of Mercury Highway across from the Control Point
- Area 6 East side of Yucca Lake (Airborne Response Team)
- Area 12 Area 12 Camp
- Area 18 Buckboard Mesa/Pahute airstrip
- Area 18 Pahute Mesa Control Point
- Area 22 Desert Rock Airport
- Area 23 Bechtel Nevada Corporation Medical Facility
- Area 25 West of the Administration Building
- Area 29 Shoshone Peak.

OTHER OFF-SITE TRANSPORTATION—In this section, other off-site transportation, such as rail and air transport, is described.

Railroads—The closest rail line to the site is the Union Pacific line, which passes through Las Vegas, approximately 80 km (50 mi) east of Mercury. This line connects Los Angeles with Salt Lake City. There is no direct railway link to the site. A 15-km (9-mi) standard-gauge railroad serves Area 25 of the NTS, but does not connect with the Union Pacific. Spurs serve Nellis Air Force Base and a gypsum plant.

Nevada has two other rail lines relevant to this analysis. These lines are part of the transcontinental routes of the Union Pacific and Southern Pacific Railroads. These lines run parallel to each other, close to Interstate 80 in northern Nevada. Over a distance of 290 km (180 mi), the Union Pacific and Southern Pacific lines are operated as a paired track.

The Union Pacific line passing through Las Vegas is designated as a Class A main line, which means heavy freight movement (exceeding 20 million tons

per year) and high-quality physical condition for the tracks. Through Nevada, this line crosses rugged desert country and, with the exception of the Las Vegas Valley, almost no other population clusters. The line is primarily single track with frequent sidings. Between Salt Lake City, Utah, and Barstow, California, this line has on average one siding for every 8 km (5 mi). However, as the line enters the Las Vegas area, it becomes a double track for approximately 16 km (10 mi). Las Vegas is the site of a yard and crew change point. The Union Pacific has constructed a new yard for the Las Vegas area, located to the north of downtown.

The daily average number of trains through Las Vegas is 10 to 15. Each train has 60 to 70 cars and a load of 3,000 to 6,000 tons. Because of the importance of the route, Union Pacific adheres to a high maintenance standard: heavy welded rails, long-life concrete ties, frequent sidings, a centralized traffic control system, several types of detectors, and radio communications. With these attributes, it is estimated that the line capacity could accommodate 25 to 54 trains per day, 2 to 4 times the current demand. It is not known how much site-related rail freight is being processed through this line.

The Union Pacific maintains gross weight restrictions for cars on the Los Angeles and Salt Lake lines, including the branches. These restrictions are 119,295 kg (263,000 lb) for four-axle cars; 178,715 kg (394,000 lb) for six-axle cars; and 238,589 kg (526,000 lb) for eight-axle cars. Four-axle cars of 147,417 kg (325,000 lb) gross weight can be handled. Six-axle locomotives are allowed over all portions of the line. The excellent track conditions allow maximum freight train speeds of 112 kph (70 mph) east of Las Vegas and 96 kph (60 mph) west where grades and curves restrict speed.

The Union Pacific is one of the nation's strongest railroads. The routes through Nevada are important transcontinental extensions of Union Pacific routes. Both main lines appear to figure prominently in the railroad's future plans. Future freight growth is projected for the Los Angeles and Salt Lake lines as a result of demands for low-sulfur coal in the Pacific Rim countries. Already, Union Pacific handles 80 percent of the lumber used in Las Vegas, and it is constantly expanding its automobile delivery business.

The Union Pacific's northern rail route parallels the Overland Route across much of northern Nevada. Union Pacific operates 10 to 15 trains per day on this line. Maximum train speeds are 113 kph (70 mph) for freight trains. This line is operated by centralized traffic control, with the dispatcher currently located in Sacramento, California.

The Southern Pacific's northern rail route (the Overland Route) operates 10 to 20 freight trains daily. It is suitable for 113 kph (70 mph) freight train speed. Southern Pacific's major Nevada freight yard is located in Sparks.

Rail passenger services in the region of influence are provided by Amtrak (the Desert Wind), which provides daily trains through Las Vegas; the Amtrak station is located downtown at the Union Plaza Hotel and Casino.

Air Transportation—Commercial air service to and from the region of influence is available through McCarran International Airport, located in Las Vegas, which provides jet air passenger and cargo service from both national and local carriers (Figure 4-16). In addition, three small airports are located in the region of influence: Sky Harbor Airport off Lake Mead Drive; and Boulder City Airport and North Las Vegas Air Terminal. Air transport service is also possible through two U.S. Air Force bases in the area: Nellis Air Force Base in North Las Vegas and the Indian Springs Auxiliary Airfield.

McCarran International Airport is located in Las Vegas, 120 km (75 mi) southeast of the NTS. It is the primary commercial airport in the region. This airport has three runways:1,524 m, 2,979 m, and 3,851 m (5,001 ft, 9,776 ft, and 12,636 ft) long. The North Las Vegas Air Terminal is located northwest of the city, 88 km (55 mi) southeast of the NTS. It has two 1,524 m (5,000 ft) runways.

Accident History—Interstates 15 and 80, and U.S. Highways 40 and 95 are potential routes for the transport of radioactive waste. Accidents on

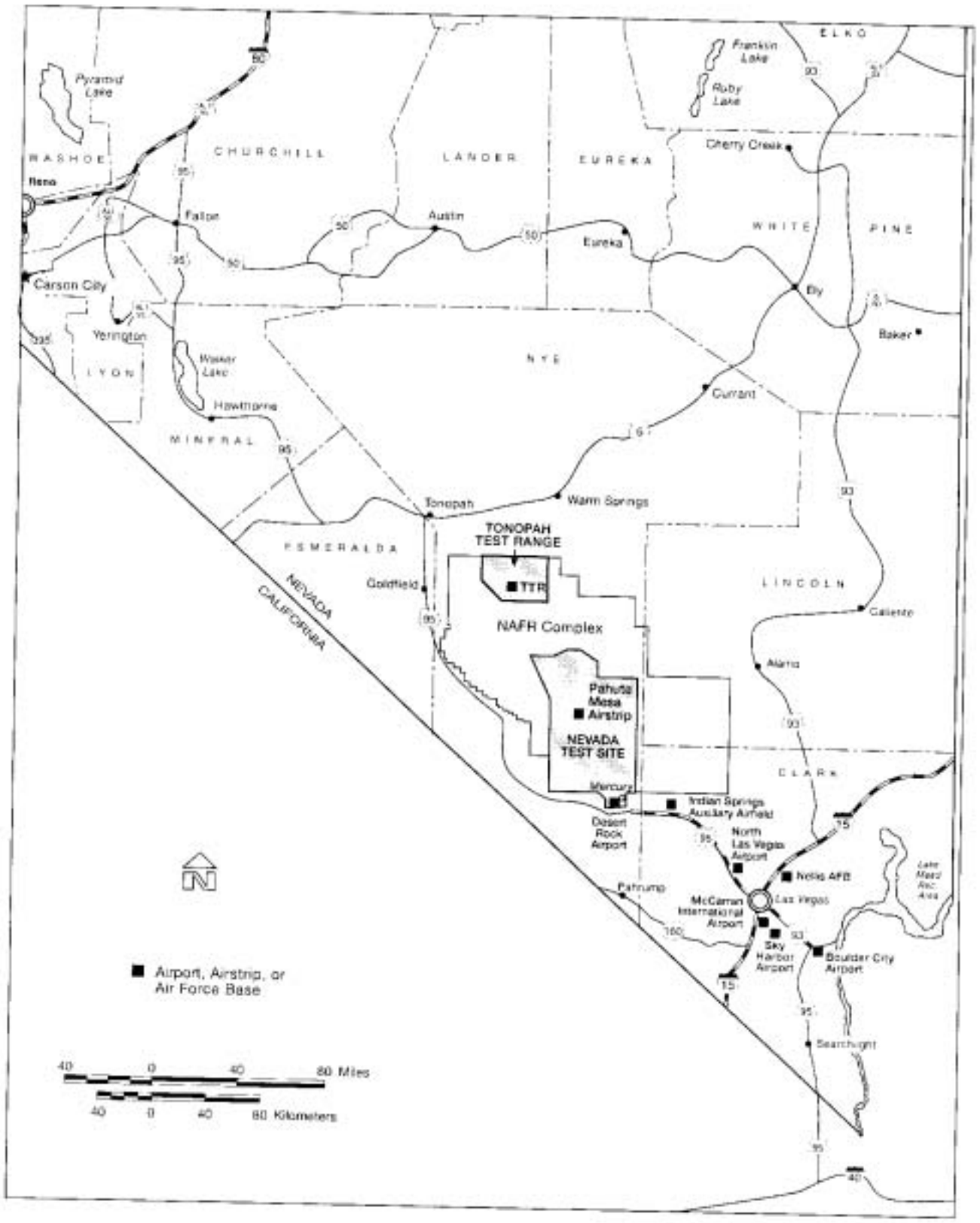


Figure 4-16. Airports in southern Nevada

state highways are generally reported and compiled by location and severity. Three classes of accidents are generally considered: fatality, injury, and property damage. Accident rates on highway segments are generally reported as number of accidents per million vehicle miles. Accident rates used in calculating the transportation risks are listed in Appendix I.

Freeways have the lowest accident rate. Multi-lane conventional highways show higher accident rates. Two-lane highways have the highest accident rates.

Expressed in number of accidents, heavily traveled segments would have the highest number of accidents.

Railroad accident information is available through the Federal Railway Administration. Railroad transport is not used for shipping waste to or from the NTS; therefore, railroad accidents were not analyzed for this study.

4.1.3 Socioeconomics

These sections present recent socioeconomic trends in the region surrounding the NTS, the Project Shoal Area, and the Central Nevada Test Area. Site effects are also discussed. Site-related effects are defined as program-related economic activity (employment, earnings, and personal income), population, housing, public finance, public services (public education, police and fire protection, and health care), and Environmental Justice.

REGION OF INFLUENCE—The region of influence is defined as the area in which the principal direct and secondary socioeconomic effects of site actions are likely to occur and are expected to be of the most consequence for local jurisdictions. The socioeconomic information presented in this EIS discusses current conditions in a region of influence comprised of Nye and Clark counties, Nevada. This region of influence includes most of the residential distribution of the employees of the DOE, its contractor personnel, and supporting government agencies. The region of influence also encompasses the probable location of future off-site contractor operations and indirect economic activities.

The regions of influence addressed in this section vary as appropriate from one socioeconomic issue to another. The public finance region of influence includes the cities of Las Vegas and North Las Vegas, the towns of Tonopah and Pahrump, Clark and Nye counties, and the Clark County and Nye County school districts. The finances of the unincorporated towns of Beatty and Amargosa Valley are administered by Nye County. The pertinent regions of influence for different public services also differ. For example, with public education, the region of influence is the Clark County and Nye County school districts.

American Indian Region of Influence—Within this region of influence, there also are several Indian reservation, tribal enterprises, tribally controlled schools, tribal police departments, and tribal emergency response units. The following reservations are located within the designated region of influence: Duckwater Shoshone Tribe, Las Vegas Paiute Tribe, Moapa Paiute Tribe, and the Yomba Shoshone Tribe. In addition, there are tribes which are located geographically outside of the region of influence, but are potentially impacted by NTS activities. One of these tribes, the Timbisha Shoshone Tribe, based in Death Valley, California, is located closer to the NTS than many towns in northern Nye County. As a consequence of this proximity, people from the Timbisha Shoshone Tribe, are a part of the social and economic region of influence of the NTS. For example, students from the Timbisha Shoshone Tribe attend public school in Beatty, Nevada whereas many Shoshone students from Tecopa, California attend school in Pahrump, Nevada. Timbisha tribal members both work and shop in Clark and Nye counties.

The Pahrump Paiute Tribe, located in Pahrump Valley, is composed of Indian people who have been historically recognized by federal and state agencies as qualified to receive services as Indian people, and who as a group are currently seeking federal acknowledgment.

ECONOMIC ACTIVITY—A survey of the NTS worker residential distributions in 1994 revealed that 90 percent of the workforce live in Clark County and 7 percent live in Nye County. The remaining 3 percent reside in other counties or

states. Within Clark County, most employees of the DOE/NV reside in the Las Vegas area (DOE, 1994b).

Analysis of economic activity impacts in the region of influence of Clark and Nye counties is accomplished separately for each county. The differences in size, economies, and contributions would produce a misleading analysis if both were analyzed as one aggregate area. For example, in 1994, the NTS accounted for 1 percent of total Clark County employment, as contrasted with 6 percent of total Nye County employment.

Between 1970 and 1980, total employment in Clark County increased from 1.13×10^5 to 2.64×10^5, or an average of 13.3 percent annually (Table 4-7). Total employment in Nevada in 1970 was approximately 256,000. By 1980, total employment increased to 488,000, an annual average increase of 9.1 percent. In contrast, total employment in the United States increased from 9.11×10^7 in 1970 to 1.14×10^8 in 1980, an annual average increase of 2.5 percent.

Clark County—Clark County, which is comprised of 20,531 km^2 (7,927 mi^2), is located in southern Nevada and is composed of large expanses of unincorporated land and five incorporated cities. These cities are Las Vegas, North Las Vegas, Henderson, Boulder City, and Mesquite. Despite the recent national recession, Clark County has continued to prosper because of expansion in the hotel and gaming industry, relocation of retirees to southern Nevada, expansion of the local government infrastructure, and additional investments. However, all indicators point to slower economic activity in the late 1990s (Schwer, 1995).

By 1990, total employment by place of work in Clark County had increased to 447,625, representing an average annual increase of 6.9 percent from the 1980 figure of 264,849. Between 1980 and 1990, average annual employment growth in Nevada was 5.3 percent, and in the United States, 2.2 percent.

The largest employment sectors in Clark County in 1990 were service industries (45.8 percent), of which the hotel, gaming, and recreation sector accounted for 61 percent. Retail trade, government, and construction accounted for 15.6 percent, 11.4 percent, and 8.6 percent, respectively (Figure 4-17). The remaining 18.6 percent was divided among the following sectors: finance, insurance, and real estate (7.3 percent); transportation and utilities (4.6 percent); wholesale trade (3.0 percent); manufacturing (2.6 percent), agricultural services (0.9 percent); agriculture (0.1 percent); and mining (0.1 percent). Employers of the largest workforces in the region are listed in Table 4-8.

In 1990, average annual earnings in Clark County were $24,382, while per capita income was $18,267 (Table 4-7). Total earnings by place of work reported in 1990 for Clark County were $10,914 million (Figure 4-17). Industrial sectors reporting the largest shares of earnings in Clark County in 1990 included services (47.5 percent), government (13.1 percent), manufacturing (10.6 percent), and retail trade (10.2 percent) (U.S. Bureau of Census, 1991).

According to the state of Nevada Employment Security Department, Clark County had 395,200 members of the total labor force who were employed, while 19,500 of the total labor force, or 4.7 percent, were unemployed (Table 4-9). The unemployment rate for Clark County was slightly lower than for the state (4.9 percent) and the nation (5.5 percent).

According to *Economic Outlook*, employment in Clark County will grow at a 3.9-percent rate during 1995 and at 3.5 percent for 1996 (Schwer, 1995). Although total employment continues to show very strong trends of growth, the unemployment rate has increased from an average of 5.0 percent in 1990 to an average of 7.1 percent in 1993 because of the in-migration rate exceeding the rate of employment opportunities. This is lower than the 1993 fourth quarter rate of 7.3 percent for Nevada and higher than the national unemployment rate of 6.4 percent (State of Nevada, 1993a).

Nye County—Nye County, located northwest of Clark County, is comprised of approximately 46,786 km^2 (18,064 mi^2). The federal government

Table 4-7. Summary of economic indicators (by place of work), Clark and Nye Counties, Nevada, and the United States

				Average Annual Change		
	1970	1980	1990	1970-1980	1980-1990	1970-1990
Clark County, Nevada						
Population	273,288	463,087	797,142	6.9%	7.2%	9.6%
Total Jobs	113,839	264,849	447,625	13.3%	6.9%	14.7%
Civilian Labor Force	116,200	237,700	414,700	10.5%	7.4%	12.8%
Unemployment Rate	5.9%	6.9%	4.7%			
Earnings Per Job	$26,178	$23,958	$24,382	-0.8%	0.2%	-0.3%
Per Capita Income	$15,629	$17,504	$18,267	1.2%	0.4%	0.8%
Nye County, Nevada						
Population	5,599	9,048	17,781	6.2%	9.7%	10.9%
Total Jobs	7,149	7,860	12,889	1.0%	6.4%	4.0%
Civilian Labor Force	2,230	2,580	9,100	1.6%	25.3%	15.4%
Unemployment Rate	1.8%	5.0%	3.5%			
Earnings Per Job	$29,389	$34,041	$31,415	1.6%	-0.8%	0.3%
Per Capita Income	$15,825	$17,991	$16,268	1.4%	-1.0%	0.1%
State of Nevada						
Population (1,000s)	493	801	1,202	6.2%	5.0%	7.2%
Total Jobs (1,000s)	256	488	748	9.1%	5.3%	9.6%
Civilian Labor Force (1,000s)	218	430	626	9.7%	4.6%	9.3%
Unemployment Rate	5.9%	6.2%	4.9%			
Earnings Per Job	$25,351	$23,660	$24,037	-0.7%	0.2%	-0.3%
Per Capita Income	$15,616	$18,051	$19,812	1.6%	1.0%	1.3%
United States						
Population (1,000s)	203,799	227,255	249,466	1.2%	1.0%	1.1%
Total Jobs (1,000s)	91,093	113,726	138,573	2.5%	2.2%	2.6%
Civilian Labor Force (1,000s)	82,771	106,940	124,787	2.9%	1.7%	2.5%
Unemployment Rate	4.9%	7.1%	5.5%			
Earnings Per Job	$23,220	$23,218	$24,278	0.0%	0.5%	0.2%
Per Capita Income	$13,017	$15,652	$18,635	2.0%	1.9%	2.2%

NOTE: Dollars are in constant 1990 dollars.

Sources: State of Nevada, 1990; U.S. Bureau of Census, 1991

Table 4-8. Workforce in Clark and Nye Counties

Employer	Number of Employees[a]	Percentage of Total
Clark County School District	15,000	3.36
Nellis Air Force Base	9,100	2.04
Nevada Test Site	7,700[b]	1.73
Clark County	4,650	1.04
University of Nevada, Las Vegas	4,600	1.03
University Medical Center (hospital)	2,650	0.59
Humana Hospital-Sunrise	2,400	0.54
Las Vegas Metropolitan Police	2,250	0.50
Smith's Food and Drug	2,225	0.50
City of Las Vegas	1,925	0.43
Las Vegas Post Office	1,875	0.42
Nevada Power Company	1,750	0.39
K-Mart Corporation	1,000	0.22
Other Employment (including hotels and casinos)	389,035	87.20
Total	**446,160**	**100.00**

[a] Numbers are approximate

[b] This number reflects the cumulative total of NTS-related employees (Las Vegas area or at the NTS) who reside in the Las Vegas metropolitan area regardless of their place of employment. This number does not reflect the anticipated layoff of approximately 2,000 for Fiscal Year 1995.

Source: State of Nevada, 1993b

Table 4-9. 1990 civilian labor force, employment and unemployment, Clark and Nye Counties, Nevada, and the United States

	Civilian Labor Force	Employed	Unemployed	Unemployment Rate
Clark County	414,700	395,200	19,500	4.7%
Nye County	9,100	8,780	320	3.5%
State of Nevada (1,000s)	626	595	31	4.9%
United States (1,000s)	124,787	117,914	6,874	5.5%

Source: State of Nevada, 1990; U.S. Bureau of Census, 1991.

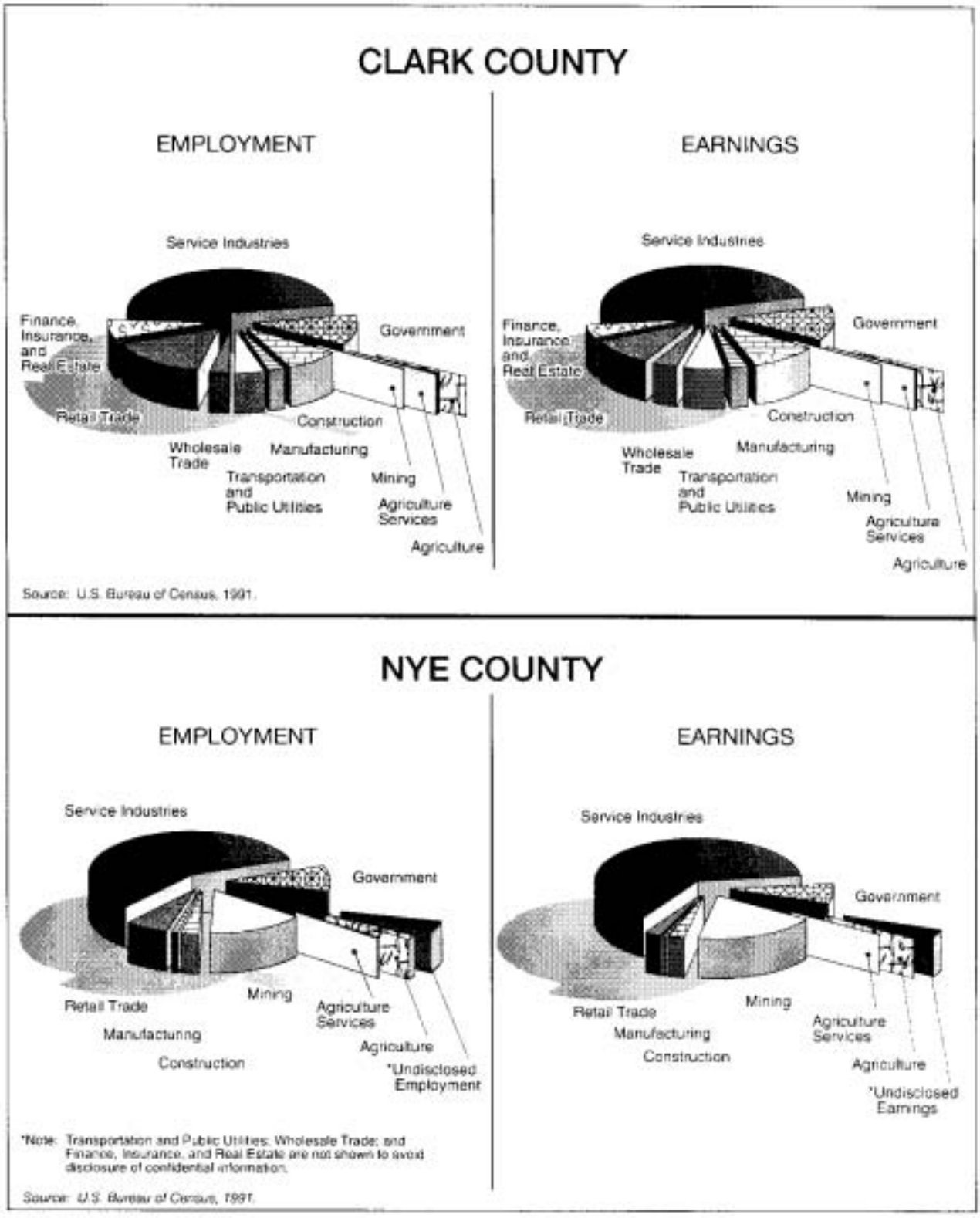


Figure 4-17. Clark County and Nye County 1990 employment and earnings by place of work

controls 93 percent of the land area. Mining, federal installations, tourist and recreation attractions, and grazing allotments all occur largely on public land in Nye County (Nye County Board of Commissioners, 1993).

Nye County is comprised of communities widely separated by distance, each with a distinct and independent economic base. The NTS and Tonopah Test Range have been operating in Nye County for several decades. Federal facilities have provided employment for Nye County residents and a modest amount of procurement for local business. The economy in each community is dependent on different private companies and, in some cases, different industries. Because the communities are widely separated by distance, economic links to each other are limited. Metropolitan economies generally absorb a significant portion of business and residential purchases. Rural economies, such as Nye County, however, often leak large portions of both business and residential purchases to larger communities, resulting in economic loss and a set of economic development needs different from those in more urban areas (Nye County Board of Commissioners, 1994).

Nye County's strategy to increase economic development opportunities from federal facilities is to engage the appropriate divisions of the DOE in a formal set of interactions. Nye County has identified the need for a qualified workforce and business base to fulfill federal requirements. To this end, Nye County has developed programs to inform local businesses of federal procurement opportunities and continuing formal and informal interaction with appropriate federal agencies (NEEDA, 1993a). One example of this proactive approach is Nye County's status as a cooperating agency in the NTS EIS.

Total employment in Nye County between 1970 and 1980 increased from 7,149 to 7,860, or an average of 1.0 percent annually (Table 4-7). Total employment in Nevada in 1970 was approximately 256,000. By 1980, employment increased to 488,000, an annual average increase of 9.1 percent. In contrast, total employment in the United States increased from 9.11×10^7 in 1970 to 1.14×10^8 in 1980, an annual average increase of 2.5 percent. In the 1970s and 1980s, nuclear weapons testing at the NTS dominated the Nye County economy when described in terms of employment by place of work. While most of the NTS workforce commutes to the Las Vegas area and most food and other services are provided at federally subsidized facilities on the NTS, some county private businesses do provide the NTS with support services.

In 1990, total employment in Nye County expanded to 12,889, an annual increase of 6.4 percent from the 1980 figure of 7,860. This increase in employment was largely composed of employees who lived outside Nye County, as can be seen in Table 4-7 (less than 10 percent live in Nye County). The table lists employees by place of work rather than by place of residence. This accounts for the low number of civilian labor force (9,100) when compared to the total number of jobs (12,889). Between 1980 and 1990, average annual employment growth in Nevada was 5.3 percent, and in the United States, 2.2 percent. While total employment in Nye County was increasing during this period, employment at the NTS and Tonopah Test Range was decreasing. In addition to the loss of an estimated 140 NTS jobs held by Nye County residents, the relocation of the U.S. Air Force 37th Tactical Fighter Wing from the Tonopah Test Range resulted in the loss of an estimated 511 jobs held by Nye County residents (SAIC/DRI, 1991).

In 1990, the largest employment sectors in Nye County were service industries (58.2 percent), mining (15.2 percent), government (9.4 percent), retail trade (6.8 percent), construction (2.6 percent), agriculture (1.7 percent), manufacturing (1.1 percent), and agricultural services (0.4 percent) (Figure 4-17). The large percentage of service jobs can be explained by the large number of jobs at the NTS, which are classified as service. The remaining 4.7 percent was divided among the following sectors: wholesale trade; finance, insurance, and real estate; and transportation and utilities. The specific breakdowns are not shown to avoid disclosure of confidential information.

In 1990, average annual earnings per job in Nye County were $31,415 (inflated by the large number of NTS workers), while per capita income was $16,268 (Table 4-7). Jobs at the NTS and Tonopah Test Range are relatively high paying. For example,

the average worker received $47,319 in compensation in 1994. Consequently, Nye County earnings decreased approximately 9 percent over a 3-year period from 1989 to 1992, a result in large part due to the decline in the NTS employment and the relocation of the U.S. Air Force 37th Tactical Fighter Wing from the Tonopah Test Range. Total earnings reported in 1990 for Nye County were $404.9 million. Industrial sectors reporting the largest shares of earnings in Nye County in 1990 included services (64.0 percent), mining (19.2 percent), and government (7.5 percent) (Figure 4-17). According to the state of Nevada Employment Security Department, 8,780 members of the total labor force were employed (Table 4-9), while 320 or 3.5 percent of the total labor force was unemployed. The unemployment rate for Nye County was lower than the State (4.9 percent) and the nation (5.5 percent) (State of Nevada, 1990).

The federal fiscal year is the period between October 1 and September 30. Total employment at the NTS in Fiscal Year 1994 was 7,016 and is expected to be approximately 6,580 in Fiscal Year 1995, a decrease of almost 19 percent. This will be the lowest employment level at the NTS for Fiscal Years 1987 through 1995. In Fiscal Year 1987, employment reached a historical high of 9,908. The subsequent reduction of employment between Fiscal Years 1988 and 1994 can be attributed mainly to budgetary constraints and the nuclear testing moratorium (Table 4-10).

Total expenditures at the NTS have been decreasing over the last five years, from $856.2 million in Fiscal Year 1990 to $769.5 million in Fiscal Year 1994. This decrease can also be attributed to budgetary constraints and the nuclear testing moratorium (Table 4-10).

POPULATION—This section presents the 1990 population for Clark and Nye counties. In addition, two cities, Las Vegas and North Las Vegas in Clark County, and four towns, Tonopah, Pahrump, Beatty, and Amargosa Valley in Nye County, are discussed. Summaries of population can be found in Tables 4-7 and 4-11.

Clark County—According to *Economic Outlook*, in 1990 the population for Clark County was 797,142, an increase of 334,055, or an average annual increase of 7.2 percent from the 1980 level of 463,087 (Schwer, 1995). The overall increase is equivalent to an annual average growth for the county of approximately 9.6 percent over the 1970 to 1990 period. By comparison, the average annual growth for Nevada was approximately 5 percent and nearly 1 percent for the United States between 1980 and 1990.

The population of the city of Las Vegas totaled 268,330 in 1990, an increase of 63 percent from the 1980 level of 164,674 (State of Nevada, 1995b). The average annual growth of 5.7 percent for the 1970 to 1990 period was below the county level. In 1970, the city of Las Vegas accounted for 46.0 percent of the Clark County population (State of Nevada, 1994); by 1990, the City accounted for 33.7 percent of the total population.

The population of the city of North Las Vegas was 50,030 in 1990, an increase of 1.5 percent from the 1980 level. The average annual growth of 1.9 percent for the 1970 to 1990 period was below the county level. In 1970, the city of North Las Vegas accounted for 13.3 percent of the Clark County population; in 1990, the city accounted for 6.3 percent of the total population in Clark County.

Nye County—In 1990, the population for Nye County was 17,781, an increase of 8,733, or an average annual increase of 9.7 percent from the 1980 level (Nye County Board of Commissioners, 1993). The overall increase is equivalent to an annual average growth for the county of about 10.9 percent over the 1970 to 1990 period. By comparison, for the period 1980 through 1990, the average annual population growth for Nevada was about 5 percent and nearly 1 percent for the United States.

As the Nye County seat, Tonopah's economic base includes government employment and a growing travel and tourist economy. However, recent layoffs at area mines and the transfer of the U.S. Air Force 37th Tactical Fighter Wing from the Tonopah Test Range have resulted in population losses in Tonopah (Nye County Board of Commissioners,

Table 4-10. DOE/NV funding and employment, 1990 to 1994

Fiscal Year	Funding (millions)	Employment
1990	$856.2	9,152
1991	$909.1	8,897
1992	$912.3	8,794
1993	$865.8	7,704
1994	$769.5	7,016

Table 4-11. Population in the region of influence, 1990 through 1995

	1990	1991	1992	1993	1994	1995
Clark County	797,142	834,907	870,692	919,388	985,827	1,032,161
Las Vegas	268,330	289,690	303,440	323,300	346,350	362,628
North Las Vegas	50,030	51,060	55,400	60,880	69,700	77,820
Nye County	17,781	19,197	20,613	22,236	23,988	25,976
Tonopah	3,810	3,586	3,375	3,514	3,659	3,810
Pahrump	7,440	8,777	10,355	11,761	13,357	15,170
Beatty	1,652	1,775	1,907	1,915	1,922	1,930
Amargosa	838	916	947	1,010	1,070	1,100

NOTE: 1990 data are U.S. Bureau of the Census counts; all other data are projections.

Sources: Nye County Board of Commissioners, 1993; Schwer, 1995.

1994). The 1990 population in the town of Tonopah was 3,810. Since 1980, the population growth for the town of Tonopah has increased by about 39 percent. In 1990, the town accounted for 21.4 percent of the population in Nye County; this percentage has decreased since 1970 when the town accounted for 30.6 percent of the Nye County population (U.S. Bureau of the Census, 1991).

Pahrump is the largest and most rapidly growing community in Nye County. It nearly tripled in size in the decade between 1980 and 1990 and has continued to grow. It can be anticipated that the community's reputation as a retirement center and bedroom community for Las Vegas will continue to attract new residents (Nye County Board of Commissioners, 1994). The 1990 population for the town of Pahrump was 7,440.

Since 1980, growth in Pahrump has driven growth in Nye County. The average annual growth of 2.5 percent for the 1970 to 1990 period was below the state and national averages. In 1990, the city accounted for 41.8 percent of the population in Nye County; this percentage has increased since 1970 when the city accounted for 17.2 percent of the Nye County population (U.S. Bureau of the Census, 1991).

The population in Beatty increased dramatically between 1985 and 1990 because of the development of the Bond Gold Bullfrog Mine and Mill. The 1990 population was 1,652 and has increased only slightly since. Beatty's economy and population are based predominately on mining, employment at federal facilities, and travel and tourism. Beatty may face potential population losses resulting from the depletion of current mineral reserves (U.S. Bureau of the Census, 1991; Nye County Board of Commissioners, 1994).

The population of the town of Amargosa Valley has ranged from 838 in 1990 to 1,100 in 1995, an increase of 31.3 percent in 5 five years. In 1995, Amargosa Valley accounted for 4.2 percent of the total population in Nye County.

HOUSING—The housing stock and number of building permits are discussed in the following section for Clark County; the cities of Las Vegas and North Las Vegas; Nye County; and the towns of Tonopah, Pahrump, and Beatty in Nye County. Table 4-12 presents housing characteristics in the region of influence.

Clark County—In 1990, the housing stock in Clark County consisted of 317,188 units, an increase of 127,328 units or 67.1 percent over the 1980 total of 189,860. Between 1980 and 1990, Clark County housing unit vacancies increased from 15,969 units or 8.4 percent of the housing stock in 1980 to 30,163 vacant units or 9.5 percent of the housing stock in 1990. The housing market continues to flourish as the demand for new housing consistently exceeds the supply. The increase in demand is attributable to the influx of retirees and other in-migrant population (U.S. Bureau of the Census, 1991; ULI, 1994).

The number of building permits issued annually in Clark County rose sharply in the mid-to-late-1980s, with a peak of 26,432 permits issued in 1988. In the early 1990s, the number of permits dropped, with 13,027 issued in 1992. Building permits issued in a given year may not represent the actual number of units built; however, they are indicative of the level of new residential development in the city (Schwer, 1995).

In 1990, the housing stock in the city of Las Vegas consisted of 109,670 units, an increase of 42,629 units or 63.6 percent over the 1980 total of 67,041. Between 1980 and 1990, the city of Las Vegas housing units vacancies increased from 4,897 units or 7.3 percent of the housing stock in 1980 to 9,935 vacant units or 9.1 percent of the housing stock in 1990.

The outlook for the Las Vegas residential market remains very positive for single-family homes. Job growth, driven by the hotel and gaming industry, should remain strong for the next several years. The addition of over 10,000 new hotel rooms in 1995 will create approximately 15,000 jobs in that sector. Applying the multiplier effect, another 30,000 additional secondary jobs could be created in other areas of the economy. This strong job growth will fuel demand for housing in all market segments. Overall, a strong market is projected though 1995. Projections beyond 1995 will be determined by new economic development activity, such as another large-scale resort and gaming project or the relocation of other major employers to Las Vegas (ULI, 1994).

The city of North Las Vegas' 1990 housing stock consisted of 15,837 units, an increase of 1,738 units or 12.3 percent over the 1980 total of 14,099. Between 1980 and 1990, North Las Vegas housing unit vacancies increased from 1,037 units or 7.4 percent of the housing stock in 1980 to 1,312 vacant units or 8.3 percent of the housing stock in 1990.

Nye County—The availability of affordable housing for senior citizens and low- and middle-income residents and the ability of entry-level buyers to obtain financing for housing are of concern in Nye County (Nye County Board of Commissioners, 1994). In 1990, the housing stock in Nye County consisted of 8,073 units, an increase of 3,871 units or 92.1 percent over the 1980 total of 4,202 (Nye County Board of Commissioners, 1993). Between 1980 and 1990, Nye County housing unit vacancies decreased from 768 units or 18.3 percent of the housing stock in 1980 to 1,409 vacant units or 17.5 percent of the housing stock in 1990. The vacancy rate does not reflect substandard units or houses held for occasional and recreational use.

Table 4-12. 1990 housing characteristics in the region of influence

	Housing Stock	Housing Demand	Vacancy Rate
Clark County	317,188	287,025	9.51%
Las Vegas	109,670	99,735	9.06%
North Las Vegas	15,837	14,525	8.28%
Nye County	8,073	6,664	17.45%
Tonopah	1,767	1,460	17.37%
Pahrump	3,514	3,029	13.80%
Beatty	912	762	16.45%

NOTE: Housing stock is the total number of units; demand is the total number of occupied units.

Source: U.S. Bureau of the Census, 1991.

The 1990 housing stock in the town of Tonopah consisted of 1,767 units. Some 1,460 were occupied and 307 were vacant (17.4 percent). The largest number of houses were built between 1980 and 1984. A major decline in new housing construction has been experienced since 1984 (NEEDA, 1993b).

In 1990, the housing stock in the town of Pahrump consisted of 3,514 units. The vacancy rate was 13.8 percent, and 3,029 were occupied (NEEDA, 1993b). Fifty-eight percent of the houses have been built since 1979, and 92 percent of all housing units have been built since 1969.

In 1990, the housing stock in the unincorporated area of Beatty consisted of 912 units. Of these, 762 were occupied, resulting in a vacancy rate of 16.5 percent. The largest portion of the houses were built between 1970 and 1979. A gradual decline in new housing has been experienced in the past 20 years. Ninety-four new structures were under construction in 1990 (NEEDA, 1993b).

PUBLIC FINANCE—The financial characteristics of potentially affected local jurisdictions are presented in this section. The local jurisdictions include Clark County, the cities of Las Vegas and North Las Vegas, Clark County School District, Nye County, the towns of Tonopah and Pahrump, and the Nye County School District. The finances of Beatty, Amargosa Valley, and Manhattan are administered by Nye County.

Government funds discussed in this section are those through which most government functions of the jurisdiction are financed. Government fund types include the general, special revenues, debt service, and capital project funds. The general fund accounts for financial transactions related to revenues and expenditures of services are not accounted for in other funds. Special revenues funds are those funds accounted for in the proceeds of specific revenue sources that are legally restricted for specified purposes. Debt service funds account for the accumulation of resources for, and the payment of, interest and principal on general long-term debt. Capital project funds are used to account for financial resources for the acquisition or construction of major capital facilities. The fiscal year for all Nevada jurisdictions is the 12-month period from July 1 to June 30.

For many jurisdictions discussed, ad valorem taxes are a major source of revenue. These are taxes that are levied on the assessed valuation of real property. Assessed valuation is a valuation set upon real estate as a basis for levying taxes. Thirty-five percent of the taxable value placed upon real property is used as the basis for levying property taxes in most Nevada jurisdictions.

Table 4-13 summarizes the fiscal position of Clark County and Nye County jurisdictions in Fiscal Year 1994. Columns are presented only to facilitate financial analysis. Such data are not comparable to a consolidation. The fund balances are the

Table 4-13. Financial summary for Fiscal Year 1994, general, special revenues, debt service, and capital project funds, Clark County and Nye County jurisdictions

	Revenues	Expenditures	Revenues Less Expenditures	Debt Service	Current Expense	Fund Balance as Percentage of Current Expense
Clark County	$696,950,016	$767,611,252	($70,661,236)	$65,178,759[a]	$457,379,897[b]	157.95%
Las Vegas	$245,511,322	$249,562,587	($4,051,265)	$10,319,245[c]	$176,253,405[d]	59.67%
North Las Vegas	$51,914,044	$53,747,125	($1,833,081)	$2,528,555[e]	$41,768,530[b]	30.97%
Clark County School District	$716,013,860	$775,193,716	($59,179,856)	$56,980,872[c]	$636,708,860[f]	12.90%
Nye County	$25,450,955	$25,493,176	($42,221)	$19,955[g]	$21,389,278[h]	76.75%
Tonopah	$762,898	$669,800	$93,098	$66,788[i]	$603,012[h]	66.65%
Pahrump	$1,043,164	$944,879	$98,285	$90,014[i]	$711,674[h]	80.35%
Nye County School District	$24,079,470	$25,176,765	($1,097,295)	$4,020,145[j]	$18,840,821[k]	26.86%

[a] Principal and interest
[b] Total expenditures less capital projects and debt service
[c] Principal and interest and fiscal charges
[d] Principal retirement and interest
[e] Principal on loans and bond retirement and interest on bonds
[f] Principal retirement and interest and bond issuance costs
[g] Total expenditures less facilities acquisition and construction and debt service

Sources: Clark County, 1994a; Clark County School District, 1994b; City of Las Vegas, 1994; City of North Las Vegas, 1994; Nye County, 1994; Nye County School District, 1994; Pahrump, 1994; Tonopah, 1994.

resources remaining from the prior year that are available to be budgeted in the current year. The fund balance as percentage of current expense is a quick look at how much reserve would be used if current (due within a year) expenses had to be paid without considering revenues. The lower the percentage, the less available to pay off current expenses. The following sections focus on Fiscal Year 1994.

Clark County—Clark County, incorporated in 1909, is governed by a Board of County Commissioners and a county manager. This seven-member board is elected by each district to serve staggered four-year terms. Within the county are 5 incorporated cities, including Las Vegas, which is the county seat, and 13 unincorporated towns (Clark County, 1994a). County services provided include the county recorder, assessor, treasurer, social services, airport, hospital, and criminal justice. In addition, the county provides a full range of local services, such as fire, police, road maintenance and construction, animal control, building inspection, and water and sewage systems to county residents living in unincorporated areas.

Total revenues for Fiscal Year 1994 were $696,950,016. The two most significant revenue sources for Clark County in Fiscal Year 1994 were intergovernmental revenues, and ad valorem taxes and special assessments. Intergovernmental revenues were approximately 48 percent of total revenues in Fiscal Year 1994 and have usually been the primary revenue source for Clark County in the past. Sales and use taxes have been a major component of intergovernmental revenues because of growth in the economy. In Fiscal Year 1992, the state of Nevada implemented a "Fair Share" sales tax distribution formula that based distribution on the point of origin rather than need. Since 1981, Clark County had been receiving fewer sales taxes than collected; therefore, this legislation had a

positive fiscal impact for the county (Clark County, 1994a).

Ad valorem taxes and special assessments are the second most significant revenue source for Clark County, comprising approximately 23 percent of total revenues in Fiscal Year 1994. Ad valorem taxes were based on an assessed valuation of $17,107,674,808 and a tax rate of $0.7131 per $100 of assessed valuation (Clark County, 1994b).

Expenditures totaled $767,611,252 for Fiscal Year 1994. The two most significant expenditure categories for Clark County in Fiscal Year 1994 were capital projects and public safety. As 32 percent of total expenditures, capital projects include major transportation improvements throughout the county, a new government center, and buildings for family court services. Public safety expenditures were approximately 27 percent of total expenditures in Fiscal Year 1994. Included in this category are expenditures for the county sheriff, fire department, and coroner.

Revenues less expenditures were a negative $70,661,236 in Fiscal Year 1994. Debt service (principal and interest) was $65,178,759. Current expenses, which are total expenditures less capital projects and debt service, were $457,379,897. The ending fund balance was 158 percent of current expense. The ending fund balance is the excess of assets over liabilities and reserves (Clark County, 1994a).

City of Las Vegas– The city of Las Vegas was incorporated in 1911 and has a council manager form of government. The city provides for fire and police protection (through the Las Vegas Metropolitan Police Department), municipal court, sanitation, construction and maintenance of roads, recreation, and general government services for residents within its approximately 233km² (90mi²) incorporated area. Las Vegas is the county seat of Clark County and has the largest population of any incorporated city in the county.

The two most significant revenue sources in Fiscal Year 1994 for the city of Las Vegas were intergovernmental revenues and taxes. Intergovernmental revenues comprised approximately 56 percent of total revenues. Intergovernmental revenues involve federal grants, cigarette taxes, liquor taxes, sales taxes, motor vehicle privilege taxes, the city share of county gaming licenses, and real property transfer taxes. In Fiscal Year 1994, taxes were approximately 16 percent of total revenues. Tax revenues have two components: real property tax and personal property tax. Both are calculated on the assessed valuation of the property. Total assessed value was $4,230,821 in 1994. The property tax rate for 1994 was $0.7247 per $1,000 of assessed value.

In Fiscal Year 1994, the two largest expenditure categories for the city of Las Vegas were public safety and capital outlay. Public safety expenditures, consisting of police, fire, corrections, traffic engineering, and building and safety services, were approximately 37 percent of total expenditures in this year. Capital outlay, the second largest expenditure category, was 25 percent of total expenditures.

Revenues less expenditures were a negative $4,051,265 in Fiscal Year 1994. Debt service was $10,319,245. Current expense was $176,253,405, and the fund balance as a percentage of current expense was 60 percent (City of Las Vegas, 1993 and 1994).

City of North Las Vegas—The city of North Las Vegas was incorporated in 1946 and has a council manager form of government. The city provides a full range of services within its 166-km² (64-mi²) incorporated area, including general government, police, municipal court, public safety, highway and streets, health and sanitation, culture and recreation, community support, and utilities.

In Fiscal Year 1994, the two most significant revenue sources for the city of North Las Vegas were intergovernmental and taxes. Intergovernmental revenue provided approximately 55 percent of total revenues in Fiscal Year 1994. The intergovernmental revenue consisted of grants, shared revenues, and payments in lieu of taxes. Taxes comprised approximately 15 percent of total revenues and included ad valorem, county option motor vehicles fuel, and room taxes. In 1994, the ad valorem tax rate in North Las Vegas was

$3.119 per $100 of assessed valuation. The total assessed valuation in this year was $661,947,000.

The two largest expenditures for the city of North Las Vegas in Fiscal Year 1994 were public safety and capital projects. Public safety expenditures (police, fire, and protective services) comprised approximately 49 percent of total expenditures in Fiscal Year 1994. Capital project expenditures were the second most important expenditure category at 18 percent of all expenditures.

Revenues less expenditures were a negative $1,833,081 in Fiscal Year 1994. Debt service was $2,528,555. Current expense was $41,768,530, and the fund balance as a percentage of current expense was 31 percent (City of North Las Vegas, 1994).

Clark County School District—Clark County School District boundaries are the same as those of Clark County. The continued rapid growth of Clark County has resulted in a shortage of schools and school buildings. In the 1988 and 1994 elections, bonds for school building programs were approved by voters. It is estimated that between 25 and 38 new schools will be built in the immediate future. In addition, the district is involved in asbestos removal and fire safety retrofitting to meet Nevada fire code requirements. The construction and retrofitting bonds are to be paid with ad valorem taxes.

The key revenue sources for the Clark County School District are local and state sources. Local sources are monies generated from sales taxes, ad valorem taxes, and motor vehicle privilege taxes. These revenues were approximately 64 percent of total revenues in Fiscal Year 1994. The Clark County School District portion of the Clark County ad valorem tax rate in Fiscal Year 1992 was $1.1935 per $100 of assessed valuation; this rate has not changed since Fiscal Year 1988. State sources are revenues generated by the state of Nevada and received by the district based on a formula. The formula includes a standard amount per student, plus special educational funding. These revenues were 33 percent of total revenues in Fiscal Year 1994.

The two major expenditures for the district were regular programs and undistributed expenditures. The regular programs category includes expenditures such as instruction, support, and transportation for all regular elementary and secondary students. Regular programs comprised 42 percent of all expenditures. Undistributed expenditures are charges not readily assignable to a program, such as student and instructional staff support; general and administrative costs; and costs of operating, maintaining, and constructing physical facilities of the district. These undistributed expenditures were 28 percent of total expenditures in Fiscal Year 1994.

In Fiscal Year 1994, revenues less expenditures were a negative $59,179,856. Debt service was $56,980,872. Current expense was $636,708,860. The ending fund balance was $82,112,931, which was 13 percent of the current expense (Clark County School District, 1994a and b).

Nye County—Nye County is governed by a five-member Board of County Commissioners. Within the county are six unincorporated towns, including Tonopah, the county seat. The governing body of Nye County has direct oversight responsibility for the unincorporated towns of Amargosa Valley, Beatty, and Manhattan. County services provided include the county recorder, assessor, treasurer, social services, and criminal justice. In addition, the county provides a limited range of local services, such as police, road maintenance and construction, and animal control. Excluded from the Nye County financial statements are the Nye County School District and the towns of Tonopah and Pahrump. These are discussed in the following sections.

The two most significant revenue sources for Nye County in Fiscal Year 1994 were intergovernmental revenues and ad valorem taxes. Intergovernmental revenues were approximately 55 percent of total revenues. Major components of this revenue were supplemental city/county relief taxes and motor vehicle fuel taxes. Ad valorem taxes are the second most significant revenue source for Nye County, comprising approximately 27 percent of total revenues in Fiscal Year 1994. The 1994 assessed valuation was $636,488,641, and the tax rate was $2.6466 per $100 of assessed valuation.

The two key expenditure categories for Nye County in Fiscal Year 1994 were general government and public safety. General government expenditures were approximately 29 percent of total expenditures in Fiscal Year 1994. Included in this category are expenditures for county administration, finance, and building services. Public safety, the second most significant expenditure at 24 percent of total expenditures, includes the sheriff, search and rescue, and fire departments.

In Fiscal Year 1994, revenues less expenditures were a negative $42,221. Debt service was $19,955. Current expense was $21,389,278. The ending fund balance was $16,416,983, which was 77 percent of the current expense (Nye County, 1994).

Tonopah—Tonopah is the county seat of Nye County and the second largest community in the county. The unincorporated town of Tonopah has a town board form of government. The unincorporated town mechanism is often chosen over incorporation for financial considerations. An unincorporated town may provide certain services and may be allowed certain revenues to fund these services. Unincorporated towns may provide a wide range of services, but are not required to do so. They may use Nye County services and benefit from the cost efficiencies of the larger service system (Nye County Board of Commissioners, 1994). The town provides a range of services within its area, including general government, public safety, highways and streets, and culture and recreation.

In Fiscal Year 1994, the two most significant revenue sources for Tonopah were taxes and intergovernmental revenues. Taxes comprised approximately 53 percent of total revenues and included property taxes and room taxes. In 1994, the property tax rate in Tonopah was $3.2403 per $100 of assessed valuation for an assessed valuation of $31,898,884 (Nye County, 1994). Intergovernmental revenue provided approximately 34 percent of total revenues in Fiscal Year 1994. This revenue included county liquor licenses, county gaming licenses, motor vehicle privilege taxes, relief taxes, and gas taxes.

The two largest expenditures for Tonopah in Fiscal Year 1994 were public safety and culture and recreation. Public safety expenditures (fire services) comprised approximately 35 percent of total expenditures in Fiscal Year 1994. Culture and recreation expenditures were the second most important expenditure category at 26 percent of all expenditures. Culture and recreation includes expenses for parks, libraries, swimming pool, fairs, and ball fields.

Revenues less expenditures were $93,098 in Fiscal Year 1994. Debt service was $66,788. Current expense was $603,012, and the fund balance as a percentage of current expense was 67 percent (Tonopah, 1994).

Pahrump—The unincorporated town of Pahrump has a town board form of government. The largest community in Nye County, the town provides for general government, public safety, public works, health, and culture and recreation services for residents within its area.

The two most significant revenue sources in Fiscal Year 1994 for Pahrump were taxes and intergovernmental revenues. In Fiscal Year 1994, taxes were approximately 49 percent of total revenues. Tax revenues have two components: property tax and room tax. The property tax rate for 1993 was $2.8830 per $1,000 for an assessed value of $225,896,898 (Nye County, 1994). The town levies room taxes. Amounts collected for the Fiscal Year 1994 were $72,288 or 14 percent of all taxes. Intergovernmental revenues comprised approximately 37 percent of total revenues. Intergovernmental revenues involve a motor vehicle privilege tax, relief tax, county and state grants, and gas tax.

In Fiscal Year 1994, the two largest expenditure categories for Pahrump were general government and culture and recreation. General government expenditures, consisting of administration, building and grounds, town board, community center, and advisory planning, were approximately 41 percent of total expenditures in this year. Culture and recreation, the second largest expenditure category,

was 16 percent of total expenditures. It included television, recreation, parks, and arena and fair activities.

Revenues less expenditures were $98,285 in Fiscal Year 1994. Debt service was $90,014. Current expense was $711,674, and the fund balance as a percentage of current expense was 80 percent (Pahrump, 1994).

Amargosa Valley—The town of Amargosa Valley is located on U.S. Highway 95, approximately 145 km (90 mi) northwest of Las Vegas. Its northern edge is adjacent to the NTS. The town encompasses some 1,243 km^2 (480 mi^2) and is about half the size of the state of Rhode Island. Its economy is based primarily on farming, the NTS, and several small- and medium-sized mines. Amargosa Valley has no professional government management or administrative staff. It is governed and funded by the Nye County Board of Commissioners. The County Commissioners set the annual budget for the town and enact ordinances and policies on the recommendation of the five-member Amargosa Valley Citizens' Advisory Council. The town provides a range of services, including a community center, library, parks and recreation, fire protection and ambulance, and a senior center.

Amargosa Valley financial and budgetary programs are administered by Nye County and are reflected in the Nye County finance section. Construction of the Amargosa Valley Community Center, library, and sheriff's substation/fire station was financed by general obligation bonds. The original amount of the bond issue was $735,000, which was reflected in increased capital outlay in Fiscal Years 1987 to 1988. The 1987 delinquency rate for ad valorem taxes was approximately 17 percent, and it is expected that Nye County will have to provide additional support to the town in the coming fiscal years (Blankenship, 1995).

Nye County School District—Nye County School District boundaries are contiguous with those of Nye County. The school district is governed by a seven-member Board of School Trustees, who are elected to serve four-year terms.

The key revenue sources for the district are state and local sources. Local sources are monies generated mostly from ad valorem taxes, school support taxes, and franchise taxes. These revenues were approximately 53 percent of total revenues in Fiscal Year 1994.

State sources are revenues generated by the state of Nevada and received by the district based on a formula. The formula includes a standard amount per student, plus special educational funding. These revenues were 44 percent of total revenues in Fiscal Year 1994.

The two major expenditures for the district were regular programs and operations and maintenance. The regular programs category includes expenditures such as instruction, support, and transportation for all regular elementary and secondary students. Regular programs comprise 39 percent of all expenditures. Operations and maintenance costs are the second most significant expenditure for the district, comprising 11 percent of total expenditures in Fiscal Year 1994. This expense includes salaries, benefits, purchased services, supplies, and property.

In Fiscal Year 1994, revenues less expenditures for the Nye County School District were a negative $1,097,295. Debt service was $4,020,145. Current expense was $18,840,821, and the fund balance as a percentage of current expense was 27 percent (Nye County School District, 1993 and 1994).

PUBLIC SERVICES—The key public services examined in this analysis are public education, police and fire protection, and health care. Providers of these services in the region of influence are public school districts, police and fire departments, and hospitals and clinics. Existing conditions for each major public service focus on those providers that are geographically close to the sites and/or maintain the closest relations to the sites. The level of general public service is determined by student-to-teacher ratios at primary and secondary public schools and by the ratio of employees (sworn officers, professional fire-fighters, and health care personnel) to serviced population.

The Superfund Amendments and Reauthorization Act of 1986 requires state and local jurisdiction, within the United States, to plan for and have the capability to respond to incidents involving all hazardous materials including waste that reside in or pass through their jurisdiction. This process is implemented through the Local Emergency Planning Committee and the State Emergency Response Commission. As part of this program local communities and counties are required to implement an Emergency Response Plan. These plans define chain-of-command, notification procedures, and evacuation procedures for each community.

For the past 15 years, the DOE has provided training to responders in Nevada through the First-On-Scene Program. The environment safety and health training will continue to be made available to state regulators, educators, the public, and agencies (firefighters, law enforcement, and emergency, medical personnel) within Nevada. Training courses for environmental safety and health, transportation, radioactive materials management, environmental restoration, and classes that meet or exceed federally mandated training requirements for personnel involved with the generation or disposal of radioactive or hazardous waste can be provided by the DOE/NV. Courses conducted associated with transportation activities include: first-on-scene responder for law enforcement, firefighters, and emergency medical personnel.

PUBLIC EDUCATION—The University of Nevada, Las Vegas, was officially established in 1957. More than 120 graduate and undergraduate programs are offered to a student body of 19,500. The university has on-campus research facilities, including the Desert Biology Research Center, Center for Business and Economic Research, Nuclear Waste Transportation Research Center, and Parent/Family Wellness Center. The Desert Research Institute, a separate division of the University and Community College System of Nevada, was founded in 1959 as an international center for environmental research. The University of Nevada Medical School trains medical students and resident physicians at the University Medical Center, where the school is located (Las Vegas Review-Journal, 1994). The Harry Reid Center is an environmental studies organization located on campus and operated by the university.

Under Nevada law, a single public school district serves each county and is responsible for educating students from kindergarten through grade twelve. The following discussion highlights the Clark County and Nye County school districts in terms of numbers of students and teachers and the student-to-teacher ratio.

American Indian Education—Under federal and Tribal Law, American Indian children can be educated in tribally controlled and federally certified schools located on Indian reservations. Federal funds are available through the Indian Education Act for the education of Indian children. Compensation from the federal government is provided to any school district who has entered into a cooperative agreement with Federally Recognized Tribes whether it be public, private, or an Indian controlled school.

Clark County School District—Approximately 62 percent of Nevada's total public school enrollment is in Clark County. The Clark County School District, with a 1993 to 1994 enrollment of 145,327 students, is the largest district in the state and the eleventh largest school district in the nation. A total of 7,928 full-time equivalent licensed teachers were employed by the school district. These figures result in a student-to-teacher ratio of 18.33:1 for the district. The district has 184 schools, including 127 elementary schools, 27 middle schools, 24 senior high schools, and 6 special schools (State of Nevada, 1995a).

With the continued rapid growth of Clark County, a 10-year, $600,000,000 school building program was approved by voters in 1988. In Fiscal Year 1990, 2 new schools opened as a result of the bond election, followed by 13 more in Fiscal Year 1991. As Fiscal Year 1992 began, 18 new schools opened. Eight schools were opened for use during Fiscal Year 1993, 13 opened in Fiscal Year 1994, and 3 new schools will open in Fiscal Year 1995, completing the 1988 bond program. Depending on the amount of additional monies passed by voters, it is estimated that between 25 and 38 new schools

will be built in the immediate future (Clark County School District, 1994a).

Nye County School District– Of the 17 school districts in Nevada, the Nye County School District ranks as the eighth largest. There are 15 schools in the district: 9 elementary, 1 junior high, 1 junior high/high school, and 4 high schools (State of Nevada, 1995a). Some 239 full-time equivalent licensed teachers were employed by the school district in the 1993 to 1994 school year, and the district had a 1993 to 1994 enrollment of 3,918 students. Using these numbers, the student-to-teacher ratio for the Nye County School District was 16.39:1 (State of Nevada, 1995a).

American Indian Tribally Operated Schools in Nye County—In Nye County there is one tribally controlled elementary school. It is operated by the Duckwater Shoshone Tribe. In 1995 the school had 32 students enrolled from preschool to 8th grade, who were taught by three full-time certified teachers; these included two certified elementary teachers, two teaching assistants, one preschool teacher, and one teacher under the Chapter 1 Program. Using these numbers the student-to-teacher ratio was 10.66:1 (Duckwater Shoshone Tribe, 1996).

A tribally operated headstart program is located on the Moapa Paiute Indian reservation. The program is open to all eligible preschool students, both Indian students and non-Indian students from nearby communities. This program is funded through the Inter-tribal Council of Nevada, who operate headstart sites elsewhere in the state of Nevada. Indian students also attend non-Indian public schools.

POLICE PROTECTION—Police protection in the region of influence is provided by the Las Vegas Metropolitan Police Department, the North Las Vegas Police Department, and the Nye County Sheriff's Office with stations at Tonopah, Pahrump, Beatty, Mercury, and Amargosa Valley. Each provides law enforcement services in conjunction with other law enforcement agencies, including the Nevada Highway Patrol.

No universal standards can be employed to determine proper patrol size considering the duties the patrol force is expected to perform, such as responding to calls for service, conducting preventive patrol, and performing miscellaneous administrative tasks. The amount of time that should be devoted to each of these three broad areas is largely a policy decision that is made locally, based on experience. Once an acceptable patrol staffing level has been determined, it is necessary to devise a plan that will provide for the most efficient use of officers' time and the most productive geographic distribution (ICMA, 1982). The following discussion describes sworn officer or deputy levels of service per 1,000 population, the number of vehicles, and the number and capacity of holding facilities.

Las Vegas Metropolitan Police Department—To reduce the duplication of services, effective July 1, 1973, the Clark County Sheriff's Department and the Las Vegas Police Department were deactivated, and the Las Vegas Metropolitan Police Department was activated to take their place. The new department is headed by the elected sheriff of the county. In addition to patrolling the city of Las Vegas, the department provides service for rural areas of the county (Keller, 1995).

The department maintains 1,274 sworn personnel for a level of service of 2.26 per 1,000 people. Training personnel include 13 sworn officers and 10 civilian employees. In addition, there are 18 sworn and 5 civilian crime prevention specialists, which include community relations, crime prevention, and Drug Abuse Resistance Education officers. Some 821 vehicles, including 4-wheel vehicles, motorcycles, and search and rescue vehicles, are used by the department. The holding facility capacity for the Clark County Detention Center is 1,650 and the Las Vegas Detention Center, operated by the city of Las Vegas, is 600 (U.S. Bureau of the Census, 1994; Reed, 1995).

North Las Vegas Police Department—The North Las Vegas Police Department has one station that has 132 commissioned police officers. There are about 1.8 officers per 1,000 North Las Vegas residents. The city also has one detention center

that presently (July 1995) houses 100 prisoners; the detention center is approximately 50 percent filled. This low occupancy rate is due to the planning of this facility to accommodate the projected prisoners for the year 2000.

Nye County Sheriff's Office—The Nye County Sheriff's Office, whose main office is located in Tonopah, serves the entire county and supports substations located in Pahrump, Mercury, Amargosa Valley, Beatty, Smoky Valley, and Gabbs. There are 104 sworn officers and deputy personnel, 2 Drug Abuse Resistance Education/crime prevention officers, and 1 assistant sheriff in charge of training in Nye County. Approximately 25 to 30 training instructors are on the force. The sheriff's office has a fleet of 78 vehicles, including 4 search and rescue vehicles.

Fourteen sworn officers and deputy personnel work in the main office in Tonopah, operating at a level of service of 3.67 per 1,000 people. The station also has 13 jailers. Staff also includes one Drug Abuse Resistance Education/crime prevention officer. The substation has 23 vehicles, 4 of which are search and rescue. Currently, there is one holding facility with a holding capacity of 18. This will change to 48 when the new jail is opened (Willen, 1995).

Pahrump Sheriff's Substation—The Pahrump substation maintains an administrative staff of one undersheriff, one area commander, and one Drug Abuse Resistance Education officer. The investigations section has two detectives. The substation employs ten deputies and three sergeants for patrol duties. The detention facility staff includes eight sworn detention deputies and a sergeant. In addition, the Pahrump substation employs two animal control officers. With a total of 28 sworn officers, the level of service is 1.85 per 1,000 people. Of the 26 vehicles used by the substation, 2 are motorcycles and 2 are trucks. The detention center at Pahrump has a total holding capacity of 37 (Redmond, 1995; Richards, 1995).

Beatty Sheriff's Substation—The Beatty substation has five sworn officers and operates at a level of service of 2.59 sworn deputies per 1,000 people. The substation uses seven vehicles. It has one holding facility with four cells and a capacity of eight people for up to 72 hours. However, detainees are often transported to Pahrump because its holding facility capacity is larger. A new building is being added to the Tonopah substation. When this facility is completed, detainees will be transported there (Sullivan, W., 1995).

Amargosa Valley Substation—Law enforcement services in Amargosa Valley are provided by the Amargosa Valley substation of the Nye County Sheriff's Department. The substation provides services to a 1,683-km^2 (650-mi^2) area, but patrols are sporadic because of the low number of sheriff's deputies. The level of service is 2.01 sheriff's deputies per 1,000 people. In addition, the great distances the sheriff's deputies must cover affect response times and wear out patrol cars at a rapid rate. Staff includes two deputies, one part-time mechanic, and three dispatchers. The substation transports prisoners to the holding facility in Beatty, and most bookings are performed at the Beatty substations (Sullivan, W., 1995).

FIRE PROTECTION—Fire protection for the region of influence is provided by the Clark County Fire Department, Las Vegas Fire Department, North Las Vegas Fire Department, and several volunteer fire departments in Nye County (including Tonopah, Pahrump, Beatty, and Amargosa Valley).

In evaluating the adequacy of fire protection levels in any given area, major consideration must be given to a fire department's ability to handle efficiently any reasonably anticipated workload. This requires an evaluation of the possibility of several simultaneous working fires, weather factors that might contribute to the spread of fire, the delay in response or the possibility of slow operation at the scene, and other demographic or geographic conditions that might affect the frequency of fire occurrence and the response time of initial firefighting units (NFPA, 1986). The following is a description of the current number of fire stations, levels of service per 1,000 people, number of firefighters, and types of equipment.

Clark County Fire Department—The Clark County Fire Department is divided in two sections: urban and rural. The urban fire stations are located in

areas that are not cities and do not have their own fire departments. The rural fire stations are manned by volunteer firefighters and are discussed in the volunteer fire subsections of this section.

The urban area Clark County Fire Department operates out of 15 stations. With 422 uniformed personnel (1 chief, 2 deputy chiefs, 4 assistant chiefs, 8 battalion chiefs, 77 captains, 100 engineers, and 230 firefighters), the department provides a level of service of 1.04 firefighters per 1,000 people. The 1995 urban population outside incorporated cities in Clark County was assumed to be 39 percent of the entire Clark County population. This reflects the 1990 ratio to the county of the populations of Sunrise Manor, Spring Valley, Whitney (formerly East Las Vegas), Winchester/ Paradise, and Enterprise (U.S. Bureau of the Census, 1994; Vinson, 1995).

The Clark County station units include 15 engines, 8 rescue vehicles, 6 ladder trucks, 2 hose wagons, 1 mobile air unit, 3 battalion chief vehicles, 1 water tender, 1 heavy-rescue vehicle, and 1 hazardous materials vehicle. In reserve are three rescue vehicles and three engines. Reserve vehicles permit the repair of first-line equipment without reducing fire ground forces and provide additional firefighting units during major emergencies. Planned acquisition of station units include a heavy-rescue chase vehicle and a hazardous-materials chase vehicle (King, 1995).

Las Vegas Fire Department—The Las Vegas Fire Department currently has 10 fire stations, but 3 more are anticipated to be built by the year 2000. The department has 303 firefighters, including 1 fire chief, 3 deputy chiefs, 1 assistant fire chief, 6 battalion chiefs, 54 captains, 52 firefighter/paramedics, 58 engineers, and 128 firefighters. This staffing leads to a level of service of 0.84 firefighters per 1,000 people. In addition, the department has 9 training staff and 20 fire prevention staff. The department's equipment consists of 1 air resource vehicle (compressor for air tanks), 11 engines/ pumpers, 4 ladder trucks, 1 hazardous materials vehicle, 6 paramedic trucks, 3 reserve engines, 2 reserve ladder trucks, 3 reserve rescue trucks, and 1 communications unit (Lawson, 1995).

City of North Las Vegas Fire Department—The city of North Las Vegas Fire Department maintains three stations; one additional station was recently built. The total number of firefighters is 84, which results in a level of service of 1.15 for every 1,000 people. In addition, the department has 16 paramedics, 2 training personnel, and 4 fire prevention personnel. Equipment consists of four engine/pumpers, one ladder truck, two reserve engines, two rescue vehicles, and seven automobiles (Marchand, 1995).

Volunteer Fire Departments—There is no Nye County fire department. Because the county population is scattered and small, each area's volunteer fire department responds to fire-related calls. Volunteer fire departments are private, nonprofit corporations. The following discussion outlines the volunteer fire departments in Tonopah, Pahrump, Beatty, and Amargosa Valley.

Tonopah Volunteer Fire Department—The Tonopah Volunteer Fire Department operates out of one station with 27 firefighters, including 1 chief, 1 assistant chief (both of whom receive salaries), and 25 volunteer firefighters. This staffing results in a level of service of 7.09 per 1,000 people. Equipment includes 2 pumpers/engines, 1 mini-pumper, and one 100-ft aerial ladder truck. In reserve are one pumper and one 1942 vintage pumper, which is used as a hose tender (Jamison, 1995).

Pahrump Valley Volunteer Fire Department— The Pahrump Valley Volunteer Fire Department maintains a staff of 30 volunteer firefighters, resulting in a level of service of 1.98 firefighters per 1,000 people. The department employs a paid administrative assistant. Ten of the firefighters are emergency medical technicians. The department has three stations, and equipment consists of one pumper, two attack trucks, one utility truck, three engines, three water tenders, and one heavy-rescue truck (Duga, 1995).

Beatty Volunteer Fire Department and Ambulance Service—The Beatty Volunteer Fire Department has one fire station with no current plans for additional stations. The number of firefighters includes 28 (27 volunteers and 1 paid) for a level of

service of 14.51 firefighters per 1,000 people. In addition, the department has five training personnel and five fire-prevention personnel. Equipment includes two pumpers and one crew cab, which is used mainly for automobile rescue (Sullivan, B., 1995).

Amargosa Valley Volunteer Fire Department—The Amargosa Valley Volunteer Fire Department has a force of about 123 volunteers, leading to a level of service of 23.12 per 1,000 people. Only the fire chief is a paid employee. The department charges for fire services to persons not living in Amargosa Valley. The service area encompasses 1,463 km^2 (565 mi^2). The fire department maintains two fire facilities. Station One is located in the town, and Station Two is located near the California border. Station One has a quick-attack truck, a pumper truck, a tanker truck, and a van that is used to transport extrication equipment. Station Two has two pumper trucks. The department has formal mutual-aid agreements with the State Bureau of Fish and Game and the U.S. Bureau of Land Management and responds to calls at Shoshone, California. The department has no equipment, such as hazardous material suits, for hazardous material response. If a hazardous material accident were to occur, the department would wait for assistance from outside sources (Blankenship, 1995).

HEALTH CARE—In Clark County, 1,418 medical doctors and approximately 5,000 registered nurses are registered to practice, resulting in a health care level of service of 1.37 medical doctors and 4.84 registered nurses per 1,000 people. The corresponding level of service for Nye County is 0.34 medical doctors and 1.53 registered nurses per 1,000 people, both of which are inadequate service levels (Table 4-14).

Health care in the region of influence includes 8 full-service hospitals, 2 medical clinics, and 3 special service hospitals located in Clark and Nye counties, with a combined bed capacity of 2,531 beds, or 2.75 beds per 1,000 people (Table 4-15). These facilities provide a wide array of medical services, including physical examinations; treatment of occupational and non-occupational illnesses; emergency, intensive, and cardiac care; coronary care; internal medicine; X-ray and laboratory; infertility; obstetrics and gynecology; neonatal intensive care; inpatient and outpatient surgery; pharmaceuticals; optometry; dental; respiratory therapy; and skilled nursing and long-term care. Services provided by the three special service hospitals include psychiatric, chemical dependency, and mental health treatment. In addition, the Clark County Health District provides public health clinics and visiting nurse services and coordinates the emergency medical services system. There are 3 public health centers, 20 immunization and child health satellite clinics, and a hospice program providing 24-hour care to terminally ill patients (Las Vegas Review-Journal, 1994).

The Tonopah Hospital District has been operating at a loss and will be taken over by the Nye County Board of Commissioners. Pahrump will open an urgent care facility. Health care clinics in Beatty and Amargosa Valley are operated by the Central Nevada Rural Health Consortium. Health care service is generally not readily available to Nye County residents.

The Central Nevada Rural Health Consortium is a quasi-governmental agency that was organized by Nye, Lincoln, Washoe, and Eureka counties to provide health care services to communities in rural Nevada that are not large enough to support private sector health care. The consortium is under contract with Nye County to provide physician's assistant supervision, support services, and equipment to rural areas. One of the clinics it supports is the Amargosa Valley Medical Clinic, which emphasizes family practice but also provides minor emergency service, X-ray service, minor laboratory work, and pharmacy services. Physician's assistants, who are staffed from Beatty, refer serious cases to hospitals and special care facilities in Las Vegas (Blankenship, 1995).

4.1.4 Geology and Soils

All DOE administrative units discussed in this EIS, including the NTS, NAFR Complex, and Tonopah Test Range, lie within the northern Basin and Range Physiographic Province. Because these units have similar settings, they are described together as a

Table 4-14. Health care personnel in the region of influence (1995)

Job Classification	Clark County	Nye County	Level of Service* Clark County	Level of Service* Nye County
Medical Doctors	1,418	9	1.37	0.34
Registered Nurses	5,000	40	4.84	1.53

* Per 1,000 people.

Source: Lyons and Fowler, 1995.

Table 4-15. Primary medical facilities serving the region of influence (1995)

Facilities	Location	Number of Licensed Beds
Clark County		
Charter Behavioral Hospital	Las Vegas	84
Desert Springs Hospital	Las Vegas	225
Horizon Hospital	Las Vegas	28
Columbia Sunrise Hospital	Las Vegas	688
Lake Mead Hospital	North Las Vegas	195
Las Vegas Federal Medical Center	Las Vegas	129
Monte Vista Hospital	Las Vegas	80
University Medical Center	Las Vegas	560
Valley Hospital	Las Vegas	416
Women's Hospital	Las Vegas	82
Nye County		
Dr. Russell Joy Medical Clinic	Tonopah	N/A*
NTS Medical Center	NTS	N/A
Nye County Regional Medical Center	Tonopah	44

* Not applicable.

Sources: DOE/NV, 1993; Las Vegas Review-Journal, 1994.

single region. However, the greatest emphasis is placed on the NTS. Discussions of specific administrative units are also included in separate subsections when information at a local scale increases understanding and assists in the evaluation of impacts.

Detailed investigations of the geology of the NTS have been in progress since 1951, shortly after the test site was established. The geologic studies were expanded in the 1950s and early 1960s as underground testing became the established mode for testing nuclear explosives. Since then, many regional and site studies have been conducted that have included detailed geologic mapping, sitewide geophysical surveys, exploratory drilling and testing, and detailed geotechnical studies. As a result of these many investigations, comprehensive databases are available on virtually every aspect of the geologic conditions on the NTS and surrounding areas. As noted in the *Final Environmental Impact Statement Nevada Test Site, Nye County, Nevada*

(ERDA, 1977), the NTS is probably the geologically best known large area within the United States.

4.1.4.1 Physiography. The NTS and surrounding areas are in the southern part of the Great Basin, the northern-most subprovince of the Basin and Range Physiographic Province (Figure 4-18). The basin-and range-province is generally characterized by more or less regularly spaced, generally north-south trending mountain ranges separated by alluvial basins that were formed by faulting. The Great Basin subprovince is an internally draining basin; i.e., precipitation that falls over the basin has no outlet to the Pacific Ocean.

The topography of the eastern and southern NTS and the entire Tonopah Test Range are typical of the Great Basin, with numerous north-south trending mountain ranges and intervening alluvial basins. In the northwestern portion of the NTS, the physiography is dominated by the volcanic highlands of the Pahute and Rainier Mesas.

The relief of the NTS is considerable, ranging from less than 1,000 m (3,280 ft) above sea level in Frenchman Flat and Jackass Flats to about 2,339 m (7,675 ft) on Rainier Mesa and about 2,199 m (7,216 ft) on Pahute Mesa. Figure 4-19 shows the general topographic expression of the region. In general, the slopes of the upland surfaces are steep and dissected, and the slopes in the lowland areas are more gentle and less eroded.

There are three primary valleys on the NTS: Yucca Flat, Frenchman Flat, and Jackass Flats. Both Yucca and Frenchman Flat are topographically closed, with playas in the lowest portions of each basin. Jackass Flats is topographically open with drainage via the Fortymile Wash off the NTS.

The topography of the NTS has been altered by historic DOE actions, particularly underground nuclear testing. The principal effect of testing has been the creation of numerous craters in Yucca Flat basin and a lesser number of craters on Pahute and Rainier Mesas. Shallow detonations were also performed during Project Plowshare to determine the potential uses of nuclear devices for large-scale excavation. Lesser alterations of the natural topography of the NTS and adjacent areas have occurred as a result of road building, sand and gravel mining, underground mining prior to the creation of the NTS, and the construction of waste disposal areas, flood controls, and drainage improvements.

4.1.4.2 Geology. The geology of the NTS consists of a thick section (more than 10,597 m [34,768 ft]) of Paleozoic and older sedimentary rocks, locally intrusive Cretaceous granitic rocks, a variable assemblage of Miocene volcanic rocks, and locally thick deposits of postvolcanic sands and gravels that fill the present day valleys (Frizzell and Shulters, 1990). Figure 4-20 is a generalized geologic map of the NTS. More detailed stratigraphic information is available from recently updated maps of the NTS (Frizzell and Shulters, 1990) and Pahute Mesa (Minor et al., 1993). Figure 4-21 shows a generalized stratigraphic column for the area in the vicinity of the NTS.

The tectonic history of the region is very complex, and major structural events have left their imprint on the stratigraphy of the area. This region of the western United States was a stable continental margin until Late Devonian time, when uplift west and north of the NTS resulted in the erosion and deposition of thick Mississippian sandstones in a foreland basin (Poole and Sandberg, 1991). Compressional deformation during the Sevier orogeny produced regional thrusts, folds, and wrench faults that fundamentally rearranged the positions of the Paleozoic and older sedimentary rocks (Armstrong, 1968). The Sevier orogenic zone may have been extended with normal faulting prior to late Mesozoic time and the intrusion of granitic rocks (Hodges and Walker, 1992; Cole et al., 1993).

Following erosion throughout most of the Early Tertiary Period, the area in and around the NTS began to pull apart along low-angle normal faults and strike-slip faults associated with the formative stages of the modern basin-and-range structural province (Guth, 1981; Hamilton, 1988; Wernicke et al., 1988; Cole et al., 1989). Eruptions of the southwest Nevada volcanic field occurred in the Middle Tertiary Period (Warren et al., 1989; Sawyer et al., 1990). Successive eruptions produced no less than seven large and partially overlapping calderas,

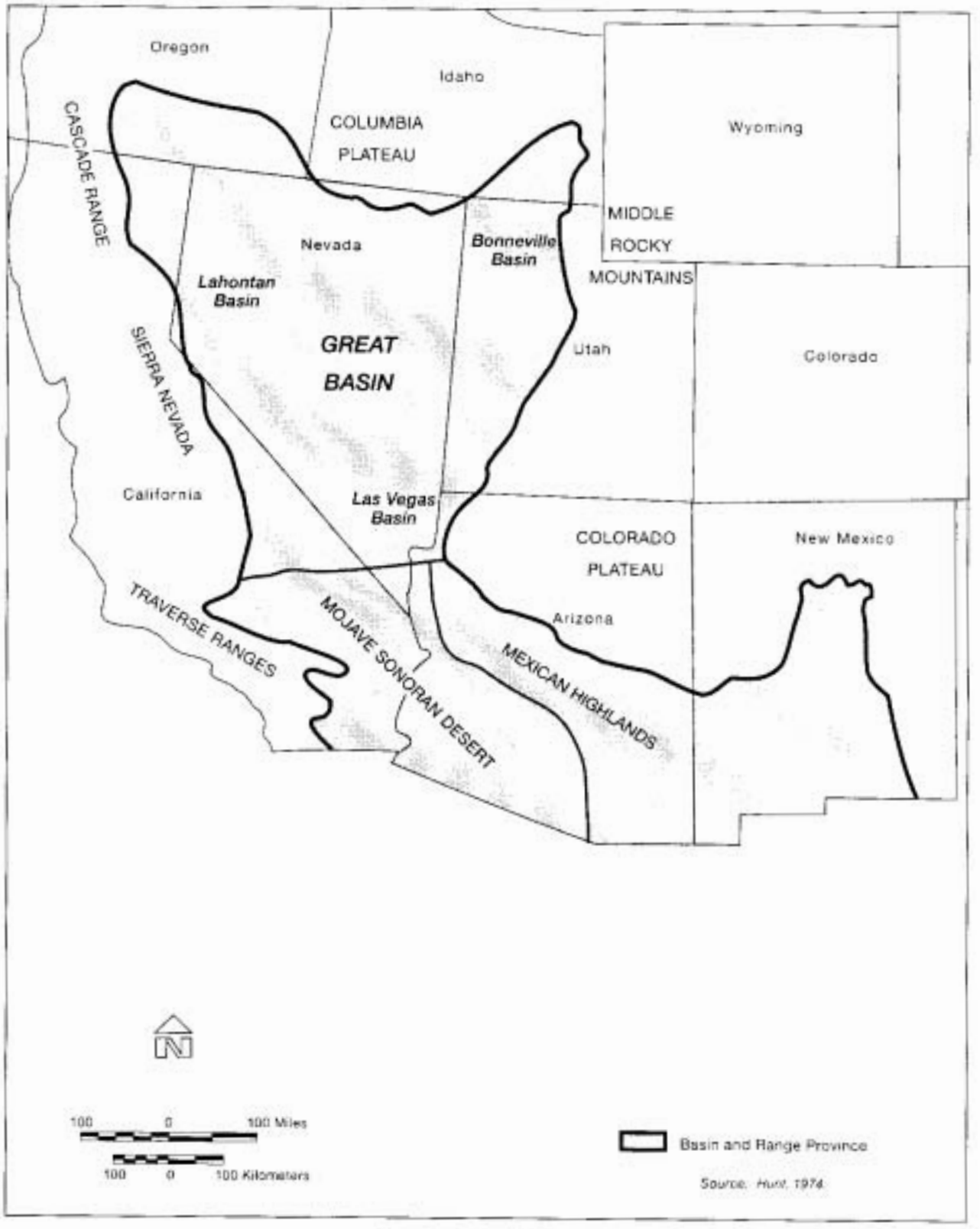


Figure 4-16. Basin and Range Physiographic Province

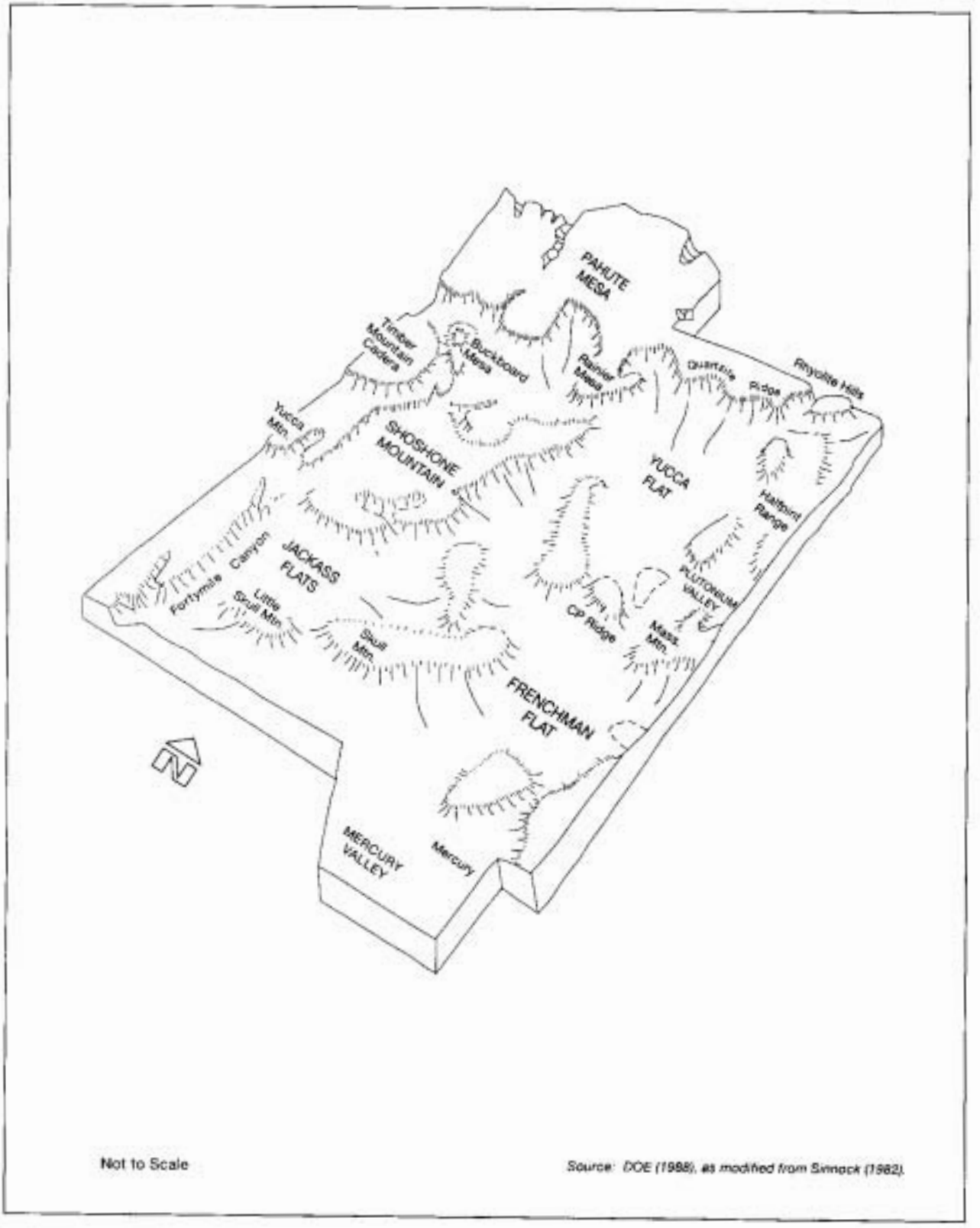


Figure 4-19. Topography of the NTS

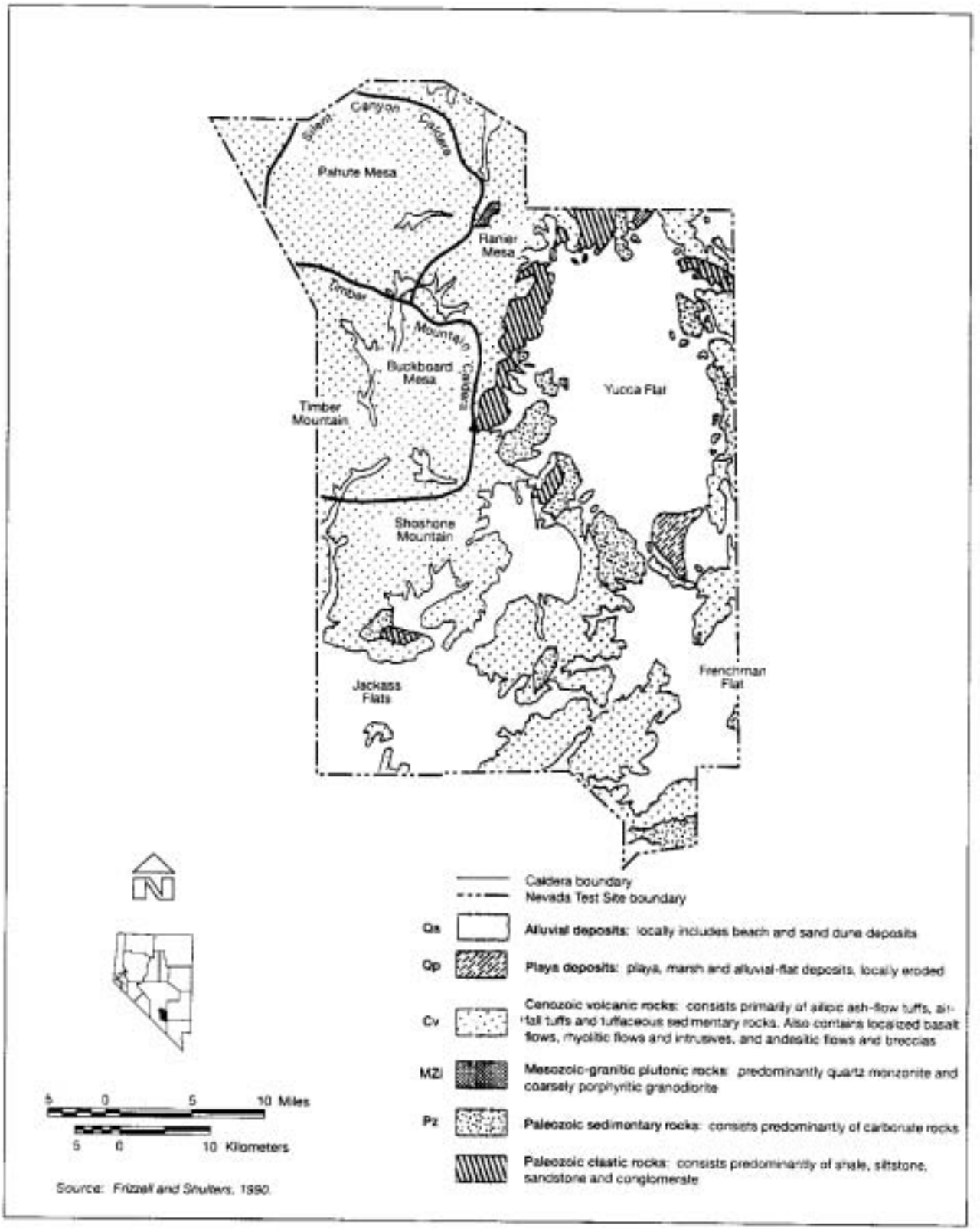


Figure 4-20. Generalized geologic map of the NTS

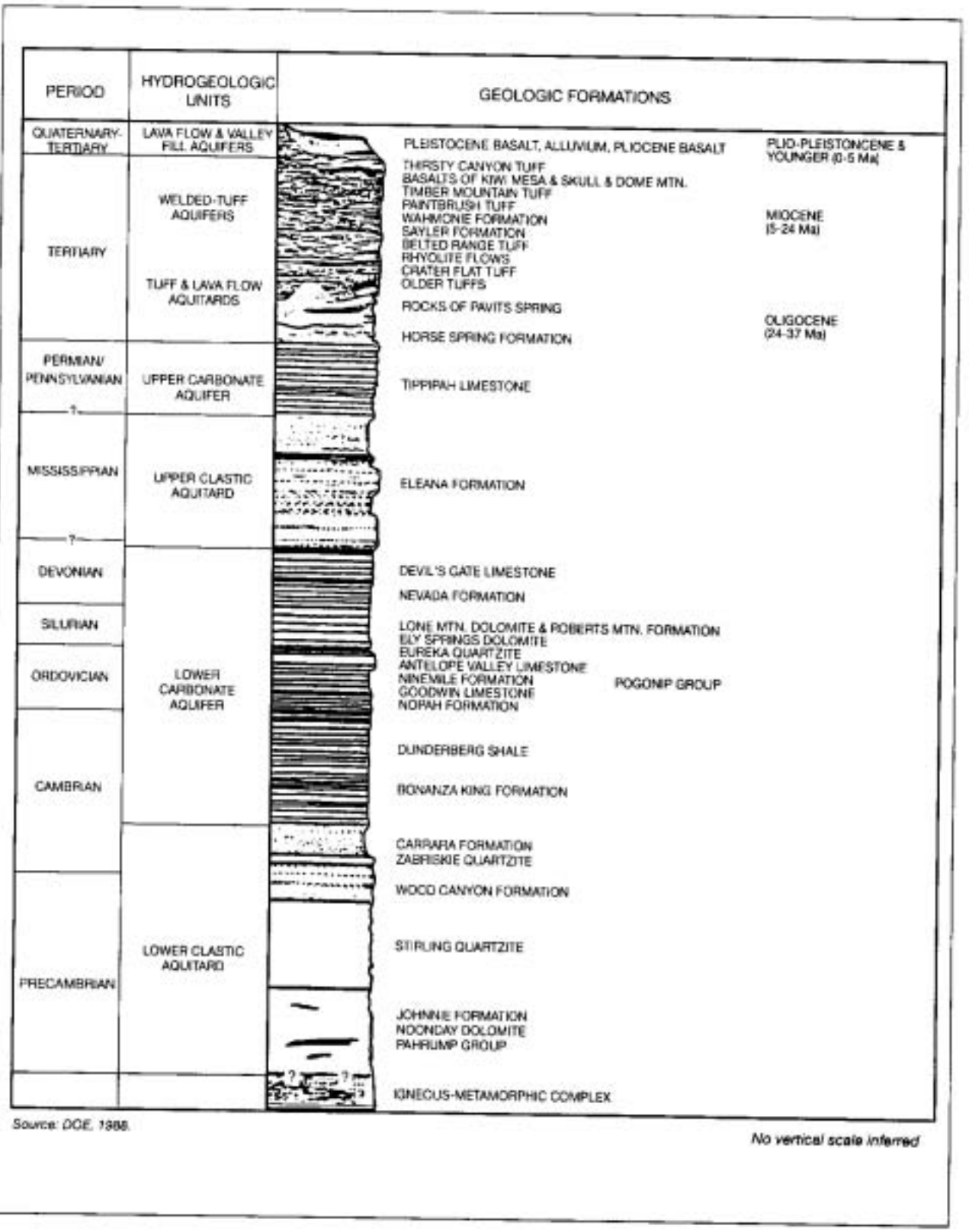


Figure 4-21. Generalized stratigraphic column

which were filled with lava flows and blanketed by vast deposits of tuff.

Cenozoic crustal extension formed normal faults, continued during and after volcanic activity, and caused further tilting and lateral translation of major upper crustal blocks. Modern alluvial basins have progressively filled with as much as 1,200 m (3,936 ft) of coarse gravels and sands and localized deposits of playa silt and clay. Tectonic extension, wrench movement, and seismic activity continue to the present day.

YUCCA FLAT AND FRENCHMAN FLAT—Yucca Flat and Frenchman Flat, where nuclear testing occurred, are intermontane basins typical of basin-and-range structure. The alluvium- and tuff-filled valleys are rimmed mainly by Precambrian and Paleozoic sedimentary rocks and Cenozoic volcanic rocks.

In the lowland areas of these basins, the consolidated rock units are overlain with alluvium. On the alluvial fans, the alluvium comprises interbedded gravel, sand, and silt with varying degrees of cementation. These coarse-grained deposits grade to the predominantly clay deposits under the playa areas. Limited areas of wind-blown sands and silts are also present in portions of the lowland areas.

Mesozoic intrusive rocks are located at the north-northeast edge of the Yucca Flat weapons test basin. Precambrian and Paleozoic rocks are regionally extensive and occur under the basins as basement rocks.

The lowermost 2,999 m (9,840 ft) of the pre-Tertiary section consists of Late Precambrian to Middle Cambrian quartzites and siltstones. These clastics are overlain by 4,599 m (15,088 ft) of Cambrian through Devonian dolomite, interbedded limestone, and thin, but persistent, shale and quartzite layers. Pennsylvanian limestone depositionally overlies the Eleana formation along the western edge of the basins. The second assemblage consists of heterogeneous carbonate rocks that lie structurally above the Eleana formation as a result of thrust faulting of low-angle normal faulting (Cole et al. 1989). A few drill holes at the NTS have penetrated these "isolated" carbonate rocks overlying the Eleana formation. Thrust faults have repeated sections of the Paleozoic and Precambrian rocks, and low-angle gravity faulting has created isolated blocks of the Paleozoic rocks out of stratigraphic order. Today, most prominent structures are related to basin-and-range extensional faulting that is younger than the volcanic rocks. In the Yucca Flat weapons test basin, fault strikes are mostly north-south; in Frenchman Flat, structure strikes are mostly west-southwest.

Outflow sheets of tuffs from the volcanic centers west of the basins occurred during the Tertiary Period and were emplaced on the irregular paleotopographic surface of the basins. The youngest sediments of the valleys are sand and gravel, derived from the volcanic and sedimentary rocks in the surrounding highlands. Tests at both locations have been detonated primarily in alluvium or in the volcanic rocks. A few larger tests were detonated in the underlying carbonate rocks beneath the northern Yucca Flat weapons test basin during the early years of the testing program, and three small tests were detonated in granite just north of the Yucca Flat weapons test basin at the Climax stock (OTA, 1989). Testing near or below the water table was common in both the Yucca Flat weapons test basin and Frenchman Flat test area.

PAHUTE MESA AND RAINIER MESA—The southwestern Nevada volcanic field, of which Pahute Mesa is part, includes a broad volcanic plateau underlain by tuffs and lavas from the Timber Mountain-Oasis Valley caldera complex and the Silent Canyon and Black Mountain calderas north of Timber Mountain (Byers et al., 1989). This Miocene, rhyolitic, eruptive center produced an overlapping complex of fault-controlled calderas in the general area of Timber Mountain and Pahute Mesa and laterally extensive tabular outflow sheets of welded tuff on Rainier Mesa. The Timber Mountain caldera is listed as a National Natural Landmark by the U.S. Park Service. Recent work indicates that as many as six calderas may be present in the Pahute Mesa area and that the calderas may be ellipsoids bounded by faults related to basin-and-range structure rather than circular collapse structures (Ferguson et al., 1994).

Stratigraphic units represent caldera-forming, caldera-filling, and caldera-burying emplacements, depending on their location relative to their originating and successive eruptions (Ferguson et al, 1994).

All underground tests within Pahute Mesa, as well as Rainier Mesa, have been detonated within volcanic rocks.

OTHER TESTING AREAS—The DOE has also conducted limited nuclear tests in areas beyond the four major testing areas already discussed. The limited testing areas include Buckboard Mesa, Dome Mountain, Shoshone Mountain, and the Climax stock.

The area of testing in Buckboard Mesa is located in the east-central portion of Timber Mountain, and the Dome Mountain testing area is located along the southern flanks of this caldera. These two sites exhibit the general geologic conditions of the caldera complex, that is, a thick sequence of volcanic rocks, including welded and ash-flow tuffs; volcanic-derived sediments, including sandstone and conglomerate; and basalts. The radial fracturing and faulting typical of a caldera are present at both of these sites.

Shoshone Mountain is located beyond the Timber Mountain caldera, but the volcanic rocks derived from this volcanic center predominate at this site, as well. The predominant rocks include the Ammonia Tanks and Tonopah Spring tuffs and ash-flow tuffs. There are also exposures of clastic sediments and carbonate rocks of Paleozoic age, including the Tippipah Limestone and the Eleana formation, on the northwest flanks of the Shoshone Mountain testing area. At this site, the northeast to southwest striking normal faults typical of many portions of the Basin and Range Province are predominant.

The Climax stock, located along the northern flank of Yucca Flat, was used for testing and experimentation. The stock is a granitic (quartz monzonites and granodiorite) intrusion of the Late Cretaceous age. The Climax stock occurs at the intersection of two geologic structures, the Tippinip fault and the Halfpint anticline, and intrudes Paleozoic sediments.

Many of the valleys have playas that may hold shallow water after seasonal storms. Playa sediments are bedded sand, silt, or clay and may include salts. Other sediments in the region carried and deposited by wind are typically sand and silt. These aeolian sediments generally are from nearby playas or dry river beds, but can be from afar. These deposits are often retransported by streams. However, surfaces of relatively stable deposits in the valleys generally have a thin veneer of wind-deposited silt.

SUBSURFACE RADIOLOGIC SOURCES—As discussed in the *Final Environmental Impact Statement, Nevada Test Site, Nye County, Nevada* (ERDA, 1977), underground nuclear testing has resulted in unavoidable adverse impacts to land resources that render the resources unusable for most purposes. Underground nuclear tests were begun in June 1957, and through 1992 there were approximately 800 underground tests conducted at the NTS with yields ranging from zero to 1,000 kilotons (kt). Underground testing, for the purposes of discussion, can be divided into three broad categories: shallow borehole tests, deep vertical tests, and tunnel tests. In this section, the current condition of the subsurface geologic resources, as they have been affected by historic activities, is presented.

Shallow borehole tests were conducted between 1960 and 1968. Some of these tests were safety-related, others were conducted as part of Project Plowshare to determine whether nuclear detonations could be used as a method for excavation. The shallow tests resulted in the development of some large ejection craters, most notably the Sedan Crater in the northern end of the Yucca Flat testing area. Sedan, a 104-kt nuclear device detonated 194 m (635 ft) underground, displaced about 1.2×10^7 tons of earth and created a crater 390 m (1,280 ft) in diameter and 98 m (320 ft) deep. McArthur (1991) estimates that the remaining inventory of surficial radioactivity at the Sedan Crater is 344 Ci. The total estimate for all releases from shallow borehole tests to the surficial soil horizon at the NTS is 2,000 Ci.

Deep vertical underground nuclear tests have been completed in Frenchman Flat, Yucca Flat, Pahute

Mesa, Rainier Mesa, Shoshone Mountain, Buckboard Mesa, and Dome Mountain. The tunnel complex at Rainier Mesa has been extensively used for special experiments and tests that require access to materials and monitoring equipment left near the point of detonation. Figure 4-22 shows the locations of the underground tests. The historic tests have left their mark on the NTS both in terms of physical disruption and a large subsurface inventory of remaining radioactive isotopes.

The major impacts of an underground nuclear test on the physical environment are ground motion, disruption of the geologic media, surface subsidence, and contamination of the subsurface geologic media and surficial soils. Ground motion is a temporary phenomenon that, with the exception of rockfalls and minor land displacements, has not resulted in permanent effects on the NTS. The cratering, the disruption of underground geologic media, and the release of radioactivity into the environment have been the most significant impacts to the physical environment as a result of historic testing operations at the NTS. The physical impacts of vertical underground tests can perhaps be best described through a discussion of the events that occur after a nuclear detonation.

Figure 4-23 shows the sequence of events after an underground detonation. Within tens of milliseconds following detonation, the nuclear device and surrounding rock are vaporized, creating a "bubble" of high pressure steam and gas. An underground spherical cavity is formed by the pressure of this gas bubble and the explosive momentum that is imparted to the host rock. As the cavity continues to expand, the pressure decreases and, usually within a few tenths of a second after detonation, equalizes with the pressure from the overlying rock. At this point, the cavity has reached its greatest dimensions. Concurrent with this pressure decrease, the shock wave from the detonation travels outward, crushing and fracturing the rock in the near-test environment.

As the hot gases cool, the molten rock begins to collect and solidify on the cavity sidewalls and in a puddle at the bottom of the cavity. When the gas pressure declines to the point where it can no longer support the overlying rock and soil, the cavity may collapse, forming a chimney upward from the cavity. The collapse occurs as the overlying rock breaks into rubble and falls into the cavity void. This process continues until either the cavity completely fills with rubble, the chimney reaches a level where the strength of the rock can support the overburden, or, as usually happens, the chimney reaches land surface. When the chimney reaches the surface, the ground sinks, forming a saucer-like subsidence crater. The crater usually forms within a few hours after the detonation.

Historic deep vertical underground testing has resulted in the formation of hundreds of craters at the NTS, leaving Yucca Flat with a "pockmarked" appearance that is even visible on satellite images of the area. The craters generally range in diameter from 61 to 610 m (200 to 2,000 ft) and range in depth from a few meters to 60 m (a few feet to 200 ft) depending on the depth of emplacement and the explosive energy yield. The development of craters has been the principal consequence of nuclear testing on the terrain of the NTS and was one of the unavoidable adverse impacts identified in the *Final Environmental Impact Statement, Nevada Test Site, Nye County, Nevada* (ERDA, 1977) (see Plate 7, entitled Aerial View of the Many Craters Within Yucca Flat, of the *Framework for the Resource Management Plan* [Volume 2]).

In addition to the cavity, chimney, and subsidence crater, pressure ridges and small displacement faults may occur at the surface. The surface fracturing and faulting are the result of the sudden uplift of the earth at the time of detonation and the collapse during the formation of the chimney and crater. Another permanent consequence of testing has been vertical displacement along existing faults, particularly along Yucca Fault and Carpetbagger Fault in Yucca Flat. Vertical displacement of as much as 2 m (8 ft) has occurred along portions of the Carpetbagger Fault. Cratering has occurred on Pahute Mesa but, because of the greater competency of the rocks in that area and the depths of most tests, cratering in this test area has been infrequent. Fracturing has occurred on the top of Rainier Mesa as a result of the loss of strength in the rocks in that area.

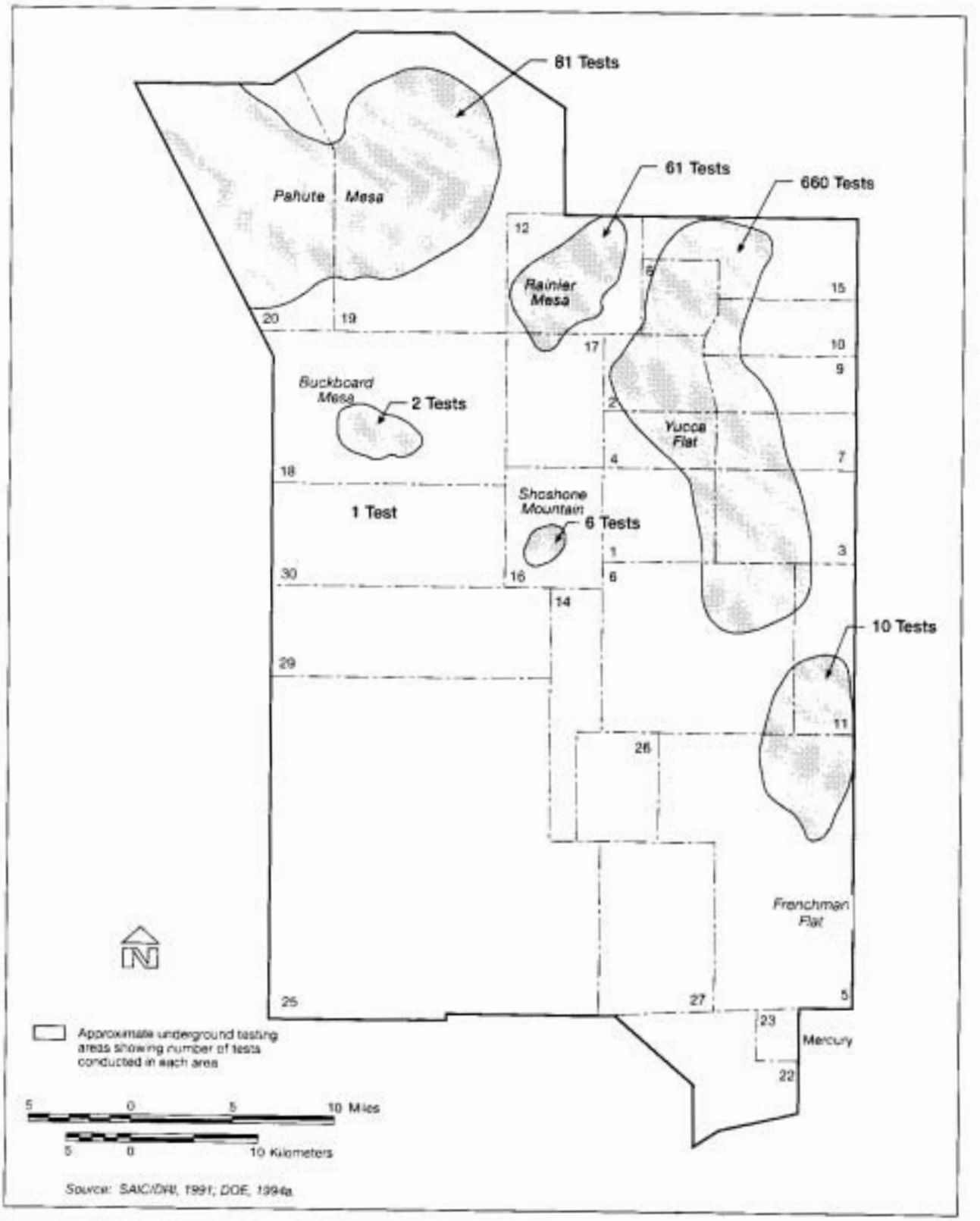


Figure 4-22. Location of underground testing areas and number of tests on the NTS

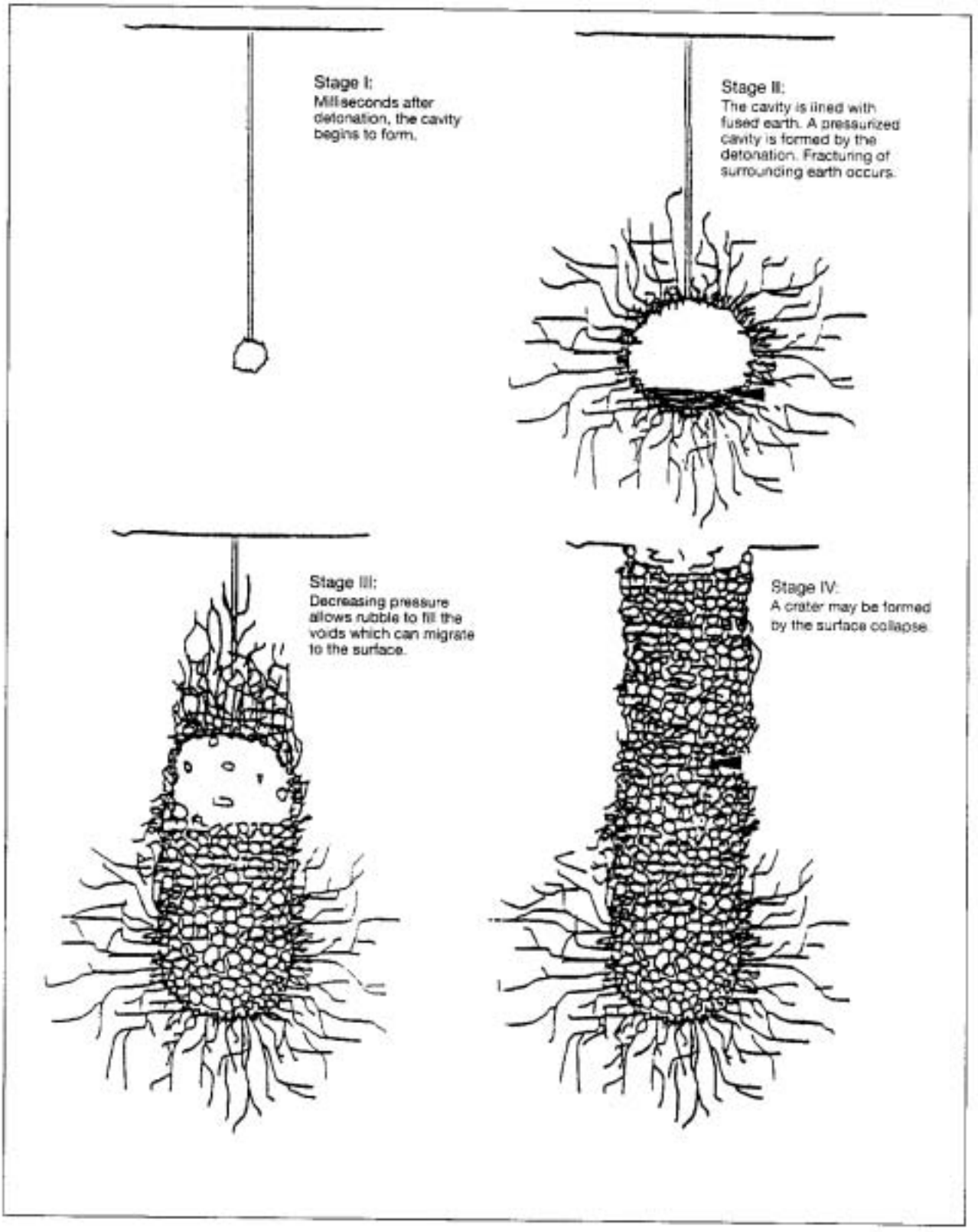


Figure 4-23. Formation of an underground nuclear explosive test cavity, rubble chimney, and surface subsidence crater

Although nuclear tests may have long-term physical consequences on the physical environment, effects of the tests are not synergistic. The sum of the effects of multiple tests does not produce unexpected consequences. Site selection factors that are essential to ensuring both containment and the integrity of test data have also ensured that failures within the test areas have not and would not occur. Appendix A describes the siting factors in greater detail.

The fracturing of the rock in the near-test environment may have resulted in some alteration of the natural permeability of the rocks underlying portions of the NTS. The shock wave and compressive forces from the tests can, on one hand, increase the permeability by creating more fractures near the test while, on the other hand, decrease the permeability by opening and closing fractures at greater distances from the test. According to the Office of Technology Assessment (OTA, 1989), post-test measurements of rock samples taken from tunnel complexes generally show that the properties of the host rock are unchanged at a greater distance than 3 cavity radii from the point of detonation. At this distance and beyond, no fracturing occurs from the detonation, but the preexisting fractures are opened as the shock wave propagates through the host rock and are closed after the shock wave is past. In some instances, the closing of the fractures may have reduced the fracture aperture and may have resulted in some permanent reduction in the gross permeability of the rock mass.

Another consequence of past underground testing has been the formation of pockets of radioactive contamination surrounding each underground test. The total amount of radioactivity released into the underground environment during a test is called the radionuclide source term. The source term includes numerous isotopes that are both short- and long-lived. For the example used for atmospheric testing of a 1-kt nuclear weapon, an initial release of 41 billion curies decays to about 10 million curies in just 12 hours. According to information presented in Borg et al. (1976), the quantity of radioactivity remaining from a 1-kt underground detonation 180 days after detonation is about 45,000 Ci (including 18,570 Ci of tritium).

It should be noted that there is considerable uncertainty concerning these estimates. For example, Borg et al. (1976) indicate that the actual tritium activity after 180 days (expressed in this EIS on a per-kiloton-basis) could range from 5,570 to 55,770 Ci.

The radionuclide inventories that have been referred to are an order of magnitude estimate to illustrate the dominance of short-lived radionuclides soon after a nuclear detonation and the effect of radioactive decay in reducing that inventory. More precise estimates of the radionuclide inventory for geologic media are discussed in the following text. Estimates of the remaining inventory that may be available for transport via groundwater and soil contamination are presented in the sections of the NTS EIS that concern hydrology and soils.

Declassification of the summed inventory (by radionuclide) that remains in, or within 98 m (321 ft) of, the water table has allowed an updated, unclassified estimate of the total radionuclide inventory remaining in the subsurface as a result of underground testing at the NTS. The estimate was based upon two key references: Borg et al. (1976) and a Los Alamos National Laboratory memorandum from T. Benjamin to M. Pankrantz (Benjamin, 1995). This memorandum, which in turn, was based upon Goishi et al. (1995), listed the remaining radionuclide inventory in, or within, 100 m (328 ft) of the water table (as of January 1994) for Los Alamos National Laboratory-only fission products as well as Los Alamos National Laboratory and Lawrence Livermore National Laboratory unfissioned fissile materials, neutron-activated radionuclides, and tritium.

Because the fission products table provided by Los Alamos National Laboratory addressed just the Los Alamos National Laboratory events, it was necessary to first project the radionuclide inventory for all tests. This adjustment was based upon the percentage of Los Alamos National Laboratory tests relative to all tests, and it resulted in the summaries presented in Section 4.1.5.2.

This estimate represents the source term exclusively for events that were detonated within 100 m (328 ft) of the water table; therefore, a further adjustment

was needed to estimate the remaining inventory from tests conducted above this level. To estimate this value, the number of announced tests and the distribution of tests in proximity to the water table (as published by Bryant and Fabryka-Martin [1991]) was used. Their work indicates that 38 percent of the tests were conducted under or within 75 m (246 ft) of the water table; thus, the total hydrologic source term for the NTS, as defined previously, represents 38 percent of the total inventory. It is noted that the number of announced tests published by these authors has since been updated, but it was assumed that the relative proportion of shallow and deep events does not vary much from the information presented in their report. Based upon these relative percentages, the total inventory from all tests was estimated to be 3.0×10^5 Ci.

There is some uncertainty regarding this estimate including: the uncertainties in the estimation techniques used by Goioshi et al. (1995), in the actual proportions of Los Alamos National Laboratory tests and water table tests, and in the assumption that the inventories per test are similar for tests in or near the water table as compared to those above the water table. Nonetheless, the estimate serves as a useful reference until declassification efforts allow the release of a more refined estimate. Insofar as the intent of this estimate is to provide a basis for comparison with the remaining inventories which can be measured (e.g., surficial soils, waste disposal units, greater confinement disposal), the estimate is considered appropriate.

GEOLOGIC HAZARDS—Many natural hazards could impact facilities at the NTS, the NAFR Complex, and the Tonopah Test Range (Guzowski and Newman, 1993). Most of these hazards can be discounted on the basis of being physically unreasonable. Six natural hazards occur at a scale that could impact large areas. These include seismicity, volcanism, and four geotechnical hazards: soil instability, slope instability, ground instability, and flooding. Each of these is discussed below, except flooding, which is discussed in Section 4.1.5.1, Surface Hydrology.

SEISMICITY—Ground-motion studies have played a large role in the weapons testing program. Sandia National Laboratories has developed a program for recording surface and subsurface motions resulting from underground nuclear explosions (Vortman, 1979; Vortman and Long, 1982a and b). There are several factors that influence the level and duration of ground motion from underground explosions, including (1) yield of the device; (2) ground-coupling at the source of the explosion, which is a function of depth of the device, local geology, and stratigraphy; (3) geological complexity along the transmission path; and (4) the topography and geology at the location receiving ground motion. There is always some variation or unknown associated with estimating these factors, but because of the long history of conducting weapon tests, the effects are reasonably predictable.

Seismic activity in the region has recently been characterized (Vortman, 1991). This analysis was based on 11,988 seismic events that occurred within 193 km (120 mi) of the NTS since 1868. Of these events, 8,161 were natural, and 3,827 were human-induced. The actual number of seismic events may be larger because emplacement of instruments capable of detecting low-magnitude events is relatively recent. Naturally occurring seismic events are associated with extensional tectonic activity characteristic of the province (Sinnock, 1982; Vortman, 1991).

Three major fault zones in the region may be currently active: Mine Mountain, Cane Spring, and Rock Valley (Figure 4-24). Small earthquakes recently occurred at or near the Cane Spring Fault zone and the Rock Valley Fault zone, although no surface displacement was associated with either of these earthquakes (Carr, 1974). A fault near Little Skull Mountain in the southwest part of the NTS was the site of a 5.6 magnitude earthquake in 1992. This is the largest earthquake recorded within the boundaries of the NTS and may have resulted from the magnitude 7.5 earthquake near Landers, California, which occurred less than 24 hours earlier. Although there was no surface rupture, the Little Skull Mountain earthquake was the first to cause significant damage to facilities on the NTS (Anderson et al., 1993). These facilities, however, were built prior to the more stringent building codes

presently followed on the NTS. The earthquake caused an estimated $40,000 in damage to the Field Operations Center, a two-story concrete-block structure located in Area 25 and used by the DOE for studies at Yucca Mountain (Anderson et al., 1993).

Additionally, the Yucca Fault in Yucca Flat weapons test basin (Figure 4-24) has been active in the recent geologic past (Sinnock, 1982; Rogers et al., 1987). This fault displaces surface alluvium by as much as 18 m (60 ft). Displacement of this young surface alluvium indicates that movement on Yucca Fault has occurred within the last few thousand to tens of thousands of years; subsurface displacement along this fault is 213 m (700 ft). The Carpetbagger Fault lies west of the Yucca Fault within Yucca Flat weapons test basin (Figure 4-24). In the subsurface, this fault shows about 610 m (2,000 ft) of displacement in the past 7.5×10^6 years (Sinnock, 1982).

Human-induced historic seismic events recorded since 1868 include those resulting from (1) filling Lake Mead, (2) high-explosive tests, (3) underground nuclear-explosive tests, (4) postnuclear explosion cavity collapses, or (5) after shocks from nuclear explosions (Vortman, 1991). Seismic waves from nuclear explosions are believed to relieve tectonic stress, as manifested by earthquakes deeper than 3 km (1.2 mi) (Rogers et al., 1987), aftershocks, and reactivation of nearby faults in the areas of nuclear-device testing (Rogers et al., 1991). Studies of nuclear-explosive tests show that these events can generate vertical and horizontal displacements on nearby existing faults. As much as 102 cm (40 in.) of vertical displacement and 15 cm (6 in.) of horizontal displacement have been observed (Rogers et al., 1991). Parts of both the Yucca Fault and the Carpetbagger Fault have been reactivated from nearby testing of nuclear devices (Frizzell and Shulters, 1990).

The NTS and the eastern parts of the NAFR Complex and Tonopah Test Range are within Seismic Zone 2B, as defined in the Uniform Building Code (ICBO, 1991) (Figure 4-25). The western parts of the NAFR Complex and the Tonopah Test Range are within Seismic Zone 3. Zone 2B is defined as an area with moderate damage potential, and Zone 3 is an area with major damage potential. Current design practices require facilities to be built to Seismic Zone 4 standards.

The *Final Environmental Impact Statement, Nevada Test Site, Nye County, Nevada* (ERDA, 1977) reported that only architectural damage has been sustained in the local communities for tests greater than 100 kt. Since the Threshold Test Ban Treaty, only a few reports of damage to local communities occur each year, and these are of a very minor nature. Beyond about 48 km (30 mi), structures would have to be higher than several stories tall before they would be affected. The closest location where structures of that height are located is Las Vegas. A smaller number of similar complaints have been recorded from people in Las Vegas high-rise structures.

Seismic activity may also have some impacts on groundwater flow. Water level fluctuations have been observed in southern Nevada that may be attributed to major earthquakes in southern California. These fluctuations are typically short-lived, with water levels rapidly returning to their pre-quake levels. Seismic activity can also fracture the rock aquifers, thereby increasing the transmissive properties of the aquifers and the rate at which groundwater flows through them.

VOLCANISM—Several late Cenozoic, silicic caldera complexes occur in an eastward-trending belt between 37 degrees and 38 degrees north latitude (Stewart, 1980). A part of this belt, which includes the mesas of the NTS and part of the northwestern NAFR Complex and the Tonopah Test Range, has been termed the southwestern Nevada volcanic field (Byers et al., 1989) (Figure 4-26). The Stonewall Caldera is the youngest (7.5×10^6 years) major silicic center in the area. Silicic volcanism is characterized by large-volume explosive eruptions.

A transition from predominantly silicic volcanism to predominantly basaltic volcanism, characterized by low-volume mild eruptions, was initiated approximately 1.0×10^6 years ago (Christiansen and Lipman, 1972). Since 7.5×10^6 years ago, only scattered, short-duration volcanic activity occurred

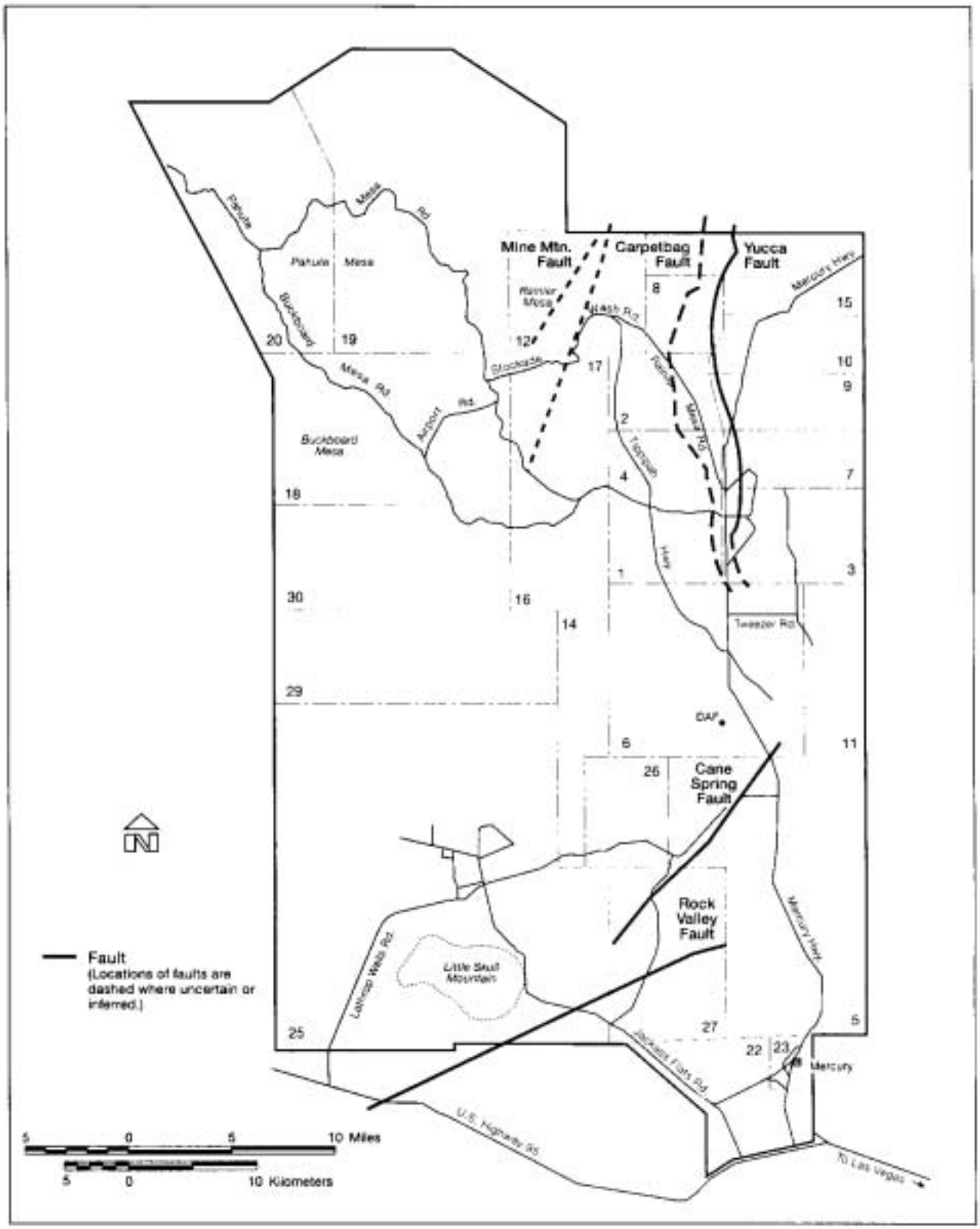


Figure 4-24. NTS fault map

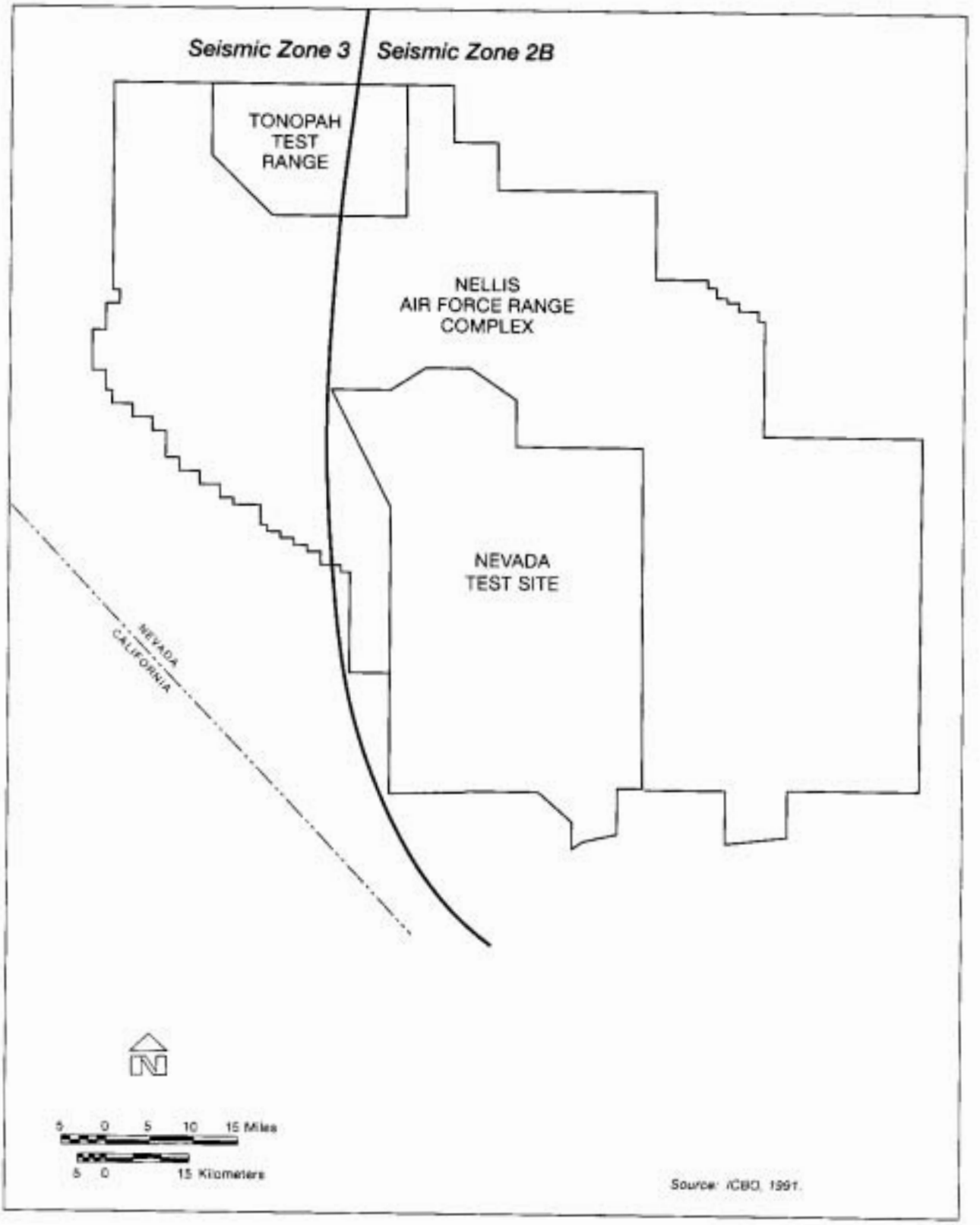


Figure 4-25. Seismic zones in the NTS area

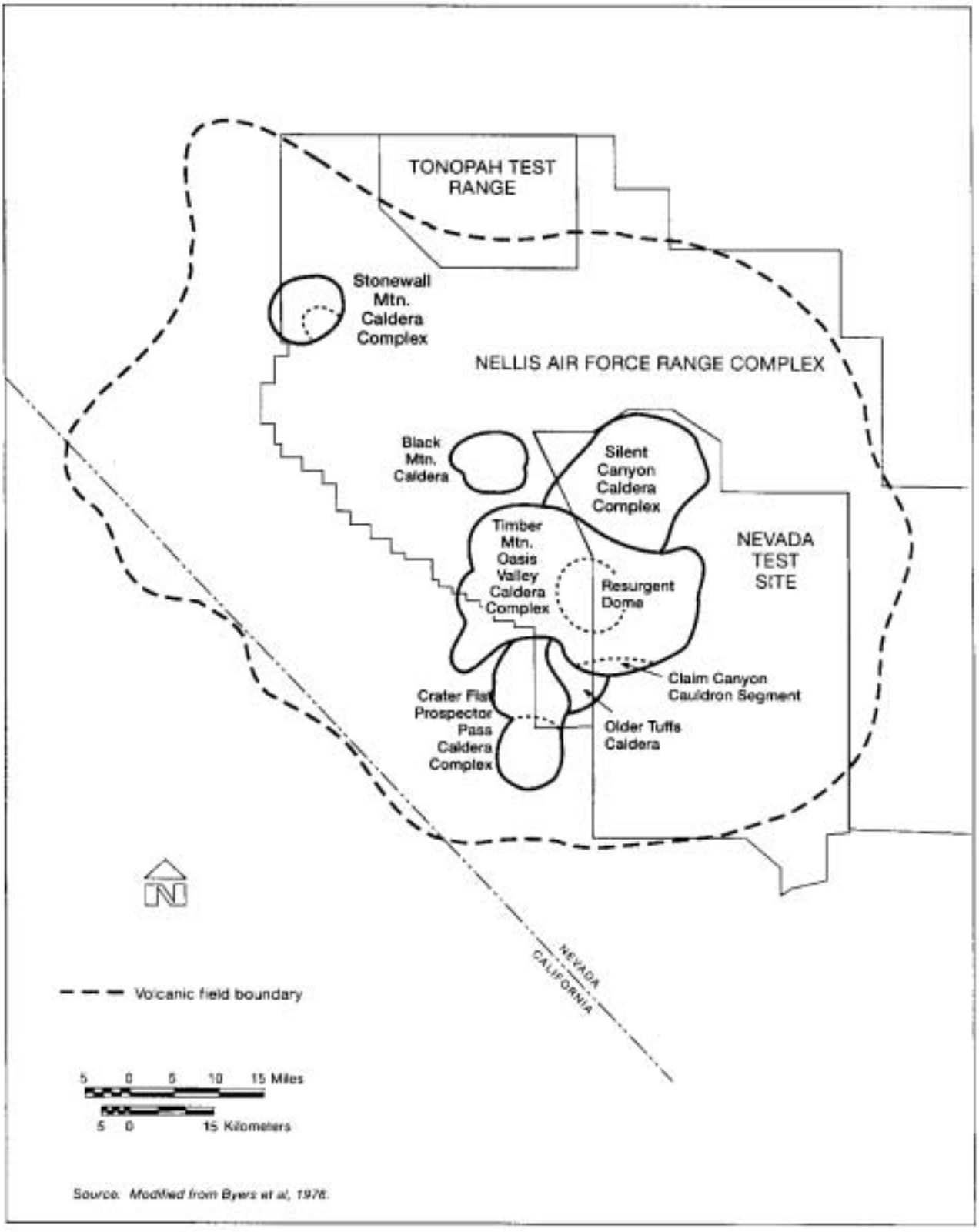


Figure 4-26. Southwestern Nevada volcanic field

in Nevada. The volcanic rocks are primarily basaltic cinder cones and lava flows (Stewart, 1980; Sawyer et al., 1990). The nearest examples of Quaternary volcanic cones and lava flows are located in Crater Flat, west of the NTS (Crowe, 1993).

Based on analysis of previous basaltic volcanism in the NTS region, there is no evidence of either an increase in the volcanic rate or the development of a large-volume volcanic field (Crowe et al., 1986).

GEOTECHNICAL HAZARDS—Geotechnical hazards are those that present an inherent direct risk to structures. Such hazards relevant to the region fall under the headings of slope stability, soil stability, and ground stability. Although this section primarily discusses hazards to engineering, areas that are particularly stable for certain activities are also noted.

Slope Stability—Within the region, no natural factors have been reported as affecting engineering aspects of slope stability. External factors that have or could affect slope stability in the region include load and fracturing and ground motion associated with nuclear explosions. Although not reported as problematic, caution is warranted for certain activities (e.g., construction and drilling) on or near slopes in or near areas of previous nuclear testing. On the NTS, particular caution is warranted on or near slopes that have been tunneled for nuclear testing. Site-specific evaluation of slope stability is necessary for specific activities.

Soil Stability—Soils in arid environments are typically rich in montmorillonite. The structure of montmorillonite is conducive to swelling or contraction as water is added or removed. Although not reported as problematic in the region, site-specific evaluation for expandable clay would be necessary for specific activities because soils in the region have not been mapped extensively.

Ground Stability—Certain soil-forming processes enhance ground stability: development of a pavement and accumulation of calcium carbonate, which are often coincident. Ground with these attributes, notwithstanding absence of factors that would result in instability, may be preferred for certain activities (e.g., waste management and foundations). In general, ground that has not been reworked by surface flow of water is more likely to have these attributes. Site-specific evaluation for pavement development, calcium carbonate accumulation, and the absence of detrimental soil conditions would be necessary for certain activities.

Ground will tend to be less stable if it:

- is composed of readily weathered and/or fractured rocks
- contains void space
- lacks vegetation
- is subjected to:
  - surface flow of water
  - freezing and thawing
  - wind
  - ground motion
  - heaving pumping of groundwater.

Although not reported as problematic, site-specific evaluation or regional evaluation for these factors would be necessary for certain activities.

Certain areas where nuclear devices have been tested may be less stable than other areas (Figure 4-22). On the NTS, not all rubble chimneys resulting from tests have reached the surface; these areas are considered to be unstable (Figure 4-23). Such areas are not appropriate for other types of use because of their instability; these areas are fenced and controlled. Areas in the region where testing of nuclear devices may be resumed certainly have to take into account ground motion associated with that testing. Evaluations of the suitability of areas for testing indicate that areas that have been used in the past are those most suited for testing (Houser, 1968).

GEOLOGIC RESOURCES—Geologic resources in the region are discussed under the headings of economic minerals, aggregate, hydrocarbons, and geothermal resources. The impact that past activities have had on geological resources is also discussed.

ECONOMIC MINERALS—Economic minerals are discussed under the headings of precious metals, base metals, ferroalloy metals, and industrial minerals. Important mineral commodities in the NTS region include gold, silver, copper, lead, zinc, tungsten, and uranium (Myhrer, 1990). Mining districts are shown in Figure 4-27. Should the region be opened for public access, areas of previous mining could become important for the collection of mineral specimens.

Precious Metals—Significant gold and silver deposits may be present east of Goldfield in the northwestern NAFR Complex. Silver may be present in the Oak Spring District at the north end of Yucca Flat and west of Area 13; a significant amount of silver has been taken from the Groom mine in this area (BLM, 1979). A potentially economic mineral deposit may remain in the Wahmonie District.

The NTS has been closed to commercial mineral development since the 1940s (SAIC/DRI, 1991). Reactivation of many other gold districts in the region, in response to current gold prices and modern extraction technologies, suggests that the potential for precious metal deposits in the NTS region should be considered moderate to high (SAIC/DRI, 1991).

Base Metals—Copper, lead, zinc, and mercury are known to be present within the region. Economic quantities of copper, lead, and zinc have been recovered from the Groom mine (Humphrey, 1945; Quade and Tingley, 1983; SAIC/DRI, 1991).

Ferroalloy Metals—On the basis of commercial tungsten mining operations in the Oak Spring District during the late 1950s and early 1960s, the NTS region is considered to have moderate potential for the occurrence of tungsten skarn deposits or polymetallic replacement deposits (SAIC/DRI, 1991). Molybdenum is also associated with these deposits (BLM, 1979). Iron (magnetite) is present in the region; however, the resource potential is considered to be low (SAIC/DRI, 1991).

Industrial Minerals—Uranium resources may be present in the northwestern part of the NAFR Complex (BLM, 1979). Zeolitized rocks underlie most of the volcanic rocks and the alluvial basins in the NTS region. The widespread occurrence of zeolite deposits in the region suggests a low to moderate potential for development. Barite is known to occur in the region in veins associated with quartz and mercury, antimony, and lead mineralization. Barite veins at the NTS are small and impure and do not represent a potential barite resource. Fluorite is also present in the region. Little is known about the occurrence of fluorite, and its resource potential is assumed to be low to moderate (SAIC/DRI, 1991).

AGGREGATE—Most of the alluvial valleys in the region have aggregate resources at least along the flanks of adjacent mountains. The quantity and quality of these resources are likely sufficient to meet future demand. These resources do not have any unique value over aggregate occurring in other areas throughout southern Nevada.

HYDROCARBON RESOURCES—Grow et al. (1994) indicated that on the basis of rock type and thermal maturity, the northeastern and southern parts of the NTS and NAFR Complex have the potential for oil and gas, and the southern part of the NTS and the southeastern part of the NAFR Complex have the potential for gas. Thermal maturity acceptable for oil, however, is just within the range of acceptability. Values for both total organic carbon and hydrogen index is regionally continuous; potential source rocks are low. Further, late Tertiary extensional faulting in the region has likely disrupted any seals that are required for hydrocarbon accumulation. Based on these findings, the potential for hydrocarbon resources in the region is considered to be low. Previous investigators have also concluded low potential for hydrocarbon resources in the region based on various parameters (Harris et al., 1980) and on reported shows of surface and subsurface hydrocarbons (Garside et al., 1988). Figure 4-28 shows the relative potential for oil and gas resources in the region. No occurrences of oil and gas, coal, tar sand, or oil shale in the region have been reported.

GEOTHERMAL RESOURCES—Hot springs are common in the province (Fiero, 1986). However, if water temperatures near Yucca Mountain are

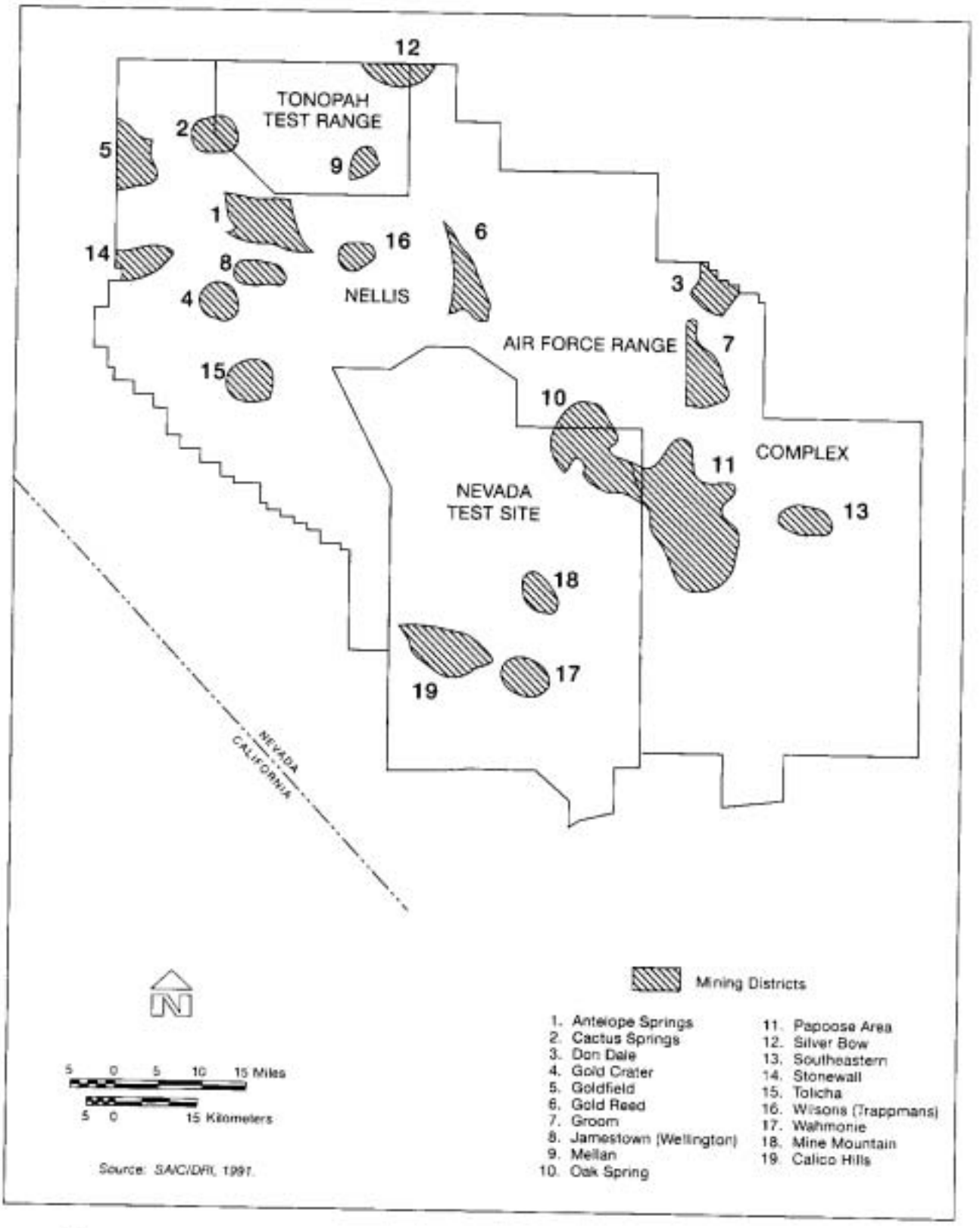


Figure 4-27. Mining districts located in the NTS, Tonopah Test Range, and NAFR Complex

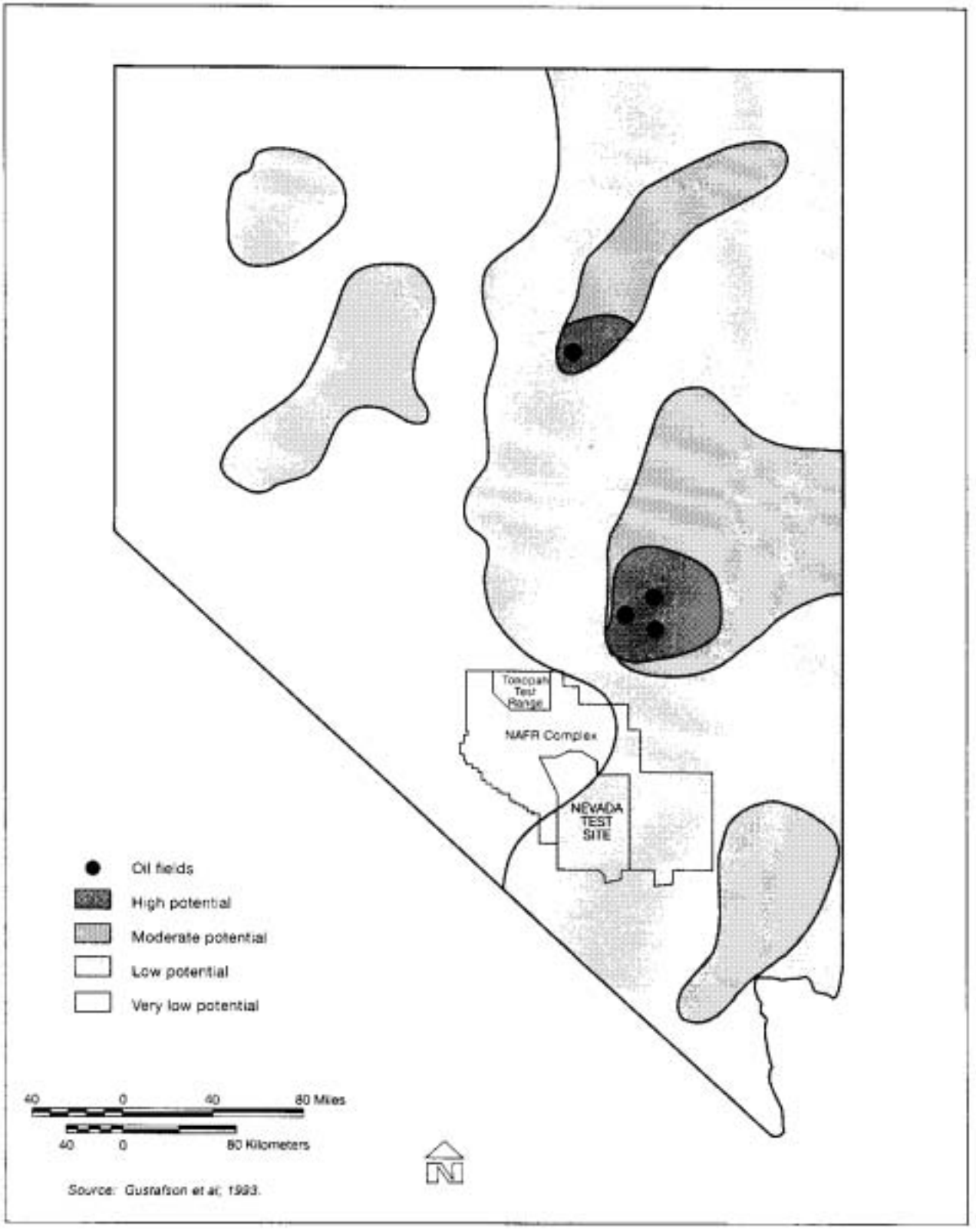


Figure 4-28. Nevada petroleum potential

representative (50 to 60 °C [120 to 140 °F]), water temperatures in the region may be insufficient for commercial power development. Current technology requires reservoir temperatures of at least 180 °C (356 °F) for commercial power generation (DOE, 1988).

A preliminary assessment of the geothermal potential of the NTS by the Harry Reid Center for Environmental Studies and Professional Analysis Incorporated (1994) found that there was very good potential for the development of a moderate temperature geothermal resource. This resource potential was judged to be suitable for the development of a binary geothermal power plant.

The North Las Vegas Facility, which is located in North Las Vegas in Clark County, is located within Seismic Zone 2. The soils on the North Las Vegas Facility range from stiff to very stiff silty and sandy clay and clay with interbedded medium-dense clayey and silty sand. The soils at the North Las Vegas Facility are considered acceptable for standard construction techniques.

4.1.4.3 Soils. Soil survey work has been limited on the NTS and surrounding areas to relatively small areas of local interest. Areas of local interest include specific facilities such as some large structures and waste disposal sites. In these cases, soil investigations are primarily limited to the characterization of specific geotechnical parameters. In some instances, the results of these investigations are published in form documents, e.g. Ho et al (1986) discusses the suitability of natural soils for foundations for surface facilities at Yucca Mountain. Often, information from these investigations has not been published and appears in various permit applications and DOE files. A great deal of research has been conducted, however, into the movement of contaminants through the soils of the NTS and the definition of areas where soils have been contaminated.

In general, the soils of the NTS are similar to those of surrounding areas and include aridisols and entisols. The degree of soils development reflects their age, and the soils types and textures reflect their origin. Entisols generally form on steep mountain slopes where erosion is active. The aridisols are older and form on more stable fans and terraces.

Soil loss through wind and water erosion is a common occurrence throughout the NTS and surrounding areas. Portions of some watersheds probably exhibit higher erosion rates, but the erosion conditions and susceptibility of soils on the NTS have not been defined.

There are limited areas of soils that can be irrigated on the NTS according to the Nevada map prepared by the Division of Water Resources (State of Nevada, 1973), and they occur only in the lower elevations of the Yucca Flat weapons test basin, Frenchman Flat, and Jackass Flats. Elsewhere on the NTS, the soils are generally very limited in both thickness and areal extent.

In the Yucca Flat weapons test basin, the soils include those soils that can be irrigated with moderate limitations and with moderately low available water-holding capacity and stony, cobbly soils. In Frenchman Flat, the soil classes present have severe limitations with low available water-holding capacities and soil subject to flooding. The soils that can be irrigated in Jackass Flats have very severe limitations, coarse textures, and very low available water-holding capacities.

According to Romney et al. (1973), the soils of the southern NTS reflect the mixed alluvial sediments upon which they form. Soils are generally young in profile development and show only weak evidence of leaching. In general, soils texture is gradational from coarse-grained soils near the mountain fronts to fine-grained soils in the playa areas of the Yucca Flat weapons test basin and Frenchman Flat. Most soils are underlain by a hardpan of caliche. Soil salinity generally increases dramatically in the direction of the playa areas, with the highest level of soluble salts having accumulated in the deeper soil profile horizons in Frenchman Flat.

The soils on portions of the NTS have been contaminated during the conduct of various testing and ancillary operations. The largest areas of surficial contamination are in the Yucca Flat weapons test basin, Frenchman Flat, Plutonium Valley, and in scattered locations in the

western and northwestern parts of the facility. A discussion of radiological contamination in the soil can be found in the following section. A comprehensive investigation is underway to determine the risks associated with this soil contamination. Actions will be taken as part of the Environmental Restoration Program to reduce these risks, as appropriate.

RADIOLOGICAL SOURCES IN SOIL—The historical impacts on soils as a result of past Defense Program actions have been considerable and, in some instances, these impacts are considered significant. Lesser impacts include excavation of soils for roads and structures, alteration in nature drainages and erosion regimes, and the contamination of soils. This section describes the baseline soils conditions at the NTS, the NAFR Complex, and the Tonopah Test Range, as documented previously in the *Final Environmental Impact Statement, Nevada Test Site, Nye County, Nevada* (ERDA, 1977).

Atmospheric Testing—Aboveground nuclear weapons tests were initiated on January 27, 1951, with the detonation of a 1-kt air-dropped weapon over Frenchman Flat, and a total of 100 tests were conducted prior to the signing of the Limited Test Ban Treaty in August 1963. Atmospheric testing included weapons that were dropped by planes, those detonated from towers constructed to heights of 30 to 213 m (100 to 700 ft), tests conducted on land surface, and tests where the weapon was lofted using helium-filled balloons 137 to 457 m (450 to 1,500 ft) above the ground.

Depending on the proximity of the explosion to the ground surface and the size of the yield, surface disturbances from atmospheric testing vary widely. The greatest surficial disturbances typically occurred when an air-dropped weapon penetrated the ground surface to a shallow depth (about 15 m [50 ft]) before detonation. According to information presented by Glasstone (1962), such a test with a yield of 100 kt would result in a crater about 36 m (120 ft) deep and about 219 m (720 ft) in diameter.

Radioactivity from atmospheric tests was dispersed by three primary mechanisms: throwout, base surge, and fallout. Throwout occurs at detonation when the fireball propels large volumes of rock and soil upward. Base surge refers to the settling and outward movement of the throwout. Fallout is the portion of material that does not settle, but rises and merges with the radioactive weapons residues. These materials subsequently descend to earth over the next few hours or more as fallout. The extent and distribution of contamination from an atmospheric test was quite variable depending on the height of detonation, the yield and type of device, the nature of the ground surface, the mass of inert material surrounding the device, and weather conditions at the time of, and following, the test (DOE, 1988). Glasstone (1962) documented the chronology of a shallow penetration air-dropped test. Typical isotopes formed during the historic atmospheric testing included strontium, cesium, barium, tritium, and iodine. Of these, strontium-90 and cesium-137 are of the most concern because of their longer half-lives of 28 and 29 years, respectively.

The vast majority of radioactivity released during atmospheric testing decayed very quickly after each test was conducted. For example, for a 1-kt atmospheric test, the initial release after 1 minute is about 4.1×10^{10} Ci. This activity is reduced to 1.0×10^{7} Ci just 12 hours after the detonation. If the activity remaining after 12 hours is used as the basis for estimates, then about 6.0×10^{10} Ci were released during atmospheric testing between 1951 and 1963 at the NTS (OTA, 1989).

Many of the fission products released during the detonations were dispersed into the atmosphere, and much of the residual radioactivity has decayed in the more than 30 years since the last atmospheric test. Nonetheless, some of the longer-lived radionuclides remain in the soil and physical structures. The primary radioactive isotopes that remain on the NTS from historic atmospheric testing include americium, plutonium, cobalt, cesium, strontium, and europium. According to the Desert Research Institute (1988), the remaining radioactivity in NTS soils within 1,829 to 3,048 m (6,000 to 10,000 ft) of the Able test (a 1-kt airdrop) totaled almost 15 Ci. Based on the most recent estimates for Frenchman Lake (McArthur, 1991), about 20 Ci of radioactivity remain in this area. Most, if not all, of this remaining activity can be

attributed to historic atmospheric testing. Residual contamination from atmospheric testing may also be present in Yucca Flat in Areas 1, 2, 3, 4, 7, 8, 9, and 10 of the NTS and in Buckboard Mesa in Area 18. However, because of the number of underground tests that were conducted in these areas, it is not possible to discriminate what residuals are remaining from atmospheric tests. Contamination remaining from the atmospheric tests in these areas is included within the inventory for shallow borehole tests, discussed in Section 4.1.4.2, Geology.

Safety Tests—Portions of the NTS, the NAFR Complex, and the Tonopah Test Range were used between 1954 and 1963 for chemical explosion tests of plutonium-bearing materials. Because of the similarities in the types of tests conducted and the consequences of those tests, the NAFR Complex and the Tonopah Test Range are included within this discussion and are not repeated in the discussion of the affected environment for those facilities.

The safety tests, or subcritical events, were conducted to evaluate the safety of nuclear weapons in accident scenarios. Two series, the GMX Project and Project 56, were conducted on the NTS in Areas 5 and 11, respectively. The GMX Project Site was used for 24 specific equation of state studies or experiments fissile materials. Project 56 was comprised of four discrete surface safety tests. Project 57 consisted of a single test and was conducted on the NAFR Complex in Area 13; the Double Tracks Test was conducted in the northern-most part of the NAFR Complex. An environmental assessment analyzing the potential environmental effects of four remediation alternatives was completed for the Double Tracks Site in April, 1996 (DOE, 1996). During preliminary characterization at the site, several pieces of highly radioactively contaminated metal were located, retrieved, and placed in a drum at the site. Between 998 and 1, 588 g (2.2 and 3.5 lbs) of plutonium were spread during the test. The recent work has shown that contamination of 200 pCi/g or higher, affects approximately 2.5 acres. Three safety tests conducted as part of the Clean Slate experiments were performed on the Tonopah Test Range. Figure 4-29 shows the locations of events conducted on the NTS and the NAFR Complex and Figure 4-30 shows the approximate areas of plutonium contamination exceeding 10 pCi/g.

The safety tests used mixtures of plutonium and uranium that were subjected to detonations of conventional explosives. Concurrent with and after these detonations, extensive studies were conducted to understand the dispersal and transport of these isotopes in the environment, including uptake by plants and animals. These studies were documented in a benchmark series of papers by the Nevada Applied Ecology Group, a panel of scientists chartered by the DOE to investigate the effects of testing at the NTS.

The immediate effects of the tests included the dispersal of plutonium and uranium over significant areas. To determine the area impacted by these tests, inventories were conducted by the Nevada Applied Ecology Group. These inventories were later augmented by extensive field-sampling efforts conducted under the Radionuclide Inventory and Distribution Program. These studies resulted in the definition of affected areas. Figures 4-30 through 4-37 show the limits of the affected areas and the distribution of radioactivity within those areas.

The total areas that were contaminated and the remaining inventory of radionuclides are summarized by McArthur and Mead (1989) and (McArthur, 1991) for areas on the NTS and in the *Final Environmental Impact Statement, Nevada Test Site, Nye County, Nevada* (ERDA, 1977) for the off-site locations. The GMX Project ion Area 5 resulted in the contamination of about 240 acres, with estimates of the total remaining inventory ranging from 1.7 to 2.5 Ci.

The Project 56 tests resulted in the contamination of about 2,200 acres, with estimates of the remaining inventory ranging from 34 to 39 Ci. On the NAFR Complex, the two disturbed areas total slightly under 1,000 acres, with an estimated remaining inventory of about 50 Ci. On the Tonopah Test Range, almost 670 acres were contaminated, with an estimated remaining inventory of about 65 Ci. The ranges in values given are all approximations and reflect the limitations in field sampling of large areas, detection equipment, and laboratory analyses.

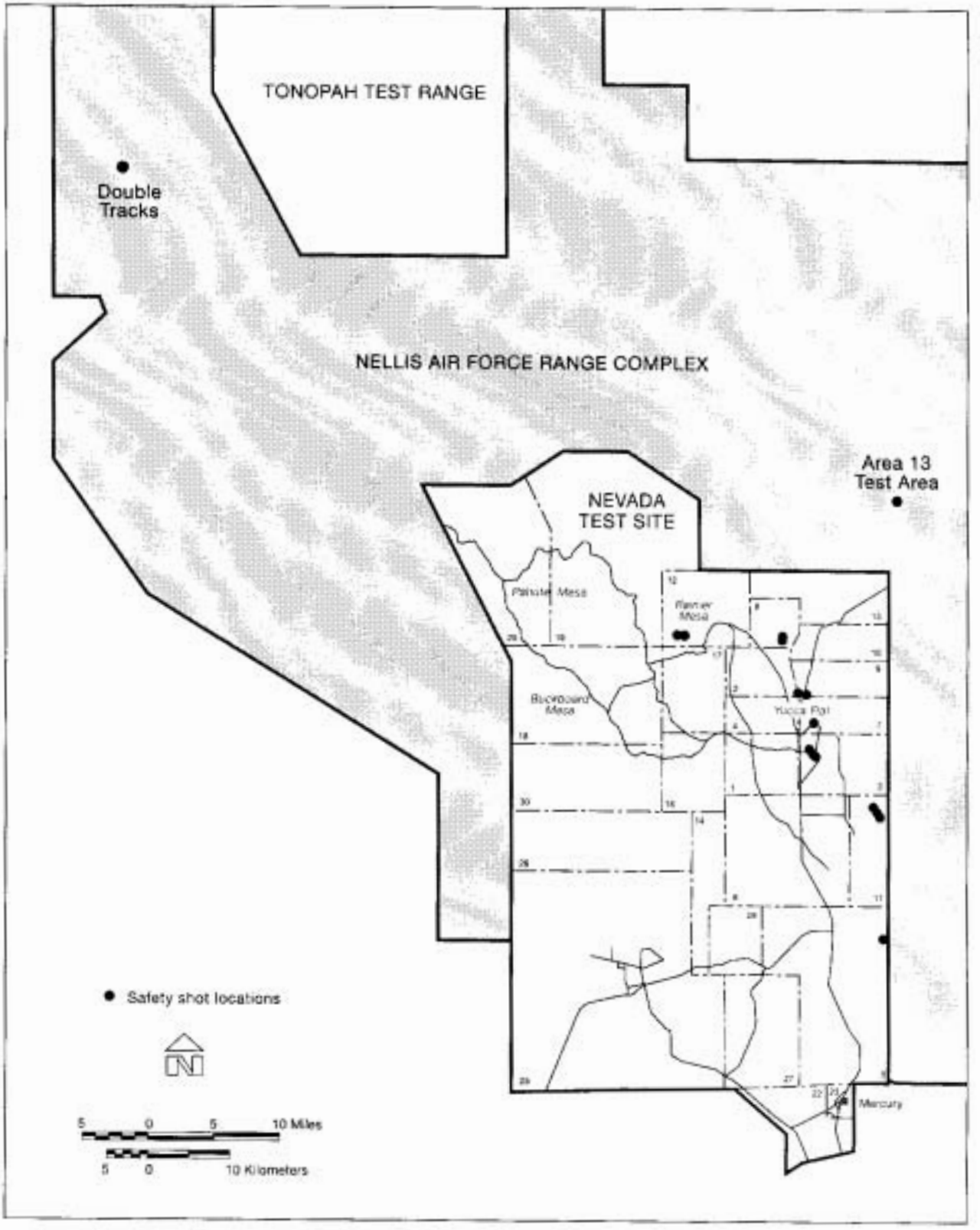


Figure 4-29. Locations of safety tests on the NTS and NAFR Complex

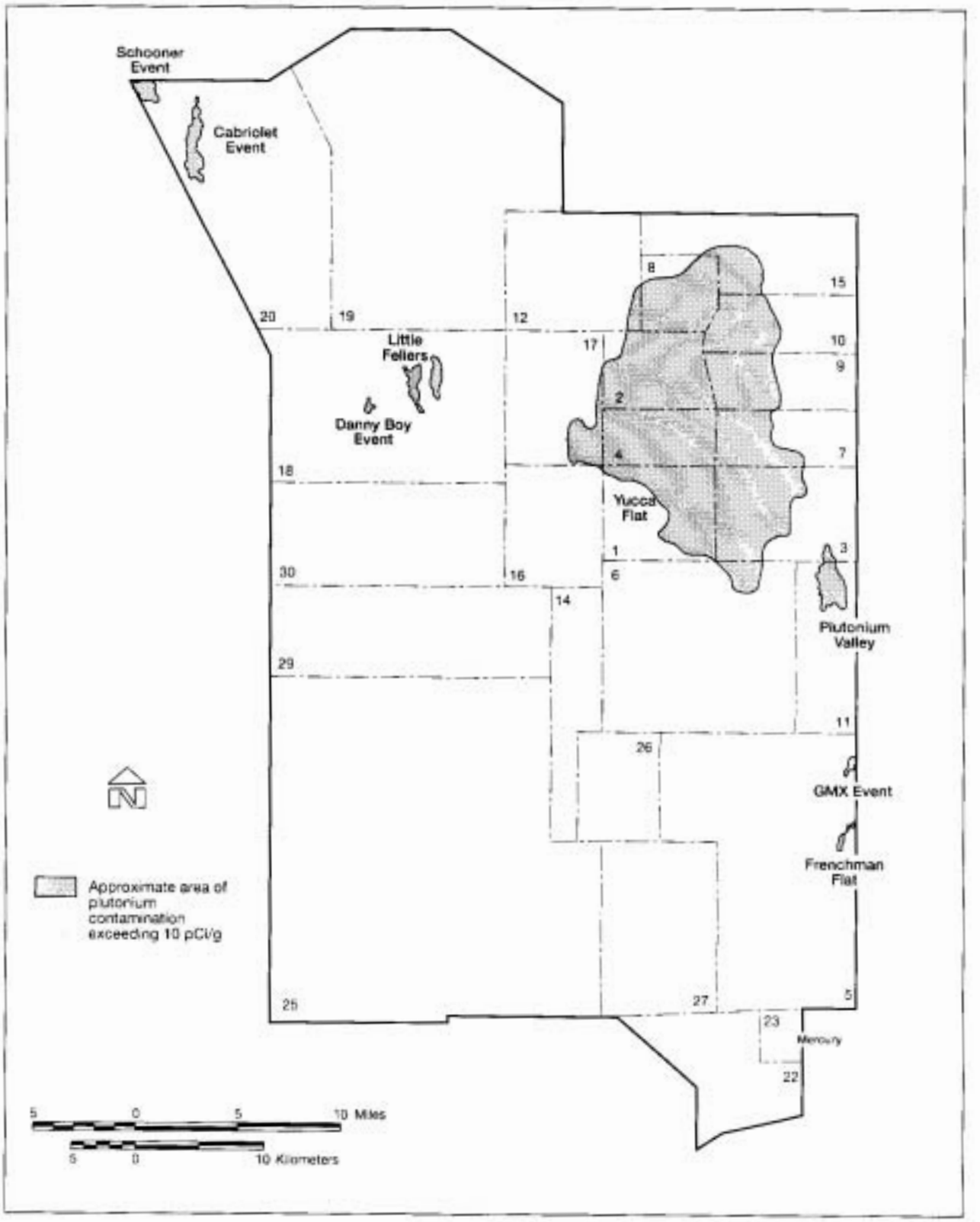


Figure 4-30. Approximate area of plutonium contamination exceeding 10 pCi/g on the NTS

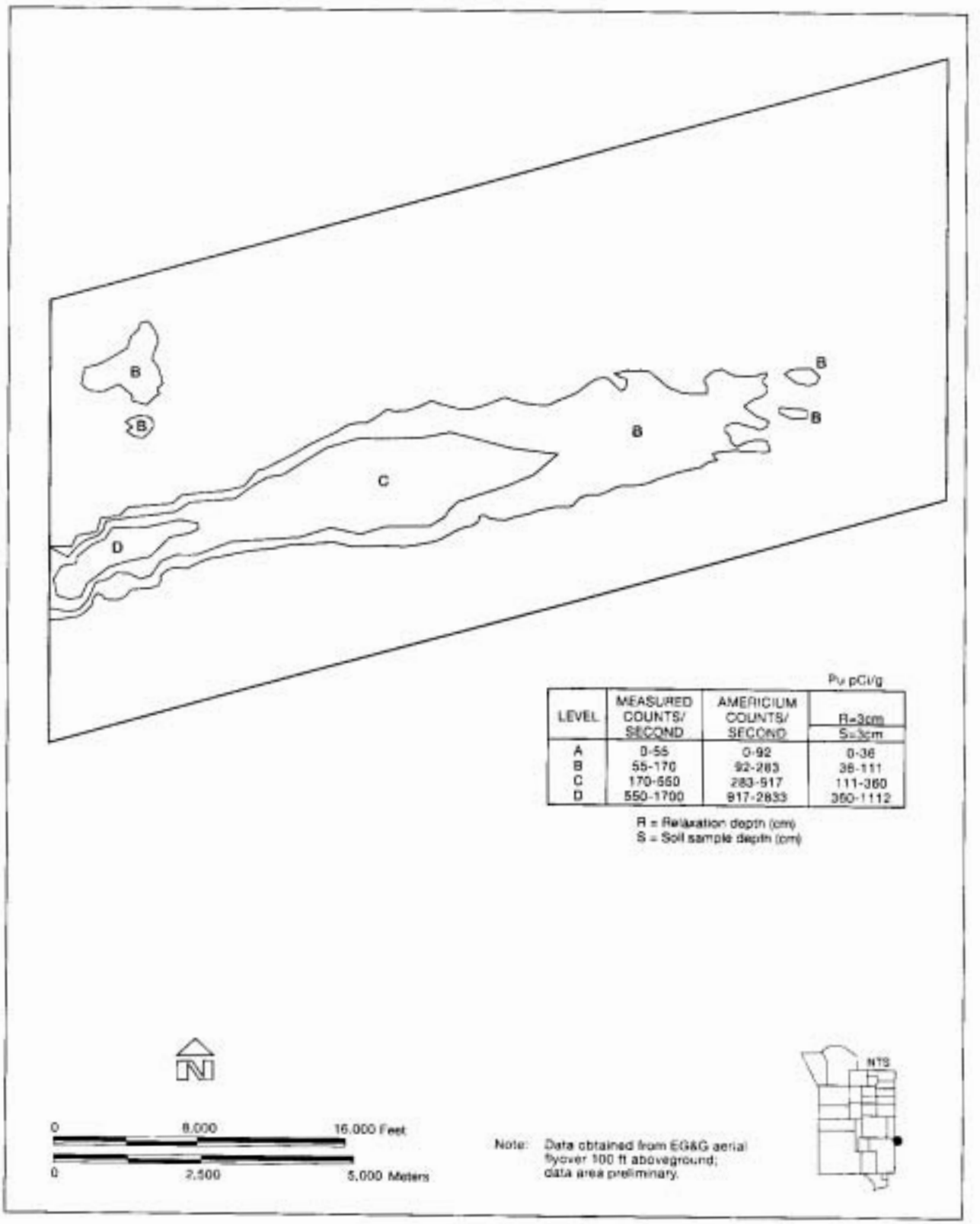


Figure 4-31. Approximate area of plutonium contamination plume east of Smallboy site

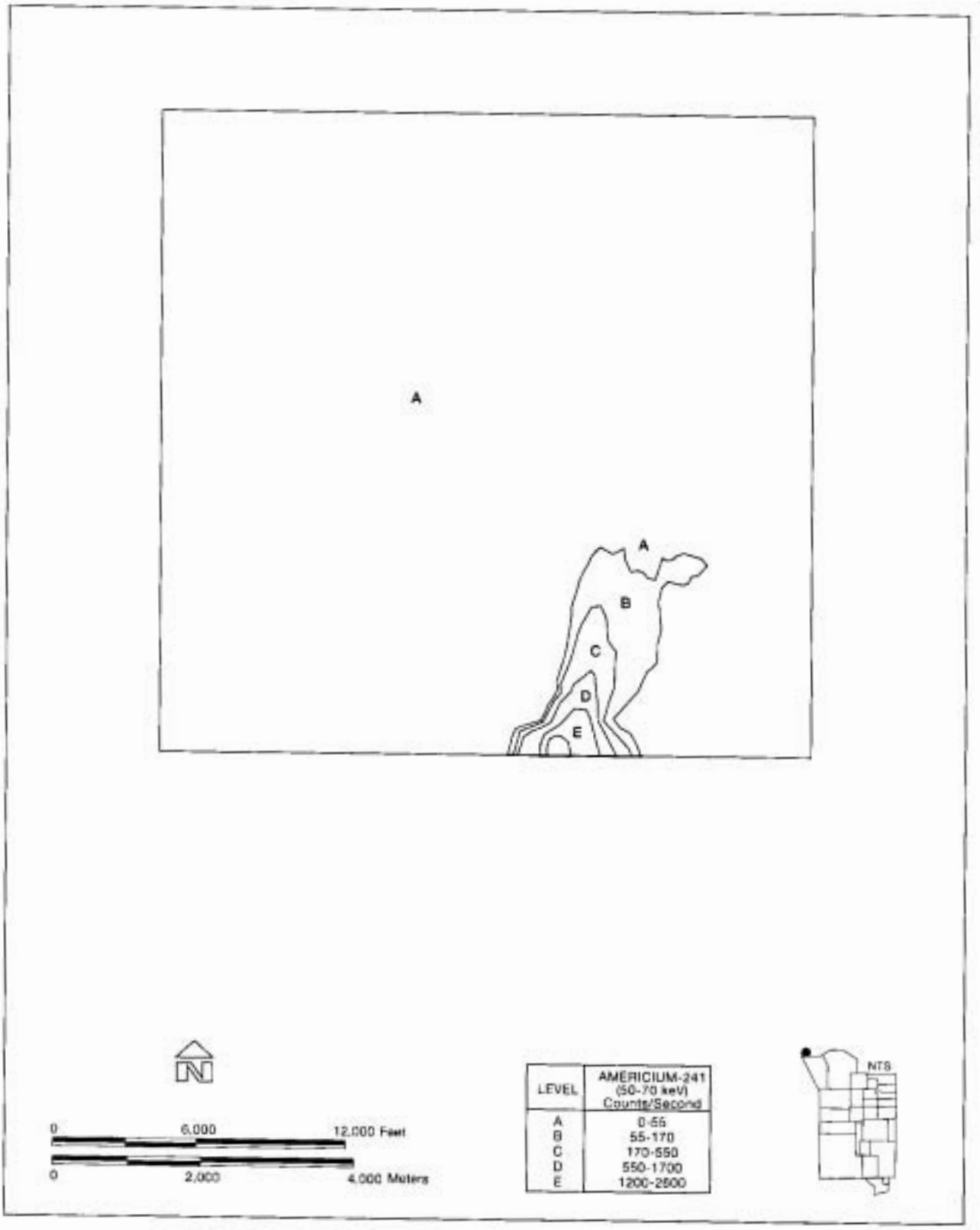


Figure 4-32. Approximate area of plutonium contamination plume north of Schooner site

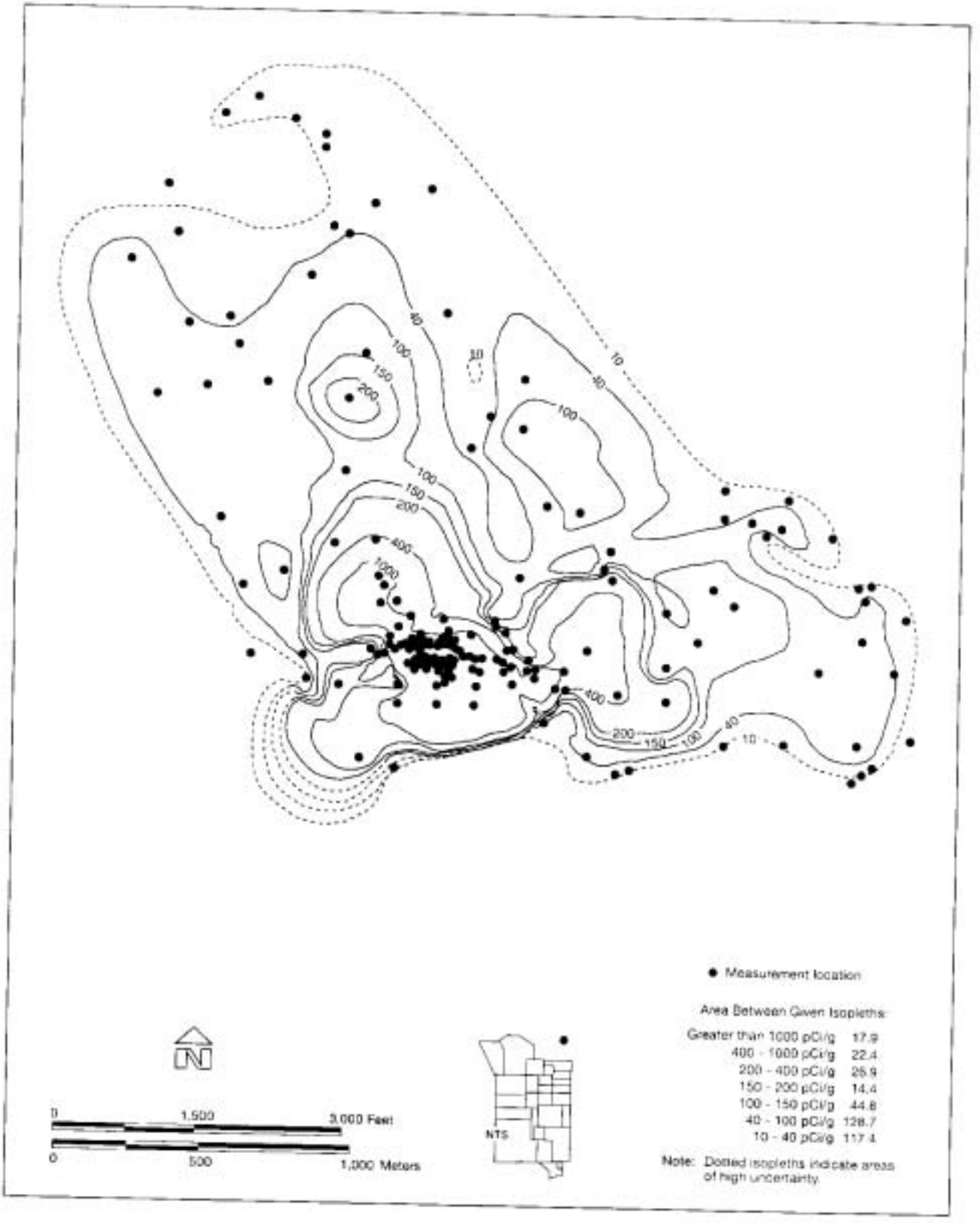


Figure 4-33. Approximate area of plutonium contamination, Area 13

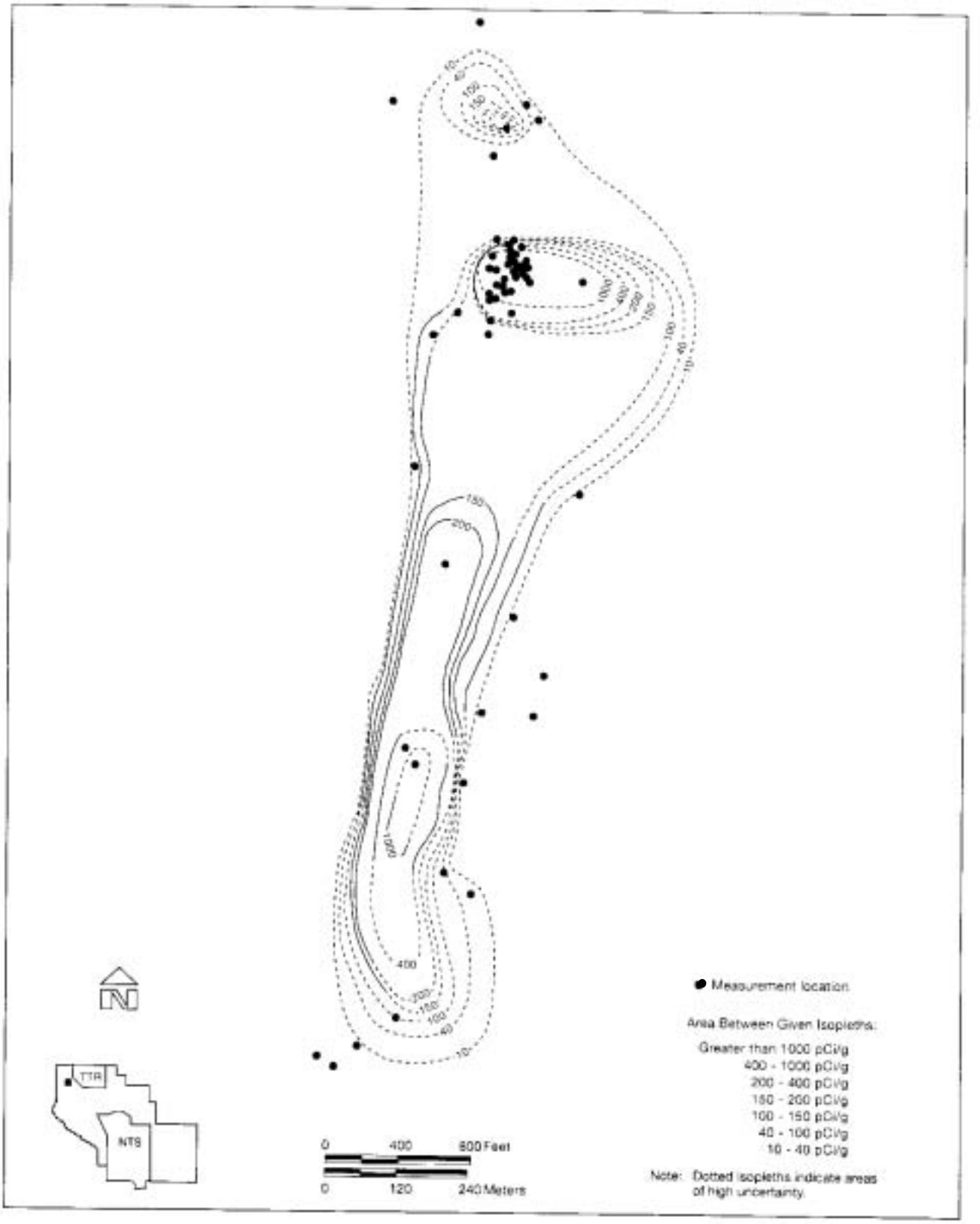
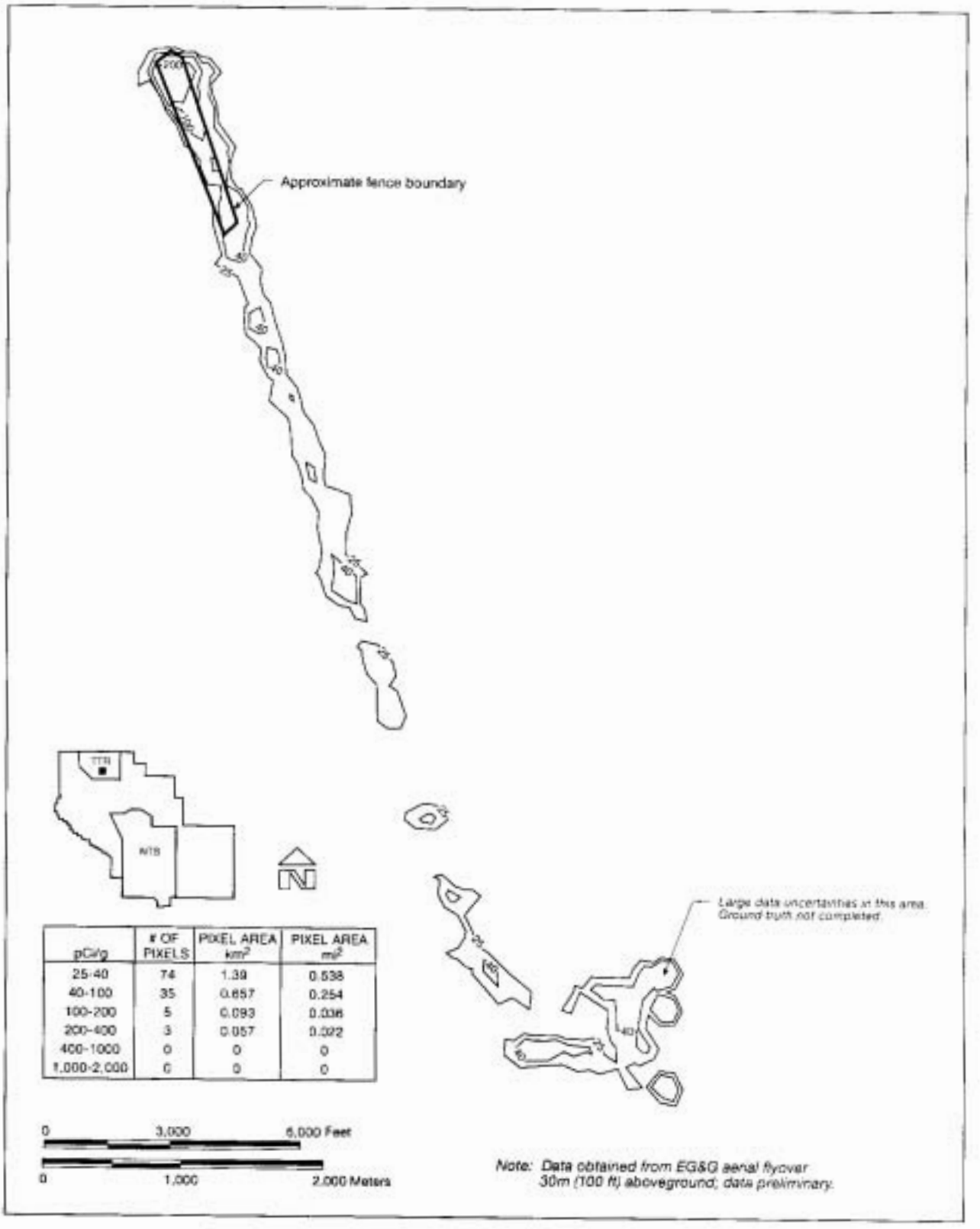
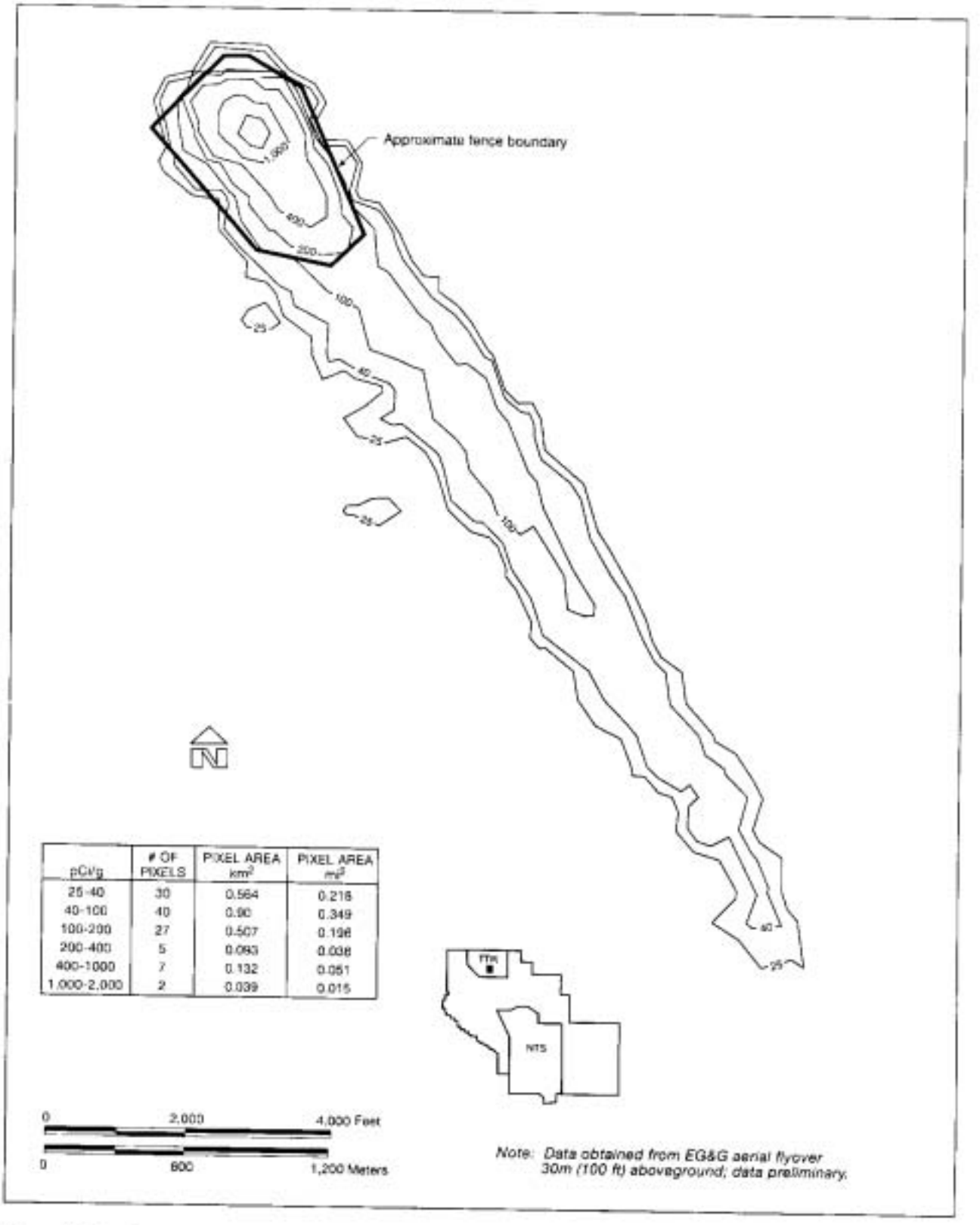


Figure 4-34. Approximate area of plutonium contamination, Double Tracks Test



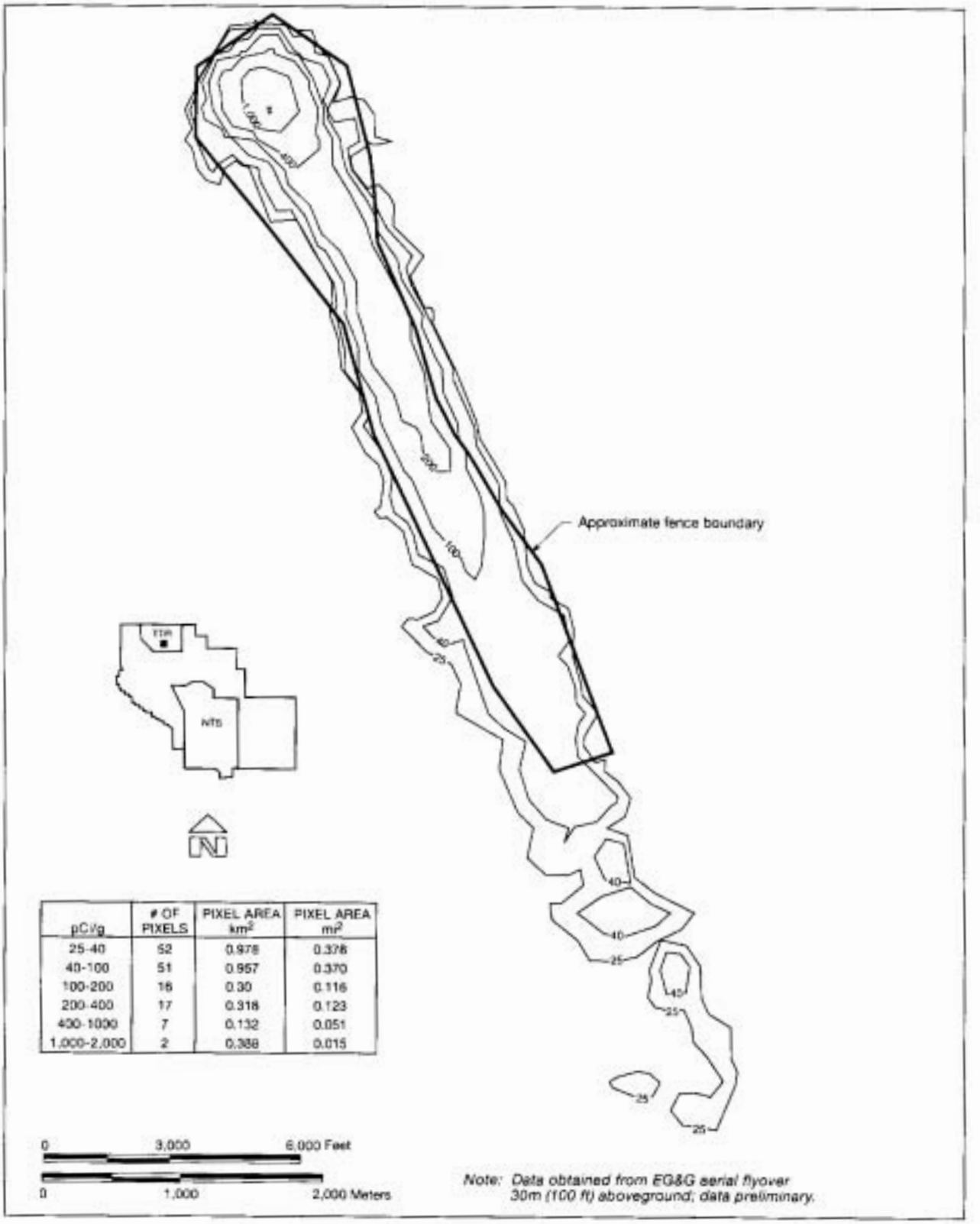
pCi/g	# OF PIXELS	PIXEL AREA km^2	PIXEL AREA mi^2
25-40	74	1.39	0.538
40-100	35	0.657	0.254
100-200	5	0.093	0.036
200-400	3	0.057	0.022
400-1000	0	0	0
1,000-2,000	0	0	0

Figure 4-35. Approximate area of plutonium contamination at the Tonopah Test Range, Clean Slate 1 site



pCi/g	# OF PIXELS	PIXEL AREA km^2	PIXEL AREA mi^2
25-40	30	0.564	0.218
40-100	40	0.90	0.349
100-200	27	0.507	0.196
200-400	5	0.093	0.036
400-1000	7	0.132	0.051
1,000-2,000	2	0.039	0.015

Figure 4-36. Approximate area of plutonium contamination at the Tonopah Test Range, Clean Slate 2 site



pCi/g	# OF PIXELS	PIXEL AREA km^2	PIXEL AREA m^2
25-40	52	0.978	0.378
40-100	51	0.957	0.370
100-200	16	0.30	0.116
200-400	17	0.318	0.123
400-1000	7	0.132	0.051
1,000-2,000	2	0.388	0.015

Figure 4-37. Approximate area of plutonium contamination at the Tonopah Test Range, Clean Slate 3 site

At both on- and off-site locations, the primary isotopes are plutonium, uranium, and americium, with lesser amounts of cesium, strontium, and europium. These long-lived radionuclides remain today in the surficial soils in the vicinity of the test areas and are available to be transported by wind and uptake by plants and animals. Extensive research into the mobility of the isotopes has found that wind can transport the contaminants and concentrate them in mounds around desert shrubs, and water can cause plutonium to migrate deeper into the soils with time. The isotopes are now relatively immobile unless the soils are disturbed.

The uptake of plutonium by plants can vary widely, with large intakes as a result of plutonium dust settling on the leaves of a plant, while the quantity of uptake is almost negligible for movement from the soil via the plant's root system. In total, the inventory of plutonium in plants is small compared to the inventory in soils. In a comprehensive study of a contaminated area in Area 13 of the NAFR Complex, 44 Ci of plutonium were estimated to be in the soils while only 0.000264 Ci were estimated to have entered the foliage. Research has indicated that this trend may be as accurate for americium, however, which is much more easily taken into the root systems of plants. Similarly, the radioactivity levels in animals has been found to vary widely depending on the species, their habitats, and time spent in the contaminated area.

One of the actions being evaluated in this EIS is the characterization and remediation of the contaminated soils on the NTS, the NAFR Complex, and the Tonopah Test Range. Over the past two decades, the DOE has conducted many different types of surveys and research projects concerning these soils. A long-term data baseline has been established, the areas of contamination have been delineated, air monitoring and radiological surveying continue for key indicator parameters (plutonium, noble gases, and tritiated water vapor), and an extensive research and development project has evaluated alternative methods for cleaning up the soils. The final disposition of the remaining isotope inventory in these soils will be determined as part of the Soils Corrective Active Unit of the Environmental Restoration Program.

Nuclear Rocket and Related Tests—A number of activities were conducted at the Nuclear Rocket Development Station in Areas 25 and 28. From 1959 through 1973, the area was used for a series of open-air nuclear reactor, nuclear engine, and nuclear furnace tests and for the High Energy Neutron Reactions Experiment. Equipment and facilities remain from some of these activities, and there are some limited areas of contaminated soils. The total estimated inventory of isotopes remaining in the soils in this area of the NTS has been estimated to be about 1 Ci (McArthur, 1991). The primary soil contaminants in this area are isotopes of strontium, cesium, cobalt, and europium. The disposition of this contamination will be addressed as part of the Soils Corrective Action Unit under the Environmental Restoration Program.

4.1.5 Hydrology

Discussion of hydrology is divided into surface hydrology and groundwater. Surface hydrology is discussed in terms of hydrographic basins, whereas groundwater is discussed in terms of hydrogeologic basins. A hydrographic basin is the area drained by a stream system and bounded by topographic divides (Bates and Jackson, 1987). A hydrogeologic basin is groundwater flow from source areas located either in the bounding mountain ranges or upgradient basins toward discharge areas where groundwater is lost to evapotranspiration, discharge to the surface water regime, or flows underground into downgradient basins. The two types of basins are not necessarily coincident, but the distribution of surface water certainly has an effect on the distribution of groundwater.

The hydrologic conditions of the NTS have been extensively studied, and a very large database is available concerning the surface water and groundwater regimes. In fact, the hydrology of the NTS has probably received more scientific scrutiny than any other area in Nevada. However, the database for areas beyond the test site boundaries is not as extensive because of the lack of activities and wells over much of the region. The off-site database has been expanded in recent years through a number of regional studies conducted by the U.S. Geological Survey, the Desert Research

Institute, and other research organizations. Further, these organizations are continuing to expand the scope of their studies on the NTS as well, thereby addressing uncertainties both on and off the site.

No surface water features are located at the North Las Vegas Facility. The North Las Vegas Facility is located in the Las Vegas Valley, which is in a desert region between sharp, rugged mountain ranges. The lowest point of the alluvial fan is the Las Vegas Wash, which drains an area of 2,280 km^2 (880 mi^2) toward Lake Mead. Storm water from the North Las Vegas Facility is discharged into local flood control system.

4.1.5.1 Surface Hydrology. The Great Basin, a hydrographic basin in which no surface water leaves except by evaporation and which includes much of Nevada, is part of the Basin and Range Physiographic Province (Stewart, 1980). The NTS, the Tonopah Test Range, and all but the southern corner of the NAFR Complex, are within the Great Basin (Figure 4-38). Similarity of the physical environment throughout the region allows general discussion of surface water of the NTS, the NAFR Complex, and the Tonopah Test Range. This general discussion of all the areas is centered on the NTS and, unless otherwise specified, referred to simply as "the region."

Discussion of specific areas are included where significant differences exist or where information at a local scale increases understanding and assists in the evaluation of impacts. Consistent with the Great Basin, hydrographic basins of the region have internal drainage controlled by topography (Figure 4-39). Streams in the region are ephemeral. Runoff results from snowmelt and from precipitation during storms that occur most commonly in winter and occasionally in fall and spring, and during localized thunderstorms that occur primarily in the summer (DOE, 1988). Much of the runoff quickly infiltrates into rock fractures or into the dry soils, some is carried down alluvial fans in arroyos, and some drains onto playas where it may stand for weeks as a lake (DOE, 1986). These playas emphasize a perennial water deficit that has characterized Nevada at least in historic times (French et al., 1984).

Floods on alluvial fans and playas in the region are most likely to have an impact on DOE facilities or activities. The discussion below gives definitions and mechanisms. The potential exists for sheet flow and channelized flow through arroyos to cause localized flooding throughout the NTS. However, because of the size of the NTS, no comprehensive floodplain analysis has been conducted in the NTS region to delineate the 100- and 500-year floodplains (see Tables 4-16 and 4-17). A rise in the surface elevation of any standing water on a playa creates a potential flood hazard.

Playas in the Yucca Flat weapons test basin and Frenchman Flat in the northeastern and eastern parts of the NTS, respectively, collect and dissipate runoff from their respective hydrographic basins (Figure 4-39). Control Point and News Knob arroyos (informal names), and Gap Wash, Red Canyon Wash, Tongue Wash, and the Aqueduct arroyos in the Yucca Flat weapons test basin pose a potential flood hazard to existing facilities. Control Point and News Knob arroyos have been assessed for flood hazard (Miller et al., 1994c).

Arroyos in Frenchman Flat that pose a potential flood hazard to existing facilities are Barren Wash, Scarp Canyon, Nye Canyon, and Cane Spring. The first three of these arroyos have also been assessed for flood hazard (Schmeltzer et al., 1993a and b; Miller et al., 1994a and b). Ground-surface disturbance and craters associated with underground nuclear tests have rerouted parts of natural drainage paths in areas of nuclear device testing. Some craters have captured nearby drainage, and headward erosion of drainage channels is occurring. However, this is considered to be negligible. In some areas of the NTS, the natural drainage system has been all but obliterated by the craters. The western half and southernmost part of the NTS have arroyos that carry runoff beyond the NTS boundaries during intense storms (Figure 4-39). Fortymile Canyon, the largest of these arroyos, originates on Pahute Mesa and intersects the Amargosa arroyo in the Amargosa Desert about 32 km (20 mi) southwest of the NTS. The Amargosa arroyo continues to Death Valley, California (ERDA, 1977).



Figure 4-38. Great Basin



Figure 4-39. Hydrographic basins of the NTS, NAFR Complex, and Tonopah Test Range area

Table 4-16. Flood regulations relevant to waste management and other facilities on the NTS and NAFR Complex

Flood Regulations	Title
DOE Order 6430.1A	General Design Criteria
DOE-STD-1020-94	Natural Phenomena Hazards Design and Evaluation Criteria for Department of Energy Facilities
Executive Order 11988	Floodplain Management
Executive Order 11990	Protection of Wetlands
44 CFR Part 9	Floodplain Management and Protection of Wetlands
44 CFR Part 65	Identification and Mapping of Special Hazard Areas
10 CFR Part 1022	Compliance with Floodplain/Wetlands Environmental Review Requirements
40 CFR Part 264.18	Hazardous Waste Management Unit - Location Standards
40 CFR Part 264.193	Containment and Detection of Releases
40 CFR Part 270.14	Contents of Part B: General Requirements
NAC 444.8456	Location of Stationary Facility for Treatment, Incineration or Disposal of Hazardous Waste

Table 4-17. Applicable flood events and other information regarding regulations listed in Table 4-16

Regulations	25-yr, 6-hr	25-yr, 24-hr	100-yr, 6-hr	500-yr	PMP	Sediment Transport	Notes
DOE Order 6430.1A	X		X	X	X	X Also implied	References: EO 11988, EO 11990, 10 CFR Part 1022, UCRL 115910
DOE-STD-1020-94					X	X	
Executive Order 11988			X				
Executive Order 11990							Wetlands
44 CFR Part 9			X	X		Implied by references to other regulations	
44 CFR Part 65			X	X		X	Also FEMA Design Criteria Chapter 10
10 CFR Part 1022			X	X			
40 CFR Part 264.18			X				
40 CFR Part 264.193		X					
40 CFR Part 270.14			X			Requirement for flood hazard delineation map and consideration of other "special flooding"	

Areas prone to flooding surround Fortymile Wash, a major tributary of Fortymile Canyon. Tonopah Wash, which runs southwesterly across Jackass Flats from Jackass Divide in the south-central part of the NTS, is a major tributary to the Amargosa arroyo. Fortymile Canyon and Jackass Flats hydrographic basins pose a flood hazard to off-site areas (SAIC/DRI, 1991). Rock Valley arroyo trends westward from the southernmost part of the NTS to Ash Meadows in the east-central part of the Amargosa Desert (ERDA, 1977). Arroyos trending southward from Red Mountain pose a potential flood hazard to sewage lagoons that service Mercury.

Playas in Papoose Valley and Emigrant Valley on the NAFR Complex, northeast of the NTS, collect and dissipate runoff from these hydrographic basins. Arroyos originating in the Belted Range and Chalk Mountains cross Area 13 and trend to Groom playa in Emigrant Valley (DRI, 1988). Playas in Kawich Valley and Gold Flat, on the NAFR Complex north of the NTS, collect and dissipate runoff from the northern part of Pahute Mesa (ERDA, 1977).

Five hydrographic basins are within the boundaries of the Tonopah Test Range: most of Cactus Flat and parts of Stone Cabin Valley, Ralston Valley, Stonewall Flat, and Gold Flat (Figure 4-39). Playas in these hydrographic basins collect and dissipate runoff from these basins. Arroyos originating in the Cactus Range, Goldfield Hills, and Stonewall Mountain trend through Range 71.

SPRINGS AND IMPOUNDMENTS—Throughout the region, springs are the only sources of perennial surface water. These are restricted to some short reaches of the Amargosa arroyo and pools at some large springs (Figure 4-40). Most water discharged from springs travels only a short distance from the source before evaporating or infiltrating into the ground (DOE, 1986).

Discharges from springs, seeps, and marsh areas in the western hydrographic basins in the region range between less than one and several thousand gallons per minute; typically, discharges are several tens to several hundreds of gallons per minute in the larger springs. The largest discharge is at Crystal Pool in Ash Meadows (DOE, 1988). According to information provided by the U.S. Department of the Interior Texas, Nevares, and Travertine Springs in Death Valley (located downgradient of the NTS) provide a potable water supply for park visitors and a privately owned resort that includes restaurants, motels, hotels, and a golf course. Moore (1961) provides data on discharges from springs on the NTS and vicinity. The largest three of the nine springs listed, Indian, White Rock, and Cane Springs, discharge greater than 1 gal/min; all others discharge less than 1 gal/min. Prior to any actions that may result in discharges to these limited surface water occurrences, reviews will be made to ensure compliance with appropriate Executive orders and federal and state environmental laws and regulations.

A small lake, locally known as Crystal Reservoir, with a storage capacity of 2.3×10^6 m^3 (1,860 acre-feet [ac-ft]) is present in the Ash Meadows part of the Amargosa hydrographic basin (Figure 4-40). Water for the reservoir is supplied by a concrete flume from Crystal Pool (Giampaoli, 1986). The reservoir was recently drained and cleaned by the U.S. Fish and Wildlife Service.

Many impoundments have been constructed on the NTS for operations there. The impoundments on the NTS do not support any vegetation stands that qualify as wetlands. Any actions that could affect these impoundments will receive the same type of review for regulatory compliance as that discussed above for the spring discharge areas.

SURFACE WATER CHARACTERISTICS—Little data on characteristics of water in the region have been collected because all streams in the region are ephemeral, and only a few springs have been sampled. Moore (1961) presented results on chemical and radiological analyses for eight springs on the NTS (Table 4-18). Tabulated data suggest that concentrations of chemical and radiological constituents are within naturally occurring ranges.

As part of the DOE NTS Monitoring Program, potable water from groundwater wells, spring water, well reservoirs, waste disposal ponds, and sewage lagoons are routinely sampled for radiological substances in accordance with federal, state, and local regulations (DOE/NV, 1994a).

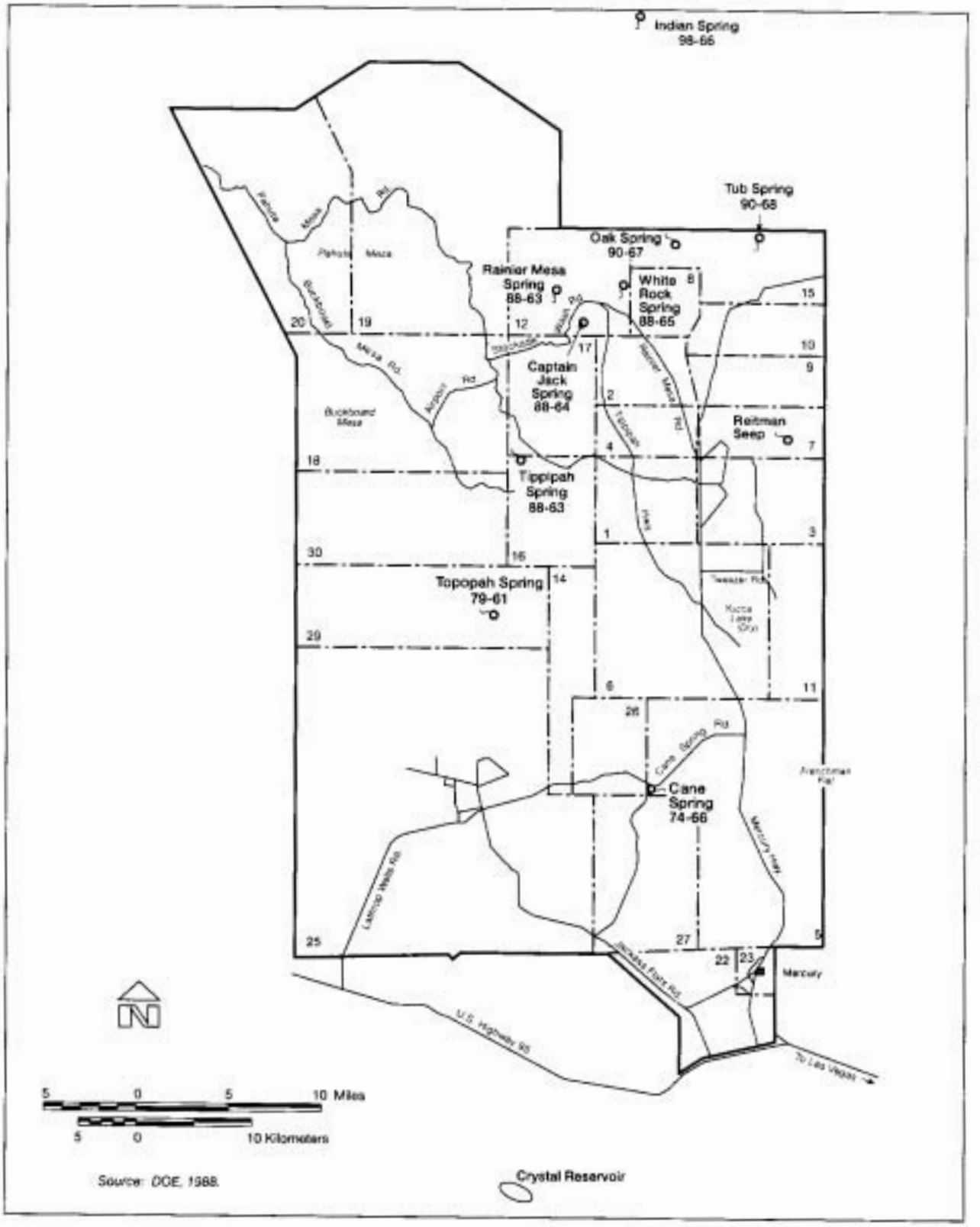


Figure 4-40. Location of springs on the NTS

Table 4-18. Chemical and radiochemical analyses of water from springs on the NTS

Spring No.	Date of Collection	°F	pH	Specific Conductance in Microohms at 25 °C	SiO_2[a]	Al[a]	Fe[a]	Mn[a]	Ca[a]	Mg[a]	Sr[a]	Na[a]	K[a]	HCO_3[a]	CO_3[a]	SO_4[a]	Cl[a]	F[a]	NO_3[a]	PO_4[a]	Total Dissolved Solids (ppm)[b]	Hardness (as $CaCo_3$)		Percent Sodium
																						Total	Noncarbonate	
74-66	9/19/57	66	7.9	425	64	.0	0.10	0.00[c]	32.0	9.2	0.0	37	7.8	163	0	28	20.0	0.5	19.0	0.25	298	118	0	399
74-66	3/24/58	64	8.0	403	63	.0	.00	.00	30.0	9.2	<.1	36	7.6	152	0	30	19.0	.7	18.0	.00	288	113	0	399
79-61	9/17/57	70	6.9	291	71	.2	.08	.00	20.0	3.9	.0	19	18.0	147	0	11	6.0	.7	.1	10	222	66	0	322
79-61	3/25/58	53	6.9	114	50	.3	.44	.00	7.2	1.0	<.1	14	6.4	48	0	15	3.0	.3	2.0	.9	123	22	0	50
83-63	9/17/57	53	7.7	207	53	.6	.31	.00	4.8	.1	.0	40	3.0	88	0	16	7.2	.2	4.6	.45	172	12	0	84
83-63	3/24/58	54	7.4	192	50	.0	.23	.00	4.8	.0	<.1	37	3.2	81	0	19	6.0	.3	4.2	.40	164	12	0	83
88-63	9/18/57	61	8.3	346	65	.2	.04	.00[c]	7.2	1.0	.2	66	4.0	158	2	18	14.0	.6	.6	2.2	256	22	0	84
88-64	5/1/59	56	6.9	188	43	.6	.95	.00[c]	3.2	.0	<.2	47	2.2	95	0	25	4.0	.4	.0	1.2	172	8	0	90
89-65	4/5/57	56	6.9	215	80	1.1	.62	.00	4.8	.0	.0	39	5.4	72	0	23	11.0	.4	4.9	.50	204	12	0	82
89-65	9/18/57	59	7.1	222	52	.1	.03	.00	4.0	.2	.0	42	5.4	78	0	29	8.0	.4	4.8	.65	184	11	0	84
89-65	3/21/58	48	7.2	197	119	.8	.44	.40[c]	6.4	.0	<.1	35	7.4	66	0	32	6.0	.6	4.8	.45	243	16	0	75
89-65	5/19/59	67	8.8	219	48	.7	.30	.00	4.8	.0	<.2	39	4.0	50	13	23	9.0	.6	1.9	.55	167	12	0	83
90-67	4/28/58	55	7.5	241	57	.1	.00	.00[c]	18.0	4.9	<.1	22	6.4	116	0	14	9.0	.3	.0	.10	189	65	0	40
90-68	4/30/59	52	7.1	260	64	.1	.13	.00	16.0	3.9	<.2	31	4.0	118	0	14	11.0	.4	.0	.21	202	56	0	52
98-66	5/1/58	50	7.2	358	61	.1	.08	.00	42.0	7.8	< 2	17	4.8	148	0	36	12.0	.4	.0	.00	254	137	16	211

[a] SiO_2=silica; Al=aluminum; Fe=iron; Mn=manganese; Ca=calcium; Mg=magnesium; Sr=strontium; Na=sodium; K=potassium; HCO_3=bicarbonate; CO_3=carbonate; SO_4=sulfate; Cl=chloride; F=fluoride; NO_3=nitrate; PO_4=phosphate

[b] Dissolved constituents given in parts per million

[c] In solution at time of analysis.

There is no known human consumption of surface water on the NTS. In fact, no public water supplies are drawn from springs in Amargosa Valley, which is located downgradient from the NTS along the primary pathway for surface water flow. The closest surface water supply that is used for public consumption is Lake Mead, which supplies a large portion of the water demand of metropolitan Las Vegas. Water availability and weather permitting, grab samples from open reservoirs, springs, containment ponds, and sewage lagoons are collected monthly. Analyses for gamma emitters, gross beta, and tritium are conducted monthly; analyses for plutonium-238, -239, and -240 are conducted quarterly; and analysis for strontium-90 is conducted annually.

The annual average for each radionuclide analyzed in surface waters is presented in Table 4-19, along with results from analysis of tunnel seepage. The annual averages for open reservoirs and natural springs are compared to the Derived Concentration Guides for ingested water. Gamma results for all sample locations indicated that radionuclide levels were consistently below the detection limit except for samples from the containment ponds. The containment ponds were constructed to catch contaminated runoff from the tunnel complexes. With the exception of containment ponds, no annual average concentration in surface waters was found to be statistically different from any other at the 5-percent significance level. The analytical results from the Area 12 containment ponds showed measurable quantities of radioactivity (DOE, 1993).

Open reservoirs have been established at various locations on the NTS for industrial uses. The annual average gross beta concentrations were compared to the Derived Concentration Guide for ingested water, listed in DOE Order 5400.5, even though there was no known consumption of these waters. The appropriate data are shown in Table 4-20 (DOE, 1993).

Of the nine natural springs found on the NTS, seven are consistently sampled. The other two springs, Tub Spring and Gold Meadows, are sampled when the discharge is large enough to allow sampling, which is infrequent. These springs are a source of drinking water for wild animals on the NTS. The annual average gross beta results for each spring are shown in Table 4-21 and compared to the strontium-90 Derived Concentration Guide for drinking water; however, the water is not used for human consumption. The highest result was for Reitman Seep, which was still below the Derived Concentration Guide (DOE, 1993). Spring discharge samples have also been analyzed for specific radionuclides (tritium, three isotopes of plutonium, and strontium). The average annual concentrations for these radionuclides are also below the Derived Concentration Guides based upon 4 millirem (mrem) effective dose equivalent for drinking water. Tritium averages were low in 1994, below 1.0 picocuries per liter (pCi/L), when eight of the springs were sampled (DOE, 1994b).

Nine of eleven sites related to containment ponds are sampled monthly: five ponds containing impounded waters from the tunnels, three liquid effluents discharged from the tunnels, and a contaminated laundry pond. All active containment ponds are fenced and are posted with radiological warning signs to prevent human access. These ponds are not fenced or flagged so as to prevent access by wildlife and migrating birds and are north of the range of the desert tortoise. The annual average of gross beta analyses from each sampling location is listed in Table 4-22 and compared to the Derived Concentration Guide for ingested water; however, the water is not used for drinking by humans (DOE, 1993).

Since the closing of the Area 6 Decontamination Facility Pond on November 8, 1992, wastewater has been discharged into holding tanks. Because the water and soil in the former pond are contaminated, grab water samples are collected from the pond monthly when possible (DOE, 1993).

As in the past, samples from the Areas 6, 12, and 23 sewage lagoons were collected quarterly during 1993. During the month of November, sampling was expanded to include all sewage lagoons that are in use, which amounted to an increase of six lagoons located in Areas 6, 12, 22, and 23. Each of the lagoons is part of a closed system used for evaporative treatment of sanitary waste. There was no known contact by the working population during the year. The annual gross-beta-concentration

Table 4-19. Radioactivity in NTS surface waters

(Annual average concentrations in units of picocurie per liter)							
Source of Water	Number of Locations	Gross β	Tritium	^{238}Pu	$^{239+240}Pu$	^{90}Sr[a]	% of DCG[b] Range
Open Reservoirs	15	5.7	-33[c]	0.0011	0.20	0.13	0.069 to 24
Natural Springs	7	9.3	5.4	0.03	0.46	0.24	0.007 to 33
Containment Ponds							
T Tunnel	3	260.0	3.1×10^7	0.028	0.81	ND[c]	([d])
N Tunnel	3	5.3	2.2×10^5	0.00076	0.047	NA[e]	([d])
E Tunnel	2	83	1.7×10^6	0.62	53	5.3	([d])
Decon Facility	1	53	1100	0.0	0.14	NA[e]	([d])
Sewage Lagoons	3	24	67	0.0011	0.0082	0.13	([d])

[a] Strontium-90 values are for one sample
[b] Derived Concentration Guide is based on value for drinking water (4 mrem effective dose equivalent)
[c] Below detection limit
[d] Not a potable water source
[e] Not analyzed.

Source: DOE/NV, 1994a.

Table 4-20. NTS open reservoir gross beta analysis results

		Gross Beta Concentration (picocurie per liter)				
Location	Number of Samples	Maximum	Minimum	Arithmetic Mean	Standard Deviation	Mean as % DCG[a]
Area 2, Mud Plant Reservoir	12	9.7	1.4	3.8	2.1	9.5
Area 2, Well 2 Reservoir	12	12.0	4.0	6.4	2.2	16.0
Area 3, Mud Plant Reservoir	12	18.0	2.8	11.0	3.5	28.0
Area 3, Reservoir	12	12.0	0.1	8.2	3.2	21.0
Area 5, UE-5c Reservoir	11	8.9	5.2	7.0	1.2	18.0
Area 5, Well 5b Reservoir	11	15.0	4.8	9.4	3.2	24.0
Area 6, Well 3 Reservoir	2	12.0	9.1	10.0	1.9	25.0
Area 6, Well C1 Reservoir	12	19.0	0.5	9.1	4.9	23.0
Area 18, Camp 17 Reservoir	11	8.7	2.8	4.2	1.6	11.0
Area 18, Well 8 Reservoir	3	6.1	3.8	5.1	1.2	13.0
Area 19, UE-19c Reservoir	10	12.0	1.4	3.4	3.0	8.5
Area 20, Well 20a Reservoir	7	12.0	1.1	4.3	3.6	11.0
Area 23, Swimming Pool	12	6.3	3.2	4.4	1.1	11.0
Area 25, Well J-11 Reservoir	12	6.5	3.7	5.2	0.9	13.0
Area 25, Well J-12 Reservoir	12	9.5	4.8	6.5	1.6	16.0

[a] Derived Concentration Guide based on strontium-90 value for drinking water (4 mrem effective dose equivalent).

Source: DOE/NV, 1994a.

Table 4-21. NTS natural spring gross beta analysis results, 1993

Location	Number of Samples	Gross Beta Concentration (picocurie per liter)				
		Maximum	Minimum	Arithmetic Mean	Standard Deviation	Mean as %DCG[a]
Area 5, Cane Spring	12	24.0	2.0	9.3	6.3	23
Area 7, Reitmann Seep	12	100.0	19.0	36.0	23.0	90
Area 12, Captain Jack	8	18.0	5.0	9.1	4.1	23
Area 12, Gold Meadows	5	23.0	8.1	14.0	7.5	35
Area 12, White Rock Spring	12	1.3	7.0	9.9	1.9	25
Area 16, Tippipah Spring	12	7.3	3.2	4.6	1.1	12
Area 29, Tonopah Spring	10	8.4	4.2	5.7	1.5	14

[a] Derived Concentration Guide based on strontium-90 value for drinking water (4 mrem effective dose equivalent).

Source: DOE/NV, 1994a.

Table 4-22. NTS containment pond gross beta analysis results

Location	Number of Samples	Gross Beta Concentration (picocurie per liter)				
		Maximum	Minimum	Arithmetic Mean	Standard Deviation	Mean as %DCG[a]
Area 6, Decontamination Pond	7	83.0	33.0	53.0	20.0	130.0
Area 12, E Tunnel Seepage	12	170.0	51.0	84.0	34.0	210.0
Area 12, E Tunnel Pond No. 1	10	130.0	53.0	82.0	29.0	210.0
Area 12, N Tunnel Seepage	5	22.0	-1.4[b]	6.8	9.2	17.0
Area 12, N Tunnel Pond No. 1[c]	(c)	(c)	(c)	(c)	(c)	(c)
Area 12, N Tunnel Pond No. 2	2	7.7	-4.3	1.7	8.5	4.3
Area 12, N Tunnel Pond No. 3	3	20.0	6.1	15.0	7.7	3.8
Area 12, T Tunnel Seepage	6	360.0	-3.9[b]	19.0	160.0	48.0
Area 12, T Tunnel Pond No. 1[c]	(c)	(c)	(c)	(c)	(c)	(c)
Area 12, T Tunnel Pond No. 2	4	310.0	170.0	260.0	58.0	650.0
Area 12, T Tunnel Pond No. 3	4	330.0	180.0	270.0	69.0	680.0

[a] Derived Concentration Guide based on strontium-90 value for drinking water (4 mrem effective dose equivalent)
[b] Below detection limit
[c] Pond dry.

Source: DOE/NV, 1994a.

averages for the three lagoons ranged between 2.0 and 3.1 pCi/L. The data for the new lagoons were similar. No radioactivity was detected above the minimum detectable concentrations for tritium and plutonium-238. Levels of strontium-90 slightly above the minimum detectable concentrations were detected in samples collected at the Area 6 Device Assembly Facility sewage lagoon, the Area 6 sewage lagoon, and the Area 12 sewage lagoon. Levels of plutonium-239 and -240 were also detected slightly above the minimum detectable concentration in two samples collected from the Area 6 sewage lagoon. No event-related radioactivity was detected by gamma spectrometry analyses (DOE, 1993).

All water discharges at the NTS are regulated by the state of Nevada. The NTS maintains compliance with required permits. Water-pollution control permits issued by the State are required for industrial and domestic wastewater discharges (DOE/NV, 1993). Discharge and monitoring requirements imposed by the State serve to prevent degradation of the surface waters (and groundwater) on the NTS.

4.1.5.2 Groundwater. Although the groundwater resources of the region are large, their physical availability is quite variable. All potentially affected areas are located within the Death Valley flow system. The Death Valley flow system is composed of 30 individual hydrographic basins and 41,440 km² (16,000 mi²) of the Great Basin (Harrill et al., 1988). This flow system originates primarily from the infiltration of precipitation over mountainous areas and flows toward the regional groundwater depression at Death Valley or smaller depressions in Sarcobatus Flats, Oasis Valley, Ash Meadows, and the Amargosa Desert.

The groundwater within the eastern portion of the NTS and within Area 13 of the NAFR Complex flows toward the Ash Meadows discharge area. In most of the western portion of the NTS, it flows toward the Alkali Flat-Furnace Creek discharge area. In the western part of the Tonopah Test Range and the extreme northwest tip of the NTS, it flows toward the Oasis Valley and the Sarcobatus discharge areas and on to Death Valley.

Table 4-23 lists the hydrographic basins that include portions of the NTS, the perennial yields of these basins, DOE's water supply wells, and DOE's peak demand rates for water in each of the basins. The perennial yield is an estimate of the quantity of groundwater that can be withdrawn from a basin on an annual basis without depleting the reservoir (Scott et al., 1971). The perennial yield values are estimates used by the Nevada State Engineer for planning purposes and may be significantly greater if recharge is greater than current estimates. The perennial yield values could also be smaller if one-half of the underflow between some basins is not considered a part of the perennial yield of specific basins, e.g., Frenchman Flat. Such considerations reflect the uncertainties involved in developing the estimates presented in the published literature. As shown in Table 4-23, the peak demand associated with historic NTS actions has been a small fraction of the available perennial yield in Gold Flat, Kawich Valley, Frenchman Flat, Mercury Valley, and Fortymile Canyon. Only in Yucca Flat have the DOE groundwater withdrawals exceeded the published perennial yield. The peak demand of 1,124,935 m^3 (912 acre-feet) in 1989 exceeded the perennial yield of 431,719 m^3 (350 acre-feet) by a factor of 2.6. Historic data indicate that annual water withdrawals have exceeded the perennial yield of Yucca Flat since 1962, but only in 1967, 1969, and 1989 were more than 863,437 m^3 (700 acre-feet) withdrawn.

The effects of the DOE's water withdrawals have included the lowering of water levels in the vicinity of water supply wells and some localized changes in groundwater flow directions. Estimates of the drawdown in the vicinity of NTS water supply wells have been made by the U.S. Geology Survey (Young, 1972; Thordarson, 1983). In general, the effects of pumping NTS water supply wells is concentrated within a distance of a few thousand feet of the operating wells. As part of their Wellhead Protection Program for the NTS, the DOE recently completed capture zone models for each water supply well and mapped the area of influence for each well. These models used a very conservative approach that assumed that each well was run continuously for a period of ten years. The results of these analyses indicate that for each well, the area of influence is restricted, and only at

Table 4-23. Perennial yields and peak historic water demands for the 10 hydrographic basins on the NTS

Basin	Estimated Perennial Yield		DOE Water Supply Wells	Peak DOE Historic Water Demand		
	m^3/yr	acre-feet/year		m^3	acre-feet	yr
Gold Flat	$2.3x10^6$	1,900	1	$4.3x10^5$	345	1989
Kawich Valley	$2.7x10^6$	2,200	1	$5.2x10^5$	425	1989
Emigrant Valley	$3.1x10^6$	2,500	None	No Demand		
Yucca Flat	$4.3x10^5$	350	8	$1.0x10^6$	912	1989
Frenchman Flat	$1.9x10^7$	16,000	3	$6.5x10^5$	530	1962
Mercury Valley	$9.8x10^6$	8,000	1	$5.3x10^5$	428	1992
Rock Valley	$9.8x10^6$	8,000	None	No Demand		
Fortymile Canyon	$9.4x10^6$	7,600	3	$4.2x10^5$	340	1988
Oasis Valley	$2.5x10^6$	2,000	None	No Demand		
Amargosa Valley	$2.9x10^7$	24,000	None	No Demand		

Army Well 1 does the capture zone extend beyond the NTS boundaries. No impacts on springs or biological resources are anticipated as a result of the operation of these wells. The extent and magnitude of water-level declines in the vicinity of these supply wells is not considered a significant impact in Gold Flat, Kawich Valley, Frenchman Flat, Mercury Valley, and Fortymile Canyon.

Because the extraction rates in Yucca Flat exceed the perennial yield of the basin, the impacts of the water supply wells could be more significant and require special consideration. The capture of groundwater in excess of the perennial yield could have removed water from storage or decreased the downgradient subsurface discharge to Frenchman Flat or both. Long-term water-level data for three wells in Yucca Flat are presented in Clary et al. (1995) and show variable results. Water levels in Well UE-2ce have been affected by underground tests and declined about 24 m (80 ft) between 1977 and 1984, while water levels in Well UE-5n rose about 0.3 m (1 ft). At Well UE-2ce, water levels rose almost 8 m (25 ft) between 1984 and 1994. Records for Well TW-7 have been affected by underground nuclear detonations and show an overall trend of rising water levels between 1957 and 1980 and declining water levels from 1980 to 1994.

HYDROGEOLOGIC UNITS—The NTS and surrounding regions are hydrogeologically complex. Three principal hydrogeologic systems—valley-fill alluvium, Tertiary volcanic rocks (tuffs and lava flows), and Proterozoic and Paleozoic sedimentary rocks—have undergone several periods of extensive faulting and deformation. As evidence of the complex hydrogeology, Winograd and Thordarson (1975) identified six major aquifers and four major aquitards in the region. The general relationship of hydrogeologic units in southern Nevada is listed in Table 4-24 and shown graphically on Figure 4-41a and 4-41b.

The hydrologic basement, referred to as the lower clastic confining unit, is comprised of approximately low-permeability Cambrian and older quartzite and metamorphic rocks. This

Table 4-24. Major hydrogeologic units of the Death Valley flow system

Hydrogeologic Units	Primary Rock Types	Age
valley-fill aquifer	alluvium, playa	Late Tertiary to Quaternary
volcanic:	rhyolite lava flows	
lava flow aquifers	welded ash-flow tuffs	Miocene
welded-tuff aquifers	nonwelded, zeolitized ash-flow tuffs	
tuff-confining units		
carbonates and clastic rocks:		
upper carbonate aquifer	limestone	
upper clastic confining unit	shales and siltstones	Pennsylvanian
lower carbonate aquifer	limestones and dolostones	Mississippian
lower clastic confining unit	quartzites and other metamorphics	Cambrian to Devonian Cambrian and Eocambrian

Sources: Modified after Waddell et al., 1984.

confining unit is regionally overlain by the lower carbonate aquifer, which is comprised of 4,000 to 5,000 m (13,120 to 16,400 ft) of relatively thick permeable limestones and dolostones, with thinner less permeable siltstones, shales, and quartzites.

Because of the past geologic history of uplift and erosion and structural deformation, the lower carbonate aquifer is not present in all areas, and rarely is the entire thickness of the unit present under the NTS or adjacent areas. Regional intrabasin flow is dominated by groundwater movement within the lower carbonate aquifer. Locally at the NTS, the lower carbonate aquifer is overlain by the upper clastic confining unit, which consists of low-permeability rocks of the Eleana and Chainman formations. In addition, Pennsylvanian-age limestones (or the upper carbonate aquifer) overlie the upper clastic confining unit in limited areas of the NTS. Flow through the upper carbonate aquifer is discontinuous and, therefore, considered less significant than flow through the regional lower carbonate aquifer.

Groundwater flow on Pahute and Rainier Mesas is through thick sequences of Tertiary volcanic rock, originating from calderas of the southwest Nevada volcanic field. Thinner sequences of these volcanic rocks overlie the upper carbonate aquifer and clastic confining units within some areas of the Yucca and Frenchman Flats. Tertiary volcanic rocks consist of ash flows, lava flows, and air-fall tuffs. Local alteration of units (primarily by zeolitization) in older, deeper parts of the volcanic pile has resulted in lower transmissivities characteristic of the volcanic confining unit. Lava-flow aquifers (present near volcanic centers) are present in Jackass Flats, Pahute Mesa, Rainier Mesa, Timber Mountain, and associated proximal areas. Tuff aquifers within the volcanic aquifer hydrogeologic unit consist of ash-fall, welded, or bedded tuffs. Welded-tuff aquifers are present in the deepest parts of the Yucca Flat weapons test basin, Frenchman Flat, and Jackass Flats. Welded- and bedded-tuff aquifers are also present on the mesas, Timber Mountain, and associated proximal areas.

Tertiary- and Quaternary-age alluvium and playa lake deposits fill the intermontane valleys and locally overlie Tertiary and Paleozoic rocks. The valley-fill deposits comprise a sequence of gravel, sand, silt, and clay. The sediments vary widely,

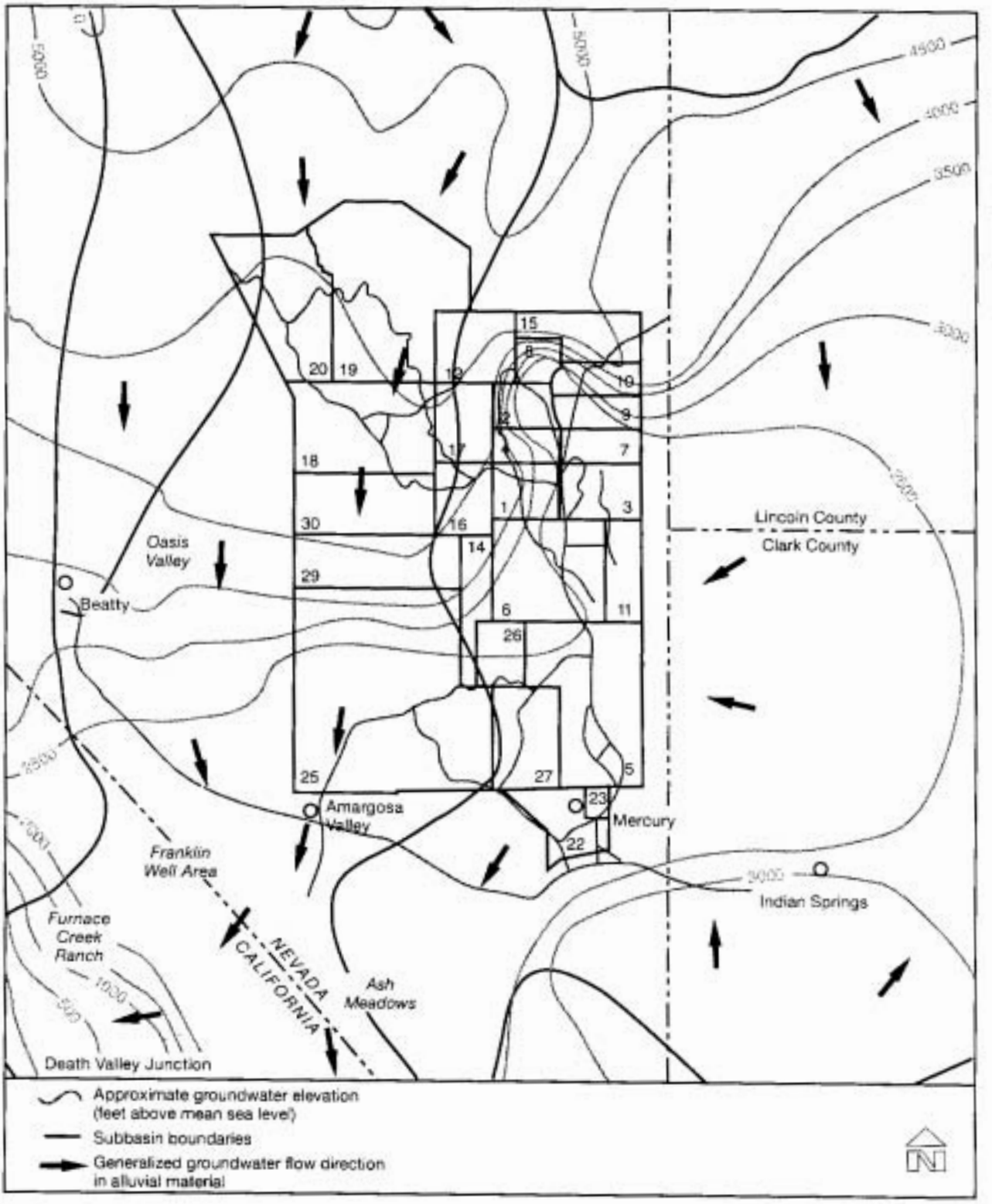


Figure 4-41a. Generalized potentiometric surface and groundwater flow directions

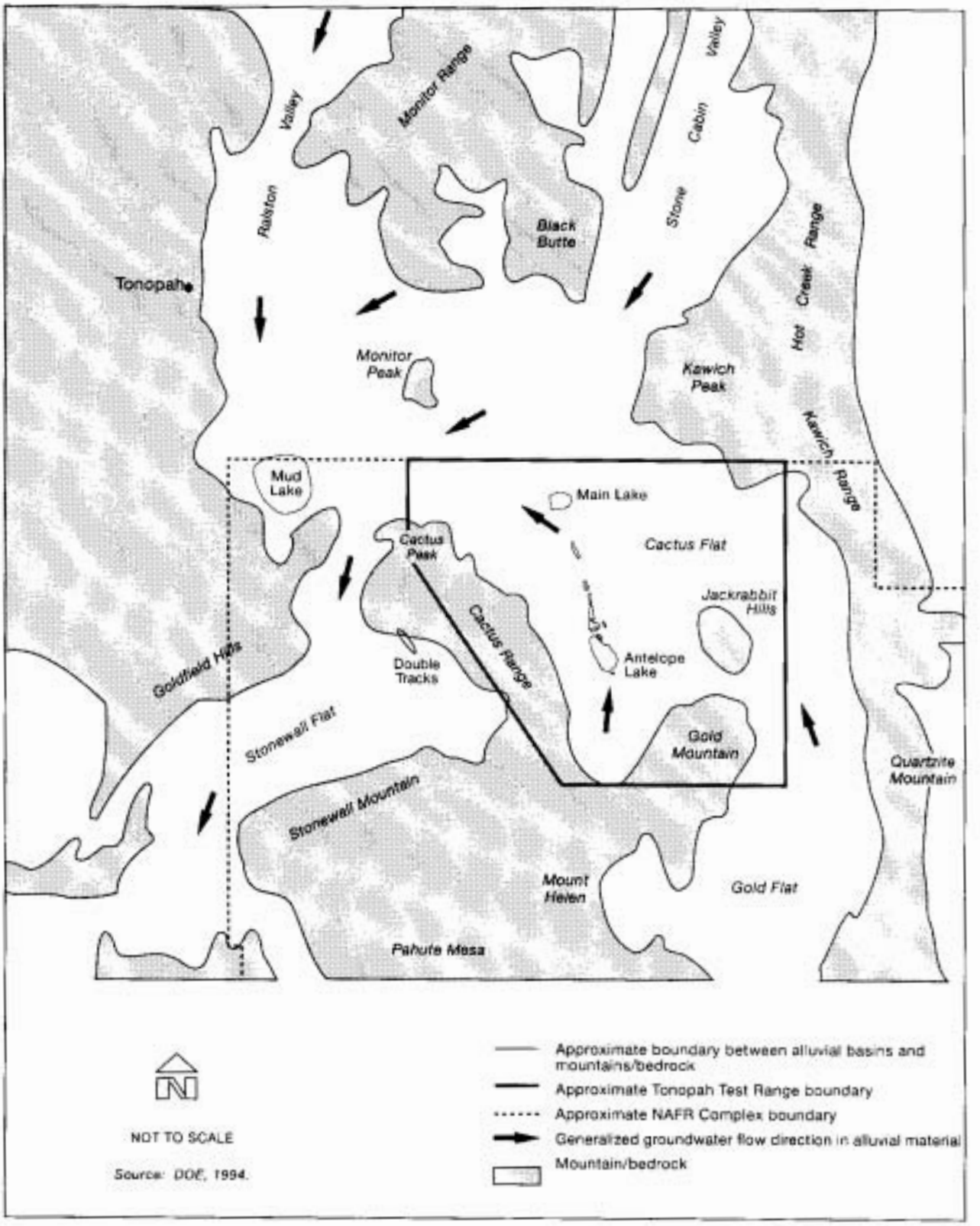


Figure 4-41b. Generalized alluvial material groundwater flow direction in the vicinity of the Tonopah Test Range

with clay predominating in the playa areas and in the gravels and sands under the alluvial fans. The permeability of these alluvial materials is quite variable with very low permeabilities associated with the fine-grained clays and silts, moderate permeabilities associated with poorly sorted mixtures and cemented or consolidated alluvium,and highest permeabilities occurring where the highest proportions of uncemented gravels and sands are located.

HYDROLOGIC/HYDRAULIC PROPERTIES—Transmissivity is defined as the rate at which groundwater flows through a unit width of an aquifer under a unit hydraulic gradient. Porosity is defined as the percentage of the volume of rock that is occupied by connected or isolated interstices (tiny open spaces). Estimated transmissivities and porosities for some of the principal hydrogeologic units are summarized in Table 4-25 (Winograd and Thordarson, 1975).

In general, water moves most rapidly through the fractured limestones and dolostones and less rapidly through valley-fill alluvium and fractured volcanic rocks; water moves most slowly through playa deposits, nonfractured volcanic rocks, quartzites, siltstones, and shales. In the limestones and dolostones, the relatively high transmissivities are associated primarily with fractures and dissolution features.

In the volcanic rocks, water movement occurs along bedding planes and cooling joints of lava-flow sheets and welded-flow units. In some locations, the overlying unaltered volcanic section is abundantly fractured and has retained its permeability. In the valley-fill deposits, transmissivity is dependent on the amount of clay and mineralization and on the degree of consolidation.

GROUNDWATER OCCURRENCE—Occurrences of groundwater are discussed in separate subsections for water levels and for groundwater flow and gradients.

Water Levels—The depth to the groundwater in wells at the NTS varies from about 79 m (260 ft) below land surface in the extreme northwest part of the NTS and about 160 m (525 ft) below land surface in portions of Frenchman Flat and Yucca Flat weapons test basin (Winograd and Thordarson, 1975) to more than 610 m (2,000 ft) under the upland portions of Pahute Mesa (Russell, 1994). Perched groundwater is known to occur in some parts of the NTS, mainly in the volcanic rocks of the Pahute Mesa area.

Groundwater Flow and Gradients—The present conceptual groundwater flow model for the Death Valley flow system is derived primarily from Winograd and Thordarson (1975) and updated by Waddell et al. (1984) and Laczniak et al. (1996). More recently, additional conceptual models of the system have been published by PAL Consultants (1995), Faunt (1994), and D'Agnese (1994). Groundwater flows generally south and southwest. The flow system extends from the water table to a depth that may exceed 1,494 m (4,900 ft) where the transmissivity of the rocks becomes much smaller (ERDA, 1977).

The rates of flow are quite variable, reflecting the types of aquifers present, the degree of fracturing and secondary dissolution of carbonate aquifers, and the hydraulic gradients that are present in a given area. In general, average flow rates over broad areas were estimated by Winograd and Thordarson (1975) to range from 2 to 201 meters per year (m/yr) (7 to 660 feet per year [ft/yr]), but rates can be much lower or much higher over short distances in certain geologic settings. Significant components of vertical groundwater flow are present in certain areas. For example, in the Frenchman Flat area, groundwater recharge derived from Indian Springs Valley on the east and the Yucca Flat weapons test basin on the north moves primarily downward into the underlying carbonate aquifers.

According to information provided by the U.S. Department of the Interior, flow rates may increase in the vicinity of Ash Meadows. The National Park Service is concerned that contaminant transport may be accelerated toward Devils Hole

and Ash Meadows. Because contaminants that remain in the underground testing areas are almost exclusively contained in the alluvial and volcanic aquifers, they must first migrate out of these aquifers and into the carbonates. Therefore, DOE's efforts to model these contaminants has concentrated on the rate of transport between the aquifers, currently thought to be significantly slower than in the carbonates. The DOE will continue to participate in cooperative investigations with the National Park Service concerning environmentally sensitive areas downgradient of the NTS.

WATER BALANCE—Within the Death Valley flow system, recharge occurs as underflow from upgradient areas and from infiltration of precipitation primarily in the northern and eastern mountain ranges, while discharge occurs primarily in the southern and western low-lying valleys. Discharge locations are controlled by the presence of low-permeability materials that force groundwater to the land surface or by the lower elevations of Death Valley.

Recharge—The groundwater underlying the NTS and surrounding areas is derived from two sources: underflow from basins upgradient of the area and from recharge over the upland areas within the NTS boundaries.

Cumulative underflow from adjacent areas is significant (see Figure 4-41a). Harrill et al. (1988) estimated underflow of 3.9×10^7 m^3 /yr (32,000 acre-feet/year) discharge from Indian Springs Valley westward into Frenchman Flat.

Table 4-25. Summary of hydraulic properties of major hydrogeologic units

Hydrogeologic Unit	Approximate Range of Transmissivities		Approximate Range of Porosities (%)
	m^2 per day	ft^2 per day	
Limestones and dolostones	0.11 to 10,996	1.2 to 118,360	1 to 12
Tuff confining units	0.0016 to 180	0.017 to 1,936	20 to 48
Lava flow aquifers	0.00021 to 5.0	0.002 to 54	32 to 45
Tuff aquifer (welded)	0.00024 to 2,299	0.0025 to 24,748	7 to 36
Tuff aquifer (bedded)	Not Available	Not Available	20 to 53
Valley-fill aquifer	0.0019 to 340	0.02 to 3,658	10 to 54

They estimated that the underflow of 6.2×10^6 m^3/yr (5,000 acre-feet/year) and 1.2×10^6 m^3/yr (1,000 acre-feet/year) is derived from Kawich Valley and Gold Flat, respectively. estimated that small to moderate volumes of water (0.1 to 7.4×10^6 m^3/yr [80 to 6,000 acre-feet/year]) may enter the carbonate aquifer in the Ash Meadows groundwater basin by underflow from the northeast. Thus, the total underflow onto the NTS is at least 4.7×10^7 m^3/yr (38,000 acre-feet/year), based on Harrill et al. (1988), and could be as high as 5.4×10^7 m^3/yr (44,000 acre-feet/year) if the inflow suggested by Winograd and Thordarson (1975) is considered.

Upland recharge occurs predominately by slow percolation of surface water through the unsaturated zone that overlies the water table. Most of this recharge is restricted to higher elevations where precipitation is greatest and along upland canyons and alluvial fans adjacent to upland areas. Recharge from upland areas of the NTS is far more limited, about 4.2×10^6 m^3/yr (3,400 acre-feet/year), one-tenth of that derived from underflow. Most of the recharge originates over the upland areas of Pahute Mesa, Timber Mountain, and the Belted Range.

Discharge—Most of the natural annual discharge from the Death Valley flow system is transpired by plants or evaporated from soil and playas in the Amargosa Desert and Death Valley. This discharge is estimated to be about 2.1×10^7 m^3/yr (17,000 acre-feet/year) from the Ash Meadows area and about 1.1×10^7 m^3/yr (9,000 acre-feet/year) from the Alkali Flat-Furnace Creek Ranch area (Rush, 1970). Less than 1×10^6 m^3/yr (a few hundred acre feet/year) may continue southward through alluvium of the Amargosa arroyos, and as much as 6.2×10^6 m^3/yr (5,000 acre-feet/year) yearly may flow westward from the Amargosa Desert to springs in Death Valley (ERDA, 1977).

Discharge at Ash Meadows and Oasis Valley is structurally controlled; the presence of low-permeability rocks retards regional flow. This geologic setting creates high water levels that result in local spring discharge and evapotranspiration. However, some water may flow into the Alkali Flat-Furnace Creek Ranch area and discharges at springs near Furnace Creek Ranch (Winograd and Thordarson, 1975).

Within the NTS, groundwater discharge is much smaller and is limited to a few springs in the upland areas and several wells. The springs discharge waters from perched zones in the upland areas. Discharge from the springs is small; three springs discharge between 8 and 30 liters per minute (L/min) (2 and 8 gal/min), while the rest discharge less than 4 L/min (1 gal/min) (DOE, 1988). The springs are important sources of water for wildlife, but they are too small to be of use as a water supply source. The chemistry of these springs is summarized in Tables 4-18, 4-19, and 4-21 in the surface hydrology section (4.1.5.1). Well pumping varies from year to year and ranges between 1.2 and 2.5 million m^3/yr (1,000 and 2,000 acre-feet/year) (Russell, 1994).

Discharge to springs and wells is small compared to the natural discharge of groundwater from the NTS through subsurface flow to Rock Valley and the Amargosa Desert, which totals an estimated 5.2×10^7 m^3/yr (42,000 acre-feet/year) (Harrill et al., 1988).

GROUNDWATER QUALITY—Groundwater quality within aquifers on the NTS is generally acceptable for drinking water and industrial and agricultural uses. According to EPA guidelines for groundwater classification, all hydrologic units that supply drinking water to the NTS are classified as Class II groundwater (Chapman, 1994). Class II refers to groundwater that is either currently being used as a source of drinking water or that could be a source of drinking water.

Recent updates in the interpretation of chemical analyses of groundwater collected at and near the NTS are discussed in Chapman and Lyles (1993). Table 4-26 presents a summary of water chemistry data for selected wells and compares the results to

Table 4-26. Summary of 1993 water chemistry data for select wells on the NTS

Well Name	Calcium (mg/L)[a]	Magnesium (mg/L)	Potassium (mg/L)	Sodium (mg/L)	Bicarbonate (mg/L)	Carbonate (mg/L)	Chloride (mg/L)	Fluoride (mg/L)	Nitrate (mg/L)	Sulfate (mg/L)	Alkalinity (mg/L)	Hardness[b] (mg/L)	pH (units/less)	Sp. Cond.[c] (µSi/cm)[d]	TDS[e] (mg/L)
Army Well 1	44	22	5	39	261	0	15	1.07	1.9	55	214	201	7.96	542	312
Well 5b	8	2	11	93	161	10	23	0.85	2.7	58	148	28	8.6	496	338
Well 5c	2	1	7	134	278	24	10	1.04	1.5	33	264	9	8.93	572	396
Well 4	24	8	5	48	149	7	12	0.8	6.8	42	134	93	8.26	401	288
Well 4a	22	6	6	55	159	5	9	0.81	NA	35	138	80	8.22	385	283
Well C	74	29	14	125	576	0	33	1.09	1.6	66	472	304	7.38	1,070	639
Well C1	73	28	13	121	578	0	34	1.14	0.6	66	474	298	7.47	1,070	639
Well 8	8	1	3	30	71	5	7	0.81	1.3	14	66	24	8.28	196	149
UE-16d	79	24	7	30	356	0	11	0.56	0.6	58	292	296	7.89	645	401
J-12	15	2	5	41	120	0	8	1.8	2	25	98	46	8.15	277	209
J-13	12	2	5	44	124	0	7	2.26	2.2	18	102	38	7.97	280	209
EPA[f] DWS	NS[g]	NS	NS	NS	NS	NS	250	2.0	10.0	250	NS	NS	6.5 to 8.5	NS	500

NOTE: The following elements are present in trace quantities below Safe Drinking Water Act limits: arsenic, boron, chromium, iron, manganese, selenium, silver, barium, cadmium, copper, lead, mercury, silica, and zinc.

NA=not applicable.

[a] Milligrams per liter = parts per million
[b] Hardness is expressed as calcium carbonate
[c] Specific conductivity
[d] Microsiemen per centimeter
[e] Total dissolved solids
[f] EPA Drinking Water Standards
[g] No standard exists.

Source: REECo, 1991.

the EPA Drinking Water Standards. Water chemistry varied from a sodium-potassium-bicarbonate type to a calcium-magnesium-carbonate type, depending on the mineralogical composition of the aquifer source.

Wells producing from the mesas (predominantly the volcanic aquifer system) yielded water containing between 150 and 200 milligrams per liter (mg/L) (parts per million [ppm]) of total dissolved solids. Ash Meadows groundwater produced higher values of total dissolved solids, ranging from 275 to 460 mg/L (275 to 460 ppm). Water from Wells C and C1 in the southern part of the Yucca Flat weapons test basin (Figure 4-42) had about 650 mg/L (650 ppm) of total dissolved solids that slightly exceed the primary recommended limit of 500 mg/L (500 ppm), but falls within the secondary limit of 1,000 mg/L (1,000 ppm) of total dissolved solids (EPA, 1992). Additionally, Wells 5B and 5C had pH values of 8.6 and 8.9, respectively, which slightly exceed the primary EPA drinking water standard for pH of 8.5. One well on the NTS produces water with fluoride concentrations that equal or exceed guidelines for continuous use (ERDA, 1977). Periodic groundwater monitoring for volatile organic compounds is performed at the NTS. Results from groundwater monitoring indicate that, except for one occurrence in 1992, no volatile organic compounds are present. In 1992, one volatile organic compound, 1,1,1,-trichloroethane, was detected in a sample collected from Area 6 Well 4a at a concentration of 2.1 μg/L (2.1 parts per billion), which was well below the drinking water standard of 200 mg/L (200 parts per million) Annual Site Environmental Report, 1991, (DOE/NV, 1992b). At that time, Well 4a had been recently developed and had not yet been connected to a distribution system. Samples for analysis from Well 4a were taken in May 1992. These analyses did not indicate the presence of volatile organic compounds, Annual Site Environmental Report, 1992, (DOE, 1993). Trends from recent analysis indicate no further presence of volatile organic compounds is expected to be detected in potable water wells (Annual Site Environmental Reports for years, (DOE/NV, 1992b, 1993, 1994a, and 1995b).

Much of what is known about radiologic sources in the groundwater and contaminant migration is derived from studies conducted by the Hydrologic Resources Management Program, and the Environmental Restoration Program. Monitoring programs are discussed in a later section and general findings of the other programs are discussed below.

RADIOLOGIC SOURCES IN GROUNDWATER—With respect to the current disposition of radioactivity at the NTS, it is important to note the difference between the total radionuclide source term and the hydrologic source term. The total radionuclide source term is considered as the total activity from all underground tests that were conducted beneath the water table or within 101 m (330 ft) of the top of the water table. Table 4-27 summarizes the isotopes and their remaining activities as of January 1, 1994. The total remaining inventory under, or within 101 m (330 ft) of, the water table is estimated to be 1.1×10^8 Ci (Benjamin, 1995). Of this quantity, an estimated 7.7×10^7 Ci is isolated on Pahute Mesa, and an estimated 3.5×10^7 Ci is isolated at the other testing areas, predominantly Yucca Flat and Frenchman Flat. These activities represent the remaining isotopes that could be available to the groundwater regime. There is considerable uncertainty concerning the actual quantity of this radioactivity that can enter the groundwater regime-- that is, the hydrologic source term. Most investigators have concluded that much of the radioactivity, exclusive of tritium, released during an underground detonation remains in the melt glass in the original cavity, especially the refractory isotope species, while the more volatile nuclides tend to condense on the chimney rubble. Refractory species include plutonium, rare earth elements, zirconium, and alkaline earth elements; the volatile species include alkali metals, ruthenium, uranium, antimony, tellurium, and iodine. The most mobile isotopes are the gaseous species, including argon, krypton, and xenon, which tend to rise through the chimney and may ultimately seep out to the surface.

The mechanisms by which radionuclides can enter the groundwater include leaching from the melt glass and condensation in the cavity and chimney; injection into fractures outside the cavity during the

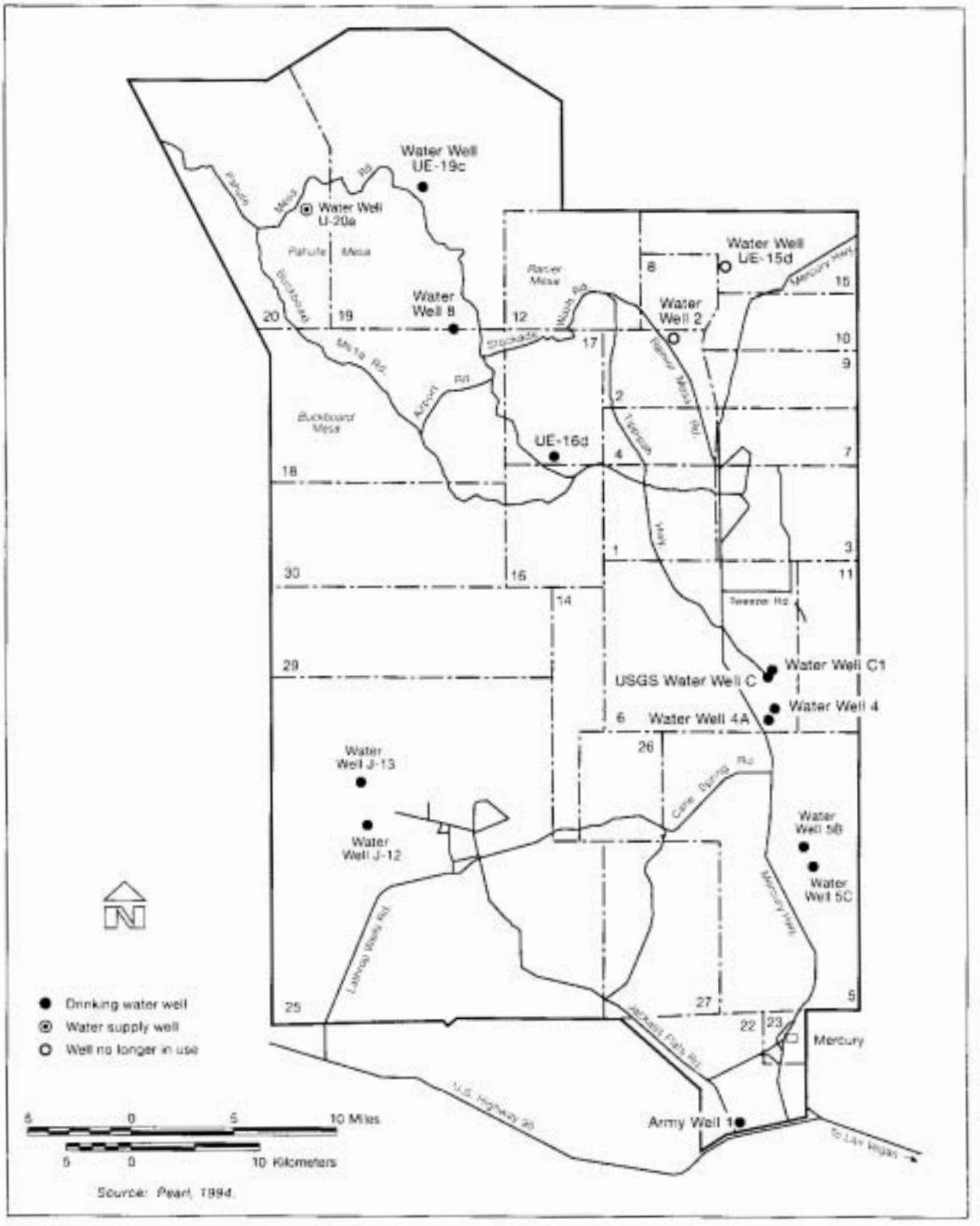


Figure 4-42. Groundwater quality sampling locations on the NTS

Table 4-27. Remaining isotope inventory under or within 100 m (330 ft) of the water table (Page 1 of 2)

Isotope	Curie Not On Pahute Mesa	Curie On Pahute Mesa
Hydrogen-3	3.07×10^{7}	6.99×10^{7}
Carbon-14	8.60×10^{2}	5.55×10^{2}
Aluminum-26	4.17×10^{-2}	8.94×10^{-2}
Chlorine-36	2.27×10^{2}	2.14×10^{2}
Argon-39	9.61×10^{2}	1.85×10^{3}
Krypton-40	2.47×10^{2}	4.69×10^{2}
Calcium-41	1.70×10^{1}	1.64×10^{1}
Nickel-59	4.23×10^{1}	3.99×10^{1}
Nickel-63	5.14×10^{3}	4.21×10^{3}
Krypton-85*	6.88×10^{2}	1.49×10^{3}
Krypton-85	5.40×10^{4}	9.54×10^{4}
Strontium-90	7.26×10^{5}	1.19×10^{6}
Strontium-90	8.93×10^{5}	1.84×10^{6}
Zirconium-93	2.63×10^{0}	4.17×10^{1}
Zirconium-93	3.11×10^{1}	6.17×10^{1}
Niobium-93m	6.35×10^{1}	7.59×10^{1}
Niobium-94 a	8.26×10^{-1}	1.44×10^{0}
Niobium-94g	1.95×10^{0}	1.73×10^{0}
Technetium-99	1.90×10^{2}	3.07×10^{2}
Technetium-99	2.23×10^{2}	4.32×10^{2}
Palladium-107	1.01	1.67
Palladium-107g	9.70×10^{-1}	1.57
Cadmium-113	6.17×10^{2}	1.38×10^{3}
Cadmium-113m	4.83×10^{2}	1.16×10^{3}
Tin-121*	2.42×10^{1}	5.14×10^{1}
Tin-121m	1.95×10^{1}	4.31×10^{1}
Tin-126	2.88×10^{1}	6.02×10^{1}
Tin-126	2.35×10^{1}	4.92×10^{1}
Iodine-129*	6.51×10^{-1}	1.29
Iodine-129	5.50×10^{-1}	9.45×10^{-1}
Cesium-135	2.32×10^{1}	4.47×10^{1}
Cesium-135g	2.00×10^{1}	3.17×10^{1}
Cesium-137*	1.09×10^{6}	2.15×10^{6}
Cesium-137	9.15×10^{5}	1.51×10^{6}
Samarium-151*	3.69×10^{4}	6.90×10^{4}
Samarium-151	3.23×10^{4}	5.71×10^{4}
Europium-150	8.86×10^{1}	1.11×10^{2}
Europium-152*	8.03×10^{-3}	1.90×10^{-1}
Europium-152	6.40×10^{4}	3.29×10^{4}
Europium-154	4.84×10^{4}	1.55×10^{4}
Holmium-166*	1.22×10^{-2}	1.88×10^{-2}
Holmium-166m	5.06×10^{1}	4.48×10^{1}
Thorium-232 Device	4.01×10^{-4}	5.84×10^{-2}
Thorium-232 Soil	1.77×10^{0}	3.38×10^{1}
Uranium-232	3.65×10^{2}	2.55×10^{2}
Uranium-233	1.50×10^{2}	1.71×10^{2}

Table 4-27. Remaining isotope inventory under or within 100 m (330 ft) of the water table (Page 2 of 2)

Isotope	Curie Not On Pahute Mesa	Curie On Pahute Mesa
Uranium-234 Device	1.41×10^{2}	1.23×10^{2}
Uranium-234 Soil	8.85	1.67×10^{1}
Uranium-235 Device	3.79	1.66
Uranium-235 Soil	4.15×10^{-1}	7.94×10^{-1}
Uranium-236	3.42	4.73
Uranium-238 Device	7.00	2.19
Uranium-238 Soil	8.83	1.67×10^{1}
Neptunium-237	1.10×10^{1}	3.65×10^{1}
Plutonium-238	1.18×10^{4}	7.16×10^{3}
Plutonium-239	2.88×10^{4}	1.93×10^{4}
Plutonium-240	7.42×10^{3}	6.20×10^{3}
Plutonium-241	1.03×10^{5}	9.00×10^{4}
Plutonium-242	4.52	3.36
Americium-241	6.83×10^{3}	4.67×10^{3}
Americium-243	3.42	1.79×10^{1}
Curium-244	2.35×10^{3}	2.97×10^{3}
Total Activity	3.27×10^{7}	7.30×10^{7}
Total Fission Products	2.09×10^{9}	4.21×10^{9}
Total Source Term	3.48×10^{7}	7.72×10^{7}
NTS Grand Total	**1.12×10^{8}**	

* Fission products.

first milliseconds after the test; and interactions between gaseous species and the groundwater.

The leaching of radionuclides from the rubble is probably an important pathway for tests that were conducted under the water table or in or under perched aquifers. Once detonation has occurred, the groundwater within the cavity area is vaporized and some portion of this vapor is forced by the shock wave out of the cavity and into the surrounding host rock. With time, groundwater gradually flows back into the cavity and chimney and comes into direct contact with the radionuclides that have condensed onto the chimney rubble. Depending on the solubility of the radionuclides, the groundwater dissolves the residues until chemical equilibrium has been achieved. Once dissolved, the radionuclides are available for migration through groundwater flow.

Leaching of radionuclides from the melt glass and cavity rubble probably has occurred to some degree. According to Borg et al. (1976), past studies have asserted that (1) less than 1 percent of the radionuclides in the melt glass near the bottom of the chimney will be sorted onto the chimney rubble and (2) most of the tritium will be mixed with the water in the chimney and cavity at times for about 1 year, and some tritium may be trapped in the melt glass. The leaching of radionuclides from the melt glass probably occurs over extended periods of time with the leachate available for transport through groundwater flow. The release of radionuclides through the leaching pathway continues to be an area of active research and, with time, a better understanding of the true hydrologic source term could be had.

Fracture injection provides the final pathway for the introduction of radionuclides into the hydrogeologic regime. Water vapor discharged from the cavity immediately following the detonation is seismically pumped into the fractures that are formed by the test and through other fractures that are opened by the shock wave. As discussed previously, the area over which this phenomenon occurs is believed to be

about 3 cavity radii from the cavity. Thus, for a cavity with a diameter of 610 m (2,000 ft), the injection of radionuclides into rock fractures is expected to occur outward to a distance of 914 m (3,000 ft) from the cavity. Following the achievement of equilibrium conditions, radionuclides that have been injected into fractures under the water table are available for transport through groundwater flow.

As noted in the preceding discussion, tritium is one of the most mobile of the radionuclides present in the subsurface environment surrounding an underground nuclear test. It is also present at higher concentrations than other radionuclides for a period of 100 to 200 years following a test, and is generally believed to be present principally as part of a free water molecule rather than being bound in the puddle glass that contains the large majority of the radionuclides remaining after a test. Tritium is known to migrate when induced by nearby pumping, while many other radionuclides remain in or near the cavity (Bryant, 1992). Therefore, tritium represents the radionuclide of greatest concern to users of groundwater for at least the next 100 years because of its mobility and high concentration. It is for these reasons that, in assessing the impacts from the groundwater pathway, tritium is the radionuclide used in the modeling processes discussed in later chapters of the EIS. Other radionuclides either do not move as rapidly and are not a consequence in the assessments, or are of much lower concentrations.

About a dozen instances of migration of radionuclides other than tritium have been documented (Nimz and Thompson, 1992). The largest distance of migration does not exceed 500 meters (1,640 ft). Migration of tritium is more difficult to interpret, but is thought to have migrated no more than several kilometers.

As noted by Borg et al. (1976), the analysis of water samples for specific isotopes at random sites on the NTS is complicated and "it is possible that only relative or quantitative conclusions could ever be made from such data. Such conclusions, nonetheless, may be important." In recent years, the drilling of new characterization wells and the retrofitting of existing boreholes and wells by the Environmental Restoration Program have provided valuable new data that are now being integrated into the overall database so that new evaluations can be made. These studies and planned future studies covered by this EIS will help to reduce the current levels of uncertainty concerning both the mechanisms and consequences of radionuclide transport via groundwater flow at the NTS. The other pathway by which radionuclides are known to have migrated from the cavity and chimney is the air pathway.

While radionuclides that remain in the environment are of the most significance, there are also other materials that are used in testing that may be available for groundwater transport. Table 4-28 lists the materials that are introduced into the subsurface as part of the actual testing and during post-detonation drillback operations. The nonradioactive species include numerous metals, organic compounds, and drilling products. Following the detonation, most of the metals are either vaporized or undergo neutron activation and are accounted for in the radionuclide inventory. The fate of the organic compounds and drilling fluids is not fully understood. No estimates are available concerning the total quantity of these materials that may still remain in the subsurface at the NTS.

From a regional perspective, the distribution of the radionuclide source term can be determined by the location of underground tests. In other words, a traditional "plume map" can be approximated by the map of underground tests on Plate 2, Volume 2. Only one of those tests, Corduroy, in Yucca Flat, was conducted in the carbonate aquifer. The remainder were conducted in the alluvial or volcanic aquifers. Within the areas of testing significant quantities of clean water remain because of the limited migration of radionuclides in the groundwater.

WATER SUPPLY—There are physical, environmental, legal, and administrative limitations on the availability of the water resources from the NTS and surrounding regions for development of water supplies.

The physical limitations are due to the water-yielding properties of the aquifers present. In

Table 4-28. Materials used in underground nuclear testing

Fuels, Detectors, Tracers	Rack and Canister Materials	Organic Compounds	Drilling and Stemming Materials
Americium[a]	Aluminum	Alcohol	Bentonite
Curium[a]	Arsenic	Anionic Polyacrylamide	Cement
Neptunium	Barite	Coal-Tar Epoxy	Gel
Plutonium	Beryllium[d]	Complex Fluorescing Compounds[b]	Gravel
Tritium	Boron	Galacto-Mannans ($C_6H_{10}O_5$)$_n$	Modified Starch
Uranium	Cadmium	Lases Dyes[c]	Neoprene®
Lithium	Chrome Lignosulfate	Liquid Anionic Polyelectrolyte	Polyethylene
Yttrium[a]	Chromium	Paraformaldehyde	Pregelatinized Starch
Zirconium[a]	Copper	Phenolic	Sand
Thallium	Gold	Polystyrene	Sepiolite
Lutetium[a]	Iron	Polyvinyl Chloride	Soda Ash
	Lead[d]	Two-Part Epoxy	Sodium Montmorillonite
	Lithium		Surfactant TF Foamer
	Magnetite[e]		Teflon™
	Nickel[a]		
	Osmium		
	Potassium Chloride		
	Sodium Hydroxide		
	Tantalum		
	Thallium		
	Tungsten		
	Zinc[a]		

[a] Less than 100 grams (3 ounces) typically used
[b] Fluorescing compounds and laser dyes used in some detector packages may contain potentially hazardous organic constituents
[c] Contains theophylline, ethylenediamine, carbonic acid disodium salt
[d] Extensive quantities of lead (57.2 metric tonnes) are typically used as shielding material for device canisters and racks
[e] Magnetite is naturally occurring Fe_3O_4 containing thorium and other heavy rare earths.

Source: Bryant and Fabrika-Martin, 1991.

general, well yields are poorest in volcanic rocks of Pahute Mesa and in the fine-grained playa sediments of Emigrant Valley and Cactus, Yucca, and Frenchman Flats.

Well yields are moderate to high in the fractured volcanic rocks of the southwest part of the NTS, in the fractured carbonate rocks that underlie the eastern part of the facility, and from the alluvium where adequate saturated thicknesses are present. The production capacities of the existing watersupply wells range from about 644 to 2,650 L/min (170 to 700 gal/min) with a total capacity of about 11,356 L/min (3,000 gal/min) or about 6.0 x 10^6 m^3/yr (4,840 acre-feet/year).

Beyond the physical availability of the water, there are water chemistry limitations that render portions of the NTS unsuitable for groundwater development. As discussed in the previous section, more than 230 nuclear tests have been conducted below or in close proximity to the water table (Bryant and Fabrika- Martin, 1991). These tests have resulted in contamination of the near test environment with radionuclides (Borg et al., 1976), and localized contamination of groundwater has occurred as a result of some tests (Nimz and Thompson, 1992). Because of these underground tests, much of Yucca Flat, portions of Frenchman Flat, and portions of Pahute Mesa may require restrictions to additional groundwater development.

There are sensitive environments downgradient of the NTS, including Death Valley, Devils Hole, and the wetland environment at Ash Meadows. A number of federal and state laws prohibit the development of water supplies that would adversely impact these environments (Dudley and Larson, 1976).

As part of their groundwater investigations being conducted through the Environmental Restoration Program, the DOE is developing regional groundwater flow and tritium transport models that include the NTS and the Ash Meadows area. These models will be of use in evaluating the effects of past DOE actions and future DOE groundwater withdrawals on the NTS. The DOE is also working with the National Park Service in evaluating observed water level fluctuations at Devils Hole.

Water-resource use in support of the primary missions of the NTS is not subject to state water appropriation laws. The NTS, under the Federal Reserve Water Rights doctrine, is entitled to withdraw the quantity of water necessary to support the NTS missions. Water used for other actions that are determined to be outside the mission will require the appropriation of the water in accordance with Nevada's water law. Presently, the water resources of the Alkali Flat-Furnace Creek Ranch basin are fully appropriated, and it may not be legally possible to develop or use water in the western part of the NTS for purposes beyond the missions of the facility. Unappropriated groundwater is available in the Ash Meadows basin and is subject to the rights of the senior water rights holders.

Administrative limitations on the groundwater resources are primarily related to ongoing tests and activities. Extensive site characterization activities are in progress by both the Environmental Restoration Program and Yucca Mountain Projects, and experiments are being conducted by the Hydrologic Resources Management Program.

A considerable quantity of groundwater is in storage in the sediments and rocks underlying the NTS and surrounding regions. An estimated 2.7×10^{9} m³ (2.2×10^{6} acre-feet) of groundwater are held in storage in the upper 30 m (100 ft) of the saturated zone in the Yucca Flat basin, Frenchman Flat, Mercury and Rock Valleys, and Fortymile Canyon (Scott et al., 1971). With certain limitations, this groundwater is an available resource for development of water supplies at the NTS. Well water is produced from the upper carbonate, volcanic tuff, and valley-fill aquifers.

WATER USE—Historically, domestic, industrial, and construction water supplies were provided by 15 water wells dispersed across the NTS, as shown in Figure 4-5. In the past several years as nuclear testing activities declined and the demand for water decreased accordingly, the total number of water wells supporting NTS operations has decreased to 12; a list of active water wells on the NTS is given in Table 4-29. Drinking water on the NTS is currently provided by 11 wells and is supplemented by bottled water in remote areas. Construction and fire-control water are supplied by other wells in addition to the potable water supply wells. Springs and seeps are not used for water-supply purposes.

Groundwater is used by small communities and scattered population areas. The communities of Indian Springs and Beatty used approximately 8.0×10^{5} m³ (660 acre feet) and 5.0×10^{5} m³ (390 acre feet) of groundwater, respectively, for potable, industrial/commercial, and agricultural purposes in 1992 (Wood, 1994). The Saint Joe Bullfrog Mine, located west of Beatty, used approximately 2.0×10^{6} m³ (1,640 acre feet) of groundwater in 1992 for potable and operation supply needs. In scattered population areas, groundwater usage was estimated for 1992 by areas as follows: Amargosa Valley, 8.0×10^{6} m³ (6,500 acre feet); Pahranagat Valley, 6.3×10^{6} m³ (5,100 acre feet); Penoyer Valley, 1.5×10^{7} m³ (12,300 acre feet); and Three Lakes Valley, 4.0×10^{5} m³ (350 acre feet) (Wood, 1994). Near Ash Meadows, groundwater usage is limited because of impacts on water levels in Devils Hole. The Devils Hole pupfish, an endangered species, relies on maintenance of the existing water level provided by spring flow for its continued existence (Dudley and Larson, 1976) (Section 4.1.6, Biological Resources). In addition, the U.S. Supreme Court has ruled that maintenance of water levels in Devils Hole has precedence over water uses for other purposes in the area. A study for the Las Vegas Valley Water District (Avon and Durbin, 1994) found no statistical correlation between water usage on the NTS and water levels in Devils Hole.

Preliminary groundwater modeling was performed as part of this EIS, and additional, detailed modeling is underway. As part of the groundwater investigations being conducted through the

Table 4-29. Summary of 1993 water well and discharge information for the NTS

Well Name	Aquifer	Depth		Static Water Level (depth)		Pump Setting (depth)		Yield		[a]Annual Pumpage (Mm^{3} [b])	Annual Pumpage ac-ft
		m	ft	m	ft	m	ft	m /min	yd^3/min		
Army Well 1	Carbonate	593.14	1,945	210.31	690	289.86	951	2.01	2.6	0.4178	338.7
Well 5c	Alluvial	361.80	1,187	211.23	693	238.96	784	1.23	1.6	0.2393	194
Well 5b	Alluvial	274.32	900	208.48	684			1.02	1.3	0.1126	91.31
Well 4	Volcanic	450.80	1,479	286.82	941	387.40	1,271	2.46	3.2	0.2856	231.51
Well 4a	Volcanic									0.4172	338.22
Well C	Carbonate	518.46	1,701	470.61	1,544	473.35	1,553	1.02	1.3	0.2390	193.78
Well C1	Carbonate	520.29	1,707	471.83	1,594	484.94	1,591	1.06	1.4	0.0357	28.95
Well 8	Volcanic	1,673.35	5,490	327.05	1,073	374.29	1,228	1.51	1.9	0.1185	96.11
UE-16D	Carbonate	914.40	3,000	230.12	755	330.10	1,083	0.73	.94	0.1813	146.95
J-12	Volcanic	347.17	1,139	225.25	739	250.55	822	3.09	4.0	0.0945	76.64
J-13	Volcanic	1,063.14	3,487	283.16	929	350.82	1,151	2.57	3.4	0.1584	128.38
UE-5c[c]	Alluvial									0.0278	22.52
UE-19c[d]	Volcanic									0.0269	21.79
U-20a[c]	Volcanic									0.1058	85.80
									Total Usage	**2.4606**	**1994.66**

[a] Well yields calculated from controlled pump tests are typically within one order of magnitude of driller's estimates.
[b] Million cubic meters
[c] Construction water well
[d] No longer in use.

Environmental Restoration Program, the DOE is developing regional groundwater flow and tritium transport models that include the NTS and these environmentally sensitive areas. These models will be of use in evaluating the effects of past DOE actions and future DOE groundwater withdrawals on the NTS. The results of these models are not yet available, but they will be available for future National Environmental Policy Act reviews prior to the construction of projects that are expected to result in significant adverse impacts. The DOE is also working with the National Park Service in evaluating observed water level fluctuations at Devils Hole.

The National Park Service continues to implement projects, collect data, support research, and conduct studies to investigate the probable cause of the decline of the Devils Hole pool level.

MONITORING PROGRAMS—On-site water wells and select off-site wells are monitored in accordance with the Safe Drinking Water Act and the Nevada Administrative Code regulations (REECo, 1991). Concurrently, the DOE monitors on-site wells and select off-site wells for specific radionuclides (not related to Safe Drinking Water Act requirements) (DOE/NV, 1993). Additionally, the state of Nevada performs independent monitoring. Analytical results for all monitoring activities are published in Annual Site Environmental Reports.

The following is a brief description of the six existing NTS groundwater monitoring programs:

- Environmental Surveillance Program - Radiological and nonradiological monitoring for Safe Drinking Water Act and DOE Order 5400.1 compliance

- U. S. Geological Survey Water-Level Monitoring Program - Monitoring for DOE Order 5400.1 compliance

- EPA Long-Term Hydrologic Monitoring Program - Radiological monitoring of nonwater supply wells and DOE Order 5400.1 compliance

- Radioactive Waste Management Site Assessment Program - Monitoring for Areas 3 and 5 Resource Conservation Recovery Act Part B permit

- Underground Test Area Corrective Action Unit Monitoring Program - Monitoring of far-field and near-field wells for specific groundwater quality parameters

- Hydrologic Resources Management Program - Monitoring in support of the investigation of the effects of underground testing on the hydrogeology, hydrochemistry, and radiochemistry of the NTS.

Under the Hydrologic Resources Management Program, the DOE has sponsored research by the Desert Research Institute, the U.S. Geological Survey, and the National Laboratories to help understand the groundwater flow directions and velocities and the mechanisms of radionuclide migration. Research under this program has included the development of chemical and isotopic models, a detailed evaluation of the hydrology of Yucca Flat, recharge and runoff studies, exploratory drilling and aquifer testing, shot-specific investigations, and radionuclide distribution studies.

As discussed previously, evidence for the transport of radionuclides produced by underground nuclear testing is scarce. The approximate areas of underground contamination, including the groundwater and vadose zones, have been estimated. Most available information is derived from borings drilled in support of underground testing rather than for investigating radionuclide transport. Nimz and Thompson (1992) summarized data collected as part of the Hydrology and Radionuclide Migration Program, the program's predecessors, and other agencies. Five cases were documented in borings as evidence of prompt injection of radionuclides into rock surrounding nearby cavities (a mechanism that does not involve transport in groundwater).

Nimz and Thompson (1992) reported five cases where radionuclide transport occurred in groundwater, and recent drilling for the Environmental Restoration Program has detected three more. However, one of the cases involved pumping for

over 16 years to induce migration. Present studies are aimed at determining the nature and extent of the migration of contaminants. Other data suggest that U.S. Geological Survey Water Well A, UE-15d Water Well, and Test Well B Exploration Hole have produced low activities of approximately 100 to 150 pCi/L (Lyles, 1993), but levels have since dropped significantly.

The DOE sponsors several monitoring efforts by NTS contractors, the U.S. Geological Survey, and the EPA on and around the NTS. The objectives of the monitoring include detection of radionuclide migration from underground nuclear tests, assurance of the water supply network on the NTS, compliance with waste disposal permits, determination of aquifer characteristics, and research into the mechanisms of radionuclide migration. The types of monitoring currently underway include the following:

Water Supply—Water supply wells on the NTS are monitored in accordance with the Safe Drinking Water Act and the Nevada Administrative Code regulations (REECo, 1991) by the DOE and, independently, the state of Nevada. In addition, offsite municipal and private water supply wells are monitored as a courtesy to assure that no radionuclides related to underground testing are present.

Ambient Water Quality—Approximately 30 monitoring wells and 10 springs are sampled on and around the NTS to detect the presence of radionuclides. These wells serve to establish the quality of water in and around the NTS. No test-related contamination has been detected offsite, and contamination onsite is limited to the extent described above.

Radioactive Waste Management—Three groundwater monitoring wells are located at the Area 5 Radioactive Waste Management Site as part of the Resource Conservation and Recovery Act compliance requirements. No contamination has been detected.

Characterization and Research—Approximately 50 wells are presently in use to characterize groundwater conditions regionally or near underground nuclear tests. These wells are part of the Underground Test Area project and the Hydrologic Resources Management Program. Some are monitored on a regular basis, and many of these wells may be incorporated into the long-term monitoring network in the future.

Water Level—Approximately 70 wells are monitored to determine the level of the groundwater surface on and around the NTS. This information is used to help determine the effects of water usage on water quantity, for groundwater flow modeling, and to predict the occurrence of water in new wells and emplacement holes.

4.1.6 Biological Resources

The NTS is located along the transition zone between the Mojave Desert and Great Basin (Beatley, 1975, 1976). As a result, this site has a diverse and complex mosaic of plant and animal communities representative of both deserts, as well as some communities common only in the transition zone between these deserts. This transition zone extends to the east and west far beyond the boundaries of the NTS. Thus, the range of almost all species found on the NTS also extends far beyond the site, and there are few rare or endemic species found there (Table 4-30 and Appendix E).

Elevation is the most obvious factor affecting the distribution of plant and animal communities on the NTS and surrounding areas. Elevations increase from south to north, from a low of 819 m (2,688 ft) in Jackass Flats to a high of 2,341 m (7,679 ft) on Rainier Mesa (O'Farrell and Emery, 1976). Climate differences associated with this increase in elevation cause a change from Mojave Desert communities in the south to Great Basin communities in the north (Beatley, 1975).

The diversity of biological communities in this region is also influenced by topography. The valleys in the southern and western parts of the NTS (e.g., Jackass Flats, Rock Valley, and Mercury Valley) have drainage outlets. In contrast, the two large valleys on the eastern side of the NTS (Frenchman Flat and the Yucca Flat weapons test basin) and Emigrant Valley to the northeast (where Area 13 is located), are closed basins. The lack of

Table 4-30. Species listed as endangered, threatened, or candidates under the Endangered Species Act that may be found in the areas addressed under the NTS, Tonopah Test Range, Central Nevada Test Area, Project Shoal Area, Dry Lake Valley, Eldorado Valley, and Coyote Spring Valley[a]

	NTS[b]	TTR[c]	CNTA	PSA	DLV	EV	CSV
Endangered							
falcon, peregrine[d]	✓	✓	✓	✓			
Threatened							
tortoise, desert[e]	✓				✓		✓
eagle, bald[d]	✓	✓	✓	✓			✓
Candidates - Category 1[f]							
milkvetch, Beatley[g]	✓						
Candidates - Category 2[h]							
Plants							
Eggvetch, Clokey's	✓						
Cholla, Blue Diamond	✓						
Birds							
Plover, mountain	✓						

[a] Compiled from the following sources: Bradley and Moor, 1975; Beatley, 1976, 1977a,b; O'Farrell and Emery, 1976; Rhoads and Williams, 1977; Rhoads et al., 1978, 1979a,b; Castetter and Hill, 1979; Clark County, 1990; Medica, 1990; Medica et al., 1990; Mendoza, 1995; 50 CFR Part 17, 1993; DOI, 1992; Cooper, 1993; EG&G/EM, 1993a, b, and c, in prep; Harlow, 1994a; NAC, 1994.
[b] Includes Area 13
[c] Tonopah Test Range includes Double Tracks test area
[d] Animal species listed by the State of Nevada as endangered
[e] Animal species listed by the State of Nevada as threatened
[f] Taxa for which the U.S. Fish and Wildlife Service has sufficient biological information to support a proposal to list as endangered or threatened
[g] Plant species listed by the state of Nevada as "threatened with extinction" and "fully protected"
[h] Taxa that may warrant listing, but for which substantial biological information to support a proposal is lacking.

surface water drainage and cold air drainage out of these closed basins has created soil conditions, temperatures, and biotic communities that differ from those found at similar elevations in the open basins (Beatley, 1975 and 1976).

The North Las Vegas Facility is in the Southern Basin and Range Ecoregion. It was built on cleared, previously disturbed land that is now mostly covered by buildings, pavement, or landscaping. Exceptions include about 11 acres of undeveloped land at the western end of the North Las Vegas Facility (the designated area for proposed new construction associated with the National Ignition Facility), an open area, and a stormwater detention basin. No original undisturbed native vegetation remains on the site.

Few wildlife species exist at the North Las Vegas Facility because it is located in an urbanized area and contains little vegetation. The only species that exists are those adapted to urban habitats which may include small mammals such as house mouse (*Mus musculus*) and Norway rat (*Rattus norvegicus*); and ubiquitous bird species such as American robin (*Turdus migratorius*), European starling (*Sturnus vulgaris*), house finch (*Carpodacus mexicanus*), house sparrow (*Passer domesticus*), and rock dove (*Columba livia*).

FLORA—The following descriptions of vegetation are taken from Beatley (1976) and O'Farrell and Emery (1976), unless otherwise stated. The flora of the NTS has been studied extensively; over 700 plant taxa in at least 67 families have been

found. One-third of these plant taxa are in three families: *Asteraceae* (sunflowers), *Poaceae* (grasses), and *Polygonaceae* (buckwheats). The scientific names of all plants mentioned in this section are presented in Appendix E.

Mojave Desert plant communities are found at elevations below approximately 1,219 m (4,000 ft) on the alluvial fans and valley bottoms of Jackass Flats, Rock Valley, and Mercury Valley, and on the alluvial fans of Frenchman Flat. Creosote bush is the visually dominant shrub, and it is associated with a variety of other shrubs, depending on soil type and elevation. Shadscale is codominant with creosote bush on most alluvial fans where desert pavement is well defined. On deep, loose soil, such as exists on southern Jackass Flats and northeastern Frenchman Flat, creosote bush is codominant with white bursage and is associated with species such as winterfat and Indian ricegrass. Range ratany, Nevada ephedra, and Fremont indigo bush are common in both communities. At roughly 1,067 to 1,219 m (3,500 to 4,000 ft) along the northern and eastern slopes of Jackass Flats and the western half of Frenchman Flat, creosote bush grows with hopsage and wolfberry.

Two plant communities are unique to the transition between the Mojave Desert and Great Basin Desert. The first is best developed at elevations from 1,219 to 1,524 m (4,000 to 5,000 ft) on alluvial fans and valley bottoms in the middle third of the NTS. The dominant shrub in this community is blackbrush, which occurs in mixed stands with creosote bush on the northern alluvial fans of Jackass and Frenchman Flats below about 1,372 m (4,500 ft). At higher elevations (e.g., in the bottom of Tonopah and Mid Valleys and on the western slopes of the Yucca Flat weapons test basin), blackbrush occurs in large, nearly monotypic stands. The second unique transition community occurs in the bottom of the enclosed Frenchman and Yucca Flat weapons test basins, where the trapped winter air is too cold for typical Mojave Desert plants (Beatley, 1974 and 1975). The most abundant shrubs in these areas are hopsage and three species of wolfberry. Winterfat also is common in silty soils. Shadscale, four-winged saltbush, and horsebrush also can be found in certain regions of enclosed basins. Little or no vegetation grows on the playas in these basins.

Plant communities typical of the desert that lie in the Great Basin occur at elevations generally above 1,524 m (5,000 ft) in the northern third of the NTS and in Area 13. Most of the basin floor is covered with shadscale, and winterfat is also common. On deep, loose soils at middle elevations (1,372 to 1,686 m [4,500 to 5,500 ft]), the plant community is dominated by four-winged saltbush. Sagebrush begins to appear at 1,524 m (5,000 ft) and is the dominant plant on large parts of Pahute Mesa and Rainier Mesa, as well as elsewhere in the northwest part of the NTS. Big sagebrush is the most abundant shrub on sites with deep soils in this area, and black sagebrush is most abundant on the shallow soils of slopes and uplands. Pinyon pine and Utah juniper are codominant with sagebrush above 1,829 m (6,000 ft), and form an open shrub-woodland.

Sites on the NTS with vegetation or soil modified by nuclear test activities, construction, or other disturbances usually have plant communities that are different from adjacent undisturbed areas. Some of the species that colonize disturbed areas (e.g., cheesebush and punctate rabbitbrush) are native plants that usually occur in washes. However, most species found on disturbed sites are ephemeral, introduced plants such as red brome, cheatgrass, Russian thistle, and red-stemmed filaree (Hunter, 1992a). Natural succession of disturbed areas on the NTS is generally a slow process. Studies of natural succession in the Mojave Desert have shown that several decades, or even centuries, may be required to establish similar plant cover and productivity (Webb and Wilshire, 1980; Angerer et al., 1994). Because of the increased and more consistent precipitation, succession rates in the Great Basin Desert are generally much quicker than those in the Mojave Desert. Active revegetation of sites can greatly enhance secondary succession. Studies have been conducted on the NTS and other sites in the arid southwestern United States to assess and improve revegetation techniques for arid environments (Wallace, 1980; EG&G/EM, 1995b; Schaller and Sutton, 1978; Allen, 1988). Variables that have been determined to be important in revegetation success are: adequate moisture during seed germination and establishment; favorable soil conditions including depth, texture, fertility, and reduced compaction; and species adapted or native

to the site. Reclamation trials at Yucca Mountain and at NTS and Tonopah Test Range sites have shown that revegetation of disturbed areas is practical and that equivalent density and cover of vegetation can be accomplished much quicker (3-10 years) than through natural succession (EG&G/EM, 1995b).

Soils on the NTS and Area 13 that were contaminated during safety shots and are to be cleaned as part of the Soils Media Corrective Action Unit of the Environmental Restoration Program were only slightly disturbed. Therefore, the biological communities on those sites are generally similar to adjacent, undisturbed sites (Moor and Bradley, 1974; Rhoads, 1974; Hunter, 1994a).

The only biological communities on and around the NTS that are not widespread are those associated with springs or other permanent sources of water. There are at least 10 springs and 23 manmade impoundments on the NTS (Greger and Romney, 1994b). Most natural springs are on the mesas and mountains in the northern part of the NTS (Figure 4-40); most reservoirs are scattered through the valley bottom to the east and south. There are no springs in the valley bottom areas. Groundwater under the NTS flows primarily to the south and west and discharges from springs in Ash Meadows, Oasis Valley, and Death Valley (see Section 4.1.5, Hydrology). Most of the springs at the NTS support wetland (hydrophytic) vegetation, such as cattail, sedges, and rushes which likely constitute wetlands as defined by the U.S. Army Corps of Engineers pursuant to Section 4.04 of the Clean Water Act. Because there have been no plans to negatively affect these water sources, studies to characterize them and determine their potential as "jurisdictional wetlands" were deferred until the summer of 1996.

FAUNA—Over 1,000 species of arthropods have been identified on the NTS, but this probably represents a small fraction of the arthropod species present (O'Farrell and Emery, 1976). About 80 percent of these species are insects; ants, termites, and darkling beetles are the most common insect taxa.

Vertebrate species have been studied much more thoroughly. Approximately 279 vertebrate species have been observed on the NTS, including 54 species of mammals, 190 species of birds, 33 species of reptiles, and 2 species of introduced fishes (O'Farrell and Emery, 1976; Castetter and Hill, 1979; Medica, 1990; Medica et al., 1990; EG&G/EM, 1993c). Eighty-six percent of the bird species on the NTS are transients (O'Farrell and Emery, 1976). The scientific names of all animals in this section are presented in Appendix E.

Many of the predators and scavengers in this region are everywhere throughout the area. These include coyotes, bobcats, common ravens, red-tailed hawks, loggerhead shrikes, speckled rattlesnakes, and gopher snakes. Other common species are the long-tailed pocket mouse, desert woodrat, white-tailed antelope squirrel, black-tailed jackrabbit, black-throated sparrow, horned lark, Say's phoebe, western kingbird, side-blotched lizard, and desert horned lizard.

Many animal species on the NTS are common only in the Mojave Desert habitats to the south or the Great Basin Desert habitats to the north. Typical Mojave Desert species found on the NTS include kit fox, Merriam's kangaroo rat, desert tortoise, chuckwalla, western shovelnose snake, and sidewinder snake. Typical Great Basin species in this region include cliff chipmunk, Great Basin pocket mouse, mule deer, northern flicker, scrub jay, Brewer's sparrow, western fence lizard, and striped whipsnake. About 60 wild horses live on the northern part of the NTS, usually on or near Rainier Mesa (Greger, 1994).

Some animal species on the NTS are typically found only in restricted habitats. Desert kangaroo rats are associated with loose, sandy soils at lower elevations. Dark kangaroo mice are restricted to fine, gravel-like soils at higher elevations. Chuckwallas occur primarily in rocky outcrops. Desert night lizards are usually found in stands of yuccas. Many of the birds on the NTS, including almost all of the waterfowl and shorebirds, use the playas in Frenchman and Yucca Flat weapons test basin, artificial ponds at springs, and sewage lagoons during their migration and/or during winter (Hayward et al., 1963). Bats often seek food over these water sources. Wild horses occur in the northern half of the NTS and their distribution may

be related to the location of man-made ponds. Camp 17 pond, in the northwest corner of Area 18, and Well 2 pond, in the northeast corner of Area 2, are heavily used by horses. During field surveys conducted in the summer and fall of 1995, a total of 52 horses were observed, and an estimated 35 horses appeared to consistently use the Camp 17 pond and 17 horses consistently used the Well 2 pond (EG&G/EM, 1995a). Deer most likely use these ponds as well.

As described in Section 4.1.5.1, surface runoff periodically ponds on the playas in Yucca and Frenchman flats. The length of time that water remains on playas, and the extent to which playas are used by migratory shorebirds are not routinely monitored. However, water has been observed on the playas for periods of days to months following rainstorms. Occasionally, migratory shorebirds have been observed if the playas have water on them during the spring or fall migratory season. If radionuclides and other contaminants were in these ephemeral ponds, migratory birds could be exposed to them. Because of the episodic nature, the short duration of ponding on playas, and the relatively small numbers of birds that visit during the migratory seasons, the hypothetical exposures would be infrequent and brief.

Several species of State-designated game animals occur in this region, including 1,500 to 2,000 mule deer (Giles and Cooper, 1985) and an unknown number of mountain lions, desert and Nuttall's cottontails, chukar, Gambel's quail, mourning dove, and several species of waterfowl. Bighorn sheep and pronghorns inhabit surrounding areas and may on occasion stray onto the NTS (O'Farrell and Emery, 1976). Bobcats and kit foxes are the only State-designated fur-bearing animals on the NTS. Bighorn sheep are hunted on the NAFR Complex. No other hunting or trapping is allowed on the NTS or the NAFR Complex.

ENDANGERED AND THREATENED SPECIES—Only one animal species listed as endangered, the peregrine falcon, has been reported on the NTS. The bald eagle (down-listed in 1995 from an endangered to a threatened species) has also been reported on the NTS. Both of these birds are rare migrants in this region and have been sighted on the NTS only once (Castetter and Hill, 1979; Greger and Romney, 1994a). The state of Nevada lists these two species as endangered (Table 4-30).

The only other animal species found on the NTS which is listed by the U.S. Fish and Wildlife Service as threatened is the Mojave Desert population of the desert tortoise. The state of Nevada classifies the desert tortoise as a threatened species. Desert tortoises are found throughout the Mojave Desert plant communities in the southern half of the NTS (Figure 4-43). The abundance of tortoises on the NTS is low to very low relative to other areas within the range of this species (EG&G/EM, 1991; U.S. Fish and Wildlife Service, 1992; Rautenstrauch et al., 1994). The NTS contains less than 1 percent of the total desert tortoise habitat of the Mojave Desert population. Desert tortoises are not found on Area 13.

No plants that have been listed as threatened or endangered are known to occur on the NTS (50 CFR Part 17.11 and 17.12; Mendoza, 1995a).

There are three species (one animal and two plants) which are candidates for listing under the Endangered Species Act (61 FR 7596) and which are known to occur or may occur on the NTS. The U.S. Fish and Wildlife Service published the latest list of candidate plants and animals on February 28, 1996. Prior to this, 12 animal and 12 plant species found on the NTS or Area 13 were classified as candidates (Mendoza, 1995a). The updated Notice of Review has removed 11 of the 12 animals and all of the 12 plants from candidate status. Therefore, the following discussion of candidate species differs from that in the Draft NTS EIS issued in January 1996.

The mountain plover is the only candidate animal which is known to occur onsite. It is an uncommon migrant through the area.

Two candidate plants may occur on the NTS. Clokey's egg-vetch was recently discovered in the Belted Range of the NAFR Complex, just north of the NTS (Knight and Smith, 1996). It was found along the margins of a pinyon-juniper community near Indian Spring. This plant may occur in a

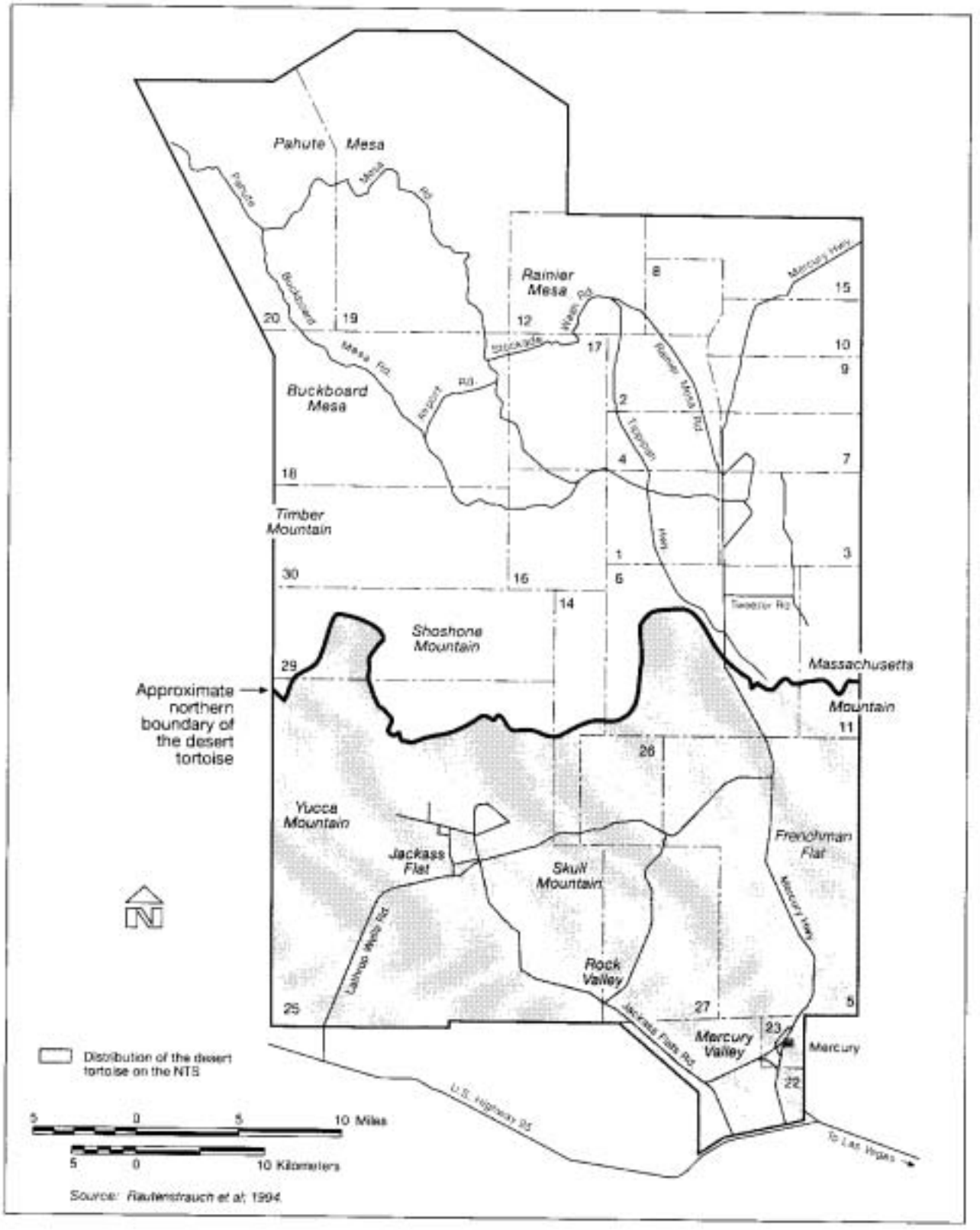


Figure 4-43. Approximate distribution of the desert tortoise on the NTS

similar habitat in the Belted Range which extends onto the NTS.

The Blue Diamond cholla may possibly have been collected on the NTS in the western Spotted Range below Mercury Ridge in Area 23. It was identified as another cholla species when first collected in 1967, and taxonomic verification of this NTS specimen is being pursued.

There also are a number of other endangered, threatened, or candidate species associated with the springs off the NTS that may be affected by NTS activities. For example, the endangered Devils Hole pupfish is endemic to the spring at Devils Hole National Monument, 27 km (17 mi) south of the NTS. At Ash Meadows National Wildlife Refuge, located 32 km (20 mi) south of the NTS, there are one endangered and six threatened plants, four endangered fishes, and one threatened invertebrate (U.S. Fish and Wildlife Service, 1994). In addition, the candidate species Amargosa toad and Oasis Valley speckled dace are found in wetlands in the Oasis Valley.

The North Las Vegas Facility is located within urban Las Vegas on previously disturbed land within a fenced site. It is not expected that any threatened, endangered, or rare species exist. No designated critical habitats for federal-listed species exist at the North Las Vegas Facility. The facility is within the range of the federal-listed desert tortoises; however, urbanized areas of Clark County are not considered tortoise habitat. No desert tortoises were found during an off-site survey of undeveloped land located near the western boundary of the North Las Vegas Facility.

OTHER SPECIES OF CONCERN—Some other species of concern which are known to occur or may occur on the NTS or Area 13 include the spotted bat (classified by the state of Nevada as threatened), the banded gila monster (classified as State-protected), over 20 state-protected birds (predominately hawks and owls), and one plant, Beatley milkvetch designated as "fully protected" by the State). Three of these State-protected animal species, the spotted bat, western burrowing owl, the white-faced ibis, and the Beatley milkvetch had been classified as Category 2 candidates for listing under the Endangered Species Act. The Beatley milkvetch had been classified as a Category 1 candidate. All were recently removed from candidate status (61 FR 7596). These species are known to occur on the NTS. Vocalizations of the spotted bat were recorded on Pahute Mesa in 1992 (EG&G/EM, 1993c). Burrowing owls are common and are permanent residents throughout the NTS but the white- faced ibis is an uncommon migrant (Hayward et al, 1963).

No documented sightings or specimens of banded gila monsters have been made on the NTS.

EFFECTS FROM PAST RADIOLOGICAL AND PROJECT ACTIVITIES—A number of studies were conducted to document the types and extent of disturbances to the biological resources that may have resulted from projects. Although much of the focus was on determining the fate and effects of radionuclides, especially transuranics (Dunaway and White, 1974; Gilbert et al., 1988; Howard and Fuller, 1987; Howard et al., 1985; O'Farrell and Emery, 1976; White and Dunaway, 1975, 1976, 1977, 1978; White et al., 1977a.,b.), long-term impacts due to nuclear tests and nonradiological causes were also investigated (Hunter, 1992b, 1994b, c, d, 1995).

In areas where atmospheric tests, safety tests, or cratering experiments were conducted, there were measurable changes in the species composition and abundance of plants and animals. Immediately following some tests that deposited fallout containing beta-emitters, shrubs that were more radiosensitive, such as sagebrush, were killed and a grass disclimax was established. The projects also involved nonradiological physical and mechanical disturbances that altered the characteristics of the soils, and usually resulted in the removal of the shrubs which are a key component of the structure and functioning of these desert ecosystems. The ecological changes observed were similar to effects associated with other human activities that disturb desert habitats, and few could be attributed solely to radiological impacts.

A herd of cattle was allowed to graze the northwestern part of the NTS for 25 years (Smith and Black, 1984). Periodically, tissues of cattle,

deer, and bighorn sheep were analyzed for concentrations of radionuclides. Results of this program suggested that since 1956 no significant amounts of biologically available radionuclides were contributed by activities on the NTS. Except for periods immediately following the deposition of close-in fallout, tissue concentrations of cesium-137 and strontium-90 reflected the deposition of worldwide fallout. Concentrations of tritium were within the ranges present in the general environment, except in tissues of animals that had access to point sources of tritium such as the Sedan Crater or the containment ponds in Area 12.

Hypothetical dose commitments for daily ingestion of NTS beef over varying lengths of time were less than 2 percent of the Federal Radiation Council or the International Commission on Radiological Protection guidelines. Both the calving rate of the herd, which exceeded 85 percent annually, and the 180-day weaning weight, usually greater that 18 kg (400 lbs), were above average. Routine necropsy and histopathological examinations revealed no harmful health effects that could be attributed to ionizing radiation in herbivores maintained for a lifetime on the NTS.

Concentrations of radionuclides in soils, plants, and animals in the vicinity of some past tests were above general background levels. Concentrations usually decreased by factors of 10 between soils-plants and plants-animals. Chromosomal aberrations were observed in cells of spiny sagebrush collected from Area 11, but the yields may not have been greater than what would be observed in the population naturally, and whether they were valuable or detrimental to the population was undetermined. Depressed levels of circulating lymphocytes and total leukocyte counts were found in kangaroo rats collected in areas contaminated with plutonium, but they were considered to be physiologically inconsequential. Gross pathological changes in native mammals appeared to be minimal and nonspecific. Reproduction in and recruitment to mammalian populations inhabiting contaminated areas was largely responding to changes in the food supply of winter annual plants, not to levels of radiation.

The long-term consequences of past DOE activities were studied at past ground zero locations above which atmospheric tests were conducted, within subsidence craters formed following underground tests, in burned areas, on compacted drill pads and scrapes, and along roadsides. One of the major findings was that ecological impacts resulting from DOE programs on the NTS did not differ in type or magnitude from those resulting from other human activities that disturb desert ecosystems. Changes in the vegetation resulted from changes in patterns and amounts of precipitation. Changes in the species composition of vertebrates appeared to be linked to the structure of the vegetation associations, and changes in abundance were in response to altered food supplies which were linked to vegetation.

Changes to the structure and function of ecosystems were restricted to the immediate vicinity of project sites, and few long-term effects could be attributed to radiological impacts. Concentrations of radionuclides did not produce genetic or cytological abnormalities that appeared to be detrimental to species or populations either in the short- or long-term. Restoration of disturbed sites will likely follow the routes and rates of succession observed in comparable, manipulated desert ecosystems.

In spite of the extensive environmental and monitoring programs conducted since the 1950s, impacts of nonradiological contaminants on wildlife are unknown. Drill sites established for the Environmental Restoration Program include plastic-lined ponds to collect and evaporate fluids. In 1994, remains of seven birds were found in one of three ponds that contained water (Greger, 1995). Although the causes of death could not be determined, and no chemical analyses of the water were performed, a hypothesis was proposed that birds may have been trapped in the steep sumps because detergents used during drilling may have removed protective oils, which caused hypothermia, which in turn inhibited flight.

There are 18 known populations of Beatley milkvetch, 14 on the NTS and 4 on the NAFR Complex, 3.5 to 8 km (2.2 to 5 mi) west of the NTS (Blomquist et al., 1992). These 18 populations cover areas ranging in size from 700 m^2 (837 yds^2) to 120 acres and are restricted to isolated sites

typically located on volcanic soils in the pinyon-juniper-sagebrush vegetation association at elevations between 1,850 m and 2,271 m (6,070 to 7,450 ft).

4.1.7 Air Quality and Climate

Air quality in a given location is described as the concentration of various pollutants in the atmosphere. Air quality is determined by the type and amount of pollutants emitted into the atmosphere, the size and topography of the air basin, and the prevailing meteorological conditions. This section describes existing air quality conditions. Topics discussed include climatology, meteorology, and ambient air quality at the NTS and Area 13.

CLIMATOLOGY AND METEOROLOGY—The climate at the NTS and Area 13 is characterized by limited precipitation, low humidity, and large diurnal temperature ranges. The lower elevations are characterized by hot summers and mild winters, which are typical of other Great Basin areas. As elevation increases, precipitation increases and temperatures decrease (DOE, 1986).

Annual precipitation at higher NTS elevations is about 23 cm (9 in.), which includes snow accumulations. The lower elevations receive approximately 15 cm (6 in.) of precipitation annually, with occasional snow accumulations lasting only a few days (Quiring, 1968).

Precipitation in the summer falls in isolated showers, which cause large variations among local precipitation amounts. Summer precipitation occurs mainly in July and August when intense heating of the ground beneath moist air masses triggers thunderstorm development and associated lightning. A tropical storm occasionally will move northeastward from the coast of Mexico, bringing heavy precipitation during September and October (DOE, 1995f).

Elevation influences temperatures on the NTS. At an elevation of 2,000 m (6,560 ft) on Pahute Mesa, the average daily maximum and minimum temperatures are 4 °C to -2 °C (40 °F to 28 °F) in January and 27 °C to 17 °C (80 °F to 62 °F) in July. In the Yucca Flat weapons test basin at an elevation of 1,195 m (3,920 ft), the average daily maximum and minimum temperatures are 11 °C to -6 °C (51 °F to 21 °F) in January, and 36 °C to 14 °C (96 °F to 57 °F) in July. Elevation at Mercury is 1,314 m (4,310 ft), and the extreme temperatures are 21 °C to -11 °C (69 °F to 12 °F) in January and 43 °C to 15 °C (109 °F to 59 °F) in July (DOE, 1995f).

The annual average temperature in the NTS area is 19 °C (66 °F) (NOAA, 1991). Monthly average temperatures range from 7 °C (44 °F) in January to 32 °C (90 °F) in July. Relative humidity readings (taken four times per day) range from 11 percent in June to 55 percent in January and December (DOE/NV, 1995f).

Average annual wind speeds and direction vary with location (Figure 4-44). At higher elevations on Pahute Mesa, the average annual wind speed is 16 kph (10 mph). The prevailing wind direction during the winter months is north-northeasterly, and during the summer months winds are southerly.

In the Yucca Flat weapons test basin, the average annual wind speed is 11 kph (7 mph). The prevailing wind direction during the winter months is north-northwesterly, and during the summer months is south-southwesterly. At Mercury, the average annual wind speed is 13 kph (8 mph), with northwesterly prevailing winds during the winter months, and southwesterly prevailing winds during the summer months. Figure 4-45 shows the annual wind direction frequencies and mean wind speeds for 1990 at Desert Rock, the U.S. Geological Survey, and National Oceanographic and Atmospheric Administration Air Resources Laboratories near Mercury. The wind speeds were measured from a height of 10 m (33 ft) above the ground.

Wind speeds in excess of 97 kph (60 mph), with gusts up to 172 kph (107 mph), may be expected to occur once every 100 years (Quiring, 1968). Additional severe weather in the region includes occasional thunderstorms, lighting, tornados, and sandstorms. Severe thunderstorms may produce high precipitation that continues for approximately one hour and may create a potential for flash flooding (Bowen and Egami, 1983). Few tornados

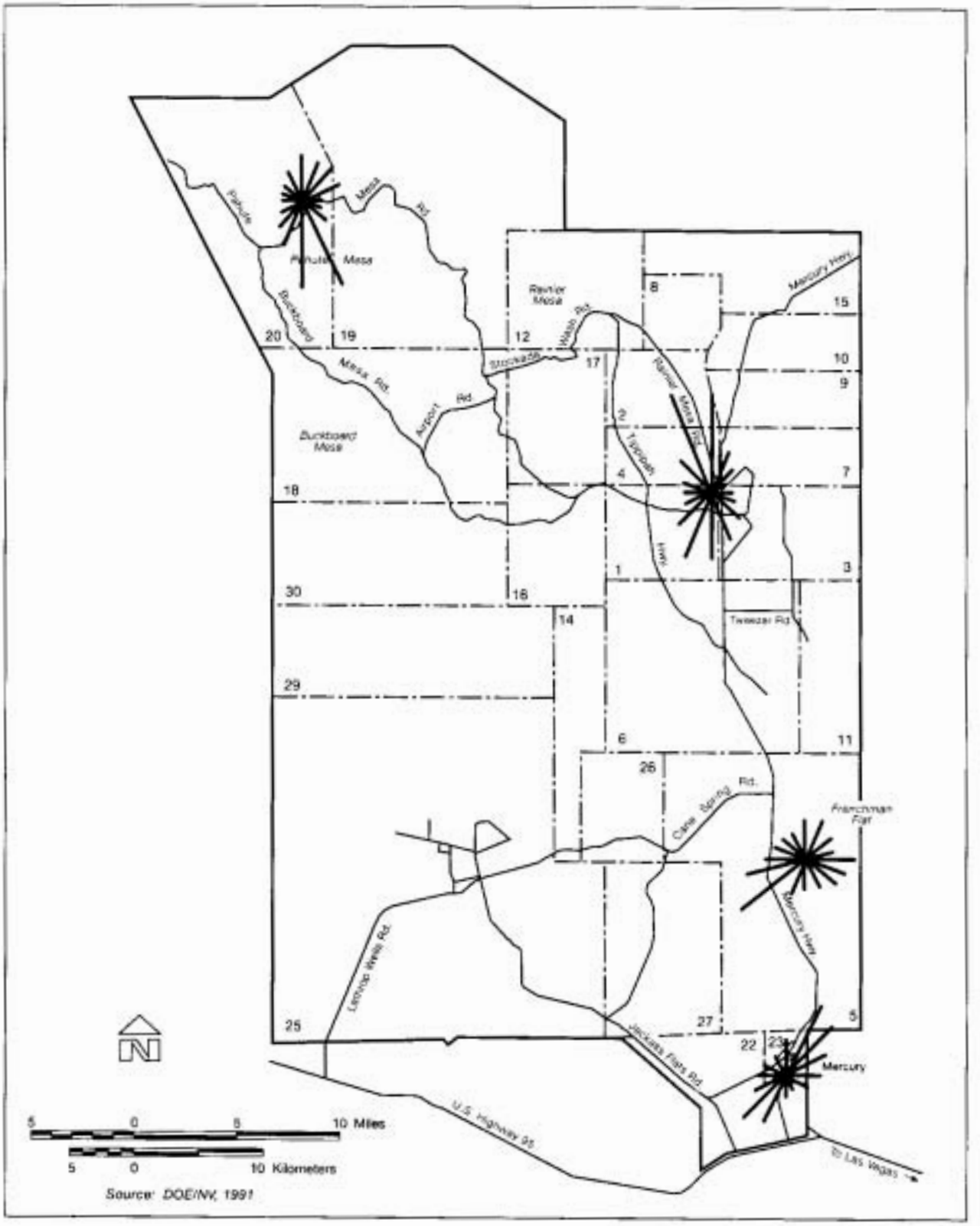


Figure 4-44. 10m (33ft) wind roses for NTS in 1990

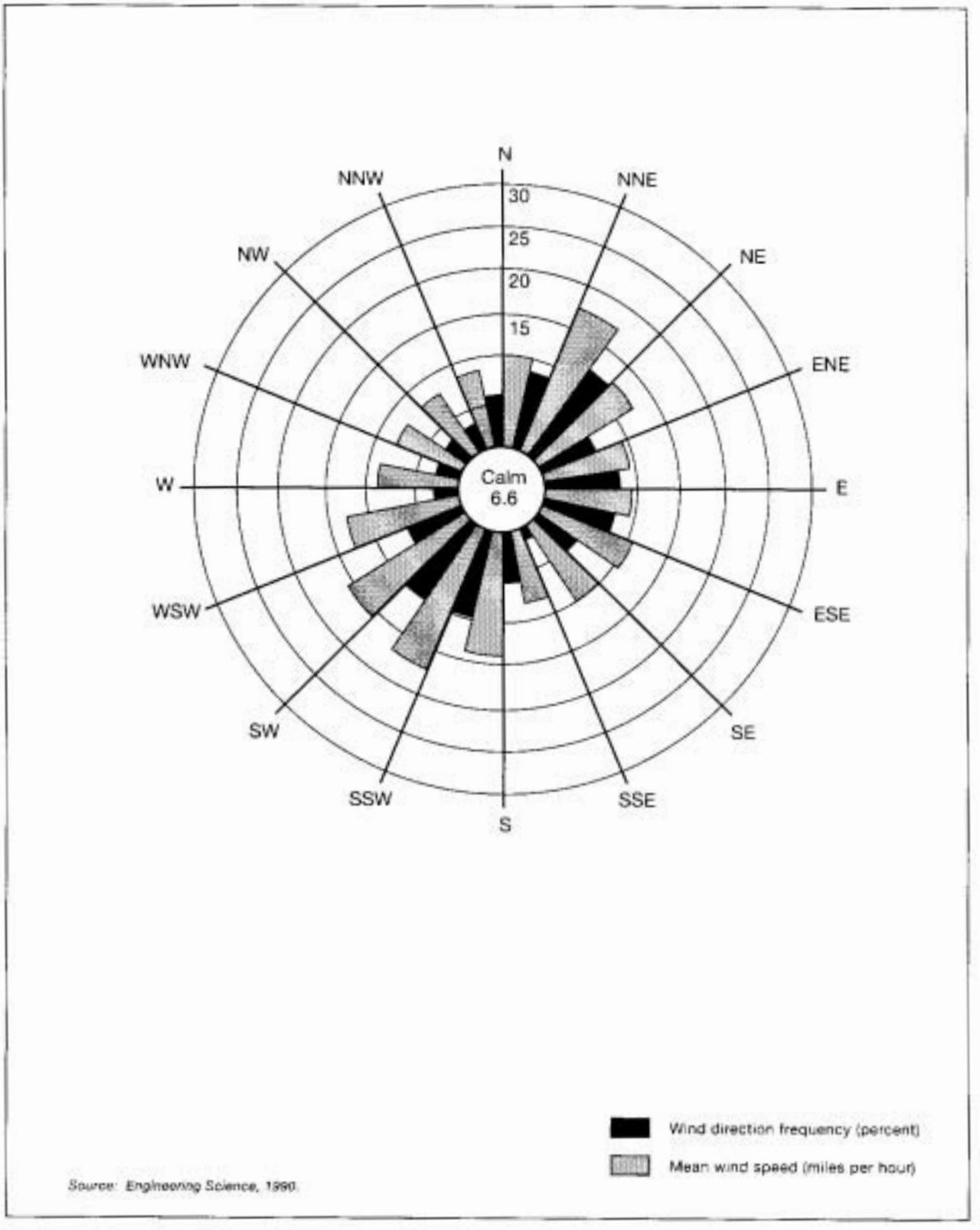


Figure 4-45. Wind direction frequencies and mean wind speed near Mercury, Nevada

have been observed in the region and are not considered a significant event. The estimated probability of a tornado striking a point at the NTS is extremely low (3 in 10 million years) (Ramsdell and Andrews, 1986).

AMBIENT AIR QUALITY—The NTS is located in the Nevada Intrastate Air Quality Control Region 147. The region has been designated as attainment with respect to the National Ambient Air Quality Standards (40 CFR Part 81.329). The nearest nonattainment area is the Las Vegas area, located 105 km (65 mi) southeast of the NTS. The Las Vegas Valley Hydrographic Area 212, located in Clark County, is classified as moderate nonattainment for carbon monoxide and serious nonattainment for fugitive dust (PM_{10}). The remaining portion of Clark County is designated as unclassifiable/attainment for these pollutants (40 CFR Part 81.329).

An area is designated by the EPA as being in attainment for a pollutant if ambient concentrations of that pollutant are below the National Ambient Air Quality Standards, and nonattainment if violations of the National Ambient Air Quality Standards occur. In areas where insufficient data are available to determine attainment status, designations are listed as unclassified. Unclassified areas are treated as attainment areas for regulatory purposes. The applicable National Ambient Air Quality Standards and Nevada State Ambient Air Quality Standards are presented in Table 4-31.

Prevention of Significant Deterioration is a regulation incorporated in the Clean Air Act that limits increases of pollutants in clean air areas (attainment areas) to certain increments even though ambient air quality standards are being met. The Prevention of Significant Deterioration Program is implemented in large part through the use of increments and area classifications. The Clean Air Act area classification scheme for Prevention of Significant Deterioration establishes three classes of geographic areas and applies increments of different stringency to each class. Air quality impacts, in combination with other Prevention of Significant Deterioration-permitted sources in the area, must not exceed the maximum allowable incremental increases presented in Table 4-32. Facilities planning construction or modifications of a facility that is located in an attainment area may be subject to Prevention of Significant Deterioration regulations if classified as a "major" source or "major" modification. A new source is major if it is one of 28 listed sources and has the potential to emit more than 100 tons per year of a regulated pollutant or more than 250 tons per year of a regulated pollutant, regardless of its source type. A modification is major if it will occur at an existing major source and will cause emission increases of regulated pollutants above "significant" emission rate levels defined in the regulations. Major sources must first obtain a Prevention of Significant Deterioration permit for either a new facility or modifications from the state where the facility is located (40 CFR Part 52.21).

The nearest Prevention of Significant Deterioration Class I areas to the NTS are the Grand Canyon National Park, 208 km (130 mi) to the southeast, and the Sequoia National Park, 169 km (105 mi) to the southwest (DOE, 1995f). The NTS has no sources subject to Prevention of Significant Deterioration requirements.

Ambient air quality at the NTS is not currently monitored for criteria pollutants or hazardous air pollutants, with the exception of radionuclides. Elevated levels of ozone or particulate matter may occasionally occur because of pollutants transported into the area or because of local sources of fugitive particulates (Bowen and Egami, 1983). Ambient concentrations of other criteria pollutants (sulfur dioxide, nitrogen oxides, carbon monoxide, and lead) are probably low because there are no large sources of these pollutants nearby. The nearest significant source of pollutants is the Las Vegas area (DOE, 1995f). Ambient air quality data for the NTS is summarized in Table 4-33. These measurements were recorded during the period from August 15, through September 15, 1990. Monitoring stations were located in Area 23 at Building 525; Area 6 at Building 170; and Area 12 at the sanitation department office trailer. Based on the data collected during this study (Engineering Science, 1990), the NTS is well within all applicable federal and state ambient air quality standards.

Table 4-31. Ambient air quality standards

		Nevada Standards[a]	National Standards[b]	
Pollutant	Averaging Time	Concentration	Primary[c,d]	Secondary[c,e]
Ozone	1 hour	235 µg/m³[f] (0.12 ppm)[g]	235 µg/m³ (0.12 ppm)	Same as primary
Ozone-Lake Tahoe Basin, #90	1 hour	195 µg/m³ (0.10 ppm)	None	None
Carbon monoxide less than 5,000 ft above mean sea level	8 hours	10,000 µg/m³ (9.0 ppm)	10 mg/m³ (9.0 ppm)	Same as primary
At or greater than 5,000 ft above mean sea level		6,870 µg/m³ (6.0 ppm)		
Carbon monoxide at any elevation	1 hour	40,000 µg/m³ (35 ppm)	40 mg/m³ (35 ppm)	
Nitrogen dioxide	Annual arithmetic mean	100 µg/m³ (0.05 ppm)	100 µg/m³ (0.05 ppm)	Same as primary
Sulfur dioxide	Annual arithmetic mean	80 µg/m³ (0.03 ppm)	80 µg/m³ (0.03 ppm)	Same as primary
	24 hours	365 µg/m³ (0.14 ppm)	365 µg/m³ (0.14 ppm)	
	3 hours	1,300 µg/m³ (0.5 ppm)	None	1,300 µg/m³ (0.50 ppm)
(Suspended) particulate matter as PM_{10}	Annual (geometric) arithmetic mean	(75) 50 µg/m³	(75) 50 µg/m³	Same as primary
	24 hours	150 µg/m³	(260) 150 µg/m³	(150 µg/m³)
Lead (Pb)	Quarterly arithmetic mean	1.5 µg/m³	1.5 µg/m³	Same as primary
Visibility[h]	Observation	In sufficient amount to reduce the prevailing visibility to less than 30 mi when humidity is less than 70 percent	There is no national standard for visibility	There is no national standard for visibility
Hydrogen sulfide[i]	1 hour	112 µg/m³ (0.08 ppm)	There is no national standard for visibility	There is no national standard for visibility

[a] These standards must not be exceeded in areas where the general public has access.
[b] These standards, other than for ozone and those based on annual averages, must not be exceeded more than once per year. The ozone standard is attained when the expected number of days per calendar year with a maximum hourly average concentration above the standard is equal to or less than one.
[c] Concentration is expressed first in units in which it was adopted and is based on a reference temperature of 25 °C and a reference pressure of 760 millimeter (mm) of mercury. All measurements of air quality must be corrected to a reference temperature of 25 °C and a reference pressure of 760 mm of mercury (1,013.2 millibars); parts per million (ppm) in this table refers to ppm by volume or micromoles of pollutant per mole of gas.
[d] National primary standards are the levels of air quality necessary, with an adequate margin of safety, to protect the public health.
[e] National secondary standards are the levels of air quality necessary to protect the public welfare from any known or anticipated adverse effects of a pollutant.
[f] Micrograms per cubic meter.
[g] Parts per million by volume or micromoles per mole of gas.
[h] For the purposes of this section, prevailing visibility means the greatest visibility that is attained or surpassed around at least half the horizon circle, but not necessarily in continuous sectors.
[i] The ambient air quality standard for hydrogen sulfide does not include naturally occurring background concentrations.

NOTE: All values are corrected to reference conditions. These standards of quality for ambient air are minimum goals, and it is the intent of the State Environmental Commission in this section to protect the existing quality of Nevada's air to the extent that it is economically and technically feasible. (Environmental Commission Air Quality Reg. §§ 12.1-12.1.6, eff. 11/7/75; A and renumbered as §12.1, 12/4/76; A 12/15/77; 8/28/79; §§ 12.2-12.4, eff. 11/7/75; § 12.5, eff. 12/4/76; A 8/28/79) (NAC A 10/19/83; 9/5/84; 12/26/91.)

Source: NAC, 1995.

Table 4-32. Maximum allowable pollutant concentration increases under Prevention of Significant Deterioration regulations

Pollutant	Averaging Time	Maximum Allowable Increment ($\mu g/m^3$)[a]		
		Class I	Class II	Class III
Particulate matter (PM_{10})	Annual	4.0	17.0	34.0
	24 hours	8.0	30.0	60.0
Sulfur dioxide (SO_2)	Annual	2.0	20.0	40.0
	24 hours	5.0	91.0	182.0
	3 hours	25.0	512.0	700.0
Nitrogen oxides (NO_x)	Annual	2.5	25.0	50.0

[a] Microgram per cubic meter.

Source: 40 CFR Part 52.21, 1995.

Table 4-33. Ambient air quality data for the NTS, 1990

Monitoring Station	Time Period	Ambient Concentration ($\mu g/m^3$)[a]									
		Sulfur Dioxide			Carbon Monoxide		Nitrogen Oxides	Particulate Matter[b]		Lead	Ozone
		Annual	Max. 24-Hour	Max. 3-Hour	Max. 8-Hour	Max. 1-Hour	Annual	Annual	Max. 24-Hour	Max. Calendar Quarter	Max. 1-Hour
Area 23	8/15/90 to 9/15/90	(c)	39.3	65.4	1,374	1,374	(c)	(c)	78.3	(c)	(c)
Area 6	8/15/90 to 9/15/90	(c)	0	0	1,145	1,947	(c)	(c)	20.2	(c)	(c)
Area 12	8/15/90 to 9/15/90	(c)	15.7	52.4	2,290	2,748	(c)	(c)	45.4	(c)	(c)

[a] Micrograms per cubic meter.
[b] Particulate matter less than 10 microns in diameter.
[c] Not measured.

Source: Engineering Science, 1990.

The criteria air pollutants emitted at the NTS include particulates from construction, aggregate production, and surface disturbances, and fugitive dust from vehicles traveling on unpaved roads; various pollutants from fuel-burning equipment, incineration, and open burning; and volatile organics from fuel storage facilities (DOE, 1995f). A summary of emission estimates for sources at the NTS is presented in Table 4-34. Emissions of hazardous air pollutants from current NTS sources are below regulatory requirements (DOE, 1995f).

RADIOLOGICAL AIR QUALITY—The DOE maintains an extensive network of air sampling stations for radiological parameters, such as particulates, tritium, noble gases, and reactive gases. Past activities at the NTS have resulted primarily in radioactive effluents from underground weapons testing. Some radioactivity detected by on-site air monitoring stations is attributed to the resuspension of soils contaminated from past aboveground nuclear weapons testing (1951 to 1962).Monitoring of airborne particulate matter, noble gases, and tritiated water vapor on the NTS in 1993 indicated on-site levels that were consistent with background concentrations (Table 4-35). The external exposure monitoring network indicated a stable level of gamma radiation levels from year to year. Airborne releases of radioactivity have occurred from past aboveground weapons testing, but in recent years no radioactivity from operations at the NTS has been detected at off-site monitoring stations.

During 1993, the radiation dose to the maximum exposed individual was estimated to be 0.004 mrem at Indian Springs (DOE, 1994b), which is well below the EPA standard of 10 mrem per year. This effective dose equivalent was based on calculations using the CAP88 air dose assessment model (an air dispersion model developed by the EPA to predict effective doses). This computer code uses site-specific radionuclide emission data, on-site meteorological data, and dose conversion factors to predict the effective dose equivalent.

Historically, releases have occasionally occurred to the ground surface and atmosphere as a result of underground testing. There have been five categories of releases: (1) venting that occurred when containment failed and there was a rapid, massive release; (2) seeps that occurred when containment failed and there was a small, slow release shortly after the test; (3) late-time seeps that released gases to the surface a few days or weeks after the test; (4) controlled tunnel purging to allow recovery of equipment and data; and (5) operational releases that are small and occur when core or gas samples are collected. According to the Office of Technology Assessment (OTA, 1989), prior to 1971, a total of 2.5×10^7 curies were released from underground tests at the NTS. After a 1971 Atomic Energy Commission review (following a 6.7×10^6 Ci release from the Baneberry test), new containment procedures were implemented. From 1971 through 1988, 54,000 Ci were released, and of this amount 11,000 Ci were unintentionally released through containment failure. Seeps continue to emit radioactive gases from the underground testing areas. The DOE maintains an extensive network of monitoring stations on the at NTS and at off-site locations to monitor extensive network of monitoring stations on the at NTS and at off-site locations to monitor conditions. The results of this monitoring measure the concentrations of gross beta, plutonium, noble gases, and tritiated water vapor in air rather than the total inventory of radionuclides.

In 1990, the average concentrations never approached the Derived Concentration Guides for inhalation for samples collected either on or off the NTS. The results of monitoring in 1990 found xenon, a key noble gas indicator, was detected only for a short period after underground tests.

The total inventory of 1990 releases to the atmosphere from underground tests through seepage of gaseous radionuclides is estimated at about 66 Ci. Of this quantity, some was related to ventilation of tunnels where tests were conducted. The 1990 monitoring of the G Tunnel Complex indicated that ventilation resulted in a release of 28 Ci of airborne tritium into the atmosphere.

No nuclear tests were performed at the NTS in 1993; therefore, the radiological monitoring consisted primarily of routine air sampling throughout the NTS. In 1993, samples of air exhausted through the ventilation duct at the P Tunnel portal (used for underground testing in

Table 4-34. NTS source emission inventory, 1993

Pollutant	Source	Emission Rate (lbs/hour)
Particulate matter (PM_{10})	Area 12 boiler	2.8
	Area 23 boiler	3.6
	Area 23 boiler	2.8
	Area 23 incinerator	0.75
	Area 6 boiler	2.9
	Area 1 rotary dryer	7.1
Sulfur dioxide (SO_2)	Area 12 boiler	2.8
	Area 23 boiler	3.1
	Area 23 boiler	2.8
	Area 23 incinerator	3.0
	Area 6 boiler	2.5

Source: NDCNR, 1988a, b, c, 1989a, b, and 1990.

Table 4-35. NTS radioactive emissions – 1993, airborne effluent releases

	Curies		
Facility Name	Tritium	Krypton-85	Plutonium
Area 3	NA*	NA	1.0×10^{-3}
Area 5, Radioactive Waste Management Site	2.9×10^{-1}	NA	NA
Area 9, Bunker	NA	NA	7.5×10^{-4}
Area 12, Containment Ponds	7.4×10^{2}	NA	NA
Area 12, P Tunnel Portal	3.7	NA	NA
Areas 19 and 20, Pahute Mesa	NA	1.6×10^{2}	NA
Total	**7.08×10^{2}**	**1.6×10^{2}**	**1.8×10^{-3}**

* Not applicable.

Source: DOE/NV, 1994b.

horizontal mines) indicated emissions of 3.7 Ci of gaseous radioactivity in the form of tritiated water vapor due to seepage within the tunnel from nuclear tests performed in previous years. Air samples collected around the Area 5 Radioactive Waste Management Site indicated trace amounts of tritium at the boundary and no measurable activity away from the area. Air samples collected in Area 3 and at the Area 9 bunker indicated levels of plutonium-239 and -240 above background. Measured krypton-85 levels on Pahute Mesa were approximately 1 pCi/m^3 higher than the NTS average because of atmospheric pumping from past nuclear events.

Using the data from the highest annual average concentration, replacing the diffuse source with an equivalent point source, and using the CAP88 Systems Laboratory, Las Vegas has an extensive air monitoring network throughout central and southern Nevada and the southern portion of Utah and California for a total of 27 monitoring sites. The EPA's off-site air monitoring network air concentration data indicated doses far below those modeled with the CAP88-PC model. The gamma exposure rates are measured weekly throughout the year at these sites. The CAP 88-PC model estimated a dose of 0.004 mem to a hypothetical maximum exposed individual. The actual data from the EPA's air monitoring network indicated that the air concentration would have to be 14 times higher than measured values to achieve the modeled dose. Table 4-36 summarizes the annual contributions to the effective dose equivalent in 1993 due to operations at the NTS as estimated by the CAP88-PC computer model.

4.1.8 Noise

Noise is defined as sound that is undesirable because it interferes with speech communication and hearing, is intense enough to damage hearing, or is otherwise annoying. The characteristics of sound include parameters such as amplitude, frequency, and duration. The decibel (dB), a logarithmic unit that accounts for the large variations in amplitude, is the accepted standard unit measurement of sound.

When measuring sound to determine its effects on the human population, A-weighted sound levels (dBA) are typically used to account for the response of the human ear (ANSI/ASME, 1983). Human responses to sounds are lowest at low and high frequency levels and greatest in the middle frequency range. A-weighted sound levels represent adjustments to sound levels that are made according to the frequency content of the sound. Examples of typical sound levels are shown in Figure 4-46.

Noise levels often change with time; therefore, to compare levels over different time periods, several descriptors were developed that take into account this time-varying nature. These descriptors are used to assess and correlate the various effects of noise on man, including land-use compatibility, sleep and speech interference, annoyance, hearing loss, and startle effects.

The day-night average sound level was developed to evaluate the total community noise environment. The day-night average sound level is the average dBA during a 24-hour period with 10 dB added to nighttime levels (between 10 p.m. and 7 a.m.). This adjustment is added to account for the increased sensitivity to nighttime noise events. The day-night average sound level was endorsed by the EPA and is mandated by the U.S. Department of Housing and Urban Development, the Federal Aviation Administration, and the DoD for land-use assessments.

The day-night average sound level is sometimes supplemented with another noise level measurement, primarily the equivalent sound level. The equivalent sound level is the dBA level of a steady-state sound that has the same dBA sound energy as that contained in the time-varying sound being measured over a specific time period. The major noise sources at the NTS include equipment and machines (e.g., cooling towers, transformers, engines, pumps, boilers, steam vents, paging systems, construction and material-handling equipment, and vehicles), blasting and explosives testing, and aircraft operations. No NTS environmental noise survey data are available. At the NTS boundary, away from most facilities, noise from most sources is barely distinguishable above background noise levels.

The acoustic environment in areas adjacent to the NTS can be classified as either uninhabited desert or small rural communities. In the uninhabited desert, the major sources of noise are natural physical phenomena such as wind, rain, and wildlife activities, and an occasional airplane. The wind is the predominant noise source. Desert noise levels as a function of wind have been measured at an upper limit of 22 dBA for a still desert and 38 dBA for a windy desert (Brattstrom and Bondello, 1983).

A background sound level of 30 dBA is a reasonable estimate. This is consistent with other estimates of sound levels for rural areas. The rural

Table 4-36. Summary of effective dose equivalents from NTS operations during 1993

	Maximum EDE[a] at NTS Boundary[b]	Maximum EDE to an Individual[c]	Collective EDE to Population Within 80 kilometers of the NTS Sources
Dose	4.8×10^{-3} mrem	$3.8 \pm 0.57 \times 10^{-3}$ mrem	1.2×10^{-2} person-rem
Risk of Cancer[d]	1.728×10^{-7} latent cancer fatalities		
Location	Site boundary 58 km (36 mi) SSE of NTS Area 12	Indian Springs, 80 km (50 mi) SSE of NTS Area 12	21,750 people within 80 km (50 mi) of NTS sources
NESHAP[e] Standard	10 mrem per year	10 mrem per year	NA[f]
Percentage of NESHAP	0.05	0.04	NA[f]
Background	97 mrem	97 mrem	1,747 person-rem
Risk of cancer (from background)[d]	3.492×10^{-5} latent cancer fatalities		
Percentage of Background	5.0×10^{-3}	4.0×10^{-3}	6.9×10^{-4}

[a] Effective dose equivalent
[b] The maximum boundary dose is to a hypothetical individual who remains in the open continuously during the year at the NTS boundary located 60 km 37 mi) south-southeast from the Area 12 tunnel ponds
[c] The maximum individual dose is to a person outside the NTS boundary at a residence where the highest dose rate occurs as calculated by CAP88 (Version 1.0) using NTS effluents listed in Table 5.1 of the 1993 Annual Site Environmental Report document (DOE/NV, 1994a) and assuming all tritiated water input to the Area 12 containment ponds was evaporated
[d] Assume individual exposed to dose per year for lifetime (72 years)
[e] National Emission Standards for Hazardous Air Pollutants
[f] Not applicable.

Source: DOE/NV, 1994a.

communities day-night average sound level has been estimated in the range of 35 to 50 dB (EPA, 1974). A background sound level of 50 dB is a reasonable estimate for Mercury.

Except for the prohibition of nuisance noise, neither the state of Nevada nor local governments have established specific numerical environmental noise standards.

At the North Las Vegas Facility, noise background levels are those that would be expected in an urbanized industrial area.

4.1.9 Visual Resources

Visual resources include the natural and man-made physical features that give a particular landscape its character and value as an environmental factor. The feature categories that form the overall impression a viewer receives of an area include landform, vegetation, water, color, adjacent scenery, scarcity, and man-made (cultural) modification (BLM, 1980).

Criteria used in the analysis of visual resources for this EIS include scenic quality, visual sensitivity, and distance and/or visibility zones from key public viewpoints.

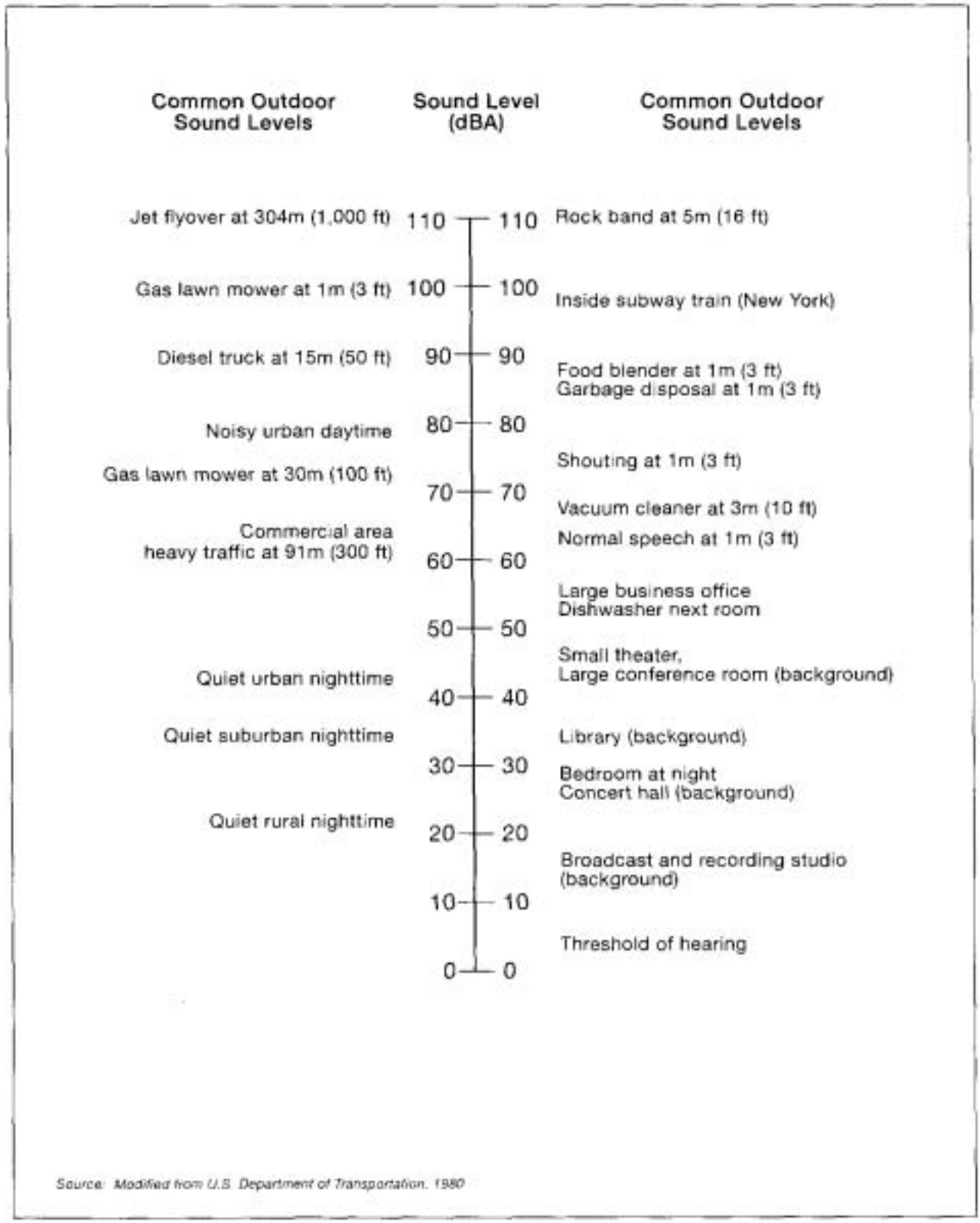


Figure 4-46. Comparative A-weighted sound levels

There are three scenic quality classes. Class A includes areas that combine the most outstanding characteristics of each physical feature category. Class B includes areas in which there is a combination of some outstanding characteristics and some that are fairly common. Class C includes areas in which the characteristics are fairly common to the region. Visual sensitivity for this analysis was based solely on the volume of travel on public highways because these roads are the only key public viewpoints from which the study areas are seen. Study areas that are visible from highways with 3,000 or more average annual daily traffic were average daily traffic were assigned a medium sensitivity level. Study areas that are visible from highways with annual average daily traffic below 1,000 were assigned a low sensitivity level.

Visual quality and sensitivity may be magnified or diminished by the distance and/or visibility of the landscape from key view points (BLM, 1980). The landscape scene can be divided into three basic distance zones: foreground, 0 to 0.8 km (0.5 mi); middleground, 0.8 km (0.5 mi) to 8 km (5 mi); and background/seldom seen, 8 km (5 mi) to infinity. Seldom-seen views also include those portions of the landscape that cannot be seen from a key viewpoint because the viewer's line of sight is blocked by terrain, vegetation, or some other physical feature.

The NTS is located in a transition area between the Mojave Desert and the Great Basin. Vegetation ranges from grasses and creosote bush in the lower elevations to juniper, pinyon pine, and sagebrush in elevations above 1,524 m (5,000 ft). The topography of the NTS consists of a series of mountain ranges arranged in a north-south orientation separated by broad valleys. A portion of the site is characterized by the presence of numerous subsidence craters resulting from past nuclear testing. Scenic views related to geologic features are numerous within this region. The southwestern Nevada volcanic field, which includes portions of the NTS, is recognized by researchers to be a classic example of a nested, multicaldera volcanic field. The scenic quality of the NTS ranges from Class B to Class C. The areas of the NTS visible from U.S. Highway 95 are common to the region. Therefore, they have been designated as Class C.

The area surrounding the NTS consists of unpopulated to sparsely populated desert and rural lands. Because the NTS is surrounded to the east, north, and west by the NAFR Complex and to the south by lands controlled by the U.S. Bureau of Land Management, the main public views into the interior of the NTS are from U.S. Highway 95. Because the southern boundary of the NTS is surrounded by various mountain ranges, including the Spector Range, Striped Hills, Red Mountain, and the Spotted Range, views from U.S. Highway 95 are limited to Mercury Valley and some portions of the southwestern sector of NTS which can be seen from Amargosa Valley. Traffic on U.S. Highway 95 at the Mercury exit is approximately 3,600 vehicles per day (NDOT,1993a). Therefore, portions of the NTS visible from this area would have a high sensitivity level.

The North Las Vegas Facility occupies approximately 80 acres in the city of North Las Vegas, Nevada. The area can be described as an urbanized industrial area, and visual resources are typical for such an area.

4.1.10 Cultural Resources

The following sections describe the cultural resources of the NTS and North Las Vegas Facilities. Resources are described in two ways. First, archeological resources are described in accordance with the provisions of the National Historic Preservation Act of 1966 and the Archaeological Resources Protection Act of 1979, as these acts are implemented through consultations and the programmatic agreement between the SHPO and the DOE/NV. The second description of resources, which begins at the unnumbered section entitled "Sites of American Indian Significance," describes cultural resources from the American Indian cultural perspective, as provided by the American Indian Writers Subgroup of the Consolidated Group of Tribes and Organizations. This section is in italics.

Archaeological research indicates that important cultural resources exist at the NTS. These resources

range from sites associated with the earliest prehistoric people in the New World to structures associated with the development of nuclear testing. At the time of contact with the Euroamericans in the mid-1800s, the area was occupied or used by the Southern Paiute, Western Shoshone (Steward, 1938), and Owens Valley Paiute (Stoffle and Evans, 1988). Historic contexts commonly employed on the NTS are the Paleoindian, Early, Middle and Late Archaic, Shoshonean and Historic periods. The latter has been subdivided into contexts concerned with mining, ranching, transportation and communication, nuclear testing and research, and American Indians. Those sites dating to the Cold War era and associated with nuclear testing and development are considered of particular relevance because they occur at only a few locations across the United States.

Current knowledge of the NTS cultural resources is the result of over 20 years of surveys and data recovery, most conducted prior to NTS activities. In addition to preactivity surveys and studies, in 1990 the DOE entered into a Programmatic Agreement with the SHPO and the Advisory Council for Historic Preservation, which implemented the Long-Range Study Plan for Negating Potential Adverse Effects to Historic Properties on Pahute and Rainier Mesas. This is a comprehensive program that examines in depth an 11-percent geographic sample of the cultural resources on the two mesas. As a result of these programs 4.68 percent of the NTS (40,491 acres) has been surveyed for cultural resources. The Long-Range Study Plan and other programs have produced a large archaeological database that is the foundation for the information presented in this document. Some sites, particularly mining, ranching, and nuclear testing sites, are known but have yet to be studied and recorded. At least 600 buildings, structures and objects dating to the Cold War era have been identified on the NTS, but these have not been systematically recorded or evaluated for significance. The sites included here are those that have been systematically recorded. Determinations of eligibility for the cultural resources have been made through consultations between the DOE and the SHPO. However, many of the older sites have not been evaluated for National Register of Historic Places eligibility. In many cases, the site records do not indicate any National Register of Historic Places recommendations. Based on current knowledge, all areas of the NTS have the potential to contain archaeological sites that are considered significant because they meet the criteria of eligibility for the National Register of Historic Places. As a result, the boundaries of the NTS mark the area of potential effect for cultural resources. The following section documents previous work conducted on the NTS and North Las Vegas Facilities, and evaluates the sites according to types and eligibility for listing on the National Register of Historic Places.

RECORDED CULTURAL RESOURCES—Over 1,700 archaeological sites have been identified on the NTS. The terminology used here to define site types is derived from the Desert Research Institute's Branch Technical Procedures Manual (DRI, 1990). Site types are grouped into prehistoric and historic categories. Prehistoric sites include temporary camps, extractive localities, processing localities, localities, caches, and stations. One other prehistoric site type is the residential base. Historic site types include mining sites, ranching sites, and transportation and communication sites. Other historic types are those related to nuclear testing and research.

Temporary camps are defined as occasional operational centers for prehistoric task groups or population groups. These sites were the hub of resource collection activities where processing, manufacturing, maintenance, and living activities were likely to take place. Consequently, the inventory of artifacts and features at these sites often reflects a number of different activities. The diversity of these assemblages makes them useful when characterizing prehistoric occupations. Extractive localities are resource procurement areas, such as quarries, water catchment basins, hunting blinds, and plant resource extraction locations. Processing localities are areas where resources, such as stone tools, plants, and animals, are processed. Localities are places where these types of activities took place, but lack sufficient information to discern which activity is represented. These sites are marked by low artifact diversity when compared to temporary camps. Caches are temporary places

used for storing either resources or artifacts. Stations are locations where special purpose task groups gather to exchange information about game movement, routes of travel, and ritual activities. Stations include rock cairns marking travel routes, isolated rock art, geoglyphs, observation points, and overlooks. A residential base is a location of extended occupation for prehistoric people. Historic sites are grouped according to major themes commonly encountered in the DOE project areas. These allow some characterization of an extremely variable resource. The major themes within which historic sites are grouped include mining, ranching, and transportation and communication. Other historic contexts are nuclear testing and research, and American Indian activities.

Documents that provide further information used to assess resources found on the NTS include Pippin (1984, 1986, 1992), Reno and Pippin (1985), and Worman (1969). The characteristics and significance of these resources are summarized in this EIS in terms of eligibility for the National Register of Historic Places. The data are presented according to hydrographic boundaries (State of Nevada Engineer's Office, 1974). These boundaries provide a useful way to organize the data in a comparable manner to other studies presented in this document. Those sites recorded as a result of DOE activities, including the Yucca Mountain Site Characterization Project, are considered in the following sections. (Figure 4-47 and Table 4-37).

Mercury Valley—This basin is bounded by the Spotted Range and the Specter Range (State of Nevada Engineer's Office, 1974). Twenty-one archeological reconnaissance surveys have been conducted within that portion of Mercury Valley that lies within the NTS. Approximately 214 acres were surveyed for cultural resources. Only four sites have been recorded as a result of these surveys. Of these, three are classified as localities, and one is a historic site. None of these sites is considered eligible for listing on the National Register of Historic Places.

Rock Valley—This basin is bounded by the Specter Range to the south and the Skull Mountains to the north (State of Nevada Engineer's Office, 1974). Most of the Rock Valley hydrographic basin lies within NTS boundaries. Nine archaeological reconnaissance surveys have been conducted within Rock Valley. Approximately 432 acres have been surveyed for cultural resources. Seventeen sites have been recorded as a result of these studies. One of the sites is an extractive locality, 15 are localities, and 1 is a temporary camp. Three of these sites have been determined eligible for listing on the National Register of Historic Places.

Fortymile Canyon-Jackass Flats—Jackass Flats is bounded by the Skull Mountains to the south and the Shoshone Mountains to the north (State of Nevada Engineer's Office, 1974). Almost the entire basin, with the exception of the extreme western edge and the southwest corner, lies within NTS boundaries. One hundred fifty-six archaeological reconnaissance surveys have been conducted within the Fortymile Canyon-Jackass Flats basin. Approximately 12,177 acres have been surveyed for cultural resources. The Fortymile Canyon-Jackass Flats area has a very high density of recorded sites. This density is partially a reflection of the intensity of archaeological survey which has occurred in the area. There have been 371 cultural resources sites recorded as a result of these surveys. This total includes 35 temporary camps, 15 extractive localities, 59 processing localities, 236 localities, 7 caches, 1 station, 1 residential base, 8 historic sites, and 9 untyped sites. Currently, 106 of these sites are eligible for listing on the National Register of Historic Places.

Buckboard Mesa—This hydrographic area includes Buckboard Mesa and part of Pahute Mesa. The entire hydrographic basin is within NTS boundaries. It is bounded by the Shoshone Mountains and the Eleana Range on its eastern boundary (State of Nevada Engineer's Office, 1974). Fifty-one archaeological reconnaissance surveys have been conducted within that portion of Buckboard Mesa that lies within the NTS. Approximately 4,190 acres have been surveyed for cultural resources. The Buckboard Mesa area has a very high density of recorded sites. This density may be a reflection of the intensity of archaeological survey which has occurred in the area. To date, 470 sites have been recorded in the Buckboard Mesa hydrographic region. This total includes

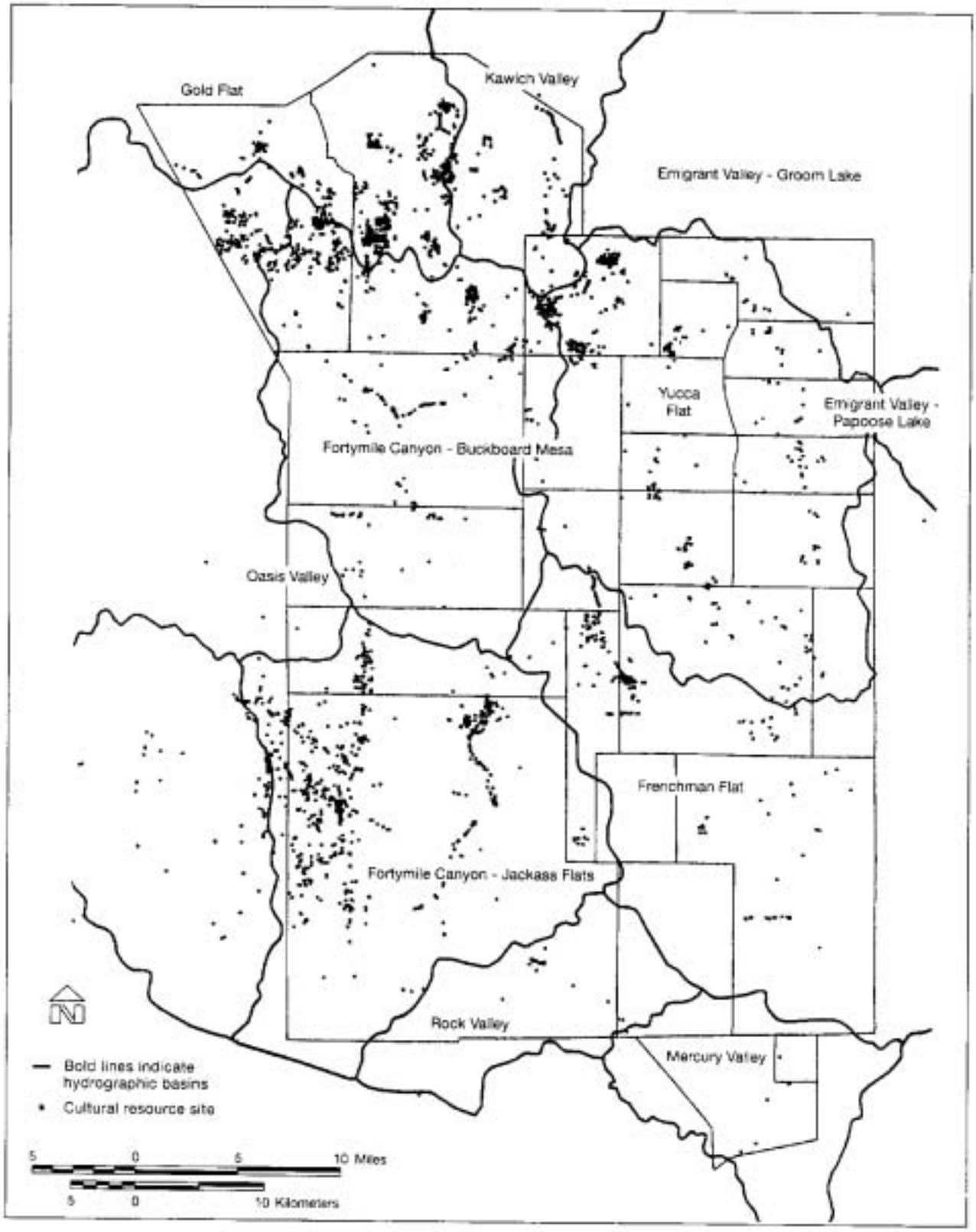


Figure 4-47. Recorded cultural resources on the NTS

Table 4-37. Types of sites found within the hydrographic basins of the NTS

Basin	Prehistoric Site Types							Historic Site Types		Untyped Sites	NR Eligible
	RB	TC	EL	PL	LO	CA	STA	HI	NT	UT	NR
Mercury Valley	0	0	0	0	3	0	0	1	0	0	0
Rock Valley	0	1	1	0	15	0	0	0	0	0	3
Fortymile Canyon & Jackass Flats	1	35	15	59	236	7	1	8	0	9	106
Buckboard Mesa	0	103	6	94	203	5	1	3	0	54	327
Oasis Valley	0	14	1	20	82	0	0	0	0	2	49
Gold Flat	0	25	1	96	124	10	0	2	0	1	169
Kawich Valley	0	9	0	25	37	0	0	2	0	8	58
Emigrant Valley & Groom Lake Valley	0	0	0	0	5	0	0	0	0	0	0
Yucca Flat	4	54	10	34	126	56	0	38	5	13	130
Frenchman Flat	1	2	2	38	52	0	0	2	2	0	49
Totals	**6**	**243**	**36**	**366**	**883**	**78**	**2**	**56**	**7**	**87**	
Total NTS Sites										**1,764**	**891**

Site type codes: RB=residential base; TC=temporary camp; EL=extractive locality; PL=processing locality; LO=locality; CA=cache; STA=station; HI=historic; NT=nuclear testing; UT=untyped; NR=National Register.

103 temporary camps, 6 extractive localities, 94 processing localities, 203 localities, 5 caches, 1 station, 3 historic ranching sites, and 54 untyped sites. Currently, 327 of these sites have been determined eligible for listing on the National Register of Historic Places. The large number of localities recorded in the Buckboard Mesa region suggest that this region was highly used by mobile groups during their annual round. These kinds of sites can often provide important information about the technological orientation of prehistoric people.

Oasis Valley –Only the eastern portion of this basin is within the NTS boundaries. This region includes parts of Pahute Mesa. Twenty-nine archaeological reconnaissance surveys have been conducted within that portion of Oasis Valley that lies within the NTS. Approximately 3,445 acres have been surveyed for cultural resources. To date, 119 cultural resources sites have been recorded in the part of the Oasis Valley hydrographic basin that is within NTS boundaries. This total includes 14 temporary camps, 1 extractive locality, 20 processing localities, 82 localities, and 2 untyped sites. While many of the smaller localities are not eligible for listing on the National Register of Historic Places, 49 of the sites are eligible for listing on the National Register of Historic Places.

Gold Flat—The southern part of this basin is within the NTS and includes part of Pahute Mesa. A wide range of site types can be found in the area. Forty-eight archaeological reconnaissance surveys have been conducted within that portion of Gold Flat Valley that lies within the NTS. Approximately 6,140 acres have been surveyed for cultural resources. Currently, 259 sites have been recorded as a result of these surveys. This total includes 25 temporary camps, 1 extractive locality, 96 processing localities, 124 localities, 10 caches, 2 historic sites, and 1 untyped site. To date, 169 of these sites are eligible for listing on the National Register of Historic Places.

Kawich Valley—Only the southern part of this hydrographic basin is within the boundaries of the NTS and includes a portion of Pahute Mesa. Twenty-one archaeological reconnaissance surveys

have been conducted within that portion of Kawich Valley that lies within the NTS. Approximately 2,635 acres have been surveyed for cultural resources. There are 81 sites that have been recorded as a result of these surveys. This total includes 9 temporary camps, 25 processing localities, 37 localities, 2 historic sites, and 8 untyped sites. To date, 58 sites are eligible for listing on the National Register of Historic Places (see Table 4-37).

Emigrant Valley-Groom Lake Valley—Only a small portion of this basin is within the NTS boundaries. This basin includes part of the Belted Range and part of Groom Lake Valley (State of Nevada Engineer's Office, 1974). Two archaeological reconnaissance surveys have been conducted within that portion of Emigrant Valley and Groom Lake Valley that falls within the NTS. Approximately 60 acres have been surveyed for cultural resources. Five localities have been identified within NTS boundaries. None of these localities has been found to be eligible for listing on the National Register of Historic Places. This small sample of sites is not necessarily representative of the hydrographic basin as a whole.

Yucca Flat Weapons Test Basin—The Yucca Flat basin area is bounded by the Eleana Hills to the west and the Halfpint Range to the east. Several isolated mountains form the southern boundary of the Yucca Flat basin (State of Nevada Engineer's Office, 1974). Most of the basin lies within NTS boundaries. One hundred twenty-two archaeological reconnaissance surveys have been conducted within the Yucca Flat hydrographic basin. Approximately 7,785 acres have been surveyed for cultural resources. This region is rich in cultural resources and includes sites from virtually all categories. There have been 340 sites recorded in the Yucca Flat weapons test basin hydrographic basin. This total includes 54 temporary camps, 10 extractive localities, 34 processing localities, 126 localities, 56 caches, 4 residential bases, 38 historic sites, 5 nuclear testing sites, and 13 untyped sites. Historic structures associated with nuclear testing are common here, but most have not been recorded and evaluated. To date, 130 sites in the Yucca Flat hydrographic basin are eligible for listing on the National Register of Historic Places. One site, Sedan Crater, is listed on the National Register of Historic Places.

Frenchman Flat—This area is bounded by the Spotted Range on the east; Mine Mountain/ Massachusetts Mountain on the north; the Shoshone Mountains, Lookout Peak, and Skull Mountains on the west, and the Ranger Mountains on the south (State of Nevada Engineer's Office, 1974). Only the western half of this hydrologic basin is within the NTS boundaries. Forty-two archaeological reconnaissance surveys have been conducted within Frenchman Flat hydrologic basin. Approximately 3,305 acres have been surveyed for cultural resources. There are 99 archaeological sites recorded as a result of these surveys. Of these, 2 are temporary camps, 2 are extractive localities, 38 are processing localities, 52 are localities, 1 is a residential base, 2 are historic sites, and 2 are related to nuclear testing and research. Forty-nine of the sites have been determined eligible for listing on the National Register of Historic Places. Historic structures relating to the development of nuclear weapons may also be eligible for listing on the National Register of Historic Places as a historic district.

SITES OF AMERICAN INDIAN SIGNIFICANCE—The Consolidated Group of Tribes and Organizations has had a long-standing relationship with the DOE since 1987. The group is comprised of 17 tribes and organizations, representing the Southern Paiutes, Western Shoshones, and the Owens Valley Paiutes. Each of these groups has substantiated cultural and historic ties to the NTS and the surrounding areas. The Consolidated Group of Tribes and Organizations has been instrumental in providing guidance by actively participating in the DOE's American Indian Religious Freedom Act Compliance Program, the Native American Graves Protection and Repatriation Act activities, the American Indian Monitoring Program, and the Yucca Mountain Site Characterization Project.

Numerous sites have been identified within the NTS boundaries that are important to American Indian people. Some of these sites have been identified through visits to the area by tribal representatives during American Indian Religious Freedom Act consultations.

These visits are summarized in Stoffle et al. (1990a) and Stoffle et al. (1994b). Any project that may impact sites of American Indian significance will include consultations with American Indian tribes and other potentially affected cultural groups before activities are initiated.

With respect to North Las Vegas, a historic site (Kyle Ranch) is located less than 1.6 km (1 mi) southwest of the proposed National Ignition Facility location; however, no archaeological remains (prehistoric or historic) are likely to be present because of the heavy past disturbance of the surface and near-surface sediment. No historic structures exist at the proposed National Ignition Facility location, nor have any American Indian cultural resources been identified at the North Las Vegas Facility in the course of past consultation with potentially affected tribal organizations.

The following information pertaining to cultural resources on the NTS is provided by the American Indian Writers Subgroup of the Consolidated Group of Tribes and Organizations.

AMERICAN INDIAN CULTURAL RESOURCES—The CGTO knows, based upon its collective knowledge of Indian culture and past American Indian studies, that American Indian people view cultural resources as being integrated. Thus, certain systematic studies of a variety of American Indian cultural resources must be conducted before the cultural significance of a place, area, or region can be fully assessed. Although some of these studies have been conducted on the NTS and nearby lands, many studies still need to be completed. In some portions of the NTS, a number of American Indian studies have been conducted, while in other areas studies have not begun. A number of studies are currently planned.

Indian people can fully assess the cultural significance of a place and its associated natural and cultural resources when all studies have been completed, and our governments and tribal organizations have reviewed the recorded thoughts of our elders and have officially supported these conclusions. American Indian studies focus on one topic at a time so that tribes and organizations can send experts in the subject being assessed. The following is a list of studies that are required for a complete American Indian assessment:

1. *Ethnoarchaeology*
   the interpretation of the physical artifacts produced by our Indian ancestors
2. *Ethnobotany*
   the identification and interpretation of the plants used by our Indian people
3. *Ethnozoology*
   the identification and interpretation of the animals used by Indian people
4. *Rock art*
   the identification and interpretation of traditional Indian paintings and rock peckings
5. *Traditional cultural properties*
   the identification and interpretation of places of central cultural importance to a people, called Traditional Cultural Properties; often Indian people refer to these as "power places"
6. *Ethnogeography*
   the identification and intrepretation of soil, rocks, water, and air
7. *Cultural landscapes*
   the identification and interpretation of spatial units that are culturally and geographically unique areas for Indian people.

When all of these subjects have been studied, then it is possible for Indian people to assess three critical issues: (1) what is the natural condition of this portion of our traditional lands? (2) how have DOE's ground-disturbing and monitoring activities altered and/or impacted American Indian cultural resources? and (3) what impacts will proposed alternatives have on either furthering existing changes in the natural environment or restoring our traditional lands to their natural condition? Indian people believe that the natural state of their traditional lands was what existed before 1492, when Indian people were fully responsible for the continued use and management of these lands.

The NTS and nearby lands were central to the Western Shoshone, Owens Valley Paiute, and Southern Paiute people (Figure 4-48). The lands were central in the lives

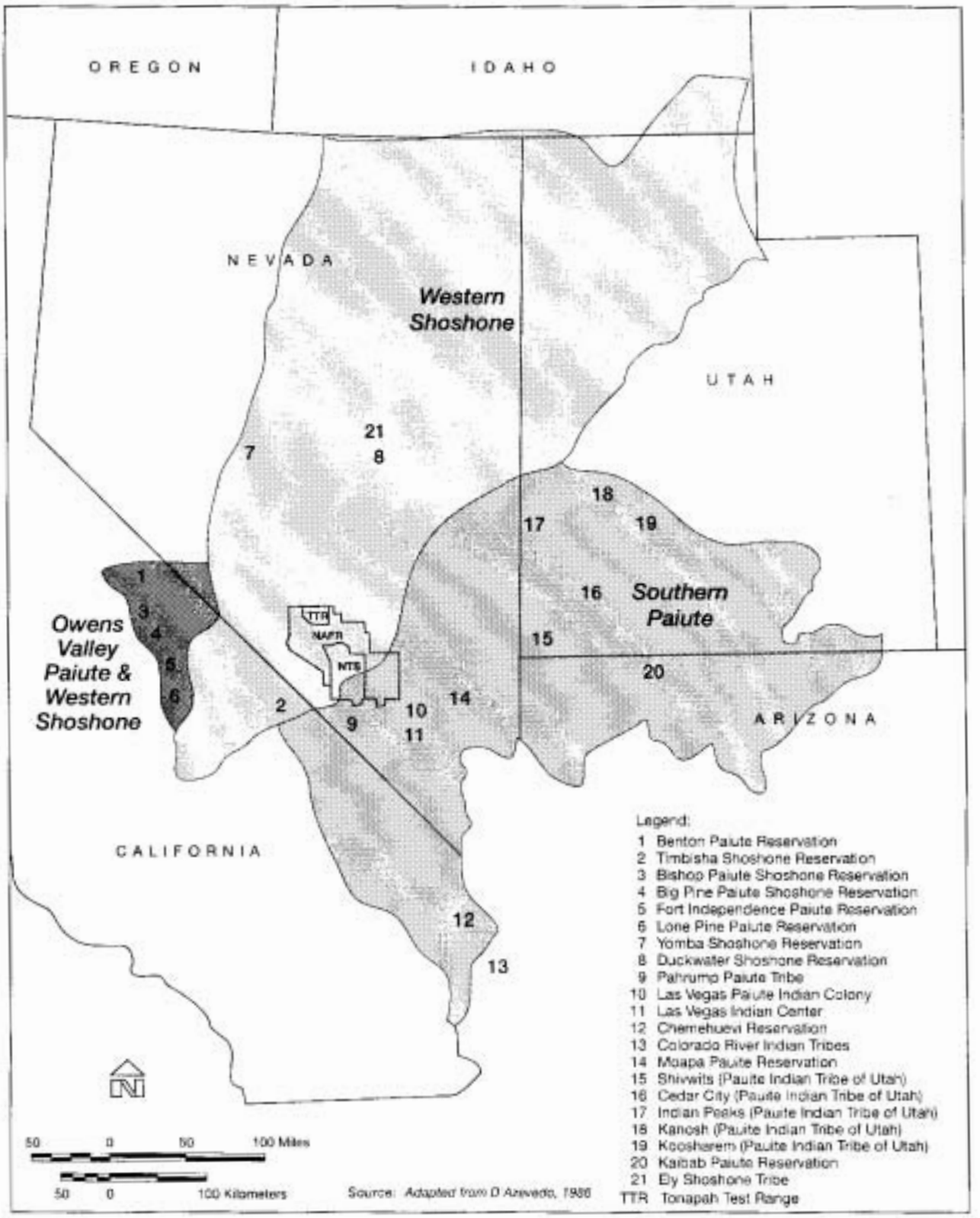


Figure 4-48. American Indian region of influence for the NTS EIS

of these people and so were mutually shared for religious ceremony, resource use, and social events (Stoffle et al., 1990a). When Europeans encroached on these lands, the numbers of Indian people, their relations with one another, and the condition of their traditional lands began to change. European diseases killed many Indian people, European animals replaced Indian animals and disrupted fields of natural plants, Europeans were guided to and then assumed control over Indian minerals, and Europeans took Indian agricultural areas. The withdrawal of Nevada lands for the use of the War Department as an aerial bombing and gunnery range in 1942 (Executive Orders No. 8578 of October 1940, and No. 9019 of January 12, 1942) and later the final land withdrawal of February 12, 1952 (Public Law Order 805), for use by the Atomic Energy Commission, continued the process of Euroamerican encroachment on these Indian lands. Pollution and destruction followed in the form of bombs and atomic testing, thus causing some places to become unusable again for Indian people. On the other hand, many places were protected by this land withdrawal because pothunters were kept from stealing artifacts from rock shelters and European animals were kept from grazing on Indian plants. The forced removal of Indian people from the NTS lands was combined with their involuntary registration and removal to distant reservations in the early 1940s. Indian people were thus removed from lands that had been central in their lives for thousands of years.

Despite the pollution and destruction of some cultural resources and the physical separation from the NTS and neighboring lands, the Indian people continue to value and recognize the central role of these lands in their continued survival. Recognizing this continuity in traditional ties between the NTS and Indian people, in 1985 the DOE began long-term research involving the inventory and evaluation of American Indian cultural resources in the area. This research was designed to comply with the American Indian Religious Freedom Act, which specifically reaffirms the First Amendment of the United States Constitution's rights of American Indian people to have access to lands and resources essential in the conduct of their traditional religion. These rights are exercised not only in tribal lands but beyond the boundaries of a reservation (Stoffle et al., 1994b).To reinforce their cultural affiliation rights and to prevent the loss of ancestral ties to the NTS, 17 Tribes and Organizations have aligned themselves together to form the CGTO. This group is formed by officially appointed representatives who are responsible for representing their respective tribal concerns and perspectives. The CGTO has established a long-standing relationship with the DOE. The primary focus of the group has been the protection of cultural resources. The DOE and the CGTO have participated in cultural resource management projects, including the Yucca Mountain Project (Stoffle 1987; Stoffle et al., 1988a; 1989a; 1990a), and the Underground Weapons Testing Project (Stoffle et al., 1994b). These studies are used in this report, along with the collective knowledge of the CGTO, as the basis of the comments in this NTS EIS.

The cultural resource management projects sponsored by the DOE have been extremely useful for expanding the inventory of American Indian cultural resources beyond the identification of archaeological remains and historic properties. To date, 107 plant and more than 20 animal species present on the NTS have been identified by Indian elders as part of their traditional resources. These plant and animal species are discussed in the following sections (see Table 4-38, Traditional-Use Plants and Table 4-39, Traditional-Use Animals).

Mercury Valley—The CGTO knows that the Mercury Valley hydrographic area contains a wide range of important cultural resources, including plants, animals, and archaeology sites. This knowledge comes from frequent visits by the CGTO members to this area. Observed plants in this valley include Indian ricegrass (Oryzopsis hymenoides), prince's plume (Stanleya pinnata), yucca (Yucca Baccata), and sacred datura (Datura meteloides). These plants represent sources of food, fiber, and medicine. Some important animal resources are rabbit, turtle, coyote, and chuckwalla. These and other Indian cultural resources found in Mercury Valley were and continue to be critical in the lives and culture of Indian peoples. No systematic American Indian studies have been conducted in Mercury Valley; therefore, at this time, it is not possible to completely assess the cultural significance of this area.

Rock Valley—The CGTO knows that the Rock Valley hydrographic area contains a wide range of important cultural resources, including plants, animals, archaeology sites, and minerals. One formal American Indian plant study involving elder Indian plant experts was conducted in Rock Valley as part of the Yucca

Table 4-38. American Indian traditional-use plants present in the NTS area
(Page 1 of 4)

Scientific Name	Common Name	GC[a]/ UTTR[b]	YM[c]	PM[d]/RM[e]
Ambrosia dumosa	*White burrsage*	X		
Amelanchier utahensis	*serviceberry*		X	
Amsinckia tessellata	*fiddleneck*		X	
Anemopsis californica	*verba mansa*		X	
Arabis pulchra	*wild mustard*		X	
Artemisia ludoviciana	*sagebrush, wormwood*	X	X	
Artemisia nova	*black sagebrush*	X		X
Artemisia tridentata	*big sagebrush*		X	X
Atriplex canescens	*four-winged saltbush*	X		
Atriplex confertifolia	*shadscale*		X	
Brodiaea pulchella	*desert hyacinth*		X	
Calochortus bruneaunis	*sego lily*			X
Calochortus flexuosus	*mariposa lily*		X	
Carex spp.	*sedge*	X		
Castilleja chromosa	*Indian paintbrush*		X	
Castilleja martinii	*narrowleaf paintbrush*			X
Ceratoides lanata	*winterfat*			X
Chenopodium fremontii	*Fremont goosefoot*			X
Chrysothamnus nauseosus	*rabbitbrush*	X	X	X
Cirsium mohavense	*desert thistle*		X	
Coleogyne ramosissima	*black brush*		X	
Coryphantha vivipara var. deserti	*fishhook cactus*	X	X	
Coryphantha vivipara var. rosea	*foxtail cactus*			X
Datura meteloides	*jimsonweed*	X	X	
Descurainia pinnata	*tansy mustard*		X	
Distichlis spicata	*salt grass*		X	
Echinocactus polycephalus	*cotton-top cactus*		X	
Echinocereus engelmannii	*hedge hog cactus*	X	X	
Eleocharis palustris	*spikerush*			X

Table 4-38. American Indian traditional-use plants present in the NTS area
(Page 2 of 4)

Scientific Name	Common Name	GC[a] UTTR[b]	YM[c]	PM[d]/RM[e]
Elymus elymoides	*squirrel tail*			X
Encelia virginensis var.actonii	*brittlebush*		X	
Ephedra nevadensis	*Indian tea*	X	X	X
Ephedra viridis	*Indian tea*		X	X
Eriastrum eremicum	*desert eriastrum*			X
Eriogonum inflatum	*desert trumpet*		X	
Erodium cicutarium	*herringbill*			X
Euphorbia albomarginata	*rattlesnake weed*		X	X
Geastrum spp.	*earthstar*		X	
Gilia inconspicua	*gilia*			X
Grayia spinosa	*spiny hop sage*			X
Gutierrezia microcephala	*matchweed*	X	X	
Juncus mexicanus	*wire grass*		X	
Juniperus osteosperma	*juniper, cedar*	X	X	X
Krameria parvifolia	*range ratany*		X	
Larrea tridentata	*creosote bush, greasewood*	X	X	
Lewisia rediviva	*bitter root*			X
Lycium andersonii	*wolfberry*	X	X	
Lichen	*lichen*		X	X
Lycium pallidum	*wolfberry*		X	
Menodora spinescens	*spiny menodora*		X	
Mentzelia albicaulis	*desert corsage*		X	X
Mirabilis multiflora	*four o'clock*	X		X
Nicotiana attenuata	*coyote tobacco*			X
Nicotiana trigonophylla	*Indian tobacco*	X	X	
Opuntia basilaris	*beavertail cactus*	X	X	
Opuntia echinocarpa	*golden cholla cactus*		X	
Opuntia erinacea	*Mojave prickly pear*	X	X	
Opuntia polycantha	*grizzly bear cactus*			X

Table 4-38. American Indian traditional-use plants present in the NTS area
(Page 3 of 4)

Scientific Name	Common Name	GC[a] UTTR[b]	YM[c]	PM[d]/RM[e]
Orobanche corymbosa	*broomrape, wild asparagus*			X
Oryzopsis (Stipa) hymenoides	*Indian ricegrass*	X	X	X
Penstemon floridus	*Panamint beard tongue*			X
Penstemon pahutensis	*Pahute beard tongue*			X
Peraphyllum ramosissimum	*squawapple*		X	
Phragmites australis	*cane, reed*	X	X	
Pinus monophylla	*pinyon pine*		X	X
Prosopis glandulosa	*mesquite*	X	X	
Prosopis pubescens	*screwbean*		X	
Psorothamnus polydenius	*dotted dalea*		X	
Purshia glandulosa	*buckbrush*		X	
Purshia mexicana	*cliffrose*			X
Purshia tridentata	*buckbrush*			X
Quercus gambelii	*scrub oak*		X	X
Rhus aromatica	*skunkbush, sumac*			X
Rhus trilobata var. anisophylla	*squawbush*		X	
Rhus trilobata var. simplicifolia	*squaw bush*	X	X	
Ribes cereum	*white squaw currant*			X
Ribes velutinum	*desert gooseberry*			X
Rosa woodsii	*woods rose*			X
Rumex crispus	*curly dock, wild rhubarb*		X	
Salix exigua	*willow*	X	X	
Salix gooddingii	*black willow*	X	X	
Salsola iberica	*Russian thistle*	X		X
Salvia columbariae	*chia sage*		X	
Salvia dorrii	*purple sage, Indian tobacco*	X	X	
Sarcobatus vermiculatus	*greasewood*	X		
Sisymbrium altissimum	*tumbling mustard*			X
Sphaeralcea ambigua	*globe mallow*	X	X	X

Table 4-38. American Indian traditional-use plants present in the NTS area
(Page 4 of 4)

Scientific Name	Common Name	GC[a] UTTR[b]	YM[c]	PM[d]/RM[e]
Stanleya pinnata	*Prince's Plume*	X	X	X
Stephanomeria sp. spinosa	*spiny wire lettuce, gum bush*		X	X
Stipa speciosa	*bunchgrass*		X	
Streptanthella longirostris	*wild mustard*		X	
Streptanthus cordatus	*wild mustard*		X	
Suaeda torreyana	*seepweed*		X	
Symphoricarpos longiflorus	*snowberry*		X	
Symphoricarpos spp.	*snowberry*			
Tessaria sericeae	*arrowweed*	X	X	
Thamnosma montana	*turpentine bush*	X	X	
Thelypodium integrifolium	*wild cabbage*		X	
Typha domingensis	*cattail*		X	
Typha latifolia	*cattail*	X	X	
Veronica anagallis-aquatica	*speedwell*		X	
Vitis arizonica	*wild grape*	X	X	
Xylorhiza tortifolia	*desert aster*		X	
Yucca baccata	*banana yucca*	X	X	X
Yucca brevifolia	*Joshua tree*		X	
Yucca spp.	*yucca*		X	
Yucca schidigera	*Mojave yucca, Spanish bayonet*		X	

[a] Colorado River Corridor
[b] Utah Test and Training Range
[c] Yucca Mountain
[d] Pahute Mesa
[e] Rainier Mesa

NOTE: American Indian traditional-use plants present in the NTS area are identified in the project reports entitled American Indian Plant Resources in the Yucca Mountain Area, Nevada (Stoffle et al., 1994b) and American Indian Cultural Resources on Pahute and Rainier Mesas, NTS. This table includes traditional-use plants identified in the Colorado River Corridor Study and in the Utah Test and Training Range Study that are also present at the NTS.

Table 4-39. American Indian traditional-use animals present at the NTS

Scientific Name	Common Name
Alectoris chukar	*chukar*
Ammospermophilus leucurus	*white-tailed antelope squirrel*
Amphispiza bilineata	*black-throated sparrow*
Aquila chrysaetos	*golden eagle*
Buteo jamaicensis	*red-tailed hawk*
Callipepla gambelii	*Gambel's quail*
Canis latrans	*coyote*
Cicadidae spp.	*cicada*
Cnemidophorus tigris	*western whiptail lizard*
Canis latrans	*coyote*
Colaptes auratus	*northern flicker*
Crotalus spp.	*rattlesnake*
Eutamias dorsalis	*cliff chipmunk*
Felis concolor	*mountain lion*
Felis rufus	*bobcat*
Formicidae formicinae	*mound-building ant (red and black ant)*
Gopherus agassizii	*desert tortoise*
Haliaeetus leucocephalus	*bald eagle*
Odocoilaus hemionus	*mule deer*
Ovis canadensis	*bighorn sheep*
Sauromalus obesus	*chuckwalla*
Spizella breweri	*Brewer's sparrow*
Stagmomantis spp.	*praying mantis*
Sylvilagus spp.	*cottontail*
Vulpes velox	*kit fox*
Zenaida macroura	*mourning dove*

NOTE: American Indian traditional-use animals are identified in the project report entitled American Indian Cultural Resources on Pahute and Rainier Mesas, NTS (Stoffle et al., 1994b). This table presents only a partial list of traditional-use animals present at the NTS. To date, no systematic or extensive animal studies have been conducted at the NTS.

Mountain Project. A total of 32 medicine and food plants in upper Rock Valley were identified as part of the Yucca Mountain Project ethnobotany study (Stoffle et al., 1989b).

Another 10 traditional-use plants were identified at the northeast base of Little Skull Mountain near the divide between Rock Valley and Jackass Flats (Stoffle et al., 1988a). Some of the important animals in the valley include rabbit, turtle, coyote, and whiptail lizard, which were used for food, ceremony, and eye surgery.

Systematic American Indian studies of animals and archaeology have not been conducted in Rock Valley; therefore, a complete assessment of the cultural significance of this area is not possible at this time.

Fortymile Canyon-Jackass Flats—The CGTO knows that the Fortymile Canyon and Jackass Flats hydrographic area contains a wide range of important cultural resources, including plants, animals, archaeology sites, minerals, and power places. Three formal plant studies were conducted in this area as part of the Yucca Mountain Project, which identified 13 traditional-use plants (Stoffle et al., 1988a). Fifteen formal ethnoarchaeological studies were conducted in this area as part of the Yucca Mountain Project, which identified numerous archaeological resources in this area, dating as early as Clovis (10,000 years ago) (Stoffle et al., 1989a). Also present in this area are important minerals, which were extracted by Indian people to make tools and other stone artifacts. Traditional quarry sites and localities are associated with these mineral resources. At least one power place, known to be associated with Indian ceremonies, is located in this area. Fortymile Canyon is well known among Indian people who continue to use either its traditional Shoshone name Dogowya Hunumpi (Snake Wash) or the Owens Valley name Towahonupi (Snake Canyon) to describe it. The canyon was a significant crossroads where numerous traditional Indian trails from distant places like Owens Valley, Death Valley, and the Avawatz Mountains came together (Stoffle et al., 1989a). While many American Indian studies have been conducted in this area, other cultural resources have not been systematically studied. Other needed studies include rock art (which is called in Southern Paiute tumpituxwinap or literally "storied rocks" [Stoffle et al., 1995]), power places, and animals.

Buckboard Mesa—The CGTO knows that the Buckboard Mesa hydrological area contains a wide range of important cultural resources including plants, animals, archaeology sites, minerals, and power places. Two ethnoarchaeology site visits have been conducted in this area. One study was focused on a power rock and a series of petroglyph panels located at the southern end of Buckboard Mesa (Stoffle et al., 1994b), and the second study included a visit to rock shelters containing obsidian nodules, artifacts, and Indian rock paintings. To the north of Buckboard Mesa is an extensive area of obsidian nodules that were significant in many ways to Indian people. Scrugham Peak, a volcanic cone, was preliminarily identified by Indian people as a place of traditional power and ceremony. A full cultural assessment of this place and its role in the Buckboard Mesa area awaits systematic American Indian Traditional Cultural Property studies. While some American Indian studies have been conducted in this area, only a few archaeology sites have been assessed. There have been no systematic studies of plants, animals, and Traditional Cultural Properties.

Oasis Valley—The CGTO knows that the Oasis Valley hydrographic area is a part of the agricultural core area of a much larger Indian district called Ogwe'pi *by the Indian people who used this farming, gathering, and medicine area. The cultural significance of the* Ogwe'pi *District is well-established by document research (Stoffle et al., 1989a), one plant area study, and one archaeology study area (Stoffle et al., 1994b) and by interviews conducted during the 1930s. According to Indian people interviewed in the 1930s (Steward, 1938), the* Ogwe'pi *District contained agricultural lands next to springs and streams in Oasis Valley itself, while the uplands formed by nearby mountains contributed pine nuts and deer to the diet of the Indian people (Stoffle et al., 1990b). The* Ogwe'pi *District was an important place for Indian trade and ceremonialism. Mineral hot springs were used by Indian people for curing, thus further increasing the cultural importance of the Oasis Valley core area. During much of the historic period, Indian people continued to live in Oasis Valley and use the surrounding uplands of the* Ogwe'pi *District. Much of the Oasis Valley hydrological basin has not been systematically studied by American Indian people. Therefore, at this time, it is not possible to fully assess the cultural significance of all places in the Oasis Valley.*

Gold Flat—The CGTO knows that the Gold Flat hydrographic area contains a wide range of important cultural resources including plants, archaeology sites, and power places. This conclusion is based on American Indian studies conducted along the central and northern portions of Pahute Mesa. These studies identified 42 species of Indian plants found in this area (Stoffle et al., 1994b). American Indian archaeological studies in this area document the presence of living areas, food and tool processing areas, burial sites, and power places. Initial animal studies indicate the presence of culturally significant species, such as hawks and eagles. At this time, it is not possible to make a full cultural assessment of this hydrological area because only the Pahute Mesa has been studied, and additional studies are planned to assess rock art and traditional cultural properties.

Kawich Valley—The CGTO knows that the Kawich Valley hydrological area contains a wide range of important Indian cultural resources, including plants, animals, archaeology sites, and places of both power and ceremony. This knowledge comes from a series of systematic American Indian studies on Pahute Mesa regarding plants and animals and by selected observations by individual Indian people. A total of 42 plants were identified from 6 plant locations, 36 of which are still used today (Stoffle et al., 1994b). Interviews with Indian experts about animals indicated a number of culturally significant species, including hawks and eagles, and a unique species of ant valued as both food and medicine. Archaeological studies at sites indicate the presence of living areas and places where food and plants were processed (Stoffle et al., 1994b). Kawich Valley contains an important trail used within the current memory of Indian people. Members of the Kawich family visited this area and recounted family memories of Kawich Valley and the use of the Pahute Mesa. Individual Indian people identified places in Gold Meadows where places of power and ceremony traditionally occurred, but no systematic interviews on this issue have been conducted. The CGTO has recommended that the Gold Meadows area be set aside for special protection and use by Indian people because of the concentration and variety of Indian cultural resources it contains (see Appendix G containing EIS-American Indian Meeting Report April, 1995). The cultural significance of the entire Kawich Valley hydrological area cannot be assessed at this time because studies have been limited to Pahute Mesa and because both Traditional Cultural Property and animal studies are planned for the area.

Emigrant Valley—The CGTO knows that the Emigrant Valley hydrological area contains a wide variety of important cultural resources, including plants, animals, and archaeology sites, because it is next to Gold Meadows and Rainier Mesa areas (Stoffle et al., 1994b). Indian people have requested access to this area but have not been permitted to either visit or conduct systematic interviews here; therefore, all current information about this area derives from recorded and unrecorded Indian oral history. It is known that an Indian man who received the Anglo name Panamint Joe Stuart was from the Belted Range, which is the western boundary of the Emigrant Valley (Steward, 1938). Steward's Indian interviews conducted in the 1930s indicated that in the late 1800s there were 15 known locations of Indian camps in the Belted Range (Steward, 1938). Steward's interviews revealed that the Indian people of these Belted Range villages associated with the Indian people in the Kawich Range to the east and the Beatty people to the southwest. These data support the tentative conclusion of the CGTO that the two valleys have similar levels of cultural significance. No systematic Indian studies have been conducted in Emigrant Valley, so a complete cultural assessment is not possible at this time.

Yucca Flat weapons test basin—The CGTO knows that the Yucca Flat weapons test basin hydrological area contains a wide variety of culturally important Indian resources including plants, animals, archaeology sites, rock paintings, and ceremonial areas. Systematic American Indian studies have been conducted along the southern rim and base of Rainier Mesa, in the Eleana Range, on the northeastern flank of Shoshone Mountain, and along the western edge of Yucca Flat weapons test basin itself. Plant studies indicate that 2 species are located in the more arid lowlands, 13 species at Tippipah Spring, 21 species at Captain Jack Spring, 11 species at White Rock Spring, and 4 species on the mesa rim (Stoffle et al., 1988a). The few interviews with Indian people about animals observed in this area do indicate that many significant animals are present, including mountain lion, deer, and hawks. The area is archaeologically complex with major camps located at permanent springs and food and tool processing places scattered throughout the area. All the springs in this area were permanent Indian camps. White Rock Spring, Toshatimbibah, *had a major settlement called* Tunava *in the late 1880s and was a central place for interethnic gatherings. Indian people came to these ceremonies from distant communities. These ceremonies included major annual rabbit drives and dances that lasted up to a month (Steward, 1938). This spring was the home of a regional chief whose name was* Wangagwana *(Steward, 1938). The White Rock Spring was occupied by Indian people until the 1930s and used until the mid-1950s after the NTS was officially withdrawn from public use. The cultural significance of the western portion of this hydrological area is well established; however, no studies have been conducted in the central, eastern, and southern portions of this area. Because additional American Indian studies are planned and some areas have not been studied, a full cultural assessment of this area is not possible at this time.*

Frenchman Flat—The CGTO knows that the Frenchman Flat hydrological area contains a wide variety of plants, animals, and archaeology sites of cultural importance to Indian people. Systematic studies of both plants and archaeology sites have been conducted in the west-central portion of this area. A total of 20 plant species were identified at 2 plant study locations, with 2 species identified on a flat area near the eastern flank of Mt. Sayler and another 18 species identified at Cane Spring (Stoffle et al., 1988a). A complete cultural assessment of this area is not possible at this time because past studies were geographically and topically restricted.

CULTURAL RESOURCES, AREA 13—Area 13 lies in the southern Great Basin, an area with a prehistory that may span the past 10,000 years or more. Properties ranging from the early prehistoric period to historic mining and ranching sites are found in the region. Archaeological research in the vicinity of Area 13 has been extremely limited. This limitation makes characterization of the cultural resources extremely difficult. Archaeological reconnaissance in the area includes a survey of three soil test units (Beck, 1993) in Emigrant Valley, a Class II cultural resources reconnaissance of the entire Groom Range (Reno and Pippin, 1986), and Class II survey of the Nellis Air Force Bombing and Gunnery Range (Bergin et al.,1979). Because these surveys only sampled this large area, it is likely that additional undiscovered resources occur within the project area.

At the time of contact with Euroamericans in the mid-1800s, the area was used by bands of Western Shoshone people centered around the Belted and Kawich Mountain Ranges (Steward, 1938) and by Southern Paiutes centered in the Pahranagat Valley (Fowler and Fowler, 1971). The project area lies adjacent to the boundary between these two groups. Ethnographic studies have focused on the central areas within these two districts, thus little is known about the interaction of these groups along the frontier of their tribal boundaries. Therefore, this region is important archaeologically.

An area of potential effect for the cultural resources in the Area 13 region is based on research performed in the area for three proposed test units for soil treatability studies. The site is on the NAFR Complex within the Emigrant Valley, adjacent to the northeast corner of the NTS. Emigrant Valley is bounded by the Halfpint Range to the south and southwest, the Belted Range to the northwest, and the Groom Range to the northeast (State of Nevada Engineer's Office, 1974).

RECORDED CULTURAL RESOURCES—Few sites have been recorded directly within the area of potential effect for Area 13. Five sites, one temporary camp, and four processing localities (Brooks et al., 1978) have been identified in the general vicinity. In the same year, the University of Nevada, Las Vegas recorded four more processing localities (Jenkins, 1978). As part of the Nellis Air Force Base Bombing and Gunnery Range survey, two of the previously mentioned sites were relocated, and two more processing localities were found. Other surveys for roads and fencelines identified more sites. Three are temporary camps, three are extractive localities, seven are processing localities, and one is a mining area (Clerico, 1978; Steinberg, 1980; Bunch, 1984).

The most extensive cultural resource reconnaissance work in the project area was conducted by the Desert Research Institute as part of a 6 percent sample survey of the Groom Range (Reno and Pippin, 1986). A total of 160 sites were recorded during this survey, including 30 temporary camps, 17 extractive localities, 63 processing localities, and 53 localities. This sample provides a background against which predictive models may be generated. Similar types of sites may be expected in Area 13, although frequencies may be quite different. Many of these sites have been recommended as eligible for listing on the National Register of Historic Places.

SITES OF AMERICAN INDIAN SIGNIFICANCE—The CGTO knows that Area 13 contains significant cultural resources, including plants, animals, archaeology sites, and places of historic value to Indian people. This is known from Indian interviews conducted in the 1930s (Steward, 1938) and recent plant, animal, and archeology studies conducted south of this area in comparable environments (Stoffle et al., 1990a; Stoffle et al., 1994b). These studies document long-term and extensive involvement of Indian people in these traditional lands. These were among the last areas lived in before Indian people were forced out of the area to live on more distant Indian reservations. As a result of oral history, Indian people know there are various types of cultural resources located in this study area, but

cannot provide site-specific information about these areas at this time. No Indian people officially representing the CGTO have visited Area 13 or any other portion of the NAFR Complex, although such interviews have been requested and one initial meeting with a NAFR Complex archaeologist has occurred. Therefore, it is not possible to fully assess the cultural significance of Area 13 at this time.

4.1.11 Occupational and Public Health and Safety/Radiation

The health and safety of site workers and the general public is discussed in this section. In addition, a brief discussion of the NTS health and safety program is presented.

OVERVIEW—The potential for activities at the NTS to impact the health and safety of the general public is minimized by a combination of the remote location of the NTS, the sparse population surrounding it, and a comprehensive program of administrative and design controls.

Visitors to the NTS, including individuals and tour groups, are subject to essentially the same safety and health requirements as workers. Safety briefings are provided as appropriate (e.g., tunnel entry), personal protective equipment is provided when necessary, and radiation dosimeters may be issued along with badges as part of the visitor-control process. Visitors may request radiation dosimeters even though none might be required in the areas visited. Secondary access control is provided when necessary for safety or security reasons. Access to areas of the NTS where working conditions require special hazard controls (e.g., the Radioactive Waste Management Sites) is restricted through the use of signs, fences, or barricades.

The health and safety of NTS workers is protected by adherence to the requirements of federal and state law, DOE orders, and the plans and procedures of each organization performing work on the NTS. A program of self-assessment for compliance with these requirements is conducted by each of the Maintenance and Operations contractors and by the DOE. In addition, workers are protected from the specific hazards associated with their jobs by training, monitoring the workplace environment, using personal protective equipment, and using administrative controls to limit their exposures to radioactive or chemical pollutants. Worker access to areas of the NTS that present working conditions requiring special hazard control is restricted through the use of signs, barriers, and fences, as appropriate.

CRITERIA—All work at the NTS is performed according to the safety and health requirements of the Occupational Safety and Health Administration as codified in Title 29 CFR Parts 1910 and 1926. The DOE orders also provide direction for worker safety and health programs (see Appendix C).

To integrate the activities of a number of contractors and NTS users and to avoid discontinuities in the health and safety program, the NTS is operated under the standard operating procedures of the NTS Operations. The relevant procedures include the following NTS standard operating procedures:

- 5401 Environment, Safety, and Health Coordination Responsibilities (DOE, 1990)
- 5402 Radiological Safety (DOE, 1995b)
- 5409 Management of Hazardous Materials and Hazardous Wastes (DOE, 1993)
- 5410 Industrial Hygiene (DOE, 1995c)
- 5411 Nuclear Criticality Safety (DOE, 1995d)
- 5412 Explosive Safety (DOE, 1995e)
- 5415 Safety and Fire Responsibilities (DOE, 1991).

Procedures relevant to specific aspects of the nuclear testing program are also part of the standard operating procedures of the NTS Operations.

INSTITUTIONAL SAFETY PROGRAMS—The NTS supports the following on-site safety services provided by the Maintenance and Operations contractor and available to all users:

- Fire department

- Occupational medicine department
- Radiological safety services, including a radioactive material control to ensure that material leaving the NTS is not contaminated
- Industrial hygiene services.

Workers at the North Las Vegas Facility may be exposed to other hazards in the workplace. Workers are protected from hazards specific to the workplace through appropriate training, protective equipment, monitoring, and management controls. Workers are also protected by strict adherence to federal standards that limit atmospheric and drinking water concentrations of potentially hazardous chemicals. Appropriate monitoring, which reflects the frequency and amounts of chemicals utilized in facility processes, ensures that these standards are not exceeded. The North Las Vegas Facility stores and uses few hazardous materials in amounts greater than the threshold planning quantities that require reporting under federal regulations.

RADIOLOGICAL HEALTH—The *Nevada Test Site Annual Site Environmental Report-1993* (Annual Site Environmental Report) (DOE/NV, 1994a) provides ambient exposure levels at numerous locations on the NTS. The Annual Site Environmental Report contains detailed information regarding ongoing radiological monitoring at the NTS and also provides some information regarding safety shots conducted on the NAFR Complex (Area 13).

Radiation exposure levels of the NTS indicate that during 1993, exposure rates varied on the NTS from 90 to 4,300 milliroentgen (mR)/yr. A group of locations that were not, to the best available knowledge, influenced by radiological contamination served as control areas for the NTS and on parts of the NAFR Complex and Tonopah Test Range. The average exposure rate from all of these control areas was 0.36 mR/day or 131 mR/yr. A complete listing of all of the exposure measurements can be found in Volume 2 of the Annual Site Environmental Report.

The North Las Vegas Facility provides calibration services using specialized radiation fields for a variety of instrument test packages in support of the DOE/NV operations. Based on operating data for the year 1993, workers at the North Las Vegas Facility received an average radiation dose of 82 millirem per year, and the maximally exposed worker received a dose of 440 millirem. The worker population received a collective dose of 0.57 roentgen equivalent man (rem) which would result in a risk of 2.3×10^{-4} of a single fatal cancer in the worker population. These doses are in addition to natural background radiation which would contribute about 300 millirem per year to each individual and a collective dose of about 2.1 rem to the worker population (based on seven monitored workers).

RADIOLOGICAL EFFLUENTS—Radiological effluent in the form of air emissions and liquid discharges is released as a routine part of operations on the NTS. Radioactivity in liquid discharges released to on-site waste treatment or disposal systems (containment ponds) is monitored to assess the efficacy of treatment and control and to provide a quantitative and qualitative annual summary of released radioactivity. Air emissions are monitored for source characterization and operational safety, as well as for environmental surveillance purposes.

Environmental surveillance on the 3,496-km^2 (1,350-mi^2) NTS is designed to cover the entire area, with emphasis on areas of past nuclear testing and present operational activities. In 1994, there were 54 samplers collected for air particulate and reactive gases, 19 samplers collected for tritiated water vapor in atmospheric moisture, and 10 samplers collected for air for analysis of noble gas content. Grab samples were collected frequently from springs, water supply wells, open reservoirs, containment ponds, and sewage lagoons. Thermoluminescent dosimeters were placed at 201 locations on the NTS.

Data from these networks are summarized as annual averages for each monitored location. Locations with concentrations above the NTS average are assumed to reflect on-site emissions. These emissions arise from diffuse (areal) sources and from particular operational activities (e.g., radioactivity buried in the low-level waste site).

Approximately 2,700 air samples were analyzed by gamma spectroscopy. All isotopes detected by gamma spectroscopy were naturally occurring in the environment (potassium-40, beryllium-7, and members of the uranium and thorium series), except for fixed instances where very low levels of cesium-137 were

detected. A slightly higher average was found in samples in certain areas, but that level was calculated to be only 0.01 percent of the Derived Air Concentration Guide for exposure to the public.

Surface water sampling was conducted quarterly at 12 well reservoirs, 8 springs, 1 containment pond, and 9 sewage lagoons. A grab sample was taken from each of these surface water sites for analysis of gross beta, tritium, gamma-emitters, and plutonium isotopes. Strontium-90 was analyzed once per year for each location. Water samples from the springs, reservoirs, and lagoons contained background levels of gross beta, tritium, plutonium, and strontium. Samples collected from the containment pond contained detectable levels of radioactivity, as would be expected. Water from on-site supply wells and distribution systems was sampled and analyzed for radionuclides. The supply-well average gross beta activity was 2 percent of the Derived Concentration Guide; gross alpha was 40 percent of the drinking water standard; strontium-90 was measured at about 1 percent of the Derived Concentration Guide; and plutonium-239, -240, and -238 were all below detectable levels.

External gamma radiation exposure data from the on-site thermoluminescent dosimeter network indicated that gamma exposure rates recorded during 1994 were statistically lower than the data collected in 1993. Recorded exposure rates on the NTS ranged from 54 mrem/yr in Mercury to 3,679 mrem/yr for a radioactive material storage area in Area 5. The 1994 sitewide average for boundary and control stations of 111 mrem/yr was about 23 percent lower than 1993.

RADIOLOGICAL CONTAMINATION—As discussed in previous sections, radiation-contaminated areas on the NTS, the NAFR Complex, and the Tonopah Test Range primarily resulted from safety tests that began in 1951 and continued through the early 1960s. Nuclear explosive tests conducted through the 1950s were predominantly atmospheric tests. These tests involved the detonation of a nuclear explosive device placed on the ground surface, on a steel tower, suspended from tethered balloons, or dropped from an aircraft. Several of the tests were non-nuclear; i.e., safety tests, involving destruction of a nuclear device with non-nuclear explosives. Since 1962, nearly all tests have been conducted in sealed vertical shafts drilled into the valley floor of Yucca Flat weapons test basin and the top of Pahute Mesa, or in horizontal tunnels mined into the face of Rainier Mesa. Other nuclear testing over the history of the NTS has included the BREN Tower and the nuclear ramjet experiment conducted in Area 26 by Lawrence Livermore National Laboratory. Waste disposal facilities for radioactive and mixed waste are located at Areas 3 and 5.

The *Contaminated Areas Report* published by Reynolds Electrical and Engineering Co. Inc. (1992) provides a complete listing and maps of all the identified radiation-contaminated areas on the NTS. This report also includes the contaminated areas that are found on the Tonopah Test Range and the NAFR Complex. Areas are considered contaminated if the radiation level is above background levels. A total of 235 contaminated areas exist on the NTS, the Tonopah Test Range, and the NAFR Complex. These areas are either posted and/or fenced, depending on their level of contamination. There are 135 km^2 (52 mi^2) of posted areas and 13 km^2 (5 mi^2) of fenced areas. Most of the contaminated areas on the NTS are a direct result of weapons tests. These areas include craters, mud pits, cellars, and muck piles. In addition to those areas, there are a number of other contaminated locations associated with tunneling and the tests conducted within tunnels. The bulk of the contaminated areas associated with tunnels are located in Area 12 and include such areas as contaminated muck piles, tunnel ponds, and holding areas for contaminated items exiting the tunnels.

Buildings used for the safe handling of spent nuclear rods and for nuclear rocket development from reactors are also listed as contaminated areas. These buildings, located in Area 25, include maintenance, assembly, and disassembly facilities and test cells. Other contaminated areas include a few core testing laboratories and the EPA Farm site in Area 15. Storage sites for radioactive material and wastes and for other miscellaneous sites make up the remainder of contaminated areas on the NTS. The current radionuclide content in most of the contaminated areas is fission products (predominately cesium-137) that have not totally decayed. Plutonium-239 is the other primary radionuclide appearing on the NTS.

ECOLOGICAL STUDIES—Studies conducted under programs sponsored by the DOE/NV included monitoring the plants and animals on the NTS to assess changes over time in their ecological conditions and to

provide information needed to document NTS compliance with environmental laws, regulations, and orders (Hunter, 1992b, 1994b,c, 1995). The monitoring effort has been arranged into three interrelated phases of work: (1) a series of five undisturbed study plots in test-impacted ecosystems that are monitored at 1- to 5-year intervals to establish natural baseline conditions, (2) a series of study plots in representative disturbed areas that are monitored at 3- to 5-year intervals to determine impacts of disturbance, document site recovery, and investigate natural recovery processes; and (3) observations of birds and large mammals throughout the NTS.

In 1994, during the seventh full year of flora and fauna monitoring, surveys were conducted at numerous sites for perennial and ephemeral plants, mammals, and reptiles. Many of these sites included paired disturbed and undisturbed plots. Three baseline sites were monitored, and perennial and ephemeral plants were measured at all of them. Sites in disturbed areas are monitored on a 3-year cycle. Baseline measurements were also made near the Device Assembly Facility in Frenchman Flat (Woodward et al., 1995).

Monitoring of wild horses continued for the fifth consecutive year. All horses, including foals, were individually identified. Field observations were also made of raptors, mule deer, and raven in appropriate habitats throughout the NTS. Desert tortoises in the Rock Valley study enclosures were monitored in the spring and fall, and free-roaming tortoises were marked and measured when encountered by chance.

GROUNDWATER PROTECTION—The DOE/NV instituted a long-term Hydrological Monitoring Program in 1972 to be operated by the EPA under an interagency agreement. In 1994, groundwater was monitored on and off the NTS and at five sites in other states to detect the presence of any radioactivity that may be related to nuclear testing activities. No radioactivity was detected above background levels in the groundwater sampling network surrounding the NTS. Low levels of tritium, in the form of tritiated water vapor, were detected in on-site wells, as has occurred previously. None of the levels exceeded 33 percent of the National Primary Drinking Water Regulation level.

Monitoring and surveillance on and around the NTS by DOE contractors and NTS user organizations during 1994 indicated that operations on the NTS were conducted in compliance with applicable federal and DOE regulations and guidelines. All discharges of radioactive liquids remained on site in containment ponds, and there was no indication of potential migration of radioactivity to the off -site area through groundwater. Surveillance around the NTS indicated that airborne radioactivity from diffusion, evaporation of effluent, or resuspension was not detectable off site, and no measurable net exposure to members of the off-site population was detected through the off-site dosimetry program.

OFF-SITE ENVIRONMENTAL SURVEILLANCE—The off-site radiological monitoring program has been conducted around the NTS since 1992 by the EPA's Environmental Monitoring Systems Laboratory, Las Vegas, under an interagency agreement with the DOE. Prior to 1972, monitoring was performed by the U.S. Public Health Service. The objectives of the Off-Site Environmental Surveillance Program are to assure nearby residents of the safety of the air and water, to provide a long-term environmental baseline, and to detect contamination from DOE activities, if present." This program consists of several extensive environmental sampling, radiation detection, and dosimetry networks.

For the first three quarters of 1994, the Air Surveillance Network was made up of 30 continuously operating sampling locations surrounding the NTS, and 77 standby stations (operated 1 week each quarter) in all states west of the Mississippi River. The 30 Air Surveillance Network stations included 18 located at Community Radiation Monitoring Program stations described below. During 1994, no airborne radioactivity related to current activities at the NTS was detected on samples from the Air Surveillance Network.

The Noble Gas and Tritium Surveillance Network initially consisted of 21 off-site noble gas samplers (8 on standby) and 21 tritium-in-air samplers (7 on standby) located outside the NTS, in associated and exclusion areas, and in Nevada, California, and Utah. During 1994, no radioactivity that could be

related to NTS activities was detected at these sampling stations.

The Milk Surveillance Network consisted of 24 sampling locations within 244 km (186 mi) of the NTS and 115 standby Milk Surveillance Network locations throughout the major milk sheds west of the Mississippi River. The levels of analytes in both milk networks have decreased over time since reaching a maximum in 1964. The results from these networks are consistent with previous data.

Other foods were analyzed regularly; most of this food was meat from domestic or game animals collected on and around the NTS. The strontium-90 levels in samples of animal bone remained very low, as did plutonium-239 and -240 in both bone and liver samples. Beets and apples from several off-site locations contained normal potassium-40 activity. Small amounts of plutonium-239, -240, and -238 were found on a few samples.

In 1994, external exposure was monitored by a network of 127 thermoluminescent dosimeters and 27 pressurized ion chambers. The ion chamber network in the communities surrounding the NTS indicated that background exposures, ranging from 73 to 164 mrem/yr, were consistent with previous data and well within the range of background data in other areas of the United States.

Sampling of Long-Term Hydrological Monitoring Program wells and surface waters around the NTS showed only background radionuclide concentrations. The program also included groundwater and surface-water monitoring at locations in Colorado, Mississippi, New Mexico, Alaska, and Nevada where underground tests were conducted.

A network of 18 Community Radiation Monitoring Program stations is operated by local residents. Each station was an integral part of the Air Surveillance, the Noble Gas and Tritium Surveillance, and the Thermoluminescent Dosimeter networks. In addition, the stations are equipped with a pressurized ion chamber connected to a gamma-rate recorder. Samples and data from these Community Radiation Monitoring Program stations were analyzed and reported by Environmental Monitoring Systems Laboratory, Las Vegas, and interpreted and reported by the Desert Research Institute, University of Nevada system. All measurements for 1994 were consistent with previous years and were within the normal background range for the United States.

No radioactivity attributable to current NTS operations was detected by any of the off-site monitoring networks. However, based on the NTS releases reported, atmospheric dispersion model calculations indicated that the maximum potential effective dose equivalent to an off-site individual would have been 0.0038 rem, and the dose to the population within 80 km (50 mi) of the emission sites would have been 0.012 person-rem. The hypothetical person receiving this dose would also have been exposed to 97.0 rem from natural background radiation.

In North Las Vegas, radiation doses to the public as a result of routine operations at the North Las Vegas Facility are too low for measurement. Two very small atmospheric releases of radioactivity occurred in 1995. Calculated doses to the public from these releases are estimated to be a fraction of one millirem and are well within regulatory limit of 10 millirem/year for the airborne pathway. These calculated doses are in addition to natural background radiation of about 300 millirem per year per person.

American Indian Perceived Risks——*Indian people believe that various perceived risks are present and occur as a result of DOE activities. Although there are no Indian words for terms such as* radiation *in the Indian language, early ethnographic studies supported by the DOE, documented a traditional view of radioactivity which centers on the perception by Indian elders of radiation being produced by an* angry rock *(Stoffle, et al., 1989a). Briefly this view is as follows:*

> *Rocks have power. It is recognized that some rocks have more or different power than others. Breaking a rock or removing if from its place without fully explaining these actions not only releases*

the power inherent in the rock, but also angers the rock.

> *Rocks can also be self-willing, inasmuch as they can reveal themselves to people and act on people. Crystals, for example have a self-willing, animate power and will reveal themselves to a person whom they desire to be with. If this person picks them up, the person will have great luck. The luck, however, is taken away from others and eventually people will come to recognize this fact and single out the excessively lucky person as having used some nonhuman power at the expense of his or her people...Usually the person takes the crystal back to where it had revealed itself and returns it with an explanation of why it was being returned.*

Radioactivity was interpreted as being the angry action of a powerful rock that had been quarried without its permission and had its power used for purposes it did not agree to. Now the remains of the rock (radioactive waste) is angry and it is taking its anger out on things around it. Plants, animals, people, water, and even the air itself can be hurt or even killed by the radiation from the angry rock. Indian people express the belief that past radiation releases have contaminated plants and animals traditionally used for foods and medicines. Spiritual people believe that they can see and feel radiation; it has unique colors. This is why they cannot eat nor collect some plants, animals, and minerals in some areas. It is now impossible for Indian people to go to certain places, do certain ceremonies, and eat certain foods because radiation from the angry rock has been released.

<u>Air: Living and Dead</u>—Indian people express the belief that the air is alive. There are different kinds of air with different names in Indian language. The Creator puts life into the air which is shared by all living things. When a child is born, they pull in the air to begin their life. The mother watches carefully to make sure that the first breath is natural and that there is no obstruction in the throat. It is believed that if the day of birth is a windy day, it is a good day and the child will have a good life. According to one elder:

> *The seasons - like winter, spring, summer, and fall - they're all important when a child comes into the world because their spirit is tied in with the harvest, or hunt, they say that it gets kinda like into their blood and they become hunters or farmers.*

You can listen to the wind; the wind talks to you. Things happen in nature. Our people had weather watchers, who are kinds of people who will know when crops and things should be done. They watch the different elements in nature and pray to ask the winds to come and talk about these things. Sometimes you ask the north wind to come down and cool the weather. The north wind is asked to blow away the footsteps of the people who have passed on to the afterlife. That kind of wind helps people; it is positive. The wind also brings you songs and messages. Sometimes the messages are about healing people, a sign that the sickness is gone now from the person, or that it's coming to get that sickness to take it away, or it's coming to bring you the strength that you need to deal with the illness.

But air can be destroyed by radiation that has been released by the angry rock, thus causing pockets of dead air. There is only so much alive air which surrounds the world. If you kill the living air, it's gone forever and cannot be restored. Dead air lacks the spirituality and life necessary to support other life forms. Airplanes crash when they hit dead air. One member of the CGTO compared this Indian view of killing air with what happens when a jet flies through the air and consumes all the oxygen, producing a condition where another jet cannot fly through the air. The atomic blast consumes the oxygen like the jet, killing the air. While this comparison of the western science view of dead air from burning seems close to the Indian perspective, the latter has a "life force" component that makes killing air more significant than just consuming its natural components.

Some Indian people who were present during the aboveground atomic blasts, believe that the

sickness they have today came from the radiation. To some of those people the effects of the radiation were in addition to what happened when the air itself was killed. Some elders today say, that even when the plants survive the effects of radiation, the dead air killed them or made them lose their power, their spiritual power to heal things.

Blast Radiation— The aboveground atomic detonations were witnessed by many Indian people. Today these Indian eyewitness accounts are told with retrospective assessment of the risks that were involved by being close to the blasts and from using the natural resources in the area. Indian people continued to regularly enter the NTS to hunt and collect long after the atomic testing began. Today, the eyewitnesses are elders talking about when they were younger in the 1950s. A few of these accounts are provided in order to explain to non-Indian people the Indian perception of risk derived from these experiences.

A Western Shoshone woman, who still lives near the NTS, recounted her memories of being a young woman during the blasts. According to her:

> *After the bombs (aboveground atomic explosions), my people (Shoshone people) would kill the animals in the area and find something wrong with them. They would kill a deer, but when the hide was skinned off it would just pull apart. When they saw the mushrooms going up (atomic bomb blasts), they knew something was bad. The people (my family and others) were in the mountains picking pine nuts when one of the blasts went off; it felt like an earthquake. I was there, about 8,000 feet. The little animals ran away. The old people looked up into the swaying trees and asked what would happen to those little (bird) nests up there. We Indian people do not go up in the trees, so we will not disturb the birds.*
>
> *After some of the blasts occurred, the old people told us not to pick the pine nuts off the ground, so after that time we took the green cones from the trees. This made fewer pine nuts available to us. Lots of animals seemed different after the blasts. The migrating birds did not come through after that. The rabbits, of which we were eating a lot at that time, were not right. We developed a way to test them for sores. Many rabbits we could not even skin properly, the skin would just fall apart. The chuckwallas and tortoises disappeared, like the migrating birds. The old people told us that the plants are not maturing properly, so the tortoises and chuckwallas are dying. Both the Indian women and the Indian cattle lost their unborn children (through miscarriage) at this time.*
>
> *Many of the essential plants were affected by the blasts, either directly or because the rain would not come. Those old basket makers would say the willows were really brittle after that, they were hard and would not split easily. Even the greasewood became bad too - it is related to the tortoises and the playas (dry lakes) - the Shoshone songs sing about the tortoises and the greasewood together. The old ones would say that when the plants go away, it (what we need to live) will not be there for us anymore. So, we will go away too. One elder is remembered as saying, "What will become of us?" You know they (the elders) would talk like that when they saw what was changing around them.*

A Southern Paiute man remembered his mother (who is still living) telling him stories of the atomic blasts and their effects on plants and animals. His mother would travel with her family to hunt and gather plants. They (old Paiutes) say that the deer would come down over the Bare Mountains and collapse. People would eat other deer that they had killed for themselves, but when they tried to make clothing out of the hides, the hides would fall apart. Plants in the area don't grow as big anymore and were not preferred because they lost some of their power as food and medicine.

A Southern Paiute woman recounted the story of one of her tribal elders who personally experienced

the blasts. This elder currently lives on the Colorado River Indian Reservation hundreds of miles to the south of the NTS, thus again reinforcing the need to talk with Indian people regardless of where they live today. (Name withheld) is a 78-year-old Chemehuevi woman who lived in this area when she was young. She was here when the blasting occurred and she remembers the white flashes. She has vivid recollections of seeing all of this and now that she is older, she has cancer and is real afraid. She feels good when she comes to the NTS as part of the CGTO studies, but she is real afraid of the rocks and the plants because of what has happened. She says that what happened to them, happened to her.

Perceptions such as these are well-known among the Western Shoshone, Southern Paiute, and Owens Valley Paiute people of this region. These perceptions of risks from radiation are frightening, and remain an important part of our lives. We will always carry these thoughts with us. Today, people are afraid of many things and places in this whole area, but we still love to come out and see our land. We worry about more radiation being brought to this land.

If the DOE wants to better understand our feelings about the impact of radiation on our cultures, they should support a study of risks from radiation designed, conducted, and produced by the CGTO. At this time there has not been a systematic study of American Indians perceptions of risk. Therefore, it's not possible to provide action by action estimation of risk perception impacts. We believe it is a topic that urgently needs to be studied so that Indian people may better address the actual cultural impacts of proposed DOE actions. There have been recent workshops funded by the National Science Foundation to understand how to research the special issue of culturally based risk perception among American Indian communities, and at least one can be more fully understood by research that deeply involves the people being considered. To understand our view of radiation is to begin to understand why we responded in certain ways to past, present, and future DOE activities.

4.1.12 Environmental Justice

Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, requires identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of federal programs, policies, and activities on minority populations and low-income populations.

This section presents a summary of the demographic analysis prepared to analyze the potential impacts to low-income and minority populations affected by the programs discussed in this EIS. Demographic analysis is the first step in determining disproportionately high and adverse human health or environmental effects to low-income and minority populations. This analysis sets the stage for the impact analysis presented in Chapter 5. Demographic analysis includes defining the region of influence, census block groups, low-income populations, minority communities, and the thresholds for calculating a low-income or minority community census block group.

All program activities described in this EIS are located in Clark, Nye, or Lincoln counties. The region of influence for Environmental Justice includes these counties for this NTS EIS. The Consolidated Group of Tribes and Organizations has identified areas on the NTS and nearby lands as culturally important to the American Indian people. The American Indian region of influence for the NTS area is shown on Figure 4-48. Although many of the American Indian groups live outside Clark, Nye, and Lincoln counties, the American Indian people continue to value and recognize traditional ties to the NTS and surrounding area. In recognition of this tie, the DOE has established a relationship with the group. Specific aspects of the participation of the group in DOE cultural resource management projects are discussed in the Cultural Resources section.

Census block groups, which are clusters of blocks within the same census tracts, have been delineated for Clark, Nye, and Lincoln counties. Census block groups do not cross county or census tract boundaries, and generally contain between 250 and 550 housing units (U.S. Bureau of the Census, 1993).

For the purpose of analysis, low-income populations are individuals living within a census block group whose income is below the poverty level. Households

are classified as being below the poverty level if their total family income or unrelated individual income is less than the poverty threshold specified for the applicable family size. For example, the weighted average threshold for a four-person family is $12,674 for the 1990 census. This reflects the different consumption requirements of families based on their size and composition (U.S. Bureau of the Census, 1994).

The U.S. Bureau of the Census identifies four racial classifications, including (1) white; (2) black; (3) American Indian, Eskimo, or Aleut; and (4) Asian or Pacific Islander. Hispanic is not considered a race by the U.S. Bureau of the Census; it is considered an origin. To determine the number of minorities for each census block group for the purpose of analysis, the white race category less whites of Hispanic origin were subtracted from the total census block group population (U.S. Bureau of the Census, 1994).

Within each census block group for each county, percentages were calculated of low-income and minority communities. The denominator used was the tricounty total 1990 population of 763,015. To determine whether a census block group percentage was meaningfully larger than other census block group percentages, thresholds (the average absolute deviation from the mean) for low-income and minority communities were determined. If a census block group percentage was larger than the threshold, it was considered a low-income or minority community census block group and was appropriately shaded. This methodology was chosen to avoid designating a large census block group as low-income or minority when its population is extremely low. For example, a 3,126-km² (1,207-mi²) census block in Nye County had a population count of 51 in 1990. The total number of people under the poverty line was 23. With some methodologies, this entire large census block group would be designated a poverty area and would have been shaded.

Clark County is subdivided into 318 census block groups. Ninety-one of the census block groups are made up of low-income populations (Figure 4-49). The 57 census block groups that constitute minority communities are also illustrated.

Nye County is divided into 25 census block groups. One of these census block groups has low-income communities above the threshold level percentage, and none has minority communities. Lincoln County contains eight census block groups. No census block groups have low-income or minority communities above the threshold level percentage (Figure 4-50).

Using a Geographic Information System, the transportation routes discussed in Appendix I were layered over census block groups shown in Figures 4-49 and 4-50. The Geographic Information System indicated the total mileage of transportation routes and how many miles of these routes traveled through areas of minority and/or low income populations. Less than 2 percent of the routes in Clark County and 0.02 percent of the routes in Nye County travel through areas of low income or minority populations.

4.2 Tonopah Test Range

The Tonopah Test Range comprises 1,616 m^2 (624 mi^2) and has been used by the DOE since the early 1950s. The facility is surrounded on three sides by the NAFR Complex and to the north by the U.S. Bureau of Land Management's open range. The town of Tonopah is located 32 km (20 mi) northwest of the main gate of the Tonopah Test Range and is approximately 241 km (150 mi) northwest of Las Vegas.

Sandia National Laboratories has been the facility operator and site manager of the facility since it was established. The laboratory facilities support their mission in stockpile stewardship, as well as research and design of new weapons and weapon components. The facility offers a unique test bed for testing DOE and DoD weapons. The DOE in the early 1960s conducted several safety-related tests on nuclear weapons, resulting in surface soil contamination of three sites (Clean Slates I, II, and III) that have been managed appropriately since the program.

The existing environmental conditions of the Tonopah Test Range are described in this section.

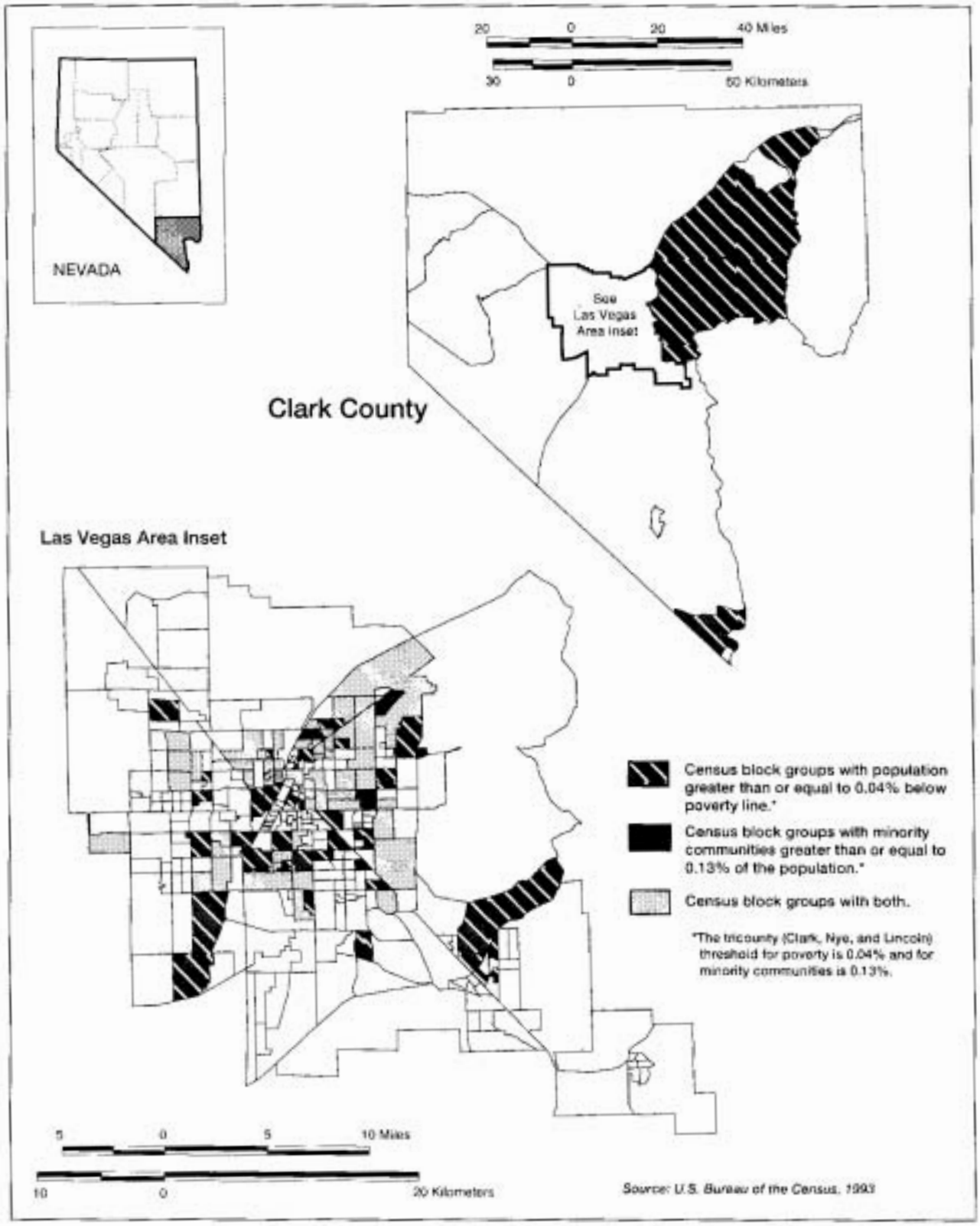


Figure 4-49. Clark County census block groups

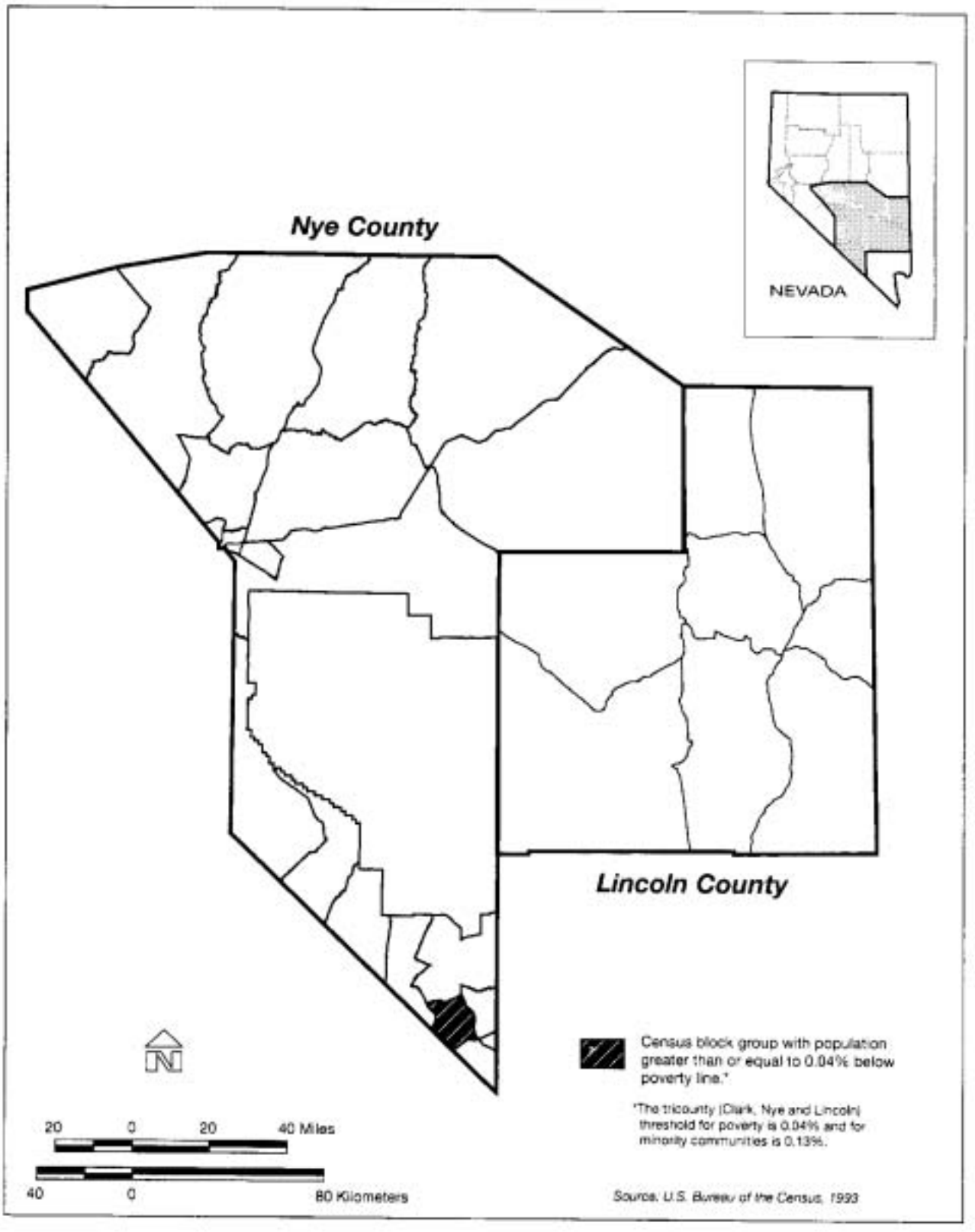


Figure 4-50. Nye and Lincoln counties census block groups

4.2.1 Land Use

Land resources are an important consideration for decisions regarding site use. The land-use analysis determines whether there is enough land available for the proposed facilities and required buffers and identifies conflicts between the proposed project and existing or projected on- and off-site land use. These analyses are necessary to determine whether public lands would be managed in a manner consistent with existing and projected land uses. To make decisions with respect to locating facilities at the Tonopah Test Range, the DOE must consider several issues, that is, the constraints and opportunities related to land resources. These include whether conflicts exist with the administrative framework and whether adequate resources are available and viable.

The known land-use constraints and opportunities at the Tonopah Test Range are outlined in this section. Land-use constraints include those features of the Tonopah Test Range, either natural or manmade, that preclude or limit the future activities that can be conducted in a specific location or area. Opportunities are the best and highest use of the land that can be accomplished within constraints.

Many of the constraints identified throughout Chapter 4 are those resulting from historic land uses, primarily from nuclear weapons safety tests and conventional weapons testing that resulted in radioactive contamination. Public Law 99-606, which consolidated the NAFR Complex under a single land withdrawal, authorizes the use of the withdrawn lands by other federal agencies for "defense-related" uses. For example, a Memorandum of Understanding between the DOE and the U.S. Air Force grants to the DOE the use of portions of the Tonopah Test Range. Consequently, many of the constraints on the DOE's use of land results from the fact that the Tonopah Test Range is used by many other federal agencies, including the U.S. Air Force, for test programs. Because of the nature of many historic and ongoing activities and their consequences, specifically the ongoing use of portions of the Tonopah Test Range by the U.S. Air Force and past DOE safety tests (see Section 4.1.4.3), land use will continue to be constrained in some areas of the Tonopah Test Range during the 10-year period covered by this EIS and likely well into the future. Based on more than 30 years of operations and the information collected, many of the consequences of past weapons testing and other activities are well understood and documented. For example, between the late 1960s through 1985, non-nuclear weapons testing was conducted at several locations on the Tonopah Test Range. Several of these tests resulted in the dispersion of depleted uranium, beryllium, and other hazardous materials. Some of these areas have been designated for no further use until remediation is complete. Many of the consequences described in this chapter were previously presented in the 1975 Environmental Assessment (ERDA, 1975) and in the EIS prepared by the DOE for U.S. Air Force operations in 1990. The information serves as a basis for evaluating the potential impacts of future actions.

The DOE and U.S. Air Force activities include the construction of remote, fully serviced facilities in the early 1980s to support the development of the F-117A fighter plane. This facility is now operated solely by the U.S. Air Force. Although the full impacts of this operation are not considered in this EIS, they will be fully analyzed during the preparation of the U.S. Air Force EIS for the 2001 land withdrawal.

Information for each affected resource is included in the specific resource discussions in this chapter. In addition, Section 4.2.2.3, Transportation of Materials and Waste, identifies the transportation of low-level waste from the Tonopah Test Range to the NTS.

4.2.1.1 Public Land Orders and Withdrawals. The Tonopah Test Range, which is part of the NAFR Complex encompasses 1,616 km² (624 mi²). The NAFR Complex has been closed to public entry since the 1940s when it was withdrawn for military use. Since 1956, the Tonopah Test Range has been managed by the DOE under a Memorandum of Understanding with the U.S. Air Force. A five-party agreement between the U.S. Air Force, the U.S. Bureau of Land Management, the U.S. Fish and Wildlife Service, Nevada Division of Wildlife, and the Energy Research and Development Administration (now the DOE) was instituted for the purpose of protecting, developing, and managing the natural resources, wildlife, vegetation, and watersheds on the NAFR Complex, the NTS, and the Tonopah Test Range. The U.S. Bureau of Land Management had previously developed a wild horse range for the

protection of wild horses and burros over a portion of the area.

4.2.1.2 Land Use Designations. The eastern portion of the Tonopah Test Range is designated as part of the 394,000 acres Wild Horse Range that is located in the north-central portion of the NAFR Complex. The Nevada Wild Horse Range is managed by the U.S. Bureau of Land Management under a 1974 cooperative agreement in compliance with the Wild Horse and Burro Act of 1971. The goal of Public Law 92-195 is to protect wild horses from unauthorized actions, and require management of their habitat to achieve an ecological balance and a population of sound, healthy individuals.

With minor exception, the Tonopah Test Range is used by the DOE as a research, design, and testing ground for defense-related activities (Figure 4-51).

Area 3 of the Tonopah Test Range contains the majority of administrative and industrial facilities. Within this area is the fenced technical compound of Sandia National Laboratories. The facilities within the compound are administrative and research-related facilities.

Area 9 of the Tonopah Test Range contains all facilities that directly support the DOE weapons testing program. Rocket launchers, Davis gun support equipment, and weapon storage facilities are located in this area. Additionally, ground-to-air related tests are initiated from this facility.

Area 10 of the Tonopah Test Range is occupied by the U.S. Air Force Northern Remote Base. These facilities include the industrial area and housing area. These facilities and activities are not being evaluated in this EIS. U.S. Air Force activities associated with these facilities will be evaluated in the U. S. Air Force EIS for the 2001 land withdrawal.

The remaining land on the Tonopah Test Range is open and used for testing and military training programs. All uses of the Tonopah

Test Range are coordinated activities to ensure they are within scope of the land use of the area.

4.2.1.3 Site-Support Activities. Minor industrial and housing areas (Areas 10A and 10B, respectively) were developed by the U.S. Air Force within the Tonopah Test Range. Other facilities operated by Sandia National Laboratories in Areas 3 and 9 exist on a smaller scale.

FACILITIES—The Tonopah Test Range contains approximately 105 major buildings, providing a gross 15,004 m^2 (161,505 ft^2) of space. The Tonopah Test Range facilities also include approximately 90 smaller buildings, including towers and small sheds.

SERVICES—Services available at the Tonopah Test Range include law enforcement and security, fire protection, and health care.

Law Enforcement and Security—Law enforcement for the Tonopah Test Range is provided by Nye County Sheriff's Department. Security on the site is provided by Advanced Security, Inc.

Fire Protection—Fire protection services on the Tonopah Test Range are provided by Sandia National Laboratories and the U.S. Air Force.

Health Care—A medic serves the Tonopah Test Range medical needs. If serious care is required, the patient is either transferred to the town of Tonopah or airlifted to Las Vegas, depending on the medical needs.

UTILITIES—Utilities at the Tonopah Test Range include water systems, wastewater systems, and electrical systems.

Water Systems—A number of water wells have been drilled on or near the Tonopah Test Range to supply water to the facility (Figure 4-52). Well 6 provides potable water to the Sandia National Laboratories facilities, while several other nonpotable wells service the Tonopah Test Range for construction and industrial activities. The water use for DOE operations is 64,345 m^3/yr (17 million gal/yr).

The U.S. Air Force has developed a water distribution system of six potable wells to service the industrial and housing areas. The estimated water usage by the U.S. Air Force is 9.5×10^5 m^3/yr (2.5×10^8 gal/yr). There is an impoundment on the southwestern portion

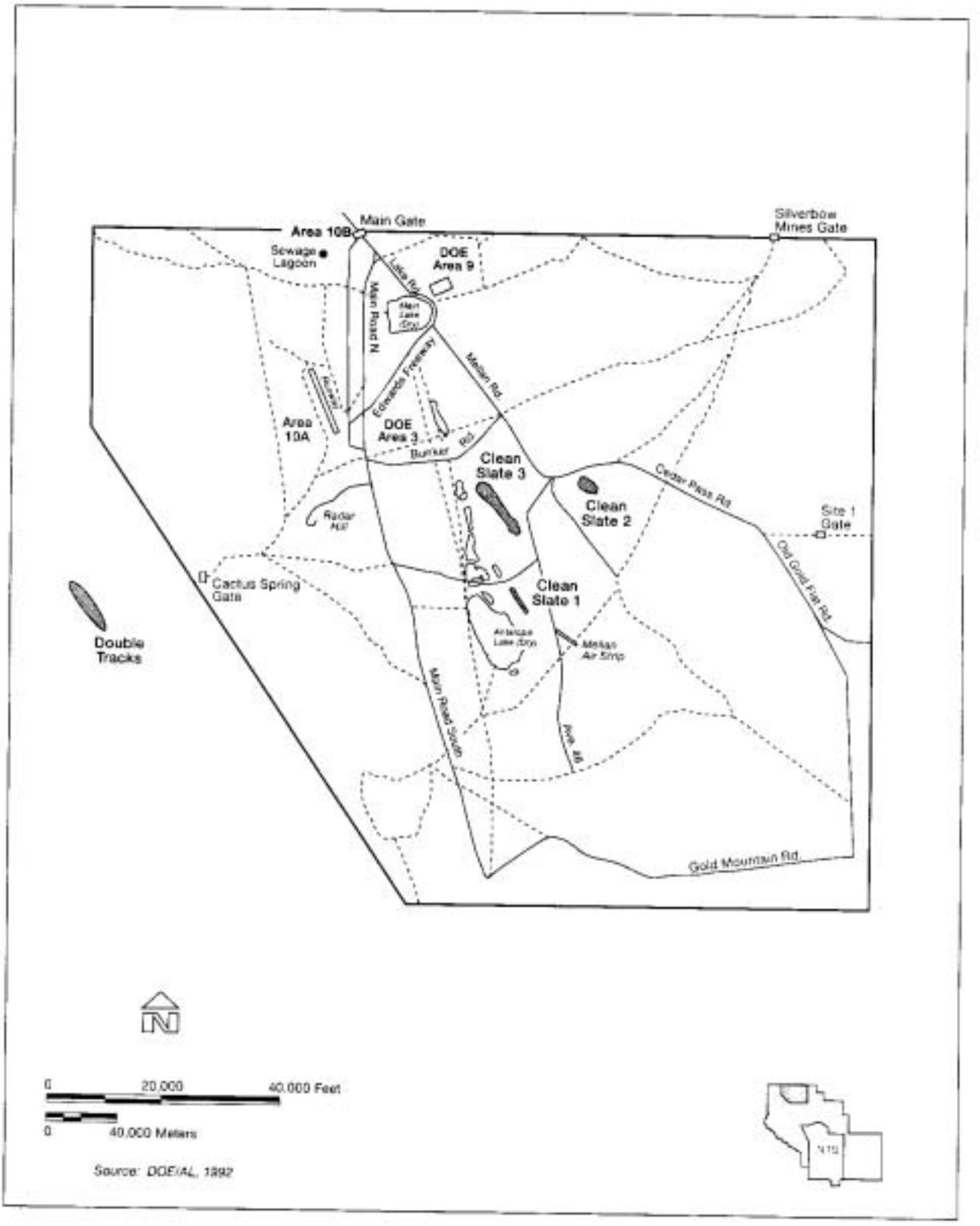


Figure 4-51. Tonopah Test Range detail

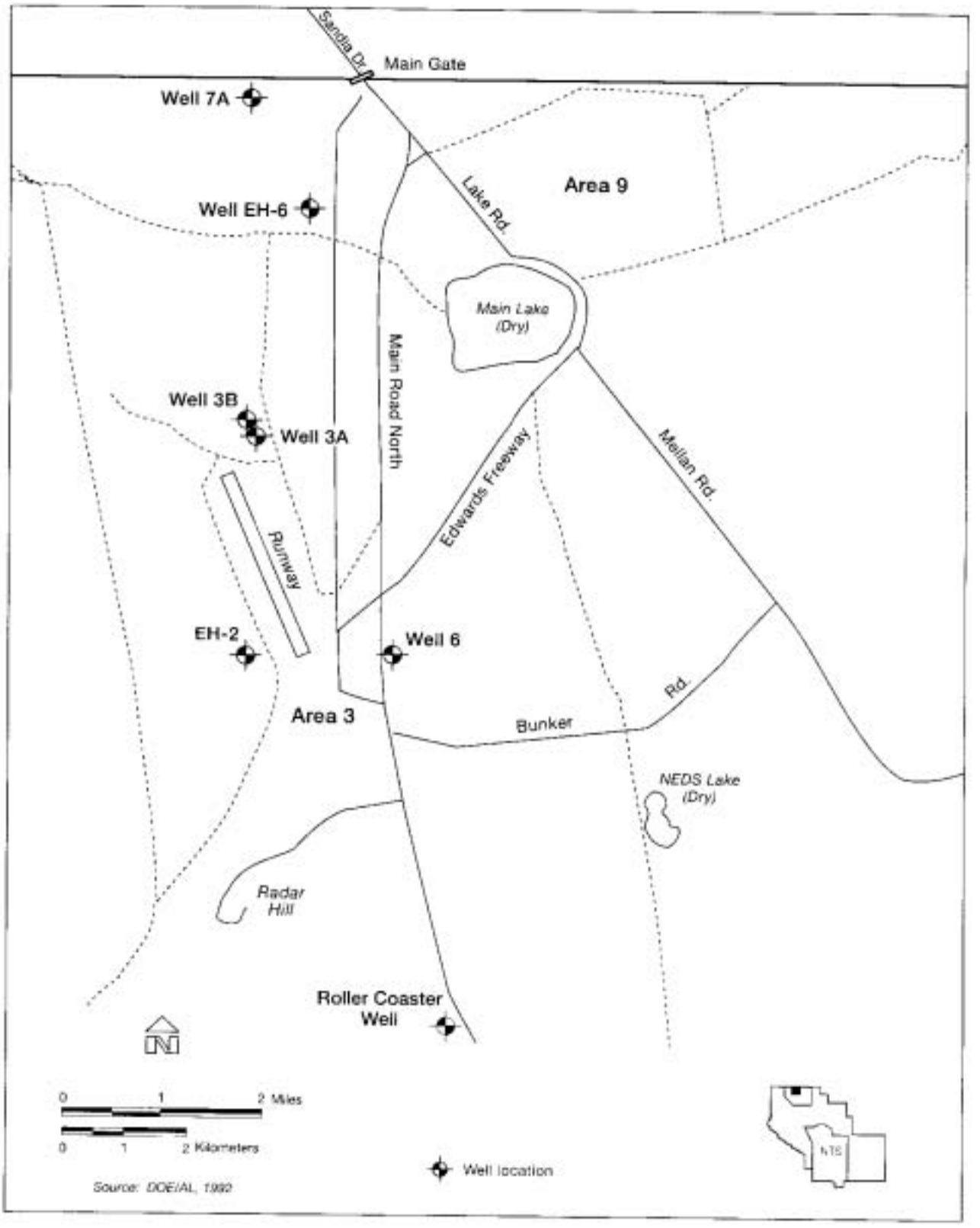


Figure 4-52. Domestic wells supporting the Tonopah Test Range

of the Tonopah Test Range that was used to store water during activities there. Other impoundments have been constructed by the DOE in the Tonopah Test Range area to provide water for the wild horse population.

Wastewater Systems—Sewage at the Tonopah Test Range is collected and pumped to the wastewater treatment unit located approximately 2.4 km (1.5 mi) southwest of the main gate. Effluent lines and three lift stations connect all DOE and U.S. Air Force facilities to the wastewater treatment unit. This treatment unit is designed to treat raw sewage in compliance with secondary treatment standards. Treatment is accomplished by an aerobic stabilization pond, followed by two parallel evaporation basins. The system allows for final disposal of the wastewater by evaporation and percolation.

Five septic tanks are still in use at remote locations on the Tonopah Test Range (DOE/AL, 1992). Their associated leachfields are used as the only means of treatment for septic tank wastes. These remote septic tanks are occasionally pumped into vacuum trucks and transported off site for ultimate disposition.

Electrical System—Power to DOE facilities at the Tonopah Test Range is supplied by the Sierra Pacific Power Company. Sierra Pacific has two supply lines to the Tonopah Test Range: one is 120 kV, and a backup line is 60 kV. Sierra Pacific transformers step the voltage down to 13.8 kV for the DOE distribution system. The remaining power line supplies the U.S. Air Force facilities. All remote operations are supplied with electrical power by portable generators.

COMMUNICATIONS—Communications at the Tonopah Test Range are supported by a regional system. The Tonopah Test Range telecommunication system employs digital telephone switching, fiber-optic transmission, microwave, two-way radio, voice privacy, data transmission systems, general-and-special-purpose data communications, and teleconferencing services.

The Tonopah Test Range also has a ground-to-air communication system that supports all air-to-ground testing programs. The VHF and UHF communication capability is reliable within a radius of 322 km (200 mi) of the range, depending on the altitude, while high-frequency communication can be reliable for thousands of miles.

Other modes of communication at the Tonopah Test Range include automated data processing equipment, automated office support systems, and information systems. Computer systems encompass general purpose, stand-alone, data management, word processing, engineering, computer-aided drafting, and computer-aided manufacturing.

4.2.1.4 Airspace. The airspace over the Tonopah Test Range is restricted area R-4809. The airspace is managed by the DOE and designated for joint use by the DOE and U.S. Air Force. Civilian aircraft may gain permission to use the facility in case of in-flight critical emergencies. This area is authorized for supersonic activity above 1,762 m (2,500 ft) above ground level with prior authorization from the appropriate agencies. The area is restricted for live ordnance unless the conditions enforced by the DOE and the U.S. Air Force are met. Currently, flying operations over the Tonopah Test Range are characterized moderate to heavy. The range has a 3,048-m (10,000-ft) concrete runway which can accommodate aircraft rated up to and including heavy cargo aircraft. The runway is lighted and marked for nighttime operations.

4.2.1.5 Waste Management. The following section addresses solid, hazardous, and radioactive waste management at the Tonopah Test Range.

SOLID WASTE MANAGEMENT—Tonopah Test Range sanitary waste from DOE and U.S. Air Force operations are disposed of in a Class II solid waste landfill. The Tonopah Test Range landfill is located just east of the U.S. Air Force industrial area. The materials disposed of are characterized as rubbish, construction debris, and sanitary waste from food service areas. The sanitary landfill currently in operation consists of one active cell.

HAZARDOUS WASTE MANAGEMENT—The DOE hazardous waste management activities are defined as a small quantity generator and operate in compliance with the Resource Conservation and

Recovery Act under an EPA identification number. All hazardous waste generated at the Tonopah Test Range can be stored up to 180 days at the facilities storage area. All waste is then transported off site for ultimate disposition by a subcontractor.

RADIOACTIVE WASTE MANAGEMENT

Current plans are to remediate the radioactively contaminated areas on the Tonopah Test Range through excavation and disposal of surface soils. Disposal volume estimates are based on the level of cleanup, but are expected to be large. The remediation waste generated from cleanup of the contaminated soils would be transported to the Area 3 Radioactive Waste Management Site for disposal.

4.2.2 Transportation

The following sections discuss baseline transportation activities at the Tonopah Test Range with respect to on-site traffic, off-site traffic, transportation of materials and waste, and other transportation.

4.2.2.1 On-Site Traffic. The Tonopah Test Range on-site transportation consists of 190 km (118 mi) of primary paved roads, 37 km (23 mi) of secondary paved roads, 182 km (113 mi) of primary compacted dirt roads and 63 km (39 mi) of secondary dirt roads. The two primary traveled paved roads on the Tonopah Test Range traverse north-south and east-west. These roads support the majority of the daily traffic, as well as traffic during operations. The dirt roads are used for secondary daily travel, but are primarily used during testing activities. A total 480 km (298 mi) of roads on the Tonopah Test Range are used on a regular basis.

The roadway system on the Tonopah Test Range is jointly maintained by the DOE and the U.S. Air Force. No personally owned vehicles are permitted on the site. Workers either drive government-supplied vehicles from the main entry of the Tonopah Test Range or ride government-supplied bus transportation to the work site. The majority of the on-site traffic is attributed to security support and facility operations. The average estimated mileage traveled on the Tonopah Test Range during 1994 was 2.5×10^6 km (1.6×10^6 mi), driven by 96 government vehicles.

4.2.2.2 Off-Site Traffic. The primary highway access to the main entry gate of the Tonopah Test Range is via U.S. Highway 6 to north-south alternate Road 504. U.S. Highway 6 links U.S. Highway 95 and U.S. Highway 93 and is an all-weather, two-lane paved roadway. U.S. Highway 6 in the vicinity of the Tonopah Test Range (near Warm Springs) carried less than 500 annual average daily traffic in 1993. Regional traffic conditions in Clark and Nye counties are presented in Section 4.1.2.2.

4.2.2.3 Transportation of Materials and Waste. All material and waste are taken off site for management at other facilities, including the NTS, or at commercial waste facilities. No radioactive or hazardous waste disposal activities are conducted at the Tonopah Test Range. The primary roads used for waste and material transportation are discussed in Section 4.2.2.2.

4.2.2.4 Other Transportation. Because of the remote location of the Tonopah Test Range, the majority of the workers are flown from Las Vegas to the Tonopah Test Range on a daily basis. The DOE uses a DeHavilland seven-commuter airplane to transport the workers. The plane is flown an average of four daily round trips per week and transports approximately 30 individuals daily. The plane is maintained at DOE facilities in Las Vegas and uses U.S. Air Force facilities on the Tonopah Test Range during operations.

The U.S. Air Force maintains an active base on the Tonopah Test Range. This facility is 929 m^2 (10,000 ft^2). The existing runway and navigation aids are open to the DOE and the U.S. Air Force on an as-needed basis. The facility is lighted for night operations. The adjacent airfield is used by the DOE in support of its mission at the Tonopah Test Range. This facility supports approximately 15 sorties per week for DOE operations. The remaining sorties are in support of the U.S. Air Force and other organizations at the Tonopah Test Range.

Mellan airstrip is located on the southern portion of the Tonopah Test Range. This airstrip supports DOE and U.S. Air Force training programs and is

used sporadically. There are no support facilities associated with this airstrip.

4.2.3 Socioeconomics

The majority of DOE/NV workers, including those assigned to projects at the Tonopah Test Range, live in Clark or Nye counties (DOE, 1994b). An analysis of socioeconomic conditions in Clark and Nye counties is presented in Section 4.1.3.

4.2.4 Geology and Soils

Geology and soils at the Tonopah Test Range are addressed in this section. The discussion includes a description of physiography, geology, including geologic resources, and soils.

4.2.4.1 Physiography. The Tonopah Test Range is located in the lowland portions of Cactus Flat and Stonewall Flat. Cactus Flat is a topographically closed basin with a total area of 1,044 km^2 (403 mi^2). Stonewall Flat is topographically open and encompasses 987 km^2 (381 mi^2). The Kawich Range on the east and northeast of the Tonopah Test Range rises to elevations of 2,438 m (8,000 ft) to more than 2,743 m (9,000 ft). To the west in the Cactus Range, which separates the two basins, the maximum elevation is 2,281 m (7,482 ft). On the south, Cactus Flat is separated from Gold Flat by the volcanic hills around Gold Mountain (about 1,829 m [6,000 ft]) and a low topographic divide through the alluvium to the east. Stonewall Flat is bounded on the south by Stonewall Mountain, which has a maximum elevation of 2,522 m (8,275 ft). On the west, Stonewall Flat is bounded by the Goldfield Hills, which rise to an elevation of almost 2,134 m (7,000 ft). On the valley floors of both basins, the dominant features are a number of small playas and the many washes that drain the upland areas.

The general appearance of the range is of great bareness. The playas support no vegetation, while the lower slopes and mountains support brush, some Joshua trees, and juniper. Only above 2,134 m (7,000 ft) are limited woodlands present.

4.2.4.2 Geology. The general geologic conditions and mineral deposits of the Tonopah Test Range have been described by the Nevada Bureau of Mines and Geology. The general geology of the area is comprised of two major geologic units: volcanic rocks and alluvium. Intrusive igneous rocks and a few isolated outcroppings of Paleozoic sediments occur in the Cactus Range.

The total thickness of volcanic rocks outcropping in the Cactus and Kawich Ranges and underlying the valley-fill deposits has been estimated to be as much as 6,096 m (20,000 ft). The Tertiary volcanics are composed of a series of welded and nonwelded ash-flow tuffs and basalts, andesites, dacites, and rhyolites. The Kawich Range is a horst that is bounded on the east by normal faults. The northern part of the range (adjacent to the Tonopah Test Range) is primarily composed of Tertiary tuffs, lavas, and intrusions of Miocene tuff.

The Cactus Range is also a horst that is bounded by an elliptical ring of fractures that suggests a collapsed cauldron. Some of these fractured areas were subsequently intruded with stocks, sills, and dikes. The central part of the range comprises minor Paleozoic sediments, a small granite mass, and a thick sequence of widespread Tertiary volcanic rocks. The hills to the south of Mellan comprise a series of lava ridges separated by valleys of tuff. The hills are capped with rubble formed from weathering and breccias in the lava piles, and breccias formed by the structural deformation (faulting and tilting) of the lava ridges.

The total thickness of alluvium is unknown. Exploratory drilling in Cactus Flat indicates that the thickness exceeds 305 m (1,000 ft). The alluvium is primarily coarse- to medium-grained and is derived from the volcanic rocks of the highlands. Volcanic ash is present in the alluvial deposits.

The Walker Lane shear zone is a major northwest to southeast trending regional structural element that transects the Tonopah Test Range. The Walker Lane is a transcurrent fault zone that extends several hundred miles through western Nevada, merging to the southwest with the Las Vegas shear zone. Numerous volcanic centers are located within or immediately east of the Walker Lane, including the Goldfield, Cactus Range, Stonewall Mountain, and Mount Helen centers. Volcanic calderas are absent

over the test range but are present immediately to the east, south, and west on the NAFR Complex.

The geologic hazards present at the Tonopah Test Range are similar to those described for the NTS and include seismicity, volcanism, and geotechnical hazards. These hazards are discussed in Section 4.1.4.2 for the region comprising both the NTS and the Tonopah Test Range.

GEOLOGIC RESOURCES—The geologic resources of the Tonopah Test Range include metals, industrial minerals, and aggregate. The Tonopah Test Range has been the site of historic mining at the Silver Bow, Antelope Springs, Cactus Springs, Wilsons, and Mellan mining districts. The Tonopah Test Range is also adjacent to a number of other mining districts, most notably the Goldfield, Gold Crater, Golden Arrow, Stonewall, Gold Reed, and Jamestown districts. Appreciable quantities of silver and gold have been produced from the Silver Bow district. The Antelope Springs district produced silver and minor amounts of gold. The Cactus Springs district produced small quantities of silver, and there are reports of turquoise, gold, and copper in the area. The Wilsons district produced small quantities of gold and silver in the early 1900s. Minor production of gold and silver came from the Mellan district. Of these areas, only the Silver Bow district is classified as having high potential for locatable minerals.

Immediately to the east of the Goldfield district in the area between the Tonopah Test Range and Goldfield, there is moderate to high potential for the occurrence of quartz-alunite gold deposits. Although gold, silver, and lead have been produced from the Gold Crater and Stonewall districts, production from these areas had ceased by the mid-1930s, and the remaining potential for mineral resources is low.

No geothermal resources have been identified, and the potential for oil and gas resources is considered low. There are no reported occurrences of coal, tar sands, or oil shale on the Tonopah Test Range or adjacent areas on the NAFR Complex. Similarly, no economic deposits of industrial minerals have been identified. Although no uranium deposits have been identified, there are speculative resources of uranium. Tertiary volcanic rocks and tuffaceous sedimentary rocks of silicic compositions occur on the Tonopah Test Range and the NAFR Complex. Other uranium host environments are located elsewhere in the Great Basin.

The aggregate resources of the Tonopah Test Range are considerable. Sand and gravel deposits are present, and the quality and quantity of these resources are likely to be sufficient to meet future demands for construction, roads, and other uses. The aggregate resources do not have any unique value compared to other areas throughout southern Nevada.

4.2.4.3 Soils. The following soils information was extracted from the *Soil Inventory of Tonopah Management Environmental Impact Area* report prepared by Earth Environmental Consultants, Inc. for the U.S. Bureau of Land Management (Cox et al., 1977).

The Tonopah Test Range is situated in the Basin and Range physiography between the elevations of 1,676 and 2,377 m (5,500 and 7,800 ft). Approximately 15 percent of the soil survey is comprised of mountainous terrain with the remaining portion consisting of alluvial fans, ephemeral washes, valley floors, and dry lake beds. The soil parent material consists of a variety of igneous and sedimentary rock with rhyolitic tuffs and ignimbrite being the most common rock.

Strongly cemented silica pans (i.e., duripans), formed primarily from igneous sources, are the most common feature on most bejadas. These pans usually occur near the surface. In general, soil depth (i.e., depth to restrictive layer) increases from the topslope/shoulder slope of the alluvial fan, downslope to the footslope/toeslope. Indurated hardpans and cemented layers can range from a few inches to several feet in thickness.

The 1977 soil inventory was conducted as a third order survey and mapped to the soil series level. Soil mapping units were derived from field descriptions and delineated on aerial photographs at a scale of 1:31,680 with the exception of Ione, which was delineated on a 1:63,360 photograph. The minimum size of the soil mapping units is

10 acre. A quality assurance procedure, called a field correlation, was conducted by the Soil Conservation Service, U.S. Department of Agriculture, State Soil Scientist.

Soil Mapping Units consist of consociations, associations, complexes, and miscellaneous areas on the landscape such as rock outcrops, areas with excessive stone, or very steep eroded slopes. The following three out of 10 Soil Orders are found in the survey area:

- Mollisols--soils that contain a horizon rich in bases
- Aridisols--dry soils with low organic matter
- Entisols--young soils with little or no development of soil horizons.

The soils of the Tonopah Test Range and adjacent areas can be separated into four general categories based primarily upon the following physiographic position:

- Valley bottoms and dry lake beds (i.e. playas)
- Upper erosional portion of the alluvial fans
- Mountains and hills.

The valley bottom and dry lake bed soils occur in the central portions of both Cactus and Stonewall Flats. These very deep, poorly drained saline and alkali, fine-textured soils occur on slopes generally less than 1 percent. These low-lying areas are usually points of groundwater discharge. Therefore, depth to groundwater is usually fairly shallow and is manifested by discharging springs or plants that indicate in shallow water table (i.e., usually within 15 m [50 ft] below ground surface). These plants are called phreatophytes with greasewood being the most common in the area. There is periodic flooding from runoff and the shrink-swell potential is generally high due to the abundance of smectitic clays. This can present problems with most construction projects. The corrosion hazard for steel and concrete is high due to the high concentrations of salts. Soil families include:

- Typic Salorthids (e.g., Saltair soil series)
- Typic Haplaquolls (e.g., Hutton soil series).

The lower, depositional portion of the alluvial fan consists of deep to very deep, well-drained, very coarse (coarse sand) to medium-textured (very fine sandy loam/loam) gravelly soils that occur on slopes ranging from gently sloping(2 to 4 percent) to strongly sloping (8 to 15 percent) slopes. The coarser-textured, very gravelly to extremely gravelly soils are located in the ephemeral washes (i.e., arroyos) and are subject to periodic flash floods.

The soils on the actual dissected alluvial fan are generally moderate-textured, gravelly soils that are often covered with desert pavement. Soil families include:

- Typic Torriorthents (e.g., Fang and Cliffdown soil series)
- Typic Camborthids (e.g., Alcorn and Dun Glen soil series)
- Typic Calciorthids (e.g., Puddle).

The upper, erosional portion of the alluvial fan consists of older, very shallow (less than 25 cm [10 in.] thick) to moderately deep (between 51 and 102 cm [20 and 40 in.] in thickness) moderate to well drained, very coarse (coarse sand) to medium textured (very fine sandy loam/loam) gravelly to extremely stony soils. Some soils contain an old, well developed, fine textured (i.e., high in clay) subsoil called an argillic horizon. The presence of a duripan is common and is usually found between 38 and 76 cm (15 and 30 in.) below the ground surface, however, in some areas may be exposed at the surface. Slopes range from moderately sloping (4 to 8 percent) to moderately steep (15 to 30 percent). Soil families include:

- Xerollic Durorthids (e.g., Ursine soil series)
- Xerollic Durargids (e.g., Ratto, Olson, Indian Creek, and Deer Lodge soil series).

The upland mountains and hills consist of rock outcrops, areas with excessive stone, or very steep

eroded slopes that generally contain a thin mantle of alluvial or colluvial soils usually less than 25 cm (10 in.). These soils can range in texture from coarse to fine, gravelly to extremely stony, and are dependent upon primarily age and parent material for textural composition. Slopes generally range from moderately steep (15 to 30 percent slopes) to extremely steep (>75 percent). These soils usually have a severe erosion hazard because of their slopes and runoff is generally rapid.

The historic use of the Tonopah Test Range has created certain site-specific restrictions for some surface soils. The clean slates sites included an open detonation on a concrete pad, and detonation in igloo-like structures with varying amounts of earth-cover to simulate accidents in open storage and weapons magazines. Depleted uranium and plutonium were used as a tracer in these Clean Slate tests. The areas that were contaminated with radioactivity from the tests (Figures 4-35 through 4-37) and associated decontamination areas and disposal sites are the subject of Environmental Restoration Program activities that will resolve their ultimate disposition. Until the appropriate investigations have been completed and remedial decisions are made, the soils in these areas are not suitable for use and have been fenced and posted. These sites were studied in the late 1970s by the Nevada Applied Ecology Group. One objective of the studies was to estimate the amount and distribution of plutonium in the soil.

Samples were primarily collected from the top 5 cm (2 in.) of the soil profile. A few profile samples were collected to a depth of 25 cm (10 in.). In almost all profiles, plutonium was detected in the 25 cm (10 in.) increment. Deeper profiles from Clean Slate 1 and 3 showed plutonium at less than 1 pCi/g at a depth of 32.5 cm (12.8 in.) (Essington, 1987).

Estimated areas of plutonium concentrations in soils range from less than 1 acre at greater than 400 pCi/g, through 6 acres at greater than 200 pCi/g, and 81 acres at greater than 40 pCi/g. Clean Slate 2 has 17 acres at greater than 400 pCi/g, 26 acres at greater than 200 pCi/g, and 170 acres at greater than 40 pCi/g. Clean Slate 3 has 17 acres at greater than 400 pCi/g, 49 acre at greater than 200 pCi/g, and 180 acres at 740 pCi/g (DOE/NV, 1995c).

Because of the similarities in the types of tests conducted and the consequences of those tests, additional discussion of the affected soils can be found in Section 4.1.4.3, NTS soils.

4.2.5 Hydrology

Surface water and groundwater at the Tonopah Test Range are addressed in this section.

4.2.5.1 Surface Hydrology. Hydrographic basins of the Tonopah Test Range are shown in Figure 4-53. Cactus Flat is a closed basin; runoff from the Cactus Range and Kawich Range drains to a series of small, north-trending playas in the lowlands along the axis of the valley. Stonewall Flat is open, with a small quantity of surface water discharged to Lida Valley. The runoff over the two basins has not been gauged, but has been estimated at 1.5×10^6 m^3/yr (1,200 acre-feet/year) for Cactus Flat and 4.9×10^5 m^3/yr (400 acre-feet/year) for Stonewall Flat. No perennial streams exist in any of the basins on the Tonopah Test Range. The many washes that drain the upland areas occasionally convey ephemeral flow that ponds on the playa areas.

4.2.5.2 Groundwater. The Tonopah Test Range encompasses portions of five hydrographic basins that comprise portions of two regional groundwater flow systems (Figure 4-39). Past DOE operations have been concentrated in two areas: in the lowland portions of Cactus Flat and in Stonewall Flat. Groundwater that originates as precipitation over the Kawich Range flows west and then southwest under the Tonopah Test Range, ultimately discharging in Death Valley as springs and evapotranspiration. Some groundwater may flow northwest off the Tonopah Test Range and into the Southern Marshes flow system, with discharge at Mud Lake, Alkali Flat, and Clayton Valley. The generalized directions of regional groundwater flow are shown in Figure 4-39.

The depth to groundwater under Cactus Flat ranges from about 27 m (90 ft) to about 137 m (450 ft) below land surface. Groundwater is derived from

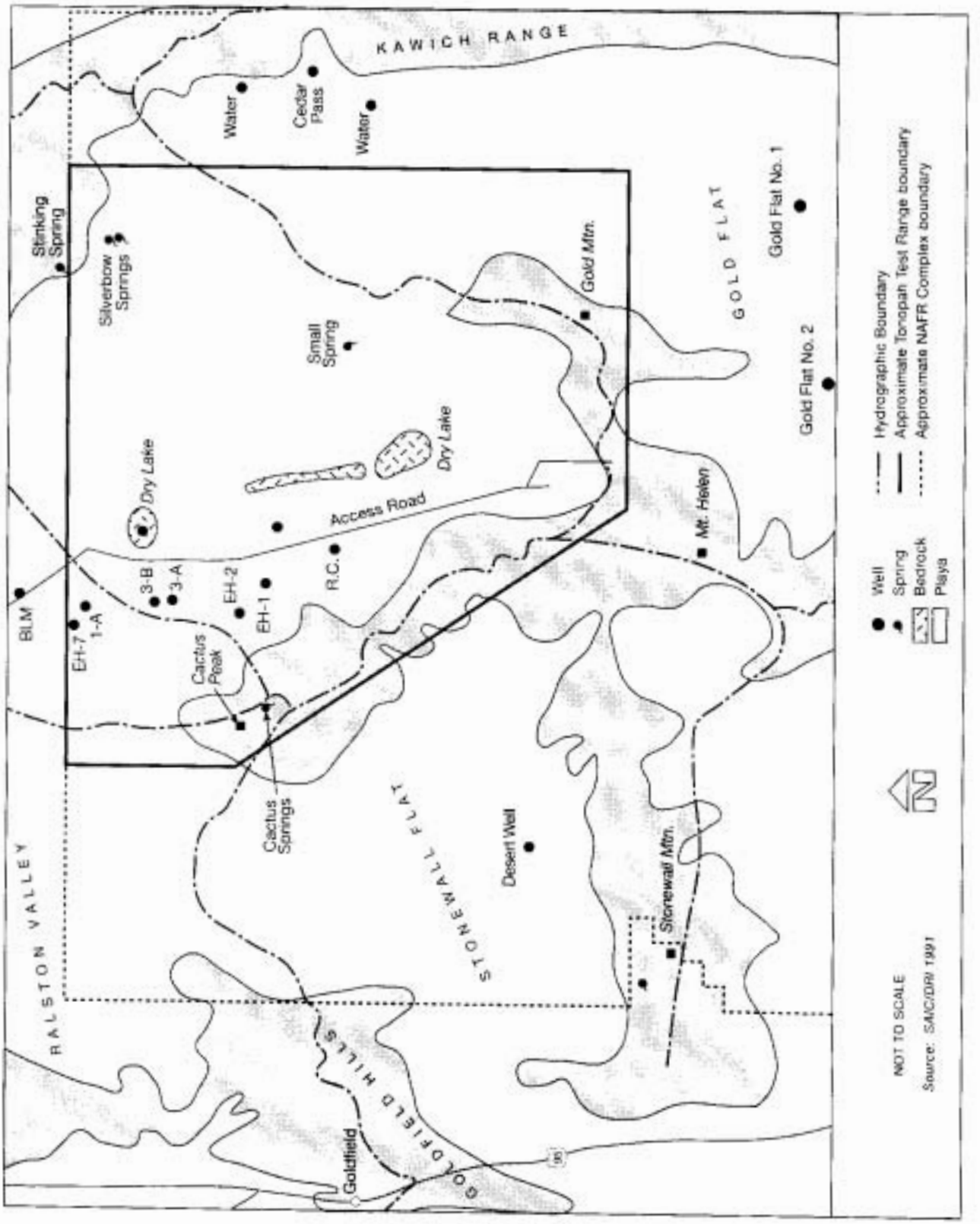


Figure 4-53. Hydrographic basins and water resource features at Tonopah Test Range.

precipitation over the upland areas; there is no subsurface recharge from neighboring basins. The total recharge has been estimated at only 7.4×10^5 m³/yr (600 acre-feet/year). Groundwater discharge, totaling only a little more than 1.2×10^6 m³/yr (1,000 acre-feet/year), is through subsurface underflow to the southwest into Stonewall Flat and Gold Flat. No groundwater is discharged to evapotranspiration by phreatophytes.

The groundwater under Stonewall Flat ranges in depth from about 31 m (100 ft) to more than 84 m (275 ft) below land surface. Groundwater is derived from recharge over the upland areas (only about 1.2×10^5 m³/yr [100 acre-feet/year]) and an unknown quantity of subsurface inflow from Cactus Flat. An estimated 2.5×10^5 m³/yr (200 acre-feet/year) is discharged through underflow to Lida Valley. No groundwater is discharged to evapotranspiration in Stonewall Flat.

Several springs are located in the north Kawich Range and along the eastern flanks of the Cactus Range. Four spring areas have been mapped within the boundaries of the Tonopah Test Range: Silver Bow Springs on the flank of the Kawich Range, Small Spring near Mellan on the valley floor, and Cactus Spring and Antelope Springs near the base of the Cactus Range. Stinking Spring is located immediately to the north of the Tonopah Test Range, and Rose Spring is located about 10 km (6 mi) to the east, in the Cedar Pass area. There are no mapped springs within the Tonopah Test Range portions of Stonewall Flat or the NAFR Complex. Willow Springs is located about 2 km (1 mi) to the west of the NAFR Complex in the Goldfield Hills. Gauging data are very limited for these springs, and water chemistry data are lacking. A single 1963 discharge measurement of 15 L/min (4 gal/min) was reported for a spring located near the mapped location for Cactus Spring.

The quality of water on the Tonopah Test Range is generally good and is suitable for domestic purposes, livestock, wild horse, and wildlife use. There are a number of areas where the groundwater may have been impaired by past activities at the facility. The nuclear safety tests conducted at the Clean Slates sites on the Tonopah Test Range have resulted in surface soil contamination. Although groundwater contamination has not been detected at these sites, there is the potential for downward migration of some contaminants into the water table. Other potential sources of groundwater contamination include french drains, septic tanks and leachfields, underground storage tanks, landfills, and sewage lagoons.

There are about 1.5×10^7 m³/yr (12,500 acre-feet/year) of water rights in the five hydrographic basins associated with the Tonopah Test Range. Almost 4.9×10^6 m³/yr (4,000 acre-feet/year) of this total are surface water rights; the remainder (about 1.0×10^7 m³/yr [8,500 acre-feet]) represents groundwater rights. Currently, defense-related federal water rights total 2.2×10^6 m³/yr (1,775 acre-feet/year), of which only 1.8×10^5 m³/yr (148 acre-feet) are surface water rights. Table 4-40 lists the water rights status for each of the basins that encompass portions of the Tonopah Test Range. Federal water rights are limited to two basins, Cactus Flat and Stone Cabin Valley. Both basins are over appropriated; i.e., the appropriations exceed the perennial yield in each basin. It is unlikely that additional water rights can be obtained in the area without groundwater mining (the removal of groundwater from storage).

Groundwater on the Tonopah Test Range has been used for domestic, industrial, and construction purposes. Groundwater is pumped from a number of wells, depending on the location of range activities and the total demand for water. Records identifying historic pumping are not available; water use in 1988 was 4.7×10^5 m³/yr (380 acre-feet), and this value is probably representative of long-term use. About 80 percent 2.9×10^5 m³/yr (240 acre-feet/year) of the domestic water is pumped from a U.S. Bureau of Land Management well located north of the Tonopah Test Range on public land in Stone Cabin Valley. The remaining 20 percent of domestic water and water for construction and industry is withdrawn from wells located in Cactus Flat (about 1.2×10^5 m³/yr [100 acre-feet/year]) and Gold Flat (about 4.9×10^4 m³/yr [40 acre-feet/year]).

All water supply wells installed at the Tonopah Test Range were completed in the alluvium. Well yields range from approximately 23 to 606 L/min (6 to

160 gal/min). These yields are based on water-supply well-construction completion records prepared by the driller.

4.2.6 Biological Resources

The following description of vegetation was taken from EG&G Energy Measurements (1995) unless otherwise stated. The scientific names of plants and animals mentioned in this section are given in Section 2.6 of Appendix E, Biological Resources.

The Tonopah Test Range is within the Great Basin desert. The lowest elevation on the Tonopah Test Range is approximately 1,600 m (5,250 ft); the highest elevation is approximately 2,301 m (7,550 ft).

The dominant flora of the valley bottoms on the Tonopah Test Range include shadscale, budsage, winterfat, and galleta grass. Less common plant species are horsebrush, greasewood, desert globemallow, and desert prince's plume. Big sagebrush occurs in wash bottoms near the playa lakes. On the bajadas above the valley floor, shadscale, budsage, winterfat, and Indian ricegrass are dominant. At higher elevations, greasewood, wolfberry, hopsage, and desert prince's plume are common. Pinyon-juniper woodlands occur at the highest elevations.

Animal species on the Tonopah Test Range include all species found in the Great Basin desert on the NTS. Some of the most common animal species include side-blotched lizards, desert-horned lizards, horned larks, chisel-toothed kangaroo rats, little pocket mice, and wild horses (Bradley and Moor, 1975). State-designated game animals that occur on the Tonopah Test Range include mule deer, bighorn sheep, pronghorn, mountain lions, desert and Nuttall's cottontails, chukar, and mourning dove.

Vegetation samples were collected on the Tonopah Test Range in 1973 (Romney, 1975) and again in 1990 and 1991 (EG&G/EM, 1993d). Recent plutonium levels in samples of vegetation ranged from 4.0×10^{-5} to 3.9×10^{-2} nCi/g dry vegetation, and have not changed substantially over the past 25 years. Many studies in arid and semiarid environments (Francis, 1973; Price, 1973; Romney, 1977; Hanson, 1975; and Hakonson, 1975) have shown that most of the plutonium remains in the soil and is not readily transported. Very little of the contamination is incorporated into the biological components of the ecosystem in similar arid areas (Hakonson and Nyhan, 1980). Plutonium contamination of vegetation at the Tonopah Test Range and the NTS is concentrated mainly on the surface of vegetation and is generally not taken up by the roots and concentrated internally. Small mammals have been collected from the Tonopah Test Range for plutonium contamination analyses in 1974-1975 (Bradley and Moor, 1975) and from other contaminated sites off and on the NTS (Gilbert et al., 1988). From these studies, the following general conclusions can be made: very low levels of contamination (from undetectable levels to a few hundred femtocuries [10^{-15} Ci] per gm) were found in animals; desert rodents (which represent the primary consumer trophic level) have very low plutonium levels; most of the radioactivity in rodents is associated with the pelt and gastrointestinal tract and not internal organs or carcasses; and the plutonium contamination does not appear to concentrate up the food chain.

No current federal threatened, endangered, or candidate plant or animal species are known to occur on the Tonopah Test Range, although bald eagles and peregrine falcons may be rare migrants.

The U.S. Fish and Wildlife Service published the latest list of candidate plants and animals on February 28, 1996 (61 F.R. 7596). Prior to this, 10 animal and 5 plant species which were identified as potentially occurring on the Tonopah Test Range were classified as candidates (Mendoza, 1995b) and were addressed in the Draft NTS EIS (listed in Table 4-30). The updated Notice of Review has removed all of these species from candidate status. The western burrowing owl, a state-protected bird, is known to occur on this site.

4.2.7 Air Quality and Climate

This section describes the air quality conditions at the Tonopah Test Range. Climatology, meteorology, and ambient air quality are discussed.

CLIMATOLOGY AND METEOROLOGY.--The climate is usually dry, but given to large diurnal and

seasonal changes in temperature. Clear, sunny days prevail, and the winds are light to moderate. Rainfall is 13 to 15 cm (5 to 6 in.) per year in the valley, primarily resulting from summer thunderstorms. Dust storms are common in the spring, and strong dust devils occur in the summer.

The average temperature at the Tonopah Test Range is about 10 °C (50 °F); maximum temperatures are over 38 °C (100 °F), and minimum temperatures are below -29 °C (-20 °F). The average relative humidity is approximately 40 percent. The average annual snowfall is 30 to 33 cm (12 to 13 in.) (Schaeffer, 1968). Surface wind directions are predominantly from the west-northwest to northwest in the winter and from south to southeast in the summer. Local terrain tends to shift southerly surface winds to a more southeasterly direction. Highest wind speeds occur in mid-afternoon in all seasons, but especially in the spring; highest wind speeds are also strongest for south winds overall. In April, the most frequent wind direction between 1 p.m. and 4 p.m. is from the south, with an average speed of approximately 25 kph (16 mph). The annual average speed for south winds is 16 kph (10 mph). Nighttime wind speeds average approximately 10 km (6 mph). There is little diurnal wind direction variability in summer and winter; however, in late spring and autumn, the diurnal cycle is typically northwest nighttime flow and south to southeast afternoon flow (Schaeffer, 1968).

AMBIENT AIR QUALITY—The Tonopah Test Range is located within Nevada Intrastate Air Quality Control Region 147. Although ambient pollutant concentrations have not been measured on the Tonopah Test Range, ambient air quality characteristics are similar to the NTS (see Section 4.1.7). Ambient pollutant concentrations on the Tonopah Test Range are below the Nevada and National Ambient Air Quality Standards (Table 4-31). The Air Quality Control Region is designated as unclassifiable/attainment for all criteria pollutants.

4.2.8 Noise

The acoustic environment around the Tonopah Test Range and the NAFR Complex can be classified as uninhabited desert or small rural communities. The primary source of noise on the Tonopah Test Range and the NAFR Complex is from the DOE and U.S. Air Force aircraft operations and ordnance testing. Because the public is prohibited from entering the Tonopah Test Range and the NAFR Complex, public exposure to these noise sources is limited to occasional sonic booms produced by supersonic overflights of military aircraft (SAIC/DRI, 1991).

4.2.9 Visual Resources

The landscape character of the Tonopah Test Range is similar to the higher elevation areas of the NTS. The Tonopah Test Range is visible only from an access road off U.S. Highway 6; therefore, visual sensitivity would be low.

4.2.10 Cultural Resources

The resources recorded at the Tonopah Test Range are limited to certain environmental areas, while the archaeological sites within other areas are virtually unknown. Recorded properties cluster within the categories of extractive localities, processing localities, and mining and ranching, but other types of sites are known. Projectile points found on the Tonopah Test Range suggest that the area has been used for the last 10,000 years. At the time of the first European explorations of the area, groups of Western Shoshone people occupied the area. The Kawich band used much of the Tonopah Test Range, while groups from the areas came to Cactus Flat to collect seeds and hunt Beatty and Belted Mountain antelope and rabbits (Steward, 1938).

Based on current knowledge of cultural resources on the Tonopah Test Range, all areas have the potential to contain significant historic properties. Thus, the current Tonopah Test Range boundaries are considered the area of potential effect for cultural resources. To date, 11,549 acres have been surveyed for cultural resources on the Tonopah Test Range. The following section summarizes previous work conducted on the Tonopah Test Range, evaluates the sites according to their types, and assesses their eligibility for listing on the National Register of Historic Places.

Table 4-40. Water rights status for hydrographic basins at the Tonopah Test Range

Hydrographic Basin Number and Name	Perennial Yield		Total Committed Groundwater Resources		Comments
	m^3/yr	ac-ft/yr	m^3/yr	ac-ft/yr	
Raiston Valley	7.4×10^6	6,000	2.4×10^6	1,917	Basin designated by Order 742, Notice of Curtailment by Order 752. No Tonopah Test Range water rights or use.
Stonewall Flat	1.2×10^5	100	1.4×10^4	12	No Tonopah Test Range water rights or use.
Gold Flat	2.3×10^6	1,900	1.2×10^5	95	Estimated Tonopah Test Range water use in 1988 was 49,339 m^3 (40 ac-ft).
Cactus Flat	3.7×10^5	300	7.6×10^5	619	Estimated Tonopah Test Range water use in 1988 was 197,357 m^3 (160 ac-ft).
Stone Cabin Valley	2.5×10^6	2,000	2.5×10^6	2,033	Basin designated by Order 720. Estimated Tonopah Test Range water use in 1998 was 296,036 m^3 (240 ac-ft).

Sources: Boqo, 1996a.

RECORDED CULTURAL RESOURCES—Large reconnaissance surveys and overviews completed at the Tonopah Test Range include the Seafarer Project (Ferraro et al., 1975), the Mt. Diablo Baseline Survey (Brooks et al., 1976), and the NAFR Complex surveys (Ellis, 1979; Bergin and Roske, 1978; Bergin et al.,1979; Crownover, 1981). Numerous smaller reconnaissance surveys have been completed by the Desert Research Institute including those compiled for the development of a U.S. Air Force base supporting the F-117A on the Tonopah Test Range (DOE, 1988). Figure 4-53 shows the hydrographic basins, and Table 4-41 lists the types of sites found.

Gold Flat—Most of this hydrographic basin lies south of the Tonopah Test Range on the NAFR Complex. The portion that is within the Tonopah Test Range is divided from Cactus Flat at the Breen Creek drainage. Seven archaeological reconnaissance surveys have been conducted within that portion of Gold Flat that lies within the Tonopah Test Range. Approximately 950 acres were surveyed for cultural resources. Forty-four cultural resources sites have been recorded as a result of these surveys. Of this total, 4 are temporary camps, 31 are localities, and 9 are historic sites associated with mining or ranching. Forty sites have been recommended as eligible for the National Register of Historic Places.

Stonewall Flat—Most of Stonewall Flat lies outside of the Tonopah Test Range on the NAFR Complex. Only the extreme eastern portion lies inside the Tonopah Test Range boundaries. Stonewall Flat is differentiated from Cactus Flat by the Cactus Range. Only one archaeological survey has been conducted within the small portion of Stonewall Flat that lies within the Tonopah Test Range. Approximately 215 acres were surveyed for cultural resources. Thirteen sites have been recorded as a result of this survey. Other sites have been recorded in the portion of Stonewall Flat that falls within U.S. Air Force jurisdiction. Of the sites recorded,

Table 4-41. Types of sites found within the hydrographic basins of the Tonopah Test Range

Basin	Prehistoric Site Types							Historic Sites	NR Eligible
	RB	TC	EL	PL	LO	CA	STA	HI	NR
Gold Flat	0	4	0	0	31	0	0	9	40
Stonewall Flat	0	0	0	0	3	0	1	9	13
Ralston Valley	0	2	0	0	36	0	0	2	38
Cactus Flat	0	19	0	2	89	0	0	17	68
Stone Cabin Valley	0	3	0	6	87	0	0	3	63
Totals	**0**	**28**	**0**	**8**	**246**	**0**	**1**	**40**	**Total NR**
Total Tonopah Test Range Sites								**323**	**222**

Site type codes: RB=residential base; TC=temporary camp; EL=extractive locality; PL=processing locality; LO=locality; CA=cache; STA=station; HI=historic; NR=National Register of Historic Places.

three are localities, one is a station, and nine are historic mining and ranching sites. All of these sites have been recommended as eligible for the National Register of Historic Places.

Ralston Valley—The extreme southeastern corner of the Ralston Valley lies within the Tonopah Test Range boundaries. This drainage is divided from the Stone Cabin Valley drainage by the Monitor Hills. Only one archaeological survey has been conducted within the small portion of Ralston Valley that lies within the Tonopah Test Range. Approximately 170 acres were surveyed for cultural resources. Forty sites have been recorded as a result of this survey. Of these, 2 are temporary camps, 36 are localities, and 2 are historic. To date, 38 sites within the Ralston Valley hydrographic basin have been recommended as eligible for the National Register of Historic Places.

Cactus Flat—Most of the Cactus Flat hydrographic basin lies within the boundaries of the Tonopah Test Range. The basin is bounded by the Cactus Range, the Kawich Range, Gold Mountain, and the Breen Creek drainage. The Cactus Flat region has the highest density of archaeological sites recorded on the Tonopah Test Range. This may be a reflection of the intensity of survey that has occurred in this basin. Forty-eight archaeological surveys have been conducted within the Cactus Flat hydrographic basin and 9,795 acres have been examined. To date, 68 sites have been recommended as eligible for the National Register of Historic Places.

Stone Cabin Valley—The extreme southern portion of Stone Cabin Valley extends into the northern part of the Tonopah Test Range. It is bounded by the Monitor Hills and the Kawich Range. Six archaeological reconnaissance surveys have been conducted within that portion of Stone Cabin Valley that lies within the Tonopah Test Range. Approximately 420 acres were surveyed for cultural resources. A total of 105 sites have been recorded as a result of these surveys. This total includes 3 temporary camps, 6 processing localities, 87 localities, and 3 historic sites. To date, 63 sites have been recommended as eligible for the National Register of Historic Places.

SITES OF AMERICAN INDIAN SIGNIFICANCE—The CGTO knows that the

Tonopah Test Range contains significant cultural resources, including plants, animals, archaeology sites, and places of historic value to Indian people. This is known from Indian interviews conducted in the 1930s (Steward, 1938) and recent plant, animal and archeology studies conducted south of this area in comparable environments (Stoffle et al., 1990a; Stoffle et al., 1994b). These studies document long-term and extensive involvement of Indian people in these traditional lands. These were among the last areas lived in before Indian people were forced out of the area to live on more distant Indian reservations. As a result of oral history, Indian people know there are various types of cultural resources located in this study area, but cannot provide site-specific information at this time. No Indian people officially representing the CGTO have visited the Tonopah Test Range or any other portion of the NAFR Complex, although such interviews have been requested and one initial meeting with a NAFR Complex archaeologist has occurred. Therefore, it is not possible to fully assess the cultural significance of the Tonopah Test Range at this time.

4.2.11 Occupational and Public Health and Safety Radiation

The DOE's commitments to quality management of the Tonopah Test Range worker safety and health as well as environmental resources is evident by the establishment of many offices and departments to oversee environmental, safety and health issues.

OVERVIEW - The potential for activities at the Tonopah Test Range to impact the health and safety of the general public is minimized by a combination of the remote location of the Tonopah Test Range, the sparse population surrounding it, and a comprehensive program of administrative and design controls. Visitors to the Tonopah Test Range are subject to essentially the same safety and health requirements as the workers. Safety briefings are provided as appropriate, personal protective equipment is provided when necessary, and radiation dosimeters are issued to long-term visitors. Secondary access control is provided, when necessary, for safety and or security reasons. Operations with higher-than-normal hazards are fenced or barricaded. The health and safety of the Tonopah Test Range workers is protected by adherence to the requirements of federal and state law, DOE orders, and plans and procedures of each organization performing work on the range. A program of self-assessment of compliance with these requirements is conducted by the Sandia National Laboratories, support contractors, and the DOE. Workers are further protected from specific hazards associated with their jobs by training, monitoring the workplace environment, using personal protective equipment, and using administrative controls to limit their exposures to chemical or radioactive materials.

All DOE activities on the Tonopah Test Range are in compliance with all environmental and other requirements established by federal, state, and local agencies. The main environmental compliance activities included the operation of a less than 90-day storage area for hazardous waste, minimal cleanup activities associated with the Environmental Restoration Program, and compliance sampling for the public water distribution system as required by the Safe Drinking Water Act.

RADIOLOGICAL ENVIRONMENT - Radiological effluent in the form of air emissions are released into the environment as a routine part of operations at the Tonopah Test Range. These emissions are monitored for source characterization and operational safety, as well as for environmental surveillance purposes.

The environmental surveillance of the Tonopah Test Range is focused on the three safety test areas that include approximately 670 acres. Environmental surveillance activities conducted by the DOE and the EPA include air, water, and soil sampling at various locations on the Tonopah Test Range and surrounding areas. The data from these efforts are summarized as annual averages for each monitoring location.

CRITERIA - All work at the Tonopah Test Range is performed in accordance with the safety and health requirements of the Occupational Safety and Health Administration as codified in Title 29 CFR Parts 1910 and 1926. In addition, the following DOE orders provide direction for worker safety and health programs:

- 5480.7A Fire Protection
- 5480.8A Contractor Occupational Medical Program
- 5480.9A Construction Project Safety and Health Management
- 5480.10 Contractor Industrial Hygiene Program
- 5480.13A Aviation Safety
- 5480.16A Firearms Safety
- 5480.1B Environmental Safety and Health Programs for Workers
- 5480.23 Nuclear Safety Analysis Reports
- 5480.28 Natural Phenomena Hazards Mitigation
- N441.1 Radiological Protection for DOE Activities.

INSTITUTIONAL SAFETY PROGRAMS - The Tonopah Test Range supports the following on-site safety services provided by Sandia National Laboratories and other support contractors:

- Fire support services
- Occupational medicine services (limited critical care patients are transported into the town of Tonopah)
- Radiological safety services, including a radioactive material control program to assure that materials leaving the Tonopah Test Range are not contaminated
- Industrial hygiene services.

The above services can be expanded to meet the requirements of the Tonopah Test Range from Sandia National Laboratories' main facility in Albuquerque, New Mexico.

4.2.12 Environmental Justice

Existing demographic conditions for Environmental Justice are discussed in Section 4.1.12. This discussion includes conditions for the Tonopah Test Range region of influence.

4.3 Project Shoal Area

Project Shoal Area was a joint effort of the DoD and the Atomic Energy Commission to study the effects of different geological media (e.g., granite) on seismic waves produced by underground nuclear shots and to determine whether seismic waves produced from underground nuclear testing could be differentiated from natural earthquakes (DOE, 1988). The Project Shoal Area was selected as a potential site in 1961, and preparations for the test began in late 1962. The Project Shoal Area was a nuclear device with an estimated yield of 12.5 kt at 367 m (1,205 ft) belowground surface on October 26, 1963. The shot produced a rubble-filled chimney 52 m (170 ft) in diameter and 140 m (460 ft) high (Gardner and Nork, 1970).

Deactivation of the site began almost immediately after the test, with all surface equipment removed by January 31, 1964. The shaft was covered by a permanent concrete slab, and all exploratory boreholes leading to the cavity were permanently sealed. A preliminary site assessment, conducted by the Desert Research Institute in 1988, resulted in a Hazard Ranking System score of 3.52. This score does not meet the minimum score required for placement on the National Priorities List under Superfund.

Management recommendations listed in the report included groundwater monitoring of nearby wells and further investigations to quantify the nature and extent of potential contaminants (DOE, 1988).

Because the activities at the Project Shoal Area are restricted to environmental restoration actions, the alternatives do not have the potential to impact waste management, transportation, or socioeconomics at the Project Shoal Area. Therefore, the development of a detailed baseline for these issues is not warranted. A brief explanation for this decision follows:

- Waste Management—No waste management facilities exist at the Project Shoal Area. Any waste generated during the course of Environmental Restoration Program activities would be transported either to the NTS or a permitted hazardous waste facility

- Transportation—The Project Shoal Area is crossed by numerous roads used for accessing surrounding public lands. Access to the site during Environmental Restoration Program activities would generate only a minor amount of traffic on local roads. Transportation of investigation-derived waste and remediation-generated waste is discussed in Section 4.1.2.3

- Socioeconomics—No new facilities are proposed to be located at the Project Shoal Area. Only environmental restoration activities are planned at this location. Environmental restoration activities would be short-term and would require relatively few personnel (less than 10 at any given time).

4.3.1 Land Use

The Project Shoal Area is a 10.4 km^2 (4 mi^2) area located at an elevation of 1,585 m (5,200 ft) in the northern part of the Sand Springs Mountain Range. It is located 48 km (30 mi) southeast of Fallon, Nevada (Figure 4-54). The closest human population is represented by a private ranching operation 8 km (5 mi) to the west. The site is surrounded by unimproved rangeland covered with sparse, low vegetation.

4.3.1.1 Public Land Orders and Withdrawals. The Project Shoal Area was withdrawn in 1962 for the proposed Project Shoal Area test by Public Land Orders 2771 and 2834. This site consists of 2,560 acres. (SAIC/DRI, 1991).

4.3.1.2 Land-Use Designations. Characterization and testing activities began at the Project Shoal Area in late 1962. Upon completion of operations on October 28, 1963, site deactivation was initiated (AEC, 1970). All vehicles and equipment were returned to the NTS, including communications equipment, technical instruments, and radiation monitoring instruments. Roads and concrete pads remained on the site. After wire, cable, poles, and lumber were salvaged, the lease of facilities in Fallon was terminated, and site decommissioning was deemed completed on January 31, 1964. Control or prevention of entry into the subsurface in the area continues to be a necessity for security purposes and is defined as the exclusion zone. The exclusion zone lies between a depth of 55 m (180 ft) and 518 m (1,700 ft) below surface ground zero and 1,006 m (3,300 ft) laterally between those depths (AEC, 1970). Access to the land surface of the withdrawal area is currently uncontrolled. The site is bounded on all sides by public land. North and south of the Project Shoal Area, land is used for grazing.

The Navy has applied for a withdrawal which surrounds and overlaps the DOE withdrawal at the Project Shoal Area site. The DOE's present plan is to characterize and complete any required remediation so that the surface can be available for unrestricted public use. Access to the deep subsurface would remain excluded. Continued access by the DOE for monitoring of the subsurface would be long term.

The preliminary Hazard Ranking System score (EPA's ranking system for Superfund cleanup determination) for the Project Shoal Area is a low score based primarily on the assumption of a low probability for the migration of radionuclides, and there are no human drinking water receptors in the vicinity of the Project Shoal Area. The nearest population center is the town of Fallon, Nevada, located 45 km (28 mi) northwest of the site, although evidence of past ranching activities can be found closer to the site.

4.3.1.3 Site-Support Activities. This section provides a brief discussion of site-support activities at the Project Shoal Area.

FACILITIES—There are no existing facilities at the Project Shoal Area.

SERVICES—Services discussed for the Project Shoal Area include law enforcement and security, fire protection, and health care.

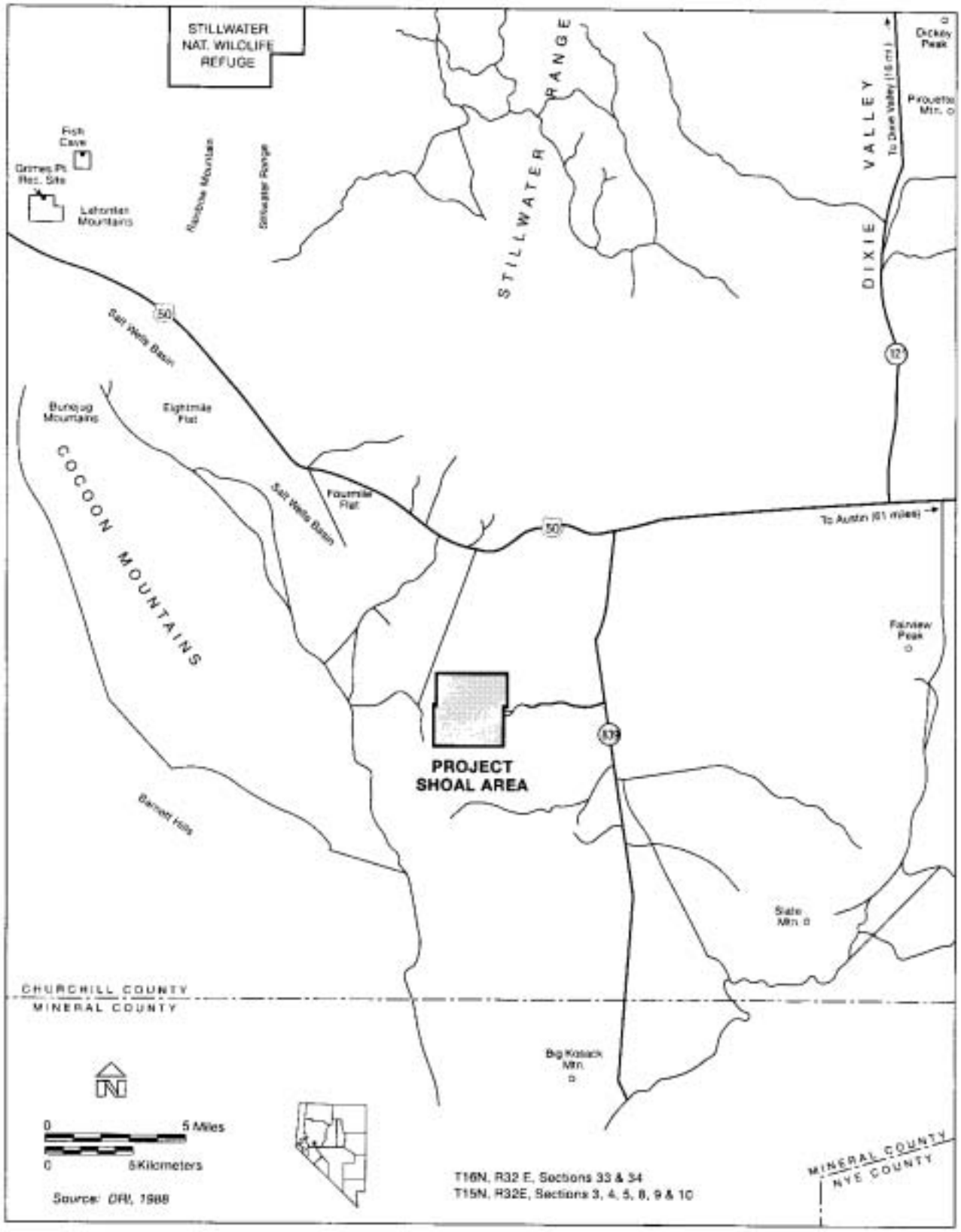


Figure 4-54. Project Shoal Area and surrounding area

Law Enforcement and Security—No security is provided at the Project Shoal Area. Law enforcement is provided by the Churchill County Sheriff's Department.

Fire Protection—Fire protection for the Project Shoal Area is provided by the U.S. Bureau of Land Management.

Health Care—No health care facilities currently exist at the Project Shoal Area.

UTILITIES—No utilities currently exist at the Project Shoal Area.

COMMUNICATIONS—No communication systems currently exist at the site.

4.3.1.4 Airspace. The airspace over the Project Shoal Area is part of the Fallon Range Training Complex located in restricted area R-4812. This area encompasses 453 km^2 (175 mi^2) of public land (see Figure 4-55). This restricted area is a joint-use area, and civilian aircraft are able to fly in the area when it is not being used for military training activities (SAIC/DRI, 1991).

4.3.2 Transportation

No public roads currently exist on the Project Shoal Area. Access to the site during environmental restoration activities would generate only a minor amount of traffic on local access roads and the immediate regional highway (U.S. Highway 50), which are currently underused. In 1993, the average daily traffic on U.S. Highway 50 near the site was 1,340 vehicles (NDOT, 1993a). This traffic volume is far below the capacity of U.S. Highway 50 at this location, which ranges from 10,000 to 20,000 vehicles.

4.3.3 Socioeconomics

The majority of DOE/NV workers, including those assigned to projects at the Project Shoal Area, live in Clark or Nye counties (DOE, 1994b). An analysis of socioeconomic conditions in Clark and Nye counties is presented in Section 4.1.3.

4.3.4 Geology and Soils

Physiography, geology, and soils are addressed in this section. Also discussed are seismic issues.

4.3.4.1 Physiography. The Project Shoal Area is within the Basin and Range Physiographic Province. Section 4.1.4.1 contains a description of this physiographic province. The area immediately surrounding the site is a high, gently rolling plateau, falling steeply away to valleys on the east and west (AEC, 1970).

The Project Shoal Area is located on Gote Flat in the northern portion of the Sand Springs Range. The range is a low, north-south-trending formation approximately 32 km (20 mi) long and 5 to 8 km (3 to 5 mi) wide. Total relief between the range and valley is 503 m (1,650 ft) (AEC, 1970). The range is bordered on the east and west by the similarly trending alluvial valleys of Fairview Valley and Fourmile Flat, respectively. Large faults are presumed to separate the range from the valleys to the east and west (AEC, 1963). Steeply dipping faults, joints, and shear zones with northwest and northeast orientations are prevalent in the range (AEC, 1970).

4.3.4.2 Geology. Sand Springs Range is composed chiefly of Cretaceous granitic rocks, bordered on both the north and south by Mesozoic metamorphic rocks. Tertiary and Quaternary alluvial and aeolian (wind-blown) deposits occupy the valleys (AEC, 1970). Locally, both the granitic and metamorphic rocks are overlain by Tertiary and Quaternary volcanic rocks, and the surface ground zero area is overlain by Quaternary alluvium. Numerous dikes composed of aplite-pegmatite, andesite, and rhyolite intrude the granite. The Project Shoal Area test was detonated in the Cretaceous granite.

There are 18 mines within 84 km (52 mi) of the Project Shoal Area surface ground zero. Two inactive tungsten mines are within 6 km (4 mi) of the site. The closest marginally active mine is a gold mine 8 km (5 mi) north of the site (AEC, 1970).

The area surrounding the Project Shoal Area is seismically active, and future earthquakes could cause rearrangement of the rubble in the test

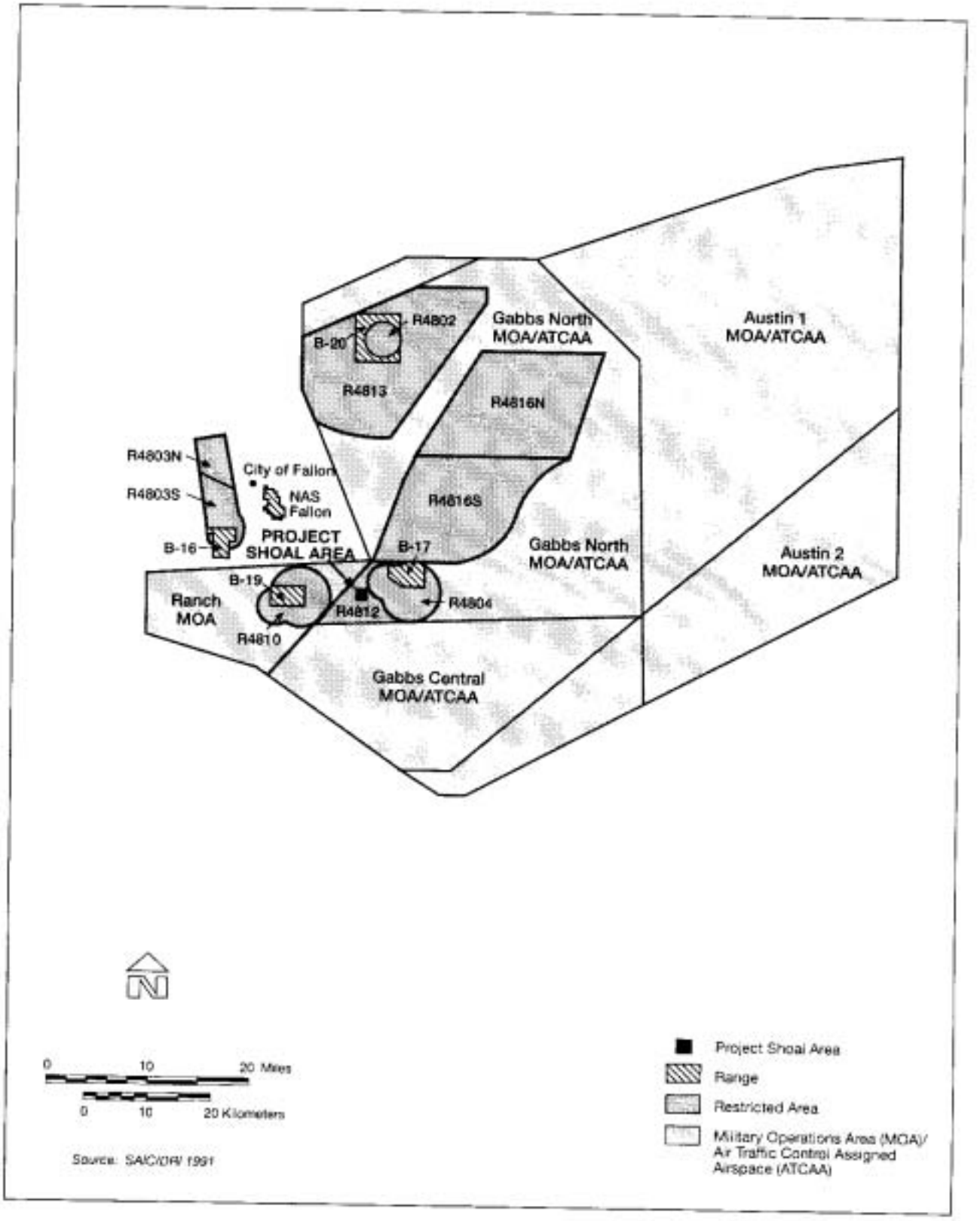


Figure 4-55. Project Shoal Area airspace

chimney and further collapse of the ceiling. However, with more than 244 m (800 ft) of granite between the top of the chimney and the land surface, a complete collapse of the chimney resulting in release of radioactivity to the surface is unlikely (DRI, 1988).

4.3.4.3 Soils. Soil at the Project Shoal Area consists of the Chill series, a gravelly, sandy loam with the soil surface covered by approximately 10 percent fine pebbles. The Chill series consists of very shallow and shallow well-drained soils, formed in residuum of granitic bedrock on low hills (Dahl, 1994).

4.3.5 Hydrology

This section addresses surface water and groundwater conditions at the Project Shoal Area. A discussion of wells in the vicinity is also presented in this section.

4.3.5.1 Surface Hydrology. The Project Shoal Area is within the Great Basin (AEC, 1970). There are no permanent bodies of water in the Project Shoal Area (DRI, 1988), only ephemeral streams fed by seasonal snow and rain. The ephemeral nature of the streams makes water monitoring difficult; consequently, there are no surface-water quality data. Ephemeral streams originating in the higher elevations of Aplite Ridge flow in an easterly direction across the site. The only springs in the area are the Bucky O'Neil Flowing Well, located 7.2 km (4.5 mi) northwest of surface ground zero on the edge of Fourmile Flat; and the Smith-James Spring, located 8 km (5 mi) southeast of surface ground zero on the edge of Fairview Valley.

4.3.5.2 Groundwater. The mountain range around the Project Shoal Area is a regional groundwater recharge area, with regional discharge occurring both in the Fourmile and Eightmile Flats area to the west of the range, and in the Humboldt Salt Marsh in Dixie Valley to the northeast of the range (Figure 4-56). The University of Nevada (1965) analyzed hydrologic data in the Project Shoal Area and concluded that a groundwater divide may exist northwest of the event and that the main component of lateral movement of groundwater near ground zero is southeast toward Fairview Valley. (Cohen and Everett, 1963) and (Glancy and Katzer, 1975) also identify a groundwater divide just west of the Project Shoal area, apparently based on a topographic divide. Though the hydraulic data suggest flow to the east from the site, hydrochemical parameters suggest flow to the west (University of Nevada, 1965), and available data are not sufficient to rule out either the east or west pathway.

At the Project Shoal Area, groundwater occurs within fractured granite. Hydraulic tests conducted at the time of the Project Shoal Area test showed that there was a range of conditions in the granite, depending on fracture geometry relative to the wells, but that overall the transmissive capacity was low. This transmission capacity is expected to be less than 2.5 m^2/day (200 gal/day/ft) (University of Nevada, 1965). In general, groundwater occurs about 290 m (951 ft) belowground surface in the immediate vicinity of the test, although a few high-altitude springs discharging from perched zones in the granite can be found to the south. In the adjacent valleys, groundwater occurs in alluvial material eroded from the highlands, and hydraulic testing indicated much higher transmissivities. These are on the order of 62 m^2/day (5,000 gal/day/ft) to 944 m^2/day (76,000 gal/day/ft) (University of Nevada, 1965). Granitic bedrock is relatively near the surface beneath a veneer of alluvium west of the Sand Springs Range. Farther to the west, and in Fairview Valley to the east, bedrock occurs at greater depths and is not penetrated by wells. Discharge of water originating in the Sand Springs Range occurs at springs and by evapotranspiration along the edge of the salt pan in Fourmile Flat. Data from a well completed in the alluvium between the range and the salt pan suggest that a counterflow of dense, saline water may be moving back toward the range from the playa, driven by buoyancy forces, with fresh water moving from the Sand Springs Range being confined to a thin lens at the top of the saturated zone (Chapman et al., 1995). The alluvium is much thicker in Fairview Valley, and the groundwater occurs in at least three separate aquifers separated by clay aquitards. No discharge to the surface occurs in Fairview Valley; rather, groundwater moves northward to discharge areas in Dixie Valley. The Long-Term Hydrologic Monitoring Program

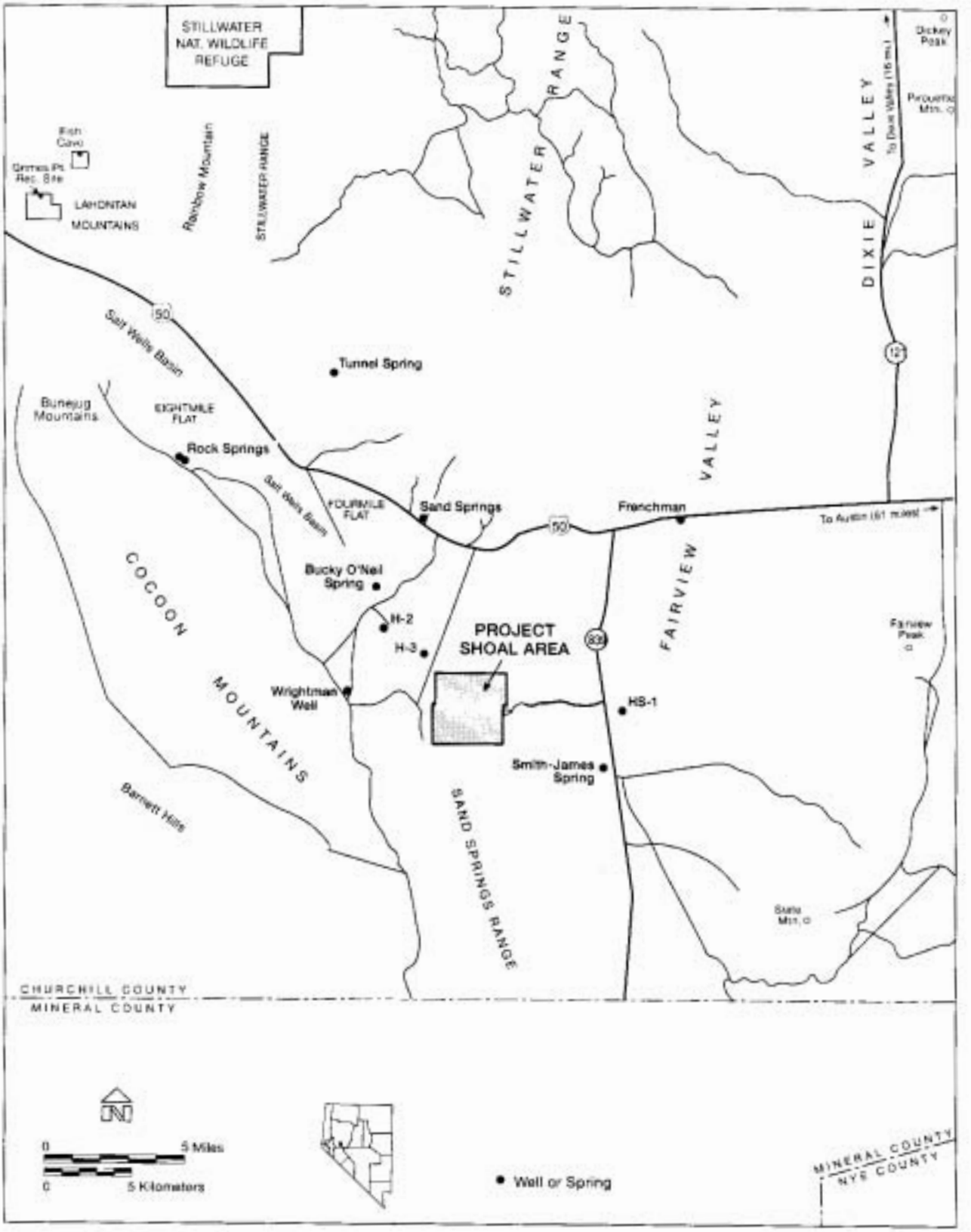


Figure 4-56. Location of wells and springs in the Project Shoal Area

samples one spring in the Sand Springs Range and five wells in the adjacent valleys. No contamination related to the Project Shoal Area test has been detected in these samples. The Environmental Restoration Program will evaluate the need for additional hydrology studies and expanded monitoring at the Project Shoal Area.

Six water wells exist within 4 miles of the site: one domestic water supply well, one livestock well, and four U.S. Bureau of Land Management exploratory wells. The only wells in the Sand Springs Range itself are associated with mining operations to the south of the Project Shoal Area. Groundwater is used in both of the adjacent valleys for stock watering, primarily on a seasonal basis. Groundwater quality is poor in the Fourmile Flat basin because of high dissolved solids, with better quality water found in Fairview Valley. Although there is a well at an apparently abandoned homestead in Fourmile Flat (Wightman Well), and there is a well at the location of a former store (known as Frenchman Station) in Fairview Valley, groundwater in the area is not currently used for private domestic supply. The perennial yield of Fairview Valley has been estimated at 16,741 m^3 (500 acre-feet) (Cohen and Everett, 1963). The yield of the Fourmile Flat area is unknown; it was grouped with a large area of the Carson Desert for the resource appraisal, but estimates of groundwater discharge exceeded estimates of groundwater recharge for the region (Glancy and Katzer, 1975).

4.3.6 Biological Resources

The scientific names of plants and animals mentioned in this section are given in Section 2.0 of Appendix E, Biological Resources. The Project Shoal Area is within the Great Basin desert. The vegetation surrounding the site varies with elevation and topography. Salt Wells Basin is located about 10 km (6 mi) northwest of the Project Shoal Area in Fourmile Flat and lies at an elevation of about 1,201 m (3,940 ft). This basin has a dry, saline lake bed vegetated only by saltgrass where sufficient moisture is available. Sand dunes are located along the northeast edge of the lake bed and extend along its eastern edge. The northern end of these dunes have no vegetation, but the southern extension contains sparse stands of greasewood, glandular indigo bush, four-winged saltbush, and shadscale. Several springs and wells occur around the lake bed and dunes. Sedges, rushes, and desert saltgrass are common where seep areas and overflow from the wells sustain small oases of vegetation.

Between the lakebed and the Sand Springs Range are shallow-sloped foothills dominated by the shrubs greasewood, shadscale, rabbitbrush, horsebrush, and glandular indigo bush. Steep, rocky slopes occur along a narrow zone between the shallow-sloped foothills and Gote Flat. These steep slopes are dominated by Nevada ephedra, rabbitbrush, horsebrush, big sagebrush, and snowberry. The highest elevations at this site, 1,500 to 1,800 m (4,920 to 5,910 ft), are dominated by big sagebrush.

It is likely that few animal species use the dry lake bed. Animal species occupying the surrounding habitats are probably widespread and similar to those described for the Tonopah Test Range and the Great Basin desert portions of the NTS. Chukar is the only common game species in the area (BLM, 1983).

No current federally threatened, endangered, or candidate plant or animal species are known to occur at the Project Shoal Area, although bald eagles and peregrine falcons may be rare migrants. The U.S. Fish and Wildlife Service published the latest list of candidate plants and animals on February 28, 1996 (61 F.R. 7596). Prior to this, 10 vertebrate species, 4 invertebrate species, and 2 plant species that were identified as potentially occurring at this site were classified as candidates (Mendoza, 1995b) and were addressed (Table 4-30). The updated Notice of Review has removed all but one of these species from candidate status. The mountain plover, which may be an uncommon migrant in the area, remains a candidate bird species. The western burrowing owl, one of over 20 State-protected bird species, is likely to occur on site.

4.3.7 Air Quality and Climate

This section includes a description of air quality conditions at the Project Shoal Area, including climatology, meteorology, and ambient air quality.

CLIMATOLOGY AND METEOROLOGY—Meteorological measurements are not available for the Project Shoal Area. Based on Nevada climatological maps of temperature and precipitation (Ruffner, 1980), temperatures would be 2 to 3 °C (4 to 5 °F) cooler than those on the Tonopah Test Range (see Section 4.2.7). Mean annual precipitation is estimated to be about 20 cm (8 in.). Wind patterns are similar to those that occur on the Tonopah Test Range.

AMBIENT AIR QUALITY—The Project Shoal Area is located in Nevada Intrastate Air Quality Control Region 147. There are no air-quality monitoring stations in the region. Because there are no significant sources of pollutant emissions in the region, the air quality is most likely good. Air Quality Control Region 147 is designated as unclassifiable/attainment for all criteria pollutants.

4.3.8 Noise

The acoustic environment around the Project Shoal Area can be classified as uninhabited desert or small rural communities. Noise measurements have not been made at the Project Shoal Area. The major sources of noise would be associated with prevailing meteorological conditions, such as wind, or would result from sonic booms produced by supersonic overflights of military aircraft. Training ranges used by the Naval Air Station, Fallon, are located several miles from the Project Shoal Area. These training ranges are used for gunnery, explosive ordnance, and bombing practice activities. C-weighted (L_{dn}) resulting from these range activities are less than 65 dB at the Project Shoal Area (SAIC/DRI, 1991). Noise from traffic on U.S. Highway 50, which is 6 km (4 mi) to the north, has negligible effect on the Project Shoal Area.

4.3.9 Visual Resources

The landscape character of the Project Shoal Area is typical of the Great Basin. Regional topography consists of mountain ranges arranged in a north-south orientation, separated by broad valleys. The landscape at the Project Shoal Area is common to the region. Therefore, scenic qualities have been designated Class C. State Route 839, which is 3 km (2 mi) east of the site, has an average daily traffic of 160 vehicles (NDOT, 1993a). Therefore, the sensitivity level would be low.

4.3.10 Cultural Resources

The Project Shoal Area lies in the western Great Basin, an area with a prehistory that may span the past 10,000 years or more. Properties ranging from the early prehistoric period to historic mining and ranching sites are known. Historical contexts are summarized in (Hardesty, 1982) and in (Bard et al, 1981). At the time of contact with Euroamericans in the mid-1800s, the area was used by the *Toedokado* band of the Northern Paiute (Stewart, 1939). Their territory centered around camps on the edge of the Carson Sink, northwest of the project area. Detailed information about the Northern Paiute can be found in (Stewart, 1939), (Bard et al., 1981) and (Fowler and Liljeblad, 1986).

The Project Shoal Area consists of three separate land areas with a total area of approximately 2,560 acres (SAIC/DRI, 1991). An area of potential effect for the cultural resources at the Project Shoal Area is based on research performed in the area for environmental restoration at the site. Environmental Restoration Program activities involve sampling wells and springs within 16 km (10 mi) of ground zero. Based on that sampling strategy, an area of potential effect was created and a stratified, random sample survey of the area of potential effect was conducted to characterize the cultural resources of the area.

RECORDED CULTURAL RESOURCES—Eleven archaeological sites have been recorded within the area of potential effect. Of the 11 sites, 1 is an extractive locality, 4 are processing localities, 1 is a station, and 5 are historic sites. Five sites have been recommended as eligible for listing on the National Register of Historic Places. Consultation with the SHPO regarding eligibility of these sites is not concluded.

SITES OF AMERICAN INDIAN SIGNIFICANCE—This study area is not within the traditional lands of the American Indian people represented by the CGTO. It is recommended by the CGTO that the DOE EIS team directly contact American Indian tribes and

organizations having traditional lands in the Project Shoal Area. The following tribes were suggested: Fallon Paiute, Walker River Paiute, Pyramid Lake, and Lovelock Paiute Tribe.

NOTE: The DOE/NV provided notification, as recommended by the Consolidated Group of Tribes and Organizations.

4.3.11 Occupational and Public Health and Safety and Radiation

Approximately 3×10^{11} Ci of radioactivity existed 1 minute after detonation of the Project Shoal Area test (Glasstone and Dolan, 1977). This amount of radioactivity was reduced by a factor of more than 2,000 during the first day after detonation. Virtually all radioactivity associated with the detonation is assumed to be confined to the puddle-glass mixture at the bottom of the shot cavity chimney. There is no evidence of venting of particulate matter during or after the explosion. Groundwater in the vicinity of the detonation is assumed to be contaminated with tritium. Historical groundwater monitoring in the vicinity of the Project Shoal Area has been performed by the EPA as part of the Long-Term Hydrologic Monitoring Program. Monitoring results demonstrate that the tritium concentration is below the EPA limit for drinking water (EPA, 1992).

Low groundwater velocities indicate that migration of radionuclides to the nearest water supply well would take 750 years (DRI, 1988). Calculations indicate that tritium would decay to negligible levels long before reaching potential receptors (DRI, 1988).

Minor levels of radioactivity were released and reached the surface during drilling and sampling operations subsequent to the detonation. The releases consisted of gases and vapors that were safely channeled into filters and traps. Historical records indicate that the radioactive material was slightly contaminated with short-lived radioisotopes of iodine and xenon. The radioactive material was placed in the post-shot mud pit and covered with several feet of uncontaminated earth. These isotopes have since decayed to negligible concentrations below detectable levels. A recent radiological survey of the surface showed no radiation levels above natural background (DRI, 1988).

4.3.12 Environmental Justice

Existing demographic conditions for Environmental Justice are discussed in Section 4.1.12.

4.4 Central Nevada Test Area

The existing environmental conditions of the Central Nevada Test Area are described in this section.

The Environmental Restoration Program activities at the Central Nevada Test Area would not have the potential to impact waste management, transportation, socioeconomics, or occupational health and safety. Therefore, development of a detailed baseline for these issues is not warranted. A brief explanation as to why these issues are not described is as follows:

- Waste Management—No waste management facilities exist at the Central Nevada Test Area. Any waste generated during the course of Environmental Restoration Program activities would be transported to either the NTS or a permitted hazardous waste facility.

- Transportation—No public roads currently exist at the Central Nevada Test Area. Access to the site during Environmental Restoration Program activities would only generate a minor amount of traffic on local roads. Transportation of investigation-derived and remediation-generated waste is discussed in Section 4.1.2.3.

- Socioeconomics—No new facilities will be located at the Central Nevada Test Area.

- Occupational Health and Safety—Any environmental restoration activities occurring at the Central Nevada Test Area would be required to comply with applicable DOE orders and directives concerning occupational health and safety as described in Section 4.1.11.

4.4.1 Land Use

The closest permanent habitation to the Central Nevada Test Area is the Hot Creek Ranch, located 16 km (10 mi) southwest of surface ground zero. The nearest population center is the town of Tonopah, located 97 km (60 mi) southwest of surface ground zero.

The Central Nevada Test Area is located in the north-central part of Hot Creek Valley, a remote desert area in south-central Nevada, 97 km (60 mi) northeast of Tonopah, in Nye County, Nevada, and 52 km (32 mi) northeast of Warm Springs, Nevada (Figure 4-57). A portion of this area is also within the Toiyabe National Forest. The Central Nevada Test Area was obtained by the Atomic Energy Commission for the purpose of developing potential alternative sites for nuclear testing activities. Several emplacement holes were drilled in anticipation of future events; however, Project Faultless was the only nuclear test conducted at the Central Nevada Test Area. The event was conducted on January 19, 1968, at a depth of 975 m (3,200 ft), and had a yield of approximately 1 megaton (DOE, 1994a).

4.4.1.1 Public Land Orders and Withdrawals. The Central Nevada Test Area consists of two non-contiguous areas that were withdrawn by Public Land Order 4338; 640 acres for the Project Faultless detonation, and Public Land Order 4748 (1,920 acres) for a total of 2,560 acres. (SAIC/DRI, 1991). Although surface is not controlled, subsurface access is restricted by the DOE.

4.4.1.2 Land Use Designations. Site-support activities, such as movable trailer modules for use as offices, dining facilities and dormitories, tanks, power lines, underground cables, and an airstrip existed only temporarily at the Central Nevada Test Area during preparation, testing, and demobilization. Demobilization activities began in 1973, when all facilities except the Base Camp, Control Point, Noname Hill, and the airstrip were removed. Numerous drillholes used for subsurface soil and groundwater sampling were plugged; however, four wells have been left open for hydrologic monitoring on the site (DRI, 1988). Aside from this long-term hydrologic monitoring site, land use is confined to cattle grazing and recreation.

4.4.1.3 Site-Support Activities. Site-support at the Central Nevada Test Area is described in this section.

FACILITIES—There are no existing facilities at the Central Nevada Test Area.

SERVICES—Services described at the Central Nevada Test Area are law enforcement and security, fire protection, and health care.

Law Enforcement and Security—No security is provided at the Central Nevada Test Area. Law enforcement is provided by the Nye County Sheriff's Department.

Fire Protection—Fire protection for the Central Nevada Test Area is provided by the U.S. Bureau of Land Management.

Health Care—No health care facilities currently exist at the Central Nevada Test Area.

UTILITIES—The Central Nevada Test Area does not contain utility systems.

COMMUNICATIONS—No communication systems are currently located at the site.

4.4.1.4 Airspace. The Central Nevada Test Area is not located beneath any special-use airspace used for DOE or defense-related purposes.

4.4.2 Transportation

No public roads currently exist on the Central Nevada Test Area. Access to the site during environmental restoration activities would generate only a minor amount of traffic on local roads and the immediate regional highway (U.S. Highway 6), which are currently under-used. In 1993, U.S. Highway 6 near Warm Springs carried an average of 145 to 210 vehicles per day. This traffic volume is far below the two-way vehicle capacity of U.S. Highway 6 at this location, which is approximately 1,700 vehicles per hour.

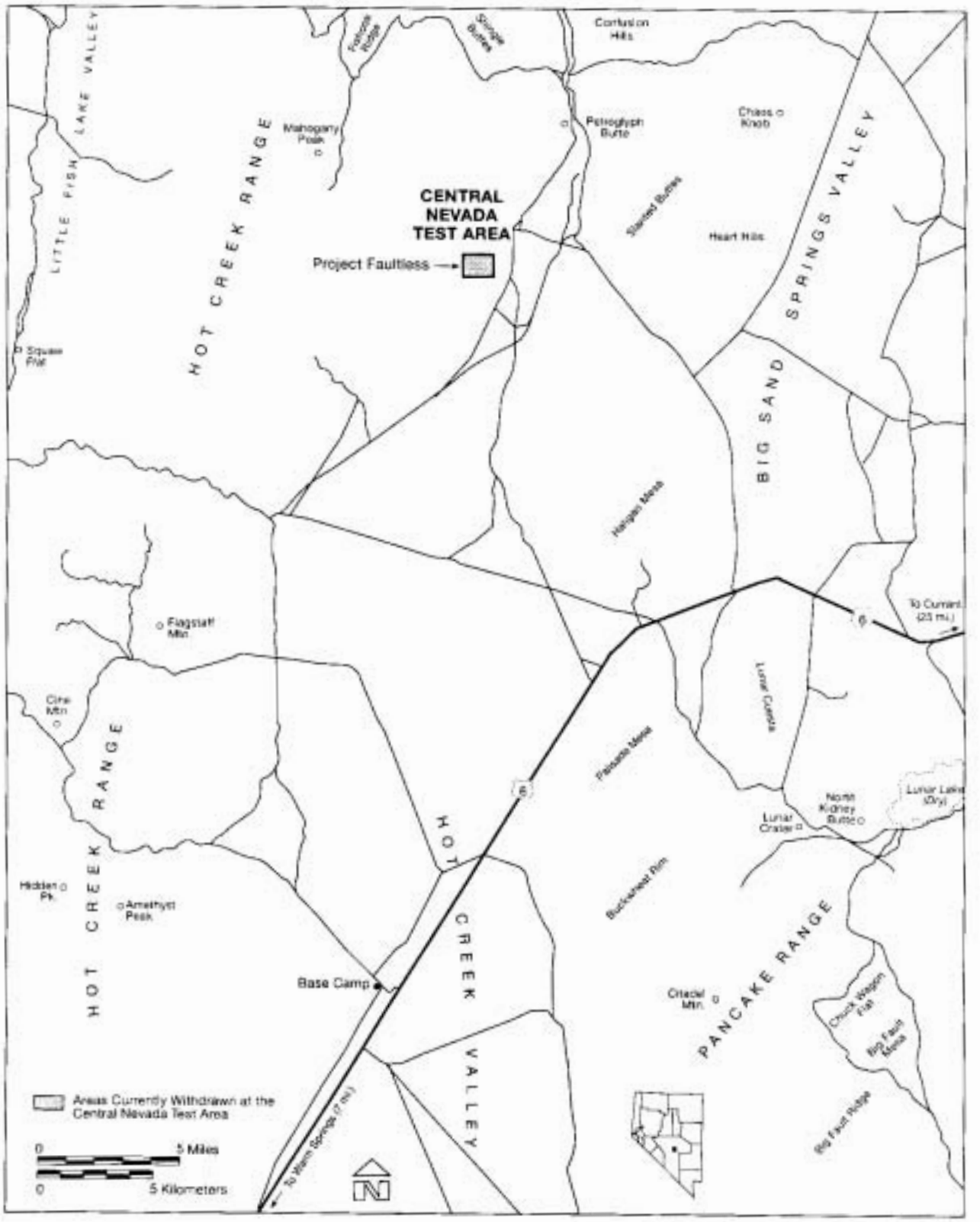


Figure 4-57. Central Nevada Test Area and surrounding area

4.4.3 Socioeconomics

The majority of DOE/NV workers, including those assigned to projects at the Central Nevada Test Area, live in Clark or Nye counties (DOE, 1994b). An analysis of socioeconomic conditions in Clark and Nye counties is presented in Section 4.1.3.

4.4.4 Geology and Soils

Physiography, geology, and soils are addressed in this section for the Central Nevada Test Area.

4.4.4.1 Physiography. The Hot Creek Valley is within the Basin and Range Physiographic Province. See Section 4.1.4.1 for a description of this province. The valley is about 113 km (70 mi) long on its north-south axis and varies in width from 16 to 32 km (10 to 20 mi). The Project Faultless site is in the north-central portion of the valley (AEC, 1973b). The Hot Creek Range lies immediately to the west and rises to an elevation that is 1,219 m (4,000 ft) above the site.

4.4.4.2 Geology. The mountains immediately west of the site are composed of volcanic rocks interlayered with sedimentary units (Stewart and Carlson, 1978). The thick alluvial fill of Hot Creek Valley displays little evidence of the structural framework or stratigraphy of the valley; therefore, the primary source of subsurface geologic data is the several exploratory holes that were drilled in the area. The Project Faultless emplacement hole (UC-1) penetrated alluvium from the surface to a depth of 732 m (2,400 ft). The alluvium is underlain by tuffaceous sediments and zeolitized tuff from 732 to 998 m (2,400 to 3,275 ft), which includes the total depth of the hole. The geologic media at the shot point consisted of tuffaceous sediments and zeolitized nonwelded tuffs (DRI, 1988).

The Project Faultless test, detonated in the saturated zone, created a large cavity. The estimated radioactivity at one minute after shot time was 3×10^{13} Ci. The event resulted in numerous surface fractures up to 2,743 m (9,000 ft) in length, with vertical displacement up to 5 m (15 ft) and horizontal offset up to 1 m (3 ft). The explosion resulted in the formation of an irregularly-shaped subsidence block of approximately 372 m^2 (4,000 ft^2), bounded by local faults in the surface ground zero area (DRI, 1988).

Although Hot Creek Valley has historically been the site of significant mineral production, most deposits have been fully developed and mining activity is now limited to a few small operations. According to (Kleinhampl and Ziony, 1984), historic production has included antimony, barite, gold, lead, silver, turquoise, uranium, and zinc. Most of this production came from two mining districts, the Morey District from 1866 to 1953 and the Danville District from 1866 to 1950.

Because of the proximity of Hot Creek Valley to the largest producing oil fields in Nevada (in Railroad Valley), there has been limited interest in oil and gas exploration. According to (Garside et al. 1988) and (Hess and Davis, 1995), only two oil wells have been drilled in Hot Creek Valley. The Hot Creek Federal No. 24-13 well was drilled in 1981 to a total depth of 3,361 m (11,028 ft). Although this well exhibited numerous gas shows below a depth of 2,710 m (8,890 ft), no oil was found, and no production came from the well. The other well, Warm Springs Federal No. 10-14, was drilled in 1981 to a total depth of 2,798 m (9,180 ft) with no reported shows of either gas or oil.

4.4.4.3 Soils. Soils most likely encountered at the Central Nevada Test Area range from rock outcrops and stony-cobbly alluvial fans to fine-loamy, and sometimes calcareous, soils (Cox et al., 1977). These are also referred to as Xerollic Durargids, Xerollic Durarthids, and Typic Durargids.

4.4.5 Hydrology

This section contains the discussion of surface water and groundwater conditions at the Central Nevada Test Area. A discussion of wells in the vicinity is also presented in this section.

4.4.5.1 Surface Hydrology. The Central Nevada Test Area, located in Hot Creek Valley, is within the Great Basin hydrographic region. This region is characterized by the alluvium-covered topographically closed valleys and elongated north-south trending mountain ranges typical of the Basin

and Range Physiographic Province. Hot Creek Valley is bordered by the Hot Creek Range on the west and the Pancake Range on the east. The topography of the region controls the surface water drainage (DOE/NV 1992), with the higher elevations receiving more precipitation than the lower elevations. Perennial surface waters are limited to low-discharge springs that travel a short distance before evaporating or infiltrating back into the ground (DOE, 1986). The Hot Creek Range hosts numerous springs that flow away from the site. The nearest spring to the site is 5 km (3 mi) away. No perennial streams cross the Central Nevada Test Area, and there are no permanent surface water bodies. Morey Canyon and South Canyon are prominent ephemeral streams that pass through the Central Nevada Test Area to Moore's Station Wash, 2 km (1 mi) east of the site. Owing to the intermittent flows in these streams, there are no surface-water quality data from streams that cross the Central Nevada Test Area.

4.4.5.2 Groundwater. The hydrogeology of Hot Creek Valley is controlled in part by the basin-and-range topography. The valley is a long graben (an elongated depressed block of crust bounded by faults on its long sides) containing a sequence of Quaternary and Tertiary alluvial fill (up to 1,200 m [3,936 ft]) underlain by Tertiary volcanic rocks. The bounding ranges on either side of the valley contain Paleozoic carbonates overlain by Tertiary age volcanics (Thordarson, 1987). Boreholes close to the site penetrate approximately 610 m (2,001 ft) of alluvium underlain by tuffaceous sediments and volcanic rocks.

The watertable in Hot Creek Valley generally occurs within the alluvium, and groundwater flow is believed to follow the general direction of surface flow (Rush and Everett, 1966; Fiero, 1986). The depth to groundwater in wells drilled at the Central Nevada Test Area ranged from 66 to 168 m (215 to 551 ft) below land surface at the time of drilling in 1967. Recharge occurs in the higher mountain range to the west (Hot Creek Range), with groundwater flowing toward the east-central part of the valley (Figure 4-58). Discharge is by evaporation in low portions of the valley (the area around Twin Springs Ranch), with a minor amount of subsurface flow out of Hot Creek Valley to Railroad Valley (Rush and Everett, 1966). Little information is available on water flow in the bedrock aquifers of the valley. Differences in hydraulic head, water chemistry, and temperature suggest that the alluvium and volcanics are distinct water-bearing zones (Dinwiddie and Schroder, 1971). Head values in the upper 340 m (1,115 ft) of the section indicate that groundwater movement is generally south to southeast. Head values measured in units 1,500 to 2,100 m (4,920 to 6,888 ft) below land surface reveal that the deep component of the flow system moves northeast and east to Railroad Valley. Evaluation of vertical head gradients indicates a potential for downward flow in the north end of the valley (in the immediate test area), while an upward potential for flow exists over the southern part of the valley. Dinwiddie and Schroder (1971) concluded that vertical movement is slow relative to lateral flow, based on the anisotropy of hydraulic properties.

The Project Faultless test occurred in the tuffaceous sediment section, but the resultant cavity extended into the overlying alluvium. The pre-event water-table level was predicted to be reached between the years of 1993 and 2018 (Thordarson, 1987), with recent measurements indicating the level is still depressed by about 50 m (164 ft), but rising at a rate of approximately 8 m/yr (25 ft/yr) (Chapman et al., 1994). Although radionuclide transport from the chimney was not expected until the pre-event water level was reached, logging in the post-shot hole at the site has revealed horizons of water outflow, which, if representative of conditions outside the chimney, suggests that transport could already be occurring (Chapman et al., 1994). The Long-Term Hydrologic Monitoring Program includes sampling of five wells and one spring in Hot Creek Valley. No contamination related to the Project Faultless test has been detected in samples from those wells.

Private wells in Hot Creek Valley are believed to be completed in the upper part of the alluvium section. They are used for domestic, farming, and stock-watering purposes. The perennial yield of Hot Creek Valley is estimated at 7×10^6 m^3 (5,500 acre-feet) (Rush and Everett, 1966). Some springs in the area have elevated temperatures and chemical characteristics that indicate they could be discharge points for deeper, regional flow systems. The

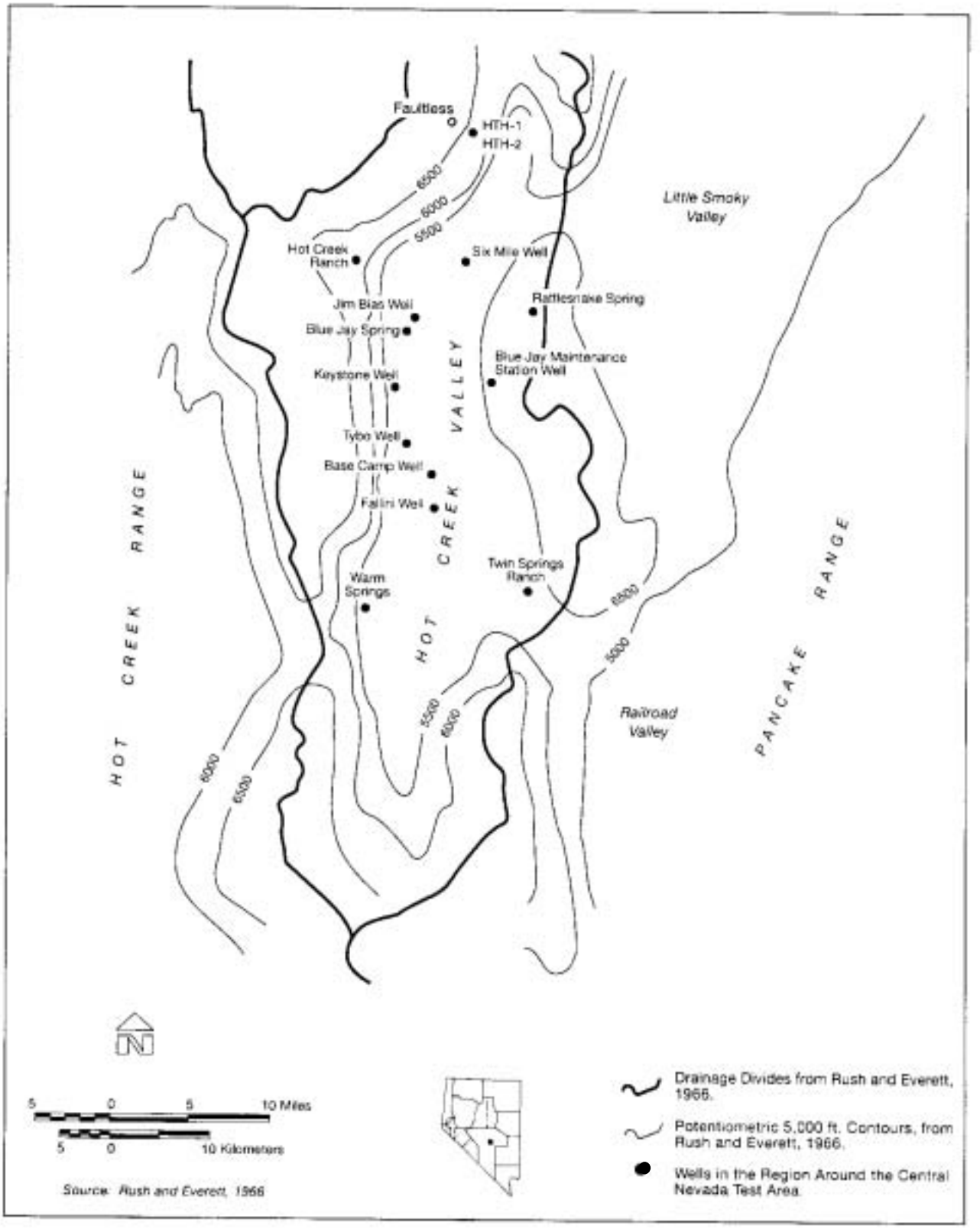


Figure 4-58. Hydrogeologic features of the Central Nevada Test Area

sparse data indicate that groundwater quality is generally good, although salinity increases in the natural discharge area near Twin Springs Ranch (Rush and Everett, 1966).

4.4.6 Biological Resources

The scientific names of plants and animals mentioned in this section are given in Section 2.0 of Appendix E, Biological Resources. The Central Nevada Test Area is at an elevation of about 1,861m (6,104 ft). This site and the rest of Hot Creek Valley has vegetation typical of the Great Basin region. The valley bottom is dominated by big sagebrush, with scattered rabbitbrush and Indian ricegrass. At the slightly higher elevations in the big sagebrush, with scattered rabbitbrush and Indian ricegrass. At the slightly higher elevations in the foothills surrounding the valley, sagebrush, pinyon pine, and juniper form an open woodland (EG&G/EM, 1993a). The most common plants found at the springs and wells in this valley and the surrounding mountains are sedges, rushes, and desert saltgrass. Disturbed sites in the valley are dominated by exotic weeds, such as halogeton, goosefoot, Russian thistle, and tansy mustard.

Animal species are probably similar to those found on the Tonopah Test Range. Mule deer are year-round inhabitants (BLM, 1993), and wild horses, pronghorn, and mourning dove are known to use springs in the area (EG&G/EM, 1993a).

No current federally threatened, endangered, or candidate plant or animal species are known to occur on the Central Nevada Test Area, although bald eagles and peregrine falcons may be rare migrants. The U.S. Fish and Wildlife Service published the latest list of candidate plants and animals on February 28, 1996 (61 FR 7596). Prior to this, 10 vertebrate species, 1 invertebrate species, and 5 plant species that were identified as potentially occurring at this site were classified as candidates (Mendoza, 1995b) and were addressed (Table 4-30). The updated Notice of Review has removed all of these species from candidate status. The western burrowing owl, 1 of over 20 state-protected birds, may occur at this site.

Five Category 2 candidate plant species may occur in the vicinity of the test area (Cooper, 1993; EG&G/EM, 1993a). None of these species was found within the test area during a survey in 1993 (EG&G/EM, 1993a); however, sanicle biscuitroot was found just south of the site. Sanicle biscuitroot is not endemic to this site and may be found throughout the southern half of Nevada, and in scattered populations in California (Blomquist, et al., 1995).

4.4.7 Air Quality and Climate

This section includes description of air quality conditions at the Central Nevada Test Area, including climatology, meteorology, and ambient air quality.

CLIMATOLOGY AND METEOROLOGY—Meteorological measurements are not available at this site. However, based on climatological maps of temperature and precipitation (Ruffner, 1980), temperatures would be 1 to 2 °C (2 to 4 °F) cooler than those on the Tonopah Test Range (Section 4.2.7). Mean annual precipitation is estimated to be about 20 cm (8 in.). Wind speed and direction characteristics are similar to those that occur on the Tonopah Test Range.

AMBIENT AIR QUALITY—The Central Nevada Test Area is located within Nevada Intrastate Air Quality Control Region. Ambient air quality has not been monitored for criteria pollutants at the Central Nevada Test Area. However, because of the lack of significant pollutant emission sources, the air quality is good. Air Quality Control Region 147 is designated unclassifiable/attainment for all criteria pollutants.

4.4.8 Noise

The acoustic environment of the Central Nevada Test Area and surrounding areas can be classified as uninhabited desert or small rural communities. Noise measurements have not been taken at the Central Nevada Test Area. The major sources of noise would be associated with prevailing meteorological conditions, such as wind. Traffic on U.S. Highway 6, which is 11 km (7 mi) to the southeast, would not have a significant acoustic

impact at the Central Nevada Test Area. The only projects anticipated for the Central Nevada Test Area are Environmental Restoration Program projects that would not create loud noises nor would they be affected by loud noises.

4.4.9 Visual Resources

The landscape character of the Central Nevada Test Area is typical of the Great Basin. Regional topography consists of mountain ranges arranged in a north-south orientation, separated by broad valleys. Because this site is located at the east base of the Hot Creek Range, scenic quality has been designated Class B. U.S. Highway 6, 19 km (12 mi) to the southeast, is the closest public highway. It has an average daily traffic of about 200 vehicles. Therefore, the sensitivity level would be low.

4.4.10 Cultural Resources

Archaeological research in the Central Nevada Test Area, and particularly in Hot Creek Valley, has documented the presence of significant cultural resources. Archaeological sites ranging from the early prehistoric period to historic mining and ranching sites are known. These sites have been identified, located, and evaluated by a variety of cultural resources surveys and excavations. A large gap exists in the archaeological database as the research conducted for the Project Faultless project was never incorporated in the statewide inventory. A large collection of between 20,000 and 30,000 artifacts, field notes, photographs, and other records on file at the University of Nevada, Las Vegas, indicates there are over 100 sites within the Central Nevada Test Area that have never been properly recorded (Edwards and Johnson, 1994).

Small bands of Western Shoshone people lived in the project area vicinity. Villages were located at Hot Springs and Twin Springs, while family camps were situated along Hot Creek and Tybo Creek (Steward, 1938 [Figure 4-48]). These groups harvested pine nuts in the southern part of the Hot Creek and Kawich Ranges. They often joined Kawich Mountain people for antelope and rabbit drives in Hot Creek Valley and the Kawich Mountains (Steward, 1938).

The Central Nevada Test Area includes three withdrawn areas of land totaling approximately 2,560 acres (SAIC/DRI 1988). Environmental restoration activities in the region of ground zero of the Project Faultless event have included sampling wells and springs up to 40 km (25 mi) from ground zero. Anticipated Environmental Restoration Program activities will include construction of wells. Thus, an area of potential effect for environmental restoration activities was created, and an overview of all recorded cultural resources and cultural resource surveys was performed.

RECORDED CULTURAL RESOURCES-Twenty-six cultural resource reconnaissance projects have been conducted in the area of potential effect. These projects and other recording projects have yielded just over 100 sites. Among the prehistoric cultural resources are two rock art sites, called stations. One of them, is called Moore's Station in (McLane, 1993:28) because of its proximity to that site. The other site is located in a rock shelter on Palisade Mesa. Prehistoric sites range from as few as four artifacts to extensive concentrations of artifacts and features. An additional site includes three large hearths and abundant flakes, flake tools, and groundstone. Most of the prehistoric sites that have been recorded in the area are smaller sites. The larger, more complex sites have a limited distribution and are in close proximity to water sources. A site found near Rattlesnake Springs includes groundstone and projectile points. Other sites in the area contain hearths and grayware pottery. Among the historic cultural resources are Moore's Station, Hobble Spring, Sixmile Well, a historic site, and Hot Creek Ranch. The latter has an additional site number assigned to the cemetery. Other historic sites in the area include the charcoal kilns located in Fourmile and Sixmile Canyons and the towns of Tybo and Morey (BLM, 1993). The charcoal kilns at Tybo are listed on the National Register of Historical Places. While the information contained in the U.S. Bureau of Land Management site files suggests that many of the other sites are eligible for the National Register of Historical Places, recommendations have not been made for most of them.

SITES OF AMERICAN INDIAN SIGNIFICANCE—The CGTO knows that there are a variety of cultural

resources contained at the Central Nevada Test Area. Information about this area comes from previous ethnographic research (Steward, 1938) and recent archaeology reports (Edwards and Johnson, 1994). The area contains a number of cultural resources of special interest to the CGTO, including hot springs, cold springs, petroglyph panels, and more than 100 archaeology sites. Earlier archaeology research conducted by the University of Nevada, Las Vegas, collected between 20,000 to 30,000 artifacts. The simple fact that so many artifacts were recovered from this small area indicated the long-term involvement of American Indian people with this site. The CGTO has requested the opportunity to visit the area as part of this EIS in order to more fully understand its cultural significance. Until this site visit occurs, it is impossible to more fully assess the cultural significance of this area.

4.4.11 Occupational and Public Health and Safety and Radiation

Radioactivity was contained during the Project Faultless test and subsequent drilling and sampling activities (DRI, 1988). A surface radiological survey conducted prior to demobilization of the Central Nevada Test Area detected no radioactivity (AEC, 1973c). A post-shot reentry hole (UC-1-P-2SR) drilled into the chimney serves as a standpipe for measuring water levels and allows samples to be taken of the water entering the chimney. The detonation caused water levels to immediately drop to 646 m (2,120 ft) (Thordarson, 1987). Water levels were observed to fluctuate over time; however, levels did not begin to rise continuously until September 1974 (ERDA, 1977).

Long-term hydrologic monitoring, conducted annually by the EPA, continues at the Project Faultless site. Numerous drillholes were established prior to the shot detonation to measure the effects on localized hydrology (Figure 4-58). Many of these holes were subsequently plugged and abandoned. Two hydrologic test holes, HTH-1 and HTH-2, were left open for monitoring, and Well UC-1-P-2SR remains open to allow sampling from above the shot cavity (DRI, 1988). Four wells and two springs are monitored for tritium on a yearly basis. Two wells, HTH-1 and HTH-2, are used as sampling points and are presumably located downgradient and within 1,494 m (4,900 ft) of the test site. An additional abandoned postdetonation hole (UC-1-P-1S) is periodically monitored (Chapman et al., 1994). In concert with multiple, ongoing groundwater monitoring programs, samples are analyzed for tritium, gross alpha, and gross beta radiation from one or more of the following sites: drill hole UC-1-P-2SR, drill hole HTH-1, HTH-2, Hot Creek Ranch domestic water supply well, 6-Mile Well, Blue Jay Springs, and Blue Jay Maintenance Station Well (DRI, 1988).

Tritium had not been detected in concentrations above background outside the chimney well until recently. Tritium (214 pCi/L) was detected in a water sample obtained from HTH-1 at 236 m (774 ft) in July 1992. The source of the tritium remains unresolved. The detection of tritium in HTH-1 could be the result of an earlier migrating pulse, recent surface recharge, or possibly inadvertent cross-contamination of the well (Chapman et al., 1994). Tritium concentrations in water samples taken from the reentry hole in 1976 varied with the depth of the sample. Results of the analysis ranged from a maximum value of 9.2×10^6 pCi/L at a depth of 789 m (2,590 ft), or 186 m (610 ft) above the detonation point, to a low of 2,200 pCi/L at 576 m (1,189 ft), or 399 m (1,310 ft) above the detonation point. Estimates made in 1977 indicated that radionuclides would not be expected to migrate away from the cavity region until water levels reached predetonation hydraulic equilibrium, estimated to be after 1997, based on average cavity fill rates (ERDA, 1977).

The preliminary Hazard Ranking System score (EPA's ranking system for Superfund cleanup determination) for the Central Nevada Test Area is a low score of 3.54. This score is based primarily on the assumption of a low probability for the migration of radionuclides and that there are no human drinking water receptors in the vicinity of the Central Nevada Test Area (DRI, 1988). Recent field studies by the Desert Research Institute have revealed a more complicated hydrologic system than previously thought (Chapman et al., 1994). As a result, flow away from the cavity may have begun sooner than anticipated and the existing monitoring

wells may not be ideally located to intercept potential contaminant plumes.

The Central Nevada Test Area is currently being investigated as part of the DOE's Environmental Restoration Program. The DOE will evaluate the site in consultation with the state regulatory authority to determine what investigations may be required and what responses may be appropriate.

4.4.12 Environmental Justice

Existing demographic conditions for Environmental Justice are discussed in Section 4.1.12. This discussion includes conditions for the Central Nevada Test Area.

4.5 Eldorado Valley

The Eldorado Valley is southwest of Boulder City, Nevada. U.S. Highway 95 to Searchlight, Nevada, transects the valley in a north-south direction. The U.S. Bureau of Land Management patented 107,412 acres of Eldorado Valley to the state of Nevada, at which time this land was transferred to the city of Boulder City. Boulder City has designated 6,000 acres of this land for a Solar Enterprise Zone facility (DOE/NV, 1994b). This zone is excluded from a conservation easement within these transferred lands that is managed for the conservation, protection, restoration, and enhancement of the desert tortoise and its habitat. The DOE would enter into a partnership agreement with the solar industry, Nevada stakeholders, and university systems to develop the solar-generating facilities.

4.5.1 Land Use

Land in Eldorado Valley is used for a limited number of activities as discussed in the following Land-Use Designations section. Also discussed in this section are the site-support activities related to Eldorado Valley.

4.5.1.1 Public Land Orders and Withdrawals. This section is not applicable to Eldorado Valley.

4.5.1.2 Land-Use Designations. Land use in Eldorado Valley is limited primarily to grazing, light industry, and recreational use, including a raceway and windsurfing. Active grazing permits have been issued by the U.S. Bureau of Land Management for the Ireteba Peaks, McCullough Mountains, and Hidden Valley allotments. The Iretaba Peaks and McCullough Mountains allotments have historically provided forage for almost 2,300 animal unit months. The McCullough Mountains allotment is operated by the Nature Conservancy. There is some limited light industry in the northwestern-most part of the basin. The playa area is used for recreation, especially land sailing, and a raceway is situated near the southern end of the playa.

4.5.1.3 Site- Support Activities. Site support in the Eldorado Valley includes three power substations and transmission lines and two natural gas pipe lines.

FACILITIES—No facilities currently exist at the proposed location of a Solar Enterprise Zone facility in Eldorado Valley.

UTILITIES—Two existing 500-kV substations and a third substation under construction are within a few miles of the proposed Solar Enterprise Zone facility in Eldorado Valley: Southern California Edison's Eldorado Substation, Los Angeles Department of Water and Power's McCullough Substation, and the Marketplace Switching Station. When the Marketplace Switching Station is completed, these substations will connect the transmission systems of California, southern Nevada, and Arizona (DOE/NV, 1994b).

Two major Southwest Gas natural gas pipe lines transect Eldorado Valley. One pipe line is immediately adjacent to U.S. Highway 95, and the other pipe line is approximately 2 km (1 mi) west of the highway. Depending on where the proposed Solar Enterprise Zone facility is sited, the pipe lines could be immediately adjacent or up to 10 km (6 mi) away. Both pipe lines are main supply lines for the Las Vegas area and consequently are insufficient to support the Solar Enterprise Zone facility during winter months. An additional 51-cm (20 in) pipe line from an existing main line would be necessary; the nearest main gas pipe line is an

El Paso Gas pipe line south of Laughlin, Nevada, 110 km (68 mi) away (DOE/NV, 1994b).

SERVICES—Services discussed for Eldorado Valley include law enforcement and security, fire protection, and health care.

Law Enforcement and Security—Eldorado Valley is not secured or restricted. Law enforcement is provided by the Clark County Sheriff's Department.

Fire Protection—Fire protection for Eldorado Valley is provided by the U.S. Bureau of Land Management.

Health Care—For health care, first aid stations would be located near field activities, if required.

4.5.1.4 Airspace. Eldorado Valley is located underneath the southeastern portion of the Las Vegas Class B airspace that begins at 2,438 m (8,000 ft) mean sea level. All aircraft operating in this area must be under positive control of Las Vegas Approach Control (see Section 4.1.1.4).

4.5.2 Transportation

This section presents existing transportation at Eldorado Valley. Transportation is discussed with respect to on-site traffic, off-site traffic, transportation of materials and waste, and other transportation.

4.5.2.1 On-Site Traffic. This section is not applicable for Eldorado Valley.

4.5.2.2 Off-Site Traffic. U.S. Highway 95 runs north-south through Eldorado Valley and is a single lane in each direction. At the northern end of the valley, U.S. Highway 95 intersects U.S. Highway 93 approximately half the distance between Boulder City, Nevada and Henderson, Nevada. U.S. Highway 93/95 continues northwestward through Henderson and through Las Vegas where it intersects Interstate 15. At the southern end of the valley at Searchlight, Nevada, U.S. Route 95 intersects east-west trending State Route 164, also a single lane in both directions. State Route 164 intersects Interstate 15, 52 km (32 mi) west of Searchlight. U.S. Route 95 continues south of Searchlight for 30.6 km (19 mi), where it intersects State Route 163, and continues an additional 39 km (24 mi) south where it intersects U.S. Highway 40 at Needles, California. From U.S. Highway 95, State Highway 163 continues 34 km (21 mi) to Laughlin, Nevada, where it continues east through Arizona to Kingman as State Route 68. In 1993, U.S. Route 95 just south of Boulder City had an average annual daily traffic of 6,600 vehicles and operated at a level of service B.

4.5.2.3 Transportation of Materials and Waste. Transportation of waste and materials at a Solar Enterprise Zone facility location is not expected. Therefore, this section is not applicable.

4.5.2.4 Other Transportation. Air or rail transportation of workers or materials to Eldorado Valley has not been proposed; therefore, these facilities have not been examined in detail. The nearest rail line to the Eldorado Valley site is the Union Pacific line in Boulder City, which connects Boulder City with Las Vegas. No rail spur exists on a Solar Enterprise Zone facility site. Airfield facilities do not exist on the site. The nearest airfield is in Boulder City. Traffic information in the vicinity of a Solar Enterprise Zone facility in Eldorado Valley is presented in Section 4.5.2.2, Off-Site Traffic.

4.5.3 Socioeconomics

Eldorado Valley is located within Clark County, and this county's existing socioeconomic conditions are addressed and characterized in Section 4.1.3.

4.5.4 Geology and Soils

Physiography, geology, and soils are addressed in this section. Also briefly discussed are seismic activities and geologic resources.

4.5.4.1 Physiography. Eldorado Valley is a topographically closed basin of 1,373 km² (530 mi²) (see Figure 4-59). Elevations range from about 2,152 m (7,060 ft) on the west at McCullough Mountain to 521 m (1,708 ft) at the playa in the north-central part of the valley. On the east, the Eldorado Mountains rise to elevations only slightly

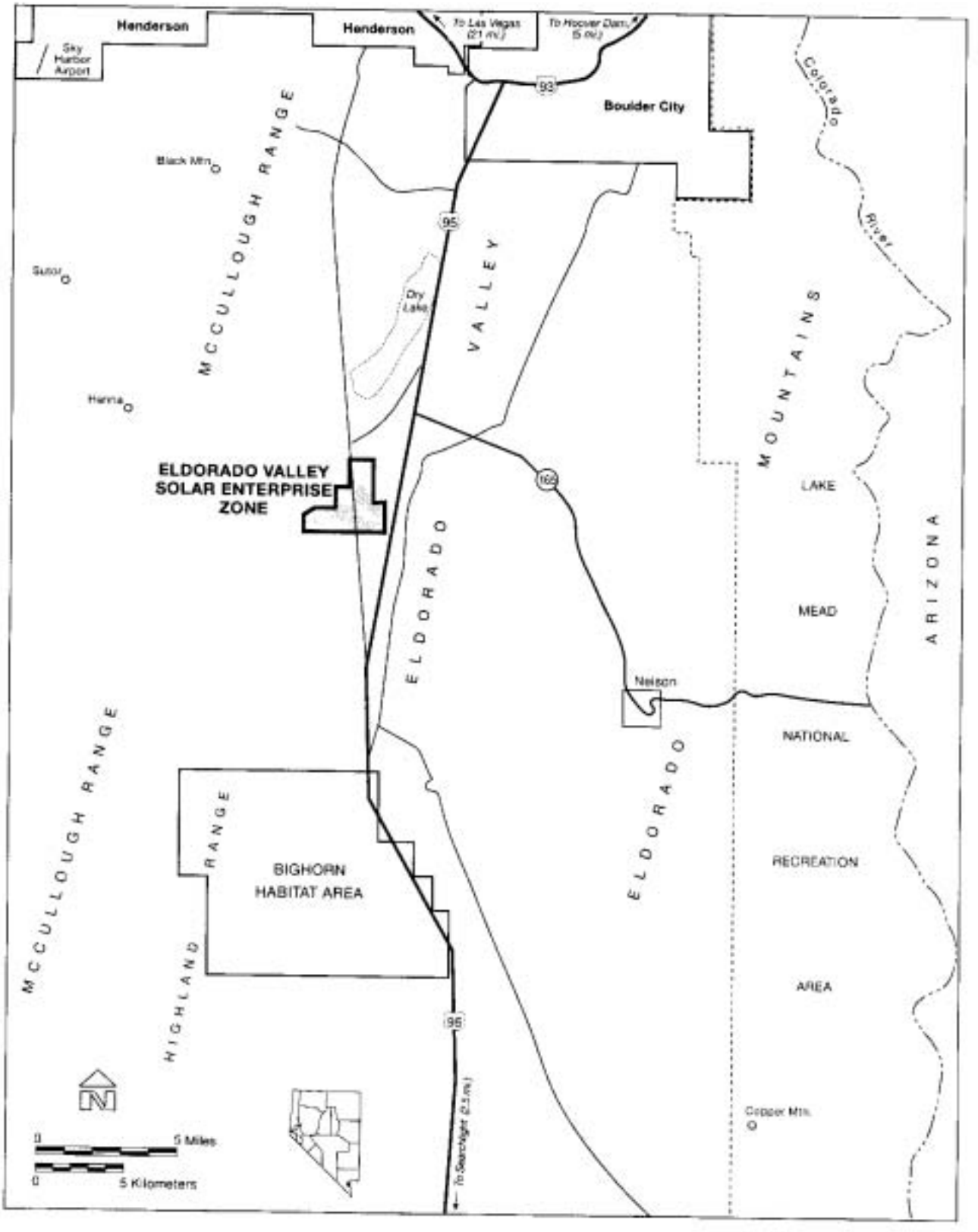


Figure 4-59. Eldorado Valley and surrounding area

above 1,524 m (5,000 ft). On the south, Eldorado Valley is separated from Paiute Valley by the Highland Range and unnamed highlands of the Searchlight district. On the north, Eldorado Valley is bounded by the Black Hills and the River Mountains. On the valley floor, the dominant feature is the playa in the north-central part of the basin and the numerous washes that drain the upland areas.

4.5.4.2 Geology. The general geologic conditions and mineral deposits of Eldorado Valley have been detailed by the Nevada Bureau of Mines and Geology (Longwell, et al., 1965). The general geology of Eldorado Valley includes a number of geologic units. The rocks and valley-fill deposits may be categorized into five types: (1) alluvial deposits, (2) older gravels, (3) volcanics, (4) granite, and (5) metamorphics.

Alluvial deposits occur in the valley-floor area and include interbedded sequences of gravel, sand, silt, and clay. These deposits are generally unconsolidated, but may be cemented in the vicinity of fault zones or where mineralized water is present. A test well near the playa penetrated more than 305 m (1,000 ft) of alluvium. Older gravels of Late Tertiary to Early Quaternary age crop out near the Searchlight area. These deposits are generally weakly consolidated, but include well-lithified fanglomerates, conglomerates, and arkoses.

Volcanic rocks of Quaternary, Tertiary, and Cretaceous ages crop out in the mountain masses of the northern half of the McCullough Range, the entire Highland Range, and in the northeastern Eldorado Mountains. Where present, the volcanic rocks reach thicknesses of 610 m (2,000 ft) to 1,219 m (4,000 ft) in some areas. These rocks include a number of discrete geologic units, including andesite, rhyolite, diorite, and tuff.

Granitic rocks of Tertiary and Precambrian age (including granites, quartz monzonites, and porphyritic granites) occur in the central and southern Eldorado Mountains. Granitic rocks of Tertiary and Precambrian age probably also form the basement complex under most of the valley. The thickness of granite is not known, but probably exceeds 1,524 m (5,000 ft). Metamorphic rocks comprising schists and gneisses of Precambrian age and metavolcanics of possible Precambrian age occur throughout the southern half of the McCullough Range. The thickness of these rocks is generally less than 610 m (2,000 ft).

The major geologic structures in Eldorado Valley include normal faults in the McCullough Range and Eldorado Mountains and in the Highland Springs Anticline in the northwest Highland Range. The major recognized faults include the McClanahan Fault in the McCullough Range and the Jeep Pass, Hidden Valley, Eldorado, and Welcome faults in the Eldorado Range.

GEOLOGIC RESOURCES—Potential mineral resources in Eldorado Valley include fluid minerals (oil, gas, and geothermal resources), nonenergy leasable minerals (primarily sodium and potassium compounds), salable minerals (common sand, gravel, and rock), and locatable minerals (metallic and nonmetallic mineral deposits). The U.S. Bureau of Land Management (BLM, 1992) has defined the level of potential for development of these mineral types.

The potential for geothermal is low and, although the oil and gas potential has been categorized by the U.S. Bureau of Land Management as moderate, there is only one oil lease within the valley. This area is located in the Railroad Pass area in the northernmost part of the basin. No oil or gas exploratory wells have been drilled in the basin.

The U.S. Bureau of Land Management (BLM, 1992) has categorized the sodium and potassium potential of Eldorado Valley as moderate in the north-central part of the basin and low elsewhere. Much of the area in the vicinity of the Eldorado playa has a high potential for salable minerals, primarily sand and gravel, with the rest of the areas of alluvium classified as having moderate potential. In the consolidated rock areas of the Eldorado Mountains and McCullough Range, the potential for salable minerals is low. The potential for locatable mineral resources is low over much of the valley. The potential for locatable resources is moderate in the McCullough Range and northern Highland Range, and high in the Eldorado Mountains and southern Highland Range.

Eldorado Valley contains portions of three mining districts: the Searchlight District, the Eldorado Canyon District, and the Alunite (Railroad Pass) District. Although production has been limited since the early 1950s, interest in these areas continues. The Searchlight District has been the most active, having produced millions of dollars worth of gold, silver, copper, and lead since 1897. Mining in the Eldorado District, located in and around Nelson, was initiated in 1857, and has since produced millions of dollars worth of gold, silver, copper, lead, and zinc. The Alunite District is located about five miles east of Boulder City and historically has produced minor amounts of gold, silver, and lead. Alunite is also present in the district, but has not been successfully developed. Because of the presence of these mining districts, hundreds of mining claims have been filed within Eldorado Valley. The Nevada Department of Transportation maintains about 10 material site rights-of-way in the valley, and there is 1 community pit.

4.5.4.3 Soils. The soils in Eldorado Valley are very deep, medium-textured saline and alkaline soils in the lowland areas; shallow, gravelly coarse-textured soils over the alluvial fans; and discontinuous, rocky gravelly coarse-textured soils in the mountain areas (BLM, 1992).

The soils in Eldorado Valley are susceptible to erosion by wind and water. The potential for erosion is generally slight except where the soils have been disturbed or along the banks of washes. There is also the potential for localized landslides on the steep slopes of the upland areas. The erosion susceptibility of the soils in Eldorado Valley ranges from low to moderate (BLM, 1992). Most of the erosion condition ranges from slight to moderate, but two areas of critical erosion condition have been identified within the basin.

4.5.5 Hydrology

Discussion of hydrology is divided into surface water and groundwater. Water supply in the vicinity is also discussed.

4.5.5.1 Surface Hydrology. The surface water resources of Eldorado Valley are very limited. Although not known, the annual runoff within the basin has been estimated at less than 1.0×10^5 m^3/yr (100 acre-feet/year) (Scott et al., 1971). Surface water runoff is very infrequent, occurring as ephemeral flow in the streambeds and, even less often, as ponded water on the playa in the north-central part of the basin. Surface water runs from the Boulder City Sewage Treatment Plant to the playa area. Flooding characteristics are probably similar to those in adjacent basins; i.e., shallow flash flooding over large areas.

4.5.5.2 Groundwater. Eldorado Valley is situated within the Las Vegas Flow System, a subsystem of the regional Colorado Flow System (Harrill et al., 1988). Groundwater that originates as precipitation over areas of higher elevation generally flows toward the axis of the basin and then north into Las Vegas Valley or eastward into the Colorado River Valley. (Harrill et al; 1988) indicate that an estimated 1.2 million m^3/yr (1,000 acre-feet/year) discharge into the Colorado River Valley.

Groundwater under Eldorado Valley occurs at depths ranging from about 84 to 98 m (275 to 320 ft) below land surface in the north-central part of the basin (Buqo and Giampaoli, 1988). The depth to water may be greater under the higher portions of the alluvial aprons that bound the valley floor. The groundwater is derived from two sources: recharge over the basin is 1.0×10^6 m^3/yr (1,100 acre-feet/year) and subsurface inflow from Hidden Valley (Rush and Huxel, 1966). The recharge derived from flow from Hidden Valley is believed to be minor; i.e., less than 370,050 m^3/yr (300 acre-feet/year) (Rush and Huxel, 1966).

Although there are a number of springs in the upland areas of Eldorado Valley, the combined discharge rate of these springs is small. The more significant springs include McCullough and Ora Hanna Springs in the McCullough Range; Cow Spring in the Highland Range; and Tule, Bridge, and Forlorn Horse Springs in the Eldorado Mountains. These springs provide an important source of water and habitat for wildlife. Eldorado Valley is a designated groundwater basin. The committed groundwater resources of 3.0×10^6 m^3/yr (2,390 acre-feet/year) are more than 4 times the

perennial yield of 6.0 x 10^5 m^3/yr (500 acre-feet/year). Mining is by far the largest water user in the basin with total water rights of 3.0 x 10^6 m^3 (2,400 acre-feet). Small quantities of water (a total of only 3.0 x 10^4 m^3 or 24 acre-feet) have been appropriated for municipal, quasimunicipal, stock watering, and industrial use (Buqo, 1996). As of October 1994, there were two additional water right applications for 7.0 x 10^5 m^3/yr (540 acre-feet/year).

Water supplies in Eldorado Valley can be augmented through the importation of water from Boulder City. According to information presented by the Nevada Solar Enterprise Zone task force work group, Boulder City has the capability to provide 1.0 x 10^6 m^3/yr (1,000 acre-feet/year) to 3.0 x 10^6 m^3/yr (3,000 acre-feet/year) of treated effluent or irrigation water to meet water demands in Eldorado Valley.

WATER QUALITY—Groundwater in Eldorado Valley is predominantly a sodium-bicarbonate type with high concentrations of total dissolved solids and a medium to high salinity hazard (Rush and Huxel, 1966). Historic analyses of the groundwater from wells in Eldorado Valley indicate that concentrations of total dissolved solids, sulfate, and chloride exceed drinking water standards in some areas. Although data are generally lacking for metals and other trace constituents for the area, the presence of historic mining districts suggests that these constituents may be present in the groundwater in the vicinity of former mining areas. Iron, lead, manganese, mercury, and nitrate have been detected in groundwater at levels exceeding their respective maximum contaminant levels in the Searchlight area, according to information on file with the Clark County Department of Health Services (Buqo and Giampaoli, 1988).

4.5.6 Biological Resources

The scientific names of plants and animals mentioned in this section are given in Chapter 2 of Appendix E, Biological Resources. The Eldorado Valley is within the Mojave Desert. Creosote bush and white bursage are the dominant shrub species within the Solar Enterprise Zone. Dry washes in this area often have stands of catclaw acacia. To the north of this area, on the fine-textured saline or alkaline soils close to the playa, four-wing saltbush, shadscale, green ephedra, seep weed, and bud sage are the dominant plants (BLM, 1992).

Common animal species are similar to those described for the Mojave Desert habitats on the NTS. This site is not habitat for mule deer or bighorn sheep (BLM, 1992), although these species do occur in some of the surrounding mountain ranges.

The threatened desert tortoise is the only threatened or endangered species that occurs at this site (U.S. Fish and Wildlife Service, 1994). The density of desert tortoises in the area was estimated at 8 per km^2 (20 per mi^2). This site occurs immediately adjacent to the Paiute-Eldorado Critical Habitat Unit for the desert tortoise (U.S. Fish and Wildlife Service, 1994). The site is not a critical habitat for the desert tortoise (U.S. Fish and Wildlife Service, 1994). The Paiute-Eldorado Critical Habitat Unit lies immediately east and south of the site. The site was excluded by Boulder City from a conservation easement granted to Clark County for the conservation, protection, restoration, and enhancement of the desert tortoise. This easement (85,617 acres) surrounds lands designated for a Solar Enterprise Zone facility. No current candidate plant or animal species (61 FR 7596) are known to occur within the Eldorado Valley site. The banded gila monster, a state-protected species, may occur in this area (BLM, 1992).

No plant species are known to occur within the Eldorado Valley site that have been listed as threatened, endangered, or candidate under the Endangered Species Act or by the state of Nevada (16 U.S.C. 1531, 1973; BLM, 1992; 58 FR 188, 1993; NAC, 1994).

4.5.7 Air Quality and Climate

This section includes a description of the air quality conditions at Eldorado Valley, including climatology, meteorology, and ambient air quality.

CLIMATOLOGY AND METEOROLOGY—Although there are no weather stations in Eldorado Valley, the climate can be represented on the basis of stations in Boulder City and Searchlight. In general,

Eldorado Valley exhibits the low humidity and low annual precipitation characteristic of the climate of Clark County. The warmest month is July, when the mean monthly maximum temperature is 40 °C (104 °F), and January is the coolest month with a mean monthly minimum of 0.5 °C (33 °F). The average monthly wind speed ranges from 11 kph (7 mph) in December to 18 kph (11 mph) in April and June. Diurnal variation in wind is common, reflecting the differential heating of the ground.

AMBIENT AIR QUALITY—Eldorado Valley is located within Nevada Intrastate Air Quality Control Region 147, which is designated unclassifiable/ attainment for all criteria pollutants. The closest Class I Prevention of Significant Deterioration area is Grand Canyon National Park, approximately 90 km (56 mi) east of Eldorado Valley. Because Eldorado Valley is largely undeveloped, there are few emission sources in the area. Typical sources include mining and milling operations; off-road vehicle, railroad, and aircraft traffic; and fugitive dust.

The closest nonattainment area to the Eldorado Valley is the Las Vegas Valley, which is a nonattainment area for PM_{10} particulates and carbon dioxide and borderline nonattainment for ozone. Eldorado Valley borders the Las Vegas Valley Air Quality Nonattainment Area on the west and north.

4.5.8 Noise

The acoustic environment of Eldorado Valley can be classified as uninhabited desert or small rural communities (Section 4.1.8). Noise measurements have not been made at the Eldorado Valley Solar Enterprise Zone facility site. The major sources of noise would be associated with prevailing meteorological conditions, such as wind. Traffic on U.S. Highway 95, which transects Eldorado Valley just east of the site, also generates noise.

4.5.9 Visual Resources

The landscape character of Eldorado Valley is typical of the Great Basin. Regional topography consists of mountain ranges arranged in a north-south orientation, separated by broad valleys. The existing viewscape includes two Bureau of Land Management Wilderness Study Areas located in the McCullough Range and one in the Eldorado Mountains, U.S. Highway 95, portions of Boulder City, power transmission lines, gravel quarries, and electrical substations. The Bureau of Land Management Wilderness Study Areas are 8 km (5 mi) from the proposed site. The landscape at Eldorado Valley is common to the region, and because of the amount of cultural modifications, the scenic quality has been designated as Class C. U.S. Highway 95 has an average daily traffic of 5,000 to 7,000 vehicles (NDOT, 1993a). Therefore, Eldorado Valley would have a high sensitivity level.

4.5.10 Cultural Resources

Eldorado Valley lies in southern Nevada, an area with a prehistory that may span the past 10,000 years or more. Properties ranging from the early prehistoric period to historic mining and ranching sites are known.

Groups of Southern Paiute and Mohave people lived within or used parts of the project area at the time of first European contact. The Colorado River defines the southern boundary of Southern Paiute territory where it formed the core of Mojave territory (Stoffle and Dobyns, 1982). Southern Paiute groups foraged widely for wild plant foods throughout southern Nevada and also practiced horticulture at select oases in the Las Vegas Valley and on the Virgin and Colorado Rivers. The Chemehuevi, a closely related group, took over much of Mohave Indian traits, including floodplain agriculture, and routinely cooperated with the Mohave in raids against enemies, such as the Cocopa and Halchidhoma. However, the Chemehuevi were occasionally at war with the Mohave themselves (Kelly and Fowler, 1986). The Mohave focused on floodplain agriculture, but also utilized wild plant and animal foods and fish.

Geographically, Eldorado Valley extends from Boulder City to Searchlight. The region of influence includes areas south of Boulder City adjacent to U.S. Highway 95 near the junction with State Route 60. A 2,000-acre zone is proposed for a parabolic trough generating station, while existing natural gas pipe line corridors would be used to

bring an additional gas supply to the generating station.

RECORDED CULTURAL RESOURCES—Most of the cultural resources that have been recorded in the previously defined area have resulted from Transmission Line and Powerline Surveys (Dames and Moore, 1985; Rafferty, 1991). Prehistoric sites have been recorded around the perimeter of Eldorado Dry Lake. Two temporary camps have been recorded. One of the sites first recorded by (M.J. Rogers, 1939) includes numerous lithic artifacts and groundstone. Testing conducted in 1990 indicated that only surface deposits occur and that the integrity of the site had been compromised owing to hydraulic action (Dames and Moore, 1985). Both sites were recommended as ineligible for the National Register of Historic Places. Other sites date to the historic period. Most are isolated occurrences of cans, which may have been left behind by prospectors or the Hoover Dam construction workers passing through the area.

SITES OF AMERICAN INDIAN SIGNIFICANCE—The CGTO knows that the Eldorado Valley study area contains a wide variety of cultural resources, including plants, animals, and archaeology sites. This knowledge derives from previous American Indian cultural resource studies of the area conducted during the Harry Allen-Warner Valley (Bean and Vane, 1979) and Intermountain Power Project (Stoffle and Dobyns, 1982; Stoffle et al., 1983) studies of American Indian concerns along various proposed power line routes, and the Ivanpah Generating Station study (Bean and Vane, 1982) conducted in a neighboring valley. Identified Indian plants include creosote (Larrea tridentata), *desert trumpet* (Eriogonum inflatum), *and Indian tea* (Nevada ephedra). *American Indian animals include bighorn sheep* (Ovis canadensis), *desert tortoise* (Gopherus agassizii), *and speckled rattlesnake* (Crotalus mitchellii). *The valley is associated with Indian funeral songs associated with the Cry Ceremonial. There are both spiritual and physical Indian trails associated with this valley. Eldorado Valley trails were used by Pahrump and Las Vegas Paiutes to travel to places along the Colorado River, especially Cottonwood Island. Traditional Indian trails are a significant American Indian cultural resource because they were both physical and spiritual paths (Laird, 1976). The Ivanpah Generating Study concluded that the McCullough Mountains (which define the western edge of Eldorado Valley) are of much concern to American Indian people, both Southern Paiute and Mohave. According to the Ivanpah study, these American Indian people have trails, sacred sites, plants, and animals of cultural importance in the McCullough Mountains, the associated Eldorado Valley, and in the Eldorado Mountains (Bean and Vane, 1982). A 1975 study of the Navajo-McCullough transmission line right-of-way further indicates the presence of traditional-use plants, early Pinto Series-style projectile points, numerous lithic scatters, and grinding stone fragments that "are related to the seed gathering activities possibly of the later Paiute peoples" (Brooks et al., 1975). Previous studies have been geographically limited to a few places within Eldorado Valley or in neighboring areas, so a complete cultural assessment of the Eldorado Valley is not possible without visiting other portions of the valley with American Indian people.*

4.5.11 Occupational and Public Health and Safety

The Eldorado Valley site proposed for siting a Solar Enterprise Zone facility is currently undeveloped desert. Baseline health and safety considerations associated with the environment include the potential for heat stroke and exhaustion (primarily during summer months), dehydration, and poisonous spider and snake bites. Other physical hazards include tripping or stumbling hazards associated with the desert terrain.

4.5.12 Environmental Justice

Existing demographic conditions for Environmental Justice are discussed in Section 4.1.12. This discussion includes conditions for Eldorado Valley.

4.6 Dry Lake Valley

The Dry Lake Valley site is near the Apex industrial area, several miles northeast of the intersection of U.S. Highway 93 and Interstate 15. The Nevada Power Company has identified 3,600 acres for development of a Solar Enterprise Zone facility.

The DOE would enter into a partnership agreement with the solar industry, Nevada stakeholders, and university systems to develop the solar-generating facilities. The area is bounded on the southwest by development in the Apex industrial area and on the southeast by Interstate 15 and the Dry Lake Range, which runs parallel to the highway.

4.6.1 Land Use

Land in Dry Lake Valley is used for a limited number of activities as discussed in the following Land Use Designations section. Also discussed in this section is the infrastructure related to Dry Lake Valley.

4.6.1.1 Public Land Orders and Withdrawals. This section is not applicable to Dry Lake Valley.

4.6.1.2 Land-Use Designations. Land use in Dry Lake Valley is limited to three types: industrial, municipal waste disposal, and land-use management by federal agencies. Industrial land use is limited to the Apex area immediately south of the proposed Solar Enterprise Zone facility site. Current industrial tenants at Apex include Kerr-McGee Chemical Corp., Chemstar Inc., and Georgia Pacific Corp. Silver State Disposal operates a waste landfill and waste processing facilities in the southern part of the basin east of Interstate 15.

4.6.1.3 Site-Support Activities. Site support in or adjacent to the Dry Lake Valley includes a power substation, a power tie, a phase shifter and autotransformer, and transmission lines; a natural gas pipe line ; a landfill; and a fiber-optic line (DOE/NV, 1994b).

SERVICES—Services discussed for Dry Lake Valley include law enforcement and security, fire protection, and health care.

Law Enforcement and Security—Dry Lake Valley is not secured or restricted. Law enforcement is provided by the Clark County Sheriff's Department.

Fire Protection—Fire protection for Dry Lake Valley is provided by the U.S. Bureau of Land Management.

Health Care—First aid stations would be located near field activities, if required.

UTILITIES—At the Dry Lake Valley site, located adjacent to the alternative Solar Enterprise Zone location, Nevada Power Company owns and operates a 345/230-kV substation, a 345-kV tie with Pacific Corp, a phase shifter, and a 345/230-kV autotransformer. A 230-kV line is also present that delivers power to the internal transmission system of Nevada Power Company. Nevada Power Company is currently constructing two power plants at the Dry Lake Valley site that will provide a total of 144 megaWatts (MW) and has plans for two additional plants that would provide an additional 144 MW. The current transmission capacity could accommodate 305 MW of solar-generated power; however, after the additional power plants are completed, the Dry Lake Valley system will be able to accommodate only 25 MW of additional power derived from alternate sources. This can only be achieved by investing in the construction of a generator bay. Transmission capacity greater than 25 MW would require additional transmission facilities. Up to 140 MW of solar power could be generated with the addition of a 48 km (30 mi) long, 230-kV circuit from the Dry Lake Valley to the Northwest substation, plus additional substation equipment. With either scenario, the total transmission capacity is relatively low because of plans for constructing gas combustion turbines at the site. Should this construction not occur, the transmission capacity would be greater.

Four natural gas pipe line s are within 187 km (116 mi) of the Dry Lake Valley: Transwestern Gas, 187 km (116 mi); El Paso Gas, 75 km (109 mi); Southwest Gas, 24 km (15 mi); and Kern River Gas, 2 km (1 mi). Nevada Power Company anticipates tapping the nearby Kern River pipe line to supply the new gas turbines at the site. However, results of studies related to land, water, and electric transmission capacity must be evaluated before determining whether this apparently readily available gas supply can be used. If so, it is assumed that all necessary natural gas infrastructure required for solar support would be in place.

4.6.1.4 Airspace. Dry Lake Valley is located east of the NAFR Complex underneath the northern

portion of the Las Vegas Class B airspace that begins at 2,438 m (8,000 ft) mean sea level. All aircraft operating in this area must be under positive control of Nellis Approach Control (see Section 4.1.1.4).

4.6.2 Transportation

Transportation at Dry Lake Valley is discussed with respect to on-site traffic, off-site traffic, transportation of materials and waste, and other transportation.

4.6.2.1 On-Site Traffic. This section is not applicable to the Dry Lake Valley.

4.6.2.2 Off-Site Traffic. Interstate 15, a four-lane, divided freeway, is the major regional access to the Dry Lake Valley site. In 1993, Interstate 15 had an average annual daily traffic of 11,550 vehicles and operated at a level of service A. U.S. Highway 93 runs north and south from the intersection of southwest-northeast-trending Interstate 15. Las Vegas, Nevada, is 35 km (22 mi) southwest of this intersection, and Glendale, Nevada, is 42 km (26 mi) northeast of this intersection. At Glendale, State Highway 168 trends northwest for 39 km (24 mi) and connects with U.S. Highway 93.

4.6.2.3 Transportation of Materials and Waste. Transportation of waste and materials is not expected at the Solar Enterprise Zone facility site. Therefore, this section is not applicable to Dry Lake Valley.

4.6.2.4 Other Transportation. Air or rail transportation of workers or materials to the Dry Lake Valley has not been proposed; therefore, these facilities have not been examined in detail. The nearest rail line to the Dry Lake Valley site is the Union Pacific line that parallels Interstate 15 just east of the site. No rail spur exists on the Solar Enterprise Zone facility site. Airfield facilities do not exist on the site. The nearest airport is the North Las Vegas Air Terminal. Traffic information in the vicinity of the Dry Lake Valley Solar Enterprise Zone facility location is discussed in Section 4.6.2.2, Off-Site Traffic.

4.6.3 Socioeconomics

There are no residences in the Dry Lake Valley. Current land use, exclusive of federal land management, is for industrial purposes, such as manufacturing and municipal waste disposal. The valley is located in Clark County, Nevada, and general existing socioeconomic conditions are presented in Section 4.1.3.

4.6.4 Geology and Soils

The physiography, geology, and soil conditions in Dry Lake Valley are discussed in this section.

4.6.4.1 Physiography. The Dry Lake Valley is a topographically closed basin comprised of about 414 km^2 (160 mi^2) (Figure 4-60). Elevations within the basin range from about 1,219 m (4,000 ft) on the west in the Arrow Canyon Range, to about 601 m (1,970 ft) at Dry Lake Playa. The Dry Lake Range on the southeast rises to an elevation of only about 1,036 m (3,400 ft). On the south, the Dry Lake Valley is separated from the Las Vegas Valley by a narrow topographic divide. A somewhat broader divide on the north and northeast separates Dry Lake Valley from the California Wash. On the valley floor, the major features are the many washes that drain the bounding upland areas and the playa in the central part of the valley.

4.6.4.2 Geology. The general geologic conditions and mineral deposits of the Dry Lake Valley have been described by the Nevada Bureau of Mines and Geology (Longwell et al., 1965). The general geology of the valley comprises three major geologic units: alluvium, Tertiary valley-fill deposits, and Paleozoic carbonate rocks. The alluvium occurs over the valley floor and comprises interbedded gravels, sand, silt, and clay. The total thickness of alluvium is about 305 m (1,000 ft).

The Tertiary valley-fill deposits include the Muddy Creek Formation, which was deposited over a large area of Clark County. These deposits are found in the area between the Dry Lake Valley and the California Wash and probably occur under the entire valley floor area. The Muddy Creek Formation is comprised of a sequence of interbedded fine-grained and coarse-grained

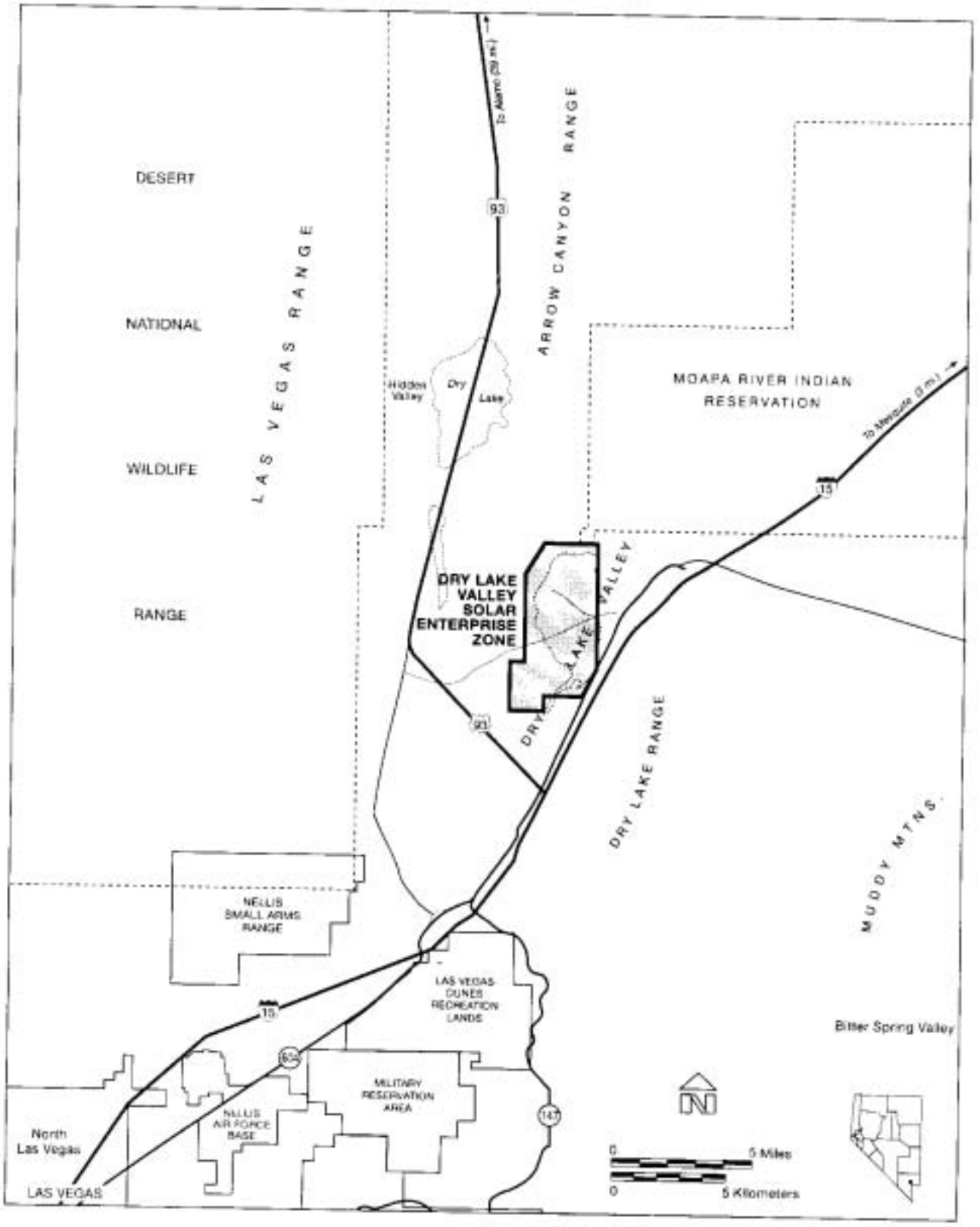


Figure 4-60. Dry Lake Valley and surrounding area

sediments, including claystone, siltstone, and minor sandstone. Gypsum is common in the more fine-grained deposits, and a conglomerate is common along the margins of the depositional basin. The thickness of the Muddy Creek Formation in the Dry Lake Valley is not known, but is probably at least several hundred feet in most areas.

The Paleozoic rocks of the Arrow Canyon Range and Dry Lake Range comprise a thick sequence of limestone, dolomites, and quartzite. In the Arrow Canyon Range, this sequence includes, in descending order, the Birdspring Formation, Monte Cristo Limestone, Sultan Limestone, Lone Mountain Dolomite, the Ely Springs Dolomite, the Eureka Quartzite, and the Pogonip Group. These rocks outcrop in the mountainous areas and probably underlie the Muddy Creek Formation at depth under the valley floor area. The total thickness of Paleozoic rocks in the area is unknown, but is probably several thousand feet.

Two major geologic structures predominate in the Dry Lake Valley; the Arrow Canyon syncline and the Dry Lake Thrust Fault. The Arrow Canyon syncline is a structural trough that is believed to underlie the south-central part of the basin and occurs along the eastern Arrow Canyon Range in the northern part of the basin. On the eastern part of the basin, in the Dry Lake Range, the Ordovician Pogonip Group has been thrust over the uppermost Paleozoic (Kaibab, Toroweap, Coconino, and Birdspring formations).

GEOLOGIC RESOURCES—Potential mineral resources in the Dry Lake Valley include fluid minerals (oil, gas, and geothermal resources), non-energy leasable minerals (primarily sodium and potassium compounds), salable minerals (common sand, gravel, and rock), and locatable minerals (metallic and nonmetallic mineral deposits). The U.S. Bureau of Land Management (BLM, 1992) has defined the level of potential for development of these mineral types.

The potential for geothermal resources is low, and although the oil and gas potential has been categorized by the U.S. Bureau of Land Management as moderate, there are only two areas with oil leases within the valley. One area is located in the central Arrow Canyon Range and includes about 8 km^2 (3 mi^2) of Dry Lake and Hidden Valleys. The second area encompasses about 10 km^2 (4 mi^2) east of the Union Pacific Railroad's Dry Lake siding. Two oil and gas exploratory wells have been drilled in the Dry Lake Valley (United Petroleum Corporation No. 1 Apex, and Pozil, Johnson, and Krug No. 1 Apex), but no production has been reported from the basin. The U.S. Bureau of Land Management (BLM, 1992) has categorized the sodium and potassium potential of the Dry Lake Valley as low. Much of the area in the vicinity of the Dry Lake playa has a high potential for salable minerals, primarily silica sand and gravel, with the rest of the areas of alluvium classified as having moderate potential. In the consolidated rock areas of the Arrow Canyon and Dry Lake Ranges, the potential for salable minerals is low. The potential for locatable mineral resources is low over much of the valley; only in the Arrow Canyon Range and in portions of the Dry Lake Range is the potential classified as moderate.

Although hundreds of mining claims have been filed within the Dry Lake Valley, the historic mining production has been limited to the production of limestone and dolomite. Chemstar, Inc., has been actively mining and processing limestone in the Apex area for more than 40 years. No metallic mineral deposits have been developed in the valley. The Nevada Department of Transportation maintains several material site rights-of-way in the valley.

4.6.4.3 Soils. The soils in the Dry Lake Valley are typical desert soils (entisols and aridisols). The soils of the area have been categorized into four series (Nevada Power Company, 1975). The Rockland-St. Thomas series occurs on the foothills and mountains with slopes of 15 to 50 percent and includes rock and cobbly loam. These soils are generally well drained and have a moderately rapid permeability. The Colorock-Tonopah series occurs at an elevation of 396 (1,300 ft) to 914 m (3,000 ft) in areas with slopes of 2 to 8 percent. Colorock soils are gravelly to a depth of 0.3 m (1 ft) and have an underlying hardpan. The gravelly material has a moderate permeability but, because of the presence of shallow hardpan, has a low water capacity. The Tonopah soils, comprising sandy loam and gravelly

loam, have high permeability and rapid drainage. Bard-Tonopah soils occur in areas of 2 to 8 percent slope between 457 m (1,500 ft) to 914 m (3,000 ft) in elevation. These soils are stony or sandy loams that exhibit moderate permeabilities and low water capacity. Bard soils are gravelly, sandy loams and gravelly sands with a hardpan occurring at a depth of 0.3 to 0.6 m (1 to 2 ft). The permeability of the Bard soils is moderate, and the water capacity is low.

The soils in the Dry Lake Valley are susceptible to erosion by wind and water (BLM, 1992). The potential for erosion is generally slight, except where the soils have been disturbed or along the banks of washes. There is also the potential for localized landslides on the steep slopes of the upland areas.

The U.S. Bureau of Land Management (BLM, 1992) indicates that the erosion susceptibility of the soils in the Dry Lake Valley is moderate to high in the northern part of the basin and low to moderate in the southern portion of the basin. The erosion condition ranges from slight to moderate.

4.6.5 Hydrology

Discussion of hydrology is divided into surface water and groundwater. Water supply in the vicinity is also discussed.

4.6.5.1 Surface Hydrology. Surface water resources in the Dry Lake Valley are meager, occurring only as ephemeral flow in the streambeds that drain the upland areas or in temporary ponding of runoff in the playa. There are no gaging stations in the Dry Lake Valley; total runoff has been estimated at 3.7×10^{-1} m^3/yr (300 acre-feet/year) (Scott et al., 1971). Heavy runoff events may result in short-duration flows along reaches of washes in the basin; however, most rainfall probably infiltrates and is transpired by vegetation or evaporated from the soil.

Flooding is probably a recurrent problem over most of the valley floor area in the Dry Lake Valley. Runoff estimates made by the Clark County Regional Flood Control District for the Apex area indicate that a rainfall event with a 0.01 recurrence interval will result in shallow (less than 0.3 m [1 ft]) flooding over extensive areas (Nevada Power Company, 1975). Such floods typically occur as flash floods wherein the depth of the water in the alluvial channels can exceed bankful conditions and result in sheet-flow over large areas of the alluvial fans that bound the playa.

The Alkali Flat Dry Lake in the Dry Lake Valley is roughly bisected by some of the land that could be used for a Solar Enterprise Zone facility. In this area, more frequent floods of longer duration are to be expected. Ponding in some areas of the dry lake may be present for periods of several months or more.

4.6.5.2 Groundwater. The Dry Lake Valley is situated within the California Wash Flow System, a subsystem of the regional Colorado River Flow System (Harrill et al., 1988). Groundwater that originates as precipitation over the upland areas of the valley discharges out of the regional flow system near Overton, Nevada, about 29 km (18 mi) to the east, ultimately reaching the Colorado River through a complicated pathway of groundwater and surface water flow including the Muddy River and Lake Mead.

Groundwater under the Dry Lake Valley occurs at depths ranging from about 70 m (230 ft) to 87 m (285 ft) (unpublished U.S. Geological Survey data). Groundwater is derived from two sources: recharge over the basin is 5.0×10^5 m^3 per year (400 acre-feet/year), and subsurface inflow on the west from Hidden Valley is 5.0×10^5 m^3 per year (400 acre-feet/year) (Rush, 1968). Groundwater is discharged via subsurface outflow to the California Wash at a rate of about 1.0×10^6 m^3 per year (800 acre-feet/year), according to (Rush, 1968).

There are no springs in the Dry Lake Valley. Groundwater is the only available water resource. There are currently only six water supply wells in the Dry Lake Valley. Well yields within the basin are low, ranging from about 76 to 303 L/min (20 to 80 gal/min). According to information on file with the Nevada Division of Water Resources, the committed groundwater resources of 1.0×10^6 m^3/yr (930 acre-feet/year) are more than double the perennial yield of 5.0×10^5 m^3/yr (400 acre-feet/year). Current groundwater rights within the basin include

4.0 x 10^5 m^3 (308 acre-feet) for mining, 3.8 x 10^5 m^3 (308 acre-feet) for commercial use, 2.0 x 10^5 m^3 (168 acre-feet) for industrial use, 1.0 x 10^5 m^3 (75 acre-feet) for municipal and quasi-municipal, and 6.3 x 10^4 m^3 (51 acre-feet) for other uses. As of October 1994, there were 16 applications for water rights in the Dry Lake Valley totaling 1.1 x 10^7 m^3/yr (21,155 acre-feet/year).

A master plan has been established for the Apex area in southern-most Dry Lake Valley (Clark County, 1990a). A 21,000-acre industrial-use park is planned for the area with three tenants already operating. This master plan indicates that any water required for industrial purposes at the Apex site would have to be imported to the site. Further, the master plan recommends a policy that private wells be limited to low water-use industries that employ conservation measures.

According to information on file with the U.S. Geological Survey, the groundwater in the Dry Lake Valley is generally calcium-sodium-sulfate type with a total dissolved solids concentrations ranging from 700 to 1,000 mg/L (700 to 1,000 ppm), exceeding the primary drinking water standard of 500 mg/L (500 ppm). Sulfate concentrations, reported for three wells in the basin, range from 360 to 380 mg/L (360 to 380 ppm), about 40 percent more than the primary drinking water standard of 250 mg/L (250 ppm).

4.6.6 Biological Resources

The scientific names of plants and animals mentioned in this section are given in Chapter 2 of Appendix E, Biological Resources. The plant communities in the Dry Lake Valley are typical of those found in deep, sandy soils throughout this part of the Mojave Desert. The visually dominant plants are creosote bush and white bursage. Other common species include range ratany and Nevada ephedra. Areas around the playa are dominated by saltbush. Blackbrush becomes the dominant shrub on the slopes of the Las Vegas Range (Clark County, 1990a).

Animal species in the Dry Lake Valley are similar to those described for the Mojave Desert habitats of the NTS. Bighorn sheep inhabit the surrounding mountains.

The desert tortoise is the only threatened or endangered species in this area. Densities of tortoises are generally low, though some patches with higher densities may occur (Clark County, 1990a). No current candidate plant or animal species are known to occur in the Dry Lake Valley. The U.S. Fish and Wildlife Service published the latest list of candidate plants and animals on February 28, 1996 (61 FR 7596). Prior to this, six species of mammals, two species of birds, two species of reptiles, and four plant species that were identified as potentially occurring at this site were classified as candidates (Clark County, 1990a; 59 FR 219) and were addressed (Table 4-30). The updated Notice of Review has removed all of these species from candidate status. Two of these former candidates are designated as State-protected and are likely to occur in the area: the western burrowing owl and the banded gila monster (Clark County, 1990a).

The Geyer milkvetch and the golden bear poppy are two plant species that may occur at the site. These plants are designated by the state of Nevada as threatened with extinction and are classified as "fully protected." Geyer milkvetch was found in nearby areas, but has not been found within the site boundary. Three Category 2 candidate plants have been found at this site. A fourth Category 2 plant, Geyer milkvetch, was found in nearby areas, but has not been found within the site boundary.

4.6.7 Air Quality and Climate

This section includes a description of the air quality conditions at the Dry Lake Valley, including climatology, meteorology, and ambient air quality.

CLIMATOLOGY AND METEOROLOGY—Although there are no weather stations in the Dry Lake Valley, National Oceanic and Atmospheric Administration data on the climate of the area are available for stations located in the Valley of Fire, Logandale, and North Las Vegas. In general, the climate of the valley exhibits the low humidity and low annual precipitation characteristics of the climate of Clark County. The warmest month is

July, when the mean monthly maximum temperature is 40 °C (104 °F), and January is the coolest month with a mean monthly minimum of 0.5 °C (33 °F). The average monthly wind speed ranges from 12 kph (7 mph) in December to 18 kph (11 mph) in April and June. Diurnal variation in wind is common, reflecting the differential heating of the ground.

AMBIENT AIR QUALITY—The Dry Lake Valley, although in Clark County, is located outside of the Las Vegas Valley Nonattainment Area (see Section 4.1.7). This part of Clark County is designated unclassifiable/attainment for all criteria pollutants. Dry Lake Valley borders the nonattainment area on the north. The closest Class I Prevention of Significant Deterioration area is Grand Canyon National Park, 100 km (63 mi) southeast of the Dry Lake Valley. Because the Dry Lake Valley is largely undeveloped, there are few emission sources in the area. Typical sources include mining and manufacturing operations at the southern end of the basin; on-road and off-road vehicle, railroad, and aircraft traffic; and fugitive dust.

Background air quality data for Dry Lake Valley are summarized in Table 4-42. These background data are for the Kerr-McGee plant and the Georgia-Pacific gypsum board production facility in the Apex industrial area. No violations of ambient air quality standards have been reported for the pollutants monitored. Emissions from individual industrial developments should be evaluated on the basis of the emission rates, the size of the facility, seasonal variations in process emissions, and source-specific atmospheric dispersion characteristics.

4.6.8 Noise

The acoustic environment of the Dry Lake Valley can be classified as uninhabited desert or small rural communities (Section 4.1.8). However, several noise producers are adjacent to or within the 3,600-acre site. The major sources of noise would be associated with traffic on Interstate 15; which forms part of the eastern border of the site, the Union Pacific Railroad, which parallels Interstate 15, and the Apex industrial area, southeast of the site. On the site, the Nevada Power Company owns and operates an electrical substation, a phase shifter and an autotransformer, and has plans to construct four additional power plants. Meteorological conditions, such as wind, generate noise at the site.

4.6.9 Visual Resources

The landscape character of the Dry Lake Valley is typical of the Great Basin. Regional topography consists of mountain ranges arranged in a north-south orientation, separated by broad valleys. In addition to the natural surroundings, the existing viewscape includes an industrial area, U.S. Highway 93, Interstate 15, a railroad, power plant, and power transmission lines. The landscape at the Dry Lake Valley is common to the region, and because of the amount of cultural modification, the scenic quality has been designated as Class C. The average daily traffic on Interstate 15 is 12,000 to 13,000 vehicles (NDOT, 1993a). Therefore, the Dry Lake Valley would have a high visual sensitivity.

4.6.10 Cultural Resources

The Dry Lake Valley lies in southern Nevada, an area with a history that may span the past 10,000 years or more. Properties ranging from the early prehistoric period to historic transportation, mining, and ranching are known.

When Europeans first entered the area around the Dry Lake Valley, they encountered groups of Southern Paiute people. Groups that are likely to have used resources found in the project area include the Moapa, Tule Springs, and Las Vegas bands (Steward, 1938; Stoffle and Dobyns, 1982).

Geographically, the Dry Lake Valley extends from Apex to well within the Moapa River Indian Reservation. The area proposed for solar power development is within the Apex industrial area northwest of Interstate 15. It encompasses approximately 3,600 acres.

Table 4-42. Background air quality data for the Dry Lake Valley

Nitrogen Oxide[a] (μg/m)				Average Period Annual
1. Kerr-McGee				0.017
2. Bonneville-Nevada's Georgia Pacific Site				1.620
	Total			1.640
	Standard			25.000
	Available			23.360
Sulfur Dioxide[b] (μg/m)		3-hour	24-hour	Annual
1. Kerr-McGee		0.010	0.004	0.001
2. Great Star		100.100	30.500	5.000
	Total	100.100	30.500	5.000
	Standard	512.000	91.000	20.000
	Available	411.900	60.500	15.000
Total Suspended Particulate (μg/m)			24-hour	Annual
1. Kerr-McGee			0.125	0.001
2. United Rock and Great Star			4.600	1.480
3. Avena			0.900	0.300
4. Georgia Pacific			2.800	0.900
5. Bonneville-Nevada			0.800	0.080
	Total		9.200	2.800
	Standard		37.000	19.000
	Available		27.800	16.200

[a] United Rock and Avena emit no nitrogen oxides from stationary sources; Great Star, and Georgia Pacific were approved prior to February 8, 1988

[b] No sulfur dioxide impact from United Rock, Avena, Georgia Pacific, Bonneville-Nevada.

Source: Clark County, 1990a.

RECORDED CULTURAL RESOURCES—Eight sites have been recorded directly within the project area boundaries. Most of these are associated with the shoreline of the Dry Lake Valley. Two processing localities were recorded as part of the Overthurst Project (Bergin et al., 1980). Two other sites were recorded as part of the Kern River Gas Pipeline Survey (Kelly et al., 1990). One site is a locality with a relatively high percentage of stone tools.

Data recovery was conducted at this site and included surface collections and limited excavation of portions of the site. Another site is untyped and includes two flakes and several pieces of burned bone. There is also a temporary camp with rock

circles, Southern Paiute grayware pottery, and numerous pieces of lithic fragments. Two other sites were recorded as part of a transmission line survey (Rafferty and Blair, 1986). Both of these were located along the Dry Lake Valley shoreline and both contained burned or fire-cracked rock concentrations. Several of the sites previously described have been recommended as eligible for the National Register of Historic Places. These sites may provide information about late prehistoric use of shoreline environments. A historic site that traverses The Dry Lake Valley is the Mormon Road, which is listed on the National Register of Historic Places. This route, originally part of the Spanish Trail, connected the Las Vegas Valley with cities in Utah and California. Use of the Mormon Road mainly postdates 1848 (Paher, 1971). Portions of the Old Spanish Trail/Mormon Road remain intact and have been recorded as significant historic archaeological sites (Myhrer et al.,1990).

SITES OF AMERICAN INDIAN SIGNIFICANCE—The CGTO knows that the Dry Lake Valley area contains a wide range of important cultural resources. This knowledge derives from previous American Indian cultural resource studies of the area conducted during the Harry Allen-Warner Valley (Bean and Vane, 1979) and the Intermountain Power Project (Stoffle and Dobyns, 1982; Stoffle et al., 1983) studies of Indian concerns along various proposed power line routes. These power line study areas were located in the bottom and along the eastern edge of the Dry Lake Valley. During these studies, elders identified a wide range of plants, animals, and archaeological sites within this valley. A 1982 mail survey of American Indian people indicated an "Intensity of Concern" score of 2.5 on a 4.0 scale (Stoffle and Dobyns, 1982). A 1983 on-site visit to the Dry Lake area indicated numerous rock shelters that American Indian people considered very significant and the presence of 10 American Indian plants (Stoffle et al., 1983). The cultural assessment of the Navajo-McCullough right-of-way indicated the presence of eight plants identified elsewhere as American Indian plants, numerous archaeological sites, and artifact scatters in the Dry Lake Valley (Brooks et al., 1975). Previous studies have been geographically limited, so a complete cultural assessment of the Dry Lake Valley is not possible without visiting other portions of the valley.

4.6.11 Occupational and Public Health and Safety

The Dry Lake Valley site proposed for siting a Solar Enterprise Zone facility is currently undeveloped desert. Baseline health and safety considerations associated with the environment include potential for heat stroke and exhaustion (primarily during summer months), dehydration, and poisonous spider and snake bites. Other physical hazards include tripping or stumbling hazards associated with the desert terrain.

4.6.12 Environmental Justice

Existing demographic conditions for Environmental Justice are discussed in Section 4.1.12. This discussion includes conditions for the Dry Lake Valley.

4.7 Coyote Spring Valley

Information concerning the physical characteristics of the Coyote Spring Valley (Figure 4-61) is available from a number of sources. The Clark County Department of Comprehensive Planning and the U.S. Bureau of Land Management have compiled data on the soils and their erosion potential, biota, and habitat. The Nevada Bureau of Mines and Geology has published information on the geology and mineral resources of the valley, and the U.S. Geological Survey has published maps of the area and maintains databases on the water resources. The Nevada Division of Water Resources maintains a database on water resource use and availability and wells within the basin. The state of Nevada has information on air and water quality. The National Oceanographic and Atmospheric Administration keeps comprehensive climate records for numerous National Weather Service Observing Sites in southern Nevada, including sites that are close to the Coyote Spring Valley.

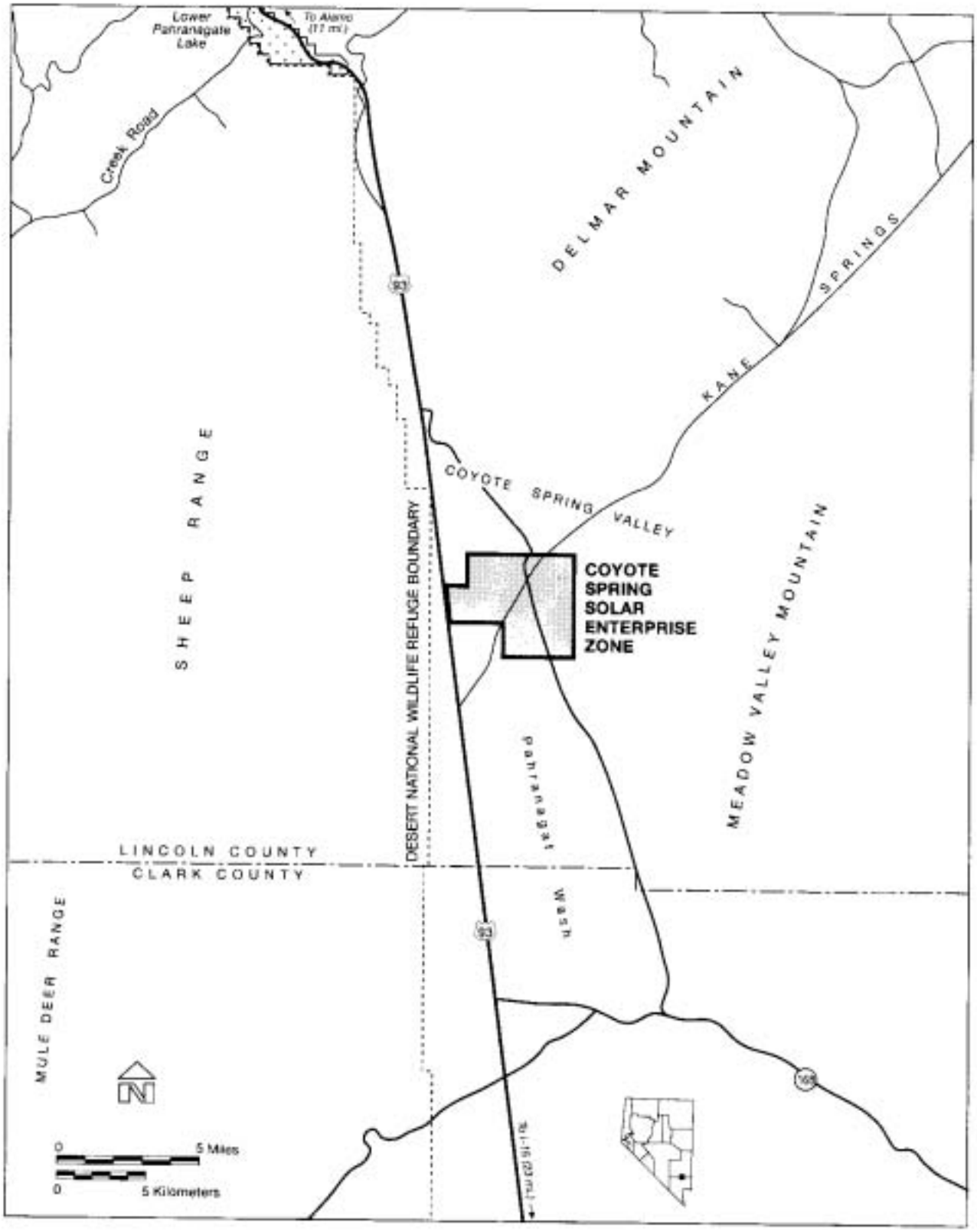


Figure 4-61. Coyote Spring Valley and surrounding area

4.7.1 Land Use

The Coyote Spring Valley includes privately owned land and land administered by the U.S. Bureau of Land Management and the U.S. Fish and Wildlife Service. Most of the area located west of U. S. Highway 93 is within the Desert National Wildlife Range. Land in the Coyote Spring Valley is used for a limited number of activities as discussed in the following Land-Use Designations section. Also discussed in this section is the infrastructure related to the Coyote Spring Valley.

4.7.1.1 Public Land Orders and Withdrawals. This section is not applicable to the Coyote Spring Valley.

4.7.1.2 Land-Use Designations. Appreciable areas of the Coyote Spring Valley have been designated by the U.S. Bureau of Land Management for special management (BLM, 1992). The U.S. Bureau of Land Management has designated a portion of east-central Coyote Spring Valley as part of the Arrow Canyon Special Recreation Management Area (BLM, 1993). This area will be managed for semiprivate recreation opportunities and the protection of cultural resources. The area between the wildlife range and U.S. Highway 93 includes portions of three Wilderness Study Areas: NV050-201, NV050-216, and NV050-217. Wilderness Study Area NV050-17 is located in northern-most Coyote Spring Valley and includes the southern Delamar Mountains.

Wilderness Study Area NV050-156 is located on the east side of the valley and encompasses most of the Meadow Valley Mountains. Wilderness Study Area NV050-215 also occurs along the east side of the basin and includes the northern portions of the Arrow Canyon Range.

The largest block of privately owned land is the Aerojet Project Area, located east of U.S. Highway 93 between the Rainbow Canyon Road on the north and U.S. Highway 168 on the south. A portion of this land was sold by Aerojet to the Wylie Corporation.

The Aerojet Project Area has been classified into four land-use types: (1) the project area of 2,760 acres; (2) a buffer area of 11,240 acres of low-density tortoise habitat; (3) a 17,885-acre conservation reserve of moderate to high tortoise density; and (4) a 10,735-acre power line corridor (Aerojet General, 1987). These areas are all located east of U.S. Highway 93, north of U.S. Highway 168, and west of the Arrow Canyon Range.

The U.S. Bureau of Land Management has also proposed a utility corridor through portions of the Coyote Spring Valley. This corridor, to be 805 m (2,640 ft) wide, would be located east of the centerline of U.S. Highway 93 from the south end of the Aerojet designated corridor. This corridor would cross the Arrow Canyon Range and into the Dry Lake Valley area substations.

Two small areas of privately owned land are located on the west side of U.S. Highway 93: the old Butler Ranch which has been abandoned, and a silica sand mining operation. These two tracts contain only about 80 acres.

4.7.1.3 Site-Support Activities. The site support of the Coyote Spring Valley is limited to two transmission lines. There are no existing facilities for water, sewage or waste disposal, or communications.

SERVICES—Services discussed for the Coyote Spring Valley include law enforcement and security, fire protection, and health care.

Law Enforcement and Security—The Coyote Spring Valley is not a secured or restricted area. Law enforcement is provided by the Lincoln County Sheriff's Department.

Fire Protection—Fire protection is provided by the U.S. Bureau of Land Management.

Health Care—No health care services are currently available on the site.

UTILITIES—One transmission line roughly parallels U.S. Highway 93 and extends the entire length of the valley. The other transmission line is located 3 to 5 km (2 to 3 mi) south of U.S. Highway 168 and extends as far west as U.S. Highway 93.

4.7.1.4 Airspace. Airspace overlying almost all of the Coyote Spring Valley is the Sally Corridor portion of the Desert Military Operating Areas. Sally Corridor is used primarily as the transition route between Nellis Air Force Base and the NAFR Complex (see Figure 4-8).

4.7.2 Transportation

This section addresses on-site traffic, off-site traffic, transportation of materials and waste, and other transportation for the Coyote Spring Valley.

4.7.2.1 On-Site Traffic. This section is not applicable to the Coyote Spring Valley.

4.7.2.2 Off-Site Traffic. U.S. Highway 93, a two-lane, two-way rural highway, is the major regional access to the Coyote Spring Valley site. In 1993, U.S. Highway 93 had an average annual daily traffic of 1,210 vehicles and operated at a level of service B. U.S. Highway 168 provides access from the central part of the basin to the Muddy Springs Area and Moapa Valley to the east. Access via unpaved roads is also limited to two main routes, the Rainbow Canyon Road on the north and the Desert Wildlife Range Road on the west. There is no rail access to the Coyote Spring Valley.

4.7.2.3 Transportation of Materials and Waste. This section is not applicable to the Coyote Spring Valley.

4.7.2.4 Other Transportation. Air or rail transportation of workers or materials to the Coyote Spring Valley has not been proposed; therefore, these facilities have not been examined in detail.

4.7.3 Socioeconomics

The Coyote Spring Valley is located in Lincoln County. What follows is a discussion of general socioeconomic conditions in Lincoln County. The county's land area is 2.7×10^4 km² (10,635 mi²). The total civilian labor force in 1991 was 2,068; 4.5 percent or 94 civilians were unemployed. Some 6.8 percent were employed in agriculture; 1.7 percent in manufacturing; 18.7 percent in wholesale and retail trade; 2.0 percent in finance, insurance, and real estate; 5.0 percent in health services; and the largest sector, 16.0 percent in public administration. Total personal income for the county was $62.0 million, a 103.3-percent change from 1980 personal income.

The 1992 population for Lincoln County was 3,739. It grew by 0.2 percent (less than 1 percent) between 1980 and 1992. Housing stock in the county totaled 1,800 with a vacancy rate of 26.4 percent. The number of houses increased by 6.8 percent between 1980 and 1990. The construction of four homes was authorized by building permits between 1990 and 1992.

Of the total students in Lincoln County (1,066), 97.7 percent are enrolled in public elementary or high school. From 1986 to 1987, general revenue for the county was $7.2 million. Intergovernmental revenue was $5.6 million, and taxes accounted for $0.9 million, 95.8 percent of which was property taxes. Direct general expenditures were 7.6 million, a 21.5-percent change from 1982 to 1987.

4.7.4 Geology and Soils

Physiography, geology, and soils are addressed in this section. Also briefly discussed are seismic activities and geologic resources.

4.7.4.1 Physiography. The Coyote Spring Valley is a topographically open basin comprised of about 1,702 km² (657 mi²). Elevations within the basin range from about 3,018 m (9,900 ft) on the west in the Sheep Range to about 650 m (2,134 ft) at the outlet for the valley along the Pahranagat Wash. The Arrow Canyon Range on the southeast rises to an elevation of only about 1,586 m (5,203 ft). On the southwest, the Coyote Spring Valley is separated from the Las Vegas Valley by the Las Vegas Range, with a maximum elevation of about 1,503 m (4,931 ft). On the valley floor, the major features are the many washes that drain the bounding upland areas and the broad alluvial fans and the Pahranagat Wash, an incised ephemeral stream. Badland topography occurs where the Muddy Creek Formation is exposed in the east-central part of the basin.

4.7.4.2 Geology. The general geologic conditions and mineral deposits of the Coyote Spring Valley have been detailed by the Nevada Bureau of Mines and Geology (Longwell et al., 1965). The general

geology of the valley comprises four major geologic units: alluvium, Tertiary valley-fill deposits, Tertiary volcanics, and Paleozoic carbonate rocks. The alluvium occurs over the valley floor and comprises interbedded gravels, sand, silt, and clay. The maximum thickness of alluvium is not known, but thicknesses of 183 to 260 m (600 to 850 ft) have been penetrated by U.S. Geological Survey and U.S. Air Force test wells.

The Tertiary valley-fill deposits include the Muddy Creek Formation, which was deposited over a large area of Clark County. These deposits outcrop to the east of the Pahranagat Wash in the east-central part of the basin. The Muddy Creek Formation comprises a sequence of interbedded fine-grained and course-grained sediments, including claystone, siltstone, and minor sandstone. Gypsum is common in the more fine-grained deposits, and a conglomerate is common along the margins of the depositional basin. The thickness of the Muddy Creek Formation in the Coyote Spring Valley is not known, but is probably at least several hundred feet in most areas. The Tertiary volcanic rocks outcrop in the northern part of the Coyote Spring Valley and include tuffs and other volcanoclastic deposits with an unknown total thickness.

The Paleozoic rocks of the Arrow Canyon, Sheep, and Las Vegas Ranges comprise a thick sequence of limestone, dolomites, and quartzite that include, in descending order, the Birdspring Formation, Monte Cristo Limestone, Sultan Limestone, Lone Mountain Dolomite, the Ely Springs Dolomite, the Eureka Quartzite, the Pogonip Group, middle and lower Cambrian Limestones and Dolomites, and the Chisolm and Pioche Shale. These rocks outcrop in the mountainous areas and probably underlie the Muddy Creek Formation at depth under the valley floor area.

A number of major geologic structures occur in the Coyote Spring Valley. The Arrow Canyon syncline is a structural trough that occurs along the eastern Arrow Canyon Range in the northern part of the basin. On the western part of the basin, in the Sheep Range, the lower clastic aquitard (formed by the Cambrian clastics) has been thrust over younger Paleozoic rocks. The other predominant structural features are an east-west trending lineament through the Muddy Springs area, which may be related to the Pahranagat Shear System, and a northeast-southwest trending lineament that extends from northeast the Coyote Spring Valley through Kane Spring Valley.

MINERAL RESOURCES—Potential mineral resources in the Coyote Spring Valley include fluid minerals (oil, gas, and geothermal resources), non-energy leasable minerals (primarily sodium and potassium compounds), salable minerals (common sand, gravel, and rock), and locatable minerals (nonmetallic mineral deposits) (BLM, 1992). Maps presented for the other off-site Solar Enterprise Zone facility alternative locations that show the resource potential are not available for the Coyote Spring Valley.

Metallic mineral deposits are absent in the Coyote Spring Valley. The only known mineral deposits include a bentonitic clay deposit and sand and gravel. There are numerous placer claims within the basin. Oil and gas resources are considered speculative. The Nevada Department of Transportation has three material site rights-of-way within the basin. The geothermal resources are moderate. The U.S. Bureau of Land Management has categorized the sodium and potassium potential of the Coyote Spring Valley as moderate.

4.7.4.3 Soils. The soils in the Coyote Spring Valley are typical desert soils (Entisols and Aridisols). The soils of the area have been categorized into seven soil types (Aerojet General, 1987). The Arizo soils form on alluvial fans with 2 to 8 percent slopes and are deep, excessively drained gravelly and cobbly sand. The permeability is very rapid, and the available water capacity is very low. The Badland soil unit forms on the Muddy Creek Formation and is stratified sand, silt, and clay with gypsum and calcium carbonate. The Badland soils are severely eroded and are unsuitable for development because of slope and erosion limitations.

The Colorock-Tonopah Association forms on 2 to 8 percent slopes on alluvial fans and are gravelly sands or very gravelly loams. The Colorock soils are shallow loam over a caliche layer about 1 m (2 ft) thick and have a moderately rapid permeability and a very low available water capacity. The Tonopah soils are excessively

drained and deep. The permeability is rapid, and the available water capacity is low.

The Glendale fine sand is limited to floodplains and terraces with 0 to 2 percent slope. The Glendale grades downward from a fine sand to brown clay loam, silty loam, and very fine sandy loam. The permeability is very low, and the available water capacity is high. The Glendale loam occurs in similar areas, but is well drained and has a moderately slow permeability and high available water capacity.

The Rockland-St. Thomas Association occurs on very steep slopes in the foothills and mountain sides. The Rockland is in areas of limestone exposures. The St. Thomas soils are cobbly loam that is well drained with a moderately rapid permeability and very low available water capacity. The Weiser cobbly sandy loam is a deep and well-drained soil that forms on steeper (15 to 30 percent slope) alluvial fans. The permeability is moderately rapid, and the available water capacity is low to very low.

SOIL EROSION—The soils in the Coyote Spring Valley are susceptible to erosion by wind and water. The potential for erosion is generally slight except where the soils have been disturbed or along the banks of washes. There is also the potential for localized landslides on the steep slopes of the upland areas.

The soils that are most susceptible to erosion include the Badland soil and the Glendale fine sand (Aerojet General, 1987). The Badland soil has a very high water-erosion hazard, and headward erosion occurs extensively in this unit. The Glendale fine sand is very susceptible to wind erosion. The erosion hazard for the Arizo soils is slight; the erosion hazard for the other soils types present is moderate.

4.7.5 Hydrology

Discussions of hydrology are divided into surface water and groundwater. Water supply in the vicinity is also discussed.

4.7.5.1 Surface Hydrology. There are no perennial surface water bodies or streams in the Coyote Spring Valley (Eakin, 1964). The surface water resources are meager, occurring only as ephemeral flow in the streambeds that drain the upland areas or in temporary ponding of runoff in the playa. Surface water flows into the basin on the north via the Pahranagat Wash (shown as White River or Muddy River on some maps). Because of the presence of surface water reservoirs in southern Pahranagat Valley, little if any runoff enters the Coyote Spring Valley from the north. To the northeast, the Kane Springs Wash discharges very infrequently to the Coyote Spring Valley.

Surface water discharges from the Coyote Spring Valley into the upper Muddy Springs area through the Pahranagat Wash. Although there are no gaging stations within the basin, the U.S. Geological Survey does maintain a gaging station in the Pahranagat Wash in Arrow Canyon, just east of the basin boundary. Flow in the wash occurs very infrequently, usually for only a few days during the winter and late summer months. In some years of record, no flow occurred at all at this gaging station. For the 5 year period of record, the average annual runoff is 668,547 m^3/yr (542 acre-feet/year). The peak instantaneous discharge rate of 95 m^3/sec (3,350 ft^3/sec) occurred on September 6, 1991.

Flooding is probably a recurrent problem over most of the valley floor area in the Coyote Spring Valley. Severe flash floods do occur infrequently in both the Pahranagat Wash and Kane Spring Wash. Such floods typically occur when the tributary alluvial channels exceed bankful conditions, resulting in sheet flow over large areas on the alluvial fans that drain to the Pahranagat Wash.

4.7.5.2 Groundwater. The Coyote Spring Valley is situated within the White River Flow System, a subsystem of the regional Colorado Flow System (Harrill et al., 1988). Groundwater that originates as precipitation over the upland areas of the valley discharges out of the regional flow system near Overton, 29 km (18 mi) to the east, ultimately reaching the Colorado River through a complicated pathway of groundwater and surface water flow.

Groundwater under the Coyote Spring Valley occurs at depths ranging from only 3 m (10 ft) below land surface in a perched aquifer in the vicinity of the Coyote Spring and the old Butler

Ranch to about 107 to 183m (350 to 600 ft) below land surface for the water table aquifer throughout the valley floor area (Buqo et al., 1992). Groundwater is derived from two sources: recharge over the basin (estimated at about 2.5 x 10^6 m^3/yr [2,000 acre-feet/year]) and subsurface inflow on the north from the Pahranagat Valley (about 4.3 x 10^7 m^3/yr [35,000 acre-feet/year]). Groundwater is discharged via subsurface outflow to the Muddy Springs area and is appreciable, estimated to be at least 4.6 x 104 m^3/yr (37,000 acre-feet/year).

There are a number of springs in the Coyote Spring Valley (Eakin, 1964). The springs are situated primarily on the eastern slopes of the Sheep Range. Of the nine springs that have been identified, discharge data are only available for two, Coyote and Mormon Well Springs. Published estimates of discharge for both of these springs is less than 4 L/min (1 gal/min); however, some seasonal variations may occur with higher discharge rates in the late spring and reduced discharges during the summer and fall. As of 1992, there were 15 surface water rights totaling only 50,573 m^3/yr (41 acre-feet/year) for springs in the basin.

Because of the limited spring discharge and the irregular nature of surface water discharge, the only reliable water resource is groundwater. There is currently only one operating water supply well in the Coyote Spring Valley. Well yields within the basin are quite variable, depending on the aquifer that is used as a water source. In general, well yields from the alluvial aquifer are quite low, approximately a few hundreds of liters (a few tens of gallons per minute), owing to the limited saturated thickness of alluvium that is present over much of the basin. In contrast, exploratory water wells drilled into the underlying regional carbonate aquifer by the U.S. Air Force were found to be quite productive, with one well capable of producing more than 11,356 L/min (3,000 gal/min).

Because of the tremendous water production potential of the regional carbonate aquifer, there has been considerable interest in developing water supplies in the Coyote Spring Valley in support of defense, municipal, and industrial applications. As of 1994, there were no groundwater rights appropriated within the basin (Buqo, 1996b). However, there are many senior applications for groundwater appropriations in the basin. In 1983, Nevada Power Company applied for 1.6 m^3/sec (55.0 ft^3/sec). In 1985, Aerojet applied for 0.17 m^3/sec (6 ft^3/sec), and, later in that year, Nevada Power Company submitted applications for an additional 1.4 m^3/sec (50 ft^3/sec). In 1986, Aerojet filed 13 additional applications, bringing its total request to 747.97 m^3/sec (26,414 ft^3/sec). In 1988, a single application for 0.44 m^3/sec (15.46 ft^3/sec) was filed for ore processing and, in 1989, the Las Vegas Valley Water District filed five applications totaling 1.1 m^3/sec (38 ft^3/sec). None of these applications have been acted on, and there is considerable uncertainty regarding the potential for obtaining approval of new applications for groundwater to support a Solar Enterprise Zone facility.

WATER QUALITY—According to information published by the Las Vegas Valley Water District (Buqo et al., 1992), the groundwater in the Coyote Spring Valley is generally a calcium-sodium-sulfate type with a total dissolved solids concentrations ranging from 700 to 1,000 mg/L (700 to 1,000 ppm), exceeding the Primary Drinking Water standard of 500 mg/L (500 ppm). Samples of water from the alluvium have been found to have concentrations of iron and manganese that exceed drinking water standards, and elevated concentrations of fluoride have been reported for wells completed in the carbonate aquifer.

4.7.6 Biological Resources

Extensive inventories and assessments of the biological resources of the Coyote Spring Valley have been performed as part of the U.S. Air Force's MX Missile studies and as part of the Aerojet land withdrawal. Detailed information on the biological resources of the basin can be found in (Aerojet General, 1987), and is summarized in the following discussion. The scientific name of plants and animals mentioned in this section is given in Section E.2.6, of Appendix E, Biological Resources. If the Coyote Spring Valley is selected as the most reasonable alternative location, updated surveys would be conducted in support of a Solar Enterprise Zone-specific environmental document.

The plant communities of the Coyote Spring Valley are typical of those found in this part of the Mojave Desert. The dominant plants include creosote bush and white bursage. Mojave yucca, beaver tail cactus, and spiny menodora are subdominant on the bajada areas; shadscale, prince's plume, and wolfberry are subdominant over badland areas; desert willow and cheesebush are subdominant in wash areas. There are no known federally listed threatened, endangered, or candidate plant species within the area designated for consideration as a Solar Enterprise Zone facility.

The desert tortoise is the only threatened or endangered animal species in the Coyote Spring Valley. The Coyote Spring Valley is within critical habitat for this species. The U.S. Bureau of Land Management has designated a large area of the basin as an Area of Critical Environmental Concern to provide for management of the desert tortoise population in accordance with the U.S. Fish and Wildlife Recovery Plan for the desert tortoise (Mojave Population). The tortoise density of the Coyote Spring Valley ranges from 65 to 194 per km² (25 to 75 per mi²) with a total population of almost 18,000, according to the U.S. Bureau of Land Management. Detailed investigations by Garcia et al., 1982 indicate that the population in the vicinity of the proposed Solar Enterprise Zone facility location ranges from 26 to 233 per km² (10 to 90 per mi²). Because of the relatively high density of tortoises and the pristine habitat conditions, the Coyote Spring Valley is considered one of the most valuable tortoise habitats in Nevada (Aerojet General, 1987).

The desert bighorn sheep is a trophy big game species that has been classified as a sensitive species for management purposes by the U.S. Bureau of Land Management and Nevada Department of Wildlife. Bighorn sheep inhabit all of the mountain ranges surrounding the Coyote Spring Valley, and five intermountain migration routes have been identified. One route is 16 km (10 mi) northeast of a Solar Enterprise Zone facility site between the Delamar Mountains and northern Meadow Valley Mountains, and another route is located 10 km (6 mi) to the southeast between the Arrow Canyon Range and the southern Meadow Valley Mountains.

Although undocumented and unsighted within the Coyote Spring Valley, the banded gila monster, a State-protected reptile, may be present. This animal has been reported in the Maynard Lake area immediately north of the Coyote Spring Valley and to the east in the Moapa Valley. The most suitable gila monster habitat in the vicinity of the alternative Solar Enterprise Zone location is in the rocky areas of Pahranagat Wash and adjacent arroyos. If present within the Coyote Spring Valley, the density of this species is expected to be quite low.

4.7.7 Air Quality and Climate

This section includes a description of the air quality conditions at the Coyote Spring Valley, including climatology, meteorology, and ambient air quality.

CLIMATOLOGY AND METEOROLOGY—Although there are no weather stations in the Coyote Spring Valley, National Oceanic and Atmospheric Administration data on the climate of the area are available for stations located in the Valley of Fire, Logandale, and North Las Vegas. In general, the climate of the valley exhibits the low humidity and low annual precipitation characteristic of the climate of Clark County. The warmest month is July, when the mean monthly maximum temperature is 40 °C (104 °F); January is the coolest month, with a mean monthly minimum of 0°C (32 °F). The average monthly wind speed ranges from 11 kph (7 mph) in December to 18 kph (11 mph) in April and June. Diurnal variation in wind is common, reflecting the differential heating of the ground.

AMBIENT AIR QUALITY—The Coyote Spring Valley is located within Nevada Intrastate Air Quality Control Region 147, which is designated unclassifiable/attainment for all criteria pollutants. The closest Class I Prevention of Significant Deterioration area is the Grand Canyon National Park, approximately 121 km (75 mi) southeast of the Coyote Spring Valley. Because the Coyote Spring Valley is largely undeveloped, there are few emission sources in the area. Typical sources include a silica sand mining operation in the north-central part of the basin; on-road and off-road vehicle, railroad, and aircraft traffic; and fugitive dust.

4.7.8 Noise

The acoustic environment of the Coyote Spring Valley can be classified as uninhabited desert or small rural communities (Section 4.1.8). Noise measurements have not been made at the Coyote Spring Valley Solar Enterprise Zone site. Natural sources include wind and thunder. The major sources of noise would be associated with prevailing meteorological conditions, such as wind.

4.7.9 Visual Resources

The landscape character of the Coyote Spring Valley is typical of the Great Basin with extensive views of linear mountain ranges and valleys arranged in a north-south orientation. The valley is surrounded to the southwest and west by the Las Vegas and Sheep Ranges, Delamar Mountains to the north, Meadow Valley Mountains to the east, and Arrow Canyon Range to the south. The steep and rugged mountain slopes give way in the valley to gently sloping surfaces dissected by arroyos and washes. The visual quality of the area ranges from Class B to Class C. Because of the surrounding vista, the visual quality of the site has been designated Class B.

The proposed Solar Enterprise Zone facility in the Coyote Spring Valley is visible to the east from U.S. Highway 93. State Route 168 is 19 km (12 mi) south of the proposed site. The site would be visible from BLM Wilderness Study Areas located in the Delamar Mountains, Meadow Valley Mountains, and along the west side of U.S. Highway 93. The BLM Wilderness Study Areas range from 2 km (1 mi) to 8 km (5 mi) from the site. There are two utility corridors that roughly parallel these two routes. An abandoned ranch is located in the northern portion of the valley, and there is an active silica sand mining operation located adjacent to this ranch. The Kane Spring Wash cuts from east to west in the north part of the site.

4.7.10 Cultural Resources

The Coyote Spring Valley lies in southern Nevada, an area with a prehistory that may span the past 10,000 years or more. Properties ranging from the early prehistoric period to historic mining and ranching sites are known. A summary of cultural resources and associated impacts are described in (Aerojet General, 1987).

SITES OF AMERICAN INDIAN SIGNIFICANCE—Coyote Spring is an area on the west flank of the Meadow Valley Mountains. The CGTO knows that this site contains a wide variety of American Indian cultural resources. The site was studied by American Indian people during the Intermountain Power Project (Stoffle and Dobyns, 1982). Nine Indian-use plants were identified during that on-site visit, including desert willow (Chilopsis linearis)*, prince's plume* (Stanleya pinnata)*, and wolfberry* (Lycium andersonii) *(Stoffle and Dobyns 1982). The large desert tortoise was observed at this location. The area contains portions of an original Indian trail-wagon road from the Moapa Valley to Pahranagat Valley. Archaeological survey of the Intermountain Power Project corridor revealed 9 sites and 20 scattered finds (Tucker et al., 1982). Known American Indian cultural resources exist in the Coyote Spring area, but it is impossible to fully understand the potential impacts to cultural resources without additional systematic on-site resource studies by American Indian people.*

4.7.11 Occupational and Public Health and Safety

The Coyote Spring Valley location proposed for siting a Solar Enterprise Zone facility is currently undeveloped desert. Baseline health and safety considerations associated with the environment include potential for heat stroke and exhaustion (primarily during summer months), dehydration, and poisonous spider and snake bites. Other physical hazards include tripping or stumbling hazards associated with the desert terrain.

4.7.12 Environmental Justice

Existing demographic conditions for Environmental Justice are discussed in Section 4.1.12. This discussion includes conditions for the Coyote Spring Valley.

4.8 References

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