FINAL

ENVIRONMENTAL ASSESSMENT FOR THE SITE, LAUNCH, REENTRY AND RECOVERY OPERATIONS AT THE KISTLER LAUNCH FACILITY, NEVADA TEST SITE (NTS)

Prepared for the
U.S. Department of Transportation
Federal Aviation Administration
Office of the Associate Administrator
for Commercial Space Transportation
Washington, DC 20591

APRIL 30, 2002

Associate Administrator for
Commercial Space Transportation

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This Environmental Assessment becomes a Federal document when evaluated and signed by the responsible Federal Aviation Administration (FAA) Official.

Responsible FAA Official	**Date**

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1. PURPOSE AND NEED AND BACKGROUND

Kistler Aerospace Corporation (Kistler), a privately funded commercial venture, proposes to launch low earth orbit (LEO) communications satellites, and other private and government satellites, using a fully reusable two-stage vehicle. The proposed location for the Kistler launch facility is at the Nevada Test Site (NTS), on land that is withdrawn from the public domain for use by the United States (U.S.) Department of Energy (DOE). The NTS is operated by DOE to fulfill missions in five program areas: Defense, Work for Others, Waste Management, Environmental Restoration, and Non-Defense Research and Development. In order to conduct commercial launch and reentry operations, Kistler must obtain a license from the Federal Aviation Administration (FAA).

Two Federal agencies are directly involved in the proposed action, FAA and DOE. The FAA would license and regulate Kistler's launch and reentry operations and is the lead Federal agency for the National Environmental Policy Act (NEPA) process. The DOE is a cooperating agency with FAA for the NEPA process and would provide land and certain infrastructure for use by Kistler.

Federal Aviation Administration. The Commercial Space Launch Act of 1984 (Public Law 98-575) (CSLA), as amended, codified at 49 United States Code (U.S.C.) Subtitle IX, Ch. 701, Commercial Space Launch Activities, declares that the development of launch vehicles for commercial operations and associated services is in the national and economic interest of the United States. To ensure that launch services provided by private enterprises are consistent with national security and foreign policy interests of the United States, and do not jeopardize public health and safety and safety of property, the Department of Transportation (DOT) is authorized to regulate and license U.S. commercial launch and reentry activities. Within DOT, the Secretary's authority under the CSLA has been delegated to the FAA. Because licensing launch and reentry operations is considered to be a major Federal action subject to the requirements of NEPA (Public Law 91-190), as amended, 42 U.S.C. § 4321, et seq., FAA must assess the potential environmental impacts of an applicant's proposed actions. Air Traffic Airspace Management at FAA must assess the proposed actions in terms of potential impacts to FAA airspace management to ensure safe and efficient operation of the National Airspace System.

In October 1998, Congress passed legislation expanding the FAA Associate Administrator for Commercial Space Transportation's (AST's) role in commercial space launch activities to include licensing the reentry of reentry vehicles, and operation of reentry sites. The FAA will examine the safety and policy implications, as well as environmental impacts associated with the space launch reentry activities in implementing its licensing program.

Department of Energy. As the Federal agency charged with operating and managing the NTS, the DOE prepared a *Final Environmental Impact Statement for the Nevada Test Site and Off-Site Locations in the State of Nevada.* The Record of Decision (ROD) for that environmental impact statement (EIS) stated: "This decision will result in the continuation of the multipurpose, multi-program use of the Nevada Test Site, under which DOE will pursue a further diversification of interagency, private industry, and public-education uses while meeting its Defense Program, Waste Management, and Environmental Restoration mission requirements..." Section 3161 of the National Defense

Authorization Act for fiscal year 1993 encouraged DOE to minimize the social and economic impacts on workers and communities affected by the downsizing of defense-related facilities. One of the methods the DOE has used to implement this Congressional direction is to establish local Community Reuse Organizations (CROs) to assist economic development efforts. The CRO for the NTS is the Nevada Test Site Development Corporation (NTSDC). Among other things, Section 3161 authorized DOE to initiate private sector economic development at DOE sites and facilities. The ROD indicates that as part of its decision, DOE would continue to support ongoing program operations and pursue diversification of use to include non-defense and private use. The ROD specifically cited Kistler as an example of a potential private use at the NTS and stated that "to the extent that future National Environmental Policy Act review is required in connection with the satellite delivery aspects of this project, such review would occur in conjunction with the Federal Aviation Administration licensing process."

1.1. Background

Kistler proposes to conduct commercial launch, reentry, landing, and recovery operations from a proposed site that would include newly constructed facilities and infrastructure for operating the Kistler K-1 reusable launch vehicle. The function of the K-1 vehicle would be to launch satellites and other payloads into prescribed orbits for commercial and government customers.

Kistler Aerospace Corporation

Kistler is a privately funded aerospace company founded in 1993 and headquartered in Kirkland, Washington. Kistler is developing a launch vehicle with components that are designed to be recovered and reused to minimize launch costs and turnaround time. Expected principal markets for the Kistler K-1 aerospace vehicle are the commercial LEO telecommunications satellite launch market and other on-orbit delivery operations. Kistler's financing is comprised of non-governmental sources, such as private resources, international equity markets, contractors, institutional investors, and strategic partners and customers who require lower cost systems to launch. Kistler's subcontractors include GenCorp Aerojet, responsible for the propulsion systems and launch ground systems design; Northrop Grumman and Boeing North American, responsible for the structure design; Draper Laboratories, responsible for the guidance, navigation and control system development; Allied Signal, responsible for the electronic systems hardware design; and Irvin Aerospace, responsible for the landing systems design.

1.2. Public Involvement

The Draft Environmental Assessment (EA) and proposed environmental finding document were released for a 30-day public comment period. Such public review was needed because the nature of the proposed action is without precedent. In addition, prior to preparation of this EA, states, tribes and other key stakeholders were notified through the Federal Register of AST's intention to prepare an EA.

Seventeen tribes and organizations with ties to the NTS have aligned together to form the Consolidated Group of Tribes and Organizations (CGTO). The CGTO was initially informed of the Kistler project in June of 1997 by the DOE. CGTO members prepared an American Indian assessment document (Appendix A) to express their opinions and provide comments on the EA. A preliminary draft of the American Indian assessment document was submitted to members of the American Indian Writers Subgroup (AIWS), the DOE, the NTSDC, and the FAA on August 31, 2000.

Following a review of the document, the DOE requested that a meeting between representatives of the AIWS, DOE, and FAA be held in Las Vegas to discuss the document and revise the text for inclusion in the Kistler EA. The document review meeting occurred on September 12, 2000, at the DOE offices in Las Vegas. Attending the meeting was the coordinator of the AIWS, three DOE personnel, FAA/AST staff, and a University of Arizona ethnographer. At the conclusion of the meeting FAA and DOE requested that the AIWS provide specific recommendations on how to further proceed with the EA process.

The FAA has included selected comments from this document in the body of the Final EA and has included a full record of all recommendations in Appendix A of this EA. There are various locations where the EA contradicts or controverts Native American comments regarding environmental impacts. The data presented in the EA are supported by scientific findings whereas the Native American comments are not accompanied by any evidence to support assertions of environmental damage. Therefore these comments, while considered by the FAA in developing the Final EA, are not specifically included in the body of the document but are included in full in the Appendix.

1.3. Purpose and Need

The proposed Kistler launch facility would provide to Kistler an alternative to launching from a Federal facility. The proposed Kistler activities would make available to Kistler infrastructure for placing telecommunications, scientific and research payloads into LEO. The proposed project would involve the use of reusable launch vehicles to launch communications satellites, private and government satellites, and provide other on-orbit services, and is therefore consistent with the objectives of the Commercial Space Launch Act. The Kistler K-1 vehicle is a reusable two-stage vehicle made up of the Launch Assist Platform (LAP) and the Orbital Vehicle (OV). Each stage is fully reusable and carries its own avionics and is designed to operate autonomously from ground control.[a] The K-1 uses liquid

[a] A fully autonomous system would not satisfy the existing FAA licensing requirements for reusable launch vehicles. Accordingly, final operational processes involving the K-1 vehicle have not yet been approved by the FAA. Those

oxygen (LO_X) and kerosene as propellants in each of the two fully reusable stages and would be the only launch vehicle used at the Kistler NTS facilities. Kistler proposed launches and reentries at the NTS would begin no earlier than 2002 and build to a capability to support a maximum of 52 launches per year.

NEPA and implementing regulations of the President's Council on Environmental Quality (CEQ) (40 Code of Federal Regulations (CFR) 1500-1508) require Federal agencies to evaluate the impact of proposed Federal actions, such as issuing a launch or reentry license, that may have the potential to significantly affect the environment. The FAA has prepared this document to serve as the basis for determining whether the proposed action would have significant impacts on the environment. The EA covers the connected actions of developing and operating private use launch and reentry infrastructure at the NTS, in addition to launch and reentry-related environmental impacts. The DOE has jurisdiction over the use of the NTS and, as envisioned in CEQ regulations (40 CFR 1501.6), is serving as a cooperating Federal agency on this EA.

1.4. Prior Environmental Analyses

The environmental effects of launch operations and launches have been previously analyzed by AST. A summary of the NEPA documents used by the FAA in the preparation of this EA include:

- *Final Programmatic Environmental Impact Statement for Licensing Launches* (PEIS LL), Department of Transportation, Office of the Associate Administrator for Commercial Space Transportation, May 24, 2001

- *Final Programmatic Environmental Assessment for Commercial Expendable Launch Vehicles,* Department of Transportation, Office of Commercial Space Transportation, February 1986

- *Final Programmatic Environmental Impact Statement for Commercial Reentry Vehicles* (PEIS RV), Department of Transportation, Office of Commercial Space Transportation, May 1992

- *Final Environmental Impact Statement for the Nevada Test Site and Off-Site Locations in the State of Nevada* (NTS EIS), DOE August 1996

- *X-33 Advanced Technology Demonstrator Vehicle Program, Final Environmental Impact Statement*, National Aeronautics and Space Administration, September 1997

- *Environmental Assessment of the Kodiak Launch Complex* (KLC EA), FAA, June 1996

- *Final Environmental Impact Statement for the John F. Kennedy Space Center*, NASA, October 1979

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processes are described generally in the EA as background information for evaluation of the range of environmental impacts.

In accordance with the CEQ regulations for NEPA documents, this EA tiers from the PEIS LL, PEIS RV, and the NTS EIS. Relevant sections of these documents are summarized and referenced to eliminate repetitive discussion of the same issue and to focus analysis in key decision areas.

The NTS EIS evaluated the environmental impacts of four possible land-use alternatives at the NTS and other sites in Nevada. The ROD for the EIS outlined DOE's decision to implement a combination of three of the alternatives analyzed:

- Expanded Use,
- No Action, and
- Alternate Use of Withdrawn Lands.

It stated that most of the activities at the NTS would be pursued as described by the Expanded Use alternative. Issues associated with waste management will be managed with no change as described by the No Action Alternative, pending decisions made by DOE as documented in its *Final Waste Management Programmatic Environmental Impact Statement for Managing Treatment, Storage, and Disposal of Radioactive and Hazardous Waste* (DOE 1997). Public education activities will be developed in accordance with the Alternate Use alternative. The Kistler proposal was specifically addressed as a potential activity under the Expanded Use alternative. The ROD for the NTS EIS states under the section, Non-Defense Research and Development Program:

> *The DOE will continue to support ongoing program operations and pursue diversification of use to include nondefense and private use. Private uses, for example, could include activities such as the Kistler Aerospace Corporation proposal identified during the public comment period on the Draft Environmental Impact Statement. Kistler's comments expressed interest in developing a commercial satellite delivery system as a future activity in this program area.*

1.5. Roadmap For This Environmental Assessment

Section 2 of this EA provides a description of the proposed action and alternatives. Section 3 discusses the affected environment and description of the environmental baseline. Section 4 outlines potential safety and health concerns associated with the proposed action. Section 5 discusses the environmental consequences of the alternatives.

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2. [INSERT SECTION 2]

3. AFFECTED ENVIRONMENT AND DESCRIPTION OF ENVIRONMENTAL BASELINE

This chapter describes the existing institutional, environmental, and socioeconomic characteristics of the Kistler facilities (i.e., the areas in which proposed Kistler facilities and launch and reentry activities would take place) that could be affected by the proposed action, as described in Chapter 2 of this environmental assessment. These characteristics will serve as the baseline from which any environmental impacts that may result from implementation of the proposed Kistler launch and recovery activities can be identified and evaluated.

The NTS EIS was used extensively as a resource in describing the affected environment. Additional information on environmental conditions has been referenced throughout this chapter to the relevant information in the NTS EIS.

Because of the nature of the proposed Kistler launch and recovery activities, potential impacts on public health and safety, especially regarding launch and reentry anomalies or failures during overflight of populated areas, have been addressed separately in Chapter 4.

3.1. Overview of Proposed Operational Area

As shown in Figure 3-1 the proposed location for the payload processing facility was heavily used at one point. This facility was known at various times as both the Area 17 Camp and as the Area 18 CP. This location was used from the mid 1960s to the early 1970s as a base camp and command point to support drilling and underground nuclear weapons testing in the northern portions of the NTS. In addition, it was used as a personnel staging area until the early 1980s. The location of the proposed payload processing facility for the project would be on the flat area that was once used as an equipment lay-down yard, shown as the large flat area in the lower center of Figure 3-1.

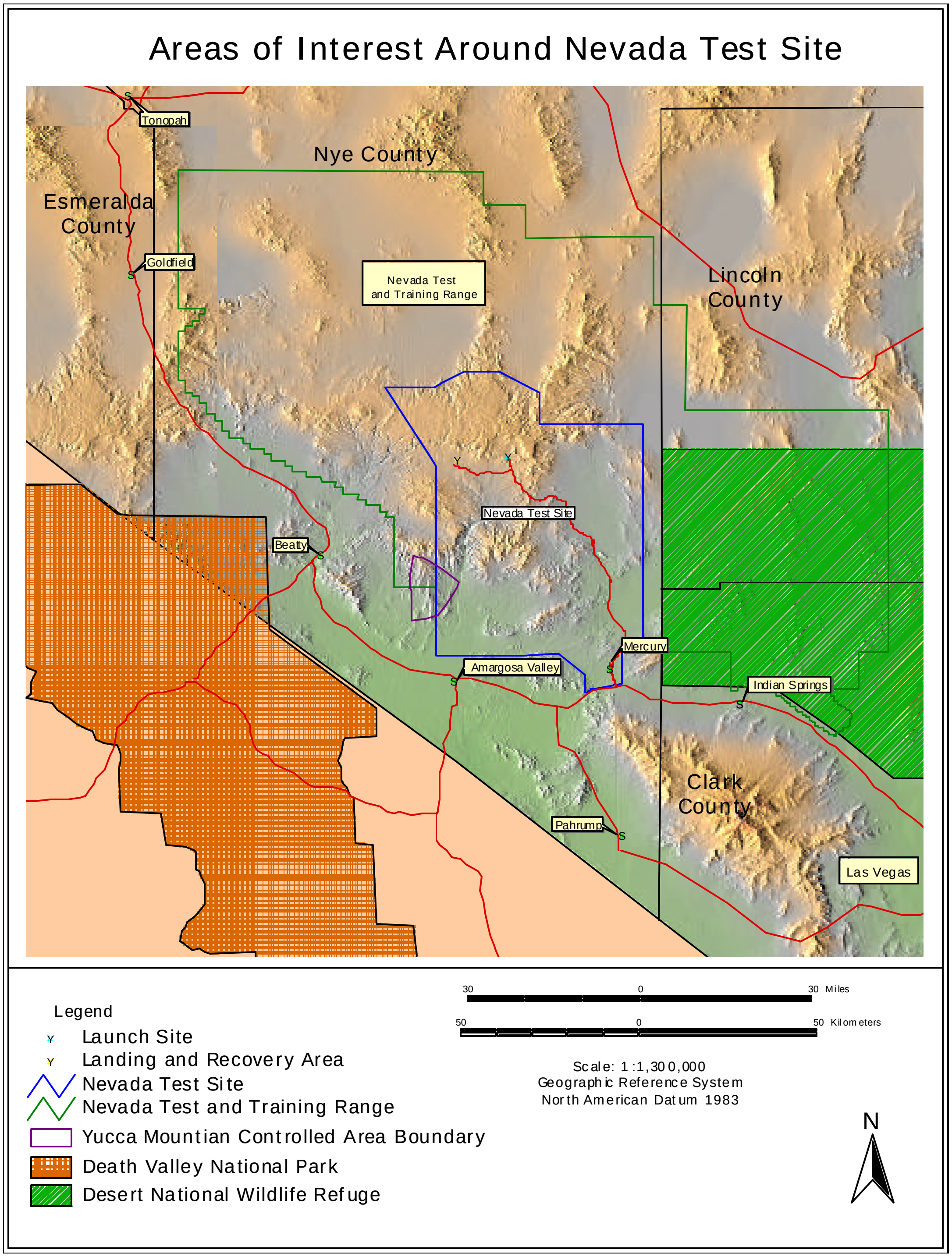
To the north, on the upper right hand side of the photograph, the proposed site for the vehicle processing facility and launch pad is visible. There are several shallow excavations in the area of the launch site approximately three feet by six feet that appear to have been made by a backhoe. The purpose of these excavations is unknown. This picture shown in Figure 3-1 was taken in April 1969 during the peak of activity in this area. The camera angle is from the southeast of the facility, viewing northwest. Pahute Mesa Road and Landmark Rock are shown in the foreground. The same location is shown in Figure 3-2 depicting the current site condition as of April 1997. (Figure 3-2 represents the area from the view in the upper left hand side of Figure 3-1.) Figure 3-3 shows the proposed area for the landing and recovery activities (NTS, Area 18, 11 kilometers (6.8 miles) west of proposed vehicle processing facility and launch site). Figure 3-4 shows these areas in overview, relative to the NTS, and surrounding counties.

Figure 3-1. Previous Activity in Kistler Operational Areas (Photo circa 1969)

Figure 3-2. Current Site Conditions

Figure 3-3. Proposed Area for Landing and Recovery Activities

Figure 3-4. Areas of Interest Relative to the NTS and Surrounding Counties



Institutional Environment

Site activities are concentrated in five major program areas: Defense; Work for Others; Waste Management; Environmental Restoration; and Non-Defense Research and Development. The NTS EIS evaluated the potential environmental impacts of four site use alternatives. Based on this analysis and other decision factors, including mission responsibilities, DOE decided in a ROD, dated December 9, 1996, (61 Federal Register 65551) to implement a combination of three alternatives: Expanded Use; No Action; and Alternate Use of Withdrawn Lands. This decision will result in the continuation of the multipurpose, multi-program use of the NTS.

The Kistler proposal is part of the Non-Defense Research and Development Program activities that are centered in the Office of Economic Development at the DOE Nevada Operations Office (DOE/NV). The purpose of this Office is to promote economic development of the site and to mitigate the downsizing impacts both for individual workers and communities near the site consistent with Section 3161 of the 1993 Defense Authorization Act. DOE/NV has established a Community Reuse Organization (CRO) to assist in private sector economic development efforts. The NTSDC is the designated CRO for the NTS. The NTSDC is a nonprofit corporation with approximately 60 members on its board from the public and private sectors. Under current arrangements, DOE/NV has issued a use permit to the NTSDC for the proposed location in Areas 18 and 19 of the NTS for the purpose of economic development. The NTSDC has issued a subpermit to Kistler for use of the NTS for the proposed launch, reentry, and recovery operations, subject to FAA licensing (See Appendix B).

3.2. Airspace

Definition of Resource

Airspace management and use are governed by the regulations set forth by the FAA. The types of airspace are dictated by (1) the complexity or density of aircraft movements; (2) the nature of operations conducted within the airspace; (3) the level of safety required; and (4) the national and public interest in the airspace. The classes of airspace are *controlled*, *uncontrolled*, *special use,* and *other airspace*. Simple definitions are provided in Table 3-1.

Controlled Airspace covers airspace used by aircraft operating under Instrument Flight Rules (IFR) that require different levels of air traffic service. Examples of controlled airspace include the altitudes above Flight Level (FL) 180 (approximately 5,500 meters (18,000 feet) above MSL), some Airport Traffic Areas, and Airport Terminal Control Areas. General controlled airspace includes the established federal airways system which consists of the high altitude (jet routes) system flown above FL180, and the low altitude structure (victor routes) flown below FL180.

Uncontrolled Airspace is primarily used by general aviation aircraft operating under Visual Flight Rules (VFR). Uncontrolled airspace is not subject to the strict conditions of flight required by those aircraft using controlled airspace, and can extend as high as 4,420 meters (14,500 feet) above MSL.

Table 3-1. Definitions of Airspace Categories

Category	Definition	Examples
Controlled Airspace	Airspace used by aircraft operating under IFR that require different levels of air traffic service	• Altitudes above FL 180 (5,500 meters [18,000 feet] above MSL) • Airport Traffic Areas • Airport Terminal Control Areas • Jet Routes • Victor Routes
Uncontrolled Airspace	Airspace primarily used by general aviation aircraft operating under VFR	As high as 4,420 meters (14,500 feet) above MSL
Special Use Airspace	Airspace within which specific activities must be confined or access limitations are placed on non-participating aircraft	• Restricted Areas • Military Operations Areas
Other Airspace	Airspace not included under controlled, uncontrolled, or special use categories	Military Training Routes

Special Use Airspace is airspace within which specific activities must be confined or for other reasons, access limitations are imposed upon non-participating aircraft. Special Use Airspace descriptions are contained in FAA Order 7400.8. Two types of Special Use Airspace are Restricted Areas and Military Operations Areas (MOAs).

- Restricted areas are established by regulation through procedures in Federal Aviation Regulation (FAR) 73 using a formal rule-making process. In general, restricted areas are used to contain hazardous military activities. The term "hazardous" implies, but is not limited to, weapons employment (either live or inert), aircraft testing, and other activities which would be inconsistent or dangerous with the presence of non-participating aircraft.

- A MOA is airspace designated for non-hazardous military activities and is established outside of controlled airspace below FL180. MOAs do not require "rule-making" action by FAA to establish, and are active only when in use by the designated user of the airspace, e.g., the MOA airspace is released back to air route traffic control for general aviation or others. Typical activities that occur in MOAs include military pilot training, aerobatics, and combat tactics training. When MOAs are in use non-participating aircraft flying under IFR clearances are directed by air traffic control to avoid the MOA. However, even when a MOA is in use, entry into the area by VFR aircraft is not prohibited, and flight by non-participating aircraft can be done on a see-and-avoid basis. Descriptions of Special Use

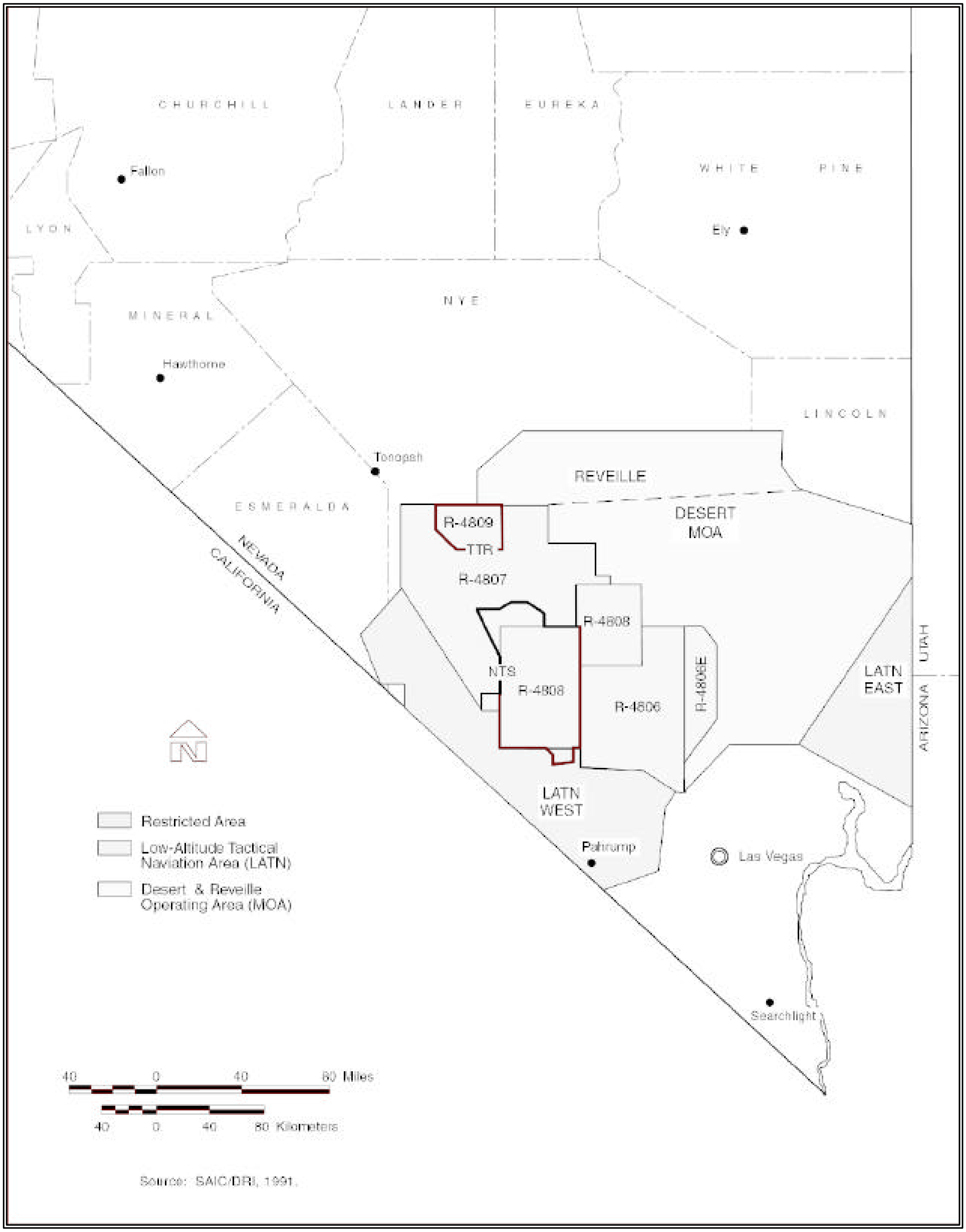
Airspace, including restricted areas and MOAs, are found in DoD Flight Information Publication AP/1A.

Other Airspace includes military training routes (MTRs). They are low altitude, high speed, routes established by the FAA as airspace for special use by the military services. Routes may be established as IFR Routes or VFR Routes. MTRs are depicted on aeronautical charts and detailed descriptions are provided in the DoD Flight Information Publication AP/1B.

Existing Conditions

The airspace associated with the NTS (Figure 3-5) is a part of the Nevada Test and Training Range (also known as the Nellis Air Force Range), which includes four restricted areas, the Desert MOA, air traffic controlled airspace, low altitude tactical navigation areas, MTRs, and air refueling areas. The restricted areas include R-4806, R-4807, R-4808, and R-4809. Flight control in the restricted areas and Desert MOA area is under the Nellis Air Traffic Control Facility. Restricted areas R-4806 and R-4807 are used for the military training and testing activities and may be released for use by non-participating aircraft when not in use by the Nevada Test and Training Range. However, R-4808 and R-4809 comprise the airspace over the NTS and other DOE facilities. These areas are managed by DOE and are not opened for overflight by general aviation or commercial aircraft. All of these restricted areas are restricted from the surface to an unlimited altitude. The top of the Desert MOA is 5,500 meters (18,000 feet) MSL. The restricted airspace over the proposed Kistler facility locations in Areas 18 and 19 is R-4808. A more detailed description of the airspace over the NTS and vicinity is found in Section 4.1.1.4 in the NTS EIS.

Figure 3-5. NTS and Nevada Test and Training Range Airspace and Vicinity



3.3 Land Use

The NTS encompasses approximately 3,500 square kilometers (1,350 square miles) of land reserved to the jurisdiction of DOE in Nye County, Nevada. The site varies from 46 to 56 kilometers (28 to 35 miles) in width and 64 to 88 kilometers (40 to 55 miles) in length (north to south). Figure 3-6 shows the status of lands around the NTS. The nearest population centers surrounding the NTS are Amargosa Valley, Indian Springs, Beatty, and Pahrump. These are all small rural communities, with Amargosa Valley, three kilometers (two miles) south, being the closest to the NTS. Las Vegas is the closest major metropolitan area and is located about 105 kilometers (65 miles) southeast of the NTS.

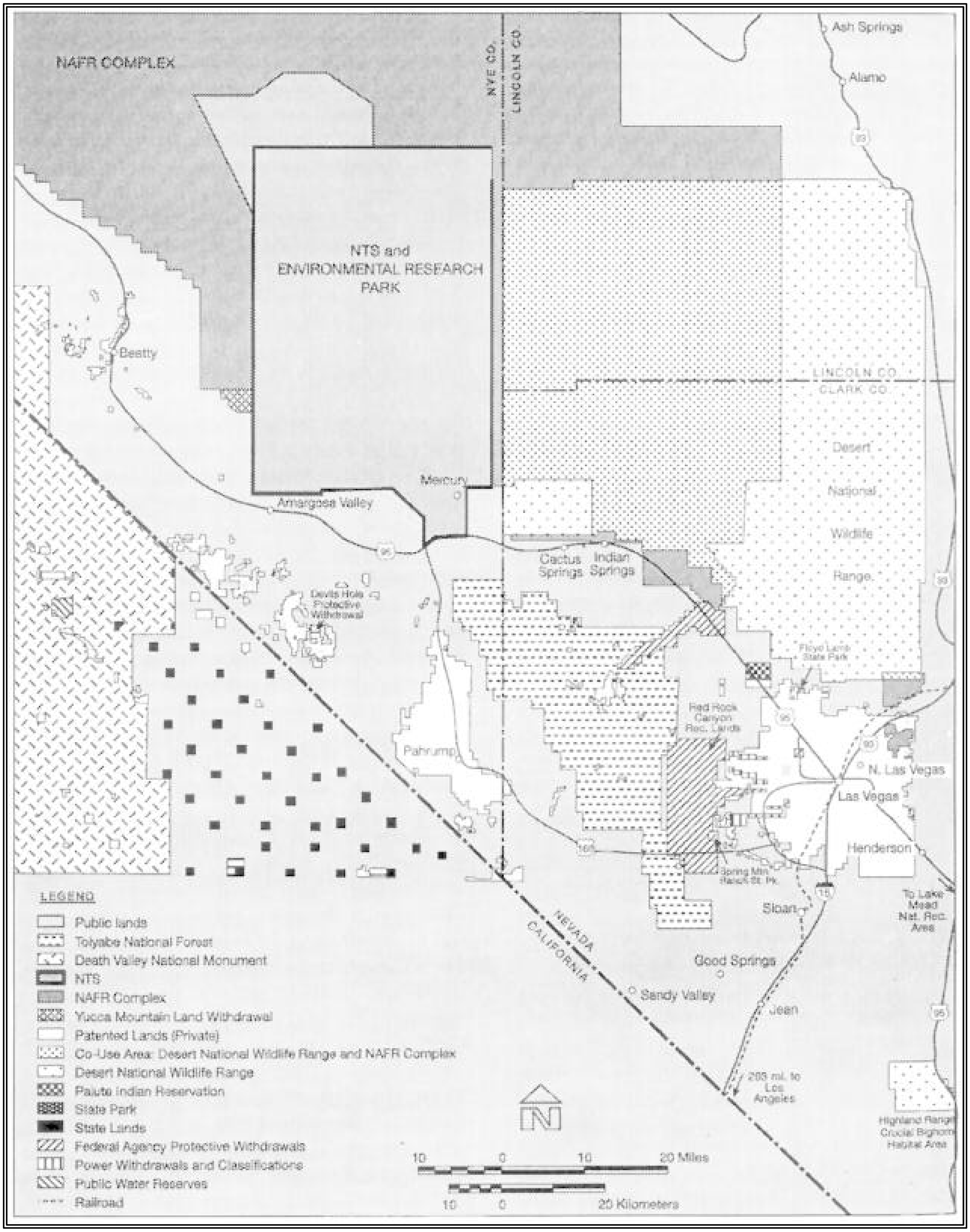
Numerous national, state, and local public recreation areas exist in the region. Outdoor recreation areas include Lake Mead National Recreation Area, located 121 kilometers (75 miles) east; the Death Valley National Park, located 19 kilometers (12 miles) to the west-southwest; the Red Rock National Conservation Area, located 64 kilometers (40 miles) to the southwest; and the Desert National Wildlife Range, located five kilometers (three miles) east. Portions of the Desert National Wildlife Range overlap with the Nevada Test and Training Range and come within three kilometers (two miles) of the boundary of the NTS. State Parks include Spring Mountain Ranch State Park, located 80 kilometers (50 miles) southwest, and the Floyd R. Lamb State Park, located 72 kilometers (45 miles) southwest. Other recreational areas include year-round campsites and picnic areas in the Toiyabe National Forest, located 40 kilometers (25 miles) 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 NTS and the Nevada Test and Training Range.

Existing Land Use on the NTS is divided into two site categories and seven zone categories. The following definitions describe the zone use categories on the NTS.

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 non-defense research, development and testing projects and activities.

Nuclear or 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 non-defense research, development and testing projects.

Figure 3-6. Status of lands around the NTS



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 non-defense 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 government or industry sponsored toxic spill clean up tests.

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 explosive 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, Federal Radiological Monitoring and Assessment Center training, and DoD land-navigation exercises and training.

Area 18 of the NTS is included in the reserved land use zone and occupies 231 square kilometers (89 square miles) in the northwest quadrant of the NTS. The inactive Area 18 Control Point is located in the extreme northeastern portion of the area. When operational, the control point was used as an industrial support site for test operations in the vicinity. The inactive Pahute airstrip is located in the east-central portion of the area. The airstrip was used to support the shipment of supplies and equipment for Pahute Mesa test operations. The south-central portion of Area 18 was used for five nuclear weapons tests: four conducted in mid-1962 and one underground test in 1964. Two of these were atmospheric, 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 is included in the nuclear test land use zone and occupies 388 square kilometers (150 square miles) 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 in the area. There are five inventory stockpile stewardship emplacement holes located in the western half of Area 19.

For a more detailed description of on-site and surrounding land use see Section 4.1.1 of the NTS EIS, Affected Environments, Test Site and Surrounding Areas, Land Use.

3.4. Air Quality

Definition of Resources

Air quality in a given location is usually measured in terms of the concentration of various air pollutants in the atmosphere. The Environmental Protection Agency (EPA) set National Ambient Air Quality Standards (NAAQS) for criteria air pollutants: sulfur dioxide (SO_2), carbon monoxide (CO), nitrogen dioxide (NO_2), ozone (including volatile organic compounds and nitrogen oxides as precursors), particulate matter with a diameter of less than 10 microns (PM_{10}), particulate matter of 2.5 microns or less in diameter ($PM_{2.5}$), and lead (Pb).

On July 18, 1997, EPA promulgated a revised particulate matter standard and revised the ozone standard.[b] However, designation and classification actions by the EPA for these standards were delayed due to litigation by industry groups and States. In February 2001, the Supreme Court upheld the constitutionality of the air quality standards. EPA has since begun discussions on the timing of the designations and whether to coordinate actions for the eight-hour ozone and $PM_{2.5}$ standards. EPA is working to promulgate an implementation rule for $PM_{2.5}$ before their designations, which are set to be promulgated by 2005 (as required by The Transportation Equity Act for the 21st Century).[c] Implementation rules for eight-hour ozone NAAQS are set to be finalized in 2003.[d]

Both primary and secondary NAAQS were established for these substances. The primary standards were established to protect the public health with an adequate margin of safety, while the secondary standards were intended to protect the public welfare from any known or anticipated adverse effects of a pollutant. These threshold levels were determined based on years of research on the health effects of various concentrations of pollutants on biological organisms. Years of research on the health effects of various concentrations of pollutants on biological organisms have helped determine these threshold levels.

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[1] In 1997, EPA added a new annual $PM_{2.5}$ standard (15 Φg/m^3) and a new 24-hour $PM_{2.5}$ standard (65 Φg/m^3). EPA retained the annual PM_{10} standard of 50 Φg/m^3 and adjusted the PM_{10} 24-hour standard of 150 Φg/m^3 by changing the form of the standard. (http://www.epa.gov/ttn/oarpg/naaqsfin/pmfact.html) EPA phased out and replaced the one-hour primary ozone standard with a new eight-hour standard (0.08 parts per million). (http://www.epa.gov/ttn/oarpg/naaqsfin/o3fact.html)

[2] EPA cannot begin to implement 1997 fine particulate matter standards until EPA and states collect three years of monitoring data to determine which areas are not attaining the standards. The fine particle monitoring network was completed in 2000. (http://www.epa.gov/airlinks/court_summary.pdf)

[d] Sources: http://www.epa.gov/ttn/rto/ozonetech/o3imp8hr/desig_022802.pdf; http://www.epa.gov/airlinks/court_summary.pdf

Nevada has also developed state ambient air quality standards similar to or more stringent than the NAAQS. Nevada's standards also include visibility and hydrogen sulfide.

Hazardous air pollutants (HAPs) or air toxics are also regulated according to the Clean Air Act (CAA). Maximum achievable control technologies (MACT) for specific emission source categories or National Emission Standards for Hazardous Air Pollutants (NESHAPs) have been developed or are in the process of being developed for over 188 compounds.

To further define local and regional air quality, EPA divided the country into areas that achieve the NAAQS called attainment areas, and those that do not achieve the NAAQS, nonattainment areas. Some areas are unclassified because insufficient data are available to characterize the area, while other areas are deemed maintenance areas. A facility (i.e., launch site) might need to prepare an analysis called a conformity analysis if two conditions exist. If the launch site is in a nonattainment area for a particular pollutant and if new emission sources such as new launches generate the same pollutant above a certain number of tons per year. A conformity analysis may involve performing air quality modeling and implementing measures to mitigate the air quality impacts. However, this does not apply to this project because the proposed Kistler site would be located in an attainment area for all criteria pollutants.

The nonattainment and attainment classifications are generally based on air quality monitoring data collected at certain sites in the state. To determine the effects of air emission sources on the ambient air concentrations, air quality modeling is usually conducted. The type and amount of pollutants, the topography of the air basin, and the prevailing meteorological conditions are considered in modeling the air quality concentrations. The meteorological parameters which most often affect pollutant dispersion are wind speed, wind direction, atmospheric stability, mixing height, and temperature.

To help attain or maintain the NAAQS, the EPA developed air quality regulations. The EPA implements some of these regulations, but has delegated authority to the states for others. Each state is required to develop a state implementation plan (SIP) which describes the manner in which the state will meet or attain the NAAQS. The SIP contains emission limiting regulations as well as record keeping and reporting requirements for affected sources. New and expanding sources exceeding certain emission thresholds must meet new source review requirements that outline the permitting provisions. In attainment areas, these requirements are called prevention of significant deterioration (PSD) regulations.

Existing Conditions

Local Meteorology and Climate. The meteorology at the NTS is characterized by limited precipitation, low humidity, and large diurnal temperature ranges. Precipitation in the summer falls in isolated showers, which cause large variations in the amount of local precipitation. Summer precipitation occurs mainly in July and August when intense heating of the ground beneath moist air masses triggers thunderstorm development and associated lightning (DOE, 1996).

The higher elevation in Area 18, particularly at the proposed Kistler site, which is 1,768 meters (5,800 feet) above MSL, influences temperatures. At the Pahute Mesa, the average daily minimum and maximum temperatures are -2 to 4 °C (28 to 40 °F) in January and 17 to 27 °C (62 to 80 °F) in July. The average annual wind speed in this area is 16 kilometers per hour (kph) (10 miles per hour (mph)). The prevailing wind direction during the winter months is north northeasterly; during the summer months winds are southerly.

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. Additional severe weather in the region includes occasional thunderstorms, lightning, tornadoes, and sandstorms. Severe thunderstorms may produce high precipitation for approximately one hour and may create a potential for flash floods. Few tornadoes have been observed in the region and are not considered a significant event (Quiring, 1968, Bowen and Egami, 1983).

Pre-Activity Environmental Condition. DOE/NV has entered into a Federal Facilities Agreement and Compliance Order with the Nevada Department of Environmental Protection. In this agreement a survey of the NTS was conducted whereby locations containing potential hazardous waste conditions were identified and cataloged as Corrective Action Sites (CAS). Sites identified in the locale of the proposed Kistler project have already been remediated under the terms of the agreement. In addition, the NTSDC and Kistler have contracted Raytheon Environmental Services to perform an Environmental Condition Survey to define the baseline environmental condition of the launch and landing sites. This survey will document the condition of the launch and landing locations prior to the commencement of construction activities.

Compliance with Air Quality Standards. The applicable NAAQS and Nevada State Ambient Air Quality Standards are presented in Table 3-2.

Table 3-2. Ambient Air Quality Standards

		Nevada Standards[a]	National Standards[b]	
Pollutant	**Average Time**	**Concentration**	**Primary[c,d]**	**Secondary[c,e]**
Ozone	1 hour	235 micrograms per cubic meter (0.12 parts per million) [g]	235 µ/m^3 (0.12 ppm)	Same as primary
Ozone-Lake Tahoe Basin, #90	1 hour	195 µ/m^3 (0.10 ppm)	None	None
Carbon monoxide Less than 5,000 ft > MSL At or greater than 5,000 ft Greater than mean sea level at any elevation	 8 hours 1 hour	10,000 µ/m^3 (9.0 ppm) 6,870 µ/m^3 (6.0 ppm) 40,000 µ/m^3 (35 ppm)	 10 µ/m^3 (9.0 ppm) 40 µ/m^3 (35 ppm)	Same as primary
Nitrogen dioxide	Annual Arithmetic mean	100 µ/m^3 (0.05 ppm)	100 µ/m^3 (0.05 ppm)	Same as primary
Sulfur dioxide	Annual Arithmetic mean	80 µ/m^3 (0.03 ppm)	80 µ/m^3 (0.03 ppm)	Same as primary
	24 hours	365 µ/m^3 (0.14 ppm)	365 µ/m^3 (0.14 ppm)	1,300 µg/m^3 (0.50)
	3 hours	1,300 µ/m^3 (0.5 ppm)	None	Same as primary
Particulate matter as PM_{10}	Annual (geometric) arithmetic mean	(75) 50 µ/m^3	(75) 50 µ/m^3	Same as primary
	24 hours	150 µ/m^3	(260) 150 µ/m^3	Same as primary
Particulate matter as $PM_{2.5}$	1 year		15 µ/m^3	Same as primary
	24 hours		65 µ/m^3	Same as primary
Lead (Pb)	Quarterly arithmetic mean	1.5 µ/m^3	1.5 µ/m^3	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 (HS) [i]	1 hour	112 µ/m^3 (0.08 ppm)	There is no national standard for HS	There is no national standard for HS

[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 adequ ate 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 1215/77; 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

The country is divided into air quality control regions, which because of common meteorological, industrial or socioeconomic factors, are single units for air pollution. The NTS is located in the Nevada Intrastate Air Quality Control Region 147. This area has been designated as attainment for all consideration of NAAQS (40 CFR Part 81.329). The nearest nonattainment area is the Las Vegas Hydrographic Area 212, located 105 kilometers (65 miles) southeast of the NTS in Clark County, which is classified as moderate nonattainment for carbon monoxide and serious nonattainment for PM_{10}. The remaining portion of Clark County is designated as unclassifiable/attainment for these pollutants (40 CFR 81.329).

Ambient air quality at the NTS is currently monitored only for radionuclides. However, there are no radiological monitors located specifically in Area 18 or the region of Area 19 being examined for Kistler use. There were some limited ambient air quality measurements of criteria pollutants taken in 1990 at the NTS as listed in Table 3-3. The nearest significant source of pollutants is the Las Vegas area. Based on the data collected during this study, the NTS is well within applicable national and state ambient air quality standards (Engineering Science, 1990).

Table 3-3. Ambient Air Quality Data for the NTS 1990

Monitoring Station	Time Period	Ambient Concentration ($\mu g/m^3$)				
		Sulfur Dioxide		Carbon Monoxide		PM_{10}
		Max. 24-Hour	Max. 3-Hour	Max. 8-Hour	Max. 1-Hour	Max. 24-Hour
Area 23	8/15/90 to 9/15/90	39.3	65.4	1,374	1,374	78.3
Area 6	8/15/90 to 9/15/90	0	0	1,145	1,947	20.2
Area 12	8/15/90 to 9/15/90	15.7	52.4	2,290	2,748	45.4

(Engineering Science, 1990)

The criteria air pollutants emitted at the NTS include particulates from construction, aggregate production, and surface disturbances; 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. The source emission inventory for 1993 for particulate matter was nine kilograms per hour (kg/h) (20 pounds per hour (lb/h)) and for sulfur dioxide was six kg/h (14.4 lb/h) (NDCNR, 1988a,b, c, 1989a,b, 1990).

Compliance with Prevention of Significant Deterioration. PSD is a regulation incorporated in the CAA that limits increases of pollutants in clean air areas to certain increments even though ambient air quality standards are being met. The CAA area classification scheme for PSD establishes three classes of geographic areas and applies increments of different stringency to each class. Class I areas include parks and wilderness areas, Class II areas are for attainment or unclassified area, and Class III areas are for nonattainment areas. Air quality impacts, in combination with other PSD permitted sources in the area, must not exceed the maximum allowable incremental increases in Table 3-4.

Entities planning construction or modification of a facility that is in an attainment area may be subject to PSD regulations if classified as a "major" source or "major" modification. A new source is major if it is one of 28 specifically designated industrial categories and has the potential to emit more than 100 tons per year of a regulated pollutant. If the new source is not one of these categories, the amount for a major source is 250 tons per year of a regulated pollutant. 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 obtain a PSD permit from the state where the facility is located prior to either building a new facility or introducing modifications (40 CFR 52.21). As discussed in Chapter 5.1.3, Air Resources, the proposed Kistler project will emit a maximum PM_{10} of 88 tons during construction. This is considerably below the 250 tons per year for a new source operating in an attainment area. The NTS has no sources subject to PSD requirements.

Table 3-4. Maximum Allowable Pollutant Concentration Increases Under PSD Regulations

Pollutant	Averaging Time	Maximum Allowable Increment (micrograms per cubic meter)		
		Class I	Class II	Class III
PM_{10}	Annual	4.0	17.0	34.0
	24 hours	8.0	30.0	60.0
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

(40 CFR 52.21, 1995)

The nearest PSD Class I areas to the NTS are the Grand Canyon National Park, 208 kilometers (130 miles) to the southeast, and the Sequoia National Park, 169 kilometers (105 miles) to the southwest (DOE, 1996).

Compliance with National Emission Standards for Hazardous Air Pollutants (NESHAPs)

Emissions of hazardous air pollutants from current NTS sources are below regulatory requirements (DOE, 1996). The DOE maintains an extensive network of air sampling stations for radiological parameters. The data for 1993, based on a computer model of the radiation dose to the maximum exposed individual in Indian Springs, was estimated to be 0.004 millirem (mrem), which is well below the EPA standard of 10 mrem per year (DOE, 1994b).

A more detailed description of the air quality in the NTS can be found in Section 4.1.7. (p 4-143) in Volume 1 of the NTS EIS.

3.5. Noise

Definition of Resource

Noise is often defined as unwanted or annoying sound that is typically associated with human activity. Most sound is not a single frequency, but rather a mixture of frequencies, with each frequency differing in sound level. The intensities of each frequency combine to generate sound, which is usually measured and expressed in decibels (dB). Decibels are measured on a logarithmic scale, which means that an increase of one decibel represents a tenfold increase in sound energy and an increase of two decibels represents a one hundredfold increase in sound energy. Environmental noise associated with industrial and transportation activities is most commonly measured on a scale designated as A-weighted (dBA), which de-emphasizes low and extremely high frequency sounds to which the human ear is less sensitive and which has been shown to correlate well with the perceived relative intensity (i.e., loudness) of sound. Although a change of 10 dBA in a measured sound level represents a tenfold increase in sound energy, such a change is generally perceived by humans as representing only a doubling in loudness. Examples of A-weighted noise levels for various common noise sources are shown in Table 3-5.

Table 3-5. Comparative A-Weighted Sound Levels

Noise Level (dBA)	**Common Noise Levels**	
	Indoor	**Outdoor**
100 - 110	Rock band inside New York subway	Jet flyover at 304 meters
90 - 100	Food blender at one meter	Gas lawnmower at one meter
80 - 90	Garbage disposal at one meter	Diesel truck at 15 meters Noisy urban daytime
70 - 80	Shouting at one meter Vacuum cleaner at three meters	Gas lawnmower at 30 meters
60 - 70	Normal speech at one meter	Commercial area heavy traffic at 100 meters
50 - 60	Large business office Dishwasher next room	
40 - 50	Small theater (background) Large conference room (background)	Quiet urban nighttime
30 - 40	Library (background)	Quiet suburban nighttime
20 - 30	Bedroom at night	Quiet rural nighttime
10 - 20	Broadcast and recording studio (background)	
0 – 10	Threshold of hearing	

(Modified from U.S. Department of Transportation, 1980)

To describe the time-varying character of environmental noise, sound levels are frequently characterized in terms of the equivalent noise level (L_{eq}), which is the energy mean A-weighted sound level during a stated measurement period. An additional measurement technique frequently used in noise studies is the Day-Night Average Noise Level (L_{dn}), which accounts for the increased annoyance associated with nighttime noise events.

Existing Conditions

The primary existing 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. At the NTS boundary, away from most facilities, noise from most sources is barely distinguishable above background noise levels. Background noise levels may include sound from wind, rain, and wildlife.

Persons and various biological resources that may be subject to stress and/or interference from noise are referred to as noise sensitive receptors. They may include residential communities and transient lodging (hotels and motels), hospitals, special care facilities, public or private educational facilities, libraries, parks, wildlife refuges, and wilderness areas. The only noise sensitive receptors in the area of the proposed Kistler facility would be located in wilderness areas (e.g., Desert National Wildlife Refuge).

The acoustical environment in areas adjacent to Area 18 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 infrequent aircraft traffic. Of these sources, wind is the predominant noise. 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 (DOE, 1996). The background sound level is estimated to be 30 dBA in Area 18 (Brattstrom and Bondello, 1983).

The day-night average sound level in rural communities has been estimated in the range of 35 to 50 dBA. Except for the prohibition of nuisance noise, neither the state of Nevada nor local governments have established specific numerical environmental noise standards.

3.6. Socioeconomic Review

Definition of Resource

Pertinent characteristics of the social and economic environment in the geographical area containing both the NTS in Nye County, Nevada and NTS-related activities in Clark County, Nevada are usually considered socioeconomic factors under NEPA. The major relevant characteristics addressed in this EA include impacts to employment and population.

Region of Influence. An analysis of the potential socioeconomic impacts of the NTS activities requires establishment of a "region of influence" (ROI). This is the geographical area within which the principal direct and secondary socioeconomic effects of a proposed action will be experienced. These effects can be measured on three geographical levels: national, statewide, and county.

The ROI for the proposed Kistler project is defined as Clark and Nye counties. Clark County is the principal county of the Las Vegas Metropolitan Statistical Area (MSA) (which also includes Nye County, Nevada and Mojave County, Arizona). Clark County encompasses the incorporated communities of Las Vegas, Boulder City, Henderson, Mesquite, and North Las Vegas. The U.S. Bureau of the Census defines an urbanized place as one where there are 2,500 persons or more in an incorporated community or Census Designated Place (CDP). Thus defined, Clark County's population is almost 98 percent urbanized. Nye County has a more rural (38 percent) population than Clark, but still has centers of population in Tonopah, Beatty, Amargosa Valley, and Pahrump.

Data were sought from a variety of sources, including the Nevada Statistical Abstract, the Regional Economic Information System Database of the Bureau of Economic Analysis, and the U.S. Department of Commerce Bureau of the Census (NSA 1990, BEA 1990, U.S. DOC, Bureau of the Census).

Socioeconomic and Environmental Justice Baseline

Nevada Test Site Federal and Contract Employment. The average annual employment at the NTS has shown significant declines during the last five years. During 1990, the employment at the NTS was 9,152, with a total of 5,102 in Nye County and 4,050 in Clark County. From 1990 to 1996, the employment level declined to 4,868 employees, a decrease of 46.8 percent. Within Nye County by 1996 the employment had decreased to 1,403, a 72.5 percent decline. Within Clark County, from 1990 to 1996, NTS-associated employment decreased to 3,465, a 14.4 percent decline. The decrease in employment is attributed to the moratorium on nuclear testing and has primarily affected the craft workers (at the NTS) and employees assigned from the National Laboratories to the NTS.

The employment distribution between on-site and off-site (i.e., at DOE's Las Vegas office) also changed. The percent distribution of on-site and off-site employment in 1990 was 55.7 percent and 44.3 percent, respectively. In 1996, the distribution changed to 28.8 percent (on-site) and 71.2

percent (off-site). Table 3-6 provides a historical view of the change in average annual employment levels, at the NTS from 1990 to 1996.

Table 3-6. Nevada Test Site Employment and Wages FY1990-1996

	Employment[1]			Wages (in $000's)[2]		
Year	**Las Vegas**	**NTS**	**Total**	**Las Vegas**	**NTS**	**Total**
1990	4,050	5,102	9,152	$ 191,642	$ 241,422	$ 433,063
1991	3,937	4,960	8,897	$ 186,295	$ 234,702	$ 420,997
1992	3,891	4,903	8,794	$ 184,118	$ 232,005	$ 416,123
1993	3,349	3,488	6,837	$ 158,471	$ 165,049	$ 323,520
1994	3,260	2,975	6,235	$ 154,260	$ 140,774	$ 295,034
1995	3,151	2,393	5,544	$ 149,102	$ 113,234	$ 262,337
1996	3,465	1,403	4,868	$ 163,960	$ 66,389	$ 230,349

[1]Average annual employment data derived from the DOE/Nevada Operations Office 254 Report.
[2]The average annual wages are computed based on a 1994 average annual wage rate of $47,319 (DOE, 1996).

This decrease in NTS-related employment contrasts sharply with the general economic and employment picture of Southern Nevada since 1990. As of September 1990, the State of Nevada, Department of Employment, Training and Rehabilitation reported that in the Las Vegas MSA (which includes Clark and Nye Counties from Nevada and Mojave County in Arizona) non-agricultural employment stood at 421,300 persons. As of September 1996, the employment level had increased to over 605,000 persons, a 43 percent increase.

Also included in Table 3-6 are estimates of the wage and salary payments to the DOE/NV employees. These estimates are based on an estimated wage rate of $47,319 per employee (DOE, 1996) and assumes a relatively constant distribution of occupational skills since the salary estimates were made. As can be seen from Table 3-6 the wage and salary payments declined from 46.9 percent between 1990 and 1996. While the total wage disbursements at the NTS have fallen, this wage rate compares very favorably with the wages available in the ROI. In 1994, jobs in Clark County paid an average of $29,489. Jobs in Nye County paid an average of $34,423. The only occupation in the region that provided wages competitive with NTS in 1994 was mining, which in Nye County paid an average of $49,758. (REIS, 1994)

Whereas Clark County has significantly more NTS-related employees than Nye County (3,151 and 2,393 in 1995, respectively), these employees constitute a much smaller proportion of Clark County's employment. Given the employment of Clark County and Mojave County as 551,620 (the Las Vegas MSA less Nye County) and Nye County as 10,750 (Nevada Statistical Abstract, 1996), NTS employees constitute only 0.6 percent of Clark and Mojave Counties' employment, as compared to 22.3 percent of Nye County's employment by place of work. Thus, the loss of these employees in Nye County would have a more substantial economic effect than in Clark County when estimating this effect by place of work. This effect is attenuated when the place of residence of the employees is considered. Place of residence has a strong influence on where income is spent. From this perspective, very few NTS employees reside in Nye County (i.e., less than 10 percent of the NTS work force)

(DOE, 1996), therefore the economic effects of these employees might be expected to be felt more strongly in Clark and Mojave Counties.

Population. The NTS-related population decline stands in contrast to the population trends of the State of Nevada. The NTS-related population declined from 24,893 to 13,240 between 1990 and 1996 (Table 3-7).

Table 3-7. NTS-Related Population within the Las Vegas MSA 1990-1996

Year	Population
1990	24,893
1991	24,200
1992	23,920
1993	18,597
1994	16,959
1995	15,080
1996	13,240

Note: Population estimates are derived from average annual employment levels times 2.72 persons per household (DOE, 1994).

Between 1980 and 1990 Nevada was one of the fastest growing states in the nation, outpacing the national average of 0.97 percent growth per year with an annual growth rate of 5.0 percent (Table 3-8). This growth continued through 1995, as Nevada grew from 1,236,130 persons in 1990 to 1,582,290 in 1995. This constitutes a net five-year gain of 346,260 persons, or 30 percent (Table 3-8).

Table 3-8. Population of the United States, State of Nevada, Clark, and Nye Counties

					Average Annual Growth Rate		
Area	**1970**	**1980**	**1990**	**1995**	**1970-80**	**1980-90**	**1990-95**
Unites States	205,052,000	227,726,000	249,913,000	263,034,000	1.11%	0.97%	1.05%
State of Nevada	488,738	800,493	1,201,833	1,582,390	6.38%	5.01%	6.33%
Clark County	273,288	463,087	741,459	1,036,290	6.95%	6.01%	7.95%
Nye County	5,599	9,048	17,781	23,050	6.16%	9.65%	5.93%

(U. S. Department of Commerce, Bureau of the Census.)

This population growth has primarily taken place in Clark County, which increased by 266,010 persons from 770,280 persons in 1990 to 1,036,290 in 1995, a 34.5 percent increase. Within Clark County, the City of Las Vegas had a total population of 268,330 in 1990, which increased 37.3 percent to 368,360 by 1995 (Table 3-9). Henderson, which is the second largest incorporated city in Clark County, had a 1990 population of 69,390 and increased to 115,490 by 1995, which represents an increase of 66.4 percent (Table 3-9).

The population of Nye County grew from 18,190 persons in 1990 to 23,050 in 1995. This was a moderate gain of 4,860 persons, but a large relative gain of almost 27 percent, which substantially exceeds the national growth rate.

Table 3-9. Population Estimates for the State of Nevada and Cities within Clark and Nye Counties

	1990	1991	1992	1993	1994	1995	Percent Change
State of Nevada	1,236,130	1,297,910	1,343,940	1,398,760	1,494,230	1,582,390	28.01
Clark County	770,280	820,840	856,350	898,020	971,680	1,036,290	34.53
Boulder City	12,760	12,960	13,000	13,350	13,640	14,090	10.42
Henderson	69,390	76,560	85,770	94,760	105,610	115,490	66.44
Las Vegas	268,330	289,690	303,140	323,300	346,350	368,360	37.28
Mesquite	1,960	2,070	2,370	3,270	3,850	5,120	161.22
North Las Vegas	50,030	51,060	55,400	60,880	69,700	77,820	55.55
Other Clark	402,470	432,340	459,680	495,560	539,150	580,880	44.33
Nye County	18,190	19,110	20,080	20,550	20,740	23,050	26.72
Gabbs	670	680	660	610	440	360	-46.27
Other Nye	17,520	18,430	19,420	19,940	20,300	22,690	29.51

(NV, 1996)

Environmental Justice Considerations. Minority populations represent approximately 25 percent (182,584 of 741,459) of the total population of Clark County and, approximately 12 percent (2,146 of 17,781) of the total population of Nye County. The percentage of the populations of both Clark and Nye Counties below the poverty line is 10.5 percent. The median household income of these counties is essentially the same (Clark County is $30,746 and Nye County is $30,211). Table 3-10 provides a breakdown of the ethnic and racial populations of these counties.

Table 3.10. Distribution of Ethnic and Racial Populations in Clark and Nye Counties

Ethnic/Racial Group	Percentage of the Total Population	
	Clark County	Nye County
Native American	2.3	7.0
Asian/Pacific Islander	0.6	2.8
Black	0.3	1.6
Other Race	1.8	2.5
White	95.0	92.2
Hispanic	5.3	7.0

(U.S. Census, 1990)

Note: Percentages are not exclusive by category, and thus add up to more than 100 percent.

3.7. Visual Resources

Definition of Visual Resources

Visual resources are defined as the natural and man-made features that constitute the aesthetic qualities of an area. Landforms, surface water, vegetation and man-made features are the fundamental characteristics of an area that define the visual environment and form the overall impression that an observer receives of an area.

The importance of visual resources and any changes in the visual character of an area is influenced by social considerations, including the public value placed on the area, public awareness of the area, and community concern for the visual resources in the area.

The visual resources of an area and any proposed changes to these resources can be evaluated in terms of "visual dominance" and "visual sensitivity." Visual dominance describes the level of noticeability that occurs as the result of a visual change in an area. The levels of visual dominance vary from "not noticeable" to a significant change that demands attention and cannot be disregarded. Visual sensitivity depends on the setting of an area. Areas such as coastlines, national parks, and recreation or wilderness areas are usually considered to have high visual sensitivity. Heavily industrialized urban areas tend to be the areas of the lowest visual sensitivity. The NTS EIS includes a discussion on three categories of scenic quality classes. *Class A*, high visual sensitivity, includes areas that combine the most outstanding characteristics of each physical feature category. *Class B*, moderate sensitivity, includes areas in which there is a combination of some outstanding characteristics and some that are fairly common. *Class C*, low visual sensitivity, includes areas in which the characteristics are common to the region. Another consideration in evaluating the visual impact of a proposed action is the ability of the general public to view the area where the proposed action or change to the visual resource will occur.

Existing Visual Resource Conditions

The NTS EIS states that the NTS is located in a transition area between the Mojave Desert and the Great Basin. The general topography of the NTS areas is that of north-south mountain ranges separated by broad valleys. The area of interest for the proposed Kistler project can be categorized as a *Class B* area. The payload processing facility and launch site are located at an elevation of 1,750 meters (5,741 feet) and the landing and recovery area at approximately 1,700 meters (5,577 feet). The vegetation around the launch site consists of juniper, sagebrush, and pinyon pine on the steeper slopes of the nearby hills. The landing and recovery area is relatively flat with a predominate ground cover consisting of sparse grasses, cactus, and some sagebrush. The primary large-scale feature near the proposed Kistler project area is the Timber Mountain Caldera, a very large depression caused by the collapse of a prehistoric volcano. Because of the large size of the caldera, it is not generally discernible except from the air. Because of the distance of the proposed Kistler site from a public road, it would not be possible for the public to view the site.

3.8. Biological Resources

The NTS is located along the transition zone between the Mojave Desert and Great Basin (Beatley, 1975, 1976). As a result, the NTS 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 (DOE, 1996). The proposed Kistler operations would be located entirely within the Great Basin zone and the flora and fauna are typical for similar habitats in the region.

On April 9 and May 7, 1997, biological surveys were conducted on areas including a portion of the proposed vehicle processing facility, payload processing facility, launch site, and landing and recovery area (Bechtel Nevada, 1997). The following site-specific discussion is based primarily on the results of that survey.

Vegetation

The payload processing facility and launch site would be located on the southern slopes of Pahute Mesa south of Rattlesnake Ridge and north of Stockade Wash. The terrain slopes to the southwest and the elevation ranges from 1,744 to 1,755 meters (5,760 to 5,820 feet). The payload processing facility would be located at the former Pahute Control Point. Although it was disturbed by the presence of the Pahute Control Point, since demolition of that facility much of the area has revegetated with species native to the area. The visually dominant vegetation in the area of the payload processing facility and launch site is singleleaf pinyon pine (*Pinus monophylla),* Utah juniper (*Juniperus osteosperma*), and big sagebrush (*Artemesia tridentata*). The plants observed in this area are listed in Table 3-11.

There are no listed threatened or endangered species of plants known to exist in the area of the payload processing facility and launch site. Two plant species of concern (formerly categorized as Category 2 by the U.S. Fish and Wildlife Service), sanicle biscuitroot (*Cymopteris ripleyi* var.

saniculoides) and Pahute beardtongue (*Penstemon pahutensis*), are known to occur within a three-kilometer (two-mile) radius of the payload processing facility and launch site. During the biological survey of the area, sanicle biscuitroot was found within the project area in sandy dry stream bed areas north of the knoll on which the launch site would be located. Pahute beardtongue was not found in the project area. In addition to these two plant species, two species of cactus protected by the State of Nevada, staghorn cholla (*Opuntia echinocarpa*) and grizzlybear prickleypear (*Opuntia erinacea*), are known to occur in the area of the proposed payload processing facility and launch site.

The landing and recovery area would be located on a piedmont slope about 11 kilometers (seven miles) west of the launch site just north of Buckboard Mesa and Scrugham Peak. The terrain is undulating and slopes to the south-southwest at about 1.5 degrees and the elevation ranges from about 1,658 to 1,694 meters (5,440 to 5,560 feet). This area is largely undisturbed, however, a few unimproved vehicle trails cross the site. The dominant vegetation at the proposed recovery area is budsage (*Artemesia spinescens*), green rabbitbrush (*Chrysothamnus viscidiflorus*), and Nevada ephedra (*Ephedra nevadensis*). All of the species observed in the proposed landing and recovery area are listed in Table 3-12.

Table 3-11. Plant Species Observed at the Proposed Kistler Launch Site

TREES/SHRUBS

Artemesia tridentata (big sagebrush)
Atriplex canescens (fourwing saltbush)
Chrysothamnus nauseosus (green rabbitbrush)
Chrysothamnus viscidiflorus (rubber rabbitbrush)
Ephedra viridis (Mormon tea)
Eriogonum microthecum (Cooper's goldenweed)
Juniperus osteosperma (Utah juniper)
Pinus monophylla (singleleaf pinyon pine)
Psorothamnus polydenius (Nevada smokebush)
Purshia tridentata (antelope bitterbrush)
Quercus gambeli (Gambel's oak)

FORBS

Adenophyllum acaulis
Amsinkia tessellata
Artemesia ludoviciana
Astragalus lentiginosus
Calochortus flexulosa
Castellija applegatei
Chaenactis xantiana
Chamaesyce albomarginata
Chenopodium album
Cryptantha flavoculata
Cryptantha nevadensis
Cryptantha pterocarya
Eriogonum ovalifolium

FORBS (continued)

Gilia brecciarum
Heliomeris multiflorus
Linanastrum nuttallii
Lupinus argenteus
Lupinus brevicaulis
Machareranthera canescens
Metzelia veatchiana
Nama aretioides
Oenothera caespitosa
Paceilia fremontii
Phlox stanburiana
Sisymbrium altissimum
Sphaeralcea ambigua
Streptanthus caudatus
Trifolium andersonii

GRASSES

Achnatherum hymenoides
Achnatherum speciosa
Bromus tectorum
Hesperostipa comata
Leymus cinereus

CACTI

Opuntia echinocarpa
Opuntia erinacea

(Bechtel, 1997a)

Table 3-12. Plant Species Observed at the Proposed Kistler Landing and Recovery Area

SHRUBS

Artemesia spinescens (budsage)
Artemesia tridentata (big sagebrush)
Chrysothamnus viscidiflorus (green rabbitbrush)
Ephedra nevadensis (Nevada ephedra)
Grayia spinescens (spiny hopsage)

CACTI

Opuntia echinocarpa (staghorn cholla)
Opuntia erinacea (grizzlybear prickleypear)
Yucca baccata (banana yucca)

FORBS

Amsinkia tessellata
Calochortus flexuosus
Chaenactis stevioides
Chorizantha thurberi
Cryptantha micrantha
Cymopterus purpurascens
Pectocarya playcarpa
Phlox stansburiana
Sphaeralcea ambigua
Syntricocarpus fremontii

GRASSES

Achnatherum hymenoides
Pleuraphis jamesii

(Bechtel, 1997b)

A number of plant species on the NTS are currently listed as species of concern by the U.S. Fish and Wildlife Service. However, there are no plants listed as threatened or endangered or species of concern known to exist in the proposed landing and recovery area. Three species that are protected by the State of Nevada do occur in this area, staghorn cholla, grizzlybear prickleypear, and banana yucca (*Yucca baccata*).

The CGTO has compiled a list of 364 American Indian traditional use plants present on the NTS (DOE 1996: Volume 1, Appendix G, Attachment A). Of the 46 plants listed in Table 3-11 as observed at the proposed launch site, at least 20 (43%) have been identified as Indian traditional use plants. Approximately 14 (70%) of the 20 plants listed in Table 3-12 as observed at the proposed landing and recovery area have been identified as Indian traditional use plants.

Wildlife

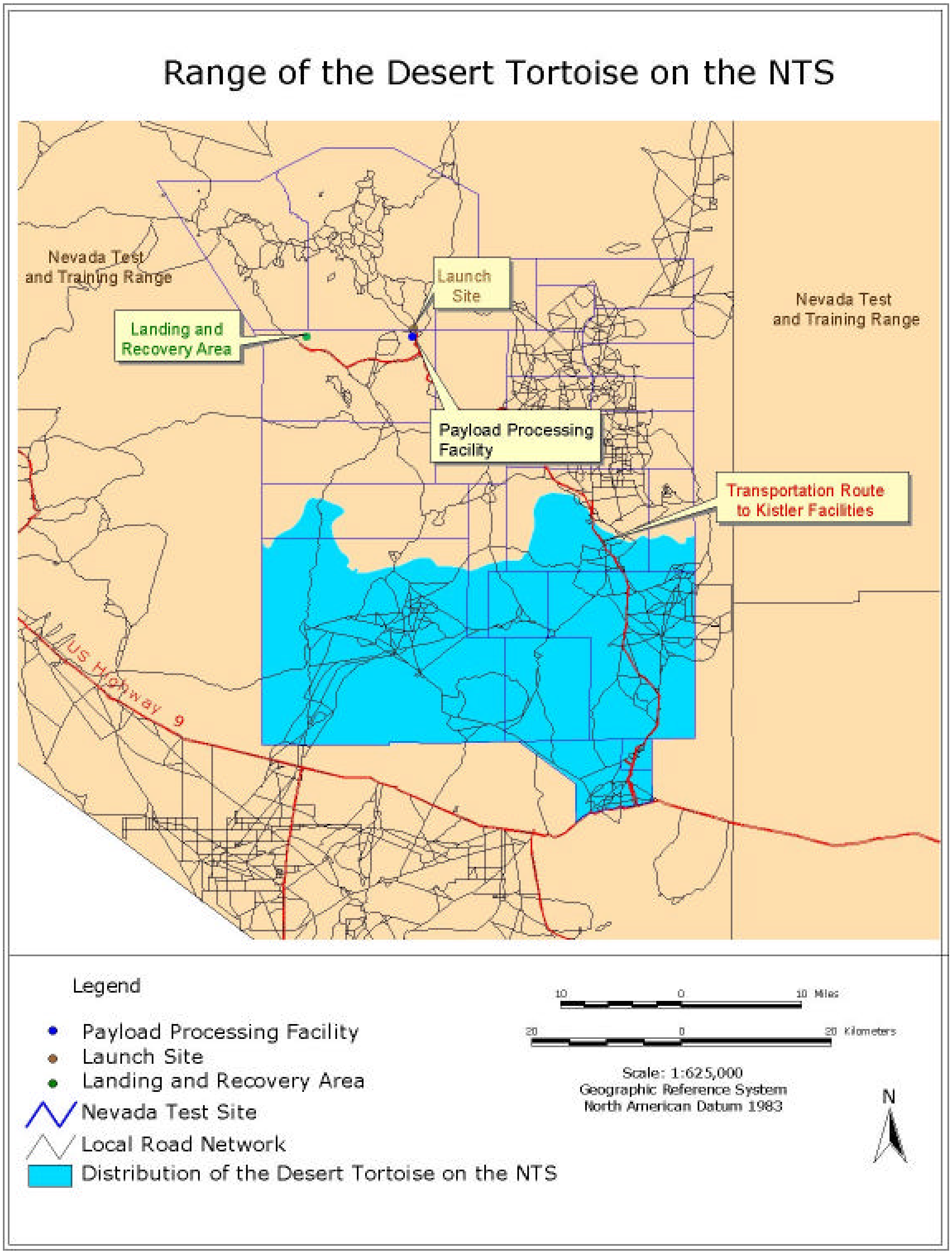
Although the proposed payload processing facility and launch site area provide different habitats and support different plant communities than the proposed landing and recovery area, similar mammals and bird species use both areas. It is known that feral horses (*Equus caballus*) inhabit the proposed project area and utilize water in the pond located near the proposed payload processing facility (EG&G/EM, 1995). It is also likely that mule deer (*Odocoileus hemionus*) occur in the area and use the pond. Mountain lions (*Felis concolor*) may use caves located at the base of the western end of the knoll as resting sites, which is where the launch site would be located (Bechtel Nevada, 1997). Wildlife typical of the region includes coyote (*Canis latrans*), bobcat (*Felis rufus*), common raven (*Corvus corax*), golden eagle (*Aquila chrysaetos*), red-tailed hawk (*Buteo jamaicensis*), chuckar (*Alectoris chukar*), desert cottontail (*Sylvilagus audobonii*), and black-tailed jackrabbit (*Lepus californicus*). Other species that may inhabit the area are listed in the NTS EIS.

The only animal species listed as threatened by the U.S. Fish and Wildlife Service that normally inhabits the NTS is the Mojave Desert population of the desert tortoise (DOE, 1996). Figure 3-7 depicts the range of the desert tortoise on the NTS. Desert tortoises are found in Mojave Desert plant communities in the southern half of the NTS. Their abundance is low to very low at the NTS relative to other areas within the range of the species (EG&G/EM, 1991; U.S. Fish and Wildlife Service, 1992; Rautenstrauch et al., 1994). There are no desert tortoises in Areas 18 and 19 of the NTS, where the Kistler facilities are proposed. All vehicular traffic accesses the NTS from Highway 95, to the south. Thus, Kistler related traffic would transit the habitat of the desert tortoise. The northern boundary of the desert tortoise habitat is in Areas 29, 14, and 6, more than 16 kilometers (10 miles) south of the Kistler facilities.

In accordance with Section 7c of the Endangered Species Act and 50 CFR Part 402.12c and prior to conducting biological surveys of the proposed project area DOE/NV obtained a list of threatened, endangered, and candidate species, and species of concern that may occur in the project area from the U.S. Fish and Wildlife Service. Five Species of Concern, all bats, are known to use the area around the pond as a feeding area: spotted bat (*Euderma maculatum*), long-eared myotis (*Myotis evotis*), fringed myotis (*Myotis thysanodes*), long-legged myotis (*Myotis volans*), and pale Townsend's big-eared bat (*Plectotus townsendii pallescens*). The bald eagle (*Haliaeetus* *leucocephalus*) and American peregrine falcon (*Falco peregrinus anatum*) are rare migrants in the region and have been sighted at the NTS only once each (Castetter and Hill, 1979; Greger and Romney, 1994). Biological surveys of the project area conducted in April and May 1997 indicated that none of these species were present in the project area at the time of the survey. The CGTO has compiled a list of 170 traditional use animals present on the NTS (DOE 1996: Volume I, Appendix G, Attachment B).

A more detailed discussion of these biological resources may be found in Section 4.1.6, Affected Environments, Biological Resources of the NTS EIS.

Figure 3-7. GIS Map of the Range of the Desert Tortoise on the NTS



3.9 Water Resources

This section provides a brief summary of the surface water and groundwater of the NTS region with respect to the location of the proposed Kistler operations.

Surface Water

The NTS is within the Great Basin, a hydrographic basin in which no surface water leaves except by evaporation, and which includes much of Nevada (Figure 3-8). The Great Basin is part of the Basin and Range Physiographic Province (Stewart, 1980). The similarity of the physical environment throughout the region allows general discussion of the surface hydrology of the NTS and the Nevada Test and Training Range.

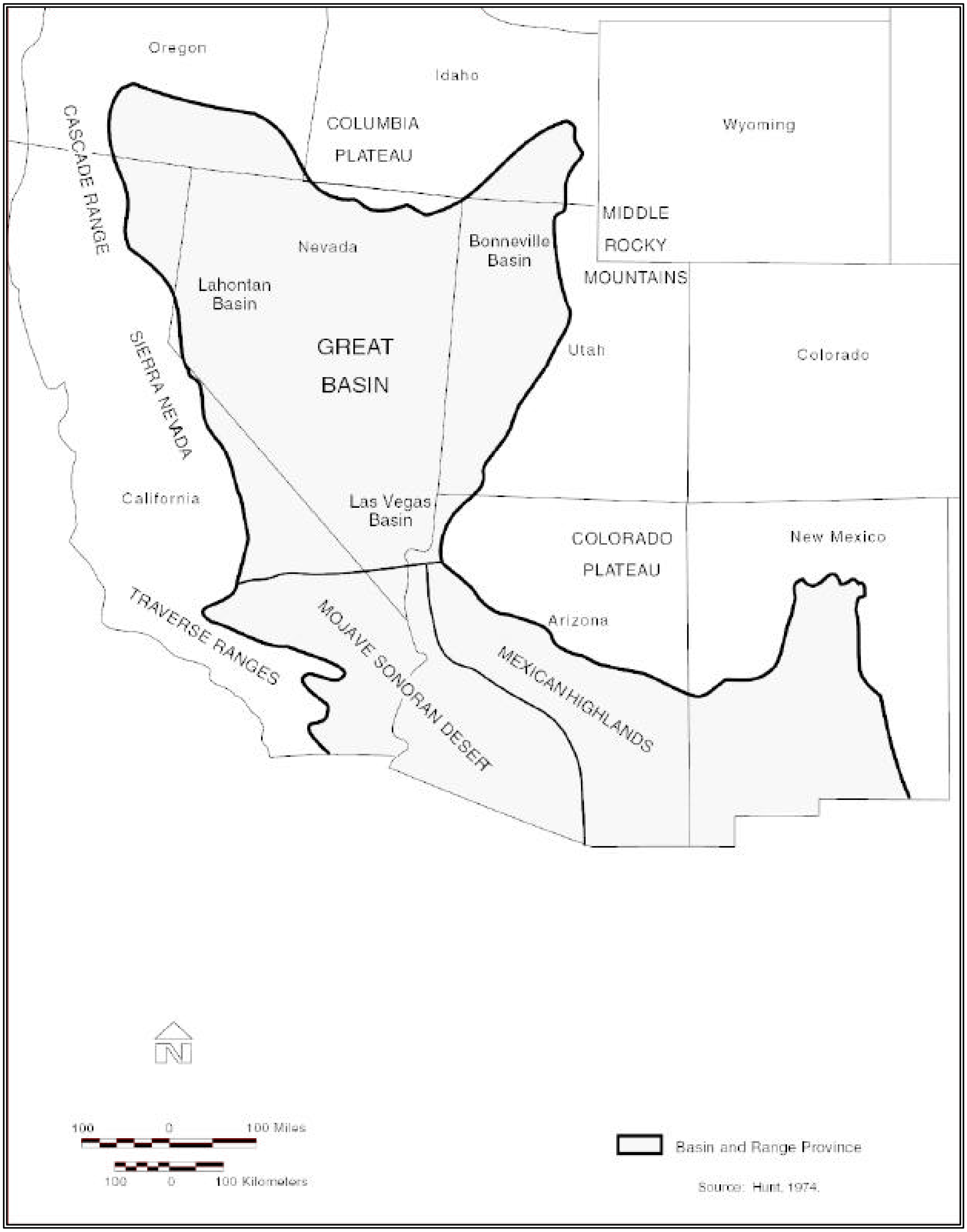
Hydrographic basins in the region have internal drainage controlled by topography. The proposed Kistler operations would be in the upper reaches of the Fortymile Canyon hydrographic basin. Streams in the region are ephemeral. Runoff results from snowmelt and from precipitation during storms that occur 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 the detrital deposits of a stream in water carved gullies, and some drains into flat areas where it may stand for weeks as a temporary lake (DOE, 1986).

The western half and southernmost portions of the NTS have arroyos that carry runoff beyond the NTS boundaries during intense storms. Fortymile Canyon, the largest of these arroyos, originates on Pahute Mesa and intersects the Amargosa arroyo in the Amargosa Desert about 32 kilometers (20 miles) southwest of the NTS. The Amargosa arroyo continues to Death Valley, California (ERDA, 1977).

Throughout the region, springs and manmade impoundments are the only sources of perennial surface water (DOE, 1996). There are no known springs within the proposed Kistler facilities location.

The only perennial surface water in the vicinity of the Kistler range is a small (less than one acre) manmade pond. The source of water for the pond is Well 8, located about two kilometers (1.2 miles) west of the proposed launch site. The water from the pond is used to supply a fill stand located next to the pond. As water is withdrawn, a float valve automatically operates to return the water level in the pond to a designated level. This pond also provides a source of water to area wildlife, including wild horses, deer, and smaller mammals, birds, and reptiles (Bechtel Nevada, 1997).

Figure 3-8. Graphic of the Basin and Range Physiographic Province



Groundwater

The NTS is located within the Death Valley groundwater flow system, which is composed of 30 individual hydrographic basins (DOE, 1996). In the area of the proposed Kistler operations, groundwater flows to the Alkali Flat-Furnace Creek discharge area. Activities at the payload processing facility and launch site would be supplied with water from Well 8. Well 8 is in the Buckboard Mesa hydrologic basin (227-b) (Scott et al., 1971).

Historically, water from Well 8 was used for CP-18 and other NTS purposes. Presently, Well 8 serves construction, fire protection and potable water uses at Area 2 support facilities and at the Area 12 camp, which is currently uninhabited.

Well 8 water is typical of the volcanic aquifer it taps. The quality of water is very high, meeting the Drinking Water Standards of the EPA. In 1993, selected water quality parameters for water from Well 8 were: pH 8.28, total dissolved solids 149 milligram per liter (mg/l), sulfate 14 mg/l, nitrate 1.3 mg/l, fluoride 0.81 mg/l, and chloride 7 mg/l. Well 8 is 1,673 meters (5,490 feet) deep and the average static water level in 1993 was 327.05 meters (1,073 feet) (DOE, 1996).

Well 8, operating at maximum installed pumping capacity, could produce no more than one million cubic meters per year (m^3/yr) (278 million gallons per year (gal/yr)). Historical water use from Well 8 reached a high of 424,000 m^3/yr (112 million gal/yr) in 1964. In 1995, use was about 68,000 m^3/yr (18 million gal/yr). Average use from 1963 to 1995, with a 15 year gap in record, was 185,000 m^3/yr (49 million gal/yr). There appears to be at least 117,000 m^3/yr (31 million gal/yr) of excess capacity from the well on a sustained, multi-year basis, and almost 356,000 m^3/yr (94 million gal/yr) on an annual basis. According to State of Nevada Water Planning Report 3, basin 227-b has an estimated total perennial yield of 4.4 million m^3/yr (3,600 acre-feet per year) (Scott et al., 1971).

A more detailed discussion of these water resources may be found in Section 4.1.5, Affected Environments, Hydrology of the NTS EIS.

3.10 Geology and Soils

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 3-8). The Basin and Range Province is characterized by regularly spaced, generally north-south trending mountain ranges separated by alluvial basins that were formed by faulting. In the northwestern portion of the NTS, where the proposed Kistler operations would be located, the physiography is dominated by the volcanic highlands of Pahute and Rainier Mesas (DOE, 1996).

The geology of the NTS consists of a thick section (more than 10,597 meters (34,768 feet)) of Paleozoic and older sedimentary rocks, locally intrusive Cretaceous granite 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). The proposed payload processing facility and launch site is underlain by Cenozoic volcanic rocks, consisting primarily of silicic ash-flow tuffs, air-fall tuffs, and tuffaceous sedimentary rocks. The landing/recovery area is underlain primarily by Quaternary alluvium. Pahute Mesa is part of the southwestern Nevada volcanic field which 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). The Timber Mountain Caldera is listed as a National Natural Landmark by the U. S. National Park Service.

The geologic environment of the NTS has been affected by the approximately 800 underground nuclear tests that were conducted there between 1957 and 1992. 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 (DOE, 1996). Surface subsidence, or cratering, disruption of the underground geologic media, and release of radioactivity into the underground environment have been the most significant impacts to the physical environment as a result of historic testing operations at the NTS (DOE, 1996). These direct effects of underground nuclear testing are generally relatively localized. Two crater tests, two surface tests, and one shaft test were conducted in Area 18 between March 1962 and December 1964. These yield tests resulted in some releases of radioactivity to the surface environment (DOE, 1995). Additional discussion of the proposed Kistler operations in relation to areas of radioactively contaminated soil resulting from these tests can be found in Section 4.

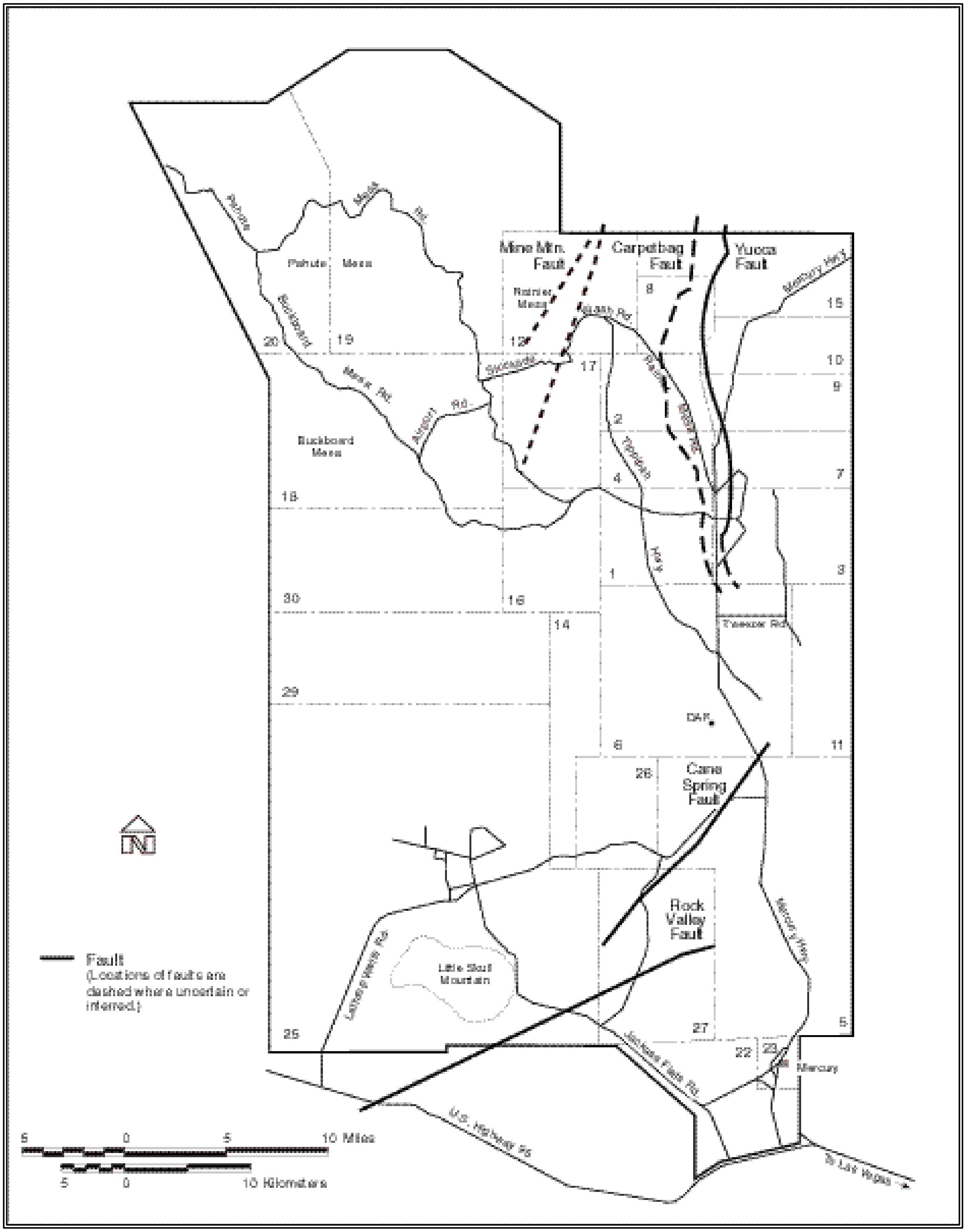
Many natural hazards could impact facilities at the NTS (Guzowski and Newman, 1993), although most can be discounted on the basis of being physically unreasonable. There are six natural hazards that could impact large areas: seismicity, volcanism, soil instability, slope instability, ground instability, and flooding.

Three major fault zones in the region may be currently active: Mine Mountain, Cane Spring, and Rock Valley. Of these, the Mine Mountain fault is the closest to the proposed Kistler facilities (Figure 3-9). The NTS is within Seismic Zone 2B, as defined in the Uniform Building Code (ICBO, 1991). Zone 2B is defined as an area with moderate damage potential.

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).

The four geotechnical hazards (i.e., flooding, soil instability, slope instability, and ground instability) are all site specific in nature and may be dealt with either by avoidance or proper engineering. The terrain on which each of the proposed Kistler facilities would be located is moderately sloping with well-defined natural drainage. For this reason, the potential for flooding in these areas is very low. However, the proposed landing site is within an alluvial plane where it will be necessary to adequately manage channelized flow of runoff water from upgradient areas. Kistler would design and site its facilities to prevent possible damage from any of these geotechnical hazards.

Figure 3-9. Graphic Depicting Faults for the NTS



Although the NTS has been closed to commercial mineral development since the 1940s (SAIC/DRI, 1991), important mineral commodities (e.g., gold, silver, copper, lead, zinc, tungsten, and uranium) have been extracted in the past and are known to exist in the NTS region (Myhrer, et al., 1990). The proposed Kistler operational sites are not in any of the known former mining districts in the region.

Soil survey work at the NTS has been limited mainly to investigations of specific geotechnical parameters associated with construction of various facilities. The payload processing facility and launch site are in an area with a combination of poorly sorted alluvial gravels and aeolian deposited sands and silt (Holz and Beck, 1997). Past activities at the payload processing facility locale have demonstrated that the soils are competent and can support similar levels of construction and development. Soils at the landing/recovery area range from moderately stable desert pavements to poorly sorted alluvial gravels and aeolian sands and silt (Holz and Drollinger, 1997).

Soil loss through wind and water erosion is a common occurrence throughout the NTS and surrounding areas (DOE, 1996). Portions of some watersheds probably exhibit higher erosion rates, but the erosion conditions and susceptibility of soils on the NTS have not been defined.

3.11 Cultural and Native American Resources

Prehistoric and Historic Cultural Resources. All areas of the NTS have the potential to contain archaeological sites that are considered significant. Current knowledge of cultural resources at the NTS is the result of over 20 years of surveys and data recovery. Approximately 4.68 percent of the NTS 16,387 hectares (40,491 acres) has been surveyed for cultural resources (DOE, 1996). These surveys have identified over 1,700 prehistoric and historic archaeological sites on the NTS. These sites range from those associated with the earliest prehistoric people in the New World to structures associated with the development of nuclear testing. Prehistoric sites include temporary camps, extractive localities, processing localities, localities, caches, and stations. A locality is a place where prehistoric people conducted various activities but where there is insufficient information available at the site to discern the activity represented (DOE, 1996). Processing and extractive activities that may have taken place include: resource procurement in quarries, water catchment basins, hunting blinds, and plant resource extraction and processing of stone tools, plants, and animals. Localities are characterized by relatively low artifact diversity. Historic sites include mining, ranching, transportation and communications sites, and sites related to nuclear testing and research.

The proposed Kistler operations would be located within the Buckboard Mesa area of the Fortymile Canyon hydrographic basin. Within the Buckboard Mesa hydrographic basin on the NTS, which includes part of Pahute Mesa, 51 archaeological reconnaissance surveys have been conducted on about 1,770 hectares (4,190 acres) (DOE, 1996). To date, 470 sites have been recorded in the Buckboard Mesa area, including 103 temporary camps, six extractive localities, 94 processing localities, 203 localities, five caches, one station, three 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 (National Register).

On March 12 and 13, 1997, a Class III Cultural Resources Reconnaissance was conducted on 23.8 hectares (58 acres) of land surrounding the area of the proposed payload processing facility (Holz, 1997). Six sites and four isolates were identified by that reconnaissance effort. The sites include four localities and two lithic artifact (i.e., stone) scatters. A lithic artifact scatter is a descriptive site type. A lithic artifact scatter may consist of stone tools and debris from a variety of site activities. The only behavior that may be inferred from the information available at the site is the use of stone as implements. An area of 13.2 hectares (32.16 acres) including the area of the proposed launch site was surveyed for cultural resources on April 22, 23, 24, and 29 and June 20, 23, 24, 25, and 26, 1997 (Holz and Beck, 1997). One large multicomponent site, labeled "26NY10133," was identified with both prehistoric and historic features. This site covers the entire surveyed area.

On July 28 through 31, 1997, a Class III Cultural Resources Reconnaissance was conducted on 417 hectares (1,029 acres) of land encompassing the proposed Kistler landing/recovery area (Holz and Drollinger, 1997). The survey located only one site, 26NY4892, a previously recorded site that has been the focus of two data recovery programs. Site 26NY4892 is a large obsidian toolstone source area, determined eligible for inclusion on the National Register under the criterion of 36 CFR 60.4 (i.e., potential to yield information important in prehistory). Pursuant to Section 106 of the National Historic Preservation Act and regulations of the Advisory Council on Historic Preservation (36 CFR 800.4), DOE consulted with the Nevada SHPO to determine the eligibility for inclusion on the National Register for each identified cultural resources site at the proposed payload processing facility and launch site. Using the criteria for evaluation at 36 CFR 60.4, it was determined that the six sites found at the payload processing facility were not eligible and that 26NY10133, at the launch site, is an historic property (i.e., eligible for inclusion on the National Register). Therefore, a total of two historic properties (26NY4892 and 26NY10133) were identified within the area of potential effect of the proposed Kistler Project.

Native American Cultural Resources. At the time of contact with the Euroamericans in the mid-1800s, the area being considered for the Kistler operations was occupied or used by the Southern Paiute, Western Shoshone (Steward, 1938), and Owens Valley Paiute (Stoffle and Evans, 1988)

Each of these groups has substantiated cultural and historic ties to the NTS and the surrounding areas and participates in the Consolidated Group of Tribes and Organizations (CGTO). The CGTO was established in 1987 and provides guidance to DOE by actively participating in 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 (DOE, 1996).

Numerous sites have been identified within the NTS boundaries that are important to Native American people. The lands were mutually shared by the aforementioned groups for religious ceremony, resource use, and social events (Stoffle et al., 1990). Although the Native American people have been removed from these lands for many years, they continue to value and recognize the central role of these lands in their continued survival (CGTO in DOE, 1996). Figure 3-10 depicts the region of Native American influence.

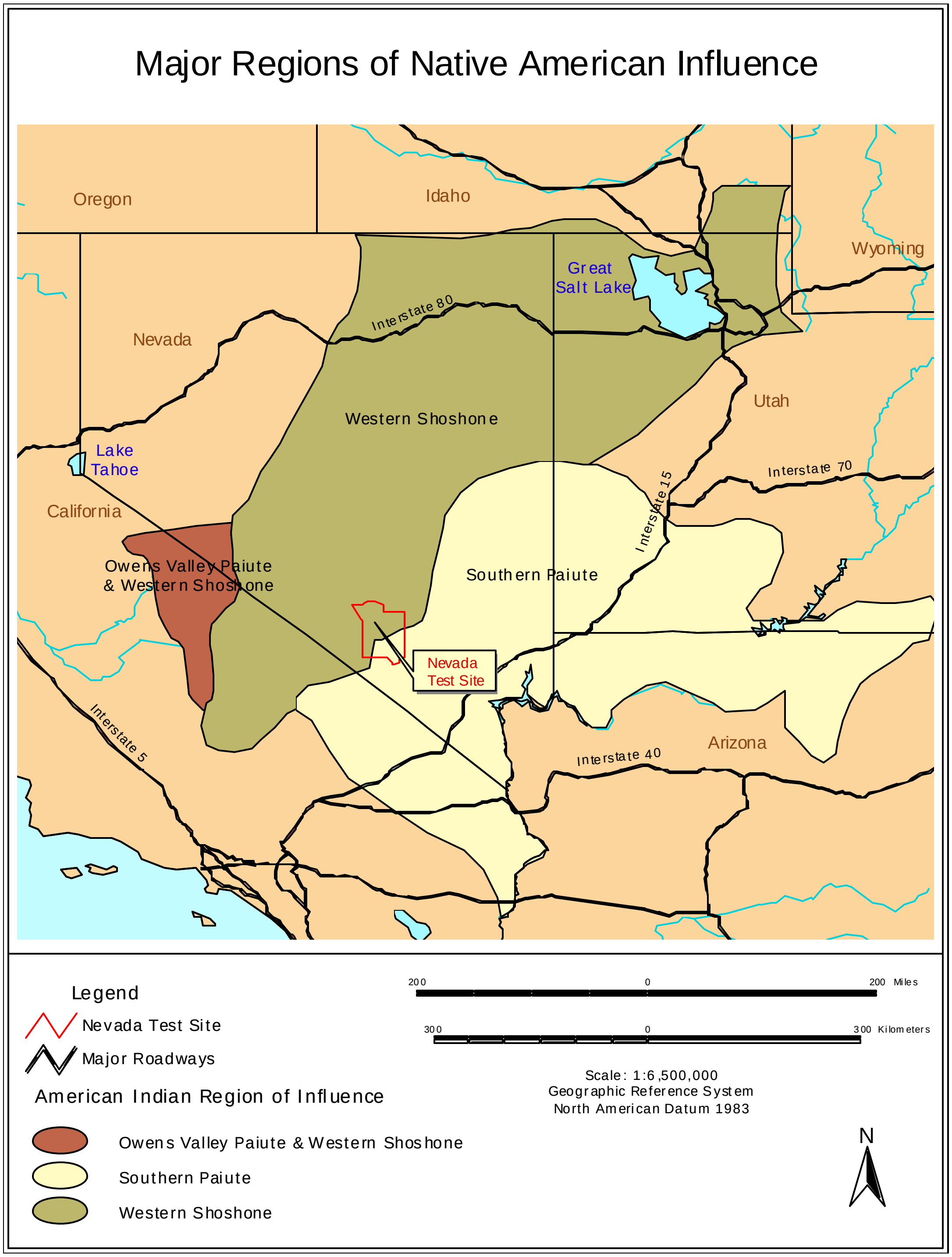


Figure 3-10. GIS Map Showing the Region of Native American Influence

In a Rapid Cultural Assessment (RCA) prepared for the Kistler project, the CGTO considered the proposed Kistler launch facility to include at least four locations, which are (1) *Paa'oatsa Hunuvi* (Water Bottle Canyon), a narrow canyon with a water bottle offering immediately to the north of the proposed construction area; (2) the "Place of Oaks" (26NY10133), an area where there are stands of oak trees directly within the proposed Kistler launch site; (3) Landmark Rock, a dominant large white rock and its surrounding area in proximity to but outside of the project area; and (4) West Canyon, a narrow canyon immediately to the north of the project area and the high ridge between it and Water Bottle Canyon to the east. Three of these areas are not within the proposed launch site construction area.

"Water Bottle Canyon" is situated to the north of the proposed Kistler launch site. After reviewing the entire area, CGTO representatives who conducted the RCA study opined that this narrow canyon with its water bottle offering deserved to be highlighted. The significant features at this site are:

- bow stave tree
- water bottle offering (Johnson et al. 1999:7, 112, 150)
- water fall - stone catchment
- tonal rock with offering holes (Johnson et al. 1999:7, 150)
- shovel and washtub hanging in tree (Johnson et al. 1999:113)
- stone circles - possible astronomical ceremony and teaching site (Johnson et al. 1999:109-111, 150)

According to the CGTO the "Place of Oaks," as this site came to be called during the American Indian RCA study, is within the area where the proposed Kistler launch facility would be constructed. The Place of Oaks is within what is officially identified as archaeology site number 26NY10133, and described by the Desert Research Institute (DRI) archaeologists as a large multi-component site consisting of both prehistoric and historic materials and occupying the complete project area (Holz and Beck 1997:8; Johnson et al. 1999:115). The Place of Oaks is, according to consensus among ethnographic and archaeological researchers-as well as CGTO representatives, the place called *Wungiakuda* by the Indian people interviewed by anthropologist Julian Steward in the mid-1930s (Johnson et al. 1999:8). The significant features observed at this site include:

- trade pottery fragment
- blue glass bead-interpreted as a possible burial offering (Johnson et al. 1999:7)
- oak tree grove
- numerous Numic pottery fragments and lithics

According to the CGTO, Landmark Rock is located across Pahute Mesa road from the southeastern corner of the proposed Kistler launch site. The major feature of this site is what is called on today's maps Landmark Rock; however, the site is perceived by the CGTO as extending across the road into the Kistler launch site area and to the east into the base of the steep ridge. The place contains the rock shelters where the Indian people were recorded by Steward as spending the winter. Steward spelled the name of the place as *Wungiakuda*, but did not provide a translation of the word (Steward

1938:94-95). He recorded the camping area as being near a large standing rock called *Tavondówåyo,* which was translated as "standing rock."

Landmark Rock is seen by the CGTO as being Standing Rock as it was discussed in the mid-1930s Indian interviews by Steward. One CGTO representative suggested the name given to Steward was *Wingkadzaigarre,* which means "standing or sitting in the open." The name implies that the rock was alive because it was sitting or standing rather than just being on the ground. Such large standing, boulder-type rocks are often seen as powerful people who have a responsibility for protecting places and Indian people. The significant features observed at this site are:

- *Wingkadzaigarre*--the white rock, Landmark Rock
- rock shelters with historic Indian structures inside
- plants
- arrow points

According to the CGTO, West Canyon is located approximately 0.25 miles to the north of the proposed Kistler launch site area. The canyon does not have a name on the U.S. Geological Survey maps and the Indian people did not assign it one. Jim Wilson's Camp is a name assigned by the DRI archaeologists to a historic period camp on the ridge between West Canyon and Water Bottle Canyon. Jim Wilson is a member of the Chemehuevi Indian tribe in California and was serving as an American Indian monitor at the time he discovered this site. This site contains a number of items from the turn of the century. The significant features observed at this site are:

- bow trees
- rock wall
- pine nut trees
- broken Dutch Oven, hematite-stained grinding stone fragments, and white button--evidence of possible funeral ceremony
- contemporary Indian stone house (*Tumpikani*)
- offering holes at natural pot hole waterfall

According to the CGTO, the Buckboard Mesa area contains a wide range of important cultural resources, including plants, animals, archaeological sites, minerals, and power places. Three ethnoarchaeological 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. 1994) and the second study included a visit to rock shelters containing obsidian nodules, artifacts, and Indian rock paintings. The third study included a comprehensive American Indian interpretive inventory of the rock art panels at Buckboard Mesa as part of a larger rock art study (Zedeno et al. 1999:35-46). The area was also visited as part of a Native American Graves Protection and Repatriation Act (NAGPRA) consultation to determine the disposition of seven obsidian projectile points under the provisions of NAGPRA (Stoffle, Halmo and Dufort 1994:76-82; Stoffle et al. 1996:66). To the north of Buckboard Mesa is an extensive area of obsidian nodules which are 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. The mesa is considered to be a power source where people obtained songs and conducted ceremonies, some of which concerned the making of arrow points and incorporated the use of arrow points in the ceremonies. A full cultural assessment of this place and its role in the Buckboard Mesa area awaits systematic American Indian traditional property studies. While some American Indian studies have been conducted in this area, only a few archaeological sites have been assessed. There have been no systematic studies of plants, animals, and traditional cultural properties. The culturally significant features of Buckboard Mesa include:

- the doctor rock, or power rock
- a quarry of obsidian toolstone nodules, used in ceremonies for arrowmaking and using arrows in other ceremonies
- extensive rock art panels
- several rockshelters with rock paintings on the walls
- vision quest cairns and grinding slabs on the top of the mesa
- the nearby Scrugham Peak, a sacred volcanic cone

Interviews conducted in 1935 and 1936 by Julian Steward describe the remembered uses and meanings of the place that corresponds to the area around the proposed Kistler launch site. In describing camp sites from the Belted Range to Beatty, Steward identified one just east of Ammonia Tanks at about 6,000 feet. Based upon this description and Steward's maps, the RCA team members, the University of Arizona ethnographers, and the DRI archaeologists believe the area of the Kistler site traditionally was called *Wungiakuda* (no translation provided by Steward). *Wungiakuda* was described as being near a rock shelter called *Tavondówåyo* (standing rock) that was lived in during the winter months and visited for seed gathering in the summer (Steward 1938: 94-95). Using contemporary linguistic analysis *Wungiakuda* probably means "oak sitting" or "oaks remaining" or "a lot of oaks there" and would be written today as *Kwingakare* (D. Shaul 1997, personal correspondence). Taking all these factors into account, the RCA team believes that the proposed Kistler launch site is a part of the area once called *Wungiakuda*.

The Fall festival, most often a large social gathering that included annual ceremony, was, according to Steward (1938:98)

> held either at Wungiakuda where Wanga^{g}wana was director, or at Beatty where Tst's paternal grandfather was director...The Wungiakuda festival was held during pine-nut time, and before the rabbit drive, probably in October...The festival lasted 5 days. *Wanga^{g}wana* and an old man from Oak Springs or other chiefs, depending on where the festival was held, talked from time to time. The first night there was an exhibition dance, performed by visitors who were paid by their hosts. The second to fifth nights were given over to the round dance, *wegi* (round) *nuk:ep* (dance), after which people dispersed.

Steward (1938:184) documents that, among Pahrump and Las Vegas Paiute people

> The annual fall festival...lasted 3 or 4 days and terminated with mourning rites. It was planned and directed by the local chief, who had it announced 6 or 8 months in advance. While the dance and rites were in progress the chief made speeches from time to time. Amusements included the circle dance...and two special dances. On the last night buckskins and other property, which had been accumulated, was burned for persons who had died within the year.

Among Shoshones of eastern California, Steward (1938:74) noted

> The fall festival, which included the circle dance, gambling, and annual mourning observances, was the only non-economic motive for large numbers of persons to assemble. There were no other group ceremonies. The fall festivals, however, were annual events, enlisting people from a considerable territory.

Steward recorded that Owens Valley Paiutes also had fall festivals and an annual mourning ceremony, also held in the fall (1938:54-55).

Steward (1938:237) emphasized the social and other non-economic (including religious and ceremonial) aspects of the fall festivals:

> The more important social determinants producing cohesion in large groups were festivals, [and] the sweat house...The essential motivation of festivals...was non-economic. People desired social intercourse with friends and relatives rarely seen during the remainder of the year. They wished to dance and gamble, and, in some localities, to hold religious observances...Owens Valley bands seemingly held special gatherings for festivals. In providing and (sic) extra occasion for band activity, festivals enhanced band solidarity. But, as neighboring bands were often invited, temporary organization greater than the band was sometimes achieved...some mourning ceremonies among Southern Paiute effected some group solidarity.

There is evidence that the proposed Kistler launch site is part of the traditional site called *Wungiakuda*. *Wungiakuda* was a place where Indian people continued to live until the 20th Century, when the dispersal of family members occurred due to a number of unknown factors. In the late 19th Century, the site was occupied on a full time basis and served as a place where people from the region wanted to visit for various reasons, including seed gathering. It was the home (perhaps one of the homes) of "*Wanda^{g}wana (?+da^{g}wana, chief)*," or *Wangagwana*, who was known as "*chief of this general region*" (Steward 1938:95, emphasis added). It was the birth place and early residence of *Wanga^{g}wana's* son who the non-Indians called Panamint Joe and who the Indian people considered as "Chief of the Shoshone" during the Rhyolite mining boom about 1906 (Steward 1939:95). *Wungiakuda* was a place to visit for hunting, gathering, trade, and ceremony in the late 19th Century. In summary, *Wungiakuda* was:

(1) a place of full time residence
(2) a place where regional chiefs lived and directed fall festivals, including annual ceremonies (Steward 1938:95, 98, 184)

(3) a place where people came for major annual ceremonies (Steward 1938:54-55, 74, 98, 184, 237), and

(4) a place that had steadily attracted Indian people for at least 11,000 years.

Indian responses and the findings presented in DRI archaeology reports (Holz and Beck 1997; Johnson et al. 1999:1, 8, 19-20, 34-35) generally agree with the substance of ethnographic observations and conclusions. The DRI reports concluded that the site (26NY10133) is eligible for listing on the National Register of Historic Places (NRHP) under criterion d of 36 CFR Part 60.4 (Holz and Beck 1997:16; Johnson et al. 1999:1). The ethnographic evidence seems sufficient to successfully nominate *Wungiakuda* to the NRHP as a Traditional Cultural Property under Criterion A. Inasmuch as the boundary delineation for a Traditional Cultural Property is primarily the responsibility of the Indian people, *Wungiakuda* would certainly include the two canyons to the north and Landmark Rock to the southeast (NRB38:16-19). In lieu of nominating the area to the NRHP as a TCP, the AIWS has determined that the Kistler launch site, including 26NY10133, is a sacred site under Presidential Executive Order 13007. E.O. 13007 requires Federal land managing agencies to accommodate access to and ceremonial use of Indian sacred sites by Indian religious practitioners and to avoid adversely affecting the physical integrity of such sacred sites. It also requires agencies to develop procedures for reasonable notification of proposed actions or land management policies that may restrict access to or ceremonial use of, or adversely affect, sacred sites. It should be noted that the Federal land managing agency for the NTS is the DOE. The DOE is responsible for granting access rights to the NTS. In making these determinations, the DOE will take into consideration all applicable guidelines, procedures, and regulations including Executive Orders.

According to the CGTO, the region around the proposed Kistler facilities contains a wide range of important cultural resources. At the south end of Buckboard Mesa, is a power rock and a series of petroglyphs (i.e., carvings or inscriptions on rock) panels (Stoffle et al., 1994). 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 (CGTO in DOE, 1996). On August 13, 1997, three representatives of potentially affected Native American tribes visited the locations of the proposed Kistler facilities. The tribal representatives expressed concern for the traditional cultural significance of these areas. Under DOE direction a Rapid Cultural Assessment was performed, by Native American representatives from the potentially affected tribes, to identify specific cultural properties in the area and suggest appropriate mitigation measures (see Appendix C). On October 28 through 31, 1997, two ethnographers, three archaeologists, one DOE representative, and six Indian people conducted an American Indian Rapid Cultural Assessment of the proposed Kistler launch site. The purpose of the study was to summarize cultural assessments of the American Indian Writers Subgroup, which represented the interests of the 17 tribes and three organizations that constitute the CGTO. The title of the study is *American Indian Rapid Cultural Assessment of Archaeological Site 26NY10133, Nevada Test Site* (See Appendix C). The DOE, FAA, and CGTO met to discuss potential impacts expected from the proposed Kistler project and the possibility of implementing appropriate mitigation measures. As a result, the DOE and FAA will implement the following mitigation measures prior to Kistler initiating operations:

- Preparation of a Rapid Cultural Assessment for the landing/recovery site and
- Permission for Tribal Elders to visit both the launch and landing/recovery sites.

These measures will be undertaken with the involvement of Kistler, DOE, FAA, and the CGTO.

3.12 Transportation

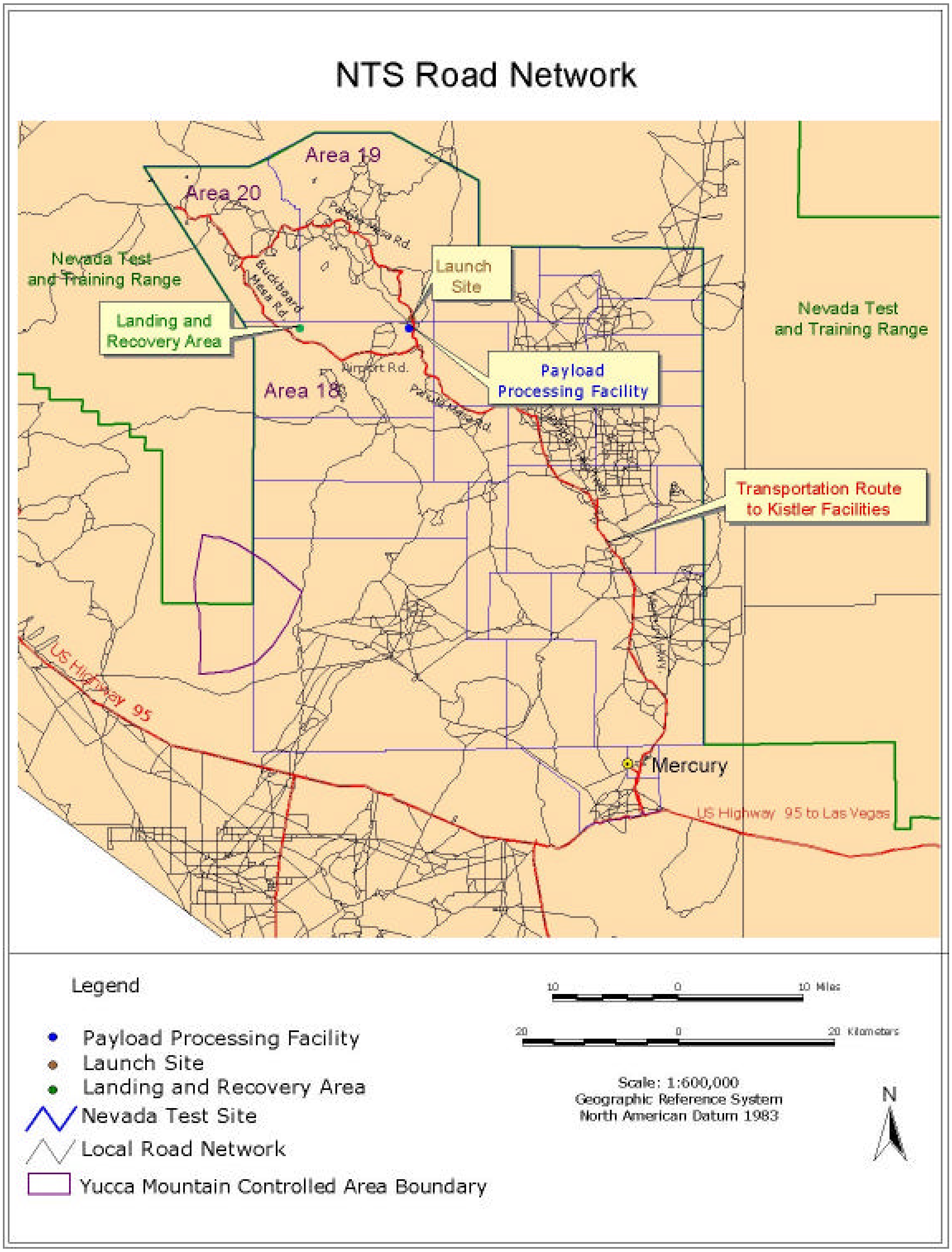
Transportation and circulation refer to the movement of vehicles from origins to destinations. Roadway operating conditions, or the adequacy of the existing and future roadway system to accommodate these vehicular movements, are usually described in terms of the volume-to-capacity (V/C) ratio, which is a comparison of the average daily traffic (ADT) volume on the roadway to the roadway capacity. The V/C ratio corresponds to a Level of Service (LOS) rating, ranging from free-flowing traffic conditions (LOS "A") for a V/C of 60 percent or less of the roadway capacity, to forced-flow, congested conditions (LOS "F") for a V/C of 100 percent of the roadway capacity. LOS A, B, and C are considered good operating conditions where minor or tolerable delays are experienced by motorists. LOS D represents below average conditions, and LOS E corresponds to the maximum capacity of the roadway. LOS F indicates a congested roadway. These levels are based primarily on the Highway Capacity Special Report 209 (Transportation Research Board, 1994) and are adapted for local conditions. Given the relatively primitive nature of the roadway system at the NTS, the condition of the roadway pavement is also considered in this section.

Existing Conditions

On-Site at NTS. The main roadway to the NTS is the Mercury Highway, which originates at U.S. Highway 95, 105 kilometers (65 miles) northwest of Las Vegas, Nevada, and accesses the main gate at Mercury. Access to the NTS is restricted, and guard stations are located at all entrances, as well as throughout the site.

There is a 1,127-kilometer (700-mile) road network which consists of 644 kilometers (400 miles) of paved roads and 482 kilometers (300 miles) of unpaved roads (Figure 3-11). Most paved roadways are two-way with 89 kilometers per hour (55 miles per hour) speed limits unless otherwise posted. The speed limit in developed areas is 32 kph (20 mph).

Figure 3-11. GIS Map of NTS Roads



Traffic volume throughout the NTS is low with flow being controlled by conventional stop and yield signs at major intersections. The Nye County Sheriff's Department enforces traffic regulations.

There have been no recent, significant road improvements at the NTS since the completion of the NTS EIS. Additional information regarding the existing transportation conditions can therefore be found in Section 4.1.2 in Volume 1 of the NTS EIS.

Proposed Action Location. The road system to the payload processing facility, launch site, and landing site consists of Mercury Highway, Tippipah Highway, Pahute Mesa Road, Airport Road, and Buckboard Mesa Road. Mercury Highway and Tippipah Highway are eight meters (26 feet) wide all-weather highways, which connect the southern part of the NTS with the northern parts. Pahute Mesa Road is accessed from the Tippipah Highway and along with Buckboard Mesa Road are the key paved roads in the northwest part of the NTS.

The proposed payload processing facility and launch site are located adjacent to Pahute Mesa Road. The landing and recovery area is adjacent to Buckboard Mesa Road, and is reached from the launch site by traveling south on Pahute Mesa Road and turning west onto Airport Road, which becomes Buckboard Mesa Road after a turnoff for an airstrip. Route 18-01 is an alternative route connecting the launch site and Airport Road. This road is winding and crosses rugged terrain, making it impassable for most vehicles without four-wheel drive.

The landing site area is accessible by a jeep trail, which runs from the proposed payload processing facility and launch site via Well 8 to Buckboard Mesa Road. In addition, in the middle of the landing area there is an older, less defined jeep trail that runs from the northwest to the southeast towards Scrugham peak.

Off-Site Traffic. Background traffic on key roads in the vicinity of the NTS has experienced rapid growth in the last 10 years, although traffic volume at the Mercury interchange has decreased by approximately two percent per year during recent years as a result of reductions in the NTS workforce. Additional information regarding the off-site transportation conditions can be found in Section 4.1.2.2 in Volume 1 of the NTS EIS.

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4. SAFETY AND HEALTH

The safety and health of the workers at the NTS and the general public could be affected by the proposed action. This chapter describes the existing conditions at the NTS including: safety and health, a brief hazard analysis, proposed safety and health protection systems, and a methodology to determine the potential risk to safety and health.

4.1 Existing Safety and Health Conditions

For purposes of analysis and assessment, the proposed action may be divided into flight operations and ground operations. The existing conditions of concern for these operations are described below.

Airspace and Air Traffic

Changes in airspace use can impact flight safety or limit airspace availability to other users. The FAA is charged with overall management of airspace and has established certain criteria and limits for use of various sectors of airspace. Restricted airspace confines certain flight activity within certain boundaries. Specific permission is required from the controlling agency to penetrate active restricted areas.

Flight operations in the vicinity of the proposed location at the NTS include the Nellis Air Force Base and commercial flights from nearby airports including McCarran Airport in Las Vegas, a regional airport in North Las Vegas, and an airport in Henderson, Nevada. The airspace over both the NTS and the Nevada Test and Training Range (also known as the Nellis Air Force Range) has been removed from public access in an extensive Restricted Area. The specific restricted airspace over the Kistler areas is R-4808, which is managed by DOE and is not available for overflight by general aviation or commercial aircraft. These areas are restricted from the surface to an unlimited altitude. Nevada Test and Training Range use of the restricted area is expected to continue at current levels, and Kistler has agreed to participate in airspace scheduling activities organized by the Nevada Test and Training Range users. The airports located near the NTS service commercial and general aviation aircraft. Commercial flights from/to the Las Vegas area are expected to increase with the growth of the city, but the integrity of the Nevada Test and Training Range restricted area will be maintained. Tables 4-1 and 4-2 provide more detail on the restricted airspace area for two different trajectories.

The Nevada Test and Training Range airspace has hosted launch programs in the past. Most recently, the DoD tested their Army Tactical Munitions System (ATACMS). The ATACMS is a small launcher being developed for the delivery of battlefield munitions. The ATACMS is a single stage system that weighs approximately 1,800 kilograms and stands about four meters tall. The ATACMS has a solid propellant propulsion system. It was launched from Area 26 in the southern portion of the NTS, and flew to a designated target at the Tonopah Test Range approximately 105 kilometers away.

The DOE has occupational and flight safety programs in place for these kinds of activities to ensure safety and handle air traffic/air restriction issues with the Nevada Test and Training Range. Such programs should be adaptable to Kistler's K-1 reusable launch vehicle.

Table 4-1. Summary of Restricted Air Space Characteristics (52 Degree Trajectory)

K-1	Time in seconds		Total time in seconds	Distance in kilometers		Total distance in kilometers
	Entry	Exit		Entry	Exit	
4808N	0	95.3	95.3	6,000	66,510	14.7
4807A	93.5	123.75	12.45	66,510	115,722	21.1
4808N	123.75	131.75	8	115,722	131,976	8.7
4807A	131.75	142.75	11	131,976	155,046	12.4
MOA	142.75			155,046		

LAP	Time in seconds		Total time in seconds	Distance in kilometers		Total distance in kilometers
	Entry	Exit		Entry	Exit	
4808N	130.75	131.75	1	115,722	131,976	1.3
4807A	131.75	142.75	11	131,976	155,046	12.4
MOA	142.75	188.44	45.69	155,046	253,608	17.8
4807A	188.44	226.44	38	253,608	291,267	13.6
4808N	226.44	235.44	9	291,267	293,561	4.1
4807A	235.44	297.17	61.73	293,561	240,936	22.2
4807B	297.17	312.17	15	240,936	210,104	6.1
4808N	312.17	526.82	214.65	210,104	6,000	19.4

Table 4-2. Summary of Restricted Air Space Characteristics (85-Degree Trajectory)

K-1	Time in seconds		Total time in seconds	Distance in kilometers		Total distance in kilometers
	Entry	Exit		Entry	Exit	
4808N	0	89.3	89.3	6,000	58,292	11
4807B	89.3	108.3	19	58,292	86,538	11.3
4807A	108.3	160.75	52.45	86,538	189,084	57.7
MOA	160.75			189,084		

LAP	Time in seconds		Total time in seconds	Distance in kilometers		Total distance in kilometers
	Entry	Exit		Entry	Exit	
4807A	131.75	142.75	11	86,538	152,798	65.6
4807B	142.75	188.44	45.69	152,798	245,783	13.1
4808N	188.44	526.82	338.38	245,783	6,000	13.8

Radiological Contamination

Surface areas with radioactive contamination on the NTS primarily resulted from atmospheric and safety tests conducted in the early 1960's. The central portion of Area 18 was used for five nuclear weapons tests: four were conducted in mid-1962 and one underground test was conducted in 1964. Two of these were atmospheric, 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.
Figure 4-1 shows the approximate areas of Posted and/or Fenced Areas of Soil Contamination.

Current NTS administrative controls on contaminated soil areas include the fencing and/or posting of areas that have trackable radioactive material. In addition, activities that will result in significant soil disturbance require further evaluation of the site to assure that the spread of contamination will not result from those activities. An NTS worker who adheres to these policies is not likely to receive a total annual dose of greater than 100 mrem.

The proposed payload processing facility, launch complex, and landing and recovery area are not within fenced and/or posted areas. Routine activities within these areas are not likely to result in a radiation dose that exceeds the annual administrative occupational dose, or the annual dose to a member of the public (both 100 mrem). Significant soil disturbing activities in these areas would require further evaluation by DOE/NV. The potential does exist to have emergency landing vehicle recovery operations in areas where radiological soil contamination exceeds threshold levels. Procedures will be developed between Kistler and DOE/NV to address the potential need for radiological decontamination and monitoring activities.

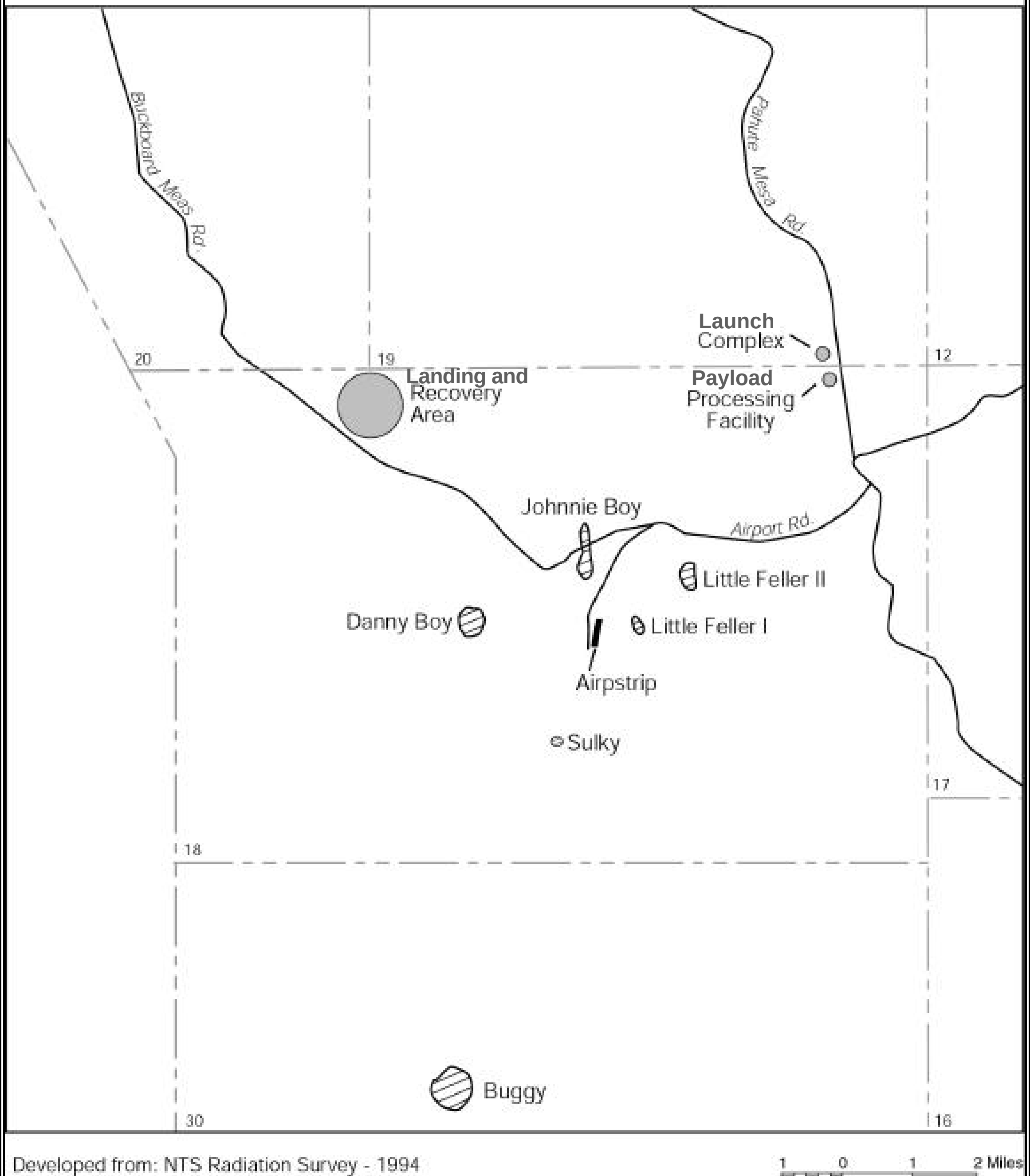
NTS Operations

Existing operations at NTS include the Defense Program, the Waste Management Program, the Environmental Restoration Program, the Non-Defense Research and Development Program, the Work for Others Program, and various site support activities (e.g., fire protection).

Past activities in Areas 18 and 19 of the NTS have included an active airstrip for operations support, atmospheric (at Area 18) and underground (at both Areas 18 and 19) nuclear weapons testing, and testing using chemical high explosives. The NTS complies with safety and health requirements and has had extensive experience in safely storing, transporting, and handling hazardous materials in several NTS programs including the Hazardous Materials Spill Test Facility (DOE, 1996). The NTS also has capabilities to ensure the proper health and safety safeguards for dealing with any existing on-site chemical and radiological contamination.

All of the roadways leading to the proposed sites are paved and prepared for shipments to support proposed Kistler operations.

Figure 4-1 Posted and/or Fenced Areas of Soil Contamination



Developed from: NTS Radiation Survey - 1994
Man Made Exposure Rate Map

Figure Posted and/or Fenced Areas of Soil Contamination (Cross hatched areas)

4.2 Hazard Analysis

A hazard analysis is necessary as part of the FAA licensing determination to assess the possible hazardous situations associated with proposed Kistler launch, vehicle processing, and landing/recovery operations and activities. This analysis of credible accident scenarios examines how Kistler operations and such accidents could affect occupational and public health and safety.

Credible Accident Scenarios

Although portions of Areas 18 and 19 of the NTS were used for nuclear weapons testing, the specific areas chosen for Kistler operations have no history of radioactive or chemical contamination, and show no trace of such in environmental surveys. In addition, there are no DOE activities in the area that could threaten such contamination.

Accident scenarios involving Kistler activities could occur during ground or flight operations.

Ground Operations. Ground operations involved in the servicing and preparation of the vehicle for launch and recovery are comprised of typical industrial activities. Examples of accidents that could occur for ground operations are identified and described further below.

- Construction accidents during site development;
- Traffic accidents due to increased activity on and off site;
- Vehicle accidents transporting the LAP and OV to the processing facility;
- Spill/fire/explosion of propellant storage, transport, handling; and
- Fire/explosion during loading operation.

Kistler operations will first involve site development. This will include construction, which poses the possibility of occupational injuries from construction accidents. Once the site is developed, Kistler operations will involve the storage, transport, and handling of hazardous materials such as LO_X and rocket propellant-1 (RP-1). Accidents involving these hazardous materials could result in spills, fires, and explosions. Accidents during ground operations could include for example, a fire/explosion at a kerosene storage tank or a fire/explosion during a LO_X/RP-1 loading operation. These scenarios have the potential for on-site rather than off-site impacts. Spills above certain quantities of certain hazardous or extremely hazardous substances will need to be reported to the EPA or state and local agencies. Also, increased traffic from Kistler operations both on and off site could result in increased traffic accidents. Vehicle accidents may occur during transport of the recovered LAP or OV to the processing facility. Table 4-3 provides a summary of hazardous and non-hazardous materials that are expected to be used in the course of Kistler operations.

Table 4-3. List of Hazardous and Non-Hazardous Materials

Chemical	Purpose
LO_X	K-1 vehicle NK engine propellant
RP-1	K-1 vehicle NK engine propellant
Ethanol	K-1 vehicle OMS engine propellant
Hydrazine	Payload/Satellite engine propellant
LN2 & GN2	K-1 vehicle pressurant
GHe	K-1 vehicle pressurant
Alcohol wipes	K-1 vehicle cleaning/TPS cleaning
TPS glue fumes	TPS repairs
Exhaust fumes	Support vehicles

Flight Operations. A detailed flight hazard analysis will be conducted as part of a Safety Review under the auspices of the FAA before a determination is made on whether to license the launch activities. Consequently, this section is intended to provide only a top-level assessment of hazards and mitigation measures for the proposed system.

Several scenarios that could occur during flight operations are identified and described below.

- LAP engine or guidance failure during boost phase
- Separation system failure
- LAP failure to re-ignite for flyback maneuver
- OV engine fails to ignite

The K-1 is designed to guard against flight failures with redundant systems and abort handling capability. Since launch occurs over land, the current K-1 conceptual design does not include a destruct system. Its Flight Safety System (FSS) consists of various functions that are activated in the event the vehicle strays from its preplanned trajectory.

In the event that the LAP experiences an engine or guidance system failure during the boost phase, the vehicle is equipped to recognize the deviation from the planned flight path.[e] The vehicle will then shut down the remaining engines and impact in open terrain.

Should the separation system fail, the OV will still ignite (fire-in-the-hole), forcing separation from the LAP. The LAP will likely be damaged in the process, as it will receive the full force of the OV engine exhaust. The LAP and any debris will carry downrange and fall in an elliptical area centered approximately 236 kilometers (130 nautical miles) downrange from the launch site. The exact location

[e] A fully autonomous system would not satisfy the existing FAA licensing requirements for reusable launch vehicles. Accordingly, final operational processes involving the K-1 vehicle have not yet been approved by the FAA. Those processes are described generally in the EA as background information for evaluation of the range of environmental impacts.

and characteristics of this debris will vary depending upon the inclination at which the vehicle is flying, atmospheric conditions, and the nature of the LAP/OV separation event.

In this scenario, assuming the OV did not suffer crippling collateral damage as a result of the anomalous separation, the OV will continue on to orbit. If sufficient damage occurred that the OV engine shuts down or OV guidance is rendered impotent, the OV will recognize the deviation from the planned flight path. It will then initiate a fuel release that lightens the vehicle and enables it to attempt a controlled, intact landing using its parachutes and airbags.

If the LAP fails to re-ignite for flyback, it will continue downrange approximately 236 kilometers (130 nautical miles) on a ballistic trajectory. The exact impact point will vary depending upon the inclination at which the vehicle was flying and atmospheric conditions. Figure 4-2 displays graphically the impact points for the LAP failure to re-ignite scenario.

If the OV engine fails to ignite, it will initiate a fuel release as described above, and use its parachutes to attempt a controlled, intact landing approximately 236 kilometers (130 nautical miles) downrange.

During reentry, the vehicle is unlikely to break up in the Earth's atmosphere due to the fact that the Stages of the K-1 vehicle are designed to withstand reentry operations. Furthermore, in the event of failure, the OV at that point in the flight has expended all its fuel and is depleted of nearly all explosive or combustible materials.

As mentioned above, a detailed flight hazard analysis covering these scenarios will be conducted as part of a Safety Review under the auspices of the FAA as part of the licensing process.

Occupational Safety and Health Analysis

Safety and health risks to workers will occur primarily from accidents during construction, decontamination and decommissioning, or maintenance activities. However, explosions/fires and spills of propellants can also endanger workers. Generally, the impact will be limited to workers within the vicinity of the accident. For many hazardous operations including launch, workers will be located at safe distances from any type of catastrophic event. (See analysis below because analysis of public safety is also applicable to worker safety.)

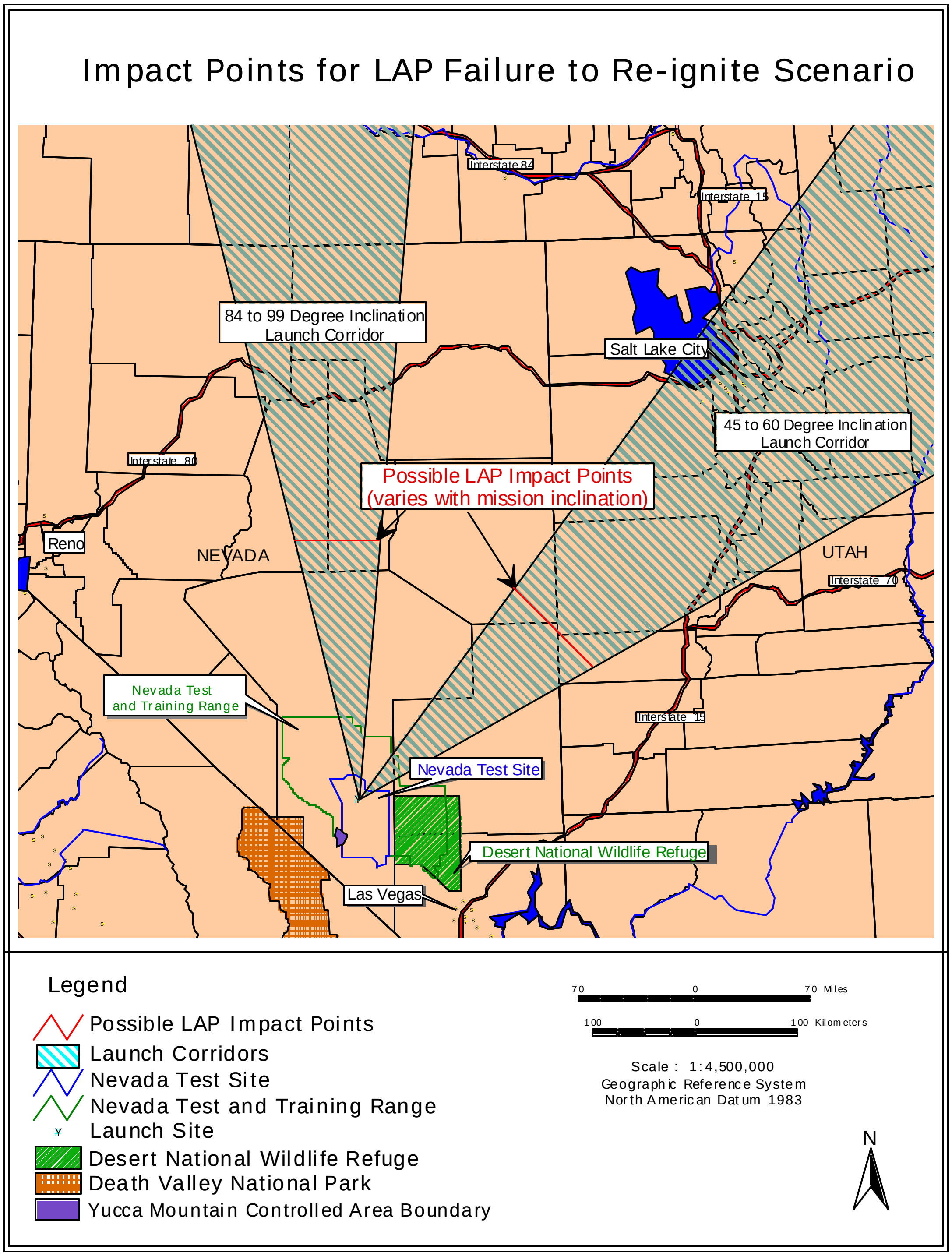
Public Safety and Health Analysis

Only accidents during K-1 flight have the potential to affect the public because of the remote and restricted location of the Kistler activities. The accident scenarios described above constitute the most likely failures. These scenarios will be explored more fully as part of a Safety Review conducted under the auspices of the FAA.

Kistler's strategy for emergency landings is to avoid populated areas rather than designate emergency landing sites.[f] The model Kistler used for overflight analyses follows the requirements in the FAA's Final Rule for Commercial Space Transportation Reusable Launch Vehicle and Reentry Licensing Regulations. 14 CFR Parts 400, 401, 404, et al. As part of the licensing process, FAA must determine whether K-1 operations pose unacceptable risks to public health and safety and not license operations that do so.

[f] The FAA's Final Rule for Reusable Launch Vehicle and Reentry Licensing Regulations requires that an applicant for RLV mission safety approval submit procedures to satisfy risk criteria set forth in § 431.35(b)(1), and an applicant for RLV mission safety approval shall identify suitable and attainable locations for nominal landing and vehicle staging impact or landing, if any. An application shall identify such locations for a contingency abort if necessary to satisfy risk criteria contained in § 431.35(b)(1) during launch of an RLV. A nominal landing, vehicle staging impact and contingency abort location are suitable for launch or reentry if (1) for any vehicle or vehicle stage, the area of the predicted three-sigma dispersion of the vehicle or vehicle stage can be wholly contained within the designated location; and (2) the location is of sufficient size to contain landing impacts, including debris dispersion upon impact and any toxic release. During the Safety Review FAA will evaluate the adequacy of the proposed landing strategy for the K-1 vehicle.

Figure 4-2. Impact points for the LAP failure to re-ignite scenario



4.3. Proposed Safety and Health Protection Systems

To address safety and health issues associated with launch operations, Kistler proposes to implement safety systems for both ground and flight operations. Table 4-4 outlines credible accident scenarios and Kistler's proposed mitigation measures.

In the event that fire or medical support were required, these services would be contracted out for launch operations to supplement current fire and medical support. Positioning the fire and medical support will depend on the response times required for reaching operations areas. For launches and landing operations, supplemental fire and medical support will be positioned in appropriate locations to provide support for each flight.

Ground Operations

During construction of the site, Occupational Safety and Health Administration (OSHA) regulations in 29 CFR Part 1920/1926 would be strictly complied with to protect construction workers. Fugitive dust generated by road and building construction would be minimized with an aggressive dust control program. Conditions would be monitored and, as appropriate, water sprays and fogs or chemical dust suppressants would be applied. The landing site and any parking lots would be constructed to allow proper drainage and to minimize fugitive dust.

Nothing about the construction of the proposed Kistler site would set it apart from other construction projects of comparable magnitude and type. Construction of roads can be compared with a highway construction project. Erection of various buildings and the future LO_X plant would be qualitatively similar to the construction of almost any small industrial facility. These risks are routine for construction workers. The public would not be subjected to health and safety risks as a result of construction.

Kistler would construct buildings designed to hold explosive substances with adequate separation distances to meet the Quantity Distance Separation requirements specified in NASA Explosive Safety Standard, NSS 1740.12 (DoD 6055.9). These requirements will also govern separations of propellant bulk storage of LO_X and RP-1. Storage would be built to National Fire Protection Administration (NFPA) standards including NFPA 30 Flammable and Combustible Liquids Code.

Table 4-4. K-1 Credible Events Matrix and Mitigation Measures

ACCIDENT SCENARIO	LOCATION OF ACCIDENT	PHYSICAL STATUS/STATE OF MATERIALS INVOLVED (AMOUNT, TEMP, PRESSURE, ETC.)	MITIGATION MEASURES
RP-1 spill and/or ignition	Vehicle processing facility, launch stand, or landing and recovery site	RP-1 stored in gallons at ambient temperature and pressure in vehicle processing facility and recovery, or at 30 degrees at launch site	Containment trench in vehicle processing facility, wash-down at launch stand or recovery site, fire extinguishers at all locations, and sprinkler systems in buildings
LO_X Spill	Launch stand or recovery site	LO_X is stored in gallons at -310 degrees at launch stand, or under ambient conditions at recovery site	None
Pyros, mortars, start cartridges, and/or ordnance devices initiate	K-1 processing facility, launch stand, or recovery site	TBD- LRU specific (propulsion LRU/Landing LRU)	TBD Per LRU
Ground vehicle airbags and discharge static electricity	Recovery site, processing area, launch stand	Static electric discharge amount unknown to date – TBD	Grounding rods/wands and ESD meters provided at landing, grounding points provided at all process launch operations
Dropping the LAP/OV at recovery during removal of the airbags or transfer to transporter TP-2	Recovery site	Stage load is suspended from SLV-1, 50,000 lbs, +/- while airbags are removed	Inflatable log installed under stage to prevent load from falling
Leak caused by high pressure tests on stage pressurization systems, TCV, ACS systems	K-1 processing facilities	Pressurizing N_2, He, fuel and hydraulic systems to 800-2,200 psi for decay leak checks	Systems rated at 6,000 psi/checks performed in “safe” state (remote operations)
Fuel satellite – hydrazine spill	Payload processing facility	Fill satellite hydrazine fuel tanks, 110 gallons of fuel at ambient temperature and pressure	Closed loop fill system, contained fill area, personnel, suit-up
Receive fuels and gases for storage at launch site - spill leak	Bulk storage facilities at launch site complex	RP-1=33,500 gal; LO_X=124,000 gal; LN2=88,000 gal; GN2=750 CF; GHe=1,500 CF; Ethanol=550 gal	Standard industry fill and storage procedures/safety rules/QD requirements

Kistler would operate the site in compliance with Occupational Safety and Health Administration requirements, including Process Safety Management requirements and with all applicable industry standards. Additionally, Kistler would need to meet various EPA regulations governing for example, hazardous waste disposal and risk management. Also, all transport of LO_X and RP-1 and other hazardous materials would be in DOT approved packages and containers. The shipments must meet the DOT requirements including packaging design, marking, labeling, and placarding for shipment over public roadways. For hazardous materials in transit, the danger of a tank leaking during handling is mitigated by compliance with DOT Hazardous Materials Regulations, 49 CFR Parts 171, 172, 173, 174, 175, 176, and 177. These DOT requirements are intended to minimize potential releases, fires, and explosions.

Contingency measures used by Kistler would include emergency response plans, training protocols, onboard monitoring and detection systems. All would be part of an integrated program to manage safety and environmental protection objectives. Emergency drains to the respective fuel and oxidizer containment tanks would be provided in each room as well as a gas monitoring/detection system for payload fuels.

The handling and use of hazardous materials at the site during and between launch operations would be limited. Hazardous materials used for maintenance, groundskeeping, and housekeeping activities would normally consist of various solvents and cleaners, paints and primers, adhesives, and lubricants. Adherence to OSHA regulations will prevent adverse safety and health impacts. Appropriate hazardous material management techniques would be followed to minimize their use and waste disposal. Substantial impacts to the environment would not be expected from the presence of hazardous materials and wastes during operations.

Some payloads would use a hydrazine-based liquid monopropellant for attitude adjustment. The quantities involved would be small. Hydrazine is toxic and can ignite spontaneously on contact with oxidizers or porous materials such as earth, wood, and cloth (NIOSH, 1989). The primary potential impact from hydrazine would occur if it was spilled or otherwise released in an uncontrolled manner to the environment.

Hydrazine-based propellant handling on-site would be performed in accordance with Kistler safety procedures required by the FAA (OCST, 1989). Storage carts stored in the payload processing facility would be designed to fully contain a “worst-case” propellant spill. For fueling operations, the cart would be moved into the facility processing bay, where trenches filled with a non-reactive absorbent material would be provided to contain spilled material. Fueling would be monitored by safety personnel, and portable detectors would be used to monitor for hazardous vapors. Personnel would be trained to respond to unplanned releases (inside or outside) in accordance with the site spill response plan, and spill response equipment would be maintained in a readily available condition. Wastes generated from spill response activities would be managed in accordance with Federal and State requirements. Because (1) fuel storage and handling would occur inside, (2) small quantities would be involved, and (3) appropriate spill response measures would be implemented, the potential for health and safety impact from hydrazine fueling operations or spills is small.

LO_X would also require special handling. Oxygen strongly supports combustion and is very cold in its liquid form. Workers must be equipped with protective equipment designed to prevent contact with the eyes or skin, and vapors must be kept away from sources of ignition and flammable materials. Any hazardous waste generated during payload and launch vehicle processing would be controlled in accordance with EPA hazardous waste regulations and transported in accordance with DOT regulations.

Flight Operations

The FAA would grant a license for the K-1 operations if Kistler demonstrates that those operations do not pose an unreasonable risk to public health, safety, or property. Substantial hazards and risk are inherent in the operation of launch and reentry vehicles, and therefore, all reasonable precautions would be taken to minimize risk to public safety, health, and property. A range safety program would be critical to the range mission and to provide for public safety. Kistler is developing a set of standards and procedures to ensure public safety during launch, reentry, and flight operations. These standards and procedures will be reviewed by the FAA as part of its Safety Review.

The flight ascent profile minimizes risk to the public. In the corridors for near polar or midrange orbits, nearly half of the K-1's ascent would occur over NTS and the Nevada Test and Training Range. During its flight, the LAP will stay within the NTS or the Nevada Test and Training Range restricted airspace, but for certain launch trajectories the LAP will fly outside of FAA controlled airspace for less than one minute at altitudes greater than 45,000 meters (150,000 feet). The LAP would not enter FAA controlled airspace. The OV would not pass out of NTS or the Nevada Test and Training Range restricted airspace until it was above 45,720 to 60,960 meters (150,000 to 200,000 feet) in altitude, well above the FAA controlled airspace ceiling of 18,288 meters (60,000 feet) for any of the planned inclinations. The OV is designed to return to earth on a steep trajectory, entering the restricted airspace over NTS while still above 33,528 meters (110,000 feet) in altitude.

To address scheduling the use of affected airspace, a working group within the Range Management Office has been established to coordinate the withdrawn airspace over the NTS and the Nevada Test and Training Range. The working group has an airspace scheduling process that requires a 90-, 60-, and 30-day review. This group is anticipated to be the airspace coordinators for activities related to the proposed Kistler operations.

Kistler would promote flight safety through preventive maintenance and inspection systems, established design margins and backup systems, validation testing, use of proven technology, and experienced staff. However, Kistler has modified existing systems and is proposing a new largely untested design for a reusable launch and reentry vehicle. A test program including test flights and subsequent operational flights, will be conducted in Australia to verify the systems and to work out issues with the operation or performance of the vehicle.

4.4 Risk Analysis for Proposed Action

A risk analysis is the technical process and procedure for identifying, characterizing, quantifying, and evaluating hazards. The potential hazards and existing safety and health conditions identified in previous sections will be used to estimate the risk. A risk analysis estimates the occurrence probabilities and the consequences of hazardous events, including catastrophic ones (AST, 1988). The intent of the risk analysis in this document is to determine the risk of the proposed action on human safety and health.

As part of the licensing process under the CSLA, the proposed action would be evaluated against certain risk assessment criteria established for launch and reentry operations. During this process, AST conducts a Safety Review and a Mission Review. The Safety Review is the procedure for determining whether the license applicant can operate safely by examining Kistler's safety personnel, procedures, and equipment. The Safety Review includes evaluation of the vehicle from a safety perspective to determine whether it is capable of performing as intended, thereby confining risks to the public to acceptable levels.

4.5 Cumulative Health and Safety Impacts

No cumulative health and safety impacts are expected from the proposed Kistler operations on the NTS. The extent of the impacts on public health and safety on and off the NTS will be addressed in the required FAA Safety Review prior to issuance of a launch and reentry license.

5. ENVIRONMENTAL CONSEQUENCES OF THE PREFERRED ALTERNATIVE

5.1. Proposed Action Area

5.1.1 Airspace

The impacts of the proposed action on airspace have been considered in three areas: construction, maximum launch schedule, and reentry. Also included is a discussion of the nearest civil aircraft air traffic routes.

Kistler would require up to two adjoining 15-minute blocks of range time for launch and recovery of the LAP and up to two 15 minute blocks for recovery of the OV approximately 24 hours after the initial launch. Range times for users of the Nevada Test and Training Range (also known as the Nellis Air Force Range) areas are typically scheduled in 15-minute blocks. Since Kistler's launch and recovery activities would be scheduled well in advance, the use of the range airspace by Kistler would be consistent with the current Nevada Test and Training Range scheduling and range time allocation constraints. The Kistler launch and reentry operations would require an average of one percent of the available range time. The specific arrangements related to airspace use will be addressed in detail during the safety analysis portion of the licensing process.

Construction Impacts. The proposed construction activities at the payload processing facility, launch area, and landing and recovery area are not expected to have any impact on the airspace use over the NTS or Nevada Test and Training Range since none of the currently projected activities in that airspace would be affected.

Maximum Launch Schedule Impacts. Kistler is designing the K-1 for a launch surge capability of one launch every three days. The maximum number of launches in one year would be 52 and with the available surge capability, Kistler may be able to launch three vehicles in the same week.

The Kistler launch windows would be customer driven and generally less than one minute long. If a launch were delayed by more than a minute (and in some cases by more than 12 seconds), the launch would have to be postponed for 24 hours. Some of the proposed Kistler payloads have very tight orbit placement requirements and, unlike the Shuttle or geosynchronous orbit missions, would not have the opportunity to use on-orbit maneuvering to make up for a missed launch window.

It would take approximately 11 minutes to get the LAP back, therefore, the launch would most likely occur in the first 15-minute increment of reserved Range time. If the initial 30-minute launch window could not be used, the launch would not be incrementally slipped; a backup launch window would be required approximately 24 hours later.

The vehicle would pass through R-4808 (DOE airspace), into R-4807 (Nevada Test and Training Range airspace) and over the Memoranda of Agreement. In addition, only a small part of the Nevada Test and Training Range would be affected in a corridor on either side of the launch ground track. Other activities outside of the corridor could continue as normal. The width of this corridor would be determined jointly by DOE, U.S. Air Force, and Kistler. The flyback of the LAP to the landing area would be in the same corridor as used during launch with the LAP landing approximately 700 seconds (11.6 minutes) after lift-off.

Reentry Impacts. Kistler would determine the landing time for the OV as soon as the vehicle has been launched. Because the launch time would be known within a minute (or the vehicle would not have launched), the time for reentry could be determined as well. It would, however, take a few minutes for the OV to descend under its parachutes, so Kistler would reserve two adjoining 15-minute schedule blocks for reentry and landing.

Upon reentry, the OV would reenter the NTS or the Nevada Test and Training Range airspace between 41 and 52 kilometers (22 and 28 nautical miles) from the landing area from the south to southwest. The altitude at which it passes into the NTS or the Nevada Test and Training Range restricted airspace is above 30,480 meters (100,000 feet) in uncontrolled airspace. On the approach into the landing area from the south, the OV enters only DOE restricted airspace. On reentry from the southwest, the OV would pass through the southwest corner of R-4807A, a part of the Nevada Test and Training Range airspace. Because the landing time would be predicted immediately after launch, the amount of time the NTS or the Nevada Test and Training Range airspace would have to be blocked could be managed with more precision. The OV would be committed to deorbit and landing immediately after launch, and its reentry and landing time could be predicted quite precisely. Thirty minutes of range time would be blocked off for each launch of the K-1 and recovery of the LAP, and another thirty minutes of range time would be blocked 24 hours later for the recovery of the OV.

Air Traffic Route Impacts. The nearest air traffic route used by civil aviation that is over-flown by the Kistler vehicle on launch would be Jet Route 80-58 (J80-58). This route is between Wilson Creek, Nevada and Tonopah, Nevada. J80-58 is approximately 102 kilometers (55 nautical miles) from the launch site. During the launch profile, the Kistler vehicle would pass over this route above 60,960 meters (200,000 feet) MSL. Figure 5-1 depicts the proximity of the Kistler vehicle to jet routes during launch.

Upon reentry, the nearest air traffic route is J92 between Beatty, Nevada and Boulder City, Nevada. This route is to the southwest of the NTS and the Nevada Test and Training Range and runs southeast to northwest. Depending on the direction of approach, the altitude of the OV at the time it crosses this route would be between 31,089 and 33,528 meters (102,000 and 110,000 feet) MSL. Figure 5-2 depicts the proximity of the Kistler vehicle to jet routes during reentry.

Figure 5-1. Proximity of the Kistler vehicle to jet routes during launch

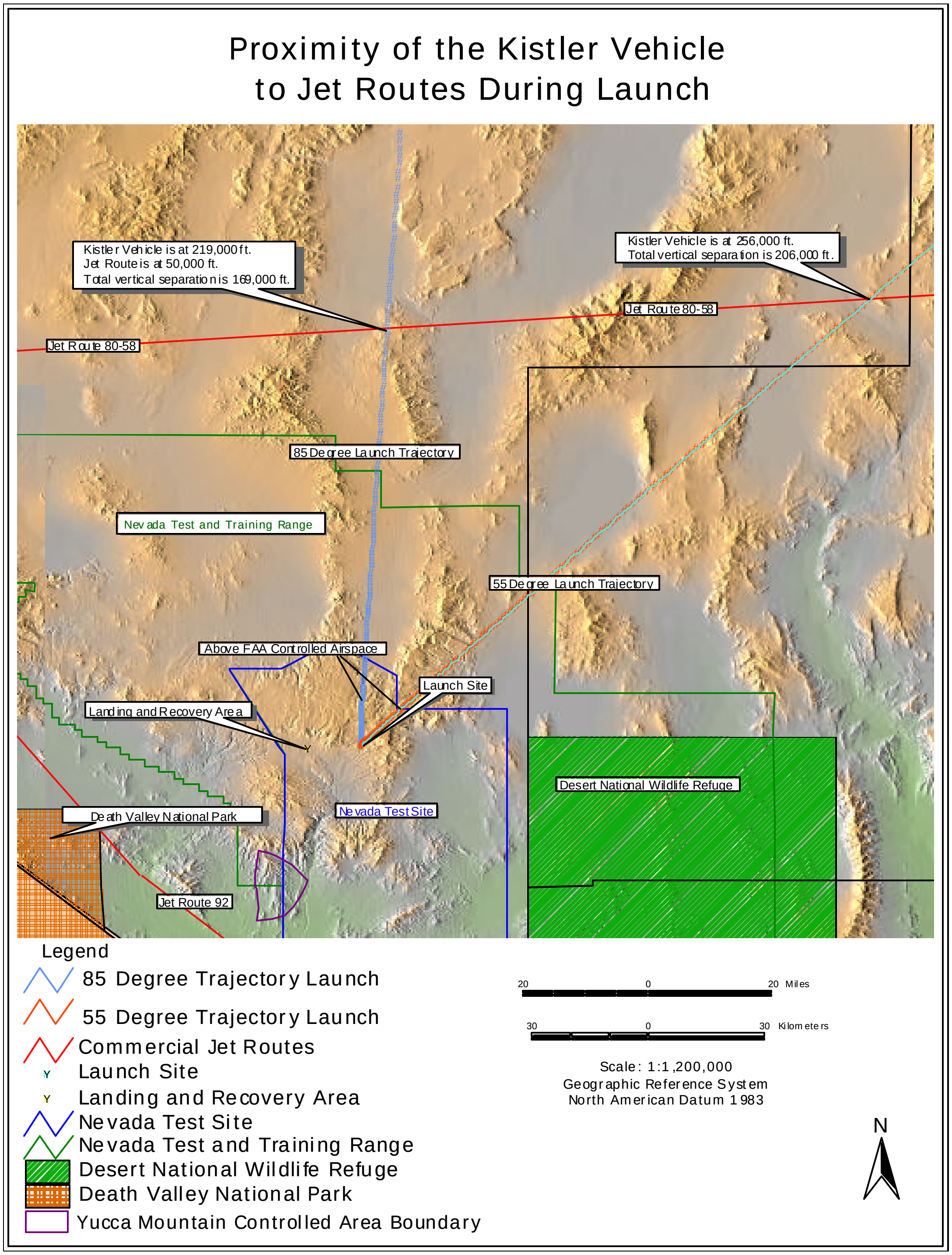
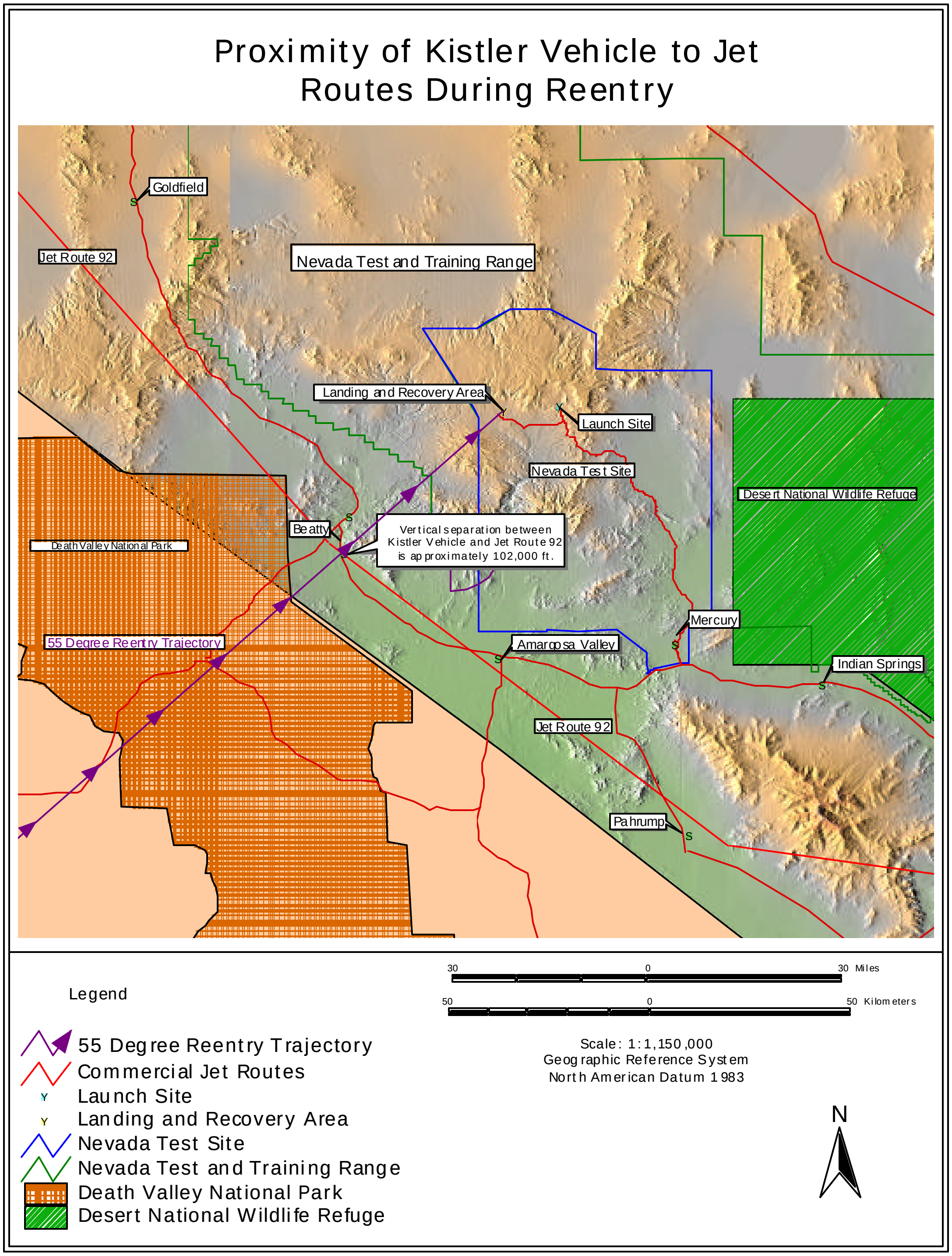


Figure 5-2. Proximity of the Kistler vehicle to jet routes during reentry



Because of the large horizontal and altitude separation distances, the nearest civil air traffic route structure would not be affected, and any potential impacts would be negligible.

5.1.2 Land Use

The sites identified for the payload processing facility and recovery areas are located in the northern portions of Area 18, and the launch site into the southern portions of Area 19.

Implementation of the proposed action would result in the designation of two industrial sites (the payload processing facility and recovery area) in Area 18 and one in Area 19 (the launch site). This would remove a total of approximately 271 hectares (663 acres) from the current Reserved Zone designation for the area. The industrial site in Area 19 would remove approximately five hectares (14 acres) from the current Nuclear Test Zone designated for the area. The definition of the Nuclear Test Zone includes compatible defense and nondefense uses. Although the proposed locations for the various facilities are in land use zones designated as Reserved and Nuclear Test Zones, the current use of these and surrounding areas is as natural or recovering habitat. The January 1997 site selection process determined that the proposed action would be a compatible use for the area. Surrounding land uses are not expected to be affected by the proposed action.

The National Security Mission of the DOE would continue to have priority over all activities conducted on the NTS. DOE programs may, for reasons related to national security or exigency, preempt Kistler activities. Thus, land use would not be impacted.

5.1.3 Air Resources

This section addresses the potential effects that the Kistler activities might have on weather, regional and local air quality, and on the upper atmosphere. Air emissions result from construction activities, and sustained launch/flight operations. Air emissions from stationary and mobile sources produced at the processing facilities under routine operations will also be discussed. Because the Kistler facilities would be located in an air quality control region that is in attainment with Federal and State ambient air quality standards, an analysis of conformity to the CAA Section 176(c) is not required. Air emissions were also calculated for the various atmospheric layers.

The Kistler launch will likely have no environmental impacts to wind and weather conditions. The Kennedy Space Center EIS estimated that ground clouds have the potential to minimally modify local weather patterns for up to 48 hours after liftoff, and some studies have shown that the relative activity of cloud nuclei decline significantly within three to five hours after launch. These studies were performed for solid rocket motors, which typically produce aluminum oxide particulates that are not produced during the launch of a K-1. No large-scale or long-range weather modification is foreseen. The Kistler vehicle will not be launched during extreme weather conditions including high winds and severe thunderstorms. Severe weather can cause damage to the vehicle and increase risks to personnel during vehicle recovery.

Criteria Pollutants

Criteria pollutants of concern for Kistler operations are carbon monoxide, nitrogen dioxide, sulfur dioxide, and particulate matter less than 10 microns in diameter (PM_{10}). (See Table 3-2 for standards for these pollutants).

Construction

Construction activities that could affect air quality include the operation of heavy construction equipment for the clearing of land for the landing and recovery site, and construction at the payload processing facility and launch site. Construction equipment could include bulldozers, graders, clamshells, dump trucks, front-end loaders/backhoes, compactors, concrete mixers, and cranes.

Emissions during construction of the launch and recovery facilities would be fugitive dust (PM_{10}) from land clearing and soil transfer, and engine exhausts (nitrogen oxides, sulfur dioxide, carbon monoxide, particulates (PM_{10}), and volatile organic compounds (VOCs)) from vehicle and equipment engines.

The EPA has developed standards for emissions of PM_{10} because of its impact on the human respiratory system. The air pollution impact of PM_{10} depends upon the quantity and the potential transport of the particles. PM_{10} will be emitted during construction and clearing operations at the landing and recovery area, payload processing facility, vehicle processing facility, and launch site from disturbed soil as well as vehicle engine emissions. The assumptions used in estimating and modeling PM_{10} emissions in this analysis are described in Appendix D. Table 5-1 describes the parameters used to estimate PM_{10} emissions from construction vehicle engines. The maximum quantity of PM_{10} emitted by construction equipment engines is not expected to exceed 8.47 kilograms per day (18.8 pounds per day). Table 5-2 describes the parameters used to estimate PM_{10} emissions from support vehicle engines. The maximum quantity of PM_{10} emitted by support vehicle engines is not expected to exceed 3.61 kg/day (7.97 lb/day).

Table 5-1. PM_{10} Emissions from Construction Equipment Engines

Equipment	#	Power	PM_{30} Emission Factor (kg/hr)	Ratio of PM_{10} to PM_{30}	Work Hours/ day (hr/day)	Maximum PM_{10} Emissions over 24 hours (kg/day [lb/day])	Work Days per Month	Total Work Days	Total PM_{10} Emissions (kgs [lbs])
Motor Grader	2	Diesel	0.0277	0.5	10	0.28 [0.6]	17.3	104	28.8 [63.5]
Dump Truck	6	Diesel	0.1160	0.5	10	3.48 [7.7]	17.3	104	361.9 [797.9]
Flatbed Truck	2	Diesel	0.1160	0.5	10	1.16 [2.6]	17.3	104	120.6 [266.0]
Backhoe	2	Diesel	0.0750	0.5	10	0.75 [1.7]	17.3	104	78.0 [172.0]
Clamshell	2	Diesel	0.0750	0.5	10	0.75 [1.7]	17.3	104	78.0 [172.0]
Mobile Crane	1	Diesel	0.0632	0.5	10	0.32 [0.7]	17.3	104	32.9 [72.5]
Water Tanker Truck	3	Diesel	0.1160	0.5	10	1.74 [3.8]	17.3	104	181.0 [398.9]
					Total:	**8.47 [18.7]**			**881.2 [1942.7]**

Note: Emission factors from EPA AP-42, dump/flatbed trucks and water tanker trucks were classified as off highway trucks, backhoes and clamshells were classified as wheeled dozers, and mobile cranes were classified as miscellaneous.

Table 5-2. PM_{10} Emissions from Support Vehicles During Construction

Type of Vehicle	#	Type of Engine	Particulate (PM_{30}) Emissions (grams per mile)	Ratio of PM_{10} to PM_{30}	Particulate (PM_{10}) Emissions (grams per mile)	Miles/ Trip	Trips/ Day	Work Days per Month (days)	Total Work Days (days)	Total PM_{10} Emissions (kg [lb])	Maximum PM_{10} Emissions over 24 hours (kg/day [lb/day])
Pick-up Truck	1	Gas	0.017	0.5	0.009	65	2	17.3	104	0.115 [0.253]	0.0011 [0.002]
Bus	1	Diesel	5.520	0.5	2.760	65	20	17.3	104	373.152 [822.651]	3.5880 [7.910]
Chemical Toilet Truck	1	Gas	0.054	0.5	0.027	65	2	17.3	104	0.365 [0.805]	0.0035 [0.008]
Step Van	1	Gas	0.017	0.5	0.009	65	20	17.3	104	1.149 [2.534]	0.0111 [0.024]
Fuel Truck	1	Gas	0.054	0.5	0.027	65	2	17.3	104	0.365 [0.805]	0.0035 [0.008]
Maintenance Truck	1	Gas	0.017	0.5	0.009	65	2	17.3	104	0.115 [0.253]	0.0011 [0.002]
Lunch Wagon	1	Gas	0.017	0.5	0.009	65	2	17.3	104	0.115 [0.253]	0.0011 [0.002]
Personal Vehicle	1	Gas	0.017	0.5	0.009	65	10	17.3	104	0.575 [1.267]	0.0055 [0.012]
									Totals:	**376 [829]**	**3.61 [7.97]**

PM_{10} emissions from disturbed soil can result from clearing operations and off-road travel. The quantity of PM_{10} produced during land clearing is proportional to the area disturbed and the amount of soil moved. PM_{10} emissions calculations are based on the EPA AP-42 emission factor of 1.2 tons of particulate matter per acre/month. At the construction areas standard dust control methods will be used which could include watering the site twice a day. Table 5-3 describes the parameters used to estimate emissions from clearing operations and off-road travel. The site cleared for the landing and recovery area is estimated to be 2.63 square kilometers (649 acres) and will take approximately three months to clear. The maximum quantity of PM_{10} emitted is estimated to be 4.9 tonnes (5.4 tons). It is estimated that it will take one month to clear the eight acres necessary for the payload processing facility at the launch complex in Area 19. These activities are estimated to result in no more than 0.06 tonnes (0.07 tons) of PM_{10} emissions. Operations for clearing the 0.06 square kilometers (14 acres) for the launch site are estimated to take one month to complete. These operations are estimated to result in PM_{10} emissions of no more than 0.11 tonnes (0.12 tons). PM_{10} emissions from off-road travel during a six-month period are estimated to be 3.4 tonnes (3.7 tons) based on AP-42 emission factors.

Table 5-3. Maximum Daily PM_{10} Emissions from Construction Clearing Operations and Off-Road Travel

	Maximum Area Disturbed *(acre)*	**Daily Emission Factor** *(tons/acre/day)*	**Control Efficiency of Watering** *(%)*	**% of PM_{30} that is PM_{10}**	**Time** *(month)*	**Work Days /Month**	**Maximum Total PM_{10} Emissions** *(tons [tonnes])*	**Maximum Daily Emissions** *(tons per day [kg/day])*
				Clearing Operations				
Payload Processing Facility	8	0.04	50	50	1	17.3	0.0666 [0.0605]	0.00385 [3.5]
Launch Site	14	0.04	50	50	1	17.3	0.1167 [0.106]	0.00674 [6.1]
Landing and Recovery Area	649	0.04	50	50	3	17.3	5.3976 [4.897]	0.104 [94.4]
				Off-Road Travel				
All Locations	-	1.24*	-	50	6	17.3	3.7213 [3.3759]	0.03588 [32.5]

Note: The emission factor for heavy construction used was 1.2 tons/acre/month of activity; assuming 30 days per month results in a daily emission factor of 0.040 tons/acre/day.

* The emission rate is based on the following formula from AP-42 pg. 11.2-1: Emission rate = 0.81*s*(S/30)*(0.62)*(W/4)*VMT, where s = silt content, S = vehicle speed, W = number of wheels, and VMT = vehicles miles traveled. The silt content was estimated to be 0.16 (unitless), the vehicle speed was estimated to be 30 miles per hour, the number of wheels was estimated to be six, and the vehicle miles traveled was estimated to be 173 miles per month (based on 10 miles per day for 17.3 days per month).

Sources: Compilation of Air Pollutant Emission Factors (EPA AP-42), Vol. II, pp. II 7-4, 7-5, N-5, and equipment estimates from Kistler Aerospace.

Table 5-4 totals all of the PM_{10} emissions by source to determine the total daily PM_{10} emission factor. The total emissions were modeled to estimate the maximum possible impact of these emissions on ambient air quality. The most conservative case was based on all construction equipment operating at the same time in the landing and recovery area, because of its large amount of area-generated dust emissions. The maximum downwind concentrations at the different averaging periods[g], which depended on the format of the applicable standards, were calculated using EPA's SCREEN3 Air Quality Model, a conservative screening model that estimates the maximum downwind concentration of the pollutant assuming worst case meteorological conditions. The emission rates for the different averaging periods and the results of the model simulations are shown in Table 5-5. The most conservative scenario was to consider, for a 10- hour workday, the cumulative effects of maximum construction operations at all sites simultaneously, full vehicular and equipment use, and off-road travel. For modeling purposes, the PM_{10} emissions were considered an area source. The size of the emission area is described in further detail in Appendix D.

The parameters used for the EPA SCREEN3 Model are as follows:

- Type of Source (Point/Area/Volume) = Area
- Length of Smaller Side = 334 meters
- Length of Larger Side = 334 meters
- Emission Rate = varied depending on averaging time (see Table 5.3)
- Source Height = 0.0 meters
- Receptor Height = 1.5 meters (a person)
- Urban/Rural Area = Rural
- Search on all directions to find maximum downwind concentration (Y/N) = Yes
- Atmospheric Stability Class (a-f) = b (based on average wind speed of 4.1 m/s)
- Average wind speed was determined from Nellis Air Force Base atmospheric data.

[g] Different averaging periods were used in different air quality standards. The length of the averaging period affects the number of hours in a day used to convert the emission rate from mass per day to mass per second. For averaging times less or equal to 10 hours, the assumption is that there are 10 hours of emissions in a day. This assumption provides the maximum average emission rate for the averaging period, assuming that emissions are constant throughout the 10 hour workday. For averaging periods between 10 hours and 24 hours, the assumption is that the number of hours of emissions in a day is equal to the averaging period (e.g., 24 hour averaging period would result in the assumption that there are 24 hours of emissions in a day). This assumption provides the maximum average emission rate for the averaging period, assuming that emissions are constant throughout the averaging period. For annual averaging times, the emission rate is converted using a one-hour averaging time and the modeling result from SCREEN3 is multiplied by the EPA conversion factor of 0.08 to obtain the maximum annual average concentration.

Table 5-4. Summary of PM_{10} Emissions from All Vehicles

	PM_{10} Emissions
Vehicle Emissions	
Construction Vehicles	8.5
All Other Support Vehicles	3.6
Total Vehicle Emissions	**12.1**
Construction Clearing Emissions (Dust)	
Payload Processing Facility	3.5
Launch Site	6.1
Landing and Recovery Site	94.4
Total Construction Emissions	**104**
Off-Road Travel Emissions (Dust)	
Total Off-Road Travel Emissions	**32.5**
Total PM_{10} Emissions	**148.6**

As seen in Table 5-5, the maximum daily average concentrations of PM_{10} are not expected to exceed 144 microgram per cubic meter (μg/m$^{3)}$, which is less than the national and Nevada daily average PM_{10} standards of 150 μg/m^3. In addition, the annual average is not expected to exceed 18.9 μg/m^3, which is well below the national and Nevada standards of 50 μg/m^3. As these maximums occur within a controlled area, the public and controlled personnel are not expected to be adversely affected. The impact on the general public is expected to be minimal.

Table 5-5. Summary of PM_{10} Emissions from SCREEN3 Model Simulations

Averaging Time	**24 hrs**	**Annual**
Modeled Emission Rate (g/s*m^2)	1.54 x 10^{-5}	3.70 x 10^{-5}
Ambient Concentration (μg/m^3)	45.4	-
Downwind Concentration (μg/m^3)	98.61	18.9
Total Concentration (μg/m^3)	144.0	18.9
NAAQS Standard (μg/m^3)	150	50
Nevada Standard (μg/m^3)	150	50

Besides PM_{10}, the equipment involved in construction of the launch site, vehicle processing facility, payload processing facility, and landing and recovery site will have other emissions. Construction and support vehicles and equipment will generate various engine exhaust emissions including, carbon monoxide, hydrocarbons (HC), nitrogen oxides, and sulfur dioxides. Table 5-6 presents the calculation of these other emissions from construction vehicles and Table 5-7 presents the emissions calculations from the support vehicles used during the construction phase. Table 5-8 totals these emissions per day (during the 10-hour day) from all construction activities. Modeling was then performed to determine the maximum ambient emission concentrations. The model and modeling assumptions were the same that were used to model the PM_{10}. Similar to the PM_{10} modeling effort, the emission rates during the 10-hour workday were used when modeling against air quality standards that had averaging times of 10 hours or less. For larger averaging times such as 24 hours, the emissions for the 10-hour day were distributed equally over a 24-hour time period. Finally, to get the model input of emission rate per area, the emission rates were divided by the same daily disturbance area (i.e., 111,462 square meters) used in the PM_{10} analysis. Thus, for carbon monoxide, the rate was 3.84×10^{-5} gram per second per square meter for either the eight or one hour averaging time. For hydrocarbons, the rate was 1.73×10^{-6} g/s per m^2 for the 24 hour averaging time. For nitrogen oxides, the rate was 7.54×10^{-5} g/s per m^2 for the annual arithmetic average rate (determined by multiplying the one-hour emission rate by the EPA factor of 0.08). Finally, for sulfur dioxides, the rate was 3.17×10^{-6} g/s per m^2 for the 24 hour averaging time and 7.6×10^{-6} g/s per m^2 for the three hour averaging time. The results of the modeling in Table 5-9 indicate that none of the NAAQS and Nevada air quality standards are exceeded during the construction.

Table 5-6. Calculation of Other Emissions from Construction Engines (diesel)

Equipment	Equipment Number	Work Hours/ Day	CO Unit Factor (lb/hr)	CO Emission	HC Unit Factor (lb/hr)	HC Emission (lb/day)	NO_X Unit Factor (lb/hr)	NO_X Emission (lb/day)	SO_X Unit Factor (lb/hr)	SO_X Emission (lb/day)
Motor Grader	2	10	0.15	3.0	0.04	0.8	0.71	14.3	0.09	1.7
Dump Truck	6	10	1.79	107.6	0.19	11.5	4.17	250.0	0.45	27.2
Flatbed Truck	2	10	1.79	35.9	0.19	3.8	4.17	83.3	0.45	9.1
Backhoe	2	10	1.79	35.9	0.19	3.8	4.17	83.3	0.35	7.0
Clamshell	2	10	1.79	35.9	0.19	3.8	4.17	83.3	0.35	7.0
Mobile Crane	1	10	0.68	6.8	0.15	1.5	1.69	16.9	0.14	1.4
Water Tanker Truck	3	10	1.79	53.8	0.19	5.8	4.17	125.0	0.45	13.6
Total Emissions (lbs/day)				**278.9**		**31.0**		**656.1**		**67.0**
Total Emissions (kg/day)				**126.5**		**14.1**		**297.6**		**30.4**
Total Emissions in Construction (kg)				**13,156**		**1,466.4**		**30,950.4**		**3,161.6**

Table 5-7. Calculation of Other Exhaust Emissions from Support Vehicles

Equipment	Miles/Trip	Trips/Day	CO Unit Factor (g/mi)	CO Emission (g/day)	HC Unit Factor (g/mi)	HC Emission (g/day)	NO_X Unit Factor (g/mi)	NO_X Emission (g/day)
Pick-up Trucks	65	2	9.32	1,211	0.64	83	0.87	114
Buses	65	20	1.35	1,755	0.44	572	1.02	1,326
Chemical Toilet Trucks	65	2	14.35	1,866	1.27	165	4.47	581
Step Vans	65	20	9.32	12,116	0.64	826	0.87	1,136
Fuel Trucks	65	2	14.35	1,866	1.27	165	4.47	581
Maintenance Trucks	65	2	9.32	1,212	0.64	83	0.87	114
Lunch Wagons	65	2	9.32	1,212	0.64	83	0.87	114
Personal Vehicles	65	10	9.32	6,057	0.64	413	0.87	568
Total Emissions (g/day)				**27,293**		**2,388**		**4,533**
Total Emissions (kg/day)				**27.3**		**2.4**		**4.5**
Total Emissions in Construction (kg)				**2,838**		**248**		**471**

All support vehicles run on gas except buses which run on diesel.
104 Days during construction.
Emission factors from AP-42, pick-up, step vans, lunch wagons, and personal/maintenance vehicles classified as light duty gasoline, fuel and chemical toilet trucks classified as heavy duty gasoline, and buses classified as light duty diesel.

Table 5-8. Summary of Other Emissions from all Construction Activities

Equipment Emissions	CO Emission (kg/day)	HC Emission (kg/day)	NO_X Emission (kg/day)	SO_X Emission (kg/day)
Construction Vehicles	126.8	14.1	298.2	30.5
All other Support Vehicles	27.3	2.4	4.5	0.0
Total Vehicle Emissions (kg/day)	**154.1**	**16.5**	**302.7**	**30.5**

Table 5-9. Maximum Downwind Concentration of Other Criteria Pollutants Compared to Nevada and National Standards

	CO Concentration ($\mu g/m^3$)		SO_X Concentration ($\mu g/m^3$)		NO_X Concentration ($\mu g/m^3$)	HC Concentration ($\mu g/m^3$)
Average Time	Max. 8 hour	Max. 1 hour	Max. 24 hour	Max. 3 hours	Annual	Max 24 hour
Ambient Concentrations at NTS	2,290.0	2,748.0	39.3	65.4	NA	NA
Maximum Downwind Concentration	245.6	245.6	20.3	48.6	38.6	11
Total Concentration	2,535.6	2,993.6	59.6	114.0	38.6	11
NAAQS Standard	NA	40,000	365	NA	100	NA
Nevada Standard	10,000	40,000	365	1300	100	NA

NAAQS and Nevada standards are annual arithmetic means for NO_2
(Engineering Science, 1990)

Ground Effects of K-1 Engine Exhaust

The NK-33 engine exhaust of oxygen and RP-1 fuel would produce ground effects and some effects on the upper atmosphere. Ground effects from the engines would occur from start cartridges and engine exhaust.

Start Cartridge Emissions

Three different types of start cartridges are used to initiate the NK-33 engine fuel flow on the LAP. Two of the starter materials are used in very small quantities, with an igniter made up of less than 50 grams (1.7 ounces) of explosive (similar to the large six kilogram (13 pound) start cartridge described below), and less than 300 grams (10 ounces) in each of the triethyl aluminum ampoules, made up of 85 percent triethylborane and 15 percent triethylaluminum. The main start cartridge weighs approximately six kilograms (13 pounds) for a total of 18 kilograms (39 pounds) of propellant consumed in less than one second at the engine ignition command. The cartridges use an Aerojet gas generator propellant, the same propellant used for the Titan launch vehicle. The three cartridges will produce approximately three kilograms (six pounds) of CO and approximately two kilograms (four pounds) of HCl. The total list of gas products from the main start cartridge for each launch is shown in Table 5-10.

Table 5-10. Gas Products from Kistler Start Cartridges for One Launch

Gas Products	Weight Fraction of gas exhaust	Kg per launch
CO_2	0.33279	5.99
CH_4	0.02764	0.50
CO	0.15684	2.82
HCl	0.11866	2.14
H_2	0.03039	0.55
H_2O	0.14222	2.56
N_2	0.18770	3.38
Cr_2O_3 (S)	0.00073	0.01
Cu(L)	0.00304	0.05
Total		**18.00**

(Aerojet Information Sheet, February 1997, and SRS, 1997)

K-1 Engine Emissions

As part of each launch, the vehicle would undergo an engine health check on the pad at 55 percent thrust. Should any anomalous readings occur, the vehicle is programmed to shut itself down (on-pad abort).

The composition of the NK-33 engine exhaust was computed using a standard theoretical performance computer program based on chemical equilibrium combustion and expansion with onedimensional fluid flow through the chamber and nozzle of the engine. The propellants were LO_X entering at its normal boiling point (-183 ^oC or -297.35 ^oF) and RP-1 (empirical formula $CH_{2.07448}$) entering at 25 degrees centigrade (77 ^oF).

Based on these operating conditions, the composition of the exhaust is given in Table 5-11.

Table 5-11. Composition of Engine Exhaust at the Exit Plane of the Nozzle

Conditions		
Thrust Level	55 percent	Emissions Per Engine
Fuel flowrate	264 kg/s (638 lb/s)	
Oxidizer/Fuel Mass Mixture Ratio	2.875	
Species	**Mass Fraction**	**kg/s**
CO	0.2011	58.2
CO_2	0.4894	141.7
H	0.0001	0.0
H_2	0.0042	1.2
H_2O	0.3030	87.7
O	0.0001	0.0
OH	0.0018	0.5
O_2	0.0004	0.1

(Aerojet Computer Model (TRAN 72), 1997)

Comparing the species above with the ambient air quality standards in Table 3-2 the only criteria pollutant emitted from exhaust is carbon monoxide.

The two kilograms of HCl emitted during the two-second health check firing would be dispersed over a large area and have little impact on the air quality. For comparison, the solid-fuel Castor 120 rocket engines emit 114 kilograms per second (251 pounds per second) for the duration of their first stage and were not determined to have adverse air quality impacts (Kodiak, 1996).

Launches

For a vehicle launch, the Kistler NK-33 engines would ramp up to 100 percent thrust level after the initial two second/55 percent thrust firing. In addition, prior to separation of the OV from the LAP, the engines would throttle down to 55 percent thrust in several steps before the engines shut down. The emissions product fractions change at different thrust levels, fuel rates, and mixture ratios, as outlined in Table 5-12.

Table 5-12. NK-33 Engine Emissions for Two Different Operating Conditions

Conditions		
Thrust Level	55 percent	100 percent
Fuel flowrate	290 kg/s	519 kg/s
Oxidizer/Fuel Mass Mixture Ratio	2.875	2.586
Species		
CO	0.2011	0.2917
CO_2	0.4894	0.4119
H	0.0001	0.0000
H_2	0.0042	0.0092
H_2O	0.3030	0.2871
O	0.0001	0.0000
OH	0.0018	0.0000
O_2	0.0004	0.0000

(Aerojet Computer Model (TRAN 72), 1997, and SRS, 1997)

Table 5-13 lists the duration and throttle setting for each segment of engine firing until it passes through the troposphere at 20 kilometers (12 miles) and its air emissions no longer impact regional air quality.

Table 5-13. Carbon Monoxide Launch Emissions in the Lower Atmosphere

	Time (s)	Cumulative Time	Percent Thrust	CO Emission Rate (kg/s)	CO Emissions per launch (kg)	CO Emissions Annually (kg)*
Start Cartridge	-	-	-	-	3	159
Engine Check	2	2	55	174.6	349.2	18507.6
Liftoff to 500 m (Nocturnal Inversion)	18	20	100	454.4	8,179	433,487
0.5-20 km (Troposphere)	77.3	95.3	100	454.4	35,124	1,861,572

* Assume 52 flights per year
(Aerojet Computer Model (TRAN 72), 1997, and Kistler, 1997)

When the K-1 vehicle exits the troposphere and reaches the stratosphere it is approximately 12 kilometers (seven miles) downrange of the launch area.

The Kistler K-1 reusable launch vehicle is compared below with six expendable launch vehicles, the Scout, Delta, Atlas Centaur, and Titan IIIE/Centaur. Table 5-14 provides comparative CO emissions for launch of these vehicles.

Table 5-14. Comparative CO Emissions (kg) into Selected Atmospheric Layers

Vehicle	Atmospheric Layer Altitude Range (ft)		
	Inversion 500 m [1,640 ft]	Troposphere 0.5-20 km [65,620 ft]	Stratosphere 20-67 km [219,827 ft]
Scout	110	4,080	970
Delta 3C	2,600	10,780	14,400
Delta 6C	2,500	11,320	14,900
Delta 9C	3,020	13,740	13,350
Atlas Centaur	6,310	24,310	17,500
Kistler K-1	8,531	35,124	24,682
Titan IIIE/Centaur	17,510	83,000	43,320

(OCST, 1986)

Kistler's CO emissions can be calculated as a percentage of Titan IIIE/Centaur because its emissions are well known, as shown in Table 5-15.

Table 5-15. Comparative CO Emissions (kg) into Selected Atmospheric Layers

Vehicle	Atmospheric Layer Altitude Range		
	Inversion (km [ft])	Troposphere (0.5-20 km [65,620 ft])	Stratosphere (20-67 km [219,827 ft])
Kistler K-1	8,531	35,124	24,682
Titan IIIE/Centaur	17,510	83,000	43,320
Percent	49%	42%	57%

(OCST, 1986)

These Titan IIIE/Centaur emissions resulted in downwind peak instantaneous concentrations of less than five parts permillion in the spring and 5.3 ppm in fall meteorological conditions at a distance of one km. (DOT, *Programmatic Environmental Assessment for Expendable Launch Vehicles*, Figures 3-5 and 3-6, pp. 19-20). At distances of only 10 kilometers (six miles) away, the concentrations dropped below 1.5 ppm. Since Kistler K-1 CO emissions are estimated to be less than 50 percent of the Titan IIIE/Centaur for all meteorological conditions, they are expected to be significantly less than the six ppm Nevada standard for sites above 1,524 meters (5,000 feet) and much less than the national standard of nine ppm. Thus, no adverse effects on air resources are anticipated from K-1 launches.

Upper Atmospheric Effects

The stratosphere begins at about 20 kilometers (65,000 feet) and can be considered the lower bound of the upper atmosphere. The mesosphere/thermosphere begins at about 67 kilometers (219,827 feet) and extends into space. As shown in Table 5-16, the LAP would throttle back its engines and shut them down before separation. The LAP would restart its center engine after separating from the OV. The LAP would complete firing the center engine before it reaches the upper boundary of the stratosphere at an elevation of 67 kilometers (42 miles). The OV would fire its NK-43 engine both in the stratosphere and thermosphere/mesosphere for its orbital insertion. Based on these engine firings, and emission factors for the NK-43, the emissions of H_2O and CO_2 were calculated and are listed in Table 5-17.

In the upper atmosphere, H_2O and CO_2 may be considered potential pollutants due to their low natural concentration, and the possible influence on the Earth's heat balance. The amount of CO_2 and H_2O generated by the Kistler vehicles and the Titan IIIE/Centaur are listed in Table 5-17. The Titan IIIE/Centaur and the Titan IIIC were identified as emitting the largest amount of CO_2 and H_2O in the DOT *Programmatic Environmental Assessment for Expendable Launch Vehicles*.

Table 5-16. Engine Firings in the Upper Atmosphere

	Atmospheric Level	Number of Engines Firing	Throttle Rate	Time (s)
LAP	Stratosphere	3	100	30
LAP	Stratosphere	3	100 & 55	3
LAP	Stratosphere	3	55	3
LAP	Stratosphere	2	55	3
LAP	Stratosphere	0	0	8.1
LAP	Stratosphere	1	100	29.1
OV	Stratosphere	1	100	36
OV	Thermosphere/ Mesosphere	1	100	159
OV	Thermosphere/ Mesosphere	1	50	31.7

(Aerojet Computer Model (TRAN 72), 1997, and Kistler, 1997)

Table 5-17. Comparative CO_2 and H_2O Emissions into the Upper Atmosphere

Atmospheric Layer Altitude Range	Stratosphere (20-67 km [65,620 - 219,827 ft])		Mesosphere - Thermosphere (67 km [219,827 ft]	
	Emissions (kg)		Emissions (kg)	
Vehicle	CO_2	H_2O	CO_2	H_2O
Kistler K-1	33,742	24,984	42,682	24,740
Titan IIIE/Centaur	19,700	18,800	20,400	47,450

The Kistler vehicle would produce more CO_2 than the Titan IIIE/Centaur in the upper atmosphere, 71 percent more in the stratosphere, and 109 percent more in the mesosphere and thermosphere. The CO_2 concentration in the exhaust cloud at an elevation of 60 kilometers (37 miles) for the Titan IIIE/Centaur would drop below ambient levels of CO_2 concentration after the cloud expanded to four square kilometers (1.5 square miles). Estimates of the area in the stratosphere into which the Titan IIID cloud would have to expand before the carbon dioxide density would reach that of the ambient air were made as in the case of water vapor based on data in the DOT *Programmatic Environmental Assessment for Expendable Launch Vehicles*. For CO_2 at 25 kilometers (15 miles) the cloud must expand to less than 0.1 square kilometers (0.06 square miles) before the CO_2 would reach ambient levels. At 60 kilometers (23 square miles) the cloud would drop below ambient levels of CO_2 concentrations after it expanded to an area of four square kilometers (1.5 square miles). For the Kistler exhaust the cloud would require a larger area for dispersion below ambient levels.

The Kistler vehicle would produce less H_2O in the upper atmosphere than the Titan IIIE/Centaur despite the fact that in the stratosphere the Kistler vehicle produces 33 percent more than the Titan IIIE/Centaur. The H_2O concentration in the exhaust cloud at an elevation of 60 kilometers (37 miles) for the Titan IIIE/Centaur would drop below ambient levels of H_2O concentration after the cloud expanded to 800 square kilometers (308 square miles). The Kistler exhaust cloud would require a smaller area for dispersion than the Titan IIIE/Centaur.

The PEIS LL states that launch activities appear to be many orders of magnitude below those that would be expected to produce detectable changes in the upper atmosphere. Therefore, the Kistler launches should have minimal impacts on the upper atmosphere.

Table 5-18 presents the annual CO_2 and H_2O emissions into the upper atmosphere from the maximum projected number of Kistler launches. The total emissions of CO_2 to the stratosphere and above from the K-1 vehicle is 4,455 tons. A U.S. EPA study showed that industrial sources contributed 150,200,000,000 tons of CO/CO_2 to the stratosphere and troposphere from the period 1990-1994 or 37,550,000,000 tons per year. Therefore the cumulative impact on global warming from the Kistler launches is not expected to be significant.

Table 5-18. Annual CO_2 and H_2O Emissions (kg) into Upper Atmosphere From Kistler Launches*

Stratosphere (20-67 km [65,620-219,827 ft])		Mesosphere – Thermosphere (above 67 km)	
CO_2	H_2O	CO_2	H_2O
1,788,326	1,324,152	2,262,146	1,311,220

* Assume 52 flights per year

Reentry and Landing Operations

The OV would return to Earth approximately 24 hours after launch. The OV would reenter the atmosphere and decelerate, using aerodynamic braking. It would pass into NTS restricted airspace at an altitude of about 33,000 meters (108,000 feet), and a stabilizing drogue parachute would deploy about 30,500 meters (100,000 feet). The six main parachutes would deploy below 6,000 meters (20,000 feet), and the vehicle would land on inflated airbags.

The OV may have some potential effects on the upper atmosphere due to its thermal protection system, but this is expected to be minimal. The high kinetic energy of space flight is dissipated during reentry as atmospheric drag slows its speed and converts the kinetic energy into primarily thermal energy. The Kistler OV would use Space Shuttle ceramic tiles and an ablator thermal protection system on portions of the nose cone to shield the reentry vehicle from the heat generated during reentry.

During reentry the Kistler OV would burn up approximately 26 kilograms (57 pounds) of ablative material. The ablator is typically a honeycomb base with a filler material. The base materials would consist of oxygen, carbon, hydrogen, and nitrogen. The filler material would consist of calcium, silicon, and sodium. The small amount of material and large area over which the material is dispersed would cause a minimal impact, as noted in the PEIS for Commercial Reentry Vehicles:

> *The carbon char and polymer binder fibers produced by the ablative material could increase particulate loading in the atmosphere along the reentry trajectory. Because of the small quantity of particulates and the dispersive properties of the atmosphere, no adverse atmospheric effects are expected based on the projected level of commercial activity.* (p.5-22).

The thermal protection system should cause no adverse effects, also noted in the PEIS for Commercial Reentry Vehicles:

> *Radiative heat shields are self-contained and generally do not introduce substances into the atmosphere; no adverse effects have been identified from the ceramic tiles used on parts of the Space Shuttle. Thermal protection systems on commercial RVs utilizing heat shield systems are not anticipated to cause any adverse atmosphere impacts.* (p. 5-24).

Air Emissions from Routine Operations

The operation and maintenance of the vehicle processing facility and launch site would generate additional air emissions. Fueling operations would present the potential for the largest source of air emissions, with more than 160,000 kilograms (350,000 pounds) of RP-1 and 62,000 kilograms (137,000 pounds) of LO_X used for each flight. Liquid oxygen would not pose a health risk other than for safety concerns. At high exposure levels, RP-1 can be harmful to human health. Kistler would use a pressure vessel to transfer kerosene and should experience annual active and evaporative losses (based on internal Kistler calculations which assume the cryogenic cooling for fuel will result in lower emissions) of less than 100 kilograms (220 pounds) of kerosene. Vapors of kerosene, like vapors of other hydrocarbon fuels, can cause toxic effects on blood-forming tissues. However, such vapors will be vented at a height and location (e.g., outside) that will give adequate protection for personnel, buildings, and the environment (reference is Hazards of Chemical Rockets and Propellants, Chemical Propulsion Information Agency, Volume III Liquid Propellants, September 1984). Also, the total quantity of emissions indicated will not occur as a large acute (short term) exposure, but will occur as a slow vapor release over a long period of time.

The other fuel used for the Kistler vehicle would be ethanol, which is used by the OMS and fueling of approximately 2,000 liters (550 gallons) would occur for each launch. Emissions from ethanol storage and fueling should be minimal. There should be virtually no other air emissions other than low levels produced by the use of small amounts of paint and adhesives.

The receipt and handling of liquid propellants, including hydrazine, could occur for some of the launches. Hydrazine, and all other toxic materials, should be handled in accordance with established safety procedures and regulatory requirements. The propellants and other materials should be stored in sealed containers, and emissions of toxic air pollutants are expected to be minimal.

Fugitive dust air emissions could also occur from vacuuming operations performed on the LAP and OV between launches. Based on conservative estimates of dust layers of 0.025 millimeter (0.001 inch), less than 1,000 kilograms (2,200 pounds) of dust per year would be generated from the vacuuming operations. This amount would be negligible in comparison with the greater than 1,000 kilograms per day of dust generated from construction activities (described above), that meet PM_{10} standards for Nevada.

Air Emissions from Launch or Ground Processing Accidents

If an accident occurs near the launch pad or a launch anomaly occurs, air quality may be affected. Accidents near the launch pad have a more local environmental impact, whereas releases during prolonged flight may contribute more to the potential for global impacts.

<u>LO_X and RP-1</u>. In the event of an accident on the launch pad, causing a rupture of the propellant containers the propellants would burn explosively. Emissions from the open burn of LO_X and RP-1 will produce similar products to those of a launch burn including CO, CO_2, and H_2O. There may be more particulate matter (unburned hydrocarbons) resulting from an accident burn. In the event of a release over water, RP-1 fuel would form a film on the surface of the water. Depending on the quantity released and the surface area of the water body, the film could inhibit oxygen from penetrating the water body[h]. The film would dissipate within hours in large water bodies[i] and would adversely affect the aquatic ecology only in small water bodies.[j]

<u>Hydrazine</u>. The Kistler K-1 vehicle does not utilize hypergolic propellants. However, the satellite payloads may carry relatively small amounts of hypergols. The open burn of hypergolic propellants such as hydrazine would result in the formation of NO_2 and NO_x. These are particularly toxic and would create a hazard to anyone unprotected in the immediate area of the accident.

If the K-1 or payload propellants are spilled directly or released as a burning byproduct into local water resources (e.g., river), the extent of impacts depend on the conditions of the accident, and the type of water resource affected. Hydrazine is acutely toxic to aquatic life.[k] If released from an accident, hydrazine would either be oxidized in the air, react and possibly ignite with the porous earth, or form soluble substances in water such as ammonia, methylamine and dimethyl amine and oxides of

[h] Environmental Assessment for NAVSTAR Global Positioning System, Block IIR, and Medium Launch Vehicle III, Department of the Air Force, November 1994.

[i] USAF Environmental Assessment, Medium Launch Vehicle Program, Cape Canaveral Air Station, Florida, May 1988.

[j] Chemical Propulsion Information Agency document, September 1994.

[k] Environmental Assessment for NAVSTAR Global Positioning System, Block IIR, and Medium Launch Vehicle III, Department of the Air Force, November 1994.

nitrogen.[l] These substances are toxic and injurious to plant and lower animal life if present in sufficient concentrations. Localized impacts would be experienced as a result of these accident scenarios.

Nitrogen Tetroxide (N_2O_4). A hypergol such as N_2O_4 is a highly toxic gas with corrosive fumes. In water, N_2O_4 will react to produce nitric and nitrous acids which themselves act as general buffers. Ocean water is basic and will generally absorb any effects. Consequently, it is not expected that the gaseous N_2O_4 byproducts will have any lasting impacts on aquatic life.[m]

If the accident occurs during prolonged flight, the K-1 and payload propellants will most likely be instantly vaporized. Flights terminated at lower altitudes might produce very limited pooling of liquid fuel on the ground or water surface being overflown, in addition to vaporization in the atmosphere; any such pools would also quickly evaporate.

5.1.4 Noise

Noise impacts would occur during construction, launch of the Kistler vehicle, and reentry activities. Noise impacts during launch of operational flights consist primarily of engine noise. Sonic booms would be generated during the vehicle ascent and reentry. Noise values used in this analysis are provided in terms of dBA.

Construction Phase

Construction activities, such as excavation, leveling, digging and pouring of foundations, building assembly would temporarily increase ambient noise levels at and adjacent to the proposed Kistler vehicle processing facility, launch site, payload processing facility, and landing and recovery area. Traffic noise from worker vehicles and trucks on the road to Mercury would also increase.

Construction equipment could include bulldozers, clamshells, front-end loaders/backhoes, concrete mixers, graders, dump trucks, compactors, and cranes.

Table 5-19 indicates the peak and attenuated noise levels from operation of various pieces of construction equipment. OSHA limits noise exposure to workers to 115 dBA for a period of no longer than 15 minutes in an eight-hour work shift and to 90 dBA for an entire eight-hour shift (29 CFR 1910.95). OSHA requires that feasible administrative and engineering controls be implemented whenever employee noise level exceeds 90 dBA (eight-hour time weighted average). The loudest construction equipment (dump trucks, graders and jackhammers) generate peak levels of 108 dBA and do not exceed the 115 dBA OSHA 15 minute noise limits. All construction workers near activities producing unsafe noise levels would be required to wear hearing protection equipment. This would

[l] Chemical Propulsion Information Agency document, September 1994.

[m] Environmental Assessment for NAVSTAR Global Positioning System, Block IIR, and Medium Launch Vehicle III, Department of the Air Force, November 1994.

prevent workers from being exposed to 90 dBA for an entire eight-hour shift. Therefore, impacts to the occupational health of construction workers as a result of construction noise would not be expected.

Table 5-19. Peak and Attenuated Noise (in dBA) Levels Expected From Operation of Construction Equipment

	Noise Level	**Distance from Source**			
Source	dBA (peak)	15 meters (50 feet)	30 meters (100 feet)	60 meters (200 feet)	121 meters (400 feet)
Heavy trucks	95	84-89	78-83	72-77	66-71
Dump trucks	108	88	82	76	70
Concrete mixer	105	85	79	73	67
Jackhammer	108	88	82	76	70
Scraper	93	80-89	74-82	68-77	60-71
Dozer	107	87-102	81-96	75-90	69-84
Generator	96	76	70	64	58
Crane	104	75-88	69-82	63-76	55-70
Loader	104	73-86	67-80	61-74	55-68
Grader	108	88-91	82-85	76-79	70-73
Dragline	105	85	79	73	67
Pile driver	105	95	89	83	77
Fork lift	100	95	89	83	77

(Golden et al., 1980)

The NTS is a restricted area. Members of the public would not be in the immediate vicinity of the construction site, and would not be exposed to unsafe noise levels. The closest public access is more than 33 kilometers (20 miles) from the payload processing facility and launch site and more than 24 kilometers (15 miles) from the landing and recovery area. At a distance of 24 kilometers (15 miles), noise levels are predicted to be less than 40 dBA, which would not be detectable under normal daytime background noise levels. The impact on the surrounding public is expected to be minimal. This noise level was calculated for a bulldozer, which has the highest noise level of all construction equipment, as follows:

84 dBA+20(Log [400 feet/78,744 feet])=38 dBA.

Launch Noise

Although there are no direct noise data from a K-1 launch (because the K-1 has not launched yet), there are noise data from an NK-33 test run at 100 percent thrust. The sound level from one NK-33 engine at 400 meters (1,300 feet) is 100 dBA. Tripling the sound energy (for three engines) is one way to predict sound level from a K-1 launch, the sound level would increase by six dBA (dBA levels are measures on a logarithmic scale and a tripling of the energy translates into a six dBA gain).

This sound level can be extrapolated out 1,070 meters (3,500 feet) to the operating facility, resulting in an initial sound level of 97.4 dBA. At the Nevada Test and Training Range, which is the closest offsite location at 11.6 kilometers (7.2 miles), the sound level at launch is predicted to be 76.7 dBA. At the closest public access of 30.7 kilometers (19.1 miles) the sound level at launch is predicted to be 68.2 dBA. This distance includes parts of the National Wildhorse Management Area and the Desert National Wildlife range. Airspace above this area is restricted and is primarily used for military training, including supersonic activities.

A radius of 50 kilometers (31 miles) from the launch site includes public lands (to the southwest of the launch area), which are not withdrawn. There are no communities or developed recreational sites in this area. Any people using this small area may experience noise above the existing background of a windy desert, and possibly approaching noise levels of an urban area. At this far field distance, noise levels are difficult to predict accurately because atmospheric conditions are an increasingly important component. Another way to predict sound levels depends upon predicting far field effects considering atmospheric conditions, rural communities and people using natural resources at further distances, based on comparison with the noise levels from other (similar and larger) launch vehicles. These communities and natural areas may include: Shoshone, CA to the south; Scotty's Castle and parts of Death Valley National Park, to the west; Tonopah, to the north; and Alamo and the Pahranagat National Wildlife Refuge to the east.

Comparing the K-1 with other launch vehicles is a way to predict launch noise which yields higher noise levels (approximately 10 to 15 dBA), resulting in the assumption that noise effects from launches could impact larger areas. At 50 kilometers (31 miles) the launch noise would be noticeable and could reach levels approaching a low-level military overflight 2,440 meters (8,000 feet) to the sideline of the flight path or that of a garbage disposal at one meter (three feet). Using these assumptions, it would be possible for natural areas around the NTS to experience noise levels similar to an urban area. However, as noted earlier these noise levels will dissipate rapidly. Furthermore, since the maximum launch rate would be 52 launches per year and people in this area are already exposed to low level military overflights, the incremental effect should not result in significant impacts. Based on the predicted rate of rise for the K-1 vehicle, sound levels can be predicted over time.

Workers at the vehicle processing facility would be required to wear hearing protection devices for the first 18 seconds of launch during which time noise levels would be around 90 dBA. Offsite locations would be unlikely to experience 90 dBA levels. Normal conversations and activity can be carried out at 65 dBA. These levels would be achieved at 1,070 meters (3,500 feet) within 21 seconds, at 11.6 kilometers (7.2 miles) within 16 seconds, and at 30.7 kilometers (19.1 miles) within 13 seconds. No appreciable noise is distinguishable over background noise at 35 dBA. These levels would be achieved at 1,070 meters (3,500 feet) within 24 seconds, at 11.6 kilometers (7.2 miles) within 21 seconds and at 30.7 kilometers (19.1 miles) within 20 seconds.

These predicted sound levels are well within occupational operating parameters for facility work and are all below 77 dBA for all offsite locations. According to analyses conducted by Aerojet System Safety engineers, no off-site locations would experience significant impacts from launch noise. Table 5-20 outlines the predicted dBA sound levels using three NK-33 engines.

The impacts of launch and recovery noise on wildlife are addressed in Section 5.1.7.2 of this EA.

Table 5-20. Predicted dBA Sound Levels

Predicted dBA Sound Levels with Three NK-33 Engines						
Time (s)	**Height above pad (m)**	**Height above pad (ft)**	**dBA at 1300 ft**	**dBA at 3500 ft**	**dBA at 7.2 mi**	**dBA at 19.1 mi**
0	0	0	106.0	97.4	76.7	68.2
1	1	3.3	106.0	97.4	76.7	68.2
2	1	3.3	106.0	97.4	76.7	68.2
3	1	3.3	106.0	97.4	76.7	68.2
4	4	13.1	106.0	97.4	76.7	68.2
5	10	32.8	106.0	97.4	76.7	68.2
6	17	55.8	106.0	97.4	76.7	68.2
7	28	91.9	106.0	97.4	76.6	68.2
8	42	137.8	105.9	97.3	76.6	68.1
9	61	200.1	105.8	97.2	76.5	68.0
10	87	285.4	105.6	97.0	76.3	67.8
11	122	400.3	105.2	96.6	75.9	67.4
12	168	551.2	104.5	95.8	75.2	66.7
13	225	738.2	103.3	94.5	74.0	65.5
14	293	961.3	101.4	92.5	72.1	63.6
15	372	1220.5	98.6	89.5	69.3	60.9
16	462	1515.7	94.9	85.6	65.6	57.1
17	563	1847.1	90.1	80.5	60.8	52.3
18	675	2214.5	84.2	74.1	54.9	46.4
19	798	2618.1	77.2	66.6	47.8	39.4
20	932	3057.7	69.0	58.0	39.7	31.2
21	1077	3533.4	59.8	48.1	30.4	22.0
22	1233	4045.2	49.5	37.2	20.1	11.7
23	1400	4593.1	38.2	25.2	8.8	0.4
24	1578	5177.1	25.9	12.3		
25	1767	5797.2	12.7			

In an attempt to develop estimates for far field noise levels, data were analyzed for five launch vehicles: the Atlas IIAS, Saturn V, the Space Shuttle, Titan IIIC, and the Taurus (using Castor 120TM rocket engines). A comparison of liftoff thrust levels for these vehicles is listed in Table 5-21.

Table 5-21. Comparison of Thrust Levels for Launch Vehicles

Vehicle	Thrust at Liftoff	
	kg	lb
Taurus	163,000	369,900
Atlas IIAS	215,000	474,000
Kistler K-1	462,927	1,020,000
Titan IIIC	1,264,000	2,788,000
Saturn V	3,404,000	7,505,000
Space Shuttle	3,356,000	7,400,000

(World Space Briefing, 1997, and Ertel 1969)

Noise data at different distances are available for these vehicles and form the basis for comparison for the noise levels for the Kistler launch vehicle. The Kistler launch vehicle has greater thrust (462,927 kilograms) than the two smallest launch vehicles listed, the Atlas IIAS (215,000 kilograms) and the Taurus (163,000 kilograms), but has considerably less thrust than the large launch vehicles listed, the Saturn V (3,404,000 kilograms), Space Shuttle (3,356,000 kilograms), and Titan IIIC (1,264,000 kilograms). Figure 5-3 shows the distances from the launch and landing and recovery areas to Nevada Test and Training Range and the public. Figure 5-4 contains noise level readings at various distances from the launch site for these vehicles. These noise levels at different distances closely correlate with the physics of sound (e.g., doubling the distance from the source, the sound intensity is one fourth).

The average noise levels for the Taurus launch vehicle are below the other vehicles described, but the maximum noise levels are comparable to the larger vehicles. The only launch vehicle with significantly higher noise levels than the maximum Taurus noise levels of 90 dBA at 9,000 meters (29,527 feet) was the Titan IIIC, which was close to four dBA louder at 9,000 meters (29,527 feet), at 93.7 dBA. The Saturn V, another very large vehicle, had noise levels of 91 dBA at 9,000 meters (29,527 feet).

Using the maximum Taurus vehicle noise as an analog for the Kistler vehicle would produce an estimate of noise levels of less than 88 dBA at 11.6 kilometers (7.2 miles), the offsite location closest to the launch site, at the border of the NTS and Nevada Test and Training Range. The sound level from launch would be predicted to be less than 78 dBA at 30.7 kilometers (19.1 miles) at the closest public access point to the launch site. With a more conservative approach, using the Titan IIIC data, the loudest launch vehicle, would result in noise levels of 91.9 dBA at the NTS border, and 83.4 dBA at the closest public access. Figure 5-4 shows predicted noise levels for other launch vehicles, including the Titan IIIC.

Figure 5-3. Proximity of Kistler Facilities to Nevada Test and Training Range and Public Access Areas

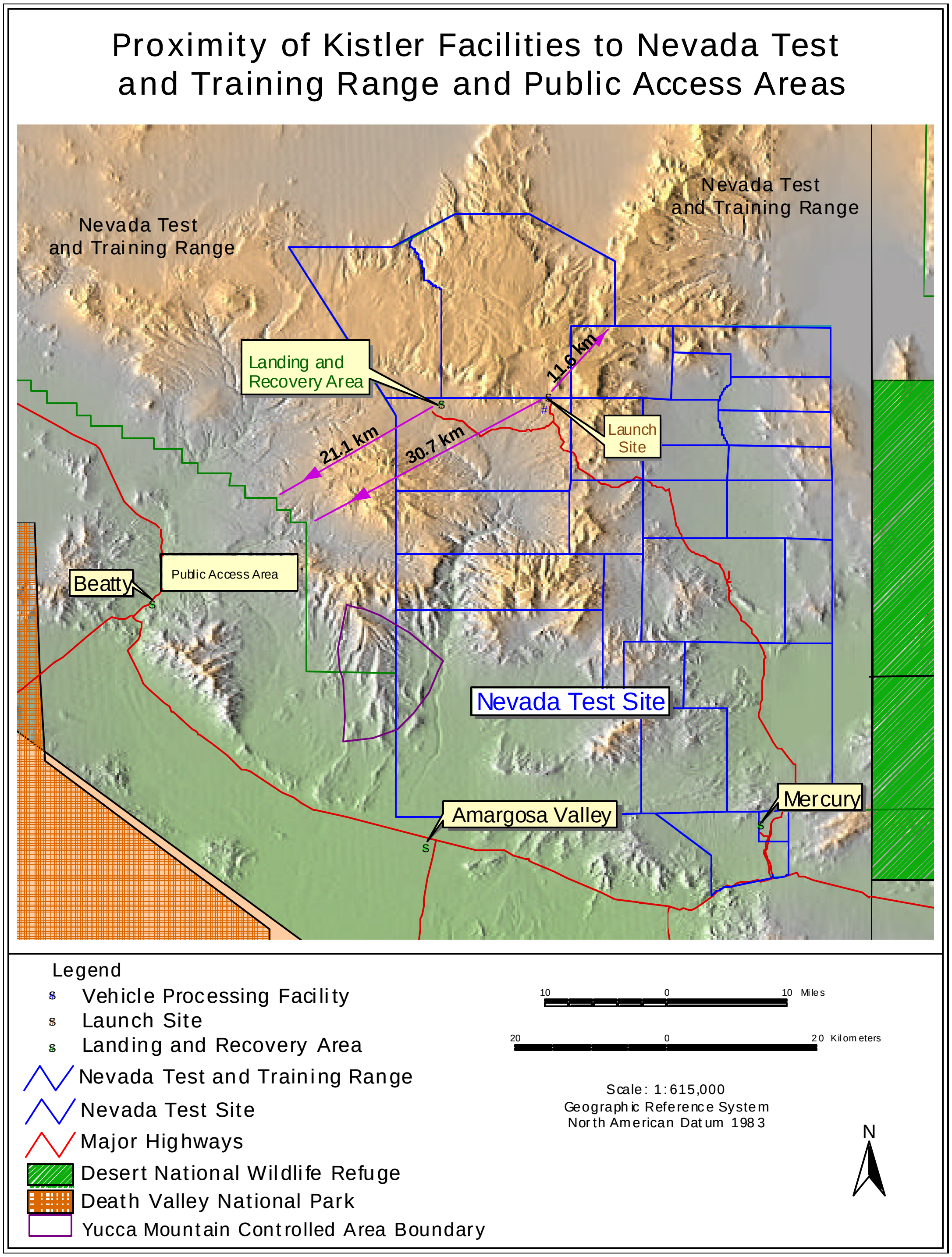
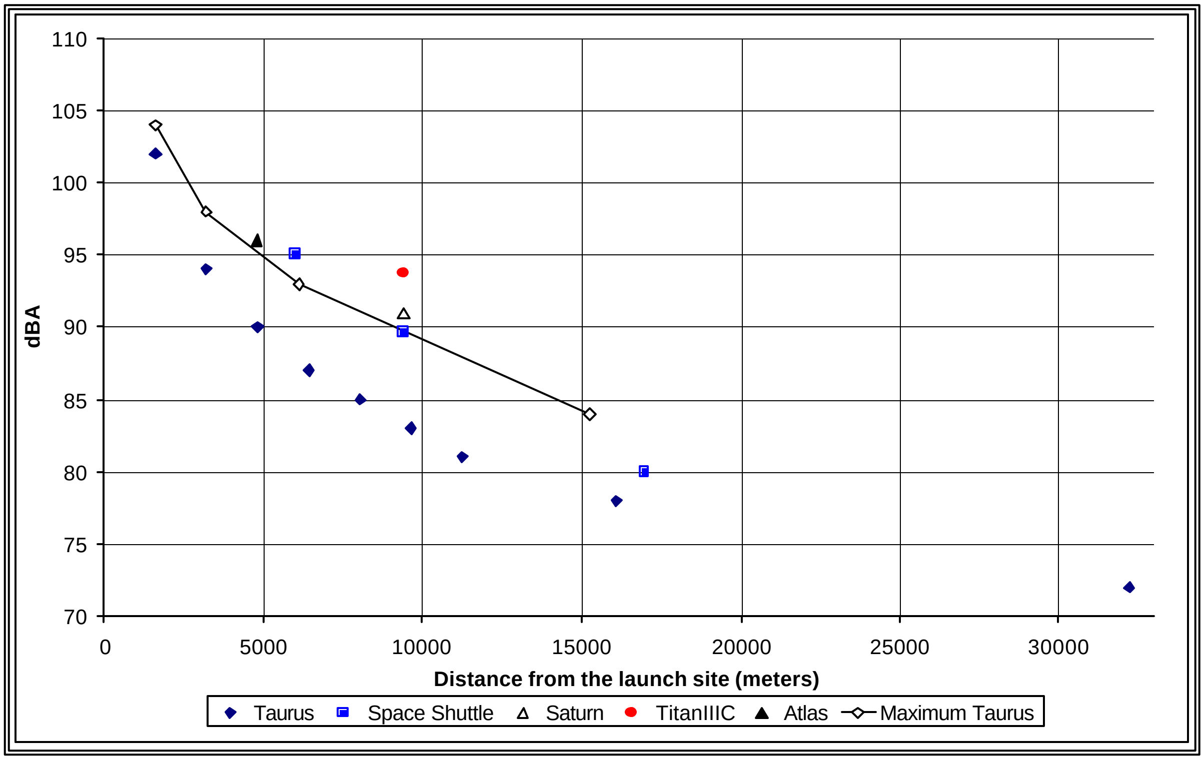


Figure 5-4. Noise Levels for Other Launch Vehicles



Based on the Taurus data, noise levels at the road closure points, approximately one kilometer (3,500 feet) from the launch site, would be approximately 106 dBA, which corresponds to a rock music band near the stage. The duration of launch noise would be less than two minutes, with the noise level decreasing rapidly within 15 seconds of launch. This noise level would be within the OSHA standard of 115 dBA over 15 minutes. Although these are high noise levels, they are well below the threshold of physical discomfort of approximately 120 dBA. Kistler range workers would be required to wear hearing protection, and any NTS workers in close proximity to the launch site would be exposed to high noise levels, but would be minimally impacted due to the short duration of launches, and their relatively infrequency. Given the large distances to the public from the launch site, and the infrequency of launches, adverse public impacts from launch noise is expected to be minimal.

Sonic Booms During Launch

Sonic booms are impulse noises that produce startling audible and dynamic characteristics similar to manmade explosions or thunder. An object moving at supersonic speeds travels faster than acoustical disturbances. Consequently, a shock wave is created by a vehicle with rapid pressure changes occurring across the object; producing sonic booms. The shock wave and associated sonic booms radiate behind the object in a conical shape. An observer on the ground hears a sonic boom when the shock wave passes overhead. Figure 5-5 displays the relationship between a human receptor, a launch vehicle, and an audible sonic boom. The intensity is greatest directly below the vehicle flight path and decreases with radial distance from the ground track. Figure 5-6 displays the maximum sound levels at different distances from the launch site from a geographical perspective.

An object moving faster than the local speed of sound can produce a sonic boom that is independent of the noise produced by the vehicle during flight. Thus, the boom produced by an unpowered projectile (e.g., a ballistic reentry vehicle) traveling supersonically has essentially the same characteristics as a powered projectile, and under some conditions will produce the idealized N-wave associated with sonic booms.

Kistler used anticipated trajectories and average U.S. atmospheric conditions as assumptions for the sonic boom model PCBoom3 (Wyle 3) to generate sonic boom footprints for the Kistler vehicle during ascent. Reentry sonic boom footprints were not generated using the model.

The booms from the Kistler vehicle typically have peak sound pressures of 130 to 140 dB [approximately 65-240 Newtons/square meter (N/m^2) or 1.3 to 5.0 pounds per square foot (psf)] and occur over a small area close to the ground path of the launch vehicle for a short duration (approximately 300 meters per second [984 feet per second]). Figure 5-7 shows the sonic boom footprint for the two Kistler launch trajectories. This figure shows approximate and actual semi-circular arc locations that will be impacted by sonic booms from the north to the northeast of the launch site corresponding to the launch trajectory corridors.

Air turbulence, wind, and temperature variations within the atmosphere have been shown to affect sonic boom ground pressure levels. Although temperature effects on overpressures are small, wind effects tend to increase as the speed of the reentry vehicle decreases. Headwinds tend to increase overpressures and the apparent ground velocity of the shock wave following the launch vehicle and tailwinds tend to decrease them. The extent of distance that a sonic boom can be heard on each side of the reentry ground track, and its intensity, are dependent on variables such as the reentry vehicle's speed (i.e., the velocity vector parallel to the ground track), altitude, weight, exterior configuration, flight conditions, and prevailing atmospheric conditions.

For launch operations, sonic boom generation begins after the vehicle reaches the speed of sound, and the shock wave generated intersects the earth. This would likely occur over areas off-site of the NTS. As the vehicle climbs to higher altitudes, the shock waves reaching the surface of the earth are attenuated to the point where they are not discernible from background noise. At an elevation of 60 km (200,000 ft) the sonic boom produced by the K-1 launch vehicle would resemble distant thunder which produces an overpressure of approximately 16 N/m^2 (0.3 psf) to a receptor on earth. Sonic boom effects from the launch vehicle are dependent on vehicle- and mission-specific parameters. Environmental effects of the sonic booms include those on human and animal receptors. Potential structural effects of the accompanying pressure waves are described in Table 5-22.

Figure 5-5. Sonic Boom Cone

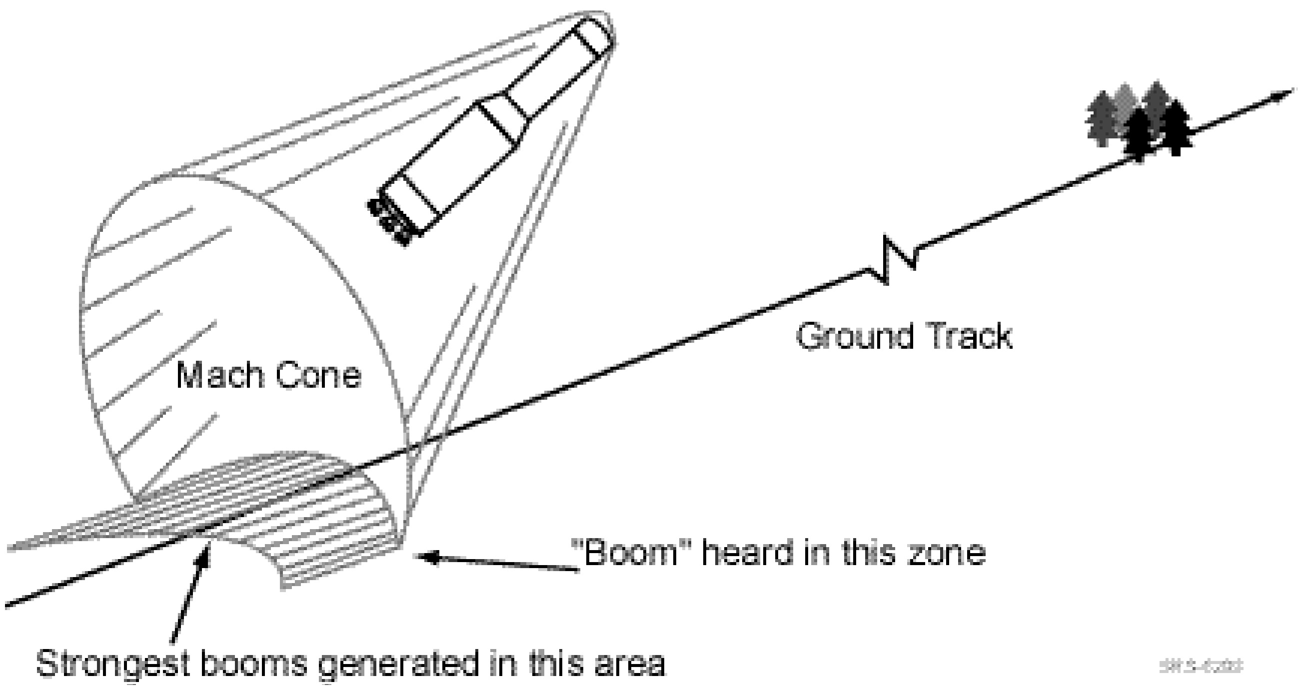
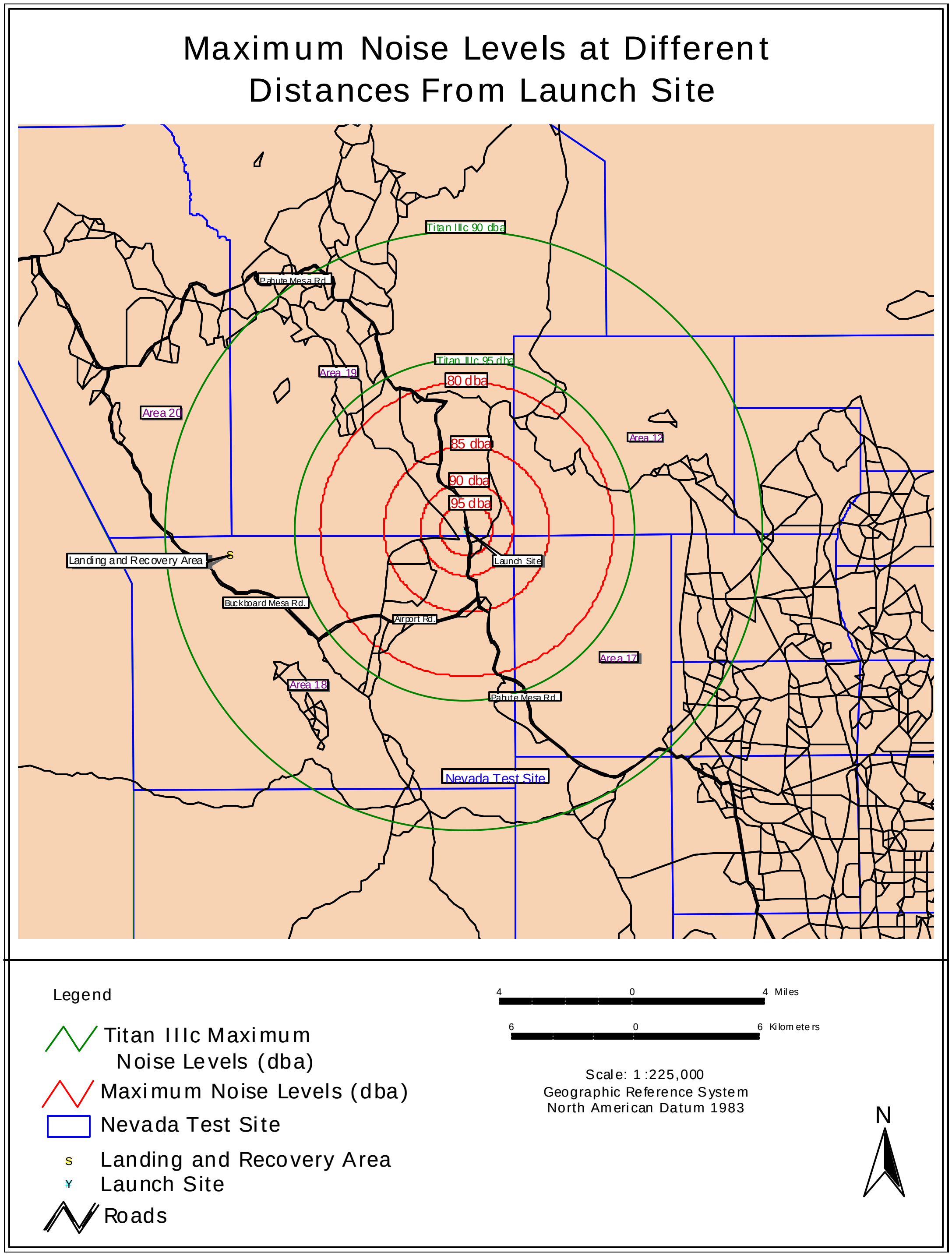


Figure 5-6. Maximum Noise Levels at Different Distances From the Launch Site – No Degradation Due to Terrain Assumed



(OCST PEA, 1996 and Kennedy Space Center EIS)

Figure 5-7. Predicted sonic boom footprint produced by the Kistler vehicle.

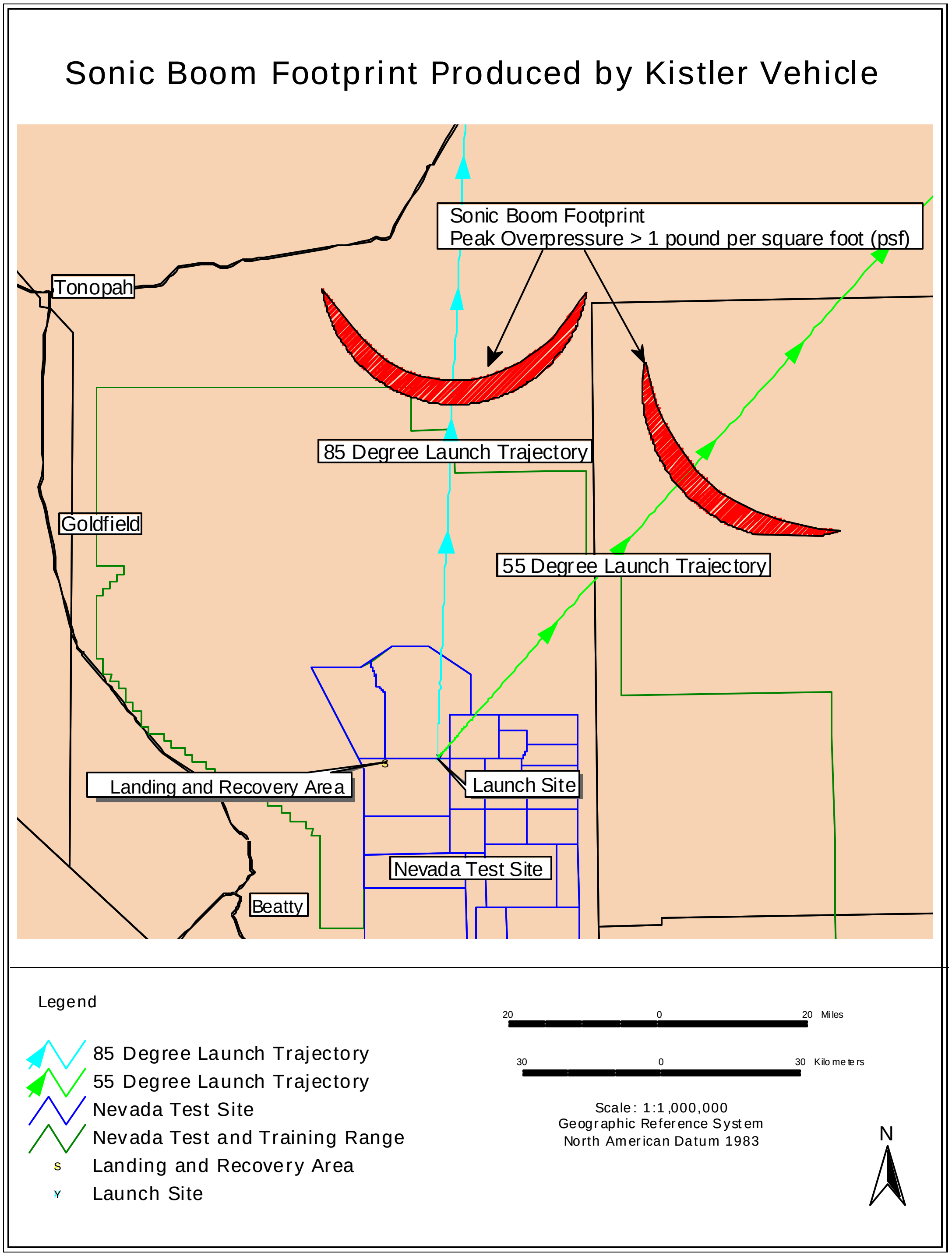


Table 5-22. Possible Damage to Structures from Sonic Booms

Sonic Boom Overpressure psf	Type of Damage	Item Affected
0.5 - 2 Compares to piledriver at construction site	Cracks in plaster	Fine; extension of existing; more in ceilings; over door frames; between some plaster boards.
	Cracks in glass	Rarely shattered; either partial or extension of existing
	Damage to roof	Slippage of existing loose tiles/slates; sometimes new cracking of old slates at nail hole.
	Damage to outside walls	Existing cracks in stucco extended.
	Bric-a-brac	Those carefully balanced or on edges can fall; fine glass; e.g., large goblets can fall and break.
	Other	Dust falls in Chimney
2 – 4 Compares to cap gun or firecracker near ear	Glass, plaster, roofs, ceilings	Failures show which would have been difficult to forecast in terms of their existing condition. Nominally in good condition.
4-10 Compares to handgun as heard at shooter's ear	Glass	Regulate failures within a population of well-installed glass; industrial as well as domestic greenhouses
	Plaster	Partial ceiling collapse of good plaster; complete collapse of very new, incompletely cured, or very old plaster.
	Roofs	High probability rate of failure in nominally good state, slurry wash; some chance of failures in tiles on modern roofs; light roofs (bungalow) or large area can move bodily.
	Walls (out)	Old, free standing, in fairly good condition can collapse.
	Walls (in)	Inside ("Party') walls known to move at 10 psf.
> 10 psf Compares to fireworks display from viewing stand	Glass	Some good glass will fail regularly to sonic booms from the same direction. Glass with existing faults could shatter and fly. Large window frames move.
	Plaster	Most plaster affected
	Ceilings	Plaster boards displaced by nail popping
	Roofs	Most slate/slurry roofs affected, some badly; large roofs having good tile can be affected; some roofs bodily displaced causing gale-end and will-plate cracks; domestic chimneys dislodged if not in good condition
	Walls	Internal party walls can move even if carrying fittings such as hand basins or taps; secondary damage due to water leakage.
	Bric-a-brac	Some nominally secured items can fail; e.g., large pictures, especially if fixed to party walls.

(Haber/Nakaki, 1989)

Comparative Measures of Sonic Boom Effects

Thunder overpressure resulting from lightning strikes at a distance of one kilometer (0.6 miles) is estimated to be near 100 N/m^2 (two psf) and is almost indistinguishable from that of a sonic boom. The unexpected, loud impulsive noise of sonic booms, tends to cause a startle effect in both people and animals. However, when animals and humans are exposed to impulse noises with similar characteristics on a regular basis, they tend to become conditioned to the stimulus and the resulting startle reaction is generally not displayed. Under certain circumstances, short-term exposure to overpressures can be experienced without discomfort. Inside standard sedan automobiles or station wagons, with the windows up, overpressures up to 200 N/m^2 (four psf) can be generated when the door is slammed. Overpressures up to 425 N/m^2 (8.5 psf) can be produced in a compact car under similar conditions.

The National Academy of Sciences/National Research Council (NAS/NRC) Committee on Hearing, Bioacoustics, and Biomechanics (CHBB) have developed criteria for impulse noise, including an upper tolerance limit. Impulse noise levels that exceed the CHBB limit can produce cochlear damage and hearing loss. The CHBB limit for one impulse per day lasting about 200 milliseconds is a sound pressure level of about 145 dB or 365 N/m^2 (7.6 psf). Table 5-23 describes the physiological effects of single sonic booms on humans for different overpressure levels.

Table 5-23. Physiological Effects of Single Sonic Booms on Humans

Sonic boom overpressure dB	Sonic boom overpressure N/m^2 (psf)	Behavioral effects
118	16 (0.3)	Orienting, but no startle response; eyeblink response in 10 percent of subjects; no arm/hand movement.
124 - 135	30 - 111 (0.6 - 2.3)	Mixed pattern of orienting and startle responses; eyeblink in about half of subjects; arm/hand movements in about a fourth of subjects, but not gross bodily movements
136 - 143	130 - 310 (2.7 - 6.5)	Predominant pattern of startle responses; eyeblink response in 90 percent of subjects; arm/hand movements in more than 50 percent of subjects with gross body flexion in about a fourth of subjects.
144 - 150	340 - 640 (7.1 - 13.3)	Arm/hand movements in more than 90 percent of subjects.

(OCST, 1992.)

Rural communities and natural areas will be affected by sonic booms from the K-1 vehicle. Areas to the north that may be affected could include, but are not limited to: Warm springs, Eureka, National Wildhorse Management Area, Toiyabe National Forest, and a number of historical sites. The northeast trajectory may affect: Rachel, Wayne Kirch Wildlife Management Area, Great Basin National Park, National Wildhorse Management Area, and the Humboldt National Forest. The following areas lie within 160 kilometers (100 miles) of the launch pad and may be subject to the highest sonic boom levels: National Wildhorse Management Area, Rachel, part of Humboldt National Forest, and Warm Springs. However, these same areas also lie under a supersonic training range and therefore some receptors may be conditioned to these events.

As the launch vehicle passes over Utah, on the northeast trajectory it will pass over DoD withdrawn land as well as public and private lands. Over western Utah there is a MOA covering much of this area. Military training including low level and supersonic activities take place in this area.

In general, people under the flight paths would experience sonic booms equivalent to distant thunder, or, at most, a fireworks display. In the relatively small area where a focused boom occurs, individuals will experience a sudden and noticeable, but not harmful, overpressure equivalent to that felt inside a car when the door is slammed shut.

The U.S. Air Force reports that the strongest sonic boom ever recorded was 144 psf and it did not cause injury to the researchers who were exposed to it. The maximum overpressure expected from the K-1 flight operation, five psf, is far below this value. These levels anticipated from the K-1 operations are similar to hearing a handgun at one meter (3 feet) as shown in Table 5-22. Glass and plaster ceilings may be damaged. According to a study reported by NASA, ten to 75 percent of the population may find an overpressure of five psf unacceptable (National Aeronautics and Space Administration, *X-33 Draft Tier 1 Environmental Assessment*, April 1996).

Sonic Booms During Reentry Operations

No adverse noise effects are anticipated from the Kistler vehicle reentry activities. The following sections on reentry noise are based on the discussion of reentry noise in the Final Programmatic Environmental Impact Statement for Commercial Reentry Vehicles.

Sonic Boom Overpressures Due to Reentry

Overpressures and the resulting environmental effects generated by commercial reentry vehicles are anticipated to be less than those produced by the Space Shuttle during reentry, as shown in Table 5-24. The peak levels generated are 101 N/m^2, which is well below the CHBB limit of 365 N/m^2. In public viewing areas, overpressures of up to 600 N/m^2 (12 psf) have been produced during fireworks displays, as shown in Table 5-22.

Table 5-24. Sonic Booms Generated by the Space Shuttle During Reentry

Distance from Landing site	Maximum Sonic Overpressure	
	N/m^2	psf
650 km (400 mi)	24	0.5
185 km (115 mi)	48	1.0
44 km (27 mi)	96	2.0
Maximum Noise Level	101	2.1

(Space Shuttle EIS)

These sonic overpressures, except for a slight startle reaction in the population that hears it, have not produced any known adverse effects. The PEIS states that at the current and projected levels of activity, sonic booms generated by commercial reentry vehicles are not anticipated to result in any adverse impacts.

Additional Reentry Noise

Once on the ground, the LAP and OV would be transported by a Retrieval Transporter (RT) separately from the landing area to the vehicle processing area. The noise generated by this vehicle would be comparable to heavy construction equipment. The landing site would be in a remote area, restricted from public access, and access along the road would be restricted within 1,220 meters (4,000 feet) of the landing and recovery area. The noise generated should not exceed 100 dBA and would be of a short duration, resulting in minimal environmental impacts.

Summary of Noise Impacts

The noise produced from K-1 launches could have a large impact for workers at the Kistler site, who would be removed to the launch control center and would be required to wear hearing protection. Other workers at the NTS may experience the loud noise and have their conversations disrupted for two to three minutes during each launch. Members of the public would be able to hear the launch, but would experience a noise level similar to a garbage disposal at one meter. The sound would be of a short duration.

Construction and recovery activities would generate noise, but at levels similar to other industrial activities, and only workers involved with the construction activity would be affected and, thus, required to wear hearing protection. The general public would not be aware of the noise generated from either construction or other heavy equipment activity related to recovery operations.

The most likely perceived noise impact would be caused by sonic booms from launch and reentry. Sonic booms cause startle reflexes and are more likely to surprise people than launch engine noise. For the launch, the population affected would be very small, and the noise level generated by the sonic boom would resemble distant thunder, unless one is in the small area where large sonic booms can occur. In this area the sound would approach loud thunder or possibly noise from a fireworks display. Although this impact is greater, it is nonetheless a very minimal impact, given the small population affected. Sonic boom levels generated during reentry would sound like distant thunder, and have minimal impact.

5.1.5 Socioeconomics

The proposed action is expected to create on average 85 direct full time jobs and 28 direct part time jobs during the construction phase of the project and 90 direct full time jobs and 28 direct part time jobs during operation of the proposed Kistler facilities. Employment projections through the year 2009 are identified in Table 5-25. The average estimated gross payroll for construction is $2 million and the average annual gross payroll for operation is expected to be $6 million. The estimated cost of construction of the Kistler facilities is $25 million. The total estimated expenditures for operation of the Kistler facilities is $13 million per year for the first three to five years. The estimated total expenditures for operation of the Kistler facilities includes expenditures for: operations and maintenance, organization-related expenditures, public interface and public awareness programs, and travel and temporary duty assignments.

Table 5-25. Employment Projections for work related to the Kistler facilities

Year	NTS Employment	
	Part Time	Full Time
2002	25	80
2003	25	85
2004	27	85
2005	27	90
2006	30	90
2007	30	90
2008	30	90
2009	30	90

The estimated employment from construction and operation of the Kistler facilities represents a 2.42 percent increase over the 1996 NTS employment and a 1.85 percent increase over the 1996 NTS-related population within the Las Vegas MSA (see Table 3-6). Of the total employment increase the vast majority (over 98 percent) are expected to live in the Las Vegas, Clark County area. Population estimates were based on the average annual employment level times 2.72 persons per household (DOE, 1994). Assuming that all 90 full time workers would bring a family, this would represent a population increase of 245 persons in the Las Vegas, Clark County area due to the proposed action. The monthly net immigration to Clark County, Nevada is currently 3,960 people (Clark County, 1997). The population associated with the proposed action is too small to affect the monthly immigration into the region of influence.

Housing availability in the region of influence would not be affected by the proposed action. In 1995, some 30,000 permits for residential units were issued in the region of influence and it is expected that this figure will increase over the coming years (MRA 1996). Children associated with Kistler employees are expected to attend Clark County public schools. Each county in Nevada has only one school district with responsibility for all public education for that county from kindergarten through twelfth grade. Geographically larger than the entire state of Massachusetts, the Clark County School District covers 3,054 square kilometers (7,910 square miles) and those cities and rural areas served reach as far north as Indian Springs and Mesquite and as far south as Laughlin and Searchlight. The Clark County school district enrollment is increasing due to current regional increases in population. The proposed action would add an estimated 43 students to the Clark County School District, based on the proportion of school age children to total population in the Las Vegas MSA of 17.5 percent (Business Location Services, 1997).

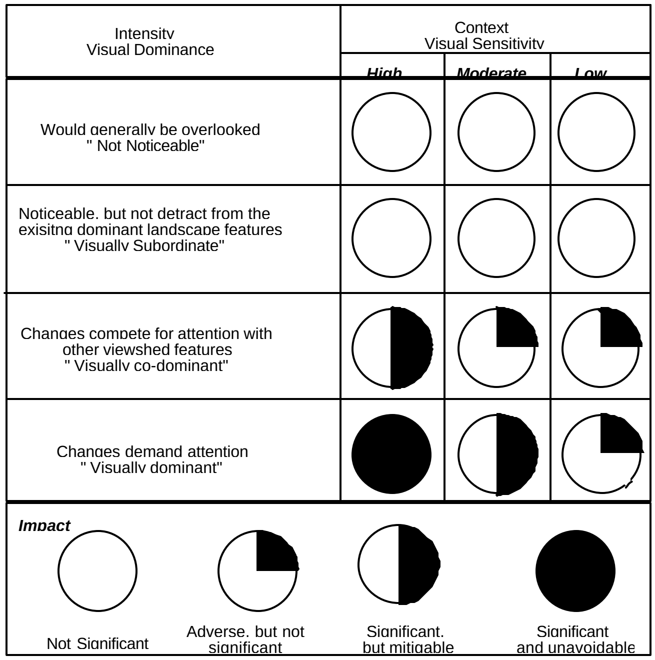
Beneficial economic impacts of the proposed action are the added diversification of the regional economy and an expanded use of NTS resources. DOE Defense Program activities have been declining steadily in recent years resulting in the need to diversify user support at the NTS. The Operation and Maintenance expenditures of the proposed action are estimated at $10.5 million for the first three to five years. A portion of this expenditure would be used to offset general infrastructure maintenance costs for DOE Defense Programs at the NTS. This could allow the best use of limited DOE Stockpile Stewardship resources and support the successful execution of the DOE Defense Programs mission at the NTS (MRA 1996).

Thus, in summary, no negative socioeconomic effects on the region are expected as a result of the proposed action. In addition, no disproportionate effects on economically disadvantaged or minority groups are anticipated as a result of the proposed action.

5.1.6 Visual Resources

The impacts of the proposed action on visual resources will be considered in four areas: construction, test launch program, normal launch schedule, and reentry. The proposed action can be analyzed with respect to two criteria: intensity and context. Intensity is measured by the estimation of visual dominance, and context is determined by the degree of visual sensitivity. Figure 5-8 graphically displays the concepts of intensity and context.

Figure 5-8. Determination of Impact Based on Visual Dominance and Sensitivity



Visual Dominance. Proposed changes in the character of an area can be defined in terms of visual dominance. For example, if the users of the area would overlook the changes to the area's setting, then the changes would be "*not noticeable*." If the changes would be noticeable but would be dominated by other features in the area's setting, then the changes would be "*visually subordinate*." A change that would compete with the visual character of an area is "*visually co-dominant*." Finally, a change that would detract from the character of the setting and would demand attention is "*visually dominant*."

Visual Sensitivity. Visual sensitivity depends on the particular setting in which the proposed action is to occur. Areas such as coastlines, national parks, recreation areas, and wilderness areas are areas of high visual sensitivity. In these areas, viewers tend to be aware of even very small changes in the visual environment. On the other hand, in areas of low visual sensitivity such as industrialized areas, major changes can occur without undue notice to observers.

The areas of interest within the NTS for the Kistler project are of Class B, moderate visual sensitivity (i.e., the site includes areas in which there is a combination of some outstanding characteristics and some that are fairly common). The setting of the proposed Kistler sites, while visually scenic, is not a National Park or an area of otherwise high visual sensitivity.

Kistler Construction Activities. All construction activities will occur within the NTS. The nearest vantage point for the general public is from U.S. 95, over 45.1 kilometers (28 miles), to the site of the payload processing facility and launch site. Several ridges of hills obscure the view from this route. Thus, Kistler construction activities would not be visible by the general public. The construction of the Kistler facilities would not impact the visual environment since they are not visible from outside the NTS boundaries. Thus, the impact would fall into the "not noticeable" category.

Normal Launch Schedule. The visual impact of each launch would last for less than five minutes. In addition, the area near the launch site has a substantial level of aircraft flight operations, many of which produce visible contrails not unlike those that would be formed by the K-1's engines. Even at the maximum proposed launch schedule the visual environment of the area is not reasonably expected to reach a level of significance. The normal launch schedule visual environment would again be "visually subordinate."

The LAP would perform a "flyback" maneuver to bring the vehicle to the NTS landing site. During the "flyback" maneuver, the vehicle is reoriented and a short engine burn is performed at an altitude of between 45,700 and 61,000 meters (150,000 and 200,000 feet) MSL. After the engine is shut down, the LAP would coast on a ballistic arc until the main recovery parachutes are deployed at approximately 6,100 meters (20,000 feet) MSL. During this phase of flight the LAP would be unpowered and would leave no visible contrail and at parachute deployment, it would be over 45 kilometers (28 miles) from the nearest area with public access, on U.S. 95 to the southwest. The landing of the LAP is not likely to be visible to the public and would be categorized as "not noticeable."

Reentry. Upon reentry the OV would enter the NTS area at a very steep angle of descent and at an altitude of over 30,500 meters (100,000 feet) MSL. The OV would be unpowered upon reentry and thus would not produce a visible contrail. It is highly unlikely that the OV would be visible to the naked eye by the nearest area accessible by the general public. Due to the distance of the OV to observers and its small size, the reentry of the OV is not expected to impact the visual environment. The reentry activities are expected to be in the "not noticeable" category.

Summary. All Kistler actions would be either "not noticeable" or "visually subordinate" and would take place in an area of "moderate visual sensitivity."

5.1.7 Biological Resources

This section addresses the potential impacts of construction and operation of the proposed Kistler facilities at the NTS and launch and recovery operations on plants and animals.

5.1.7.1. Vegetation

Construction of the proposed Kistler facilities would result in clearing vegetation from a total area of over 268.4 hectares (671 acres). All of the vegetation would be removed from the landing and recovery area. The land would be devoid of vegetation during all Kistler operations. Soil erosion caused by water movement across the recovery area would impact downstream flows in ephemeral drainages in the areas. Directing upstream runoff around the recovery area can mitigate this impact. The only water that would have erosional effects would be the volume of water that falls but does not infiltrate the soil. Due to the low precipitation, there would be relatively small increments of additional sediment load in runoff waters downstream of the recovery zone. The vegetation in these areas is classified as the Artemesia Type by Beatley (1976), although the payload processing facility (3.2 hectares (eight acres) and launch site (5.6 hectares (14 acres) are in areas that may be considered ecotonal between the Artemesia and Mountain Types. This vegetation would be permanently destroyed and the land maintained for use by Kistler. There are approximately 348,242 square kilometers (86,050,598 acres) of the Artemesia Type on the NTS. This plant community type is common throughout the Great Basin. The total loss of vegetation for the Kistler facilities would represent only about 0.008 percent of the total area of the Artemesia Type on the NTS. Because this plant community type is common both on the NTS and throughout the Great Basin, the anticipated loss would represent only a small portion of this habitat type and would not adversely affect local or regional diversity of plants and plant communities.

Ground based operations at the vehicle processing facility and launch site would not affect vegetation. Buildings or pavement would cover both of these operational areas. The landing/recovery area would be allowed to revegetate naturally by herbaceous plant species. Woody vegetation that could damage the landing bags on the K-1 vehicle would be selectively removed on a periodic basis. The vegetation that would regrow on the landing/recovery site would be subjected to occasional crushing by the rubber-tired recovery vehicle. The plants would be able to recover from this crushing unless it becomes too repetitive, which would also tend to compact the soil and make further new plant establishment more difficult.

The plant species that would colonize the landing/recovery area would depend upon a number of factors. In areas where there is little disturbance and the topsoil is left in place, there would be a ready seed source of plant species presently growing in the area. Portions of the landing/recovery area that are subjected to grading and where topsoil is displaced will likely provide habitat for invader species, such as Russian thistle (*Salsola kali*), halogeton (*Halogeton glomeratus*), red brome grass (*Bromus rubens*), and cheatgrass (*Bromus tectorum*). Invader species, because of their short life cycle, are able to reproduce quickly in disturbed areas; and therefore help to create a habitat that is more suitable for species other than the invader. Succession from invader species to those more typical of the area would occur over time; however, such succession could take several decades.

Potential vegetation impacts associated with launching the K-1 vehicle would stem from vehicle launch emissions. These impacts could be both physical and chemical. The K-1 would be fueled by kerosene and liquid oxygen. Using this fuel, exhaust emissions would consist of H_2O, CO, CO_2, H_2, H, and OH. In addition, within the first second of the ignition command, three start cartridges would burn a total of about 17.55 kilograms (39 pounds) of propellant.

Vegetation may be damaged or destroyed by high temperature exhaust gases produced by launching the K-1. The exhaust gas temperature at the exit plane of the nozzle would be about 1,474 degrees Celsius (2,685 degrees Fahrenheit) with an initial velocity of 3,231 meters per second (10,601 feet per second). Both the exhaust gas temperature and velocity would decrease rapidly upon exiting the flame duct, the exhaust gas would tend to rise due to the high temperature, and winds would begin to disperse the cloud. In addition, the launch site would be located on a ridge and the flame deflector would direct the exhaust gases into the air above the vegetation in the area below the ridge.

Further analysis will be conducted and any area over which vegetation could be burned or heat damaged severely would be cleared to prevent wildfires. Vegetation in areas of less severe heating would likely be affected by lack of vigor and reduced reproductive success.

Chemical impacts to plants could occur from vehicle exhaust products. The emission product that has the greatest potential for impacts to vegetation is gaseous hydrogen chloride, which combines with water vapor in the exhaust to form hydrochloric acid (HCl). Direct impacts to plants as a result of acid deposition could include discoloration, partial or complete loss of foliage, and a decline in seedling survivorship, seed germination response, and seedling emergence (DOT, 1996). Various meteorological conditions, such as wind direction and speed, could affect the extent and severity of these impacts.

According to NASA (1992), deposition of more than one gram per square meter of chloride is necessary to cause serious damage to many plant species. The EA covering the construction and operation of the Kodiak Launch Complex (KLC EA) stated that firing an Athena 2 [formerly called the Lockheed Martin Launch Vehicle (LMLV 2)] launch vehicle would generate 4.3 metric tons (4.7 tons) of hydrogen chloride within the first 3,000 meters (9,840 feet) of altitude. This would result in the deposition of about 0.427 grams of HCl per square meter over a 10-square kilometer area (four square miles), which was predicted to result in minor damage to vegetation in the immediate area of the Kodiak Launch Complex launch pad. By contrast, launch of the Kistler K-1 vehicle would produce only 2.14 kilograms of HCl, resulting in deposition of about 0.009 grams per square meter over an area of 250,000 square meters (0.1 square miles), or 0.468 grams per square meter per year based on the assumption of a maximum of 52 launches. Because of the low density of vegetation in the area, much of the HCl would be deposited on the soil. Therefore, the actual deposition on vegetation would be much less than 0.468 grams per square meter per year. Adverse impacts to vegetation from hydrogen chloride deposition are expected to be negligible.

5.1.7.2. Wildlife

Potential impacts to wildlife could be produced by construction-related activities such as noise, human presence, clearing, and grading and by operations-related phenomena, including launch noise, sonic booms, and vehicle launch emissions.

Construction-related impacts to wildlife would consist of removal of vegetation, which could result in a permanent loss of available habitat and possible degradation of adjacent habitat due to increase in noise and human activity. Individuals of smaller terrestrial species, such as the Great Basin pocket mouse, if present in the project area, would be displaced or could possibly be crushed or buried by ground clearing/grading activities. Larger mammals and birds could be displaced and could avoid the immediate areas of disturbance. It is also likely that many species would adapt to the presence of the proposed facilities and the ongoing human activity and would begin to utilize the remaining habitat adjacent to disturbed areas after completion of the construction activities. Less adaptable species may avoid the area completely. Loss of over 268.4 hectares (671 acres) of habitat would result in a reduction of overall population levels of some animal species, particularly those utilizing smaller areas of habitat and/or those that are less mobile. This habitat loss would not be expected to adversely affect the local or regional diversity of animal species or populations.

Kistler's day-to-day operations around the payload processing facility and launch site would not extend beyond the developed areas and would be expected to cause only minor disturbance to animals inhabiting the area. The pond near the payload processing facility would still be available for use by wildlife and would probably be used during non-working hours or other periods of low human activity. Vehicle landing and recovery operations are not expected to disturb wildlife because the landing and recovery area would not provide suitable habitat to most species that inhabit the region.

The small amount of HCl produced during the launch and deposited on the surface of the on-site pond would not pose a significant threat to the animals that use the pond.

Although the Kistler facilities would be located outside of the range of the desert tortoise, the proposed project could impact this species. All vehicular traffic must access the NTS from Highway 95, to the south. Thus all Kistler-related traffic would transit desert tortoise habitat. The NTS EIS (DOE, 1996) assessed the potential mortality of desert tortoises resulting from expanding the use of the NTS. The level of traffic resulting from Kistler's construction and operations activities would not exceed the levels anticipated in the NTS EIS and so, would not result in any unanticipated increase in threat to the desert tortoise population on the NTS. In order to reduce the potential for harm to desert tortoises, Kistler-related workers would receive the same desert tortoise training required of all NTS workers.

Noise generated by vehicle launches could affect wildlife. At 100 percent throttle, at a distance of 400 meters (1,300 feet), the noise generated by the Kistler K-1 vehicle would be about 106 dBA. This level is approximately the same as the sound levels assessed in the KLC EA (DOT, 1996) for vehicles that could be launched from the Kodiak Launch Complex. For purposes of this assessment, it is assumed that noise levels would be similar throughout the K-1 launch and flight.

Noise levels during a launch of the K-1 would be less than 77 dBA at a distance of about 11.6 kilometers (7.2 miles) from the launch site. Noise levels cause responses in birds (85 dBA and above) and mammals (82 dBA and above) (Golden, et al., 1980). These effects are species specific and range from startle responses to temporary hearing impairment (ES, 1990). At Cape Canaveral Air Force Station, during the breeding season, birds respond to Space Shuttle launch noise by flying away from the nests but return within two to four minutes (USAF, 1994). Birds residing in areas near Titan launch complexes at Cape Canaveral were subjected to noise levels as high as 115 dBA and there was no noise-associated mortality or reduction in habitat use (USAF, 1994). Mammal species have not been substantially affected by launches of the Space Shuttle or Titan IV, both of which create much higher noise levels (up to 138 dBA at 1.2 kilometers (0.75 mile) than are anticipated for the K-1 (USAF, 1988; DOT, 1986; USAF, 1989; and USAF, 1994). While some wildlife species may exhibit a degree of response, it is not anticipated that noise associated with launch and flight of the K-1 would affect the viability or diversity of wildlife in the region.

Other substantial noise impacts that could affect wildlife are sonic booms. The intensity of and potential for sonic booms are dependent on the shape of the vehicle, the trajectory, the velocity, and meteorological conditions (DOT, 1996). Personnel at the Pahranagat National Wildlife Refuge reported to the Air Force that low-flying aircraft over the Refuge frequently caused nesting waterfowl to flush from nesting or roosting locations (SAIC/DRI, 1991). For this reason, the Air Force has placed restrictions on supersonic operations over some wildlife refuges in southern Nevada, limiting altitudes of overflights to 609 meters (2,000 feet) for subsonic and 1,524 meters (5,000 feet) for supersonic operations (USAF, 1988). Based on long-term observations of desert bighorn sheep in the portion of the Desert National Wildlife Refuge used by the Air Force for supersonic operations since 1955, reproductive success has not suffered (SAIC/DRI, 1991). The Kodiak Launch Complex EA characterized the sonic boom from the Athena 2 [formerly called the LMLV2] vehicle as a "sound resembling mild thunder." It is estimated that the sonic boom generated by the K-1 would be of similar magnitude. Sonic booms caused by flights of the K-1 are not expected to elicit any greater reaction by wildlife than is caused by exposure to natural thunder.

Although noise from launches of the K-1 would likely be audible at the Desert National Wildlife Refuge and the northern flight corridor would cross the Nevada Wildhorse Management Area on the Nevada Test and Training Range, the effects of noise on wildlife would be mitigated by the distance between the noise source and sensitive receptors. The launch site is about 20 miles from the Desert National Wildlife Refuge and noise levels at the distance would be less than 68 dBA, well below the 82 to 85 dBA expected to affect mammals and birds. Before entering the airspace above the Nevada Wildhorse Management Area, the K-1 would be about 100,000 feet above the ground level and noise levels would not be expected to approach the threshold for eliciting responses from birds and mammals. In addition, launches are relatively infrequent events thus further minimizing potential impacts on wildlife.

When considered in the context of the 100,000 sub-and supersonic sorties expected each year at the Nevada Test and Training Range under the No Action Alternative in *Renewal of the Nellis Air Force Range Land Withdrawl Draft Legislation Environmental Impact Statement* (Department of the Air Force, 1998), the impacts on regional wildlife resulting from noise from Kistler's operations would be relatively minor.

5.1.8. Water Resources

5.1.8.1. Surface Water

The only perennial surface water in the vicinity of the proposed Kistler facilities is the man-made pond located between the proposed payload processing facility and the launch site. Construction of the proposed facilities would not affect the quantity or quality of the water in this pond. Any water that would be withdrawn for construction purposes would be replaced automatically from Well 8 (see section 3.9) and there would be no discharges of materials into the pond.

Potential construction-related impacts to surface drainages that carry ephemeral waters could result from alteration of existing runoff patterns, erosion, and increased sediment loading. Due to the low levels of precipitation on the NTS, the amount of runoff-caused erosion would be very small. In addition, the distance of the site from any perennial surface water is so great that it is unlikely that any water quality impacts could occur.

Spills of petroleum products used by construction equipment, such as gasoline, diesel fuel, oil, and hydraulic fluid, could potentially contaminate runoff. Should such spills occur, they would be contained and cleaned up and the contaminated soils disposed at an appropriate facility.

Kistler operations could have minor direct and indirect effects on the intermittent surface waters that occur in the area. Runoff from paved areas of the payload processing facility and launch site could carry hydrocarbons and residues from rubber tires and other contaminants associated with normal vehicular operations. These contaminants would be transported to the ephemeral drainages in the area but because they would be small quantities would not pose a hazard to water quality in the area. Additionally, there would be some ground deposition of exhaust emission constituents from the K-1 vehicle launches. The most notable of these would be a small quantity of HCl, which would combine with water vapor to form hydrochloric acid. Some of this hydrochloric acid could be incorporated into runoff from precipitation and be washed downstream. The quantity of hydrochloric acid would be so small that it would not adversely affect surface waters in the area.

The launch pad is designed to operate without a deluge system, therefore, water will not be used for flame suppression during the launches.

Soil erosion caused by water movement across the landing/recovery area would impact downstream flows in ephemeral drainages in the area. This impact would be somewhat mitigated by directing upstream runoff around the landing and recovery area. The only water that would have erosional effects would be the volume of water that falls but does not infiltrate the soil. Due to the low precipitation, there would be relatively small increment of additional sediment load in runoff waters downstream of the landing/recovery area.

During the development of a project the impacts to the surrounding environment resulting from storm and sanitary sewer design requirements for additional water, waste treatment capacity, erosion controls to prevent siltation, contingent plans for fuel spills, designs to preserve drainage or minimize dredge and fill, and minimizing impacts to the aquifer or sensitive ecological area are addressed.

5.1.8.2. Groundwater

The U.S. EPA does not designate any of the aquifers of the NTS as sole source. The water systems are defined as consecutive water systems within the Safe Drinking Water Act (SDWA). A two-fold effort in monitoring the groundwater would be performed by DOE and Kistler. DOE is responsible for the quality of water from the well head to the proposed point of connection (dual back-flow preventers) of the Kistler water system and Kistler would be responsible for the water quality from the identified point throughout their system.

Because of the commercial nature of this activity DOE/NV determined that the water appropriations would have to be obtained from the State Engineer of the Division of Water Resources, Department of Conservation and Natural Resources of the State of Nevada. An Application for Permit to Appropriate the Public Water of the State of Nevada was filed for the Kistler Aerospace Project on June 12, 1997. The State Engineer granted Permit No. 63176 on March 20, 1998 for this purpose.

Kistler's estimated maximum water requirement for operations is 6,800 cubic meters ($1.8x10^6$ gallons or 5.5 acre-feet) per year. Construction of the payload processing facility and launch site would require an estimated 3,800 cubic meters ($1.0x10^6$ gallons or approximately three acre-feet) of water. According to State of Nevada Water Planning Report 3, basin 227-b has an estimated total perennial yield of 4.4 million m^3/yr (3,600 acre-feet per year). Based on the capacity and historic use of Well 8 and the estimated total perennial yield of basin 227-b, it is unlikely that construction and operation of the Kistler facility would affect groundwater availability.

The depth to the water table in the vicinity of the Kistler facility is over 305 meters (1,000 feet). Evaporation exceeds precipitation in the area, so there would be little downward migration of water from the surface. Therefore, it is not likely that any of Kistler's activities could affect groundwater quality.

Groundwater pumping related to this project will have no effect on any threatened, endangered, or candidate species of concern on the NTS. The issue of collective ground water pumping on the NTS and its potential effect on the springs and federally listed species in the Ash Meadows ecosystem has been addressed and resolved in the NTS EIS.

The process of establishing a potable water system in the state requires that all systems are designed to meet 10 State Standards, Uniform Plumbing Code, Water Well Association, and SDWA requirements prior to the initiation of the construction effort. Periodically throughout a construction effort the regulator will visit the construction site to review the work to date. During those visits, if standards are not met, the regulator has the authority to issue a stop work order. These two processes assure that the system being constructed will meet and/or exceed the regulatory requirements for a potable water system.

5.1.9 Geology and Soils

All of Kistler's facilities would be constructed on the ground surface or near surface. Except for excavation for standard footings for buildings and other structures, and for construction of the flame bucket and launch stand, disturbance of subsurface geologic media would not occur.

Soil disturbance would occur over the entire area of the proposed project. All three operating areas (launch complex including the vehicle processing facility, landing/recovery area, and payload processing facility) would be cleared and graded. In the landing/recovery area, the soil is generally undisturbed, although there are some existing two-track roads in the vicinity. Woody vegetation and large rocks would be removed and the ground surface graded to specified contours. This would expose the soils to increased potential for wind and water erosion. Soil erosion caused by water could be mitigated by diverting upstream runoff around the landing/recovery area by excavation of a diversion channel or berms. This is an effective means of preventing run-off of water from upgradient areas and has been used for other facilities at the NTS, such as Area 5 Radioactive Waste Management Site, which is located on the Barren Wash Alluvial Fan. Site-specific hydrologic studies could provide the basis for the engineering design of the channel and berm. Although the landing/recovery area would be maintained to prevent growth of woody vegetation that could damage the landing bags of the K-1 vehicle, natural revegetation by herbaceous species would be allowed. The vegetation would ameliorate wind and water erosion from the site.

Buildings, roads, parking areas, walkways, and other features would essentially cover the soil in the other two operating areas (launch complex and payload processing facility).

Operation of the Kistler facilities would not affect subsurface geological media but could impact surface soils. These impacts would occur in the form of vehicular traffic across the landing/recovery area and/or deposition of exhaust emission material on the soil surface in an area around the launch site.

The primary exhaust emission component of concern from the Kistler K-1 would be HCl. This compound combines with water vapor in the exhaust or in the atmosphere to form hydrochloric acid. The K-1 would emit 2.14 kilograms (4.729 pounds) of HCl within the first second of a launch, all from the start cartridges (see section 5.1.3). There would be no other source of HCl during K-1 launch or flight. This can be compared with emissions from other launch vehicles. As reported in the KLC EA, the Athena 2 vehicle emits 4.7 tons of HCl during a launch, resulting in the deposition of an estimated 0.427 grams of hydrochloric acid per square meter over a 10-square-kilometer (3.9-square-mile) area. Using a conservative dispersion area for the exhaust plume of the K-1 vehicle subsequent deposition of HCl on the soil surface was estimated. Assuming a deposition area one-half kilometer on a side, or 250,000 square meters (0.1 square mile) about 0.009 grams of HCl would be deposited on each square meter of soil surface for each launch. This is equal to 0.468 grams per square meter per year based on an assumption of 52 launches each year.

The proposed Kistler launch site is in an area of very low rainfall and high evaporation with sandy texture soils with a low organic content. Such arid areas tend to have alkaline (pH above 7.0) soils. As the soil pH rises, nutrient availability to plants may be reduced for some elements (EPA, 1983). Sandy and low organic content soils generally have a very low cation (positive ion) exchange capacity and hence a low buffering capability (EPA, 1983). This means that the deposition of acid in the launch site area could cause a slight lowering of the soil solution pH. This would be offset somewhat by dilution of the acid in the soil by precipitation and subsequent transport downgradient. A slight increase in the level of soil acidity could have a minor beneficial effect on vegetation by increasing the availability of some plant nutrients.

The proposed Kistler project would not be located in a floodplain area. Therefore, there would be no expected risk to human safety, health, or welfare for the proposed project due to siting the project in a floodplain area.

5.1.9.1. Cultural and Native American Resources

Prehistoric and Historic Resources. Construction of the proposed project would involve disturbance of 268 hectares (671 acres) of ground surface. This would affect any surface or subsurface cultural remains in the disturbed areas. Although a cultural resources reconnaissance of the proposed payload processing facility did not find any historic properties, the reconnaissance of the proposed launch site and landing/recovery site identified two such sites; 26NY10133 and 26NY4892, respectively. 26NY4892 is a previously recorded historic property that has been the subject of two previous data recovery efforts. 26NY10133 is a previously undiscovered site. Both sites were determined to be historic properties under criterion d of 36 CFR 60.4.

Pursuant to Section 106 of the National Historic Preservation Act of 1966 (P.L. 89-665), as amended, the effects of the proposed Kistler project on historic properties (i.e., sites eligible for the National Register of Historic Places) will be taken into account. In order to take these effects into account, cultural resources within the area of potential effect have been identified by means of surveys conducted by qualified professionals. The area of potential effect includes all three portions of the Kistler facilities (i.e., payload processing facility, launch site, and landing/recovery area) and appropriate buffer areas.

Under the Criteria of Effect and Adverse Effect (36 CFR 800.9), it was determined that implementation of the proposed action would affect both historic properties. Due to project requirements, neither the launch site nor the landing/recovery site could be moved or modified to avoid 26NY10133 or 26NY4892, respectively. Effects of an undertaking that would otherwise be considered adverse may be considered "not adverse when the historic property is of value only for its potential contribution to archaeological, historical, or architectural research, and when such value can be substantially preserved through the conduct of appropriate research, and such research is conducted in accordance with applicable professional standards and guidelines" (36 CFR 800.9(c)(1)). A data recovery plan was prepared to avoid the adverse impacts to site 26NY10133. The Nevada SHPO approved that plan and the Advisory Council on Historic Preservation concurred. The data recovery plan was implemented and completed and impacts to 26NY10133 have been mitigated. It was further determined that additional data recovery efforts at 26NY4892 would not yield any new significant information about the site or contribute to the existing archaeological information already recorded from the site through the two previous data recovery efforts.

<u>Native American Cultural Resources.</u> To insure that Native American concerns were considered and data recovery conducted in a culturally sensitive manner and as part of DOE/NV's ongoing American Indian Monitoring Program, representatives of the Owens Valley Paiutes, Western Shoshones, and Southern Paiutes were invited to participate in all phases of data recovery. In addition, at the request of DOE/NV, a Rapid Cultural Assessment (RCA) was conducted of the proposed Kistler payload processing facility and launch site, as described in section 3.11 of this EA. The RCA team recommended a number of measures to mitigate impacts to traditional cultural values connected to the area. Those recommendations were evaluated and implemented, as appropriate. Appendix E of this document provides a record of further consultation that occurred between FAA, DOE, and CGTO.

5.1.10 Transportation

The analysis of transportation impacts is presented with respect to on-site traffic and off-site traffic. The off-site transportation impact will be analyzed by determining if the proposed action will affect the level of service of the roadway operating conditions or the adequacy of the roadway to accommodate additional vehicles.

Some activities will require closing off sections of the NTS road system in the immediate vicinity of the launch site and landing and recovery site. These closings would not affect the off-site traffic, only activities on the NTS.

<u>On-Site Traffic.</u> The peak average daily traffic generated as a result of on-site activities associated with the proposed action is estimated to be 66 one-way vehicle trips per day. This represents traffic generated by bussing workers to and from the sites, vans for hourly transportation to and from the sites, and fuel trucks filling the LO_X, LN_2, RP-1 and helium tanks. Table 5-26 depicts average on-site daily trip generation for different phases of the Kistler proposed action.

The LAP and OV will be flown into Desert Rock Airport and taken by road from there to the operations areas. Components that are not flown in will be transported by road from manufacturing and assembly locations.

Assuming that DOE maintains the roads in the conditions they were in on June 3, 1997 when the agreement between DOE and the NTSDC was signed, no road improvements would be required to support the Kistler operations. The Kistler LAP and OV will be transported using a tractor-trailer vehicle designed to operate on the existing NTS roads. For safety reasons, roads will need to be closed temporarily to allow the LAP and OV tractor-trailer to transport the LAP and OV. Operation of the tractor trailer will follow DOE road safety requirements, just as when DOE closes or restricts roads if they are moving a piece of heavy machinery on the NTS.

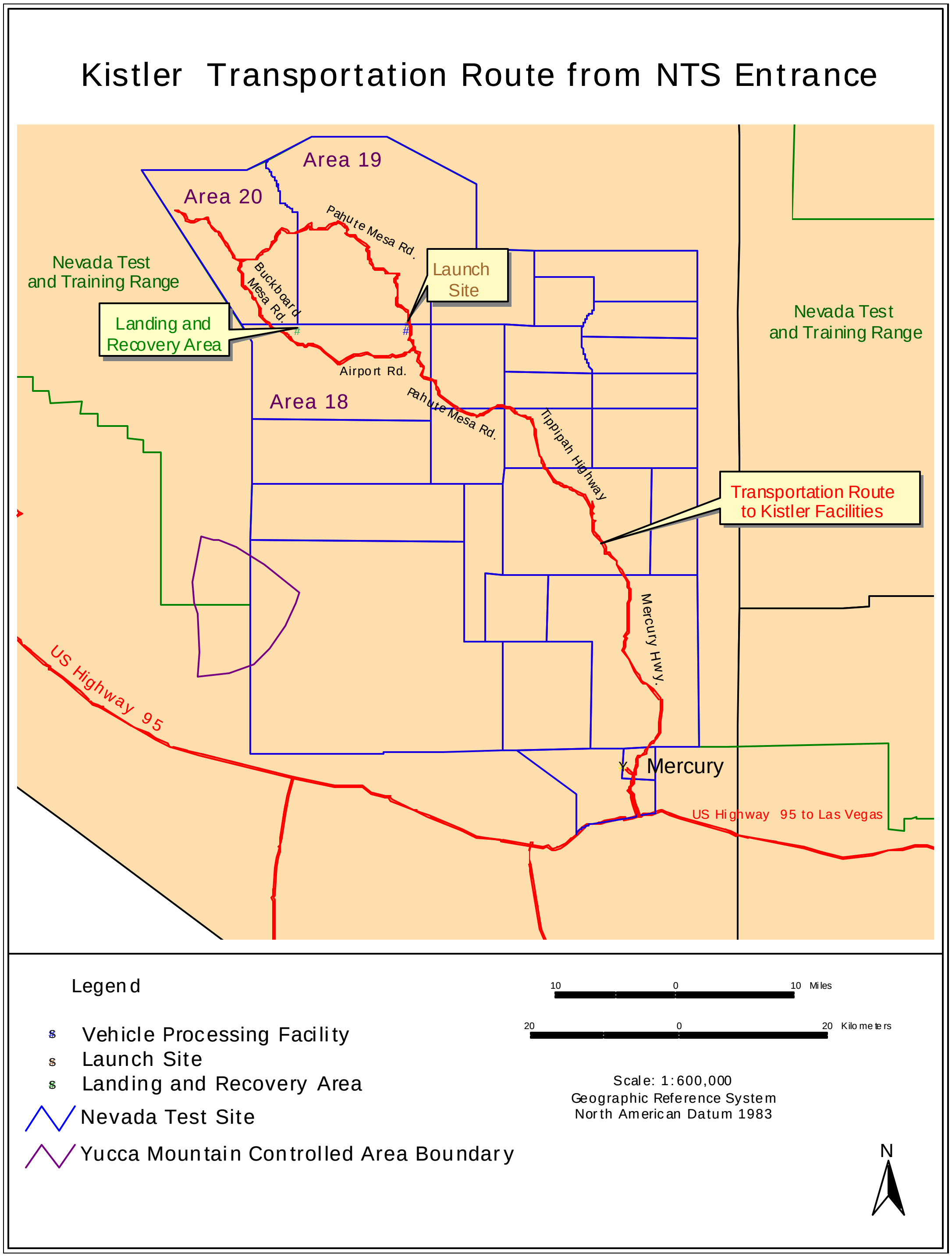
Table 5-26. Average On-Site Daily Trip Generation for Different Phases of the Proposed Kistler Project

Phase	Buses	Vans/ Cars	Tank Fueling	Average Daily Trips
Construction	12	30		42
Initial Launch Phase	8	28	6	42
Sustained Operations (2 Shifts)	12	42	12	66

As shown in Figure 5-9, these one-way trips would use the following NTS roadways:

Mercury Highway	from Mercury to Tippipah Highway
Tippipah Highway	from Mercury Highway to Pahute Mesa Road
Pahute Mesa Rd.	from Tippipah Highway to Kistler facilities
Airport Rd.	from Pahute Mesa Road to Buckboard Mesa Road
Buckboard Mesa Rd.	from Airport Road. to border between Area 18 and Area 20

Figure 5-9. Map showing roadways from entrance to Kistler Facilities.



The last two road stretches would be used primarily during construction and recovery operations, and would not be used frequently after construction during non-launch time periods.

All key on-site roadways have capacities exceeding 2,000 vehicles per hour for both directions combined (Transportation Research Board, 1994). A comparison of capacity to the volumes assigned to each segment on Table 5-27 shows that no roadway would experience significant traffic congestion. The most heavily traveled stretch of road on the NTS, between Mercury and Road 5-01, averages 8,070 vehicles per day, and 8,151 vehicles per day with the proposed Kistler action. With a capacity of 2,000 vehicles per hour, there would be little or no impact on level of service

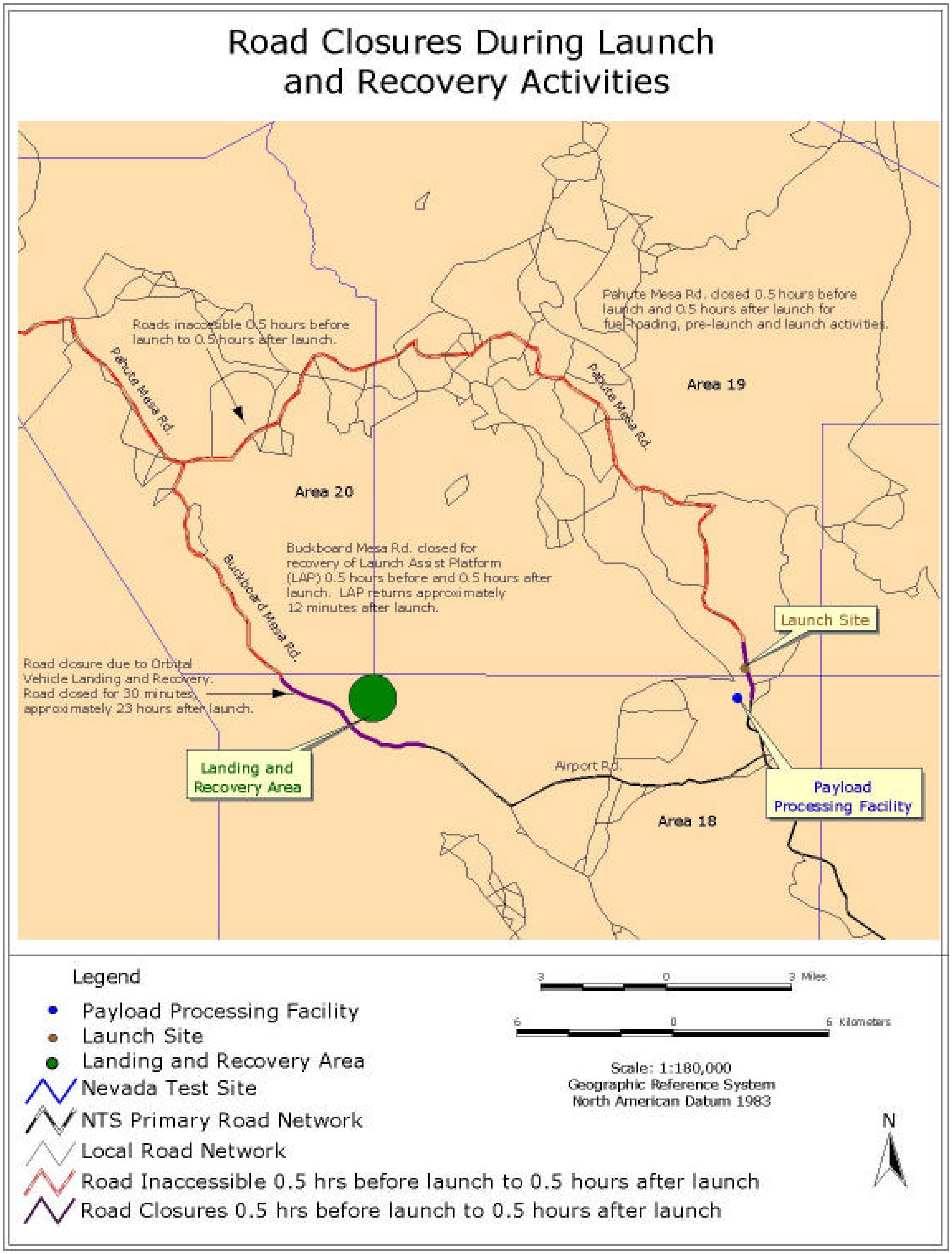
Table 5-27. Average Daily Traffic Volume on Key NTS Roadways and Peak Kistler Additional Traffic Volume

Roadway	Segment	Average Daily Traffic Volume	
		Alternative 3 NTS EIS[1]	Peak Kistler Addition
North			
Buckboard Mesa Rd	Pahute Mesa Rd to Airport Rd	355	81
Pahute Mesa Rd	Mercury Highway to Stockade Wash Dr	705	81
Pahute Mesa Rd	Stockade Wash Dr to Buckboard Mesa Rd	355	81
Tippipah Hwy	Mercury Hwy to Pahute Mesa Rd	1,410	81
South			
Mercury Hwy	Mercury Hwy to Road 5-01	8,070	81
Mercury Hwy	Road 5-01 to Cane Spring Rd.	7,050	81
Mercury Hwy	Cane Spring Rd to Tippipah Hwy	3,530	81

[1]Note: Alternative 3 NTS EIS is the preferred alternative from the NTS EIS which identifies the future baseline for average daily traffic volumes.
(NTS EIS and SRS Analyses)

Road Closures. During fuel loading, pre-launch and launch activities (approximately six hours) Pahute Mesa Road will be barricaded and blocked within 1,070 meters (3,500 feet) of the launch stand. Areas north of the launch stand on Pahute Mesa Road can be accessed by taking Buckboard Mesa Road through Area 18 and Area 20 to Pahute Mesa Road, except during the launch recovery windows (one hour during launch days and 30 minutes the following day during reentry). Figure 5-10 depicts specific road closure areas for Kistler vehicle launches and reentry.

Figure 5-10. Road closure areas for Kistler vehicle launch and recovery activities



Buckboard Mesa Road will be barricaded within 1,220 meters (4,000 ft) of the recovery area/road interfaces for 30 minutes before and after the launch and for a 30 minute window during reentry. During the 30-minute window the day following a launch, areas north of the landing area on Buckboard Mesa Road could be accessed using Pahute Mesa Road. No key roadway access would be available to areas north of the launch stand on Pahute Mesa Road or north of Buckboard Mesa Road for less than one percent of the time. This would have a minimal impact on transportation.

Off-Site Traffic. On-site NTS employment would increase because of the proposed action. The increase in employment would correspondingly increase daily vehicle trips and traffic volume on key roadways to the NTS. Increases in traffic volume from construction activities will be temporary, and once construction is finished will no longer be a factor. Traffic volume from on-going operations would increase as launches proceeded more frequently. Initially, one shift of 100 workers (working four days per week, 10 hours per day) would be employed at the Kistler Range. After launch activity reached a certain threshold, an additional shift of 50 workers (working four days per week, 10 hours per day) would be added. Table 5-28 outlines the estimates for average daily vehicle trips resulting during the construction and peak continuing operations.

Table 5-28. Average Off-Site Daily Vehicle Trips Generated during Construction and Continuing Operations

	Single Driver	Car Pool	Bus	Total Vehicle Trips
Construction	70	30	12	112
On-going Operations	100	50	8	158

During construction, the majority of construction workers will be based in Mercury. The off-site traffic generated during construction will be lower than during the routine operations phase when up to 150 employees will be traveling from off-site to the NTS. This analysis will focus primarily on the peak level of employment and perform analyses based on 150 employees in two shifts.

The peak-hour traffic volumes would occur during the start or end of one of the 100 person shifts during continuing operations. Peak-hour volumes could increase by 79 vehicles if 50 workers drove by themselves, 50 carpooled in a vehicle with two passengers, and 50 workers rode on buses resulting in four additional buses. In addition at most two vehicle trips by the fueling tankers could occur during the peak-hour. This would result in 81 additional vehicles traveling during the peak hour.

Based on Association of American State Highway and Transportation Officials (ASHTO) standards, level of service B is appropriate for freeways; arterials; and rural, level, or rolling terrain. Level of service C is appropriate for rural (mountainous), urban, and suburban highways. For local roads, level of service D is appropriate in all terrain (AASHTO, 1990). Table 5-29 outlines levels of service for a multi-lane highway and a two-lane highway.

Table 5-29. Road Transportation Levels of Service

LOS	Description	Criteria (volume/capacity) Multi-lane Highway	Criteria (volume/capacity) Two-Lane Highway
A	Free flow with users unaffected by presence of other users of roadway	0-0.33	0-0.12
B	Stable flow, but presence of users in traffic stream become noticeable	0.34-0.50	0.13-0.24
C	Stable flow, but operation of single users becomes affected by interactions with others in flow stream	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	0.66-0.80	0.40-0.62
E	Unstable flow; operating conditions at capacity with reduced speeds, maneuvering difficult, and extremely poor levels of comfort and convenience.	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

(Transportation Research Board, 1995)

The additional traffic would increase peak hour traffic volume as outlined in Table 5-30. The Kistler increment will not change any LOS designations from current estimates. The U.S. Highway 95 east of the Mercury interchange would have increased peak hour traffic flow to 697 vehicles per hour. This increase in traffic volume would not affect the level of service, and the road could support an additional 475 vehicles before level of service would degrade to B. The only road close to a change in LOS is the short access road from the NTS to Hwy 95, State Road 433. This segment would experience an increase from 588 to 663 vehicles per hour. This access road is projected to have a low level of service, D, but the additional Kistler traffic would not be enough to bring service down to E. According to ASHTO standards and considering this access to the highway, level of service D is acceptable.

Under the Preferred Alternative of the NTS EIS in the year 2000, State Road 433 (the NTS access road) would experience the greatest traffic congestion during the peak hour, with LOS decreasing from its current LOS C to LOS D. This would occur because of other increases in activity at the NTS, not related to Kistler. The proposed action would not change any LOS for any of the main routes outlined in Table 5-30. U.S. Highway 95 east of Mercury would continue to have excess capacity and would continue to operate at level of service A. State Road 433 would approach a lower LOS. The other routes would have a minimal impact from the additional traffic generated by the Kistler action.

Table 5-30. Peak-Hour Traffic Volumes and Level of Service On Key Off-Site Roads Under Alternative 3 of the NTS EIS, and Additional Traffic Volume Generated by Kistler Action

Roadway Segments	Capacity	Baseline Estimate Year 2000		Year 2000 with Kistler Increment		Additional capacity available before LOS change
	VPH[a]	DDHV[b]	LOS[c]	DDHV	LOS	
U.S. Hwy 95 just east of Mercury Interchange	6,800	633	A	697	A	475
U.S. Hwy 95 Interchange at Mercury						
Southbound off-ramp	1300	75	B	75	B	525
Southbound on-ramp	1300	489	B	553	B	97
Northbound off-ramp	1300	489	B	489	B	161
Northbound on-ramp	1300	75	B	90	B	560
State Road 433 (access to NTS from Hwy 95)	2200	588	D	663	D	15

[a]VPH = Vehicles per hour
[b]DDHV = Directional design hourly volume (one direction)
[c]LOS = Level of Service
(DOE NTS EIS, and SRS Analyses)

Summary of Transportation Impacts

The additional traffic generated by the proposed Kistler action is minimal. The NTS on-site road network could easily support the additional traffic generated by Kistler activities. Traffic on off-site roads would increase, but other than State Road 433, the access road to the NTS, additional Kistler traffic would have almost no impact on traffic flow. The impact on traffic on State Road 433 as a result of the Kistler activities at the NTS would be minimal. This road would continue to operate at an acceptable level of service. The other minor transportation impact is closure of two paved roads during launch for approximately one hour per launch, resulting in the disruption of paved road access to the north west part of the NTS for one hour.

5.1.11 Other Impacts

The proposed Kistler activities at the NTS are expected to generate 6,000 pounds of solid waste per month and require 660 kilovolt-ampere of power per month. The volume of waste to be disposed is relatively small. The small volume will not have an impact on the lifetime of the landfill. Two of the three landfills on the NTS receive more over 7,500 tons of solid waste combined annually. This project will not generate more than 36 tons of solid waste annually, less than two percent of the annual solid waste disposed at these two landfills. If the waste is disposed outside of the NTS, there are many permitted landfills with available capacity within 100 miles of the NTS entrance.

The DOE infrastructure has over 5000 kVA available in that area of the NTS. A short line extension or local distribution transformer may be required depending upon the exact location of the consumer.

De-orbiting debris is a potential concern in the stratosphere as it can serve as a possible reaction site for ozone depletion. Large pieces of debris are a concern because they can fall through the atmosphere and impact the Earth. There are several sources of orbital debris which can become de-orbiting debris: inactive payloads account for approximately 21 percent of all orbital debris, operational debris released either intentionally (ejection springs, lens debris) or unintentionally (screwdrivers, gloves) account for approximately 13 percent of all orbital debris, and fragmentation debris accounts for approximately 51 percent of debris. Fragmentation debris is generated by the explosion of rocket bodies or the collision and resulting break up of orbital objects (rocket bodies, payloads, and/or debris).

Orbital debris like other orbiting objects loses energy through friction with the upper layer of the atmosphere and other forces that alter orbits (e.g., solar storms). Over time the orbit decays and the object eventually falls to Earth. As the objects enter the lower portions of the atmosphere, atmospheric drag will either slow the rate of descent and cause the object to either burn up or fall to Earth.

The reusable nature of the K-1 vehicle minimizes the amount of de-orbiting debris produced. Although some small objects (i.e., bolts etc) may be ejected when the payload is deployed, it is unlikely that the K-1 would produce significant amounts of de-orbiting debris.

5.1.12 Cumulative Impacts

Cumulative impact is "the incremental impact of the actions when added to other past, present, and reasonably foreseeable future action regardless of what agency (Federal or non-Federal) or person undertakes such other actions." (40 CFR 1508.7) The Proposed Action has been evaluated for cumulative impacts on air resources, noise, socioeconomic, biological resources, cultural and Native American resources, and transportation. In conducting these analyses, it is useful to distinguish among three types of effects:

1) those that are simply additive to other effects expected to occur in the region,

2) those that may be synergistic, causing an effect greater than the arithmetic sum of individual project impacts, and

3) chain reaction effects, in which an initial action can be reasonably expected to trigger a series of environmental consequences.

In researching cumulative projects, the Department of Energy, Nevada Operations Office and the U.S. Air Force were contacted. The following assessment of foreseeable future actions is based on information presented in the NTS EIS.

Chapter 4 and Chapter 5.1.1 through 5.1.11 analyze environmental impacts from constructing and operating the proposed Kistler launch and reentry/recovery facilities, which are scheduled to begin in 2002 and build to a capability to support a maximum of 52 missions in 2005 from Kistler's facilities on the NTS. The potential sources of cumulative impacts have been identified as air emissions, engine noise, socioeconomic factors, biological resources, cultural and Native American resources, and transportation. No potential cumulative impacts were determined to exist for water resources and hazardous waste because the Kistler operations would be the only activity contributing to these impacts and the Kistler operations were determined to have insignificant impacts.

Air Emissions

For the NTS, it is projected that construction activities under the new baseline (Alternative 3 under the NTS EIS) will generate about 600 tons of fugitive dust (PM_{10}) per year. This level will comprise just over three percent of the total of 177,760 tons associated with land disturbance activities throughout the region. The Kistler activities will add to this amount during the construction of the payload processing facility, launch area, and particularly for the work at the landing and recovery area. The major Kistler construction activities will be completed within a year of the initiation of the project so the period of the most significant impact is relatively short. The air modeling analyses performed included cumulative impacts by adding impacts to the current background PM_{10} levels and no cumulative effects on air quality are expected.

Launch Vehicle Engine Noise

Background noise at the Kistler facility areas will increase with the increased level of activity. During launches, the noise levels will be very high, but for a short time interval. In addition, activities are planned for various parts of the NTS that will add to noise levels from traffic in Kistler's range areas. Nonetheless, noise impacts associated with activities at the NTS will be restricted to the geographical area contained therein and would not affect persons resident in adjacent areas or add measurably to regional noise levels.

Socioeconomic Factors

Contributions of the proposed action to cumulative socioeconomic impacts would be additive. Given the proposed action's small relative size to the NTS workforce, the impacts would be minimal from a population and residential living standpoint. The impacts for the economic climate at the NTS could be visualized as starting a beneficial economic "chain reaction." With Kistler supporting and using some of DOE's resources, overhead costs for DOE's projects would be spread over a large base. The savings from lower infrastructure costs for DOE would allow additional work to be performed. The beneficial socioeconomic impact could be greater than Kistler's direct impact. In addition to no expected negative socioeconomic impact on the region, no disproportionate impacts are anticipated on economically disadvantaged or minority groups.

Transportation Impacts

There are minimal cumulative impacts expected to NTS on-site traffic as a result of implementing the Kistler activities. The existing capacity of the roadways on the NTS was examined in the NTS EIS and determined to be more than adequate to meet the traffic expected as a result of implementing Alternative 3 from the NTS EIS (preferred alternative) and the traffic expected to result from the proposed Kistler activities. The Association of American State Highway and Transportation Officials developed level of service ratings for roadways. Using the baseline estimates for off-site traffic levels generated by users of the NTS provided in the NTS EIS and adding the projected number of vehicles proposed to be used as part of the Kistler operations, it is possible to determine that the cumulative traffic levels do not exceed the capacity on the off-site roadways. The cumulative impacts of the Kistler activities and other anticipated off-site impacts would not cause a change in the level of service of any of the major roads that would be used to support the Kistler operations.

Biological Resources

Air emissions and noise impacts must be considered for cumulative impacts. Although evaluated separately, consideration must be given to whether, in combination with other activities in the area, they may contribute to the creation of significant impacts. Air emissions are not expected to have significant cumulative effects on air quality. As described in Section 5.1.7, noise will temporarily drive birds and animals away from the launch area, which will further limit their exposure to air emissions. Consequently, air emissions and noise levels are not expected to have cumulative effects on biological resources.

Additionally, the total loss of habitat is 671 acres. The total loss of vegetation community (Artemesia type community) represents 0.008 percent of the total area of Artemesia Type on the NTS. This plant community type is common throughout the Great Basin. The anticipated loss would represent only a small portion of this habitat type and would not adversely affect local or regional diversity of plants and plant communities. For wildlife species, loss of habitat would result in a reduction of overall population levels of some animal species, particularly those utilizing smaller areas of habitat and/or that are less mobile. This habitat loss would not be expected to adversely affect the local or regional diversity of animal species or populations.

Cultural and Native American Resources

As a result of DOE activities, 16,387 hectares (40,492 acres) on the NTS have been surveyed for cultural resources, approximately 4.7 percent of the land surface of the site, including portions of Area 18 and 19. Impacts to cultural resources could occur through ground-disturbing activities, unauthorized artifact collecting, and vandalism. This may result in a loss of 12,000 sites, 1,460 of which may be eligible for the National Register of Historic Places (based on the SHPO's records, 12 percent of all sites identified in Nevada are eligible). Because the proposed Kistler facilities were surveyed for cultural resources and through data recovery it was determined that the project would have "no adverse effect" on historic properties, the proposed action would not have a significant cumulative impact.

5.2 No Action Alternative

Under the no action alternative, Kistler would not conduct launch/reentry operations at the NTS, and the FAA would not issue a license for Kistler to conduct launch and reentry operations. Kistler would not construct its proposed launch and recovery facilities. The general use permit between DOE and the NTSDC would continue to exist but the subpermit between NTSDC and Kistler would be void.

The predicted environmental effects of the proposed action including potential beneficial impacts to socioeconomics would not occur. The area around the proposed launch and landing/recovery areas would remain in its current state. Given the competition in the marketplace for launching satellites, it is reasonable to assume that in the absence of Kistler, potential Kistler customers would contract with alternative launch services, and the relative benefits of the Kistler project would be lost. The goals of the Commercial Space Launch Act would not be furthered.

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11. GLOSSARY

A-Weighted Sound Level (dBA): A number representing the sound level which is frequency weighted according to a prescribed frequency response established by the American National Standards Institute and accounts for the response of the human ear.

Accident Scenario: A probable, possible, and/or plausible incident or sequence of failure events that can lead to the occurrence of an accident.

Acoustics: The science of sound that includes the generation, transmission, and effects of sound waves, both audible and inaudible.

Ambient Air Quality Standards: Standards established on a state or federal level, that define the limits for airborne concentrations of designated "criteria" pollutants (nitrogen dioxide, sulfur dioxide, carbon monoxide, total suspended particulates, ozone, and lead), to protect public health with an adequate margin of safety (primary standards) and to protect public welfare, including plant and animal life, visibility, and materials (secondary standards).

Apogee: That point in an earth orbit at which the moon or an artificial satellite is most distant from the earth; the term is sometimes loosely applied to positions of satellites of other planets.

Archaeology: A scientific approach to the study of human ecology, cultural history, and cultural process.

Attainment Areas: A region that meets the U.S. EPA National Ambient Air Quality Standards (NAAQS) for a criteria pollutant under the Clean Air Act.

Azimuth: A horizontal direction expressed as the angular distance between the direction of a fixed point (as the observer's heading) and the direction of the object; in context the compass direction expressed in degrees clockwise from north.

Carbon Monoxide: (CO) a colorless, odorless, poisonous gas produced by incomplete fossil fuel combustion. One of the six pollutants for which there is a national ambient standard.

Carpet Boom: Shock waves produced by an aircraft traveling at supersonic speeds that cover the ground in a parabolic shape, resulting in a sound resembling a short, impulse noise, similar to a double gun shot.

Criteria Pollutant: A pollutant determined to be hazardous to human health and regulated under EPA's National Ambient Air Quality Standards. The 1970 amendments to the Clean Air Act requires EPA to describe the health and welfare impacts of a pollutant as the "criteria" for inclusion in the regulatory regime.

Cumulative Impacts: The combined impacts resulting from all activities occurring concurrently at a given location.

Day-Night Average Noise Level: (L_{dn}) accounts for increased annoyance associated with nighttime noise events. An A weighted L_{eq} for a 24 hour day that is calculated by adding a penalty to sound levels occurring at night.

Decibels: A unit for describing the ratio of two powers or intensities, or the ratio of a power to a reference power. In the measurement of sound intensity, the pressure of the reference sound is usually taken as 2×10^{-4} dyne per square centimeter (equal to one-tenth bel).

Endangered Species: A plant or animal that is in danger of extinction throughout all or a significant portion of its range.

Equivalent Noise Level: (L_{eq}) energy mean A-weighted sound level during a stated measurement period.

FAA Controlled Airspace: Airspace controlled by the FAA to a ceiling of 18,288 meters (60,000 feet).

Hydrazine: (N_2H_4) a toxic, flammable, fuming corrosive, strongly reducing liquid used as launch vehicle fuel.

Hypergolic: Term applied to describe the auto-initiation of the explosive reaction between a fuel and an oxidizer upon mixing with each other without a spark or other external aid.

Impacts: An assessment of the meaning of changes in all attributes being studies for a given resource, an aggregation of all of the adverse effects, usually measured using a qualitative and nominally subjective technique.

Instantaneous Impact Point (IIP): The point on the surface of the earth where an airborne mass would strike without atmospheric (e.g., wind) or continuing propulsive effects; the area containing impact points is described by impact limit lines.

Mach Number: The ratio of the speed of an object to the speed of sound.

Native Americans: Used in a collective sense to refer to individuals, bands, or tribes who trace their ancestry to indigenous populations of North America prior to Euro-American contact.

Nitrogen Dioxide: (NO_2) Gas formed primarily from atmospheric nitrogen and oxygen when combustion takes place at high temperature. NO_2 emissions contribute to acid deposition and formation of atmospheric ozone. One of the six pollutants for which there is a national ambient standard.

Nitrogen Tetroxide: (N_2O_4) a highly toxic, strongly oxidizing gas that produces corrosive fumes; often used as the oxidizer in hypergolic propulsion systems.

Non-Attainment Areas: An area that has been designated by the Environmental Protection Agency or the appropriate state air quality agency, as exceeding one or more national or state Ambient Air Quality Standards.

Ozone: (O_3) A molecule made up of three atoms of oxygen. Occurs naturally in the stratosphere and provides a protective layer shielding the Earth from harmful ultraviolet radiation. In the troposphere, it is a chemical oxidant and major component of photochemical smog.

Particulate Matter: Matter in the form of small liquid or solid particles.

Payload: The spacecraft, satellite, or scientific experiment that a launch vehicle transports into the proper orbit for deployment.

Propellants: Balanced mixtures of fuel and oxidizer designed to produce large volume of hot gases at controlled, predetermined rates, once the burning reaction is initiated.

Restricted Airspace: Airspace above a surface area of published dimensions within which flight of aircraft is subject to restrictions caused by "unusual and often invisible hazards" published in FAR 73. Area where restrictions are in force to minimize interference between friendly forces.

Sonic Boom: A noise caused by a shock wave that emanates from an aircraft or other object traveling at or above sonic velocity.

Sonic Boom Footprint: A predicted semi-circular arc of ground which would be likely to experience a sonic boom during a supersonic event. The ground pressure experienced within these arcs will be affected by air turbulence, wind, and temperature variations in the atmosphere.

Sound: An alteration of properties of an elastic medium, such as pressure, particle displacement, or density, that propagates through a medium, or a superposition of such alterations; sound waves having frequencies above the audible (sonic) range are termed ultrasonic waves; those with frequencies below the sonic ranges are called infrasonic waves. Also known as acoustic wave, sound wave.

Stratosphere: The atmospheric shell above the troposphere and below the mesosphere. It extends from the tropopause to about 55 kilometers, where the temperature begins again to increase with altitude.

Sulfur Dioxide: (SO_2) a toxic gas that is produced when fossil fuels, such as coal and oil, are burned. SO_2 is the main pollutant involved in the formation of acid rain. SO_2 also can irritate the upper respiratory tract and cause lung damage.

Telemetry: Automatic data measurement and transmission from remote sources, such as space vehicles, to receiving station for recording and analysis.

Threatened Species: Plant and wildlife species likely to become endangered in the foreseeable future.

Trajectory: The path of an object moving through space.

Visual Dominance: The level of noticiability that occurs as a result of a visual change in the area. Levels of visual dominance range from "not noticeable" to a significant change which becomes "visually dominant."

Visual Sensitivity: Depends on the setting of an area. Coastlines, national parks, recreation, or wilderness areas are considered to have high visual sensitivity where viewers would be aware of even very small changes to the visual environment.

Volatile Organic Compounds: (VOCs) Organic compounds that easily volatize or evaporate and can break down through photodestructive mechanisms.