FINAL
ENVIRONMENTAL IMPACT STATEMENT

EVOLVED EXPENDABLE LAUNCH VEHICLE PROGRAM

ENOVARUM PRAESTARUM
(Affordability Through Innovation)

APRIL 1998

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS UNITED STATES AIR FORCE
WASHINGTON DC

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FROM: HQ USAF/ILEVP
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SUBJECT: Final Environmental Impact Statement (FEIS) for the Evolved Expendable Launch Vehicle (EELV) Program

We are pleased to provide you the FEIS for the EELV Program. This document is provided in compliance with the regulations of the President's Council on Environmental Quality implementing the National Environmental Policy Act.

Please maintain this document in your library reference collection for public review. If additional information is needed, or to comment on the FEIS, please contact: Mr. Jonathan D. Farthing, Chief, Environmental Analysis Division, HQ AFCEE/ECA, 3207 North Road, Brooks AFB, TX 78235-5363; Phone (210) 536-3668.

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Attachment:
Final EIS

COVER SHEET

FINAL ENVIRONMENTAL IMPACT STATEMENT
EVOLVED EXPENDABLE LAUNCH VEHICLE PROGRAM

a. Responsible Agency: U.S. Air Force

b. Cooperating Agency: Federal Aviation Administration (FAA)

c. Proposed Action: Implementation of the Evolved Expendable Launch Vehicle (EELV) Program

d. Inquiries on this document should be directed to: Mr. Jonathan D. Farthing, Chief, Environmental Analysis Division, HQ AFCEE/ECA, 3207 North Road, Brooks Air Force Base, Texas, 78235-5363, (210) 536-3668

e. Designation: Final Environmental Impact Statement (FEIS)

f. Abstract: This FEIS has been prepared in accordance with the National Environmental Policy Act to analyze the potential environmental consequences of the Proposed Action and the No-Action Alternative. The Proposed Action is the development, deployment, and operation of EELV systems. EELV systems would replace current Atlas IIA, Delta II, and Titan IVB launch systems and are intended to meet the requirements of the U.S. government National Executable Mission Model (NMM), both medium and heavy lift, at a lower launch cost than the present expendable launch systems. The proposed launch locations for the program are Cape Canaveral Air Station (AS), Brevard County, Florida, and Vandenberg Air Force Base (AFB), Santa Barbara County, California. Under the Proposed Action, three concepts were examined. Concepts A and B depict each of the two EELV contractor concepts. The number of launches analyzed for each of these concepts includes the government NMM, plus 16 commercial launches per year. Under Concept A/B, there is no distinction between government and commercial flights. For the analysis, each contractor is assumed to launch 50 percent of the combined total of EELV flights.

The No-Action Alternative would be a decision not to proceed with the EELV program. The Atlas IIA, Delta II, and Titan IVB launch vehicles would support space launches to meet the requirements of the NMM.

The FEIS includes analyses of potential impacts to local community (employment and population), land use and aesthetics, transportation, utilities, hazardous materials and hazardous waste management, health and safety, geology and soils, water resources, air quality (upper and lower atmosphere), noise, orbital debris, biological resources, cultural resources, and environmental justice.

Under the Proposed Action, the number of direct and indirect jobs, and population associated with launch activities at both installations, would increase temporarily. Thereafter, employment and population associated with launch activities would decline as the requirement for jobs associated with current launch programs is phased out. No impacts to land use, utility systems, or transportation networks are anticipated. Although quantities of hazardous materials utilized and hazardous waste generated may increase under the Proposed Action (due to the addition of commercial launches) over No-Action Alternative levels, both installations have appropriate management procedures in place in compliance with applicable regulations; therefore, no impacts are expected. No Class I ozone-depleting substances (ODSs) would be utilized under the Proposed Action; the use of Class II ODSs would be minimized or eliminated. Proposed Action construction activities at both installations would be coordinated with installation personnel to minimize impacts to remediation activities and the EELV program schedule. At both installations, procedures are in place to respond to launch-related failures. Using procedures established for

existing launch systems, risks to installation personnel and the general public have been minimized to acceptable levels during normal and aborted launches, in accordance with Eastern and Western Range 127-1, Range Safety Requirements.

Appropriate erosion control measures (proper construction practices and compliance with permit requirements) would be implemented to reduce the potential for impacts to soils, geology, and water resources. A Storm Water Pollution Prevention Plan would be required at both installations. Under both concepts, water would be recycled after launch or disposed of in accordance with applicable requirements. Under Concepts B and A/B (for some commercial launches), as well as the No-Action Alternative, effects from deposition of hydrochloric acid (HCl) and aluminum oxide are expected to be minimal.

During construction activities, there would be a short-term, temporary increase of local concentrations of criteria pollutants. Peak launch year emissions would not be sufficient to jeopardize the attainment status for criteria pollutants at either installation. EELV systems would have lower emissions per launch than No-Action Alternative systems, and no adverse impacts are anticipated. Because Vandenberg AFB is within an area designated by the U.S. Environmental Protection Agency as in severe nonattainment for ozone, EELV activities must comply with Clean Air Act requirements mandating that federal actions comply with the applicable State Implementation Plan (SIP) to achieve attainment. In addition to releases of ozone in the lower atmosphere impacting the SIP, impacts in the stratosphere were studied. Under Concept A, launches would produce no estimated emissions of ODSs, and therefore would not contribute to any degradation of the stratospheric ozone layer. For some Concept B and A/B commercial launches and for some No-Action Alternative launches involving use of solid rocket motors, alumina particulates and chlorine compounds would be emitted into the stratosphere; however, these amounts would be minimal, and no adverse impacts are expected. Launch and sonic boom noise would be short-term and temporary, and no impacts to structures or humans are anticipated. A small, incremental contribution to the existing orbital debris population could occur under the Proposed Action and the No-Action Alternative; however, all EELV program vehicles would be designed to minimize orbital debris.

At both installations, impacts to vegetation and wildlife would be minimal. At Vandenberg AFB, short-term impacts could occur to wildlife exposed to sonic booms; launches require a marine mammal take permit from the National Marine Fisheries Service; permit requirements may include monitoring during launches. Wetland areas that could be affected by Proposed Action construction activities under Concept A would be mitigated in accordance with permit requirements. Under Concept B, dredging activities at the South Vandenberg AFB Boat Dock area would require a permit and could temporarily affect sea otters, harbor seals, and brown pelicans. Construction associated with the Proposed Action at Cape Canaveral AS would not affect any National Register of Historic Places (National Register)-listed or -eligible prehistoric or historic archaeological sites, or archaeologically sensitive areas. No traditional resources have been identified in the Area of Potential Effect (APE) at either installation. Under Concept B, one facility that would require modification (Hangar C) may possess historical significance; a determination is pending. Mitigations, if required, would be developed in consultation with the Florida State Historic Preservation Officer. Construction associated with Concept B at Vandenberg AFB would occur at Space Launch Complex-6, which is an archaeologically sensitive area. Ground-disturbing activities would require archaeological and Native American monitoring. Because no construction or facility modifications are proposed under the No-Action Alternative, there would be no effects to historic properties. Activities associated with the Proposed Action and the No-Action Alternative would not cause disproportionately high and adverse impacts to low-income and minority populations.

SUMMARY

PURPOSE OF AND NEED FOR ACTION

The primary requirement of the Evolved Expendable Launch Vehicle (EELV) program is to provide the capability for lifting medium (2,500 to 17,000 pounds) and heavy (13,500 to 41,000 pounds) payloads to orbit according to the National Executable Mission Model (NMM) for government space launches at lower recurring costs than those of current expendable systems. The EELV would replace current Atlas IIA, Delta II, and Titan IVB launch vehicles meeting the NMM. The EELV would be DoD's source of expendable medium and heavy spacelift transportation to orbit through 2020. EELV systems would provide capabilities to launch unmanned DoD, National Aeronautics and Space Administration (NASA), and other payloads to orbit.

The Air Force has prepared this environmental impact statement (EIS) to provide information on the potential impacts resulting from the development and operation of EELV systems. Because commercial launches are included in the Proposed Action, the Federal Aviation Administration (FAA) is serving as a cooperating agency in the preparation of this EIS.

ALTERNATIVES INCLUDING THE PROPOSED ACTION

Proposed Action. The Air Force is considering participation in the continued development and deployment of EELV systems. These systems would be unmanned, expendable space launch systems evolved from existing systems. The EELV family of vehicles would consist of medium launch vehicles (MLVs) and heavy launch vehicles (HLVs).

Cape Canaveral Air Station (AS), Florida, and Vandenberg Air Force Base (AFB), California, are the only locations within the United States that currently provide space launch capabilities to support the EELV program. Both the MLV and HLV would be designed so that all launch vehicle configurations could be launched from both locations.

As a result of the Air Force implementation of EELV, one or more contractors may use EELV systems to launch commercial payloads. The proposed government and commercial launch activities for both contractors are discussed herein and their impacts analyzed.

The government portion of the EIS mission model is based on the Air Force Space Command (AFSPC) NMM. Information included in the AFSPC NMM for both the east and west coasts includes vehicle types and proposed payload. The commercial portion of the mission model used in this EIS was created using commercial forecasts from the AFSPC NMM, the Commercial Space Transportation Advisory Council (COMSTAC) projections, and FAA estimates. The projected peak launch rate at Cape Canaveral AS would be achieved in

2015, and the projected peak launch rate at Vandenberg AFB would be achieved in 2007.

This EIS analyzes three options for implementing the Proposed Action. Concepts A and B depict each of the two EELV contractor concepts: that of the Lockheed Martin Corporation and that of McDonnell Douglas Aerospace, a wholly owned subsidiary of the Boeing Company. The number of launches analyzed for each of these concepts includes the government NMM, plus 16 commercial launches per year. Under these concepts, only one of the two contractors would continue to develop and use an EELV system. The third option, Concept A/B, depicts a scenario under which both contractors would continue with the development and use of EELV systems. Under Concept A/B, no distinction is made between government and commercial flights. For the EIS analysis, each contractor is assumed to launch 50 percent of the combined total of EELV flights.

Under Concept A, Space Launch Complex (SLC)-41 at Cape Canaveral AS and SLC-3W at Vandenberg AFB would be utilized for EELV launches. Under Concept B, SLC-37 at Cape Canaveral AS and SLC-6 at Vandenberg AFB would be utilized for EELV launches. In addition to the launch complexes, other facilities at both locations would be utilized for both concepts. All of the facilities used for Concept A and Concept B activities would be utilized under Concept A/B.

No-Action Alternative. The No-Action Alternative would be a decision not to proceed with the development and deployment of the EELV program. The Atlas IIA, Delta II, and Titan IVB launch vehicles would continue to support space launches to meet the requirements of the government portion of the NMM. These launch vehicles would provide DoD's source of expendable medium and heavy spacelift transportation to orbit through 2020. The No-Action Alternative does not include analysis of commercial launches.

SCOPE OF STUDY

In order to establish the context in which environmental impacts may occur, potential changes in population and employment, land use and aesthetics, transportation, and utility services are discussed, as are issues related to current and future management of hazardous materials and wastes. Additionally, health and safety issues are examined. Potential impacts to the natural environment are evaluated for geology and soils, water resources, air quality, noise, orbital debris, biological resources, and cultural resources. Potential environmental justice impacts to minority and/or low-income populations that could occur as a result of the EELV program are also considered.

SUMMARY OF ENVIRONMENTAL IMPACTS

Following is a brief description of potential environmental impacts of the Proposed Action and No-Action Alternative. Options for mitigating potential adverse environmental impacts that might result from development and operation of EELV systems are presented and discussed, where applicable.

LOCAL COMMUNITY

Proposed Action

The number of direct and indirect jobs, and population associated with launch activities at both installations, would increase temporarily during construction activities. Thereafter, employment and population associated with launch activities would decline as the requirement for jobs associated with current launch vehicle programs is phased out. This decline in employment and population would be very small in comparison to projected regional growth in the vicinity of both installations.

No-Action Alternative

Under the No-Action Alternative, the number of direct and indirect jobs would remain at 1997 levels through 2015. Population and employment in the region are projected to increase through 2015.

LAND USE AND AESTHETICS

Proposed Action

Incompatible land uses would not result from implementation of the EELV program. A coastal zone consistency determination has been prepared for EELV activities at both installations. At Vandenberg AFB, more frequent annual beach closures are expected from EELV launch activities because of the increased number of launches (due to the addition of commercial launches) over the No-Action Alternative.

No-Action Alternative

Under the No-Action Alternative, no construction or facility modification would occur. The number of annual beach closures at Vandenberg AFB would be similar to that of current closures.

TRANSPORTATION

Proposed Action

During construction activities, project-related traffic would increase slightly over No-Action Alternative levels. During the operational phase of the EELV program, project-related traffic is expected to decline, and no impacts are anticipated.

No-Action Alternative

Under the No-Action Alternative, project-related traffic would continue at existing volumes, and no impacts are expected.

UTILITIES

Proposed Action

During construction activities, utility consumption would increase slightly over No-Action Alternative levels; however, all systems would continue to operate within capacity. During the operational phase, utility usage on the installations would increase. However, utility usage associated with existing launch vehicle programs would decline, and the EELV-related increases would be minimal in comparison to regional growth; therefore, no impacts are expected.

No-Action Alternative

Under the No-Action Alternative, no changes in current utility consumption are expected. All systems would continue to operate within capacity, and no impacts are anticipated.

HAZARDOUS MATERIALS AND WASTE

Proposed Action

Under Concept A, total hazardous materials and propellant usage is expected to increase over No-Action Alternative levels; per launch usage is expected to decrease. Activities would be conducted in accordance with applicable regulations for the use and storage of hazardous materials. Solid rocket motors would not be used for Concept A activities, thus eliminating the need for storage of solid propellant. Hazardous waste generation would increase because of the increased number of launches (due to the addition of commercial launches) over the No-Action Alternative. The types of waste would be similar in nature to wastes currently handled by both installations. No Class I ozone-depleting substances (ODSs) would be used for Concept A activities.

Under Concept B, total hazardous materials usage is expected to decrease from No-Action Alternative levels; however, the amount of propellants stored would increase. Activities would be conducted in accordance with applicable regulations for the use and storage of hazardous materials. Hazardous waste generation would increase because of the increased number of launches (due to the addition of commercial launches) over the No-Action Alternative. The wastes would be similar in nature to wastes routinely handled by both installations. No Class I ODSs would be used for Concept B activities.

Construction activities associated with Concepts A and B at both installations would be coordinated with Installation Restoration Program personnel to minimize impacts to remediation activities and the EELV program schedule.

Under Concept A/B, total hazardous materials and propellants usage and hazardous waste generated would increase at both installations as a result of the increased number of launches (due to the addition of commercial launches) over the No-Action Alternative. Other aspects of hazardous materials and waste management would be a combination of the effects described for Concepts A and B.

No-Action Alternative

Under the No-Action Alternative, types and amounts of hazardous materials utilized and hazardous wastes generated would be similar to those associated with current launch programs.

HEALTH AND SAFETY

Proposed Action

At both installations, procedures are in place for launch-related accidents, fire protection, alarm, fire suppression, flight termination, and explosive safety. Using procedures established for existing launch systems, risks to installation personnel and the general public have been minimized to acceptable levels during normal and aborted launches, in accordance with Eastern and Western Range (EWR) 127-1, Range Safety Requirements.

No-Action Alternative

Under the No-Action Alternative, both installations would continue to implement current health and safety procedures. Using procedures established for existing launch systems, risks to installation personnel and the general public have been minimized to acceptable levels during normal and aborted launches, in accordance with EWR 127-1, Range Safety Requirements.

GEOLOGY AND SOILS

Proposed Action

Construction activities would uncover and disturb soils, increasing the potential for wind and water erosion; appropriate measures to control soil erosion would be implemented, and no adverse impacts are expected. At Vandenberg AFB, new facilities and facility modifications would incorporate earthquake-resistant design to meet requirements for Seismic Zone IV, and no adverse impacts are anticipated. In addition, under Concept B and Concept A/B, the South Vandenberg AFB boat dock area would be dredged. The dredging would be performed to its previous depth in a previously dredged area, thus eliminating impacts to undisturbed sediments.

No-Action Alternative

Under the No-Action Alternative, no changes to existing launch programs would take place. No ground disturbance would occur, and no impacts are expected.

WATER RESOURCES

Proposed Action

Under Concept A, peak-year water requirements would represent a decrease from No-Action Alternative levels. Under Concepts B and A/B, peak-year water requirements would increase over No-Action Alternative levels (due to addition of commercial launches). EELV activities would not affect the quantity of water available to the installations or to the surrounding areas, or increase the amount of water withdrawn from groundwater resources. A Storm Water Pollution Prevention Plan would be required at both installations. Under both concepts, water would be recycled after launch or disposed of in accordance with applicable requirements.

Concept B and Concept A/B dredging activities at the South Vandenberg AFB Boat Dock would require a permit. Under Concepts B and A/B, minimal deposition of hydrochloric acid (HCl) associated with the use of solid rocket motors for some launches (commercial missions only) would be concentrated near the launch pad. Adverse impacts to surface water and groundwater are not anticipated.

No-Action Alternative

Under the No-Action Alternative, water requirements would not impact the quantity of water available to either installation. Existing launch vehicles use some solid rocket motors, so impacts would be similar to those described for solid rocket motors for Concept B. Adverse impacts to water resources are not anticipated.

AIR QUALITY (LOWER ATMOSPHERE)

Proposed Action

During construction activities, there would be an increase of local concentrations of criteria pollutants. However, these emissions would be temporary and short-term and would not jeopardize either region's attainment status for these pollutants. Application of water during ground-disturbing activities and efficient scheduling of equipment use would mitigate impacts during construction. Launch vehicle preparation and assembly activities would create short-term air emissions. EELV systems would have lower emissions than the current launch vehicle systems, on a per launch basis, and no adverse impacts are expected.

Because Vandenberg AFB is within an area designated by the U.S. Environmental Protection Agency (EPA) as in nonattainment for ozone, EELV program activities must comply with Clean Air Act requirements mandating that federal actions comply with the applicable State Implementation Plan to achieve attainment.

No-Action Alternative

Under the No-Action Alternative, annual nitrogen oxides (NO_x) emissions would be lower than those projected for the Proposed Action. This difference could be due to the smaller number of launches analyzed under the No-Action Alternative. No adverse impacts are expected.

AIR QUALITY (UPPER ATMOSPHERE)

Proposed Action

Under Concept A, launches would produce no estimated emissions to the stratosphere of any ODSs, and therefore would not contribute to any degradation of the stratospheric ozone layer. Under Concept B, launches that involve use of solid rocket motors (commercial missions only) would produce emissions of alumina particulates and chlorine compounds into the stratosphere; however, compared to baseline and No-Action Alternative emissions to the stratosphere, these amounts would be significantly less, and adverse impacts are not anticipated.

No-Action Alternative

The emissions of alumina particulates and chlorine into the stratosphere would be greater under the No-Action Alternative than emissions resulting from the Proposed Action because of the larger number of launches utilizing solid rocket motors. However, these emissions are minimal compared to worldwide emissions of alumina particulates and chlorine compounds to the stratosphere, and no adverse impacts are anticipated.

NOISE

Proposed Action

Launch noise associated with EELV launches would be short-term and temporary. No human or structural impacts are anticipated. Sonic boom footprints for Cape Canaveral AS launches are far offshore over the Atlantic Ocean. At Vandenberg AFB, sonic booms could occur over the Channel Islands.

No-Action Alternative

Under the No-Action Alternative, noise and sonic boom exposure would be similar to current launch operation levels, which are comparable to those described under the Proposed Action. No impacts from noise and sonic boom are anticipated.

ORBITAL DEBRIS

Proposed Action

A small, incremental contribution to the existing orbital debris population could occur under all EELV concepts through fragmentation of upper stages. However, EELV program vehicles would be designed to minimize size and quantity of orbital debris.

No-Action Alternative

The No-Action Alternative launch vehicles would continue to contribute to the orbital debris population.

BIOLOGICAL RESOURCES

Proposed Action

At both installations, impacts to vegetation and wildlife would be minimal. Launch noise and sonic booms associated with EELV launches would be infrequent, short-term, and temporary. No noise impacts to wildlife are anticipated at Cape Canaveral AS. Temporary, minor impacts to sensitive species (startle effects) would occur from launch noise and sonic booms at Vandenberg AFB; launches require a marine mammal take permit from the National Marine Fisheries Service. Permit requirements may include monitoring during launches.

At Cape Canaveral AS, any changes to artificial light sources would be designed to minimize impacts to sea turtles.

Under Concept A, the potential loss of jurisdictional wetlands at SLC-41 and at assembly facilities sites would be mitigated, as required, through appropriate permits. Mitigations could include replacement, protection, restoration, or avoidance. At Vandenberg AFB, proposed construction activities at SLC-3 would affect a small portion of the wetland present at the site that would fall within the most stringent acreage restrictions of a nationwide permit.

Under Concept B, effects of HCl deposition from solid rocket motors at both installations would be minimal; pre- and post-launch monitoring would be conducted to assess long-term effects. At Cape Canaveral AS, vegetation impacts associated with clearing scrub jay habitat for construction of the Horizontal Integration Facility south of SLC-37 would be compensated under the Cape Canaveral AS Scrub Jay Habitat Compensation Plan. The potential loss of jurisdictional wetlands at SLC-37 would be mitigated, as required, by the appropriate permits. Impacts to the southeastern beach mouse east of SLC-37 from fire and heat from the flame duct and from construction of a lightning tower anchor could be mitigated through a trapping and relocation effort and through habitat restoration. Prior to construction activities, a biological survey would be conducted to identify and relocate gopher tortoises or other listed species, such as the eastern indigo snake, at SLC-37.

Under Concept B, dredging activities at the South Vandenberg AFB Boat Dock area would require a permit and could temporarily affect harbor seals, sea otters, and brown pelicans.

Implementation of Concept A/B is expected to result in a combination of the effects described previously for Concepts A and B.

No-Action Alternative

Under the No-Action Alternative, there would be minimal effects on biological resources from the deposition of HCl associated with the continued use of some solid rocket motors. Other direct effects to vegetation and wildlife would be similar to those discussed for Concepts A and B.

CULTURAL RESOURCES

Proposed Action

Construction associated with the Proposed Action at Cape Canaveral AS would not affect any National Register of Historic Places (National Register)-listed or eligible prehistoric or historic archaeological sites, or archaeologically sensitive areas. Under Concept B, one facility that would require modification (Hangar C) may possess historical significance; a determination is pending. Mitigations, if required, would be developed in consultation with the Florida State Historic Preservation Officer (SHPO). No traditional resources have been identified in the Area of Potential Effect (APE).

Construction associated with Concept A at Vandenberg AFB would not affect any National Register-listed, eligible, or potentially eligible prehistoric or historic archaeological sites. Construction associated with Concept B at Vandenberg AFB would occur at SLC-6, which is an archaeologically sensitive area. Ground-disturbing activities would require archaeological and Native American monitoring. No traditional resources have been identified in the APE.

No-Action Alternative

Under the No-Action Alternative, existing facilities would continue to support the current launch vehicle programs. However, no new construction or facility modifications have been proposed; therefore, no effects on historic properties are expected.

ENVIRONMENTAL JUSTICE

Activities associated with the Proposed Action would not cause disproportionately high and adverse impacts to low-income and minority populations.

1.0 PURPOSE OF AND NEED FOR ACTION

This environmental impact statement (EIS) examines the potential for impacts to the environment as a result of the development, deployment, and operation of Evolved Expendable Launch Vehicle (EELV) systems. The proposed launch locations for the EELV program activities are Cape Canaveral Air Station (AS), Florida, and Vandenberg Air Force Base (AFB), California. For the purposes of this document, EELV systems consist of one or more families of vehicles that could replace Atlas IIA, Delta II, and Titan IVB launch vehicles. A glossary of terms, acronyms, and abbreviations used in this document is provided in Appendix A.

1.1 PURPOSE AND NEED

In 1994, representatives from the defense, intelligence, civil, and commercial space sectors developed a Space Launch Modernization Plan (SLMP) to evaluate national space launch systems and to improve the United States' launch capability. The SLMP contained four alternatives for the modernization of the United States' space launch capabilities:

- Sustain existing launch systems
- Evolve current expendable launch systems (EELV)
- Develop a new, expendable launch system
- Develop a new, reusable launch system.

On August 5, 1994, the President signed the National Space Transportation Policy, tasking the Secretary of Defense to provide an implementation plan for improvement and evolution of the current Expendable Launch Vehicle fleet. On October 25, 1994, the Deputy Secretary of Defense signed the National Space Implementation Plan for National Space Transportation Policy, which identified the EELV program as the Department of Defense's (DoD's) solution for reducing the cost of launches.

The primary governmental requirement of EELV systems is to provide the capability for lifting medium (2,500 to 17,000 pounds) and heavy (13,500 to 41,000 pounds) payloads to orbit according to the National Executable Mission Model (NMM) for government space launches at lower recurring costs than those of current expendable systems.

1.2 DECISION TO BE MADE

The Air Force will decide whether to participate in the development and operation of EELV systems. Participation may include funding development of EELV systems, purchase of launch vehicles or services, and/or Air Force authorization of the use of government property.

1.3 SCOPE

This document has been prepared in accordance with the National Environmental Policy Act (NEPA) of 1969, the Council on Environmental Quality (CEQ) regulations implementing NEPA, Air Force Instruction (AFI) 32-7061, and DoD Regulation 5000.2R.

1.3.1 Public Participation Process

The public participation process provides an opportunity for public involvement in the development of an EIS. The Notice of Intent (NOI) (Appendix B) to prepare an EIS for the development and deployment of the EELV program was published in the Federal Register on February 19, 1997. Notification of public scoping was also made through the local media, as well as through letters to federal, state, and local agencies and officials, and interested groups and individuals.

The scoping period for the EELV program began on February 19, 1997. The Air Force held two public meetings during the scoping period to solicit comments and concerns from the general public: at Cape Canaveral, Florida, on March 11, 1997, and in Lompoc, California, on March 13, 1997. In addition to oral comments accepted at these meetings, written comments were received during the scoping process. The Air Force used these comments, as well as NEPA requirements and information from previous Air Force programs, to determine the scope and direction of studies/analyses to accomplish this EIS.

The draft EIS (DEIS) was filed with the U.S. Environmental Protection Agency (EPA) and circulated to the interested public and government agencies for a period of 45 days for review and comment. This DEIS was made available for public review and comment in December 1997; copies of the document were provided to local libraries and those requesting copies. At public hearings held on January 13, 1998, and January 15, 1998, the Air Force presented the findings of the DEIS and invited public comments. All comments were reviewed and addressed, when applicable, and have been included in their entirety in this document. Responses to comments offering new data or changes to data and questions about the presentation of data are also included. Comments simply stating facts or opinion, although appreciated, did not require specific responses. Chapter 9.0, Public Comments and Responses, more thoroughly describes the comment and response process. Appendix C presents a listing of agencies and individuals who have received a copy of the final EIS (FEIS).

The FEIS is filed with U.S. EPA and distributed in the same manner as the DEIS. Once the FEIS has been available for at least 30 days, the Air Force may publish its Record of Decision (ROD) for the action.

1.3.2 Scope of the EIS

This EIS is limited to the consideration of government and commercial activities directly associated with the EELV systems (e.g., construction, operation). The environmental effects of payloads that would utilize these systems to reach orbit shall be addressed, as required, under separate NEPA documentation that would be prepared for each of the satellite programs.

As a part of the scoping process, the Air Force made the decision to include analysis of the potential commercial launch operations of each of the two EELV contractors described in this EIS. It is likely that any contractor selected to conduct government EELV activities would also request use of the same facilities and EELV vehicle to launch commercial payloads. Therefore, to provide a complete analysis of potential environmental impacts of the implementation of the EELV program, Section 2.1 describes both the proposed government and commercial launch activities. It should be noted that although this analysis includes commercial launch operations, these operations may be increased, reduced, or modified depending on the actual commercial markets. Additional NEPA documentation may be required.

The Commercial Space Launch Act of 1984 (Public Law [P.L.] 98-575), as codified, 49 United States Code (U.S.C.) Subtitle IX, Ch. 701, Commercial Space Launch Activities (CSLA), declares that the development of commercial launch vehicles 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 safety and safety of property, the Department of Transportation (DOT) is authorized to regulate and license U.S. commercial launch activities. Within DOT, the Secretary's authority under CSLA has been delegated to the Federal Aviation Administration (FAA). Because licensing launch operations is considered to be a major federal action subject to the requirements of NEPA, the FAA Office of the Associate Administrator for Commercial Space Transportation must assess the potential environmental impacts of an applicant's proposed actions. Because of the addition of commercial activities, the FAA is serving as a cooperating agency in the preparation of this EIS. The FAA may use this EIS to document its NEPA requirement.

The potential impacts associated with use of the launch vehicles and facilities addressed within this EIS have been assessed using the most current information available. However, should there be changes to launch vehicles, facilities, or other aspects of the EELV program that would alter the analysis provided within this EIS, appropriate additional environmental documentation would be prepared, as required.

Other facilities would be utilized for manufacturing and/or operational and developmental testing and evaluation in support of the EELV systems. These facilities (including facilities belonging to contractors) and their operation are independent of this proposed government action. Operational test and evaluation activities would be limited to data gathering associated with operational launches and developmental testing activities; there would be no separate launches for testing purposes only.

1.4 CHANGES FROM THE DEIS TO THE FEIS

The text of this EIS has been revised, where appropriate, to reflect concerns expressed in public comments. Based on more recent studies and/or comments received, sections of the EIS have been updated or revised. The following list summarizes major revisions to the text:

- Information on low-azimuth launches from Vandenberg AFB launch complexes has been revised based on recent changes in toxic hazard exposure criteria.

- Changes in upper-stage propellant quantities for one contractor have been incorporated in Section 2.1.2; additional modeling was conducted, and revised air emissions estimates have been provided in Sections 4.10 and 4.11 and Appendix J.

- Text in Sections 3.9.1.2 and 4.9.1.1.1 has been revised, based on Flood Insurance Rate Map data and current Federal Emergency Management Agency policy, to reflect that no 100-year floodplains are present within areas proposed for EELV construction.

- The Clean Air Act Conformity Applicability Analysis for Vandenberg AFB (Appendix K) and applicable text in Section 4.10 have been revised based on receipt of more refined information from the contractors.

- The discussion of impacts associated with acidification of soils and water from the use of solid rocket motors has been revised based on the review of results from recent studies.

- The discussion of solid waste and industrial wastewater disposal is Sections 2.1, 3.5, and 4.5 has been expanded to address potential impacts on regional utility systems.

- The text in Section 4.14.1.2.2 has been revised, based on updated information, to reflect that arroyo wetland would not be affected by construction of a security fence.

- Emission comparisons within Section 4.10 have been revised, where appropriate, to reflect the potential effects of EELV activities on annual federal and state air quality standards.

- Analysis of potential noise effects on biological resources resulting from barge unloading activities at Vandenberg AFB Boat Dock has been added in Section 4.14.1.2.2.

1.5 RELEVANT FEDERAL PERMITS, LICENSES, AND ENTITLEMENTS

The representative federal permits, licenses, and entitlements that may be required of the EELV program are presented in Appendix D. More detailed discussions of environmental regulations are provided in the appropriate resource sections of Chapters 3.0 and 4.0.

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2.0 ALTERNATIVES INCLUDING THE PROPOSED ACTION

This section describes the Proposed Action and the No-Action Alternative. The Proposed Action (Section 2.1) is implementation of the EELV program. The No-Action Alternative (Section 2.2) involves the continuation of current launch vehicle systems to meet the requirements of government spacelift transportation programs under the NMM.

2.1 DESCRIPTION OF THE PROPOSED ACTION

The U.S. Air Force is considering participation in the continued development and deployment of EELV systems to replace current Atlas IIA, Delta II, and Titan IVB launch systems. The EELV systems are intended to meet the requirements of the U.S. government NMM, both medium and heavy lift, at a lower launch cost than the present expendable launch systems. The EELV System Performance Document (SPD) identifies additional requirements and goals that must be implemented by the contractors for development of the EELV system (Appendix E). The EELV would be DoD's source of expendable medium and heavy spacelift transportation to orbit through 2020. EELV systems would provide capabilities to launch unmanned DoD, National Aeronautics and Space Administration (NASA), and other payloads to orbit. Cape Canaveral AS and Vandenberg AFB are the only locations within the United States that currently provide space launch capabilities sufficient to support EELV systems.

The 45 Space Wing (SW) manages Cape Canaveral AS, conducts East Coast space and missile launch operations, and manages the Eastern Range (ER), which provides continuous and complementary instrumentation coverage over a broad portion of the Atlantic Ocean. The 30 SW manages Vandenberg AFB, conducts West Coast space and missile operations, and manages the Western Range (WR), which provides continuous and complementary instrumentation coverage over a broad portion of the Pacific Ocean.

As a result of the Air Force implementation of the EELV program, one or more contractors may use EELV systems to launch commercial payloads. For this reason, both government and commercial use of EELV systems are analyzed in this EIS. A combined government/commercial mission model was developed for this purpose.

The government portion of the EIS mission model, based on the Air Force Space Command (AFSPC) NMM (dated July 1997), includes the total number of DoD and NASA space vehicle launches scheduled through 2020. Information in the AFSPC NMM for both the east and west coasts includes vehicle types and proposed payload. The commercial portion of the mission model used in this EIS was created using commercial forecasts from the AFSPC NMM, the Commercial Space Transportation Advisory Council (COMSTAC) projections, and FAA estimates. The projected peak launch rate at Cape Canaveral AS would be achieved in 2015, and the projected peak launch rate at Vandenberg AFB would be achieved in 2007.

This EIS analyzes three options for implementing the Proposed Action. Concepts A and B depict each of the two contractor EELV concepts: that of the Lockheed Martin Corporation (described as Concept A in Section 2.1.1) and that of McDonnell Douglas Aerospace, a wholly owned subsidiary of the Boeing Company (described as Concept B in Section 2.1.2). Both of these proposed systems are evolved from current launch vehicle systems. The number of launches analyzed under both concepts for the EIS includes the government NMM, plus 16 commercial launches per year. Under these concepts, only one of the two contractors would continue to develop and use an EELV system. The third option, Concept A/B (described in Section 2.1.3), depicts a scenario under which both contractors would continue with the development and use of EELV systems. Under Concept A/B, no distinction is made between government and commercial flights. For the EIS analysis, each contractor is assumed to launch 50 percent of the combined total of EELV flights.

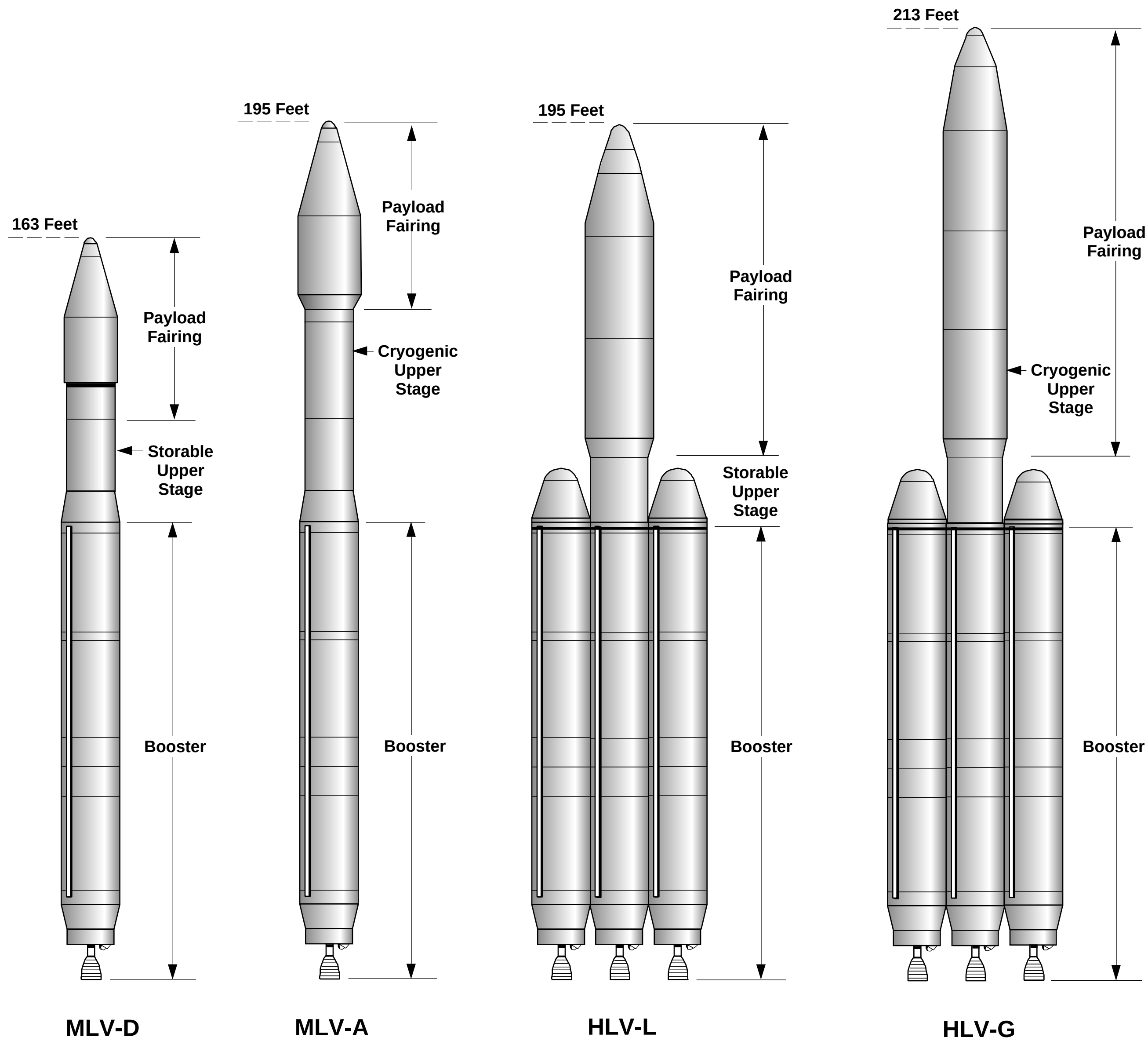
Predicting a precise EELV mission model for both government and commercial flights through the life of this dynamic program is difficult. These mission models are the most accurate estimates that can be made at this time and are intended to identify the range of activities that may occur with implementation of the EELV program.

2.1.1 **Concept A**

Under Concept A, the contractor would use Space Launch Complex (SLC)-41 at Cape Canaveral AS and SLC-3W at Vandenberg AFB for EELV system activities, as well as other facilities at both locations.

The following is a general description of the launch vehicle and facility requirements for Concept A. Specific descriptions for implementation of this concept at Cape Canaveral AS and Vandenberg AFB follow the general description. Construction would include modifications to existing facilities and construction of new facilities. Most of the components (boosters, upper stages, and avionics modules) would be assembled before shipment to the launch site (i.e., Cape Canaveral AS or Vandenberg AFB) in flightworthy condition.

2.1.1.1 **Launch Vehicle Concept.** The EELV family of vehicles would consist of two configurations of medium lift variant (MLV) (MLV-D and MLV-A) and two configurations of heavy lift variant (HLV) (HLV-L and HLV-G) as shown in Figure 2.1-1. MLVs would use one booster; HLVs would use three boosters. MLV-D and HLV-L configurations would use a Storable Upper Stage (SUS), while MLV-A and HLV-G configurations would use a Cryogenic



EXPLANATION

HLV	Heavy Lift Variant
MLV	Medium Lift Variant

Concept A Launch Vehicle Concept

Figure 2.1-1

Note: Heights shown represent maximum vehicle height.

EELV/045

Upper Stage (CUS). Table 2.1-1 provides data for the launch vehicle components.

Table 2.1-1. Launch Vehicle Components, Concept A

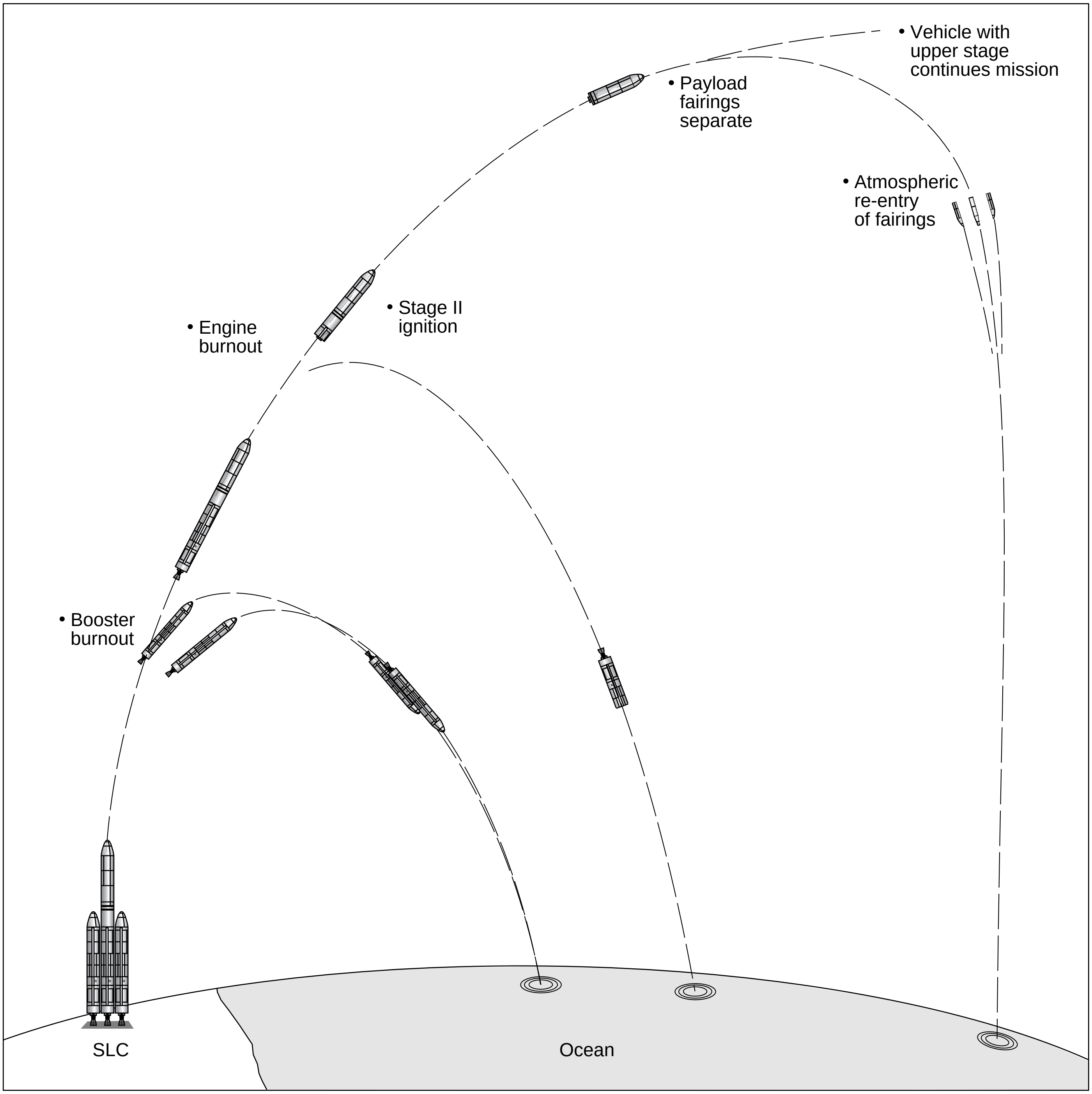
Launch Vehicle Component	Launch Vehicle	Propellant (lbs)	Fueling Location	Reaction Control System (lbs)	RCS Loading Location
Booster	MLV	RP-1 (<200,000) LO_2 (<500,000) PG-2 (<100)	Launch Pad	NA	NA
Booster (3 per vehicle)	HLV	RP-1 (<600,000) LO_2 (<1,500,000) PG-2 (<300)	Launch Pad	NA	NA
CUS	MLV-A/HLV-G	LH_2 (<8,000) LO_2 (<40,000)	Launch Pad	N_2H_4 MLV (<200) HLV (<400)	Assembly Facility
SUS	MLV-D/HLV-L	MMH (<11,000) N_2O_4 (<20,000)	Launch Pad	N_2H_4 MLV (<200) HLV (<200)	Assembly Facility

CUS = Cryogenic Upper Stage
HLV = heavy lift variant
lbs = pounds
LH_2 = liquid hydrogen
LO_2 = liquid oxygen
MLV = medium lift variant
MMH = monomethyl hydrazine
NA = not applicable
N_2H_4 = anhydrous hydrazine
N_2O_4 = nitrogen tetroxide
PG-2 = triethyl boron/triethyl aluminum
RCS = reaction control system
RP-1 = rocket propellant-1 (kerosene fuel)
SUS = Storable Upper Stage

All Concept A launch vehicles would use the Russian-designed RD-180 booster engine, which is fueled by kerosene fuel (rocket propellant [RP-1]) and liquid oxygen (LO_2) and ignited by triethyl boron/triethyl aluminum (PG-2). Avionics would be used for guidance, power, telemetry, ordnance separation, and range safety. The Flight Termination System (FTS) would provide the capability for range safety personnel to terminate a vehicle undergoing erratic flight before it could endanger people and property.

Figure 2.1-2 shows a representative launch vehicle ascent sequence. After they are expended, the boosters would fall into the ocean and would not be recovered. The payload fairings would separate from the vehicle prior to orbit and fall into the ocean; they would not be recovered. No trawling or recovery activities would occur under Concept A. The upper stage (CUS or SUS) of the space launch vehicle boosts the satellite into orbit, where the launch vehicle separates from the satellite. Residual propellant within the CUS would be vented to minimize orbital debris caused by breakup.

2.1.1.2 **Primary Support Structures.** Various support structures and equipment would be necessary to process and launch the vehicle. These would consist of structures at the proposed launch complex (i.e., SLC-41 or SLC-3W), as well as facilities and utilities located elsewhere on the launch.



EXPLANATION

SLC Space Launch Complex

NOT TO SCALE

Representative Ascent Sequence

Figure 2.1-2

EELV/065b

site. The primary support structures and equipment that would be required at both Cape Canaveral AS and Vandenberg AFB are described in the following paragraphs. Facility locations at each launch site are described for Cape Canaveral AS in Section 2.1.1.6 and for Vandenberg AFB in Section 2.1.1.9.

Unloading Facilities. Flight hardware transported by truck would be unloaded to the appropriate processing facilities or to storage facilities until needed for launch. Hardware delivered by cargo aircraft would be unloaded at the airstrips at both locations.

Storage Facilities. The EELV program would require storage of flight hardware to meet launch responsiveness requirements.

Vehicle Processing Facilities (VPFs). These facilities would be used for booster and upper-stage processing (e.g., installation of interstage adapters, payload fairings, and booster nose cones; installation of batteries and destruct ordnance into the upper stages and boosters).

Payload Processing Facilities (PPFs). Preprocessed and fueled payloads would be encapsulated within these facilities; payload processing and encapsulation would occur within existing PPFs. The payload would be inspected at these facilities; any final assembly and checkout would be conducted, and, if required, storable propellant would be loaded on the payload.

Assembly Facilities. The launch vehicle would be assembled on the launch platform associated with the assembly facility. The fuel servicing systems, including vapor abatement as required, support all off-pad hydrazine load and emergency detanking operations. Other services that would be provided in this facility include transferring gaseous nitrogen (GN_2) and gaseous helium (GHe) into the launch vehicle for reaction control and systems verification. Upper-stage processing would also be conducted within this facility. When vehicle assembly is complete, the launch system would be moved on rails to the launch pad for propellant loading, final check out, and launch.

Launch Pad. Each launch pad would consist of a deck, launch platform rails, hardpoints and tiedowns, vehicle servicing connections to the launch platform, pad water systems, and equipment housing. The launch pad would also contain launch exhaust ducts that direct the exhaust flame from the launch vehicle for safe dispersal away from the launch deck and complex. Vehicle servicing on the pad includes, as required, transfer of GN_2, GHe, and propellants into the launch vehicle. Propellant vapor abatement systems and a hydrogen vent stack would be provided at the launch pad. The hydrogen flare stack pilot would use propane at Cape Canaveral AS and natural gas at Vandenberg AFB.

Launch Control Support. The launch control support facilities include one launch control center at each range. The EELV launch control centers would interface with the Range Operations Control Center (ROCC).

Propellant and Gas Holding Areas. Propellant holding areas would be used to store RP-1, LO_2, liquid hydrogen (LH_2), monomethyl hydrazine (MMH), and nitrogen tetroxide (N_2O_4). The gas storage area would include storage and handling facilities for GHe and GN_2; the propellant and gas holding areas would be located at the SLC. Secondary containment for propellants would be sized to contain a minimum of 110 percent of the stored commodity tank volume.

An RP-1 tank, pump, and piping system would be used for the common booster. This would include a 90,000-gallon RP-1 tank, an unloading area, pumps, a piping system, secondary containment, and a leak detection system. Piping to the launch pad would be installed. In addition, LO_2 tanks and a piping system would be required for the common booster. Facilities would include two 300,000-gallon tanks, an unloading area, pumps, and a piping system.

An LH_2 fuel tank and piping system would be required for the CUS. Facilities would include a 55,000-gallon tank, an unloading area, pumps, a piping system, secondary containment, a leak detection system, a flare stack to burn excess vapor, a fire suppression/deluge system, power, and instrumentation. Piping to the launch pad would be installed. In addition, an LO_2 storage (28,000 gallons) and servicing area would be required for the CUS.

Requirements for the SUS propellant systems include mobile MMH and N_2O_4 storage tanks, propellant conditioning units, and scrubbers. The double-walled storage tanks (2,500 gallons each) are truck-mounted and DOT-certified. The propellant conditioning units maintain the required temperature during SUS loading. Existing scrubbers would be used for vapor abatement at both sites. The systems would also include tanks for temporary storage of waste fuels, piping, secondary containment, and leak detection systems.

Mobile packed-tower N_2O_4 and hydrazine fuel scrubbers currently being used by both the Air Force and NASA for payload loading and other hypergolic propellant transfer operations would be used for SUS loading at Cape Canaveral AS. The packed-tower N_2O_4 scrubber and bubble-cap hydrazine fuel scrubber currently available at SLC-3E would be used for SUS loading at Vandenberg AFB.

2.1.1.3 **Launch Site Operations.** The launch vehicle components would be shipped separately to each launch site (i.e., Cape Canaveral AS or Vandenberg AFB). Upon arrival, the components would undergo a variety of receiving inspections and off-line processing in the facilities noted above before final integration on the launch platform associated with the assembly facility. Figure 2.1-3 provides an overview of the Concept A launch operation concept.

Launch process operations to be conducted at the launch site would include launch preparation, launch operations, and post-launch refurbishment. The operations process would be standard for both launch sites, as described below. Launch process operations for the MLV vehicle configurations, using the processes described below, would take approximately 30 days; launch process operations for the HLV vehicle configurations would take approximately 60 days.

Table 2.1-2 lists the types and total estimated amounts of hazardous materials used per launch for these processes under Concept A. All hazardous materials used would be handled in accordance with applicable federal, state, and local regulations. Any spill of these materials would be collected and disposed of by a certified subcontractor in accordance with the Spill Prevention, Control, and Countermeasures (SPCC) plan.

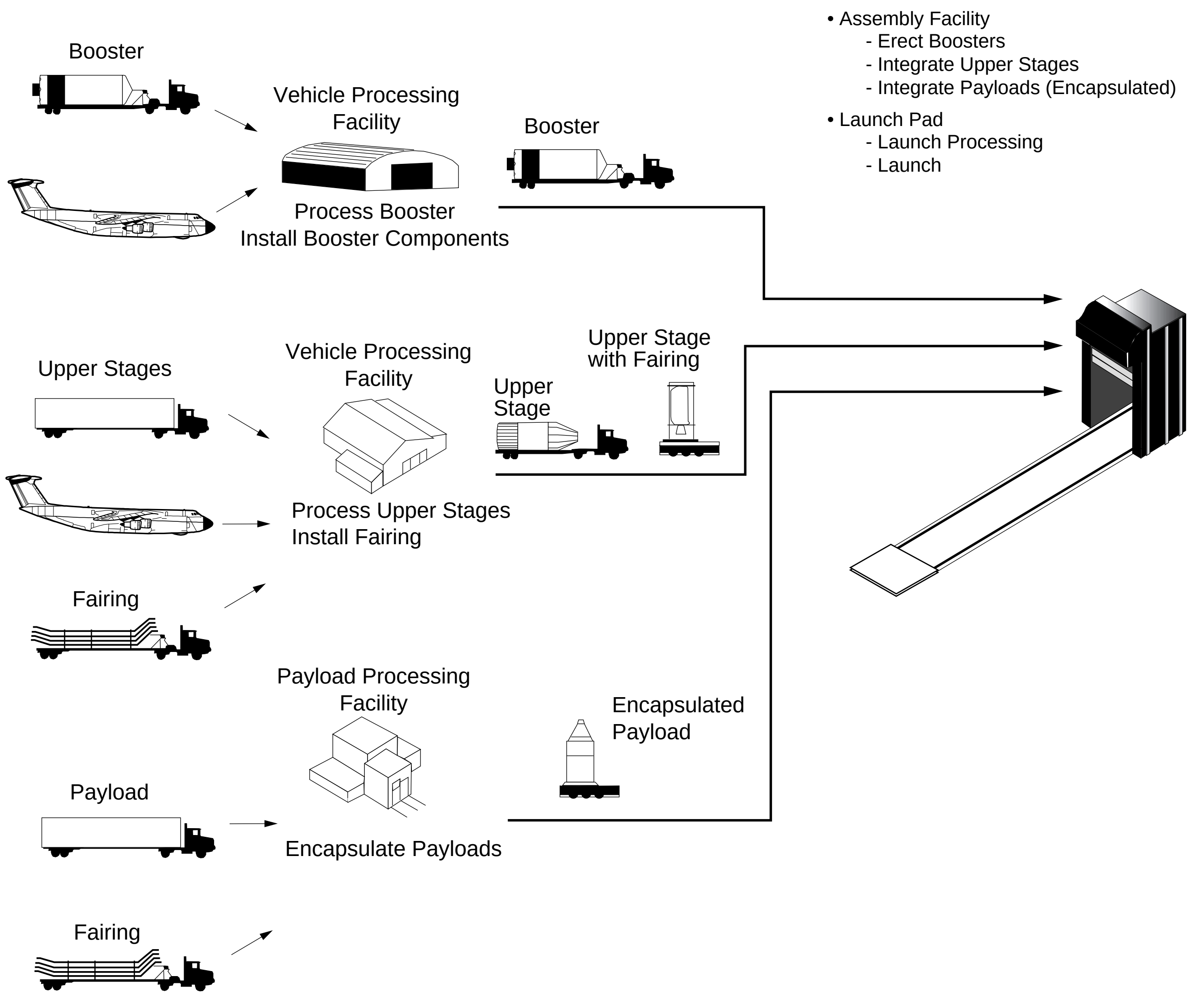
Table 2.1-2. Estimated Hazardous Materials Utilized Per Launch (all processes), Concept A[(a)]

Material	Quantity (lbs) MLV	Quantity (lbs) HLV
POL	4,790	9,580
VOC-Based Primers, Topcoats, and Coatings	320	640
Non-VOC-Based Primers, Topcoats, and Coatings	190	320
VOC-Based Solvents and Cleaners	1,380	2,750
Non-VOC-Based Solvents and Cleaners	950	1,900
Corrosives	5,500	5,500
Refrigerants	0	0
Adhesives, Sealants, and Epoxies	2,280	4,570
Other	440	870
Total	15,850	26,130

Note: (a) Propellants are shown in Table 2.1-1.
HLV = heavy lift variant
lbs = pounds
MLV = medium lift variant
POL = petroleum, oil, and lubricants
VOC = volatile organic compound

Receive and Check-Out Vehicle Components. The SUS, fairings, and associated hardware (i.e., batteries, interstage skirts, and destruct ordnance) would be shipped via truck to both launch sites. The CUS would be transported by cargo aircraft, and the boosters would be transported via truck or by cargo aircraft. The boosters would be delivered in near- flightworthy condition and either placed in storage at the launch site or in the processing flow. Once flightworthy vehicle components (e.g., boosters,

Figure 2.1-3 Concept A Launch Operation Concept



Concept A Launch Operation Concept

Figure 2.1-3

Note: Storage facilities not shown on figure.

EEL/003

ordnance, batteries) have been delivered to the launch sites, a receiving inspection would be performed, which would include downloading transportation data to verify that no out-of-specification conditions existed as a result of transportation to the site. Payload fairings would arrive cleaned, double-bagged, and ready for storage. No additional cleaning would be required at the launch site.

Propellants for the launch vehicle would be shipped directly from the manufacturing location. All propellants would be shipped in accordance with DOT regulations, found in Title 49 Code of Federal Regulations (CFR) Parts 100-199. LO_2, LH_2, and RP-1 would be transported by truck and would be shipped from the manufacturing locations to the launch site. After the Directorate of Aerospace Fuels Management, located at Kelly AFB, Texas, approves the shipment of N_2O_4, it would be shipped by rail or truck from the manufacturing location to the launch site. MMH would be transported via truck by one of the authorized shippers (Directorate of Aerospace Fuels Management or NASA) to the launch site.

Store Vehicle Components. Flightworthy vehicle components would be stored until needed for launch. The function begins when the component is placed in storage, and ends when the component is removed from storage for service.

Process Components. Final processing required to make vehicle components ready for integration into the launch vehicle in the assembly facility would occur under this function. This includes transport of the vehicle elements from the check-out/storage facility to the processing facility, as required. Processing includes installation of any loose items shipped (including destruct ordnance and batteries) and installation of the interstage adapters to the upper-stage elements. The function begins with completion of element inspection or element removal from storage, and ends when the launch vehicle components are ready for integration in the assembly facility.

Encapsulate Payload. This function begins when payload processing has been completed, and ends when the encapsulated payload is ready for transport to the assembly facility. This function also includes receipt of payload fairing sectors, establishment of a clean environment, encapsulation of the payload within the fairing, and positioning and securing the encapsulated payload on the transporter.

Integrate Launch Vehicle. Transporting, erecting, assembling, and integrating vehicle elements, including the encapsulated payload, into the completed launch vehicle would occur under this function. The function begins with transportation of processed vehicle elements to the assembly facility, and ends with the mating of the payload to the launch vehicle.

Conduct Integrated Systems Test. This function would be the final integrated test conducted within the assembly facility prior to launch countdown and would verify the functionality of all interfaces and services between the launch vehicle and the payload. Upon successful completion of this function, the vehicle would be configured for transport to the pad. This function begins with completion of all payload mating operations, and ends with the launch vehicle ready for transport to the pad.

Perform Launch Countdown. Under this function, the launch system would be moved from the assembly facility to the pad. Activities performed for this function include moving equipment to safe positions, performing an interface test, loading propellants, performing initial FTS closed-loop checks, final range verification, countdown, engine firing, thrust verification, and final countdown.

For a launch, the launch platform would be rolled into position at the launch pad. Launch platform/pad connections include GN_2 and GHe, conditioned air, propellants, power, and data. Following a successful validation test, the booster would be fueled with RP-1 and LO_2 at the launch pad. No nonessential on-pad personnel access would be allowed during propellant transfer. The LH_2 and LO_2 for the CUS and the MMH and N_2O_4 for the SUS would also be loaded at the launch pad. Vapor emissions from these propellants would be controlled by vapor abatement devices (scrubbers or incinerators) at propulsion system vents to minimize air quality impacts. Once the pad is cleared of all nonessential personnel, final communication and vehicle checks would be performed. After range safety has verified safe operations, final countdown would be completed and the vehicle would be launched.

At launch, water would be sprayed at the launch vehicle exhaust, cooling the exhaust to minimize damage to the launch pad and providing acoustic damping. Approximately 50,000 gallons of water would be required for pad deluge for each launch. It is estimated that approximately 10,000 gallons of water would be lost as mist or vapor and 40,000 gallons would collect in the launch duct. Remaining deluge and wash water within the flame duct would be tested in the duct after launch in accordance with applicable regulations. At Cape Canaveral AS, deluge water remaining in the launch duct after launch would be pumped out to a percolation area or to the wastewater treatment plant (WWTP) if treatment is required. Deluge water dispersed as mist would not be collected. At Vandenberg AFB, water would be recycled on site or disposed of in accordance with applicable regulations.

Flight Support Operations. During the flight, data would be transmitted to either ground-based telemetry or through the Tracking and Data Relay Satellite System (TDRSS) to recording ground stations. Data would be available real-time at the launch control centers at Cape Canaveral AS and Vandenberg AFB. Data collected would include final trajectory and orbital information, orbital insertion parameters, anomaly data (if an anomaly occurs), significant event descriptions, and spacecraft flight environment during flight.

Perform Post-Launch Countdown. This function would follow vehicle lift-off after the pad has been declared safe for access. It would include inspection of the launch pad facilities, launch platform, and equipment for damage, as well as general clean-up and performance of maintenance and repairs necessary to accommodate the next launch cycle. System design (e.g., aft umbilicals, auto couplers, rise-off disconnects, protective covers, and water deluge), combined with the use of liquid propulsion systems, would minimize refurbishment required after each launch. This function ends when the launch platform and the launch pad are certified as ready for the next launch.

Although launch vehicle and payload fueling would be completed in a closed system, there may be small leaks and spills during fueling, as well as other hazardous material spills. These materials would be cleaned up, if necessary, by dilution with water, absorption or adsorption by the appropriate materials, and collection of the waste materials into DOT-approved waste containers for disposal. Disposal of waste materials would be conducted in accordance with applicable federal, state, and local regulations.

2.1.1.4 **Safety Systems.** Specific safety plans would be developed to ensure that each launch operation is in compliance with applicable regulations, as specified in numerous compliance documents, and by various organizations, including the following:

- Eastern and Western Range (EWR) 127-1, Range Safety Requirements
- Air Force Manual (AFM) 91-201, Explosive Safety Standards
- DoD Standard 6055.9, Ammunition and Explosives Safety Standards
- AFI 32-1023, Design and Construction Standards and Execution of Facility Construction Projects
- Air Force Occupational Safety and Health Standards
- National Fire Protection Association, National Fire Codes
- American National Standards Institute
- Occupational Safety and Health Administration (OSHA).

EWR 127-1 provides overall safety regulations for both Cape Canaveral AS and Vandenberg AFB. The objective of the range safety program is to ensure that the general public, launch area personnel, foreign land masses, and launch area resources are provided an acceptable level of safety, and that all aspects of prelaunch and launch operations adhere to public law. EWR 127-1 provides a framework for review and approval of all hazards associated with construction, prelaunch, and launch operations and incorporates all Air Force, DoD, and other applicable health and safety standards.

Fire Protection System. Fire protection, alarm, and fire suppression systems would be provided for all fuel holding areas and support facilities. Flame detectors in the fuel holding area would activate both the area deluge system and alarms to the Air Force Fire Department. A fire detection and alarm system would be provided in oxidizer holding areas. However, a deluge system would not be included because N_2O_4 and water are highly reactive.

Security. Security requirements, an integral component of project safety, would be incorporated within the project design and operational procedures. Site security measures would include a perimeter security fence, a clear zone, an entrapment area road, security lighting, security standby power, an intrusion detection system, and security patrol roads. Procedures for security would include the use of entry controllers, alarm monitors, alarm/security response teams, radios, and vehicles in accordance with Air Force regulations.

Launch Hazard Area Safety. Both Cape Canaveral AS and Vandenberg AFB have established safety procedures for the areas affected by launch operations. Launches are not allowed to proceed if they present an undue hazard to persons and property due to potential dispersion of hazardous materials, propagation of blast, or other effects. At both launch locations, a standard dispersion computer model, run by installation meteorological/ environmental personnel, would be used for both normal and aborted launch scenarios prior to launch. If the model predicted that populated areas lay within the toxic hazard corridor (THC), the launch would be delayed until more favorable meteorological conditions existed.

At Cape Canaveral AS, Range Safety would monitor launch surveillance areas to ensure that the risks to people, aircraft, and surface vessels were within acceptable limits. Control areas and airspace would be closed to the public as required. A Notice to Mariners and Notice to Airmen would be provided in accordance with established procedures to provide warning to personnel.

At Vandenberg AFB, the coastal waters and surrounding areas would be patrolled prior to launch, and train movement through the base would be monitored. Ocean Beach County Park would be closed to public access prior to launches from SLC-3W. Low-azimuth launches (180 degrees or less) from SLC-3W would also require closure of Jalama Beach County Park. A Notice to Mariners and Notice to Airmen would be provided in accordance with established procedures to provide warnings to marine craft and aircraft. In accordance with 30 SW Instruction 91-105, Evacuating or Sheltering of Personnel on Offshore Oil Rigs, the Air Force would notify oil rig companies of an upcoming launch event approximately 10 to 15 days in advance. The Air Force's notification, provided through the Department of the Interior's Minerals Management Service, would request that operations on the oil rigs in the path of the launch vehicle overflight be temporarily suspended and that personnel be evacuated or sheltered.

Detanking or other procedures to be followed in the event of a launch delay or cancellation would be established and would generally be in accordance with procedures used for current vehicle systems.

Mission/Vehicle Reliability. Mission and launch vehicle reliability would meet the requirements set forth in the SPD prepared for the EELV program (see Appendix E). Mission reliability is measured from launch commit and is defined as the probability of successfully placing the payload into its delivery orbit with the required accuracy, and then executing a collision avoidance maneuver.

Quantity-Distance Criteria. Explosive Safety Quantity-Distance (ESQD) criteria are used to establish safe distances from launch complexes and associated support facilities to nonrelated facilities and roadways. These regulations are established by DoD and Air Force Explosive Safety Standards. The criteria utilize the trinitrotoluene, also called TNT, explosive equivalent of propellant onboard a fueled launch vehicle, or stored components or propellant, to determine safe distances from space launch operations or processing and holding areas. The facilities associated with this concept would be sited to meet these criteria.

2.1.1.5 **Project Location and Access - Cape Canaveral AS.** EELV launch operations would be conducted at the 47-acre SLC-41 at Cape Canaveral AS, in the northwestern portion of the station. SLC-41 was used by the Air Force from 1964 to 1977 for Titan III launches. Renovated in 1986, it has been used for Titan IV launches since 1989. The last Titan IVB launch at SLC-41 has been tentatively scheduled for 1998.

Access to Cape Canaveral AS is provided through Gate 1 from State Route (SR) 401 (Figure 2.1-4). Once on Cape Canaveral AS, access to the site is along Samuel C. Phillips Parkway to Titan III Road, which connects to SLC-41.

2.1.1.6 **Support Structures/Operations - Cape Canaveral AS.** The launch rates associated with Concept A are provided in Table 2.1-3. Approximately 240 personnel are expected to be required to support EELV launch operations by 2003. Launch site operations for Cape Canaveral AS would be as described in Section 2.1.1.3 and would be conducted in the structures listed

EXPLANATION

- New Utility System Corridor
- Station Boundary
- (A1A) State Route

0 3000 6000 12000 Feet

Note: Mobile Launch Platform Transportation Route is from Building 70000 to LC-41

Proposed Facility Map, Cape Canaveral AS, Florida

Figure 3.2-40

EELV/001

Table 2.1-3. Concept A Launch Rates

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Total
ast Coast[a]																					
overnment[b]																					
MLV-D	1	2	3	2	2	3	3	3	3	3	5	3	5	3	3	3	3	3	3	3	59
MLV-A		2	2	4	7	6	4	4	1	3	3	5	4	5	7	5	3	4	5	4	78
HLV-L																					
HLV-G			1			1		1			1		1		1			1		1	8
ommercial																					
MLV-D	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	120
MLV-A	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	120
HLV-L																					
HLV-G																					
ıbtotal																					385
est Coast[c]																					
overnment[b]																					
MLV-D		1	1		1	1	3	2	1	2		2	1	2		1	1	1		1	21
MLV-A		1	1	3	2	3	3	1	3	2	4	2	2	4	1	2	3	4	1	3	45
HLV-L								1													1
HLV-G																					
ommercial																					
MLV-D	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	80
MLV-A																					
HLV-L																					
HLV-G																					
ıbtotal																					147
otal	17	22	24	25	28	30	29	28	24	26	29	28	29	30	28	27	26	29	25	28	532

otes: (a) Cape Canaveral Air Station, Florida.
(b) Based on the National Executable Mission Model.
(c) Vandenberg Air Force Base, California.
HLV = heavy lift variant
MLV = medium lift variant

in Table 2.1-4. Figures 2.1-4 and 2.1-5 provide the general location of facilities at Cape Canaveral AS and the site layout plan for SLC-41, respectively. The entire SLC-41 area would be utilized for launch operations.

Table 2.1-4. Support Structures, Cape Canaveral AS, Concept A

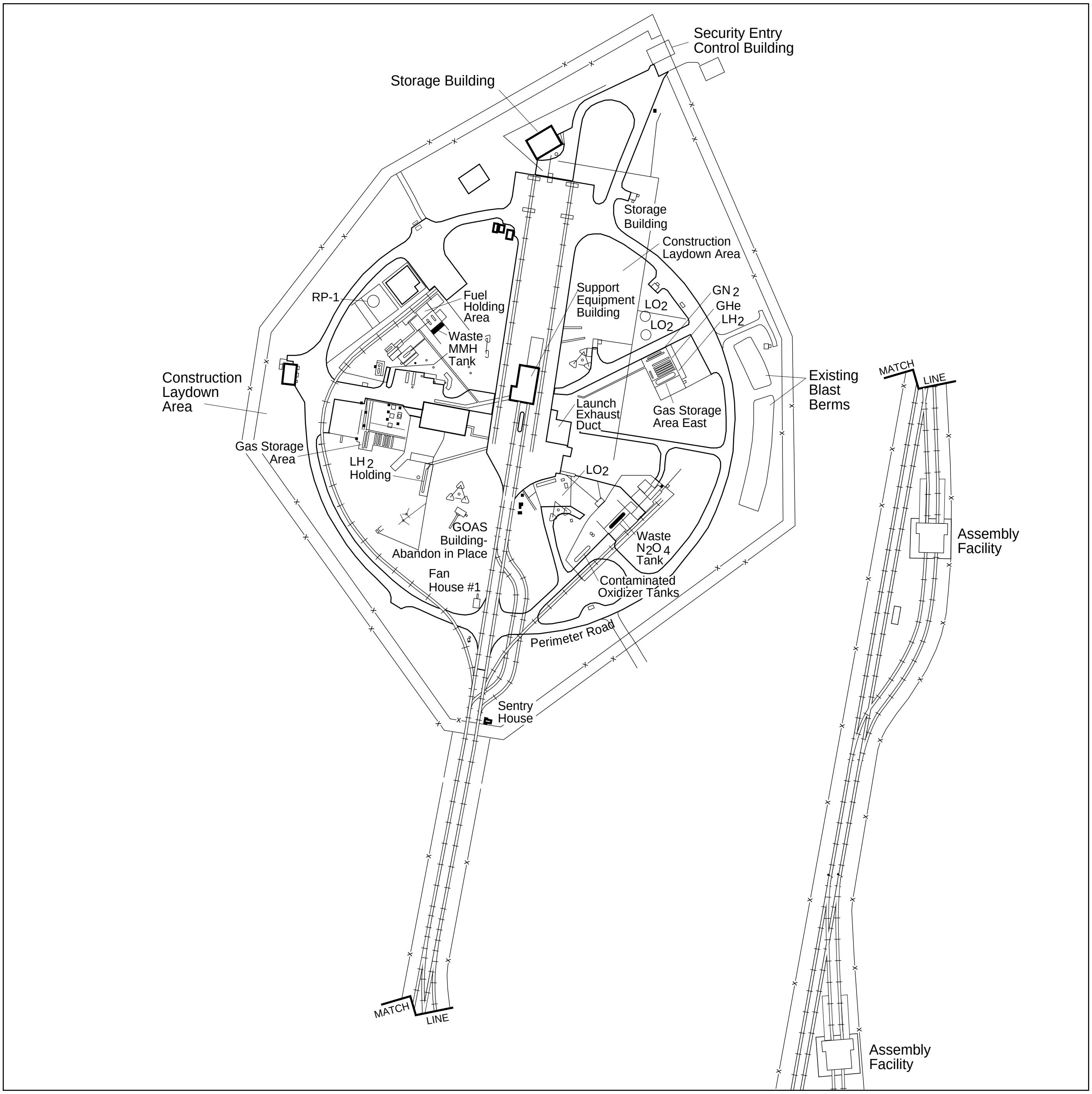
Common Support Structure	Building	Operation	EELV Modifications
Aircraft Unloading	Cape Canaveral AS Skid Strip	Receive CUS/Booster	None
Storage	Building 1721 (Hangar J) Building 70500 (Vehicle Integration Building [VIB] Annex) Building 70580 (Receiving, Inspection, and Storage) Building 75251 (Missile Inert Storage)	Store Launch Vehicle Elements	Modification (Facility 1721)
Office Space	Building 70510 (Integrate Transfer Launch [ITL] Warehouse)	Administration	None
Vehicle Processing Facilities[a]	Building 1721 (Hangar J)	Receive and Check Out Vehicle Elements, Process Elements	Modification
Payload Processing Facilities[a]	Building 70000 Annex (Spacecraft Processing Integration Facility [SPIF]) Building 55820 (DSCS Processing Facility [DPF])	Encapsulate Payload	None
Refurbishment Area	Building 70665 (VIB Parking Area)	Refurbish Mobile Launch Platform (MLP)	None
Assembly Facilities	New construction (south of SLC-41)	Integrate Launch Vehicle, Conduct Integrated System Test	New Construction
Launch Complex	SLC-41	Launch Countdown, Post-Launch Countdown	Modification
Launch Control Support	Building 27220 (Launch Operations Control Center [LOCC])	Launch Countdown, Launch	Modification
Propellant and Gas Holding Areas	SLC-41	Launch Vehicle Fueling, Pressure Testing	Modification

Note: (a) These are currently identified facilities; other facilities may be utilized by the payload contractor.
AS = Air Station
CUS = Cryogenic Upper Stage
DSCS = Defense Satellite Communications System
EELV = Evolved Expendable Launch Vehicle
SLC = Space Launch Complex

Under Concept A, the activities associated with EELV would generate the following average utility demands at Cape Canaveral AS during the projected peak launch year (2015):

- Water - 13,950 gallons per day (gpd)
- Wastewater - 10,800 gpd

- Solid waste - 0.5 ton per day
- Electricity - 467 kilowatt hours (kWH) per day.



EXPLANATION

GHe	Gaseous Helium
GN_2	Gaseous Nitrogen
LH_2	Liquid Hydrogen
LO_2	Liquid Oxygen
MMH	Monomethyl Hydrazine
N_2O_4	Nitrogen Tetroxide
RP-1	Rocket Propellant-1 (Kerosene Fuel)
—x—	Security fence

0 150 300 Feet

Concept A SLC-41 Site Plan, Cape Canaveral AS, Florida

Figure 2.1-5

EEL/047

Based upon employment projections and project activities, Concept A would generate 770 average daily vehicle trips. The evening peak-hour volume (PHV) is projected to be 160 vehicles.

2.1.1.7 **Project Construction Activities - Cape Canaveral AS.** At Cape Canaveral AS, construction activities would begin in July 1998 and continue through June 2000. Most of the ground-disturbing activities would occur between August 1998 and June 1999. Construction of the second assembly facility would occur between January of 2002 and July of 2003. Additional ground-disturbing activities would occur at the Hangar J driveway between April and May 2000. Construction personnel requirements would average 260, with a maximum of 382 during peak construction activities. Proposed construction activities at Cape Canaveral AS are described below.

<u>Existing Facility Modification</u>

SLC-41. Most of SLC-41 would be modified for this concept. Major modifications would include changing the existing site topography, as required, to support rail system work and facility modification/new construction. Modifications at the SLC would be as follows:

- The Mobile Service Tower (MST) and the umbilical tower would be demolished.
- Exterior modifications to the Support Equipment Building (SEB) would include extending the building to house the payload equipment van; interior modifications would consist of removing and/or abandoning existing cables and piping and reconfiguring the building interior to support communications equipment.
- The catch basins, gas storage area (GN_2 and GHe), and propellant systems (LH_2 and LO_2) would be modified. Mobile systems for N_2O_4 and MMH, and any necessary scrubbers, would be utilized.
- New facilities for the kerosene fuel (RP-1) system and piping would include a 90,000-gallon tank, an unloading area, pumps, a piping system, secondary containment, and a leak detection system.
- Piping to the launch pad would be installed.
- An aerial sound suppression water deluge system and fuel and oxidizer piping would be installed.
- New facilities for the LO_2 storage system would include a 600,000-gallon tank farm (two 300,000-gallon tanks), an unloading area, pumps, a piping system, secondary containment, and a leak detection system.

Building 1721, Hangar J, Booster Storage and Check Out. The existing driveway would be modified to provide an increased turning radius. Interior utilities would be modified to meet program requirements.

Building 27220, Launch Operations Control Center (LOCC). The consoles inside the LOCC would be replaced. No exterior modifications would be required.

Road Modifications. The road turning radius at the northeastern corner of Skid Strip Road and Samuel C. Phillips Parkway would be modified to allow transport of the launch vehicle.

Infrastructure. Utility lines required for the EELV program would be modified within SLC-41 in previously disturbed areas.

New Facilities

Assembly Facilities. Two identical assembly facilities, located in separate complexes of identical design, would be constructed south of SLC-41 along the current Titan IVB transporter rail line. Construction of the two assembly facilities would disturb approximately 29.5 acres. A single fence, utility shed, and guardhouse would be constructed within each complex, and an asphalt parking area would be constructed adjacent to each complex.

The transporter track systems would be modified to allow movement of the launch systems to the launch pad, assembly facilities, and refurbishment areas in the Integrate Transfer Launch (ITL) area.

Utilities for each assembly facility would include an electrical substation, a diesel generator, and two water chillers. Electrical power, potable water, GN_2, and GHe lines would need to be extended from SLC-41 to each assembly facility along the previously disturbed road corridor.

Construction Phase

Most of the construction activities would take place along existing road corridors. At the assembly facilities site, vegetation would be removed to create a cleared area approximately 300 feet wide. Construction equipment laydown areas, personal vehicle parking, temporary mobile offices (trailers), maintenance facilities, and other ancillary construction areas would be sited in previously disturbed areas (see Figure 2.1-5).

Earthwork for construction would be performed in accordance with the construction Storm Water Pollution Prevention Plan and project SPCC Plan that would be developed for this project.

A temporary truck washdown area would be provided within the boundaries of the construction laydown areas. In order to contain collected wastewater, the washdown area would be provided with an impoundment containing a sump that would allow water to percolate into the ground.

Approximately 29.5 acres of land would be disturbed for construction of the assembly facilities. Depending upon the final design and grading plans, earth movement would involve a minimum of about 24,000 cubic yards of cut and fill material. Unsuitable cut material would be removed from the project area to a spoil site located off station or at other approved locations. Appropriate erosion control would be implemented at the stockpile. Construction materials would generally be transported by truck through Gate 1 over Samuel C. Phillips Parkway to Titan III Road to SLC-41.

During the construction period, water use would average approximately 4,000 gpd for general activities (e.g., site washdown, cement mixing, personnel requirements). Some water would also be used for dust control. Wastewater generation would average approximately 3,760 gpd. In addition, approximately 3,450 tons of solid waste would be generated during the 3 1/2-year construction period. The construction contractor would remove construction debris; any hazardous materials identified during construction (e.g., asbestos, lead-based paint) would be abated in accordance with applicable regulations. Approximately 3,100 tons of construction debris, consisting of concrete (650 tons), structural steel (2,200 tons), and miscellaneous rails, fencing, piping, and wire (250 tons) would be generated by demolition activities. The concrete would be reused as structural fill; the remaining construction materials would be recycled. Approximately 440 tons of crating, packaging, sheet rock, roofing material, and trash would be generated over the life of the construction period at an average rate of 0.35 ton per day. This debris would be disposed of in a sanitary landfill.

From 1998 through 2000, construction traffic entering and exiting project construction sites on Cape Canaveral AS under Concept A is estimated to generate an average of 1,640 daily vehicle trips, with 170 trips expected during the peak hour. Construction traffic entering and exiting project construction sites during the peak construction period is expected to be 2,400 trips, with 250 trips occurring during the peak hour.

2.1.1.8 **Project Location and Access - Vandenberg AFB**. EELV launch operations would be conducted at the 33-acre SLC-3W at South Vandenberg AFB. SLC-3W was used for Atlas D/Agena launches from 1960 to 1963, for Thor Agena launches from 1963 to 1972, and for Atlas E/F launches from 1972 to 1995. SLC-3W is currently inactive and requires minimal maintenance.

Access to the SLC would be primarily through the Vandenberg AFB South Gate entrance via SR 246, then over Air Force-controlled secondary roadways, including Arguello Boulevard and Bear Creek and Coast roads (Figure 2.1-6).

2.1.1.9 **Support Structures/Operations - Vandenberg AFB.** Launch rates associated with Concept A are provided in Table 2.1-3. Approximately 135 personnel are expected to be required to support EELV launch operations by 2006. Launch site operations for Vandenberg AFB would be as described in Section 2.1.1.3 and would occur in the structures listed in Table 2.1-5. Figures 2.1-6 and 2.1-7 provide the general location of facilities at Vandenberg AFB and the site layout plan for SLC-3W, respectively. The entire SLC-3W area would be utilized for launch operations.

Under Concept A, the activities associated with EELV would generate the following average utility demands at Vandenberg AFB during the projected peak launch year (2007):

- Water - 7,400 gpd
- Wastewater - 6,100 gpd
- Solid waste - 0.3 ton per day
- Electricity - 233 kWH per day.

Based upon employment projections and project activities, Concept A would generate 430 average daily vehicle trips, with 90 trips anticipated during the peak hour.

2.1.1.10 **Project Construction Activities - Vandenberg AFB.** At Vandenberg AFB, construction would begin in March 2000 and continue through March 2002. Most of the ground-disturbing activities would occur between March and September 2000. Construction personnel requirements would average 252, with a maximum of 324 during peak construction activities. Proposed construction activities at Vandenberg AFB are described below.

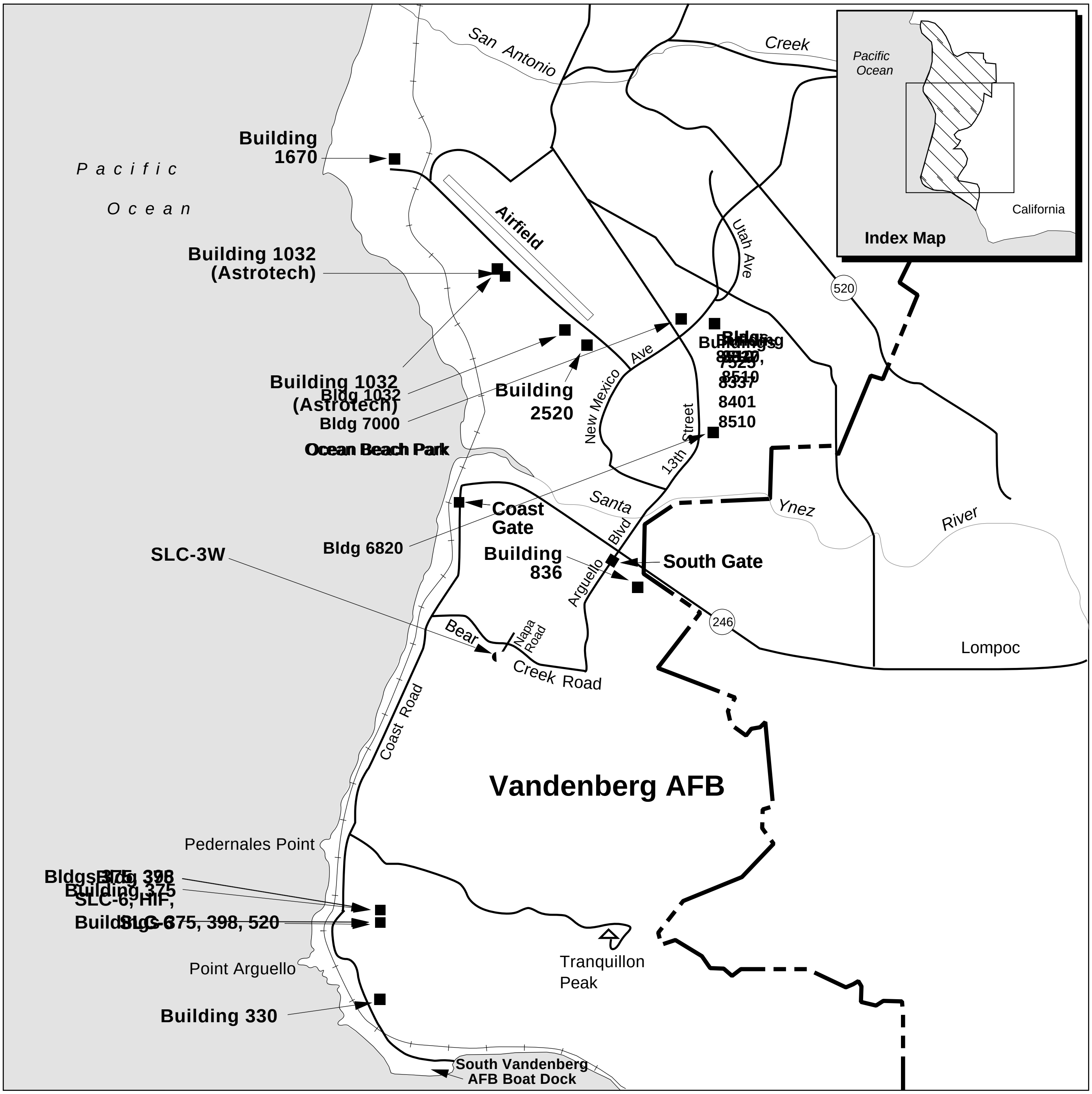
<u>Existing Facility Modification</u>

SLC-3W. Most of SLC-3W (within the fence line) would be modified for this concept. Major modifications would include:

- The kerosene fuel (RP-1) tank and piping system, fueling skid, skid foundation, and secondary containment would be removed.

- A 150-kilowatt generator and associated electrical and fuel systems would be removed.

- The roadway would be modified.



EXPLANATION

Base Boundary

HIF Horizontal Integration Facility

(246) State Route

0 .5 1 2 Miles

EELV/002

Proposed Facility Map, Vandenberg AFB, California

Figure 2.1-12

Table 2.1-5. Support Structures, Vandenberg AFB, Concept A

Common Support Structure	Building	Operation	EELV Modifications
Aircraft Unloading	Vandenberg AFB Airfield	Receive Upper Stage/Booster	None
Storage	Building 7525 (Booster Assembly Building [BAB]) Building 8337 (Payload Fairing Processing Facility)	Store Launch Vehicle Elements	Modification (Building 7525)
Vehicle Processing Facility	Building 7525 (BAB)	Receive and Check Out Vehicle Elements, Process Elements	Modification
Office Space	Building 8401	Administration	None
Payload Processing Facilities	Building 375 (Integrated Processing Facility [IPF]), Building 1032 (Astrotech) Building 2520 (Payload Processing Facility [PPF])	Encapsulate Payload	None
Assembly Facility	New construction (SLC-3W)	Integrate Launch Vehicle, Conduct Integrated Systems Test	New Construction
Launch Complex	SLC-3W	Launch Countdown, Post-Launch Countdown	Modification
Launch Control Support	Building 8510 (Remote Launch Control Center [RLCC])	Launch Countdown, Launch	None
Propellant and Gas Holding Areas	SLC-3W	Launch Vehicle Fueling, Pressure Testing	Modification

AFB = Air Force Base
EELV = Evolved Expendable Launch Vehicle
SLC = Space Launch Complex

- The existing utility systems and the perimeter security fence, including new lighting, would be renovated.

- A new rail system would be added from the assembly facility to the launch pad.

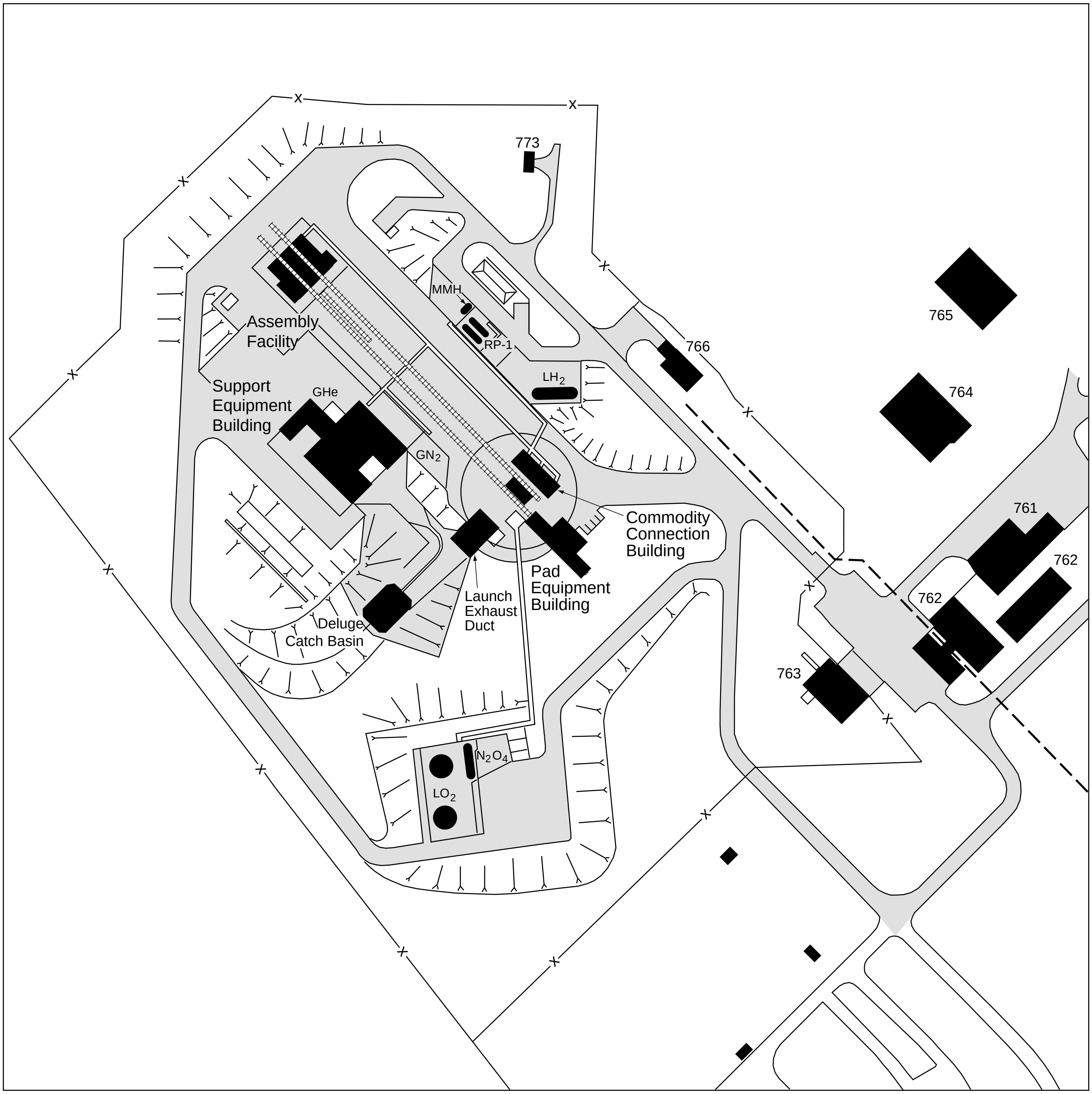
- The existing MST, MST rail system, and the umbilical tower would be removed.

- The launch mounts, existing deluge systems, and pressurization and purge systems would be removed.

- A launch exhaust duct would be constructed.

- The area around the existing retention basin would be utilized as a secondary catch basin for storm water.

- Renovations to the SEB would include removal of the interior of the existing facility and installation of a new power substation.



EXPLANATION

GHe	Gaseous Helium	— —	Electrical Line
GN_2	Gaseous Nitrogen	≻—	Embankment
LH_2	Liquid Hydrogen	▭	New Pavement
LO_2	Liquid Oxygen		
MMH	Monomethyl Hydrazine		
N_2O_4	Nitrogen Tetroxide		
RP-1	Rocket Propellant-1 (Kerosene Fuel)		

0 60 120 240 Feet

Concept A
SLC-3W Site Plan,
Vandenberg AFB,
California

Figure 2.1-7

EEL/096

The existing LO_2 tank and piping would be removed.

- Modifications to the gas storage area would include the addition of He storage bottles and piping connections to the existing GN_2 line that serves SLC-3E.

- A new launch pad deluge water and acoustic suppression system would be installed.

- Kerosene fuel (RP-1), LH_2, and LO_2 systems would be installed. Mobile systems for N_2O_4 and MMH, and any necessary scrubbers, would be utilized.

Building 7525, Booster Assembly Building (BAB). New entrance/exit driveways would be constructed in the front and rear of the facility. Construction would occur on the previously disturbed roadway shoulder.

Road/Pavement Improvements. Intersections at the following locations along the booster tow route would be widened to accommodate the turning radii of booster transporters: Coast and Bear Creek roads (south of intersection), Bear Creek and Napa roads (west of intersection), and Napa and Alden roads (intersection area) (see Figure 2.1-6). The route widening would occur in previously disturbed areas. Existing power poles at the northeastern side of Coast and Bear Creek roads would have to be relocated, and the traffic signal at Utah and New Mexico avenues would need to be modified (see Figure 2.1-6).

Infrastructure. New utility lines and connections would be located in previously disturbed areas or within construction areas or other proposed facilities. These would include water, wastewater, electrical, and gas lines.

New Facilities

Assembly Facility. An assembly facility containing a new power substation would be constructed approximately 500 feet northeast of the launch pad.

Construction Phase

Initial construction would consist primarily of clearing and grading, and demolition of existing structures at the project site. Construction activities would take place within the previously disturbed SLC-3W area or along existing road corridors. Construction equipment laydown, personal vehicle parking, temporary mobile offices (trailers), maintenance facilities, and other ancillary construction areas would be sited in previously disturbed areas at the SLC-3 fallback parking area.

Earthwork for construction would be performed in accordance with the construction Storm Water Pollution Prevention Plan and project SPCC Plan that would be developed for this concept.

To contain collected wastewater, a temporary truck washdown area with an impoundment would be provided within the boundaries of the construction laydown areas.

Approximately 33 acres of land within the SLC-3W fenceline would be disturbed during construction. Depending upon the final design and grading plans, earth work would involve a minimum of about 142,000 cubic yards of cut material. An equal amount of fill material would come from borrow areas on Vandenberg AFB (Manzanita Borrow Area). Unsuitable cut material would be returned to the embankment cut at the SLC that would be regraded prior to site revegetation. Some spoil material may be disposed of on the base landfill. A site restoration plan would be developed to replace non-native plant species disturbed during construction with native vegetation. Construction materials would generally be trucked through the Coast Gate entrance (see Figure 2.1-6), then to SLC-3W.

During the construction period, water use would average approximately 8,240 gpd for general activities (e.g., site washdown, cement mixing, personnel requirements). Some water would also be utilized for dust control. Wastewater generation would average approximately 3,760 gpd. In addition, approximately 4,900 tons of solid waste would be generated during the 25-month construction period. The construction contractor would remove construction debris; hazardous materials found during construction (e.g., asbestos, lead-based paint) would be abated in accordance with applicable regulations. Approximately 4,600 tons of debris, consisting of concrete (1,500 tons), asphalt (500 tons), structural steel (1,600 tons), and miscellaneous rails, fencing, piping, and wire (1,000 tons), would be generated by demolition activities in the first 3 months of the project. The concrete would be reused as structural fill; the remaining construction materials would be recycled. The remaining 300 tons of debris, consisting of crating, packaging, sheet rock, roofing material, and trash, would be generated over the life of the construction period at an average rate of 0.4 ton per day. This debris would be disposed of in a sanitary landfill.

From 2000 to 2002, construction traffic entering and exiting project construction sites on Vandenberg AFB under Concept A is estimated to generate an average of 1,600 daily vehicle trips, with 170 trips expected during the peak hour. Construction traffic entering and exiting project construction sites during the peak construction period is expected to be 2,000 trips, with 210 trips occurring during the peak hour.

2.1.2 **Concept B**

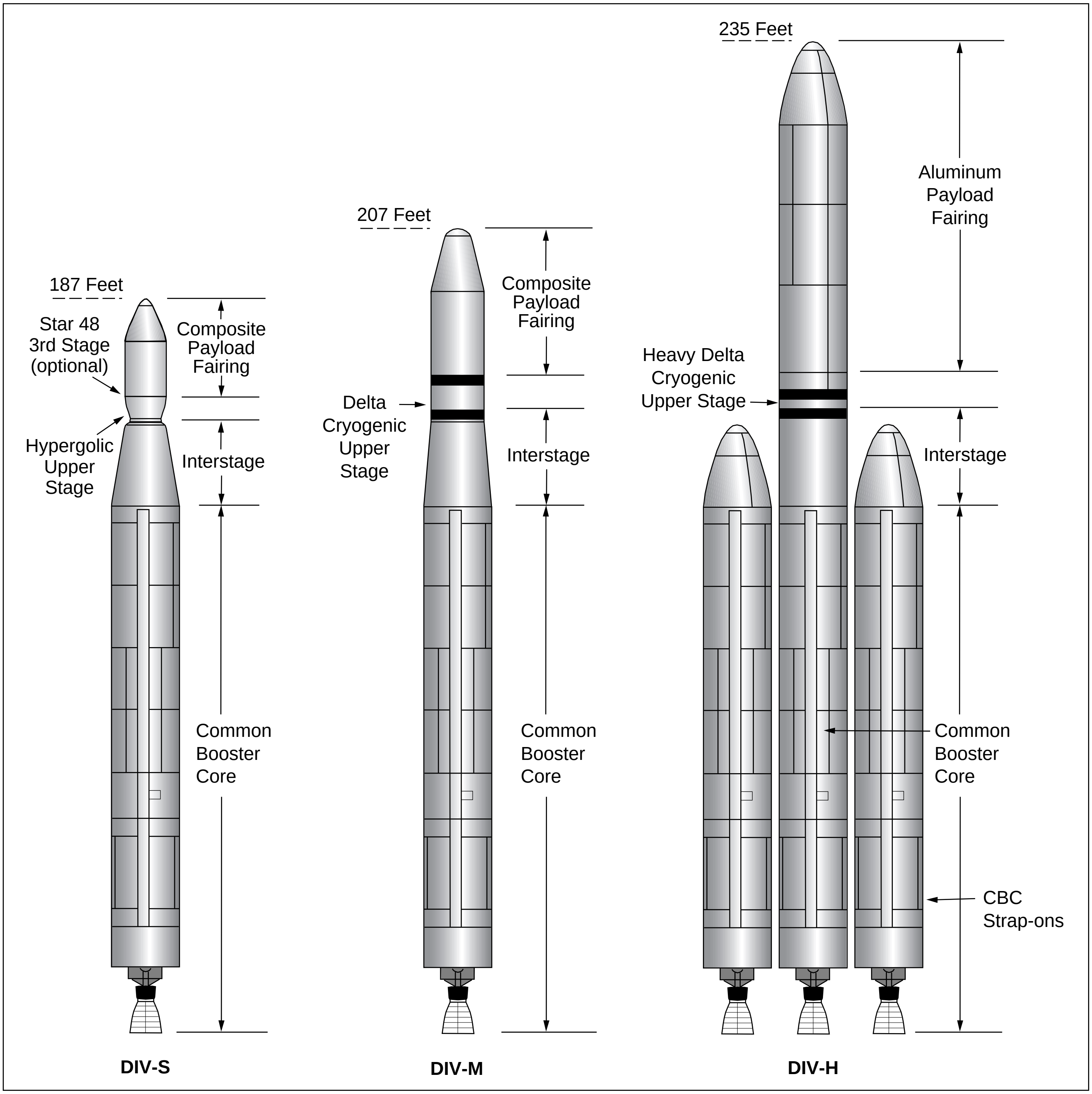
Under Concept B, the contractor would use SLC-37 at Cape Canaveral AS and SLC-6 at Vandenberg AFB for EELV system activities, as well as other facilities at both locations.

The following is a general description of the launch vehicle and facility requirements for Concept B. Specific descriptions for implementation of this alternative at Cape Canaveral AS and Vandenberg AFB follow the general description. Construction would include modifications to existing facilities and construction of new facilities. Most of the components (boosters, upper stages, and avionics modules) would be assembled and tested prior to shipment to the launch site (i.e., Cape Canaveral AS or Vandenberg AFB) in near flightworthy condition.

2.1.2.1 **Launch Vehicle Concept.** The EELV would consist of several variations of a Delta IV (DIV) launch vehicle, including small (DIV-S), medium (DIV-M), and large (heavy) (DIV-H) launch vehicles, shown in Figure 2.1-8. This system would use a common booster core (CBC), with a Hypergolic Upper Stage (HUS), Delta Cryogenic Upper Stage (DCUS), or Heavy Delta Cryogenic Upper Stage (HDCUS) as second stages, depending upon the payload requirements. The small and medium vehicles would use one CBC first-stage core booster; the heavy vehicle would use one first-stage CBC and two CBC strap-ons. The strap-ons are the standard version of the CBC with Titan IV nose cones and appropriate separation hardware added. They have shorter burn times than the center core and would be jettisoned prior to burnout of the center core vehicle. A Delta IV Medium Plus (DIV-M+) vehicle, consisting of a DIV-M with solid rocket motors (SRMs), would be utilized for some commercial missions (not shown in Figure 2.1-8). The SRM booster casing would be composed of graphite epoxy. Table 2.1-6 provides data for the launch vehicle components.

Due to the continued evolution and refinement of the EELV, the DIV-M+ vehicle would likely use larger SRMs than are analyzed in this EIS. The SRMs would be approximately 30 percent larger than those upon which the current analysis is based. Because information regarding design characteristics for the larger SRM is not currently available, if the contractor proceeds with its development, the environmental effects of its use would be addressed under additional environmental documentation. It is anticipated that this analysis would result in a finding of no significant impact, as the larger SRMs would still be smaller than those currently utilized on the Titan IV at both installations.

The medium and heavy upper stages would be fueled by LH_2 and LO_2, and the small vehicle upper stages would utilize Aerozine-50 (A-50) and N_2O_4. All propellant transfer would occur on the launch pad.



EXPLANATION

CBC	Common Booster Core
DIV	Delta IV
DIV-H	Heavy Launch Vehicle
DIV-M	Medium Launch Vehicle
DIV-S	Small Launch Vehicle

NOT TO SCALE

Concept B Launch Vehicle Concept

Figure 2.1-8

EEL/046

Table 2.1-6. Launch Vehicle Components, Concept B

Launch Vehicle Component	Launch Vehicle	Propellant (lbs)	Fueling Location	Reaction Control System (lbs)	RCS Loading Location
CBC	DIV-S, DIV-M, and DIV-H	LH_2 (<63,000) LO_2 (<387,000)	Launch Pad	NA	NA
HUS	DIV-S	N_2O_4 (<12,000) A-50 (<6,500)	Launch Pad	Cold gas N_2 (24)	PPF
DCUS	DIV-M	LH_2 (<7,000) LO_2 (<40,000)	Launch Pad	N_2H_4 (160) He(1)	PPF
HDCUS	DIV-H	LH_2 (<9,000) LO_2 (<55,000)	Launch Pad	N_2H_4 (320) He (2)	PPF
Strap-on SRM[(a)]	DIV-M+	NH_4ClO_4 (25,000) Al (7,000) HTPB (5,000)	Launch Pad	NA	NA
Star 48B	DIV-S	NH_4ClO_4 (3,200) Al (800) HTPB (500)	Launch Pad	NA	NA

Note: (a) Propellant weight shown is for an individual SRM.

A-50 = Aerozine-50 (50 percent by weight unsymmetrical dimethylhydrazine and anhydrous hydrazine)
Al = aluminum
CBC = common booster core
DCUS = Delta Cryogenic Upper Stage
DIV = Delta IVB
DIV-H = heavy launch vehicle
DIV-M = medium launch vehicle
DIV-M+ = medium launch vehicle with solid rocket motor strap-ons
DIV-S = small launch vehicle
HDCUS = Heavy Delta Cryogenic Upper Stage
He = helium
HTPB = hydroxyl-terminated polybutadiene (binder material)
HUS = Hypergolic Upper Stage
lbs = pounds
LH_2 = liquid hydrogen
LO_2 = liquid oxygen
NA = not applicable
N_2 = nitrogen
N_2H_4 = anhydrous hydrazine
N_2O_4 = nitrogen tetroxide
NH_4ClO_4 = ammonium perchlorate
PPF = Payload Processing Facility
RCS = reaction control system
SRM = solid rocket motor

The CBC is a new design for the EELV program using a Rocketdyne RS-68 engine and would be a common element for all Concept B launch vehicles. The CBC casing would be composed of aluminum alloy and composite structures. The CBC propellants are LH_2 and LO_2.

The HUS would be designed to satisfy the low end of the NMM in terms of payload delivery to orbit and would be used on the DIV-S only. The DCUS would be used for the DIV-M, and the HDCUS would be used for the DIV-H. The DIV-S and the DIV-M both satisfy the medium lift requirement of the NMM.

For some small vehicle missions, a third stage (Star 48B) containing solid propellant would be utilized. The propellant would be composed of ammonium perchlorate (NH_4ClO_4), aluminum (Al), and hydroxyl-terminated polybutadiene (HTPB) (binder material). The third stage would be encapsulated with the payload and transported to the launch pad.

For the medium and heavy vehicles, fueling of the reaction control system (RCS) would occur in the payload processing facility. The RCS propellant would be anhydrous hydrazine (N_2H_4) and helium (He).

The payload fairings would be developed from existing Delta and Titan IV designs. The fairing structures for the DIV-H would be made of aluminum; small and medium vehicle payload fairings would be a graphite-epoxy composite.

The CBC avionics' basic architecture and all elements would be developed from Delta II/III avionics that provide single-fault tolerant control that monitors electrical power for all critical functions. The upper-stage avionics provide the inertial sensing and data processing for the navigation, guidance, control, and sequencing; radio frequency (RF) communication electronics; flight termination; and the telemetry, power, and distribution network.

The FTS would be a redundant system that would provide the capability to terminate a vehicle undergoing erratic flight before it could endanger people and property. The system for Concept B would rely upon existing technologies that have been used for the Titan, Delta, and space shuttle programs.

Figure 2.1-2 depicts a representative launch vehicle ascent sequence. After completing its mission, the CBC would fall into the ocean and would not be recovered. Less than 25 gallons of hydraulic fluid would remain in the booster when it falls into the ocean and sinks. The payload fairings would separate from the vehicle prior to orbit, fall into the ocean, and would not be recovered. No trawling or recovery activities would occur under Concept B. The upper-stage engine would cut off when the payload reached the desired orbit. The upper stages (HUS, DCUS, and HDCUS) of the launch vehicle would boost the payload into orbit, where the upper stage would separate from the payload. Residual propellant within the upper stages would be vented to minimize orbital debris due to breakup.

2.1.2.2 **Primary Support Structures .** Various support structures and equipment would be necessary to process and launch the vehicle. These would consist of structures at the proposed SLC (i.e., SLC-37 or SLC-6), as well as facilities and utilities located elsewhere on the launch site. The primary support structures and equipment that would be required at both Cape Canaveral AS and Vandenberg AFB are described in the following paragraphs. Exact facility locations at each launch site are described for Cape Canaveral AS in Section 2.1.2.6 and for Vandenberg AFB in Section 2.1.2.9.

Unloading Facilities. Barge/boat unloading facilities at each location would be used to unload CBCs transported by barge or boat. Airstrips at each location would be utilized to unload flight hardware transported by cargo aircraft. Hardware transported by truck would be received at appropriate processing facilities or interim storage facilities.

Storage Facilities. CBCs, upper stages, fairings, and other flight hardware may be stored in these facilities, if necessary, prior to processing. These facilities would also be utilized to store ground support equipment (GSE).

Horizontal Integration Facility (HIF). An HIF would be utilized for vehicle processing. Functions performed in the HIF would include the receiving, integration of CBCs and strap-ons for the DIV-H, and check-out of the CBC and upper stages. In addition, this facility would house many support functions required for integration of the launch vehicle.

Payload Processing Facility. Preprocessed and fueled payloads would be encapsulated within this facility. The Star 48B would be integrated with the payload and encapsulated. The payload would be inspected, any final assembly and checkout conducted, and if required, storable propellant (N_2H_4) loaded. Encapsulation of the payload within the fairing would be the final operation prior to transport to the launch pad.

Launch Complex. The launch complex would include the launch table and installation/interface points for various support services. It would also contain launch exhaust ducts that direct the exhaust flame from the launch vehicle away from the launch deck and complex for safe dispersal. The launch pad would include an MST, a Fixed Umbilical Tower (FUT), and an SEB that would provide miscellaneous support systems that need to be close to the launch pad, as well as propellant and gas storage areas. At Cape Canaveral AS, each SEB would house a 1,000-kilowatt (kW) backup diesel generator.

Launch Control Center. Launches would be controlled at the launch control center once SLC operations/procedures had been completed.

Propellant and Gas Holding Areas. Propellant and gas holding areas would include a gas storage area and LH_2 and LO_2 holding areas at the SLC. An LH_2 system, consisting of a double-walled tank; a leak detection system; and a piping system would be used for CBC, DCUS, and HDCUS fueling. This would include an 850,000-gallon tank at Cape Canaveral AS and an 850,000-gallon tank at Vandenberg AFB. This area would also include an unloading area, a piping system, a sloped spill runoff area, a propane flare stack, a hydrogen burn stack to burn excess vapor, a fire suppression system, power, and instrumentation. Piping to the launch pad would be installed. In addition, an LO_2 system consisting of a double-walled tank, pumps, and a piping system would be required for CBC, DCUS, and HDCUS loading. Facilities would include a 350,000-gallon tank at Cape Canaveral AS and a 300,000-gallon tank at Vandenberg AFB. An unloading area, an LH_2 leak detection system, and a piping system would also be required. At Vandenberg AFB, an existing berm that slopes to an existing containment area would be utilized for secondary containment. At Cape Canaveral AS, a containment system would be designed in accordance with Range Safety and OSHA requirements. The earthen berm containment areas would accommodate 100 percent of the liquid volume because of the rapid volatilization of any potential spills.

The gas storage area would include storage and handling facilities for GHe and liquid nitrogen (LN_2). At both Cape Canaveral AS and Vandenberg AFB, one 20,000-gallon tank of LN_2 and twelve 300-cubic-foot vessels of GHe would be required. GN_2 would also be provided to the launch facilities via existing pipelines and/or trucks. Additional piping would be installed, as required. Two additional GN_2 truck connections would be required at Cape Canaveral AS.

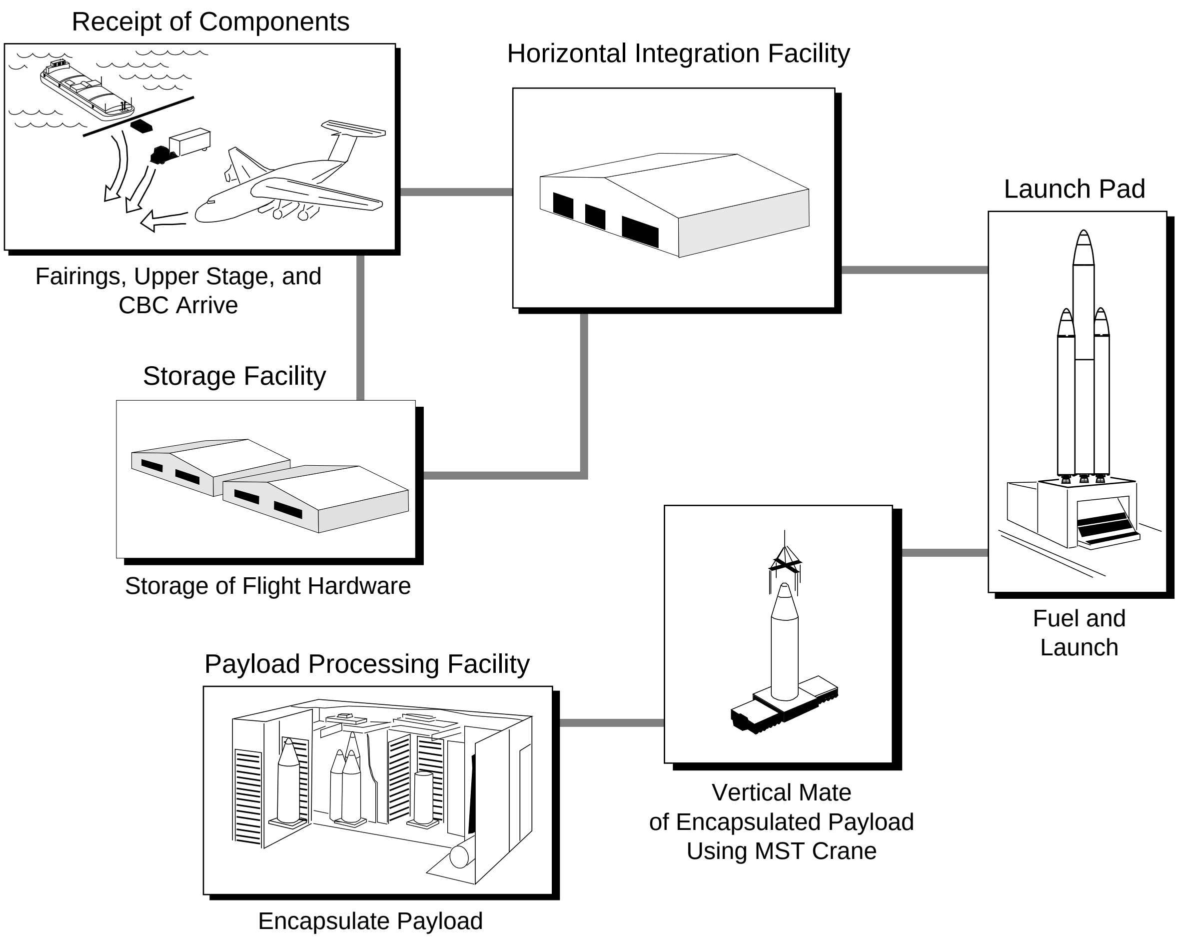
A-50 and N_2O_4 for the HUS would be transported to the site by DOT-approved supply tankers following procedures similar to those used currently for the Delta II program. These chemicals would not be stored on site. The loading area would include secondary containment and a leak detection system. Mobile scrubbers and fixed scrubbers on the FUT used during propellant loading and tank venting would require applicable air permits or exemptions similar to those required for current Delta II operations.

Small quantities of MMH required for the DCUS would be provided in DoD-approved drums. MMH would be scrubbed and permitted, as required. Hypergolic rinseate would be managed and disposed of in accordance with applicable federal, state, and installation requirements.

Solid propellant would not be stored in the launch pad area. Existing solid propellant storage facilities would be utilized at each launch location. At Cape Canaveral AS, solid propellant would be stored in a new Delta III building within Area 57E to be constructed in 1998, and within portions of Buildings 50801 and 50803. At Vandenberg AFB, solid propellant would be stored in Building 1670.

2.1.2.3 **Launch Site Operations.** The launch vehicle components would be shipped separately to each launch site (i.e., Cape Canaveral AS or Vandenberg AFB). Upon arrival, the components would undergo a variety of receiving inspections and off-line processing in the facilities noted above before final integration on the launch pad. Figure 2.1-9 provides an overview of the Concept B launch operation concept.

Launch process operations that would occur at the launch site include launch preparation, launch operations, and post-launch refurbishment of the launch pad. Table 2.1-7 lists the types and total estimated quantities of hazardous materials used for these processes for each Concept B launch. All hazardous materials used would be handled in accordance with applicable federal, state,



EXPLANATION

CBC	Common Booster Core
MST	Mobile Service Tower

Concept B Launch Operation Concept

Figure 2.1-9

Note: Solid rocket motors would be shipped by rail.

Table 2.1-7. Estimated Hazardous Materials Utilized Per Launch (all processes), Concept B[(a)]

Material	Quantity (lbs)[(b)]
POL	80
VOC-Based Primers, Topcoats, and Coatings	580
Non-VOC-Based Primers, Topcoats, and Coatings	460
VOC-Based Solvents and Cleaners	530
Non-VOC-Based Solvents and Cleaners	1,070
Corrosives	5,500
Refrigerants	0
Adhesives, Sealants, and Epoxies	690
Other	20
Total	8,930

Notes: (a) Propellants are shown in Table 2.1-6.
(b) Estimated quantities are rounded to the nearest pound and are the same for Cape Canaveral AS and Vandenberg AFB. Estimates are not dependent on vehicle type.
lbs = pounds
POL = petroleum, oil, and lubricants
VOC = volatile organic compound

and local regulations. Any spill of these materials would be collected and disposed of by a certified subcontractor in accordance with the SPCC Plan.

Vehicle Receiving/Inspection. The major transportation methods for this concept would include barge/boat, air, and truck. The CBCs, CBC/interstage, and CBC strap-ons would be shipped to the installation by barge/boat and received at the barge unloading facilities. The CBCs and CBC components would be loaded onto an elevated platform transport (EPT) vehicle (stored on the barge) for delivery to the HIF or an interim storage facility. At Vandenberg AFB, the EPT would deliver components, then return to the Boat Dock in reverse along the same route. Delivery of these components would require three trips to and from the dock. In addition, the barge would be required to move to the dock, then move out to deeper water three times to complete the unloading process. The entire unloading process is expected to take approximately 19 hours.

Some of the payload fairings would be transported to the launch site via aircraft and received at the airstrip; the upper stage and the remainder of the payload fairings would be transported by truck. Once at the launch site, the payload fairings would be transported to the payload encapsulation facility. The HUS, CUS, and HDCUS would be transported to the HIF or an interim storage facility. Items received would be inspected and prepared for integration/encapsulation at designated facilities.

Liquid propellant for the launch vehicle would be shipped directly from the manufacturing location. All propellant would be shipped in accordance with DOT regulations in Title 49 CFR Parts 100-199. LO_2 and LH_2 would be transported by truck and would be shipped from the manufacturing locations to the launch site. After the Directorate of Aerospace Fuels Management, located at Kelly AFB, Texas, approves the shipment of N_2O_4, it would be shipped by rail or truck from the manufacturing location to the launch site.

MMH and A-50 would be transported via truck by one of the authorized shippers (Directorate of Aerospace Fuels Management or NASA) to the launch site. Solid rocket motors could be shipped by truck, rail, barge, or aircraft.

Horizontal Integration Facility Processing. Receiving, integration, and check-out of the CBC and upper stages would be performed in the HIF. When the launch vehicle is ready, it would be transported to the launch pad.

Payload Encapsulation. This process would involve encapsulating the payload within the payload fairing, which would entail mating the payload-attach fittings, payload, and fairing, and conducting automated tests to ensure that all interfaces are verified. The third stage would be encapsulated with the payload, if required, for some small vehicle missions. Fueling of the payload would be conducted prior to encapsulation in payload processing.

Launch Vehicle Transfer and Erection. During this process, the unfueled launch vehicle would be moved to the launch pad from the HIF and erected. The assembled launch vehicle and umbilicals would then be raised and connected to the launch table.

Launch Pad Processing. The launch pad processing for all three vehicles would be similar, with the exception of the propellant servicing of the upper stages and attitude control systems. The vehicle would be erected and the launch mount unit secured to the launch table. The MST/mobile assembly shelter (MAS) (at Vandenberg AFB only) would be moved over the pad, and access platforms would be lowered or rotated in place to gain access to critical vehicle points. Interfaces at the pad include electrical, engine purge lines, GHe purge lines, ground equipment purge lines, LO_2 and LH_2 fill and drain lines, and vent lines, as applicable. The encapsulated payload would be hoisted by the MST crane and positioned over the upper stage.

Upon completion of final vehicle preparations for launch, the MST/MAS would be moved into the launch position, and final countdown would commence. The vehicle would undergo a final "hold fire" test to ensure range safe operation, followed by fueling of the vehicle stages. The final countdown would then be completed and the vehicle launched.

Approximately 125,000 gallons of Ignition Pulse Suppression (IPS) water per launch would be sprayed into the flame deflector to cool the rocket exhaust and minimize damage to the launch pad. At Cape Canaveral AS, water remaining in the launch duct after launch would be released to a concrete-lined pond, then to grade in accordance with permit requirements. Water that could not be released to grade would be released to the new pre-treatment plant; the effluent would then be pumped to the central WWTP. At Vandenberg AFB, water would be routed to an existing holding pond. The water would be tested, if solids were used, and neutralized, if required. It would then be treated with a reverse osmosis unit and pumped to an existing water tank and recycled for use during the next launch. Approximately 30 percent of this water would require replacement for each launch.

Approximately 30,000 gallons of water per launch would be required for pad washdown after DIV-M+ vehicle launches. This water would be neutralized and disposed of according to installation requirements.

Flight Support Operations. Flight operations after launch include the downlinking of composite vehicle performance and system payload telemetry data to the NASA TDRSS. These data would be routed to recording stations, as required for processing, data archiving, analysis, and monitoring by launch team personnel. Pre- and post-launch telemetry data would be used to perform event reconstruction, trend analysis, and vehicle performance evaluation. Flight support operations also include range safety control throughout all phases of the mission.

Post-Launch Operations. This process would include pad refurbishment in preparation for the next launch. Following launch, some of the components would require sandblasting and repainting; ablative material would be applied on some areas.

The HUS hypergolic propellant transfer system would be flushed with demineralized water and purge-dried with GN_2.

Small leaks and spills could occur during fueling, as could other hazardous material spills. These materials would be cleaned up, if necessary, with water, and/or absorption, or adsorption by the appropriate materials, and collection of the waste materials into DOT-approved waste containers for disposal. Collected wastewater would be disposed of in accordance with applicable federal, state, and local regulations.

If a launch were to be canceled or delayed beyond the launch window, it would be necessary to defuel the launch vehicle in accordance with EWR 127-1 requirements. Defueling is accomplished through pneumatic-activated valves that allow propellant to drain to ground/mobile storage containers. Electrically activated valves would allow high-pressure helium to vent to the atmosphere.

2.1.2.4 **Safety Systems.** Concept B would be subject to the same rules and policies described in Section 2.1.1.4 for Concept A. Systems with aspects unique to Concept B are described below.

Fire Protection System. Fire protection, alarm, and fire suppression systems would be provided for all fuel (A-50, LH_2, N_2H_4) holding areas and support facilities. Gas (H_2) detectors, detecting the lower explosive limit in the LH_2 storage area, would activate the alarms to the Air Force Fire Department. Flame detection alarms would also automatically activate deluge systems and notify the Fire Department. At Cape Canaveral AS, fire suppression water would be obtained through an existing 10-inch potable water line; a fire suppression water tank (144,000-gallon minimum) and pumps would likely be required. At Vandenberg AFB, an existing tank above the launch complex would be utilized for fire suppression water. An underground fire suppression water loop encircling the site would be installed at the Cape Canaveral AS SLC-37 launch pads. This loop would contain approximately 21 hydrants; the total anticipated fire suppression water flow would be 1,500 to 2,000 gallons per minute (gpm). At Vandenberg AFB (SLC-6), the existing fire suppression loop would be used and extended to include the new HIF. At the HIF, approximately 4 additional hydrants may be required. For oxidizer fueling performed by truck, a deluge system would not be included because N_2O_4 and water are highly reactive. Flushdown hoses, however, would be available.

Security. Security requirements, an integral component of project safety, would be incorporated within the project design and through operational procedures. Elements of site security would include a perimeter security fence, a clear zone, security lighting, security standby power, an intrusion detection system, and security patrol roads. Security procedures include the use of entry controllers, alarm monitors, closed circuit television (CCTV), alarm/security response teams, radios, and vehicles in accordance with Air Force regulations.

Launch Hazard Area Safety. The procedures for launch safety would be the same for Concept B as described for Concept A, except for the number of beach closures at Vandenberg AFB. Jalama Beach County Park would be closed to the public during low-azimuth launches (less than 180 degrees) from SLC-6. Ocean Beach County Park would not be closed during launches from SLC-6.

Quantity-Distance Criteria. The facilities associated with Concept B would be sited to meet ESQD criteria.

2.1.2.5 **Project Location and Access - Cape Canaveral AS.** EELV launch operations would be conducted at the 120-acre SLC-37 (Pads 37A and 37B) at Cape Canaveral AS, in the north-central portion of the station. SLC-37 was originally used for the Apollo Program. The only remaining structures at SLC-37 are concrete support equipment buildings that served as bases for the two launch pad umbilical towers, the former launch control center, miscellaneous retaining walls, and the concrete pad/refractory brick pad areas.

Cape Canaveral AS is accessible through Gate 1 from SR 401 (Figure 2.1-10). Once on Cape Canaveral AS, access to the site is along Samuel C. Phillips Parkway to Beach Road, which connects to SLC-37.

2.1.2.6 **Support Structures/Operations - Cape Canaveral AS.** Launch rates associated with Concept B are provided in Table 2.1-8. Approximately 540 personnel are expected to be required to support EELV program operations by 2007. Launch operations for Cape Canaveral AS would be as described in Section 2.1.2.3 and would be conducted in the structures listed in Table 2.1-9. Figures 2.1-10 and 2.1-11 provide the general location of facilities at Cape Canaveral AS and the site layout plan for SLC-37, respectively. Most of the area would be utilized for launch operations.

Under Concept B, the projected activities associated with EELV would generate the following average utility demands at Cape Canaveral AS during the projected peak launch year (2015):

- Water - 24,400 gpd
- Wastewater - 24,300 gpd
- Solid waste - 1.1 tons per day
- Electricity - 96,200 kWH per day.

Based upon employment projections and project activities, Concept B would generate an average of 1,730 vehicle trips daily, with 360 trips expected to occur during the peak hour.

2.1.2.7 **Project Construction Activities - Cape Canaveral AS.** Construction at Cape Canaveral AS would begin after Engineering and Manufacturing Development (EMD) award (summer 1998) and would be completed by June 2000. Construction personnel requirements would average 220, with a maximum of 405 personnel required during peak construction activities in June 1999. Proposed construction activities at Cape Canaveral AS are described below.

Existing Facility Modification

At SLC-37, launches are planned from both Pads 37A and 37B. Modifications required to support EELV activities would include the following (see Figure 2.1-11):

EXPLANATION

New Utility System Corridor

Station Boundary

A1A State Route

0 3000 6000 12000 Feet

Note: Mobile Launch Platform Transportation Route is from Building 70000 to LC-41

Alliant Tech / Boeing Concept B Proposed Facility Map, Cape Canaveral AS, Florida

Figure 3.1-40

EELV/001

Table 2.1-8. Concept B Launch Rates

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Total
East Coast[a]																					
Government[b]																					
DIV-S	1	2	3	2	2	3	3	3	3	3	5	3	5	3	3	3	3	3	3	3	59
DIV-M		2	2	4	7	6	4	4	1	3	3	5	4	5	7	5	3	4	5	4	78
DIV-H			1			1		1			1		1		1			1		1	8
Commercial																					
DIV-S	4	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	118
DIV-M																					
DIV-M+	8	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	122
DIV-H																					
Subtotal																					385
West Coast[c]																					
Government[b]																					
DIV-S		1	1		1	1	3	2	1	2		2	1	2		1	1	1		1	21
DIV-M		1	1	3	2	3	3	1	3	2	4	2	2	4	1	2	3	4	1	3	45
DIV-H								1													1
Commercial																					
DIV-S		4																			4
DIV-M																					
DIV-M+	2			4	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	38
DIV-H	2		4		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	38
Subtotal																					147
Total	17	22	24	25	28	30	29	28	24	26	29	28	29	30	28	27	26	29	25	28	532

Notes: The DIV-S and DIV-M vehicles fulfill the medium lift requirement of the National Mission Model. The DIV-H vehicle fulfills the heavy lift requirement of the National Mission Model.
(a) Cape Canaveral Air Station, Florida.
(b) Based on the National Executable Mission Model.
(c) Vandenberg Air Force Base, California.
DIV-H = heavy launch vehicle
DIV-M = medium launch vehicle
DIV-M+ = medium launch vehicle with solid rocket motor strap-ons
DIV-S = small launch vehicle

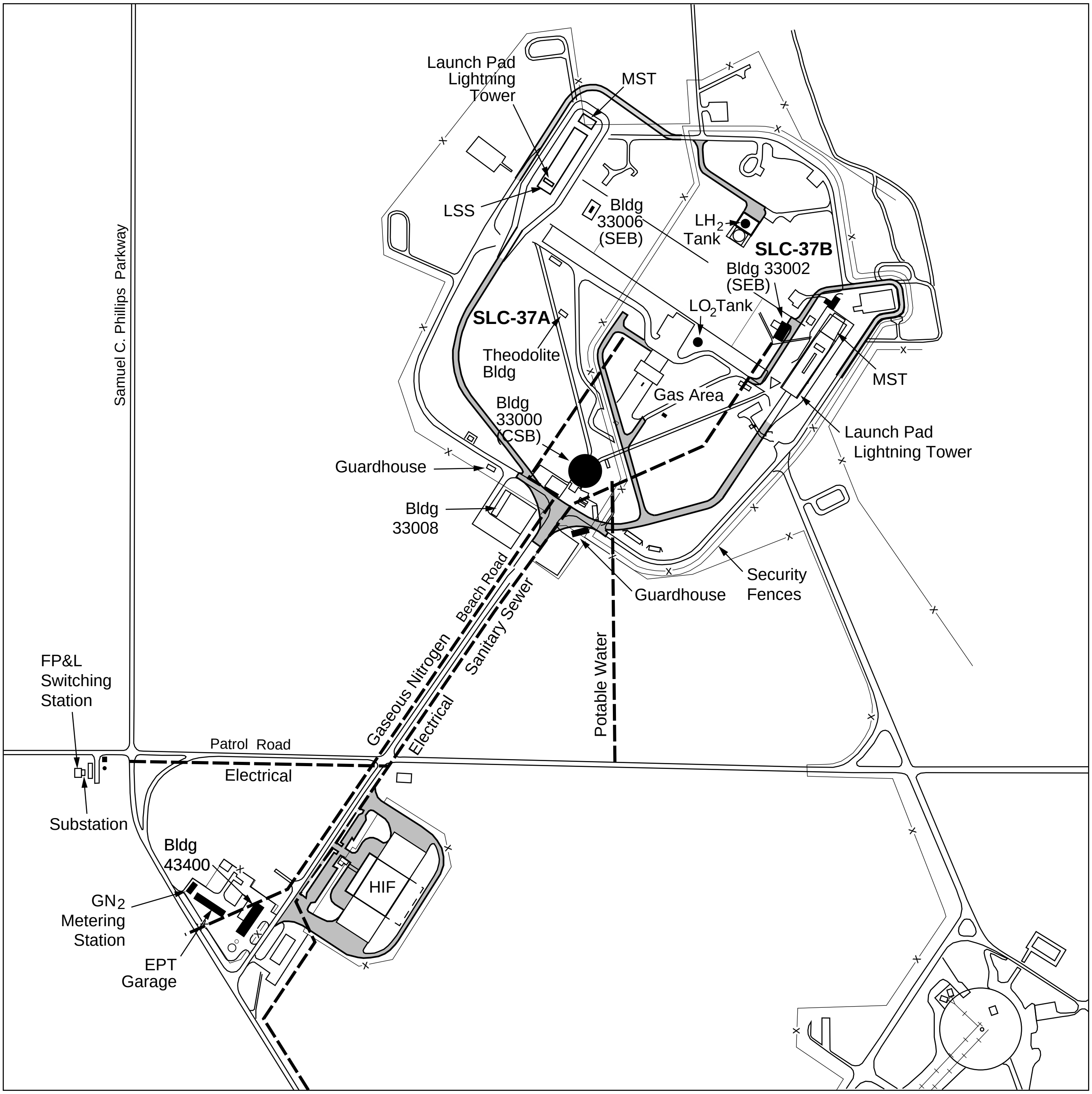
Table 2.1-9. Support Structures, Cape Canaveral AS, Concept B

Common Support Structure	Building	EELV Modifications
Barge/Boat Unloading	Port of Canaveral Dock	None
Aircraft Unloading	Cape Canaveral AS Skid Strip	None
Storage Facility	Building 1348 (Hangar C)	Modification
Equipment Storage Facility	Buildings 33008/43400	Modification
Electric Substation	New Construction	New Construction
Machine Shop	Building 43400	Modification
Storage/Office Space	Buildings 38804/38835 (Centaur Processing Facility [CPF] Complex)	Modification
Storage/Processing	Buildings 50801/50803 (Area 57E)	None
Horizontal Integration Facility	New Construction	New Construction
DSCS Processing Facility	Building 55820 (DSCS Processing Facility [DPF])	None
Payload Processing Facility	Building 70000 (Spacecraft Processing Integration Facility [SPIF])	None
Launch Complex	SLC-37 (Pads 37A and 37B)	New Construction/ Modification
Launch Control Center	Building 38835 (Centaur Processing Building [CPB])	Modification

AS = Air Station
DSCS = Defense Satellite Communications Systems
EELV = Evolved Expendable Launch Vehicle
SLC = Space Launch Complex

Pad 37A

- The existing roads would be modified.
- A launch pad would be constructed at the previous location of the existing Pad 37A. An FUT and MST would be constructed on the pad, which would be raised above the location of the previous pad to accommodate the exhaust duct and provide a level area for the MST. Support and tie-downs for the MST and the FUT would be provided on the pad.
- Facility 33006 (former Utility Building) would be modified for use as the SEB. A fire detection and suppression system would be installed.



EXPLANATION

CSB Common Support Building
EPT Elevated Platform Transporter
FP&L Florida Power and Light
GN_2 Gaseous Nitrogren
HIF Horizontal Integration Facility
LH_2 Liquid Hydrogen
LO_2 Liquid Oxygen
MST Mobile Service Tower
SEB Support Equipment Building

New Pavement
New Utility System Corridor

0 400 800 Feet

Concept B SLC-37 Site Plan, Cape Canaveral AS, Florida

Figure 2.1-11

EEL/015

A modular security building with parking spaces would be constructed.

- Lightning protection towers would be constructed.
- A launch table containing the interfaces to the vehicle from the ground support systems would be constructed to support the vehicle prior to launch.
- A launch support structure connected to the SEB by a service tunnel would be constructed to support the launch table and MST. A fire detection and suppression system would be installed.
- A flame deflector and exhaust duct would be installed.
- A Theodolite Building and an MST would be constructed.
- Buildings 33001, 33003, 33007, 33009, 38320, 43401, 43403, and 43405 are inactive, and would be abandoned in place.

Pad 37B

- The existing roads would be modified.
- The launch pad area would be modified, including removal of approximately 32,000 square feet of refractory brick that may contain asbestos and silica. Portions of the roads within SLC-37 would be new.
- A 250,000-gallon LO_2 tank would be installed within a gas storage area.
- An 850,000-gallon LH_2 tank would be installed.
- The existing SEB (Facility 33002) would be renovated, and a Theodolite Building, lightning protection towers, a guardhouse, a security fence between the Pad 37A and 37B areas, an MST, a launch table, and exhaust ducts would be constructed.
- A launch support structure deck would be installed to provide rooms and passageways under the launch deck for umbilicals and services.
- The Common Support Building (CSB) (Facility 33000) would be modified.
- The existing Sentry House (Facility 33005) would be removed.
- A guardhouse would be installed at the entrance of the SLC.
- Chain-link security fence would be installed around the SLC between SLC-37A and SLC-37B.
- A pipeline and lift station would be installed to transfer wastewater to the Cape Canaveral AS WWTP.

- A GHe vaporization system and pipeline tie-in would be installed at SLC-37.

- A compressed GN_2 pipeline would be installed to connect the new gas storage area to the Cape Canaveral AS commercial line at Samuel C. Phillips Parkway. The underground portion of the line that ties into the existing line northeast of Building 43400 and runs along Beach Road to the SLC-37 gas storage area would be carbon steel; the aboveground piping at the gas storage area would be stainless steel. The carbon steel underground line would have cathodic protection.

Port of Canaveral Dock. A dock at the Port of Canaveral would be used for EELV program activities. Any additional required road or facility improvements would be the responsibility of the Port of Canaveral.

Building 1348 (Hangar C). This building would be used for GSE storage. Upgrades to Hangar C would include interior asbestos and lead-based paint abatement, minor interior modifications, and construction of new entrances. Additional storage space (approximately 20,000 square feet) would be required on Cape Canaveral AS; available facility space has not yet been identified.

Buildings 33008 and 43400. These buildings would be used for storage. Modifications to Buildings 33008 and 43400 would be required to support EELV program activities. The extent of modifications required has not yet been determined.

Buildings 38804, 38835, Centaur Processing Facility. These facilities would be used for storage of fairings and upper stages, as well as other support activities. Interior modifications to these buildings would be required. The launch control area within Building 38835 would be modified.

Building 43400. A portion of this building would be utilized as a machine shop. Interior modifications would be required.

Area 57E. Portions of existing Buildings 50801 and 50803, and a new building scheduled for construction for the Delta III program, all within Area 57E, would be utilized for storage and processing.

Infrastructure. New wastewater, electrical, and water lines would be installed (see Figure 2.1-11). Some improvements would be made along existing road corridors; new wastewater and electrical lines may be installed through undisturbed areas between SLC-37 and Samuel C. Phillips Parkway.

New Facilities

Horizontal Integration Facility. An HIF would be constructed near SLC-37 on the south side of Beach Road (see Figure 2.1-11). The facility would be of a hangar-like configuration, with a parking lot in front. A fire detection system and sprinkler system would be installed. An estimated 15 acres would be disturbed for construction of the HIF.

Electric Substation. An electrical substation and associated connections would be constructed in the vicinity of Patrol Road and Samuel C. Phillips Parkway, at the area of Building 43302 (which would be removed). All electrical lines would be run underground.

Elevated Platform Transporter Garage. An elevated platform transporter (EPT) garage would be constructed west of and adjacent to Building 43400. The facility would be approximately 6,500 square feet in size.

Gaseous Nitrogen Metering Station. A GN_2 metering station would be constructed west of the EPT garage, on Samuel C. Phillips Parkway.

Alternative Facilities

Two alternative facilities have been identified at Cape Canaveral AS for Concept B activities, in the event that the preferred locations are not available in the time period required to support the EELV program. These facilities are described below.

Horizontal Integration Facility. An alternate location for construction of the HIF is adjacent to the CPF Complex (Buildings 38800/38804/38805).

U.S. Air Force Roll-On/Roll-Off Dock. If the Port of Canaveral Dock is not available to support EELV, the existing Air Force Roll-On/Roll-Off Dock would be modified. Limited dredging activities may be required in previously dredged areas. The dock would be modified to accommodate the turning radius of the transport vehicle/dolly in the egress area.

Construction Phase

The majority of new construction, except for construction of the HIF, would occur within the previously disturbed SLC-37 area or along existing road corridors. The majority of the area at SLC-37 inside the new security fence would be cleared of vegetation (approximately 25 to 30 acres for Pad 37A and 55 acres for Pad 37B). Construction equipment laydown areas, personal vehicle parking, temporary mobile offices (trailers), maintenance facilities, and other ancillary construction areas would be sited in previously disturbed areas (see Figure 2.1-11). The concrete batch plant would be located between Pads 37A and 37B. Construction laydown areas would be located approximately 200 feet southeast and 800 feet southwest of Pad 37A, along the perimeter road.

Earthwork for construction would be performed in accordance with the construction Storm Water Pollution Prevention Plan and the SPCC plan.

To contain wastewater, a temporary truck washdown area with an impoundment would be provided within the boundaries of the construction laydown areas.

Approximately 96 acres of land, including the area for construction of the launch complex, HIF, and electric substation, would be disturbed during construction. Depending upon the final design and grading plans, 10,000 to 18,000 cubic yards of material would be excavated and 220,000 to 360,000 cubic yards of fill would be required. Fill material would come from the East Trident Spoil Area on station. Unsuitable cut material would be removed from the project area to a spoil site on Cape Canaveral AS, or to other approved locations. Appropriate erosion control would be implemented at the stockpile. Construction materials generally would be trucked through Gate 1 over Samuel C. Phillips Parkway to SLC-37.

During the construction period, approximately 3,300 gpd of water would be required for general activities (e.g., site washdown, cement mixing, personnel requirements). Wastewater generation would average approximately 2,000 gpd. In addition, approximately 6,240 tons of solid waste would be generated during the 2-year construction period. Removal of construction debris would be the responsibility of the construction contractor; any hazardous materials found during construction (e.g., asbestos, lead-based paint) would be abated in accordance with applicable regulations. Approximately 5,830 tons of construction debris, consisting of concrete (3,900 tons), asphalt (1,650 tons), and fire brick (280 tons), would be generated by demolition activities in the first 3 months of the project. These construction materials would be recycled. The remaining 410 tons, consisting of wood (120 tons), paper (10 tons), copper and miscellaneous metal (80 tons), and miscellaneous garbage (200 tons), would be generated over the life of the construction period at an average rate of 0.6 ton per day. The miscellaneous garbage would be disposed of in a sanitary landfill; the remaining materials would be recycled to the maximum extent possible.

From 1998 through 2000, construction traffic entering and exiting project construction sites on Cape Canaveral AS under Concept B is estimated to generate an average of 1,400 daily vehicle trips, with 150 trips expected during the peak hour. Construction traffic entering and exiting project construction sites during the peak construction period in June 1999 is expected to be 2,550 trips, with 270 trips occurring during the peak hour.

2.1.2.8 **Project Location and Access - Vandenberg AFB.** EELV launch operations would be conducted at the 100-acre SLC-6 at South Vandenberg AFB. The SLC-6 site was originally constructed in 1970 for the Titan IIIM manned launch vehicle that was to be used for the Manned Orbital Laboratory (MOL) program. After the MOL program was canceled, SLC-6 was modified for the space shuttle program, but was never used for this program. Most of the facilities are currently in mothball status. Some of the other facilities are currently being used by the California Commercial Spaceport and a launch contractor.

Access to the SLC would be primarily through the Vandenberg AFB South Gate entrance via SR 246, then over Air Force-controlled secondary roadways, including Arguello Boulevard, and Bear Creek and Coast roads (Figure 2.1-12).

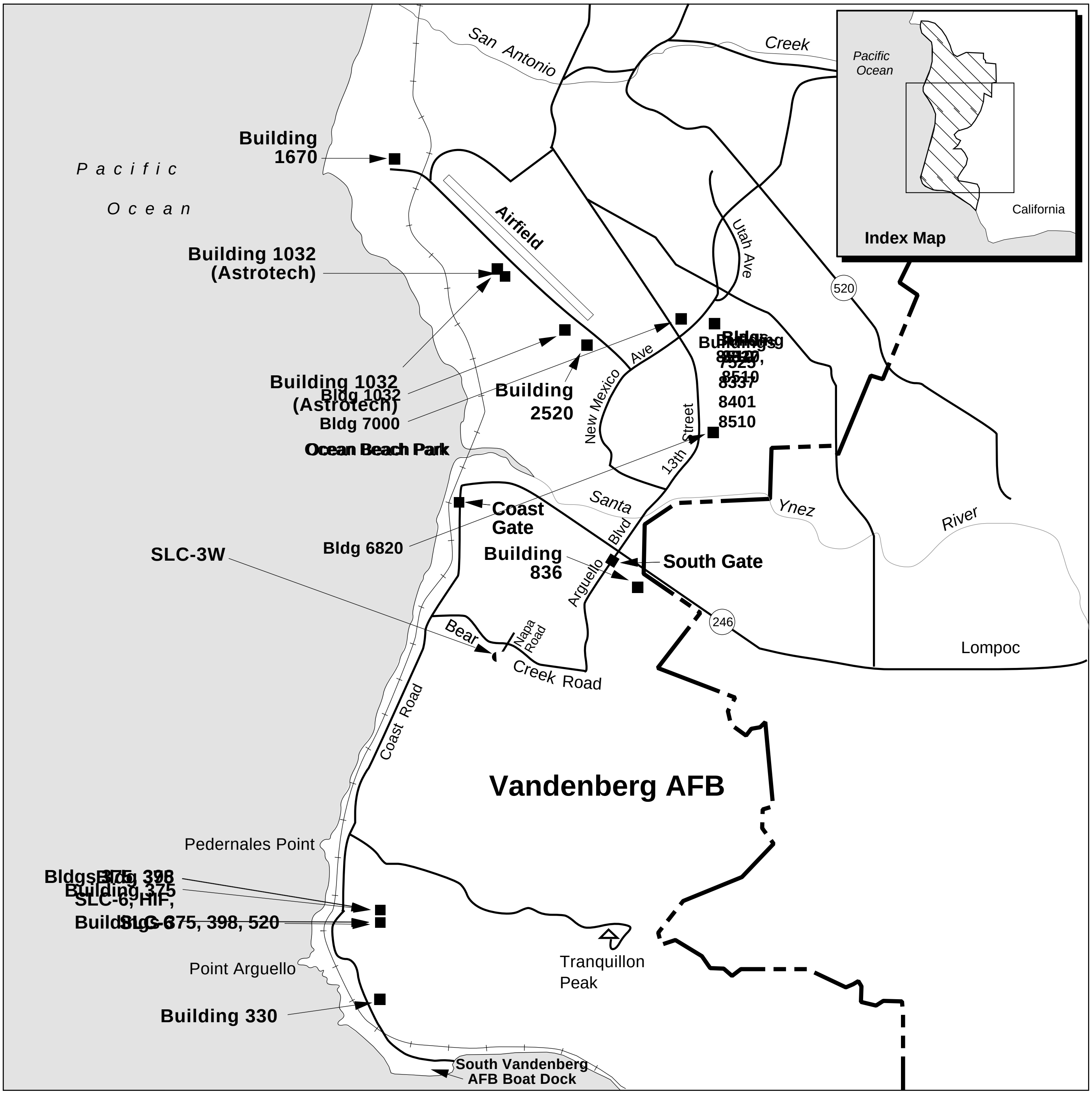
2.1.2.9 **Support Structures/Operations - Vandenberg AFB.** Launch rates associated with Concept B are provided in Table 2.1-8. Approximately 400 personnel are expected to be required to support EELV launch operations by 2007. Launch site operations would be as described in Section 2.1.2.3 and would occur in the structures listed in Table 2.1-10. Figures 2.1-12 and 2.1-13 provide the general location of facilities at Vandenberg AFB and the site layout plan for SLC-6, respectively. Most of the SLC-6 area would be utilized for launch operations.

Under Concept B, the projected activities associated with EELV would generate the following average utility demands at Vandenberg AFB during the projected peak launch year (2007):

- Water - 18,100 gpd
- Wastewater - 18,000 gpd
- Solid waste - 0.8 ton per day
- Electricity - 89,500 kWH per day.

Based upon employment projections and project activities, Concept B would generate an average of 1,280 vehicle trips daily, with 270 trips occurring during the peak hour.

2.1.2.10 **Project Construction Activities - Vandenberg AFB.** At Vandenberg AFB, construction would begin in March 1999 and would be completed by March 2001. Construction personnel requirements would average 173, with a maximum of 350 personnel required during peak construction activities between January and March 2000. Proposed construction activities at Vandenberg AFB are described below.



EXPLANATION

Base Boundary

HIF Horizontal Integration Facility

246 State Route

0 .5 1 2 Miles

Proposed Facility Map, Vandenberg AFB, California

Figure 2.1-12

EELV/002

Table 2.1-10. Support Structures, Vandenberg AFB, Concept B

Common Support Structure	Building	EELV Modifications
Barge/Boat Unloading	South Vandenberg AFB Boat Dock	Modification
Aircraft Unloading	Vandenberg AFB Airfield	None
Hardware Storage	Building 836	Modification
Storage and Refurbishment	Buildings 330, 398, 520	Modification
Horizontal Integration Facility	New Construction (SLC-6)	New Construction
Payload Processing Facilities	Building 375 (Integrated Processing Facility [IPF]) Building 1032 (Astrotech) New Construction (SLC-6)	Modification/New Construction
SRM Storage and Processing	Building 1670	Modification
Launch Complex	SLC-6	Modification
Launch Control Center	Building 8510 (Range Launch Control Center [RLCC])	None

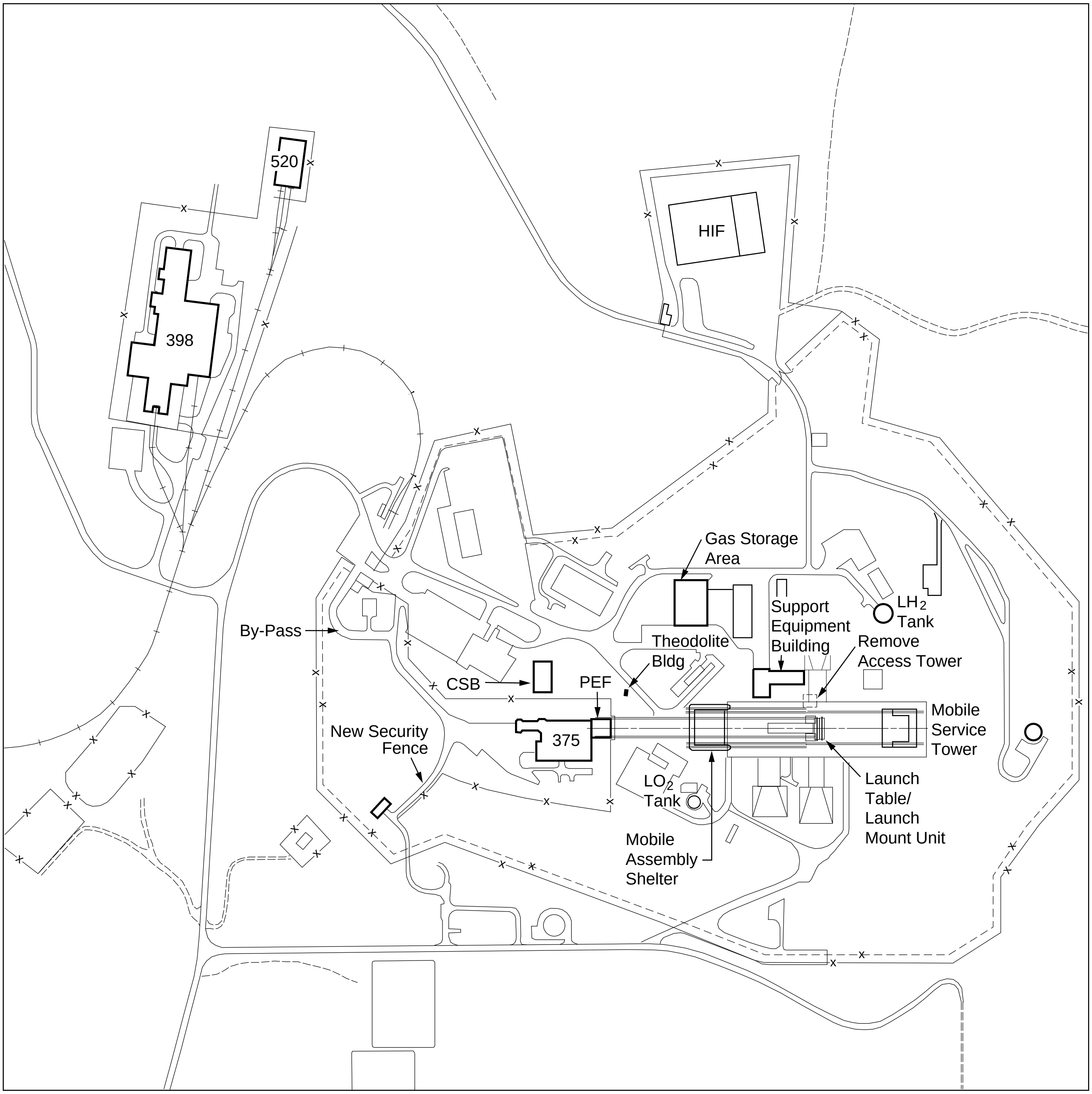
AFB = Air Force Base
EELV = Evolved Expendable Launch Vehicle
SLC = Space Launch Complex
SRM = solid rocket motor

Existing Facility Modification

SLC-6. The MST, bridge cranes, launch mount and exhaust ducts, and LO_2 and LH_2 storage areas would be modified. Other modifications would include:

- A launch table and FUT would be constructed on the launch pad.
- The fuel holding area, oxidizer storage area, and payload changeout room would be demolished.
- A Theodolite Building would be constructed east of the launch pad.
- Chain-link fencing would be installed between the launch complex and the Integrated Processing Facility (IPF) to form a security boundary. This would require clearance of vegetation for 30 feet on both sides of the fence.

South Vandenberg AFB Boat Dock. Modifications would consist of dredging approximately 20,000 cubic yards of sediment from the existing harbor channel. Dredging would be accomplished to the previously dredged depth. Disposal of material would be conducted in accordance with U.S. Army Corps of Engineers (USACE) permit requirements. Spoil disposal methods under consideration include disposal in a landfill, ocean disposal, or beach replenishment.



EXPLANATION

CSB	Common Support Building
HIF	Horizontal Integration Facility
LH_2	Liquid Hydrogen
LO_2	Liquid Oxygen
PEF	Payload Encapsulation Facility
——x——	Security Fence
– – –x– – –	Double fence (if required)

0 200 400 800 Feet

Note: Construction laydown areas would be located immediately adjacent to the SLC-6 launch pad.

Concept B SLC-6 Site Plan, Vandenberg AFB, California

Figure 2.1-13

EEL/014

Building 836. Building 836 would be utilized for receiving, inspection, and storage of CBCs and upper stages. Minor interior modifications would be required.

Building 375, Integrated Processing Facility and Building 1032 (Astrotech). The IPF would require substantial exterior and interior modifications. A Payload Encapsulation Facility (PEF) would be added to the east side of the IPF. The addition would be approximately 65 feet by 67 feet and would be constructed in a previously disturbed area. The Astrotech facility would likely require construction of a new high bay for encapsulation of heavy payloads.

Buildings 330, 398, and 520. These facilities would be utilized for storage and refurbishment of GSE. Minor interior modifications would be required at all three facilities.

Building 1670. Building 1670 would be utilized for SRM storage and processing.

Infrastructure. Utility modifications would occur within previously disturbed areas of SLC-6.

<u>New Facilities</u>

New Horizontal Integration Facility. A new HIF would be constructed in the northern portion of SLC-6. This area was the laydown area used during the initial construction of SLC-6 and is now a parking lot. Approximately 14 acres would be disturbed during construction. A payload processing facility for commercial launch program customers may be constructed adjacent to the HIF. The facility would measure approximately 66,500 square feet and would be sited within an area identified as disturbed for HIF construction; however, the exact location of facility construction is unknown.

<u>Alternative Facilities</u>

Two alternative facilities have been identified for Concept B activities at Vandenberg AFB, in the event that the preferred facilities are not available in the time period required to support the EELV program. These facilities are described below.

Building 2520. If Building 375 is not available for payload encapsulation activities, Building 2520 would be utilized for unbagging of payload fairings and encapsulation of small and medium payloads.

Building 7525. If Building 330 is not available to support EELV, Building 7525 would be utilized for GSE storage and refurbishment, and sandblasting and painting activities. If Building 836 is not available for storage of flight hardware, Building 7525 would be utilized for this purpose. The extent of modifications required has not yet been determined.

<u>Construction Phase</u>

Construction activities would take place within the previously disturbed SLC-6 area or along existing road corridors. SLC-6 consists of 100 acres of semi-improved grounds within a perimeter fence. Construction equipment laydown areas, personal vehicle parking, temporary mobile offices (trailers), maintenance facilities, and other ancillary construction areas would be sited in previously disturbed areas, to the north of the construction site.

Earthwork for construction would be performed in accordance with the construction Storm Water Pollution Prevention Plan and the SPCC plan.

To contain collected wastewater, a truck washdown area and impoundment within the boundaries of the construction laydown areas would be provided.

Depending upon the final design and grading plans, 4,500 to 7,500 cubic yards of material would be excavated, and 80,000 to 135,000 cubic yards of fill would be required. Fill material would come from the Vandenberg AFB Manzanita Borrow Area. Unsuitable cut material would be removed from the project area to the Manzanita spoil site, or to other approved locations. Top-soil would be removed and stockpiled on site for re-spreading on disturbed areas for revegetation and erosion control after completion of construction. Appropriate erosion control would be implemented at the stockpile. Construction materials generally would be trucked through the Coast Gate, then over Coast Road to SLC-6.

During the construction period, approximately 2,100 gpd of water would be required for general activities (e.g., site washdown, cement mixing, personnel requirements). Wastewater generation would average approximately 1,400 gpd. In addition, approximately 12,400 tons of solid waste would be generated during the 25-month construction period. Removal of construction debris would be the responsibility of the construction contractor; any hazardous materials found during construction (e.g., asbestos, lead-based paint) would be abated in accordance with applicable regulations. Approximately 11,250 tons of concrete would be generated by demolition activities during the first 6 months of the project. The concrete waste would be reused to fill the abandoned flame duct on the project site. The remaining construction materials, consisting of wood (120 tons), paper (12 tons), copper (18 tons), structural steel (800 tons), and miscellaneous garbage (200 tons), would be generated over the life of the construction period at an average rate of 1.5 tons per day. The miscellaneous garbage would be disposed of in a sanitary landfill; the remaining materials would be recycled to the maximum extent possible.

From 1998 to 2001, construction traffic entering and exiting project construction sites on Vandenberg AFB under Concept B is estimated to generate an average of 1,100 daily vehicle trips, with 115 trips expected during the peak hour. Construction traffic entering and exiting project construction sites during the peak construction period between January and March 2000 is expected to be 2,200 trips, with 230 trips occurring during the peak hour.

2.1.3 Concept A/B

Under Concept A/B, the contractors would use SLC-41 and SLC-37 at Cape Canaveral AS and SLC-3W and SLC-6 at Vandenberg AFB for the EELV system activities, as well as other facilities at both locations.

2.1.3.1 **Launch Vehicle Concept.** Under Concept A/B, the launch vehicle system described in Section 2.1.1.1 for Concept A and that described in Section 2.1.2.1 for Concept B would both be utilized.

2.1.3.2 **Primary Support Structures.** Structures described in Sections 2.1.1.2 and 2.1.2.2 for Concept A and B, respectively, would be utilized to support Concept A/B activities. If this concept were to proceed, any conflicts in facility usage between the two contractors would be addressed as the EELV program is further defined.

2.1.3.3 **Launch Site Operations.** Launch vehicle components would be delivered to the site, and all operations would be conducted as described in Sections 2.1.1.3 and 2.1.2.3 for Concepts A and B, respectively. Quantities of hazardous materials to be utilized would be the same per launch as shown in Tables 2.1-2 and 2.1-6, respectively, for both Concepts A and B.

2.1.3.4 **Safety Systems.** Concept A/B would be subject to the same rules and policies described in Sections 2.1.1.4 and 2.1.2.4, respectively, for Concepts A and B.

2.1.3.5 **Project Location and Access - Cape Canaveral AS.** As described in Section 2.1.1.5 for Concept A and in Section 2.1.2.5 for Concept B, EELV launch operations would be conducted at SLC-41 and SLC-37 at Cape Canaveral AS.

2.1.3.6 **Support Structures/Operations - Cape Canaveral AS.** Launch rates associated with Concept A/B are provided in Table 2.1-11. As described in Section 2.1, each contractor is assumed to launch approximately 50 percent of the combined total of EELV flights. No distinction has been made between government and commercial flights. Full staffing to support EELV program operations would be reached in 2003 for Concept A at 150 personnel and in 2007 for Concept B at 440 personnel.

Table 2.1-11. Concept A/B Launch Rates

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Total
Coast(a)																					
cept A																					
MLV-D	4	4	5	3	3	3	3	5	4	5	5	4	5	4	5	4	3	3	5	3	80
MLV-A	3	4	4	5	7	6	5	4	3	4	3	6	4	5	7	6	5	4	6	6	97
HLV-L																					
HLV-G			1			1		1			1		1		1			1		1	8
cept B																					
DIV-S	3	2	2	3	2	2	2	2	1	1	3	3	2	2	3	3	2	3	3	3	47
DIV-M	2	2	3	3	3	4	3	4	2	2	3	4	4	3	4	2	3	2	3	2	58
DIV-M+	2	3	4	2	4	3	2	4	4	4	2	2	2	3	4	4	2	2	4	4	61
DIV-H		1	1		1	1	1			2	1	1	2	1	2	1	1	1	1	1	19
otal																					370
t Coast(b)																					
cept A																					
MLV-D	2	2	2	1	2	2	4	2	2	3	1	2	2	2		2	2	2		1	36
MLV-A		1	1	3	2	3	3	1	3	2	4	2	2	4	1	2	3	4	1	3	45
HLV-L								1													1
HLV-G																					
cept B																					
DIV-S					1			1	1	1	1	1	1	1		1	2	2		1	14
DIV-M	1	1	1	2	1	3	1	1	1	1	2	1	1	1		1	1	2	1	1	24
DIV-M+		2	2	2	2	2	4		2	2	2	1	1	4	1	2	2	1		1	33
DIV-H	1						2	2	1	1		1	1					1		1	11
otal																					164
l	18	22	24	24	28	30	30	28	24	28	28	28	28	30	28	28	26	28	24	28	534

s: To ensure that an HLV system was analyzed for each contractor, the full AFSPC government HLV NMM has been included under Concept A/B.
(a) Cape Canaveral Air Station, Florida.
(b) Vandenberg Air Force Base, California.
AFSPC = Air Force Space Command
DIV-H = heavy launch vehicle
DIV-M = medium launch vehicle
DIV-M+ = medium launch vehicle with solid rocket motor strap-ons (commercial missions only)
DIV-S = small launch vehicle
HLV = heavy lift variant
MLV = medium lift variant
NMM = National Executable Mission Model

Under Concept A/B, the projected activities associated with EELV would generate the following average utility demands at Cape Canaveral AS during the projected peak launch year (2015):

- Water - 27,700 gpd
- Wastewater - 26,600 gpd
- Solid waste - 1.2 tons per day
- Electricity - 72,817 kWH per day.

Based upon employment projections and project activities, Concept A/B would generate an average of 1,900 vehicle trips daily, with 390 trips expected to occur during the peak hour.

2.1.3.7 **Project Construction Activities - Cape Canaveral AS.** Construction activities described in Sections 2.1.1.7 and 2.1.2.7 for Concept A and B, respectively, would occur under Concept A/B. No additional construction would be required under this concept.

2.1.3.8 **Project Location and Access - Vandenberg AFB.** As described in Section 2.1.1.8 for Concept A and in Section 2.1.2.8 for Concept B, EELV launch operations would be conducted at SLC-3W and SLC-6 at Vandenberg AFB.

2.1.3.9 **Support Structures/Operations - Vandenberg AFB.** Launch rates associated with Concept A/B are provided in Table 2.1-11. Full staffing to support EELV operations would be reached in 2006 for Concept A at 135 personnel and in 2007 for Concept B at 300 personnel.

Under Concept A/B, the projected activities associated with EELV would generate the following average utility demands at Vandenberg AFB during the projected peak launch year (2007):

- Water - 19,700 gpd
- Wastewater - 18,700 gpd
- Solid waste - 0.83 ton per day
- Electricity - 66,551 kWH per day

Based upon employment projections and project activities, Concept A/B would generate an average of 1,300 vehicle trips daily, with 280 trips expected to occur during the peak hour.

2.1.3.10 **Project Construction Activities - Vandenberg AFB.** Construction activities described in Sections 2.1.1.10 and 2.1.2.10 for Concept A and B, respectively, would occur under Concept A/B. No additional construction would be required under this concept.

2.2 ALTERNATIVES TO THE PROPOSED ACTION

2.2.1 No-Action Alternative

Under the No-Action Alternative, Atlas IIA, Delta II, and Titan IVB launch vehicles would continue to support space launches to meet the requirements of the government portion of the NMM, both medium and heavy lift. These launch vehicles would provide DoD's source of expendable medium and heavy spacelift transportation to orbit through 2020. The No-Action Alternative does not include analysis of commercial launches. Table 2.2-1 presents the peak launch rates of these vehicles to meet the government portion of the NMM. These launches would continue at existing launch complexes at both Cape Canaveral AS and Vandenberg AFB (Figures 2.2-1 and 2.2-2), utilizing existing manning levels. The infrastructure, operational procedures, and safety systems are in place for these launch vehicles at both Cape Canaveral AS and Vandenberg AFB. Chapter 3.0, Affected Environment, provides a description of the baseline conditions associated with these launch programs.

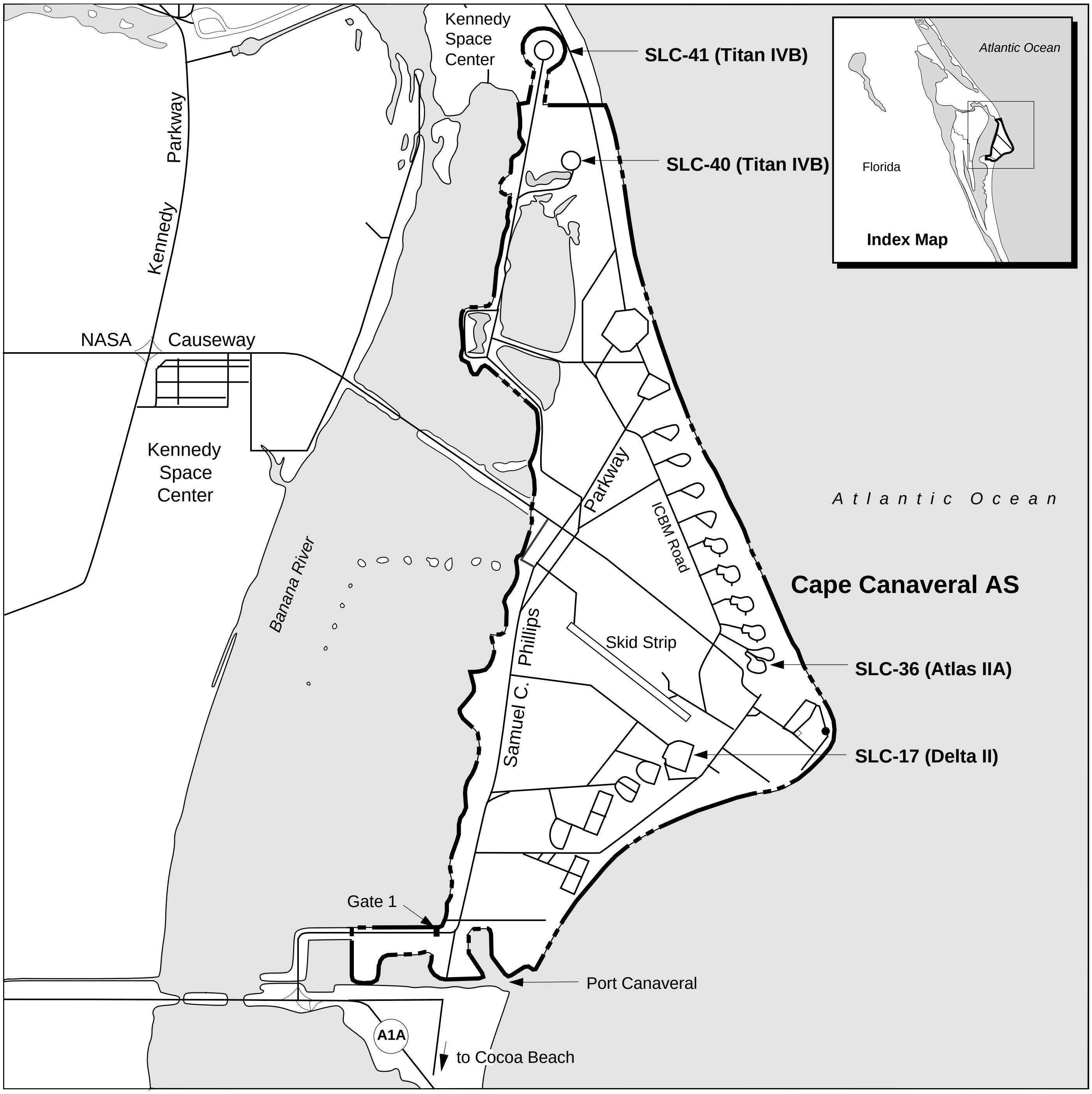
Table 2.2-1. Launch Program, No-Action Alternative

	Cape Canaveral AS			Vandenberg AFB		
Launch Vehicle	Launch Complex	Peak Year Launches (2015)	Operational Personnel Requirements	Launch Complex	Peak Year Launches (2007)	Operational Personnel Requirements
Atlas IIA	36	7	250	3E	3	175
Delta II	17	3	260	2W	3	141
Titan II	NA	NA	NA	4W	0	200 [a]
Titan IVB	40/41	1	700	4E	0	330

Note: (a) Launch requirements; caretaker of facilities only requires 25 personnel.
AFB = Air Force Base
AS = Air Station
NA = not applicable

Under the No-Action Alternative, the Air Force would continue to utilize the Atlas IIA, Delta II, and Titan IVB. Table 2.2-2 and Figure 2.2-3 present the general characteristics of these launch vehicles. The heavier lift version of each vehicle has been selected for analysis purposes.

Atlas IIA. The Atlas IIA has the ability to lift payloads of up to 14,000 pounds to low Earth orbit (LEO). The Atlas IIA consists of two LO_2/kerosene fuel (RP-1) booster engines, a sustainer section, and a CUS (see Table 2.2-2). The Atlas IIA is launched from SLC-36 at Cape Canaveral AS and SLC-3E from Vandenberg AFB. Deluge water requirements for the Atlas IIA are approximately 100,000 to 200,000 gallons per launch. The types and amounts of hazardous materials utilized for, and hazardous waste generated from, Atlas IIA launch operations are presented in Section 3.6, Hazardous Materials and Hazardous Waste Management (Tables 3.6-1 and 3.6-4, respectively).



EXPLANATION

Station Boundary

A1A State Route

No-Action Alternative Launch Complexes Cape Canaveral AS, Florida

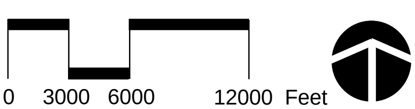
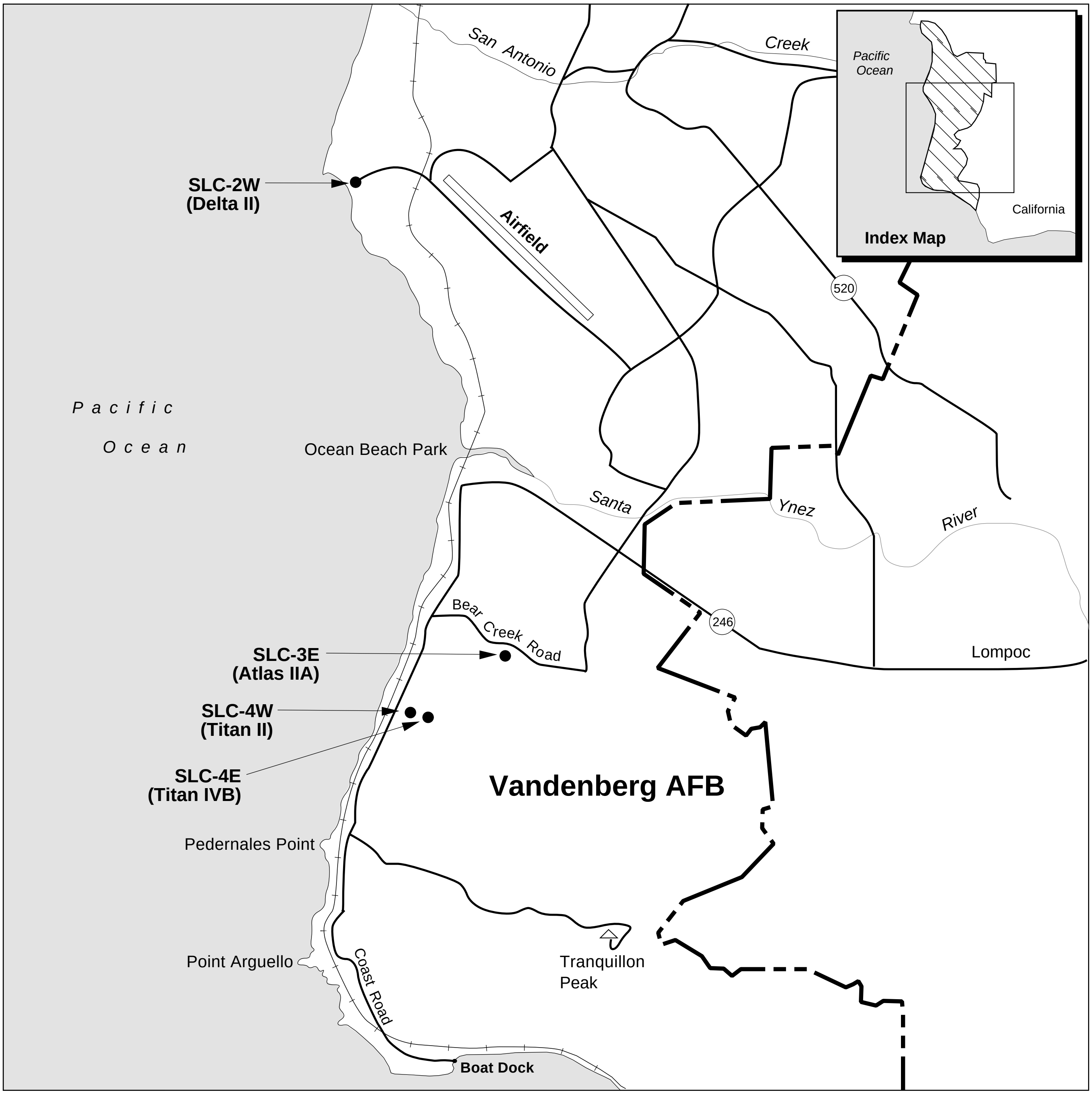


Figure 2.2-1

EELV/037



EXPLANATION

Base Boundary

246 State Route

0 .5 1 2 Miles

EELV/038

No-Action Alternative Launch Complexes Vandenberg AFB, California

Figure 2.2-2

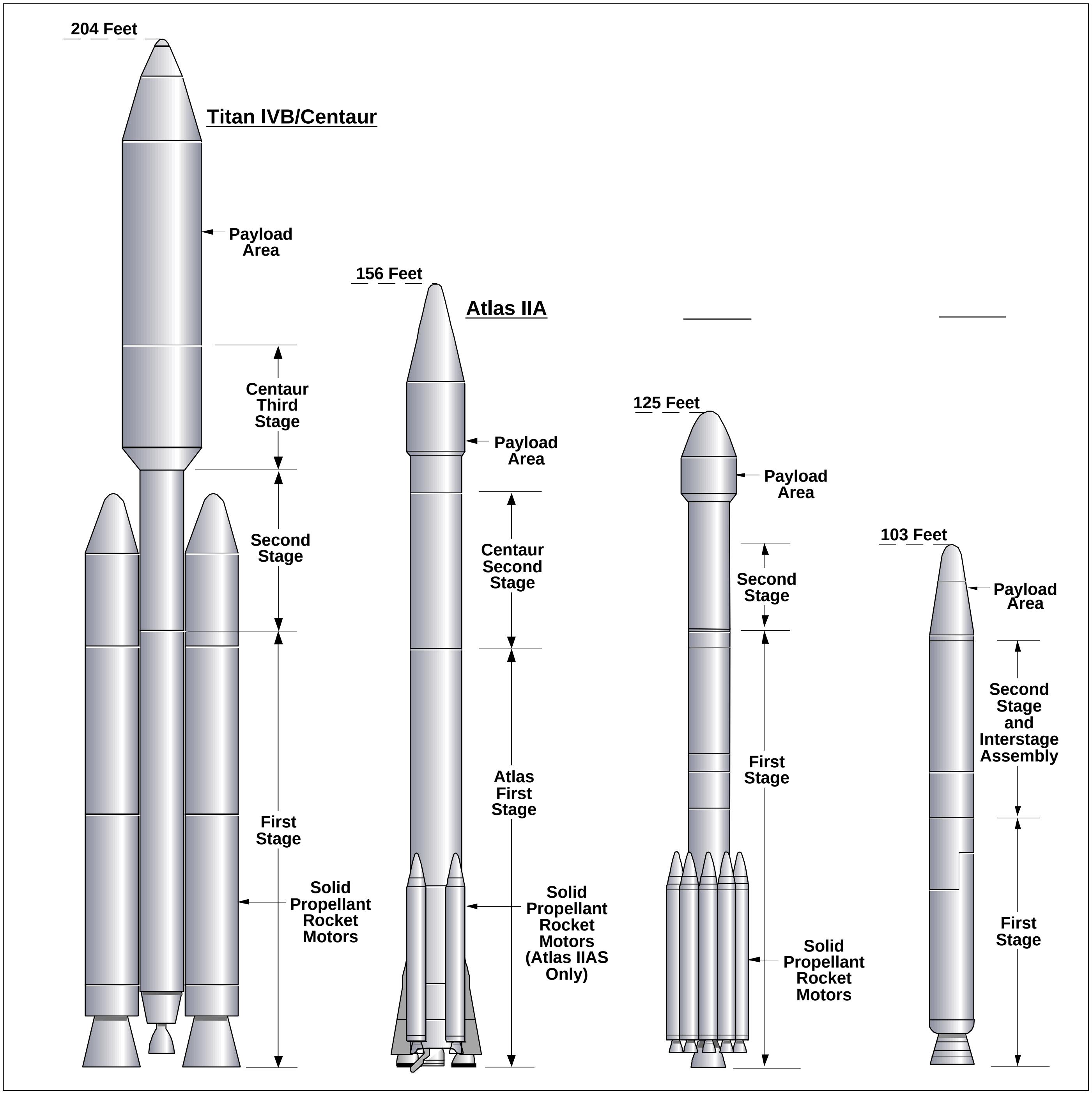
Table 2.2-2. Launch Vehicle Components, No-Action Alternative

Launch Vehicle	Maximum Vehicle Height (ft)	Approximate Vehicle Weight (lbs)	Approximate Propellant Weight (lbs)
Atlas IIA	156	413,500	
Stage I			LO_2 (240,320)
			RP-1 (108,050)
			N_2H_4 (40)
Centaur II Upper Stage			LO_2 (31,370)
			LH_2 (5,990)
Castor IVA SRM (4 per Atlas IIAS only)[a]			NH_4ClO_4 (15,160)
			Al (4,240)
			HTPB (2,900)
ACS			N_2H_4 (170)
Delta II	125	510,000	
Stage 1			LO_2 (146,070)
			RP-1 (66,500)
Stage 2			A-50 (4,610)
			N_2O_4 (8,630)
Star 48B (Stage 3)			NH_4ClO_4 (3,200)
			Al (800)
			HTPB (500)
SRM (9 per vehicle)[a]			NH_4ClO_4 (18,380)
			Al (2,850)
			HTPB (4,660)
NCS			N_2H_4 (6)
Titan IVB SRMU	204	1,900,000	
Stage 1			N_2O_4 (220,770)
			A-50 (117,580)
Stage 2			N_2O_4 (48,430)
			A-50 (27,580)
SRMU (2 per vehicle)[a]			NH_4ClO_4 (479,840)
			Al (132,130)
			HTPB (83,450)
Centaur Upper Stage			LO_2 (38,220)
			LH_2 (7,900)
			N_2H_4 (340)
Titan IVA	204	1,900,000	
Stage 1			N_2O_4 (218,110)
			A-50 (117,380)
Stage 2			N_2O_4 (47,940)
			A-50 (27,470)
SRM (2 per vehicle)[a]			NH_4ClO_4 (403,060)
			Al (94,840)
			PBAN (94,840)
TVC motors (2 per vehicle)[a]			N_2O_4 (8,420)

Note: (a) Propellant weight shown is for an individual motor.

A-50	=	Aerozine-50 (50 percent by weight symmetrical dimethylhydrazine and percent anhydrous hydrazine)
ACS	=	attitude control system
Al	=	aluminum
ft	=	feet
HTPB	=	hydroxyl-terminated polybutadiene (binder material)
lbs	=	pounds
LH_2	=	liquid hydrogen
N_2H_4	=	anhydrous hydrazine
LO_2	=	liquid oxygen
N_2O_4	=	nitrogen tetroxide
NCS	=	nutation control system
NH_4ClO_4	=	ammonium perchlorate
PBAN	=	polybutadiene-acrylic acid-acrylonitrile terpolymer (binder material)
RP-1	=	rocket propellant (kerosene fuel)
SRM	=	solid rocket motor
SRMU	=	solid rocket motor upgrade
TVC	=	Thrust Vector Control

Sources: Isakowitz, 1991; U.S. Air Force, 1994f, 1996e.



No-Action Alternative Launch Vehicles

NOT TO SCALE

EELV/036

Figure 2.2-3

Delta II. The Delta II has the ability to lift payloads of up to 7,500 pounds to LEO. The Delta II is a three-stage launch vehicle with a first stage that uses kerosene fuel (RP-1) and LO_2 (see Table 2.2-2). The second stage utilizes a mixture of 50 percent unsymmetrical dimethylhydrazine (UDMH) and 50 percent anhydrous hydrazine (A-50) and N_2O_4, and the third stage utilizes solid propellant. Nine SRMs are attached to the first-stage motor to provide additional thrust. The Delta II is launched from SLC-17 at Cape Canaveral AS and from SLC-2W at Vandenberg AFB. IPS and pad washdown water requirements for the Delta II are approximately 25,000 to 35,000 gallons per launch (ENSR Corporation, 1996). The types and amounts of hazardous materials utilized for, and hazardous waste generated from, Delta II launch operations are presented in Section 3.6, Hazardous Materials and Hazardous Waste Management (Tables 3.6-2 and 3.6-5, respectively).

Titan IVB. The Titan IVB/solid rocket motor upgrade (SRMU) has the ability to lift payloads of up to 40,000 pounds to LEO. The typical Titan IVB launch vehicle consists of a two-stage core vehicle that uses N_2O_4 and a mixture of 50 percent UDMH and 50 percent anhydrous hydrazine (A-50), two SRMUs consisting of three segments each and a Centaur Upper Stage (see Table 2.2-2). The Titan IVB is launched from SLC-40 and SLC-41 at Cape Canaveral AS and from SLC-4E at Vandenberg AFB. Deluge water requirements for the Titan IVB are approximately 100,000 to 150,000 gallons per launch. The types and amounts of hazardous materials utilized for, and hazardous waste generated from, Titan IVB launch operations are presented in Section 3.6, Hazardous Materials and Hazardous Waste Management (Tables 3.6-3 and 3.6-6, respectively).

Titan II. The Titan II has the capability of carrying payloads of up to 5,600 pounds and is not currently launched from Cape Canaveral AS; SLC-4W has been utilized for Titan II launches from Vandenberg AFB. No Titan II launches are currently scheduled, and no future launches are planned to occur during the peak years considered in this EIS. The Titan II program is a relatively small program, with infrequent launches in the past; therefore, the Titan II launch vehicle will not be discussed further or analyzed in this EIS.

2.3 ALTERNATIVES ELIMINATED FROM FURTHER CONSIDERATION

Other launch concepts besides an expendable launch system were addressed in 1994, when a multi-agency SLMP was developed to evaluate national space launch systems and to improve the United States' launch capability. The SLMP contained four alternatives for the modernization of the United States' space launch capabilities: sustaining the existing launch systems (No-Action Alternative); evolving the current expendable launch systems (EELV); developing a new, expendable launch system; and developing a new, reusable launch system.

On August 5, 1994, the President signed the National Space Transportation Policy, tasking the Secretary of Defense to provide an implementation plan for improvement and evolution of the current Expendable Launch Vehicle fleet. On October 25, 1994, the Deputy Secretary of Defense signed the National

Space Implementation Plan for National Space Transportation Policy, which identified the EELV program as DoD's solution to reduce the government launch cost baseline by 25 to 50 percent and lead implementation of DoD acquisition reform policies.

2.4 OTHER FUTURE ACTIONS AND POTENTIAL FOR CUMULATIVE IMPACTS

No other reasonably foreseeable actions have been identified that could be considered as contributing to a potential cumulative impact on the environment along with impacts associated with implementation of the EELV program.

2.5 COMPARISON OF ENVIRONMENTAL IMPACTS

A summary of the potential environmental impacts associated with implementation of the Proposed Action and the No-Action Alternative at Cape Canaveral AS and Vandenberg AFB is provided in Tables 2.5-1 and 2.5-2, respectively. Each resource potentially affected by implementation of the Proposed Action and No-Action Alternative is listed, and proposed mitigation measures, if applicable, are presented. Local community, land use and aesthetics, transportation, and utilities are considered factors that could influence environmental impacts; these factors are not included within the tables. Impacts to the environment are described briefly in the Summary and in detail in Chapter 4.0.

Table 2.5-1. Cape Canaveral AS - Summary of Environmental Impacts and Suggested Mitigations [(a)] from the Proposed Action and No-Action Alternative

Resource Category	Proposed Action			No-Action Alternative
	Concept A	Concept B	Concept A/B	
Hazardous Materials and Hazardous Waste Management				
· **Hazardous Materials Management**	· **Impacts:** Total hazardous materials and propellant usage would increase; per launch usage would decrease.	· **Impacts:** Total hazardous materials usage would decrease and propellant use would increase; per launch usage would decrease.	· **Impacts:** Similar to that described for Concept A.	· **Impacts:** Similar to that associated with current launch vehicle programs.
· **Hazardous Waste Management**	· **Impact** Hazardous waste generation would increase due to an increased number of launches.	· **Impacts:** Similar to that described for Concept A.	· **Impacts:** Similar to the combined effects of Concepts A and B.	· **Impacts:** Similar to that associated with current launch vehicle programs.
· **Pollution Prevention**	· **Impacts:** No Class I ODSs would be utilized.	· **Impacts:** Same as Concept A.	· **Impacts:** Same as Concept A.	· **Impacts** Class I ODSs to be phased out.
· **Installation Restoration Program**	· **Impacts:** Construction activities would be coordinated with IRP personnel to minimize impacts to remediation activities and the EELV program schedule.	· **Impacts:** Same as Concept A.	· **Impacts:** Same as Concept A.	· **Impacts:** None.

Note: (a) Mitigation measures are presented only where impacts are identified.
EELV = Evolved Expendable Launch Vehicle
IRP = Installation Restoration Program
ODS = ozone-depleting substance

Table 2.5-1. Cape Canaveral AS - Summary of Environmental Impacts and Suggested Mitigations [(a)] from the Proposed Action and No-Action Alternative

Resource Category	Proposed Action			No-Action Alternative
	Concept A	Concept B	Concept A/B	
Health and Safety	· **Impacts:** Safety procedures are in place to protect the public. With use of procedures established for existing launch systems, risks to installation personnel and the general public have been minimized to acceptable levels during normal and aborted launches, in accordance with EWR 127-1.	· **Impacts:** Same as Concept A.	· **Impacts:** Same as Concept A.	· **Impacts:** Safety procedures are in place to protect the public. With use of procedures established for existing launch systems, risks to installation personnel and the general public have been minimized to acceptable levels during normal and aborted launches, in accordance with EWR 127-1.
Geology and Soils	· **Impacts:** Construction would occur on previously disturbed areas at SLC-41. Compliance with standard construction practices and adherence to permit requirements would reduce the potential for erosion during construction.	· **Impacts:** Construction would occur on previously disturbed areas at SLC-37. Compliance with standard construction practices would be the same as that described for Concept A.	· **Impacts:** Similar to combined effects of Concepts A and B.	· **Impacts:** None.

Note: (a) Mitigation measures are presented only where impacts are identified.
EWR = Eastern and Western Range
SLC = Space Launch Complex

Table 2.5-1. Cape Canaveral AS - Summary of Environmental Impacts and Suggested Mitigations [(a)] from the Proposed Action and No-Action Alternative

Resource Category	Proposed Action			No-Action Alternative
	Concept A	Concept B	Concept A/B	
Water Resources	· **Impacts**: Adequate water supply to meet demand; no impacts to groundwater are expected. An SWPPP would be required. Deluge water would be recycled after launch and disposed of in accordance with applicable regulations.	· **Impacts**: Similar to Concept A. Minimal effects on surface water from deposition of HCl. No long-term impacts are expected. Dredging activities would require a permit.	· **Impacts**: Similar to combined effects for Concepts A and B.	· **Impacts**: Adequate water supply to meet demand. Minimal effects on surface water from deposition of HCl. No long-term impacts are expected.
Air Quality (Lower Atmosphere)	· **Impacts**: Attainment status for criteria pollutants would not be jeopardized during construction or operations. Peak-year launch operations would not jeopardize attainment status of criteria pollutants.	· **Impacts**: Similar to that described for Concept A.	· **Impacts**: Similar to combined effects for Concepts A and B.	· **Impacts**: Annual NO_x emissions would be less than those projected for the Proposed Action, due to the smaller number of launches which do not include commercial launches.

Note: (a) Mitigation measures are presented only where impacts are identified.
HCl = hydrochloric acid
NOx = nitrogen oxides
SWPPP = Storm Water Pollution Prevention Plan

Table 2.5-1. Cape Canaveral AS - Summary of Environmental Impacts and Suggested Mitigations [(a)] from the Proposed Action and No-Action Alternative
Page 4 of 7

Resource Category	Proposed Action			No-Action Alternative
	Concept A	Concept B	Concept A/B	
Air Quality (Lower Atmosphere) (Continued)	· **Mitigation:** Application of water during ground-disturbing activities, scheduling of equipment use, and implementation of a phased construction schedule would mitigate impacts during construction.	· **Mitigation:** Similar to that described for Concept A.	· **Mitigation:** Similar to that described for Concept A.	· **Mitigation:** None required.
Air Quality (Upper Atmosphere)	· **Impacts**: No estimated emissions to the stratosphere of any pollutants.	· **Impacts**: Some commercial launches would produce emissions of alumina particulates and chlorine compounds into the stratosphere.	· **Impacts**: Similar to combined effects for Concepts A and B.	· **Impacts**: Continued emissions of alumina particulates and chlorine from solid rocket motors.
Orbital Debris	· **Impacts**: Intact upper stages would contribute to orbital debris population through fragmentation. Stages would be designed to minimize breakup and reduce orbital debris.	· **Impacts**: Same as Concept A.	· **Impacts**: Same as Concept A.	· **Impacts**: Would continue to contribute to the orbital debris population through fragmentation of upper stages.

Note: (a) Mitigation measures are presented only where impacts are identified.

Table 2.5-1. Cape Canaveral AS - Summary of Environmental Impacts and Suggested Mitigations [(a)] from the Proposed Action and No-Action Alternative

Resource Category	Proposed Action			No-Action Alternative
	Concept A	Concept B	Concept A/B	
Noise	· **Impacts**: Launch noise and sonic booms would be short-term and temporary; no human or structural impacts are expected. Sonic booms would occur over the Atlantic Ocean.	· **Impacts**: Similar to that described for Concept A.	· **Impacts**: Similar to that described for Concept A.	· **Impacts**: Noise and sonic boom exposure would be similar to current levels, which are comparable to those for the Proposed Action.
Biological Resources	· **Impacts:** Potential loss of up to 10.9 acres of jurisdictional wetlands at SLC-41. No impact to sea turtles because artificial light sources would be designed to minimize impacts. Minimal impacts to wildlife and scrub jays are anticipated from launch noise.	· **Impacts:** Up to 3.68 acres of jurisdictional wetlands and waters may be impacted at SLC-37. Impacts to sea turtles would be as described for Concept A. Southeastern beach mouse may be impacted by fire and heat from the flame duct and from construction of a lightning tower anchor.	· **Impacts:** Similar to combined effects of Concepts A and B.	· **Impacts:** Minimal effects on biological resources would continue from deposition of HCl. No long-term impacts are expected. Noise effects would be similar to those discussed for Concept A. No wetlands or sensitive species habitat impacts because no construction planned.

Note: (a) Mitigation measures are presented only where impacts are identified.
HCl = hydrochloric acid
SLC = Space Launch Complex

Table 2.5-1. Cape Canaveral AS - Summary of Environmental Impacts and Suggested Mitigations [(a)]
from the Proposed Action and No-Action Alternative

Resource Category	Proposed Action			No-Action Alternative
	Concept A	Concept B	Concept A/B	

Biological Resources (Continued)	· No impacts to manatees or their critical habitat are anticipated.	Gopher tortoises and other listed species, as appropriate, at SLC-37 would be identified and relocated prior to construction. Up to 15.25 acres of scrub jay habitat to be removed for facility construction. · Minimal short-term effects on biological resources are expected from deposition of HCl and from launch noise.		
	· **Mitigation:** Proposed 1.5 to 1 for restoration and 7.4 to 1 enhancement of the existing wetlands. Wetland mitigation efforts would be monitored to avoid impacts to sensitive species. Enhance surrounding scrub jay habitat by allowing USFWS to burn during facility construction.	· **Mitigation:** Mitigation for wetlands impacts at a 1 to 1 ratio would be conducted when clearing of scrub jay habitat occurs for scrub jay mitigation. Impacts to the southeastern beach mouse could be mitigated by trapping and relocation and habitat restoration. Enhance surrounding scrub jay habitat by allowing USFWS to burn during facility construction.	· **Mitigation:** Wetlands mitigations would be the same as those described for Concepts A and B combined.	· **Mitigation:** None required.

Note: (a) Mitigation measures are presented only where impacts are identified.
HCl = hydrochloric acid
SLC = Space Launch Complex
USFWS = U.S. Fish and Wildlife Service

Table 2.5-1. Cape Canaveral AS - Summary of Environmental Impacts and Suggested Mitigations [a] from the Proposed Action and No-Action Alternative

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	Proposed Action			No-Action Alternative
Resource Category	Concept A	Concept B	Concept A/B	
Cultural Resources	· **Impacts:** None identified.	· **Impacts:** Proposed alterations to one potentially eligible facility.	· **Impacts:** Similar to effects described for Concepts A and B combined.	· **Impacts:** None.
	· **Mitigation**: None required.	· **Mitigation**: Recordation if facility is eligible.	· **Mitigation**: Similar to that described for Concept B.	· **Mitigation**: None required.
Environmental Justice	· **Impacts:** None.	· **Impacts:** None.	· **Impacts:** None.	· **Impacts:** None.

Note: (a) Mitigation measures are presented only where impacts are identified.

Table 2.5-2. Vandenberg AFB - Summary of Environmental Impacts and Suggested Mitigations [(a)] from the Proposed Action and No-Action Alternative

Resource Category	Proposed Action: Concept A	Proposed Action: Concept B	Proposed Action: Concept A/B	No-Action Alternative
Hazardous Materials and Hazardous Waste Management				
· **Hazardous Materials Management**	· **Impacts:** Total hazardous materials and propellant usage would increase; per launch usage would decrease.	· **Impacts:** Total hazardous materials usage would decrease and propellant use would increase; per launch usage would decrease.	· **Impacts:** Similar to that described for Concept A.	· **Impacts:** Similar to that associated with current launch vehicle programs.
· **Hazardous Waste Management**	· **Impact** Hazardous waste generation would increase due to an increased number of launches.	· **Impacts:** Similar to that described for Concept A.	· **Impacts:** Similar to combined effects of Concepts A and B.	· **Impacts:** Similar to that associated with current launch vehicle programs.
· **Pollution Prevention**	· **Impacts:** No Class I ODSs would be utilized.	· **Impacts:** Same as Concept A.	· **Impacts:** Same as Concept A.	· **Impacts** Class I ODSs to be phased out.
· **Installation Restoration Program**	· **Impacts:** Construction activities would be coordinated with base personnel to minimize impacts to remediation activities and the EELV program schedule.	· **Impacts:** Same as Concept A.	· **Impacts:** Same as Concept A.	· **Impacts:** None.

Note: (a) Mitigation measures are presented only where impacts are identified.
EELV = Evolved Expendable Launch Vehicle
ODS = ozone-depleting substance

Table 2.5-2. Vandenberg AFB - Summary of Environmental Impacts and Suggested Mitigations [(a)] from the Proposed Action and No-Action Alternative
Page 2 of 6

Resource Category	Proposed Action: Concept A	Proposed Action: Concept B	Proposed Action: Concept A/B	No-Action Alternative
Health and Safety	· **Impacts:** Safety procedures are in place to protect the public. With use of procedures established for existing launch systems, risks to installation personnel and the general public have been minimized to acceptable levels during normal and aborted launches, in accordance with EWR 127-1.	· **Impacts:** Same as Concept A.	· **Impacts:** Same as Concept A.	· **Impacts:** Safety procedures are in place to protect the public. With use of procedures established for existing launch systems, risks to installation personnel and the general public have been minimized to acceptable levels during normal and aborted launches, in accordance with EWR 127-1.
Geology and Soils	· **Impacts:** Construction would occur on previously disturbed areas at SLC-3W. Compliance with standard construction practices and adherence to permit requirements would reduce the potential for erosion during construction.	· **Impacts:** Construction would occur on previously disturbed areas at SLC-6. Compliance with standard construction practices would be the same as described for Concept A.	· **Impacts:** Similar to combined effects for Concepts A and B.	· **Impacts:** None.

Note: (a) Mitigation measures are presented only where impacts are identified.
EWR = Eastern and Western Range
SLC = Space Launch Complex

Table 2.5-2. Vandenberg AFB - Summary of Environmental Impacts and Suggested Mitigations [(a)] from the Proposed Action and No-Action Alternative

	Proposed Action			No-Action Alternative
Resource Category	Concept A	Concept B	Concept A/B	
Water Resources	· **Impacts**: Adequate water supply to meet demand; no impacts to groundwater are expected. An SWPPP would be required. Deluge water would be recycled after launch and disposed of in accordance with applicable regulations.	· **Impacts**: Similar to that described for Concept A. Dredging activities would require a permit. Minimal effects on surface water from deposition of HCl. No long-term impacts are expected.	· **Impacts**: Similar to combined effects for Concepts A and B.	· **Impacts**: Adequate water supply to meet demand. Minimal effects on surface water from deposition of HCl. No long-term impacts are expected.
Air Quality (Lower Atmosphere)	· **Impacts**: Attainment status for criteria pollutants would not be jeopardized during construction or operations. Emissions of ozone and ozone precursors would be mitigated to the extent feasible, as the area is in serious non-attainment for state standards. Peak-year launch operations would not jeopardize attainment status of criteria pollutants.	· **Impacts**: Similar to that described for Concept A.	· **Impacts**: Similar to combined effects for Concepts A and B.	· **Impacts**: NO_x emissions would be less than those projected for the Proposed Action, possibly due to the smaller number of launches.

Note: (a) Mitigation measures are presented only where impacts are identified.
HCl = hydrochloric acid
NOx = nitrogen oxides
SWPPP = Storm Water Pollution Prevention Plan

Table 2.5-2. Vandenberg AFB - Summary of Environmental Impacts and Suggested Mitigations [(a)] from the Proposed Action and No-Action Alternative

Resource Category	Proposed Action			No-Action Alternative
	Concept A	Concept B	Concept A/B	
Air Quality (Lower Atmosphere) (Continued)	· **Mitigation**: Application of water during ground-disturbing activities, scheduling of equipment use, and implementation of a phased construction schedule would mitigate impacts during construction.	· **Mitigation**: Similar to that described for Concept A.	· **Mitigation**: Similar to that described for Concept A.	· **Mitigation**: None required.
Air Quality (Upper Atmosphere)	· **Impacts**: No estimated emissions to the stratosphere of any pollutants.	· **Impacts**: Some commercial launches would produce emissions of alumina particulates and chlorine compounds into the stratosphere.	· **Impacts**: Similar to combined effects for Concepts A and B.	· **Impacts**: Continued emissions of alumina particulates and chlorine from solid rocket motors.
Orbital Debris	· **Impacts**: Intact upper stages would contribute to orbital debris population through fragmentation. Stages would be designed to minimize breakup and reduce orbital debris.	· **Impacts**: Same as Concept A.	· **Impacts**: Same as Concept A.	· **Impacts**: Would continue to contribute to the orbital debris population through fragmentation of upper stages.

Note: (a) Mitigation measures are presented only where impacts are identified.

Resource Category	Proposed Action: Concept A	Proposed Action: Concept B	Proposed Action: Concept A/B	No-Action Alternative
Noise	· **Impacts**: Launch noise and sonic booms would be short-term and temporary; no human or structural impacts are expected. Sonic booms would occur over the Pacific Ocean.	· **Impacts**: Similar to that described for Concept A.	· **Impacts**: Similar to that described for Concept A.	· **Impacts**: Noise and sonic boom exposure would be similar to current launch operation levels, which are comparable to those for the Proposed Action.
Biological Resources	· **Impacts:** Construction activities at SLC-3W may impact a portion of a wetland. Temporary, minor impacts to sensitive species may occur from launch noise and sonic booms. A marine mammal take permit would be required, and monitoring may be required during launches.	· **Impacts:** Impacts from launches to sensitive species similar to Concept A; peregrine falcons could also be affected. Dredging and off-loading barge activities at the Boat Dock area would require a permit and could cause short-term effects to the sea otter, harbor seal, and brown pelican. Minimal effects on biological resources from deposition of HCl. No long-term impacts are expected.	· **Impacts:** Similar to combined effects for Concepts A and B.	· **Impacts:** Minimal effects on biological resources would continue from deposition of HCl. No long-term impacts are expected. Other launch operation effects would be similar to those described for Concepts A and B. No wetlands impacts because no construction planned.

Note: (a) Mitigation measures are presented only where impacts are identified.
HCl = hydrochloric acid
SLC = Space Launch Complex

Table 2.5-2. Vandenberg AFB - Summary of Environmental Impacts and Suggested Mitigations [a] from the Proposed Action and No-Action Alternative

	Proposed Action			No-Action Alternative
Resource Category	Concept A	Concept B	Concept A/B	
Biological Resources (Continued)	· **Mitigation:** Replacement, protection, restoration, or avoidance of wetlands could be required. Monitoring of launch impacts on listed species.	· **Mitigation:** Monitoring of launch impacts on listed species. During launches utilizing solid rocket motors, monitoring could be required for HCl impacts on surface waters, if winds are from the south.	· **Mitigation:** Mitigations for wetland impacts would be the same as those described for Concept A.	· **Mitigation:** None required.
Cultural Resources	· **Impacts:** None identified.	· **Impacts:** Proposed construction in an archaeologically sensitive area at SLC-6. Archaeological or Native American monitoring would be required during ground-disturbing activities.	· **Impacts:** Similar to effects described for Concept B.	· **Impacts:** None.
Environmental Justice	· **Impacts:** None.	· **Impacts:** None.	· **Impacts:** None.	· **Impacts:** None.

Note: (a) Mitigation measures are presented only where impacts are identified.
SLC = Space Launch Complex

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3.0 AFFECTED ENVIRONMENT

3.1 INTRODUCTION

This chapter describes the existing environment of Cape Canaveral AS, Florida, and Vandenberg AFB, California, and their regions of influence (ROIs). This information serves as a baseline from which to identify and evaluate environmental changes resulting from the implementation of the EELV program. The baseline conditions assumed for the purposes of analysis are the existing conditions at Cape Canaveral AS and Vandenberg AFB. These conditions include activities conducted for the Atlas IIA, Delta II, and Titan IVB launch vehicle programs, which currently support space launches that meet the requirement of the government portion of the NMM.

Although this EIS focuses on the biophysical environment, the following nonbiophysical elements (influencing factors) are addressed: local community, land use and aesthetics, transportation networks, and public utility systems in the regions and local communities. In addition, this chapter describes the storage, usage, disposal, and management of hazardous materials/wastes as well as pollution prevention and Installation Restoration Program (IRP) status. The chapter contains a description of health and safety practices at each installation, and the pertinent natural resources of geology and soils, water resources, air quality, noise, orbital debris, biological resources, and cultural resources. Information on low-income and minority populations in the area used for the environmental justice analysis, concludes the chapter.

The ROI to be evaluated for the two installations is defined for each resource area potentially affected by the Proposed Action and No-Action Alternative. The ROI determines the geographical area to be addressed as the affected environment. Although the installation boundary may constitute the ROI limit for many resources, potential impacts associated with certain issues (e.g., air quality, utility systems, and water resources) transcend these limits. Within each resource discussion, separate ROIs for Concepts A and B are provided, where applicable. The Concept A/B ROI is considered to encompass the ROIs for both Concepts A and B and is therefore not provided separately.

3.2 COMMUNITY SETTING

3.2.1 Cape Canaveral AS

Cape Canaveral AS is situated on the Canaveral Peninsula along the east-central Atlantic Coast in Brevard County, Florida. The Canaveral Peninsula is a barrier island bordered on the east by the Atlantic Ocean, on the west by the Banana River, on the north by the Kennedy Space Center (KSC), and on the south by Port Canaveral. Patrick AFB is also situated south of Cape Canaveral AS. Incorporated cities within Brevard County include Cape

Canaveral, Titusville, Cocoa, Melbourne (including Melbourne Beach and Melbourne Village), West Melbourne, Palm Bay, Cocoa Beach, Indialantic, Indian Harbor Beach, Malabar, Satellite Beach, and Rockledge.

3.2.1.1 **Employment.** In 1997, there were 231,553 total jobs within Brevard County, Florida (Table 3.2-1). The number of jobs in the county grew at an average annual rate of 4.1 percent between 1975 and 1990. During the same period, job growth at the national level was 1.9 percent annually. Between 1994 and 1997, the rate of annual county job growth averaged 2.9 percent.

Table 3.2-1. Summary of Economic Indicators, Brevard County, Florida, Estimates for 1975, 1990, 1994, 1997 and Forecasts for 1998, 2000, 2007, 2015

	1975	1990	1994	1997	1998	2000	2007	2015
Total Jobs[(a)]	97,084	205,128	212,706	231,553	237,835	250,400	285,540	315,600
Average Annual Change[(b)]	224	7,433	1,895	6,282	6,282	6,283	5,020	3,360
Average Annual Change (percent)	0.2	4.1	0.9	2.9	2.6	2.6	1.8	1.1

Notes: (a) Total jobs are average annual full- and part-time jobs within Brevard County.
(b) Average Annual Change in each column is calculated over the period of years from the preceding column; for the 1975 column, the change is calculated for the 1975-1990 period.

Sources: U.S. Bureau of Economic Analysis, 1996a, 1996b.

The services and retail trade sectors supported the greatest number of jobs in Brevard County in 1994 with 34.1 percent and 19.2 percent of total jobs, respectively. There were 5,922 jobs, or 2.8 percent of total jobs, in the transportation-communication-public utilities sector in 1994. Manufacturing, with 13.7 percent of total jobs in 1994, and construction, with 6.1 percent, provided the bulk of jobs within the goods-producing sectors (agriculture, mining, manufacturing, and construction). In 1994, state and local government supported about 8.7 percent of all county jobs, and the federal government provided about 5.2 percent of total jobs within Brevard County.

An employment forecast prepared by the U.S. Bureau of Economic Analysis (1996) projected that the number of jobs in Brevard County would increase at an average annual rate of 2.6 percent between 1994 and 2000. By 2000, the forecast projected that there would be more than 250,000 jobs in the county.

The unemployment rate averaged 7.4 percent in 1994, 6.5 percent in 1995, and 5.4 percent in 1996. By comparison, the state unemployment rate was 6.6, 5.5, and 5.1 percent, respectively, for the same 3 years (U.S. Bureau of Labor Statistics, 1997).

3.2.1.2 **Population.** The total population of Brevard County increased from 398,978 in 1990 to 460,824 in 1997 (Table 3.2-2). A 1997 forecast by the University of Florida Bureau of Economic and Business Research (BEBR) anticipates county population growth of 2.3 percent annually between 1997 and 2000, which would increase total population in Brevard County to 492,803 in 2000. A population forecast prepared by the U.S. Bureau of the Census projects the number of persons in Brevard County to increase at an average annual rate of 2.2 percent between 1994 and 2000 (U.S. Bureau of Economic Analysis, 1996a).

Table 3.2-2. Population, Brevard County, Florida, Estimates for 1990, 1996, and 1997 and Forecasts for 2000, 2007, 2015

	1990	1996	1997	2000	2007	2015
Brevard County	398,978	450,164	460,824	492,803	557,856	629,314
Cape Canaveral	8,014	8,375	8,457	8,701	8,963	9,047
Cocoa	17,722	17,874	17,939	18,134	18,206	18,227
Cocoa Beach	12,123	12,794	12,940	13,379	13,941	14,156
Indialantic	2,844	2,938	2,961	3,029	3,079	3,081
Indian Harbour Beach	6,933	7,579	7,713	8,114	8,809	9,342
Malabar	1,977	2,364	2,445	2,687	3,239	3,929
Melbourne	60,034	66,970	68,395	72,668	80,785	88,313
Melbourne Beach	3,078	3,198	3,226	3,309	3,386	3,403
Melbourne Village	591	612	617	632	644	648
Palm Bay	62,543	74,395	76,860	84,254	100,951	121,515
Palm Shores	210	578	641	829	1,098	1,300
Rockledge	16,023	18,434	18,930	20,418	23,530	26,941
Satellite Beach	9,889	10,106	10,166	10,344	10,382	10,463
Titusville	39,394	41,321	41,749	43,033	44,524	45,167
West Melbourne	8,399	9,171	9,331	9,810	10,637	11,261
Unincorporated	149,204	173,455	178,457	193,462	225,682	262,469

Source: University of Florida, 1997.

With an estimated population of 76,860 persons in 1997, Palm Bay is the largest city in Brevard County. Between 1990 and 1997, Palm Bay's population increased by 14,317, an average of 3.3 percent annually. The population of Melbourne, the second largest city in the county, increased by 8,361, an average of 1.9 percent per year, to 68,395 in 1997. The third largest city, Titusville, increased in population by 2,355, an average of 0.9 percent per year, to 41,749 in 1997. The cities of Rockledge, Cocoa, and Cocoa Beach are the next three largest cities in the county, with populations of 18,930, 17,939, and 12,940, respectively, in 1997.

Almost half of the population growth between 1990 and 1997 occurred in the unincorporated portion of Brevard County. In 1997, the population of unincorporated Brevard County was 178,457.

3.2.2 **Vandenberg AFB**

Vandenberg AFB is in the western part of unincorporated Santa Barbara County, California. The Santa Ynez River and SR 246 divide the base into North and South Vandenberg AFB. North Vandenberg AFB generally includes the developed portions of the base, whereas South Vandenberg AFB includes primarily open space. The city of Lompoc lies to the east, the city of Santa Maria to the northeast, and the city of Guadalupe to the north. Two unincorporated communities, Vandenberg Village and Mission Hills, are north of the city of Lompoc, and the unincorporated community of Orcutt is north of the base.

3.2.2.1 **Employment.** In 1997, there were 229,107 total jobs within Santa Barbara County (Table 3.2-3). The number of jobs in the county grew at an average annual rate of 2.3 percent between 1975 and 1990. By comparison, the number of jobs in the state of California grew at an average annual rate of 2.5 percent during the same period. Between 1990 and 1997, the rate of county job growth averaged 2.4 percent annually.

Table 3.2-3. Summary of Economic Indicators, Santa Barbara County, California, Estimates for 1975, 1990, 1994, 1997 and Forecasts for 1998, 2000, 2001, 2007, 2015

	1975	1990	1994	1997	1998	2000	2007	2015
Total Jobs[(a)]	137,224	217,428	213,313	229,107	234,371	244,900	271,380	292,600
Average Annual Change[(b)]	4,232	4,686	(1,029)	5,265	2,118	5,265	3,782	2,300
Average Annual Change (percent)	3.4	2.3	-0.5	2.4	0.9	2.2	1.4	0.8

Notes: (a) Total Jobs are average annual full- and part-time jobs within Santa Barbara County.
(b) Average Annual Change in each column is calculated over the period of years from the preceding column; for the 1975 column, the change is calculated for the 1970-75 period.

Sources: U.S. Bureau of Economic Analysis, 1996a, 1996b, 1997.

The services and retail trade sectors supported the greatest number of jobs in Santa Barbara County in 1994 with 32.2 percent and 17.6 percent, respectively. There were 6,027 jobs, or 2.8 percent of total jobs, in the transportation-communication-public utilities sector in 1994. Manufacturing, with 8.8 percent of total jobs in 1994, and agriculture (including agricultural services, forestry, and fishing) with 8.2 percent, provided the bulk of jobs within the goods-producing sectors. In 1994, state and local government agencies supported about 11.6 percent of all county jobs, and the federal government provided about 3.7 percent of total jobs in Santa Barbara County.

An employment forecast prepared by the U.S. Bureau of Economic Analysis projects the number of jobs in Santa Barbara County to increase at an average rate of 2.3 percent annually between 1994 and 2000 to almost 245,000 total jobs by 2000. The Santa Barbara County Association of Governments is anticipating employment growth to average 1.7 percent annually between 1995 and 2000 (Damkowitch, 1997). The University of

California at Santa Barbara (UCSB) Economic Forecast Project projects the number of county jobs to increase at an average annual rate of 1.6 percent between 1996 and 2000.

The county unemployment rate averaged 7.2 percent in 1994, 6.7 percent in 1995, and 5.7 percent in 1996. By comparison, the state unemployment rate averaged 8.6 percent, 7.8 percent, and 7.2 percent, respectively, for those 3 years.

3.2.2.2 **Population.** The total population of Santa Barbara County increased from 369,608 persons in 1990 to 399,988 in 1997 (Table 3.2-4). A forecast by the Santa Barbara Association of Governments anticipates county population growth of 1.3 percent annually between 1996 and 2000, which would increase total population in the county to 416,213 in 2000 (Damkowitch, 1997). A population forecast prepared by the UCSB Economic Forecast Project projects the number of persons in Santa Barbara County to increase at an average annual rate of 0.9 percent between 1996 and 2000. A forecast prepared by the U.S. Bureau of the Census projects an average annual growth rate of 1.6 percent between 1994 and 2000.

Table 3.2-4. Population, Santa Barbara County, California, Estimates for 1990, 1996, 1997 and Forecasts for 2000, 2007, 2015

	1990	1996	1997	2000	2007	2015
Santa Barbara County	369,608	394,580	399,988	416,213	445,415	439,320
Buellton[(a)]	NA	3,509	3,623	3,966	4,234	4,528
Carpinteria	13,747	14,490	14,790	15,689	17,320	17,804
Guadalupe	5,479	6,262	6,431	6,936	7,811	8,916
Lompoc	37,649	41,002	41,804	44,208	47,083	48,026
Santa Barbara	85,571	89,370	90,338	93,241	98,217	103,650
Santa Maria	61,552	68,888	70,454	75,152	83,688	96,573
Solvang	4,741	5,109	5,191	5,437	5,890	6,369
Unincorporated	160,869	165,950	167,359	171,584	181,172	193,454

Note: (a) Buellton became an incorporated city in 1993.
NA = not applicable

Sources: California Department of Finance, 1997; Santa Barbara County Association of Governments, 1994.

Santa Barbara, with an estimated population of 90,338 persons in 1997, is the largest city in the county. Between 1990 and 1997, Santa Barbara's population increased by 4,767, an average of 0.8 percent annually. Santa Maria, the second largest city in the county, increased in population by 8,902, an average of 2.0 percent per year, to 70,454 in 1997. The third largest city, Lompoc, increased in population by 4,155, an average of 1.6 percent per year, to 41,804 in 1997.

About 20 percent of the population growth between 1990 and 1997 occurred in the unincorporated portion of Santa Barbara County. In 1997, the population of the unincorporated portion of the county was 167,359.

Incorporated in 1993, the city of Buellton, with 3,623 persons in 1997, is anticipated to experience the greatest rate of growth in the county between 1997 and 2000, at 3.1 percent per year. Lompoc and Santa Maria are forecast to experience average annual growth rates of 2.6 percent and 2.2 percent, respectively, during the same period.

3.3 LAND USE AND AESTHETICS

This section describes the existing environment in terms of land use and aesthetics for the areas on and surrounding Cape Canaveral AS and Vandenberg AFB. Topics addressed are regional land use, on-station/base land use, coastal zone management, recreation, and aesthetics.

Land use can be defined as the human use of land resources for various purposes including economic production, natural resources protection, or institutional uses. Land uses are frequently regulated by management plans, policies, ordinances, and regulations that determine the types of uses that are allowable or protect specially designated or environmentally sensitive uses.

Potential issues typically stem from encroachment of one land use or activity on another, or an incompatibility between adjacent land uses that leads to encroachment. Cape Canaveral AS and Vandenberg AFB coordinate with surrounding local and state jurisdictions to ensure that off-station/base development does not encroach on installation activities, and that installation activities do not encroach on, or create land use incompatibilities with, off-station/base uses.

Visual resources include natural and man-made features that give a particular environment its aesthetic qualities. The analysis considers visual sensitivity, which is the degree of public interest in a visual resource and concern over adverse changes in the quality of the resource.

3.3.1 Cape Canaveral AS

The ROI for land use at Cape Canaveral AS encompasses the station boundaries and potentially affected adjacent lands, including off-station lands within launch safety clear zones or land uses that may be affected by activities on the station.

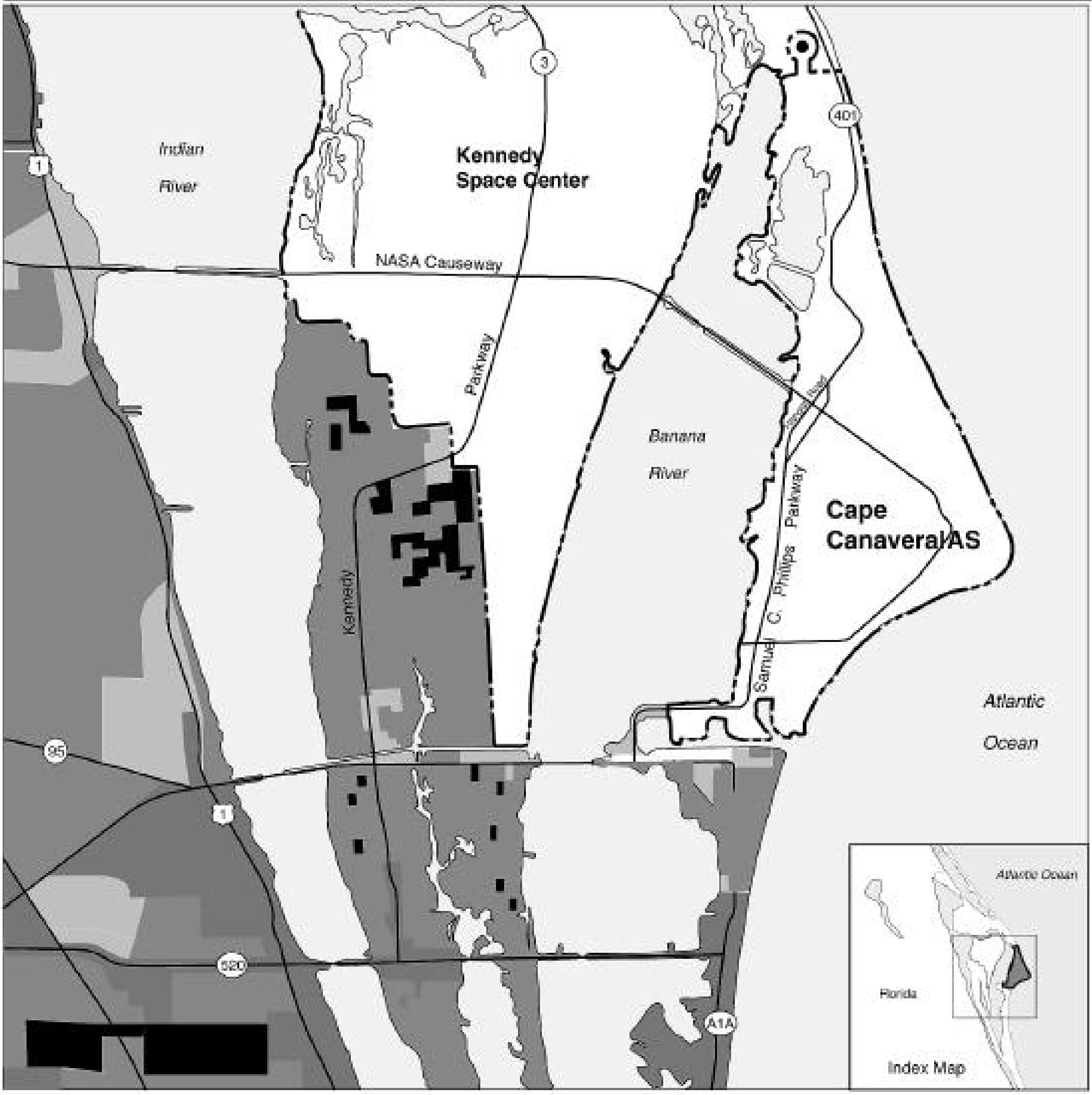
3.3.1.1 **Regional Land Use**. Brevard County and the city of Cape Canaveral are the local planning authorities for incorporated and unincorporated areas near Cape Canaveral AS. Land uses designated by Brevard County for Merritt Island (a barrier island located between the Indian River and the Atlantic Ocean) include residential, industrial, public facilities, agricultural, recreation, and conservation (Figure 3.3-1). The City of Cape Canaveral Comprehensive Plan (Briley, Wild and Associates, 1990) designates residential, commercial, industrial, public facilities and recreation, and open space land use areas, with continued commercial and industrial uses planned for Port Canaveral. Port Canaveral is also used by NASA, the Navy, and the Air Force to support launch and shipping activities. Neither the county nor the city of Cape Canaveral has land use authority over Cape Canaveral AS land because it is federally owned. Cape Canaveral AS designates its own land use and zoning regulations. The general plans of the county and City of Cape Canaveral designate compatible land uses around Cape Canaveral AS.

KSC, which is north and west of Cape Canaveral AS, includes predominantly industrial uses associated with NASA launch programs and open space associated with the Merritt Island National Wildlife Refuge. Uses of the river and ocean water areas surrounding Cape Canaveral AS include commercial fishing, marine recreation, and marine transportation.

3.3.1.2 **Cape Canaveral AS Land Use.** Cape Canaveral AS encompasses an area of 15,800 acres, representing approximately 2 percent of the total land area of Brevard County. Land uses at Cape Canaveral AS include launch operations, launch and range support, airfield, port operations, station support area, and open space (Figure 3.3-2).

The launch operations land use category is present along the Atlantic Ocean shoreline and includes the active (SLCs 17A and B, SLCs 36A and B, SLC-40, and SLC-41) and inactive (all other SLCs) launch sites and support facilities. The launch and range support area is west of the launch operations land use area and is divided into two sections by the airfield (Skid Strip). The airfield includes a single runway, taxiways, and apron, and is in the central part of the station. The port operations area is in the southern part of the station and includes facilities for commercial and industrial activities. The major industrial area is located in the center of the western portion of the station, near the Banana River, and is shown on Figure 3.3-2 under the station support area category. Although many of the activities are industrial in nature, this land use area includes administrative, recreational, and range support functions. Open space is dispersed throughout the station. The areas around SLC-37 and SLC-41 are within the launch operations land use area. There are no public beaches located on Cape Canaveral AS.

3.3.1.3 **Coastal Zone Management.** Federal activity in, or affecting, a coastal zone requires preparation of a Coastal Zone Consistency Determination, in accordance with the federal Coastal Zone Management Act (CZMA) of 1972, as amended (P.L. 92-583), and implemented by the National Oceanic and Atmospheric Administration (NOAA). This act was passed to preserve, protect, develop and, where possible, restore or enhance the nation’s natural coastal zone resources, which include wetlands,



EXPLANATION

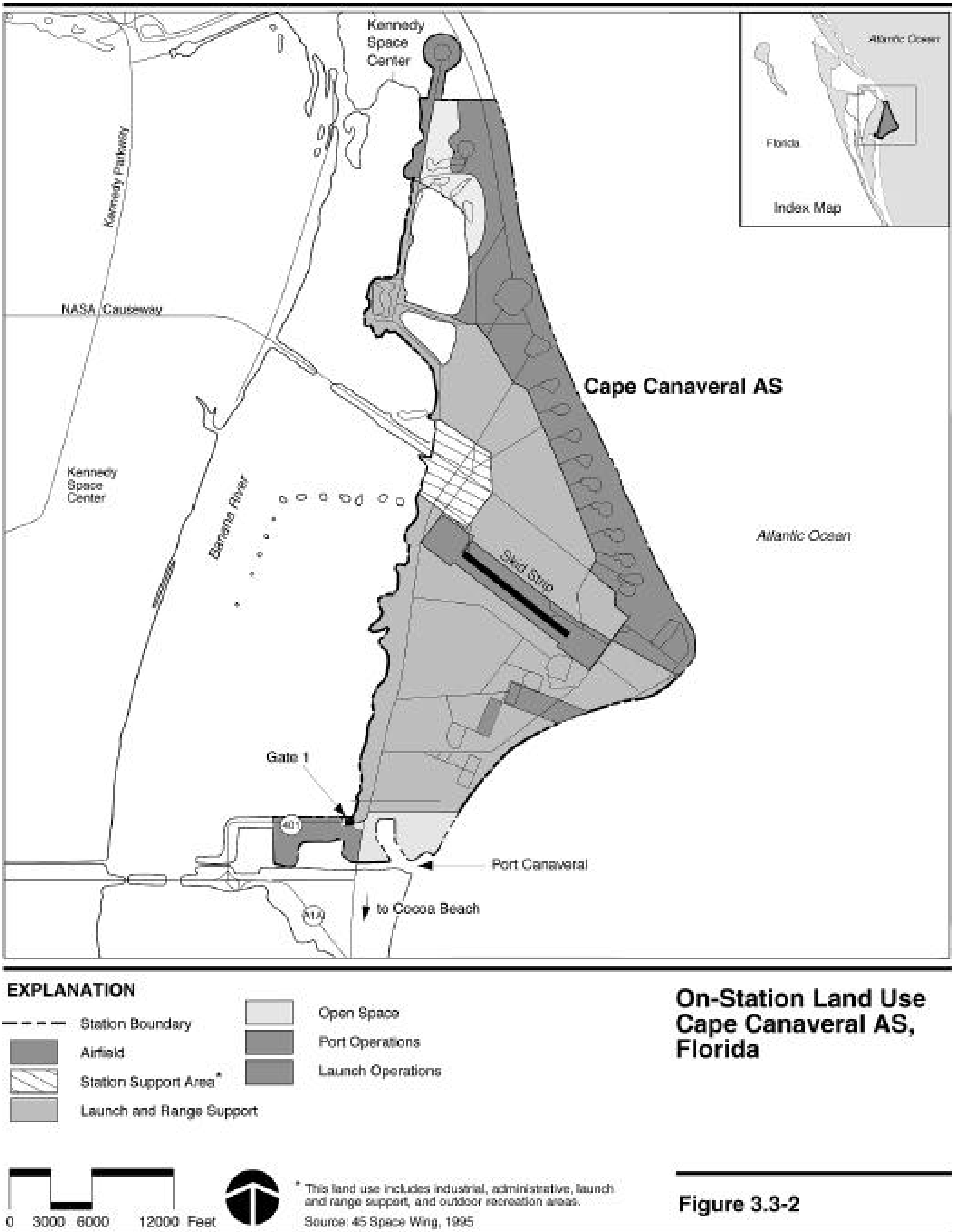
- Station/Government Property Boundary
- Industrial (includes port operations)
- Public Facilities/ Recreation
- Residential
- Mixed Use
- Conservation
- Agriculture

0 1 2 4 Miles

Off-Station Land Use, Cape Canaveral AS, Florida

Figure 3.3-1

EELV/107



On-Station Land Use Cape Canaveral AS, Florida

Figure 3.3-2

EELV070

floodplains, estuaries, beaches, dunes, barrier islands, coral reefs, and fish and wildlife and their habitat. The act also requires the management of coastal development to minimize the loss of life and property caused by improper development in a coastal zone. Responsibility for administering the Coastal Zone Management Program (CZMP) has been delegated to states that have developed state-specific guidelines and requirements. A federal agency must ensure that activities within the coastal zone are consistent with that state's coastal zone management program.

In Brevard County, the Florida Coastal Management Program, formed by the Florida Coastal Management Act (FCMA), applies to activities occurring in or affecting the coastal zone. The entire state of Florida is defined as being within the coastal zone. For planning purposes, a "no development" zone has been established. In Brevard County, the no development zone extends from the mean high water level inland 75 feet. Cape Canaveral AS has additional siting and facility design standards for construction near the coast, which require that facilities be set back at least 150 feet from the coast. The Florida Department of Community Affairs (FDCA) is the state's lead coastal management agency. The Air Force is responsible for making the final coastal zone consistency determinations for its activities within the state, and the FDCA will review the coastal zone consistency determination.

3.3.1.4 **Recreation.** Recreational activities near Cape Canaveral AS center mainly around the coastal beaches and large expanses of inland waters in the Indian and Banana rivers, the St. John's River, and large freshwater lakes. Boating, surfing, water skiing, and fishing are common activities. Brevard County provides several parks within the area surrounding the station. Jetty Park is situated immediately south of Port Canaveral on the beach and is the only park in the area that allows overnight camping. Public parks in the region are not affected by launch activities from Cape Canaveral AS. The beaches along Cape Canaveral AS are used for launch operations and are therefore restricted from public use. Recreational fishing is allowed at SLCs 34 and 16, and Camera Road A and B for KSC and Cape Canaveral AS personnel and their guests.

3.3.1.5 **Aesthetics.** The ROI for aesthetics at Cape Canaveral AS includes the general visual environment surrounding the station and areas of the station visible from off-station areas.

The visual environment in the vicinity of Cape Canaveral AS is characterized by the barrier island on which it is located. The Indian and Banana rivers separate the barrier island from the mainland. Topography of the island is generally flat, with elevations ranging from sea level to approximately 20 feet above sea level. The landscape is dominated by Florida coastal strand, coastal scrub, and coastal dune vegetation. The most visually significant aspect of the natural environment is the gentle coastline and flat island terrain. The area has a low visual sensitivity because the flatness of the area limits any prominent vistas.

Cape Canaveral AS is fairly undeveloped. The most significant man-made features are the launch complexes and various support facilities. These developed areas are surrounded by disturbed grasses, oak hammocks, and scrub vegetation. Most of Cape Canaveral AS outside of the developed areas is covered with native vegetation.

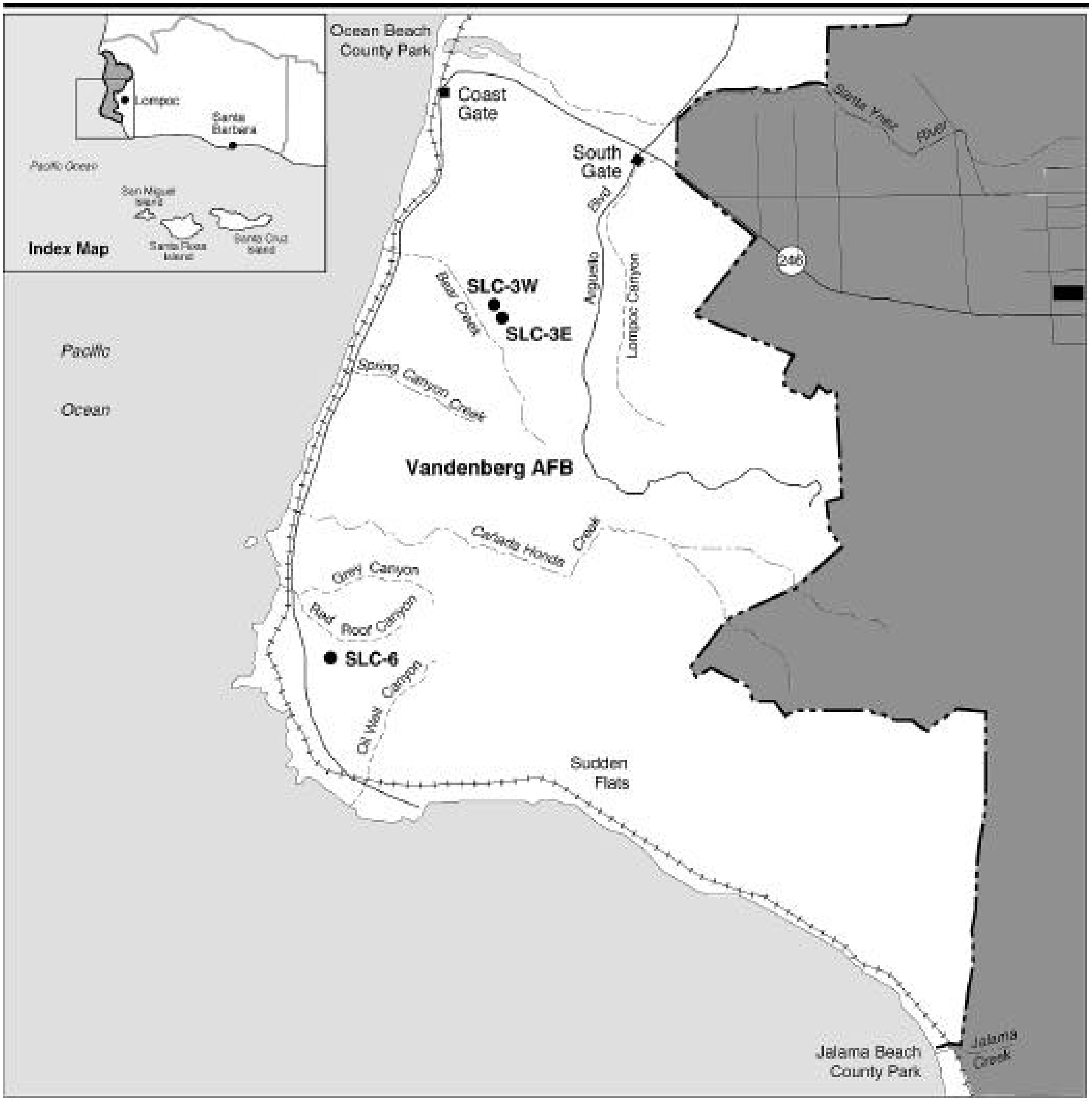
Since public access to the station is prohibited, viewpoints are primarily limited to marine traffic on the east and west and distant off-site beach areas and small communities to the south. The station is bordered by approximately 15 miles of the Atlantic coastline on the east and approximately 12 miles of shoreline on the west. However, marine traffic is limited and public observation of the coastline is infrequent. Marine traffic consists mainly of transportation and fishing vessels, pleasure boats, and cruise ships. From the south, launch complexes can be viewed from various beach areas and small communities including Port Canaveral and the cities of Cape Canaveral and Cocoa Beach. Additionally, from KSC (north and west of the station), views of the launch complexes are available to a limited population.

3.3.2 **Vandenberg AFB**

The ROI for land use at Vandenberg AFB encompasses the base boundaries and potentially affected adjacent lands including off-base lands within launch safety clear zones. Within this EIS, the ROI for land use consists generally of Northern Santa Barbara County, primarily the cities of Lompoc and Santa Maria.

3.3.2.1 **Regional Land Use.** Santa Barbara County and the cities of Lompoc and Santa Maria are the local planning authorities for both incorporated and unincorporated areas adjoining the base. Of these planning authorities, only the county adjoins areas of South Vandenberg AFB near the proposed launch complexes. Neither the county nor the cities of Lompoc and Santa Maria have land use authority over Vandenberg AFB land because it is federally owned. Vandenberg AFB designates its own land use and zoning regulations. The general plans of the county and cities of Lompoc and Santa Maria designate compatible land uses around Vandenberg AFB. Figure 3.3-3 shows land uses adjacent to South Vandenberg AFB.

Santa Barbara County land use plans designate much of the area adjoining the base as agricultural. This designation is applied to the productive agricultural soils of the Lompoc and Santa Maria valleys. Other nonurban land east of the base is designated for rural residential use. Two large ranches, the Bixby Ranch and the Hollister Ranch, are located more than



EXPLANATION

Industrial	Commercial
Residential	Industrial
Agriculture	Vandenberg AFB Boundary

0 .5 1 2 Miles

Off-Base Land Use, South Vandenberg AFB, California

Figure 3.3-3

EEL/108

10 miles southeast of SLC-6. Although some residential development has occurred, these ranches have been traditionally used for cattle grazing. The ranches are zoned AG-II-320, with a minimum parcel size of 320 acres with one primary residence per parcel allowed.

Urban land use dominates within the cities of Lompoc and Santa Maria, and the unincorporated communities of Vandenberg Village and Mission Hills. Outside of these areas, other land uses adjacent to the base are primarily agriculture and grazing, with some scattered oil production activities and other undeveloped uses (primarily recreation). To the west, offshore uses of the Pacific Ocean and beaches include primarily oil production, commercial fishing, and recreation. Three public beaches are near the base: Point Sal Beach State Park to the north, Ocean Beach County Park at the terminus of SR 246 near the north/south division of Vandenberg AFB, and Jalama Beach County Park, which is south of the base.

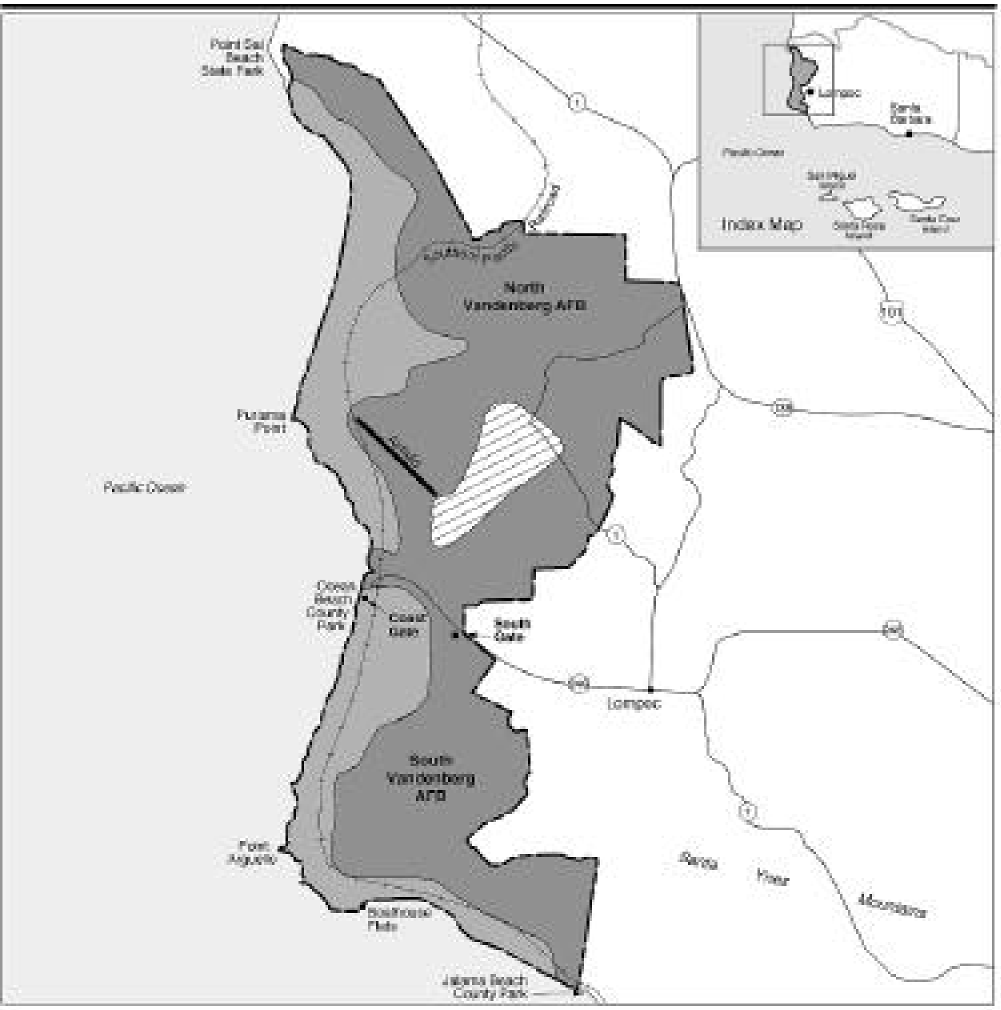
3.3.2.2 **Vandenberg AFB Land Use.** Vandenberg AFB encompasses approximately 98,400 acres, representing approximately 6 percent of the total land area of Santa Barbara County. According to the Base Comprehensive Plan (U.S. Air Force, 1989d), the base comprises the following land use areas: airfield operations and maintenance/space and missile launch, industrial, outdoor recreation, open space, and cantonment (Figure 3.3-4). The cantonment area includes residential, administrative, industrial, recreational, open space, airfield, and community land uses and is centrally located, north of SR 246.

The greatest use of land on Vandenberg AFB (approximately 90 percent) is for open space, followed by industrial (approximately 6 percent) and aircraft operations and maintenance/space and missile launch (approximately 2 percent).

Development has occurred mainly on North Vandenberg AFB, primarily within the cantonment area. The remaining north base development includes an airfield and test/launch facilities.

The majority of South Vandenberg AFB is undeveloped; the developed portion includes launch complexes, test/launch facilities, technical support areas, several mountaintop tracking stations, and a 150-acre administrative/ industrial area. Some of the undeveloped areas on South Vandenberg AFB are leased for grazing.

3.3.2.3 **Coastal Zone Management.** Federal activity in, or affecting, a coastal zone requires preparation of a Coastal Zone Consistency Determination, in accordance with the federal CZMA Management Act of 1972, as amended P.L. 92-583), and implemented by the NOAA (see Section 3.3.1.3).



EXPLANATION

- - - - Base Boundary

Base Support Area*

Launch Area

Technical Support Area

0 .75 1.5 3 Miles

* This land use area includes residential, administrative, industrial, recreation, airfield, and community services uses.

Source: U.S. Air Force, 1989

On-Base Land Use Vandenberg AFB, California

Figure 3.3-4

EELV071

The California Coastal Zone Management Program was formed through the California Coastal Zone Conservation Act of 1972. The Air Force is responsible for making final coastal zone consistency determinations for its activities within the state, and the California Coastal Commission reviews federally authorized projects for consistency with the California Coastal Zone Management Program.

Under the Coastal Plan for Santa Barbara County, the Santa Barbara County coastline is divided into seven subareas. The subarea along the western boundary of Vandenberg AFB is the North Coast Planning Area. On Vandenberg AFB, the coastal zone extends inland from approximately 3/4 mile at the northern boundary to 4-1/2 miles at the southern end of the base. It varies in width between the northern and southern boundaries, with the widest portion occurring at San Antonio Creek and south of Cañada Honda Creek to the southern boundary (Santa Barbara County, 1982).

3.3.2.4 **Recreation.** The recreational opportunities in the vicinity of Vandenberg AFB provide limited public access to the base's shoreline up to the mean high tide line. Ocean Beach and Jalama Beach county parks may be closed during launch activities on Vandenberg AFB.

Jalama Beach County Park is situated at the southern end of the base and is reached via Jalama Road from SR 1 (see Figure 3.3-4). Amenities are provided for day-use picnicking, and there are approximately 100 sites available for overnight camping. Approximately 122,400 people visited the park from June 1995 to June 1996, 60 percent of whom camped overnight. The park is closed to the public during low-azimuth Atlas, Delta, and Titan launches. The Santa Barbara County Parks Department, County Sheriff, and California Highway Patrol are notified of scheduled launch events. Park rangers post a notice indicating the time and date of park closure. On the day of a launch, the County Sheriff initiates procedures for beach closures, and park rangers begin to clear the area 2 to 3 hours prior to each launch. Following the launch or launch cancellation, the Air Force informs the park ranger and sheriff, and the park is reopened. Between 1990 and 1995, the park averaged one closure per year. The park is closed for approximately 3 to 4 hours per launch event. However, longer closures have occurred for a single launch event due to a launch abort or rescheduled launch resulting from unsuitable weather conditions or mechanical problems. For night launches, the park is usually closed by the park rangers at dusk to avoid potential traffic problems on Jalama Road, thus extending the closure period for these types of launches.

Ocean Beach County Park is located between North and South Vandenberg AFB and is reached via SR 246 (see Figure 3.3-4). The park provides amenities for day-use picnicking and sightseeing and was visited by approximately 63,000 people in 1993. Ocean Beach County Park is closed for Atlas, Delta, and Titan launches. Closure procedures for this park are similar to those used for Jalama Beach County Park. Between 1990 and 1995, the park was closed an average of three times per year.

The Boathouse Flats area on South Vandenberg AFB, the former location of the U.S. Coast Guard Rescue Station, provides Air Force personnel and their guests picnicking, diving, swimming, and fishing recreation opportunities. Approximately 1,800 persons use this area annually. Boathouse Flats lies on the coast south of SLC-6. This area would experience the same closures as Jalama Beach County Park.

3.3.2.5 **Aesthetics.** The ROI for aesthetics at Vandenberg AFB includes the general visual environment surrounding the base and areas of the base visible from off-base areas.

The visual environment in the vicinity of Vandenberg AFB is varied and characterized by rolling hills covered with chaparral and oak trees, valleys utilized for grazing or more intensive agriculture, and urbanized areas of the Lompoc Valley. Topography is largely dominated by the east-west-trending Santa Ynez Mountains that narrow toward the coast and terminate at Point Arguello. Views of the coastline are generally not available from inland locations due to access limitations and intervening topography.

South Vandenberg AFB is characterized by the somewhat rugged terrain of the western Santa Ynez Mountains, which rise to more than 2,000 feet at Tranquillon Peak. From this elevation, the mountains drop toward the coast, terminating at a narrow marine terrace at about 50 to 100 feet above the ocean. Slopes and terraces are covered with grasses and chaparral or coastal sage vegetation. With the exception of scattered launch facilities, South Vandenberg AFB is generally undeveloped. The most visually significant aspects of the natural environment are the rugged coastline and adjacent mountain slopes, and the most significant man-made features are the launch complexes.

Vandenberg AFB has a low visual sensitivity because views of South Vandenberg AFB from the east, and from the approximately 40 miles of coastline, are generally restricted by distance from public/private land, limited roadways, and the topography of the Santa Ynez Mountains that extend to Point Arguello at Cypress Ridge. Since public access to South Vandenberg AFB is generally not permitted, viewpoints are primarily limited to marine traffic, passengers on the Southern Pacific Railroad that traverses through the area parallel to the coastline, and views from Ocean Beach and Jalama Beach county parks.

The marine traffic consists primarily of fishing vessels and occasional pleasure boats. Visibility from the ocean is limited. Passenger railroad traffic provides the closest views of the area; about four passenger and eight freight trains pass through Vandenberg AFB daily. From the west, views for marine and railroad traffic include both SLC-3 and SLC-6. Views of the South Vandenberg AFB coastline north of Point Arguello are available from Ocean Beach County Park. Views from this location include SLC-3 and SLC-4; SLC-6 is not visible from the park.

From the south, views of the South Vandenberg AFB coastline are available from Jalama Beach County Park, which offers views north to Point Arguello. This area offers expansive views reflecting the predominantly undeveloped nature of the coastline. Existing launch facilities, such as SLC-3 and SLC-6, cannot be seen from this location due to the intervening topography of the Santa Ynez Mountains.

3.4 TRANSPORTATION

This section addresses roadways and railways. The ROI for the roadways analysis includes the key road networks that provide access to Cape Canaveral AS and Vandenberg AFB. The analysis will focus on the immediate areas and local roadways surrounding the two installations. The rail networks in the vicinities of the two installations are described.

Roadways. The evaluation of the existing roadway conditions focuses on capacity, which reflects the ability of the network to serve the traffic demand and volume, usually expressed in number of vehicles per hour. The capacity of a roadway depends on the street width, number of lanes, intersection control, and other physical factors. Depending on the project and data available, traffic volumes are typically reported as the number of vehicular movements averaged over a daily period (ADT) or an annual period (AADT). Peak-hour volume (PHV) is defined as the highest volume of traffic in a 24-hour period that is recorded on a segment of roadway or intersection during a 1-hour period. The ADT and PHV values are useful indicators in determining the extent to which the roadway segment is used, and in assessing the potential for congestion or other traffic problems.

The performance of a roadway segment is generally expressed in terms of level of service (LOS). The LOS scale ranges from A to F, with each level defined by a range of volume-to-capacity (V/C) ratios. LOS A, B, and C are considered good operating conditions under which minor to tolerable delays are experienced by motorists. LOS D represents below-average conditions. LOS E reflects a roadway at maximum capacity, and LOS F represents traffic congestion. Table 3.4-1 presents the LOS designations and their associated V/C ratios used in this analysis.

Existing roads and highways within the ROI are described at two levels: (1) regional roads, representing key regional access, and (2) local roads, representing roads connecting the project site to regional roads within the ROI. The local road network selected for analysis was determined based on the residential distribution of current employees. Traffic data and physical

Table 3.4-1. Road Transportation Levels of Service

LOS	Description	Criteria (V/C) Multi-Lane Arterial	Criteria (V/C) 2-Lane Highway
A	Free flow with users unaffected by presence of other roadway users	0-0.3	0-0.15
B	Stable flow, but presence of the users in traffic stream becomes noticeable	0.31-0.5	0.16-0.27
C	Stable flow, but operation of single users becomes affected by interactions with others in traffic stream	0.51-0.7	0.28-0.43
D	High density, but stable flow; speed and freedom of movement are severely restricted; poor level of comfort and convenience	0.71-0.84	0.44-0.64
E	Unstable flow; operating conditions at capacity with reduced speeds, maneuvering difficulty, and extremely poor levels of comfort and convenience	0.85-1.00	0.65-1.00
F	Forced breakdown flow with traffic demand exceeding capacity; unstable stop-and-go traffic	>1.00	>1.00

LOS = level of service
V/C = volume to capacity

Source: Compiled from Transportation Research Board, 1994.

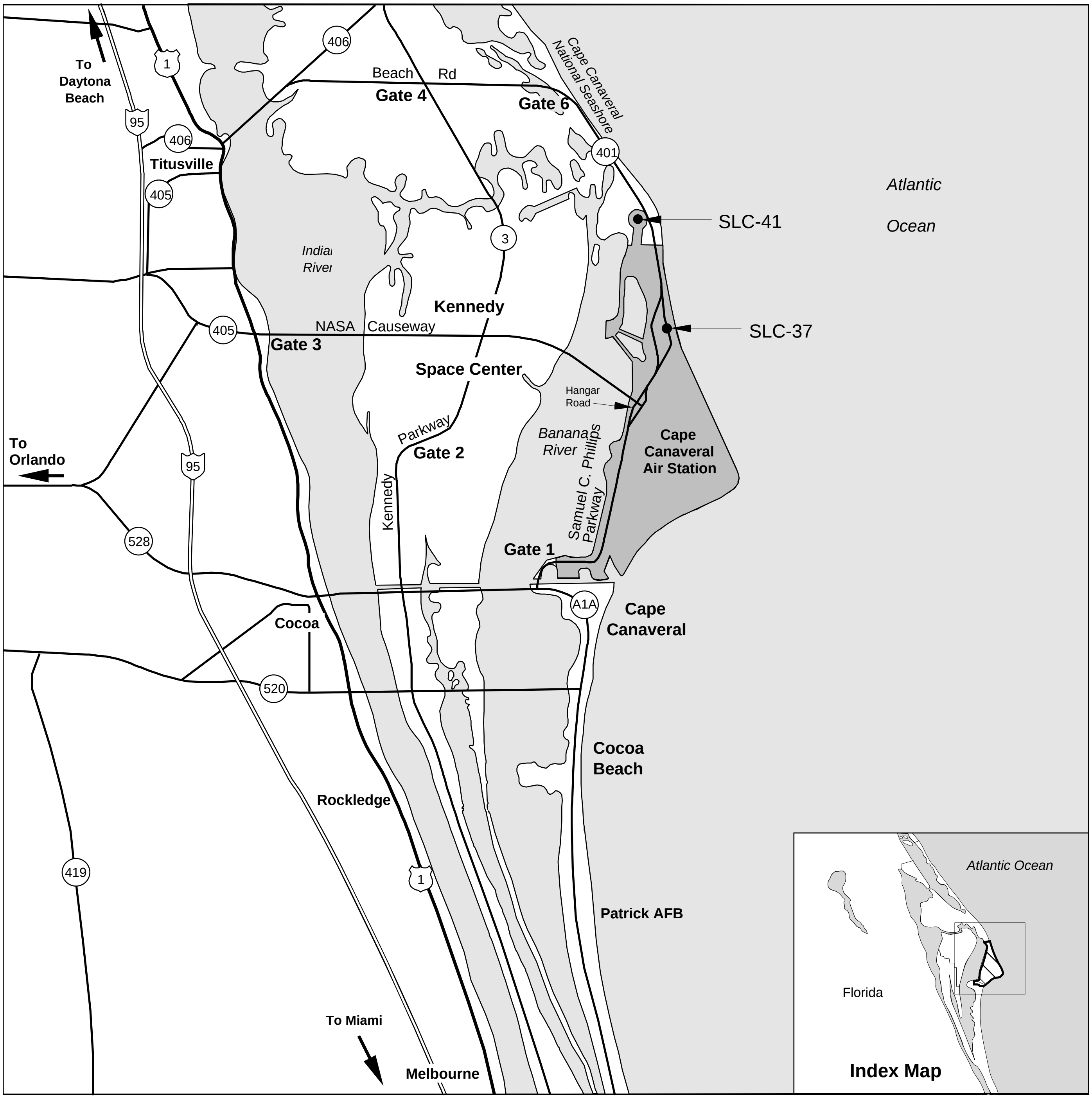
roadway characteristics were obtained primarily from data provided by the state and local highway departments.

The capacity of each roadway segment surrounding Cape Canaveral AS and Vandenberg AFB was determined using existing roadway geometric characteristics.

3.4.1 Cape Canaveral AS

3.4.1.1 **Regional.** The Cape Canaveral AS area can be accessed from Daytona Beach and other locations via U.S. Highway (U.S.) 1 or Interstate 95 (Figure 3.4-1). Orlando lies approximately 50 miles to the west on SR 528, and Miami is approximately 187 miles to the south on U.S. 1 or Interstate 95.

Local. The majority of the employees and other related support services providers for Cape Canaveral AS reside within the unincorporated areas of Brevard County and in the cities of Cape Canaveral, Cocoa, Cocoa Beach, and Rockledge, which are all within 14 miles of the station. The key local roads providing access to Cape Canaveral AS from KSC and the local communities include SR A1A, SR 520, SR 528, SR 401, SR 3, and SR 405.



EXPLANATION

101 U.S. Highway

95 Interstate Highways

154 State Route

Cape Canaveral AS

Regional and Local Road Systems, Cape Canaveral AS, Florida

0 1.25 2.5 5 Miles

Figure 3.4-1

EELV/090

The NASA Causeway and Beach Road connect KSC and Cape Canaveral AS (see Figure 3.4-1).

Southern access into Cape Canaveral AS through Gate 1 is provided by SR 401, SR A1A, SR 520, and SR 528. SR 401 is a 5-lane road that narrows to a 4-lane divided road as it approaches Gate 1 where it becomes Samuel C. Phillips Parkway. SR A1A is a north-south, 4-lane divided highway to the south of Cape Canaveral AS that is used as a transportation corridor connecting SR 401 with the cities of Cape Canaveral and Cocoa Beach, and Patrick AFB. SR 520 is a 4-lane, east-west urban roadway that connects the cities of Cocoa and Rockledge to Merritt Island. By 2010, the road is expected to be resurfaced to a 6-lane roadway. As it continues east, SR 520 connects with SR A1A. SR 528 is a 4-lane, limited-access toll road that approaches the southern portion of Cape Canaveral AS from the west, connecting the mainland to Merritt Island and the barrier islands. The road is used extensively by KSC personnel. SR 528 and SR A1A merge into SR 401 just south of Cape Canaveral AS.

Western access onto Cape Canaveral AS is provided by SR 3 and SR 405. SR 3 is a north-south highway that bisects KSC. It becomes Kennedy Parkway on KSC and provides access to Gate 2. SR 405 is a 4-lane road providing access to Cape Canaveral AS from the west. It turns into the NASA Causeway after entering KSC at Gate 3.

From the north, Cape Canaveral AS can be accessed through Gate 4 and Gate 6 at KSC. SR 3 provides access to Gate 4 from the north, and Beach Road provides access to Gate 4 and Gate 6 from the west. Beach Road becomes SR 401 as it approaches Cape Canaveral AS and subsequently turns into Samuel C. Phillips Parkway. PHVs and existing LOS for key roads on Cape Canaveral AS are presented in Table 3.4-2.

Table 3.4-2. Peak-Hour Traffic Volumes and LOS on Key Roads - Cape Canaveral AS

Roadway	Segment/No. of Lanes	Capacity VPH	1996 PHV	LOS
SR A1A	South from Samuel C. Phillips Parkway; 4-lane	8,000	3,950	C
SR A1A	East from Samuel C. Phillips Parkway; 4-lane	8,000	3,750	B
NASA Causeway	Between U.S. 1 and Samuel C. Phillips Parkway; 4-lane	8,000	1,750	A
Samuel C. Phillips Pkwy/Hangar Road	Between Gate 1 and SR 401 (Gate 6); 4-lane	8,000	1,900	A

LOS = level of service
NASA = National Aeronautics and Space Administration
PHV = peak-hour volume
SR = State Route
U.S. = U.S. Highway
VPH = vehicles per hour

On-Site. The major on-site roadway on Cape Canaveral AS is Samuel C. Phillips Parkway, a 4-lane divided highway that accommodates most of the north-south traffic. At its intersection with Skid Strip Road, Samuel C. Phillips

Parkway becomes a one-way northbound arterial, with Hangar Road serving as the southbound arterial. Samuel C. Phillips Parkway provides access to the launch site locations (SLC-41 and SLC-37). To the north and south of Cape Canaveral AS, Samuel C. Phillips Parkway becomes SR 401.

3.4.1.2 **Railways.** The ROI for railways includes the Florida East Coast Railway, which provides rail service to Brevard County through the cities of Titusville, Cocoa, and Melbourne. An additional railway in the ITL area on Cape Canaveral AS is accessible by the Florida East Coast Railway through KSC and Titusville.

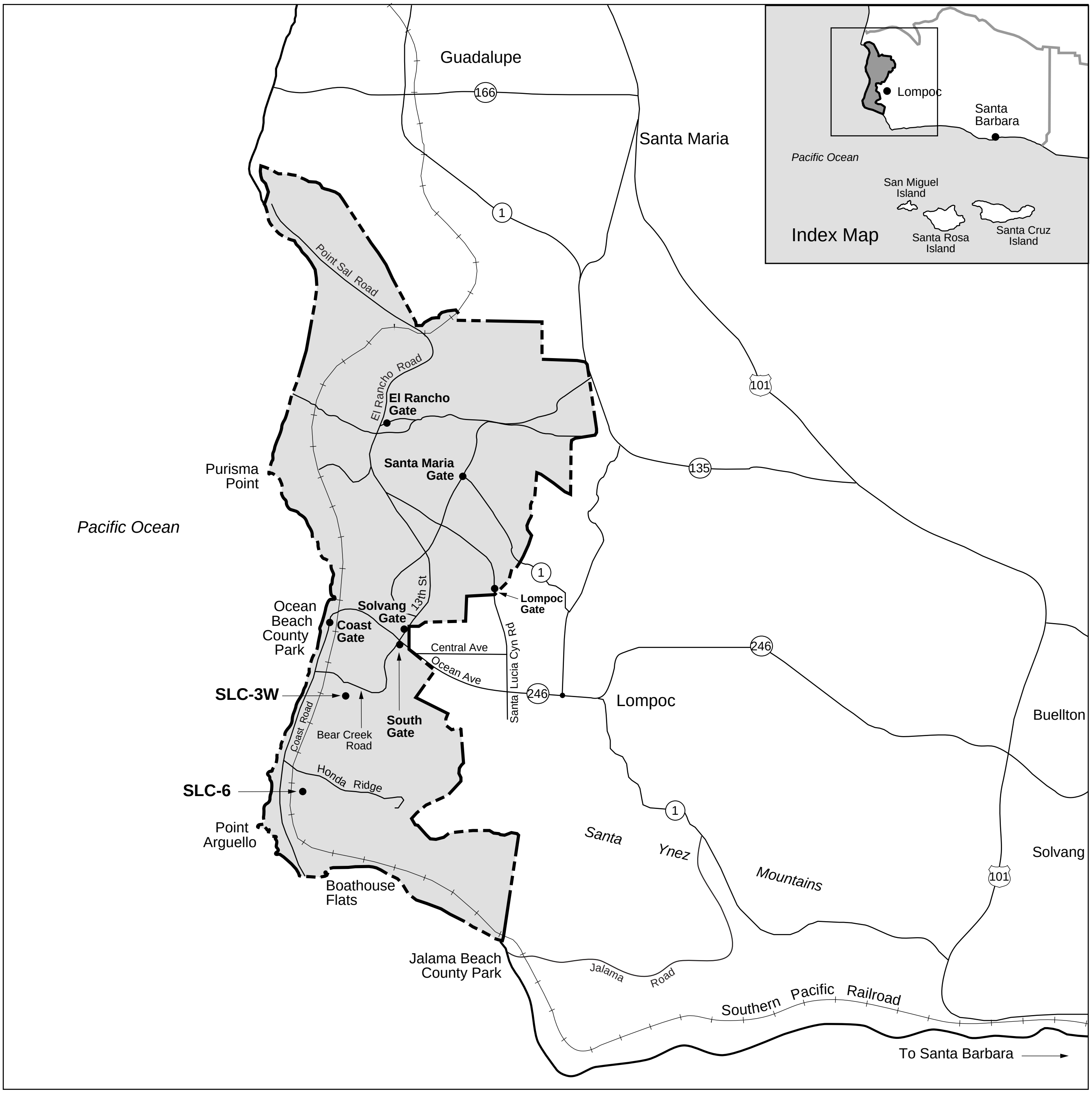
3.4.2 Vandenberg AFB

3.4.2.1 **Regional.** Vandenberg AFB is accessible by U.S. 101, which connects the base with San Francisco on the north and Santa Barbara on the south. SR 1, SR 135, and SR 246 provide access to the base from U.S. 101.

Local. The majority of the workers and other related support services providers for Vandenberg AFB reside within the unincorporated areas of Santa Barbara County and in the cities of Lompoc, Santa Maria, Guadalupe, Buellton, Solvang, and Santa Barbara. The key local roads providing access to Vandenberg AFB include SR 1, SR 135, Santa Lucia Canyon Road, SR 246, U.S. 101, and Central Avenue (Figure 3.4-2).

Vandenberg AFB is accessible through the northeast at the Santa Maria Gate by SR 1, a 4-lane rural expressway extending primarily along the coastal region of California. SR 1 connects with SR 135 south of the city of Santa Maria.

SR 246, Central Avenue, and Santa Lucia Canyon Road provide eastern access to Vandenberg AFB. SR 246 leads to two base gates, the South Vandenberg AFB Gate and Solvang Gate. SR 246 is a 2-lane rural highway connecting Lompoc to U.S. 101, a divided, 4-lane, major arterial. SR 246 becomes Ocean Avenue within the city of Lompoc and is one of the main transportation routes connecting Lompoc with Vandenberg AFB. Ocean Avenue is a major east-west, 4-lane divided road running through southern Lompoc. Central Avenue connects SR 1 with Ocean Avenue, and subsequently, SR 246. Central Avenue is a 2-lane undivided street running east-west through the northern part of Lompoc. The other western gate is Lompoc Gate, north of the city of Lompoc, and accessible through Santa Lucia Canyon Road, a 2-lane undivided highway. Santa Lucia Canyon Road runs north-south, connecting Ocean Avenue with Lompoc Gate. PHVs and existing LOS for key roads on Vandenberg AFB are presented in Table 3.4-3.



EXPLANATION

Base Boundary

101 U.S. Highway

135 State Route

Regional and Local Road Systems, Vandenberg AFB, California

0 1 2 4 Miles

Figure 3.4-2

EELV/089

Table 3.4-3. Peak-Hour Traffic Volumes and LOS on Key Roads - Vandenberg AFB

Roadway	Segment/No. of Lanes	Capacity VPH	1996 PHV	LOS
Coast Road	Between SLC-6 and Bear Creek Road; 2-lane	2,800	350	A
Bear Creek Road	Between Coast Road and Ocean Avenue; 2-lane	2,800	350	A
13th Street	Between Ocean Avenue and Santa Maria Gate; 2-lane	2,800	1,550	D
Ocean Avenue	Between Bear Creek Road and SR 1; 4-lane	8,000	250	A
SR 1	Between Santa Maria Gate and SR 135; 4-lane	8,000	1,550	B

LOS = level of service
PHV = peak-hour volume
SR = State Route
VPH = vehicles per hour

Source: Santa Barbara County Planning Department Traffic Count, 1996

On-Site. The major roads on Vandenberg AFB that provide access to the project sites are Coast Road, Bear Creek Road, 13th Street, and Ocean Avenue. Coast Road is a 2-lane undivided roadway providing access to SLC-6. Coast Road connects to Bear Creek Road, north of SLC-6. Bear Creek Road is a 2-lane arterial that provides access to the launch site location SLC-3W. Bear Creek Road is accessible through 13th Street from the north or Ocean Avenue from the east. The Solvang Gate, Santa Maria Gate, and El Rancho Gate are connected to 13th Street, a 2-lane arterial that runs north-south on the base. Ocean Avenue is an east-west road that bisects Vandenberg AFB and connects with Bear Creek and Coast roads. The Solvang and South Vandenberg AFB gates are located just north and south, respectively, of Ocean Avenue.

3.4.2.2 **Railways.** The ROI for railways includes the Southern Pacific, Santa Maria Valley, and the Ventura County Railroad companies, which provide services to the cities of Santa Maria, Lompoc, Santa Barbara, San Luis Obispo, and Ventura. Three branch lines connect Vandenberg AFB to the Southern Pacific Railroad main line. Approximately four passenger and eight freight trains pass through Vandenberg AFB daily. The railroad tracks pass between the Pacific Ocean and the launch facilities and must be overflown during launches; however, trains are never overflown during launches due to the potential risk to people and property. An electronic surveillance system, posted railroad schedules, and close coordination, including radio communication, between train engineers and Vandenberg AFB launch personnel, are used to minimize the possibility of an overflight.

3.5 UTILITIES

The utility systems addressed in this EIS include the facilities and infrastructure used for potable water supply, wastewater collection and treatment, solid waste disposal, and electricity.

The ROI for utilities consists of all or portions of the service areas of each utility provider that serves the project site, other installation facilities, and incorporated and unincorporated areas of the applicable county. The major attributes of utility systems in the ROI are processing, distribution, and storage capacities, and related factors, such as average daily consumption and daily peak demand. These factors are used in determining whether the existing utility systems are capable and adequate to provide services to the project sites in the future.

ROI utility use was determined from records of purveyors, historic consumption patterns, and system-wide average annual growth rates.

3.5.1 Cape Canaveral AS

Potable water, wastewater, solid waste, and electrical systems for Cape Canaveral AS and the surrounding area are discussed in this section.

3.5.1.1 **Water.** The ROI for water supply and distribution consists of Patrick AFB, Cape Canaveral AS, KSC, the cities of Cocoa, Cocoa Beach, Rockledge, Cape Canaveral, unincorporated areas of Merritt Island, and unincorporated areas north, west, and south of the city of Cocoa. The water delivered to the ROI comes from the Florida aquifer and is delivered by the city of Cocoa's water distribution system, with a capacity of 37 million gallons per day (MGD). In 1995, the water consumption in the ROI averaged 25 MGD. Cape Canaveral AS used an average of 0.75 MGD including deluge water in 1995 and has a system capacity of 3 MGD.

Water is supplied to the launch complexes through the domestic water distribution system. Eight ground-level tanks with a total capacity of 5,200,000 gallons are used to store deluge water, which is supplied to the launch pads. Because these tanks are used infrequently, the stored water can become stagnant and chlorine levels can dissipate below acceptable human consumption levels. This condition also occurs in the large-volume pipes for the deluge system because average daily water use is small compared to the quantity in large-volume pipes. To prevent this stagnant water from contaminating drinking water, Cape Canaveral AS plans to install a separate piping system. In 1995, there were 16 launches from Cape Canaveral AS, resulting in use of approximately 3,200,000 gallons of deluge water.

3.5.1.2 **Wastewater.** Cape Canaveral AS treats both domestic and industrial wastewater on site. The wastewater treatment plant has a permitted capacity of 0.8 MGD and a peak daily flow of approximately 0.3 MGD. Cape

Canaveral AS has an industrial wastewater permit to discharge deluge water to grade or to pump to the WWTP for treatment. Maximum total flow of wastewater from domestic use allows a residual wastewater capability of approximately 500,000 gpd for treatment of contaminated deluge water, if required.

3.5.1.3 **Solid Waste.** The ROI for solid waste management consists of the cities located within central Brevard County. General solid refuse at Cape Canaveral AS is collected by a private contractor and disposed of off-site at the Brevard County Landfill, a 192-acre Class I landfill located near the city of Cocoa. In 1995, the landfill received between 2,200 and 2,400 tons of waste per day, of which 8.5 tons per day came from Cape Canaveral AS. The Brevard County Landfill has a 10- to 12-year life expectancy. Cape Canaveral AS also operates an on-site landfill that accepts construction and demolition debris and asbestos-containing material. The landfill has a capacity of 182 acres but currently uses only 55 acres. Of the remaining 127 acres, there are 7 acres of permitted capacity for construction and demolition debris disposal. In 1995, Cape Canaveral AS disposed of approximately 2,085 tons of construction and demolition debris, 25,546 tons of concrete, and 748 tons of asbestos-containing material.

3.5.1.4 **Electricity.** In 1995, approximately 220,000 megawatt-hours per day (MWH/day) were delivered to Brevard County, of which 864 MWH/day were consumed by Cape Canaveral AS. Transmission lines enter the station at three locations: the southwestern boundary; across the NASA Causeway; and from Merritt Island. The capacity of the three substations is 55 megawatts (MW); the substations are capable of providing 1,320 MWH/day. There are also 170 substations on Cape Canaveral AS that convert the voltage to user voltages.

3.5.2 **Vandenberg AFB**

Potable water, wastewater, solid waste, and electrical systems for Vandenberg AFB and the surrounding area are discussed in this section.

3.5.2.1 **Water.** The ROI for water supply and distribution consists of the Lompoc and Santa Maria valleys. Water supplies in these areas are provided by wells located in the Santa Ynez, San Antonio Creek Valley, and Santa Maria watersheds. In 1997, Vandenberg AFB was connected to the State Water Project for supplemental water supply. A maximum of 5,000 acre-feet per year may be obtained through the base’s entitlement rights. The total potable water consumption in the ROI was approximately 33.9 MGD in 1995.

Water on Vandenberg AFB is supplied from the San Antonio Aquifer and the Lompoc Terrace Groundwater Basin. The main portion of the water supply delivered to North Vandenberg AFB comes from the western portion of the San Antonio aquifer. The total potable water supplied from this aquifer in 1995 was approximately 3.22 MGD. South Vandenberg AFB obtains water from the Lompoc Terrace Groundwater Basin. The water supplied from this aquifer in 1995 was approximately 0.20 MGD. In 1995, the combined potable water use for Vandenberg AFB was approximately 3.42 MGD.

3.5.2.2 **Wastewater.** The Lompoc Regional WWTP services the city of Lompoc, Vandenberg AFB, and portions of the surrounding areas. In 1996, Vandenberg AFB contributed approximately 1.29 MGD of wastewater to the Lompoc Regional WWTP. The capacity of the Lompoc Regional WWTP is 5 MGD.

3.5.2.3 **Solid Waste.** Solid waste disposal facilities within Santa Barbara County include: the Vandenberg AFB on-base landfill, four off-base landfills, three transfer stations, and a proposed Materials Recovery Facility. These off-base facilities consist of the Lompoc Landfill, Santa Maria Landfill, Foxen Canyon Landfill, Tajiguas Landfill, Santa Barbara County Transfer Station, New Cuyama Transfer Station, Ventucopa Transfer Station, and Los Padres Resource Recovery Facility. Of these, the Lompoc and Tajiguas landfills can be used for disposal of solid waste originating from Vandenberg AFB. The Vandenberg, Lompoc, and Tajiguas landfills are described in the following paragraphs.

Vandenberg AFB Landfill. The Vandenberg AFB Sanitary Landfill, a 187.31-acre Class III waste management facility, is operated and managed by 30 CES/CEOX, Horizontal Construction. The base landfill contains four areas of disposal (active landfill, nonfriable asbestos disposal area, animal cemetery, and wood yard), and currently accepts residential, commercial, and industrial garbage, rubbish, and inert wastes. Based on calendar year 1997 projected disposal rates, it has a life expectancy through 2034. It is permitted to accept up to 400 tons per day, with an anticipated average of 82 tons per day of Class III municipal waste.

Lompoc Landfill. The Lompoc Landfill, approximately 13 miles from the Vandenberg AFB Main Gate, is operated and managed by the city of Lompoc. Based on projected disposal rates, the landfill has a life expectancy through 2050. It is permitted to accept up to 500 tons per day, with an anticipated average of 127 tons per day of waste. The landfill accepts imported solid waste in addition to the regular incoming waste.

Tajiguas Landfill. The Tajiguas Landfill, approximately 44 miles from the Vandenberg AFB Main Gate, is operated and managed by Santa Barbara County. The life expectancy of this landfill can be assessed once permit expansion information is received. It is permitted to accept up to 1,500 tons per day. This landfill accepts imported solid waste in addition to the regular incoming waste.

3.5.2.4 **Electricity.** Electricity is provided by Pacific Gas and Electric Company's Morro Bay plant to Vandenberg AFB's main substation, then distributed through the base distribution system. The base also maintains diesel-powered generators to support technical facilities. In 1995, approximately 452 MWH/day were consumed by Vandenberg AFB.

3.6 HAZARDOUS MATERIALS AND HAZARDOUS WASTE MANAGEMENT

The relevant aspects of hazardous materials/waste management include the applicable regulations and procedures for hazardous materials usage and hazardous waste generation, and management programs for existing hazardous waste-contaminated sites within the ROIs.

3.6.1 Regulatory Framework

3.6.1.1 **Hazardous Materials Management.** Hazardous materials are those substances defined as hazardous by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (42 U.S.C. Sections 9601-9675), the Toxic Substances Control Act (TSCA) (15 U.S.C. Sections 2601-2671), and the Hazardous Materials Transportation Act (HMTA) (49 U.S.C. Section 1801, Parts 172-173). In general, this includes substances that, because of their quantity, concentration, or physical, chemical, or infectious characteristics, may present substantial danger to public health or welfare, or to the environment, when released. Air Force Instruction (AFI) 32-7086, *Hazardous Materials Management*, establishes procedures and standards that govern management of hazardous materials on Air Force installations.

3.6.1.2 **Hazardous Waste Management.** Management of hazardous waste must comply with the Resource Conservation and Recovery Act (RCRA), as amended by the Hazardous and Solid Waste Amendments of 1984 (HSWA) (42 U.S.C. Sections 6901-6992), which is administered by the U.S. EPA, unless otherwise exempted through CERCLA actions. Title C Part 261 identifies which solid wastes are classified as hazardous waste. RCRA requires that hazardous wastes be treated, stored, and disposed of to minimize the present and future threat to human health and the environment. Air Force guidance in AFI 32-7042, *Solid and Hazardous Waste Compliance*, provides a framework for complying with environmental standards applicable to hazardous waste.

3.6.1.3 **Pollution Prevention.** The federal Pollution Prevention Act (PPA) of 1990 established pollution prevention as a national objective. It is DoD acquisition policy to eliminate and reduce the use of hazardous materials during a system's acquisition (DoD 5000.2-R, Mandatory Procedures for Major Defense Acquisition Programs [MDAPs] and Major Automated Information System [MAIS] Acquisition Programs, Sections 4.3.7.4 and 4.3.7.5). Air Force Policy Directive (AFPD) 32-70, Environmental Quality, outlines the Air Force policy for pollution prevention and references AFI 32-7080, *Pollution Prevention Program*, which defines the Air Force's Pollution Prevention Program requirements. AFI 32-7080 instructs all Air Force installations to implement a hierarchy of actions into daily operations to reduce the use of hazardous materials and the release of pollutants into the environment. The hierarchy of actions to prevent pollution is as follows: source reduction, waste reuse, waste recycling and, as a final option, waste disposal.

3.6.1.4 **Installation Restoration Program.** The IRP is an Air Force program that identifies, characterizes, and remediates past environmental contamination on Air Force installations. The program has established a process to evaluate past disposal sites, control the migration of contaminants, and control potential hazards to human health and the environment. In response to CERCLA and Section 211 of Superfund Amendments and Reauthorization Act (SARA) requirements, DoD established the Defense Environmental Restoration Program (DERP) to facilitate clean up of past hazardous waste disposal and spill sites nationwide. Section 105 of SARA mandates that response actions follow the National Oil and Hazardous Substances Pollution Contingency Plan, as promulgated by the U.S. EPA. AFI 32-7020, *The Environmental Restoration Program*, implements the DERP as outlined in DoD Manual 5000.52-M, Environmental Restoration Program Manual.

The following subsections discuss specific programs for management of hazardous materials, hazardous waste, pollution prevention, and IRP sites at Cape Canaveral AS and Vandenberg AFB. The ROI for hazardous materials and hazardous waste management at both installations encompasses all geographic areas that are exposed to the possibility of a release of hazardous materials or hazardous wastes.

3.6.2 Cape Canaveral AS

The ROI for Cape Canaveral AS includes the areas around SLC-41 and SLC-37 and areas adjacent to proposed EELV facility locations.

3.6.2.1 **Hazardous Materials Management.** Numerous types of hazardous materials are used to support the various missions and general maintenance operations at Cape Canaveral AS. These materials range from common building paints to industrial solvents and hazardous fuels. Hazardous materials used to support current launch vehicle system activities (Atlas IIA, Delta II, Titan IVB) are presented in Tables 3.6-1, 3.6-2, and 3.6-3.

Table 3.6-1. Hazardous Materials Utilized Per Launch, Atlas IIA

Hazardous Material	Quantity (lbs)
POL	4,160
VOC-Based Primers, Topcoats, and Coatings	480
Non-VOC-Based Primers, Topcoats, and Coatings	2,800
VOC-Based Solvents and Cleaners	1,130
Non-VOC-Based Solvents and Cleaners	600
Corrosives	5,500
Refrigerants	0
Adhesives, Sealants, and Epoxies	2,540

Extremely Hazardous Substances (not otherwise included)	0
Other	460
Total	17,670

Note: Propellant quantities are listed in Table 2.2-2.
lbs = pounds
POL = petroleum, oil, and lubricants
VOC = volatile organic compound

Source: Lockheed Martin, 1997

Table 3.6-2. Hazardous Materials Utilized Per Launch, Delta II

Hazardous Material	Quantity (lbs)
POL	40
VOC-Based Primers, Topcoats, and Coatings	290
Non-VOC-Based Primers, Topcoats, and Coatings	230
VOC-Based Solvents and Cleaners	270
Non-VOC-Based Solvents and Cleaners	530
Corrosives	5,500
Refrigerants	0
Adhesives, Sealants, and Epoxies	340
Extremely Hazardous Substances (not otherwise included)	0
Other	10
Total	7,210

Note: Propellant quantities are listed in Table 2.2-2.
lbs = pounds
POL = petroleum, oil, and lubricants
VOC = volatile organic compound

Source: Boeing Company Response to Data Needs, 1997

A separate hazardous materials pharmacy distribution system (HazMart) has not yet been established or enforced at Cape Canaveral AS. Individual contractors at Cape Canaveral AS may obtain hazardous materials through their own organizations, local purchases, or other outside channels, although contractors are encouraged to obtain hazardous materials through the Patrick AFB pharmacy whenever possible. Cape Canaveral AS is scheduled to implement a pharmacy system in 1998.

Table 3.6-3. Hazardous Materials Utilized Per Launch, Titan IVB

Hazardous Material	Quantity (lbs)
POL	830
VOC-Based Primers, Topcoats, and Coatings	220
Non-VOC-Based Primers, Topcoats, and Coatings	40
VOC-Based Solvents and Cleaners	6,900
Non-VOC-Based Solvents and Cleaners	25,200
Corrosives	5,500
Refrigerants	60
Adhesives, Sealants, and Epoxies	290
Extremely Hazardous Substances (not otherwise included)	0
Other	160
Total	39,200

Note: Propellant quantities are listed in Table 2.2-2.
lbs = pounds
POL = petroleum, oil, and lubricants
VOC = volatile organic compound

Source: Lockheed Martin Environmental Analysis Report, 1997

Management of hazardous materials, excluding hazardous fuels, is the responsibility of each individual or organization. The primary source for hazardous materials purchase and acquisition is through the Patrick AFB supply system. Patrick AFB implemented a HazMart for procurement, storage, and distribution of hazardous materials. The purpose of the HazMart is to improve hazardous materials tracking and minimize hazardous waste generation by minimizing the use of hazardous materials. Under the HazMart concept, all hazardous materials are screened prior to being procured to determine if less toxic alternative materials could be utilized during an industrial process. Under this system, only specific individuals within an organization can order and sign for hazardous materials.

Hazardous propellants are controlled by the Joint Propellants Contractor (JPC) for the 45 SW. The JPC handles the purchase, transport, and temporary storage of hypergolic propellants and oxidizers.

Spills of hazardous materials are covered under 45 SW Operations Plan (OPlan) 32-3, Hazardous Materials Response Plan, which ensures that adequate and appropriate guidance, policies, and protocols regarding hazardous material incidents and associated emergency response are available to all installation personnel (45 Space Wing, 1996d).

3.6.2.2 **Hazardous Waste Management.** Hazardous waste management, including explosive ordnance disposal (EOD) at Cape Canaveral AS is regulated under the RCRA (Title 40 CFR 260-280) and the Florida Administrative Code (FAC) 62-730. These regulations are implemented through 45 SW OPlan 19-14, Petroleum Products and Hazardous Waste Management Plan, which addresses the proper identification, management, and disposition of hazardous waste on Cape Canaveral AS, and compliance with applicable federal, state, and Air Force requirements (45 Space Wing, 1996d).

All DoD-generated hazardous waste is labeled with the U.S. EPA identification number for Cape Canaveral AS, under which it is transported, treated, and disposed of. All individuals or organizations generating hazardous waste at Cape Canaveral AS are responsible for administering all applicable regulations and plans regarding hazardous waste. Generators must also comply with applicable regulations regarding the temporary accumulation of waste at the process site.

Cape Canaveral AS reported 513,507 pounds of DoD-generated hazardous waste in 1996. Typical hazardous wastes include various solvents, paints and primers, sealants, photo-developing solutions, adhesives, alcohol, oils, fuels, and various process chemicals. Hazardous wastes associated with current launch vehicle system activities are presented in Tables 3.6-4, 3.6-5, and 3.6-6. They are grouped by general description and the EPA-designated hazardous waste number.

Table 3.6-4. Hazardous Waste Generated Per Launch, Atlas IIA

RCRA Hazardous Waste	Quantity (lbs)
Ignitable (D001) RCRA Wastes	3,270
Halogenated Solvents (F001/F002) RCRA Wastes	0
Non-Halogenated Solvents (F003/F004/F005) RCRA Wastes	0
Toxic (D004) EPA Wastes	40
Commercial Chemical Products (U) RCRA Wastes	380
Corrosive (D002) RCRA Wastes	5,500
Acutely Hazardous (P) RCRA Wastes	0
Reactive (D003) RCRA Wastes	0
State-Regulated Wastes	0
Miscellaneous Wastes	50
Total	9,240

EPA = Environmental Protection Agency
lbs = pounds
RCRA = Resource Conservation and Recovery Act

Source: Lockheed Martin Response to Data Needs, 1997

Individual contractors and organizations maintain hazardous waste satellite accumulation points (SAPs) and 90-day hazardous waste accumulation areas in accordance with 45 SW OPlan 19-14. Cape Canaveral AS operates 40 SAPs. A maximum of 55 gallons per waste stream of hazardous waste can be accumulated at an SAP. There are currently 14 90-day accumulation areas on the station. There is no limit to the volume of waste that can be stored, but wastes must be taken to the permitted storage facility or disposed of off site within 90 days.

Table 3.6-5. Hazardous Waste Generated Per Launch, Delta II

RCRA Hazardous Waste	Quantity (lbs)
Ignitable (D001) RCRA Wastes	2,380
Halogenated Solvents (F001/F002) RCRA Wastes	0
Non-Halogenated Solvents (F003/F004/F005) RCRA Wastes	440
Toxic (D004) EPA Wastes	850
Commercial Chemical Products (U) RCRA Wastes	220
Corrosive (D002) RCRA Wastes	5,500
Acutely Hazardous (P) RCRA Wastes	0
Reactive (D003) RCRA Wastes[(a)]	10
State-Regulated Wastes	5,240
Miscellaneous (Remediation) Wastes	2,170
Total	16,810

Note: (a) Vandenberg AFB only.
EPA = Environmental Protection Agency
lbs = pounds
RCRA = Resource Conservation and Recovery Act

Source: U.S. Air Force, 1994b

Table 3.6-6. Hazardous Waste Generated Per Launch, Titan IVB

RCRA Hazardous Waste	Quantity (lbs)
Ignitable (D001) RCRA Wastes	5,990
Halogenated Solvents (F001/F002) RCRA Wastes	430
Non-Halogenated Solvents (F003) RCRA Wastes	70
Toxic (D004) EPA Wastes	2,200
Commercial Chemical Products (U) RCRA Wastes	0
Corrosive (D002) RCRA Wastes	5,500
Acutely Hazardous (P) RCRA Wastes	0
Reactive (D003) RCRA Wastes	20,000
State-Regulated Wastes	2,000
Miscellaneous Wastes	0
Total	36,190

EPA = Environmental Protection Agency
lbs = pounds
RCRA = Resource Conservation and Recovery Act

Source: U.S. Air Force, 1988e

The permitted storage facility (RCRA Part B Permit, Number HO01-255040) is operated within Buildings 44200/44205. The facility is permitted to store hazardous wastes for up to 1 year under the current Florida Department of Environmental Protection (FDEP) permit and is operated by the Launch Base Support (LBS) contractor. The waste storage site facility is not permitted to store waste hydrazine, MMH, or N_2O_4.

The JPC is responsible for the collection and transportation of hazardous waste (including propellant waste) from accumulation sites to a 90-day hazardous waste accumulation area, to the permitted hazardous waste storage facility, or to a licensed, permitted disposal facility off station. The Defense Reutilization and Marketing Office (DRMO) is responsible for managing and marketing excess and recoverable products and waste materials in accordance with applicable regulations. Hazardous items that cannot be managed by the DRMO are disposed of as hazardous wastes.

Waste deluge water that has been used for fire and sound suppression is discharged into percolation ponds adjacent to the launch pads or pumped to the WWTP for treatment (see Section 3.5.1.2). Groundwater monitoring wells are sampled quarterly in accordance with permit requirements.

3.6.2.3 **Pollution Prevention.** The 1996 45 SW Pollution Prevention Program Guide (PPPG) and Pollution Prevention Management Action Plan (PPMP) satisfy requirements of the Pollution Prevention Act of 1990. The PPPG also complies with requirements in DoD Directive 4210.15, AFI 32-7080, and the Air Force Installation PPPG. The PPPG establishes the overall strategy, delineates responsibilities, and sets forth specific objectives for reducing pollution of the ground, air, surface water, and groundwater. The purpose of the PPPG is to provide sufficient guidance for pollution prevention management on Patrick AFB and Cape Canaveral AS. Specific goals include implementation of management practices that eliminate or reduce the use of hazardous materials, increase efficiency in the use of raw materials, protect natural resources, and encourage source reduction through recycling, treatment, and disposal practices.

3.6.2.4 **Installation Restoration Program.** The IRP efforts at Cape Canaveral AS have been conducted parallel with the program at Patrick AFB and in close coordination with the U.S. EPA, the FDEP, and NASA. Cape Canaveral AS is not a National Priorities List (NPL) site. The IRP sites are remediated under RCRA regulations in lieu of CERCLA.

Contamination has been confirmed at 63 IRP sites. Of the 63 IRP sites, 28 are proposed for closure and are awaiting regulatory concurrence, have regulatory concurrence for closure (No Further Response Action Planned [NFRAP]), or require monitoring only, and 35 remain under investigation. Of the 35 remaining sites, 5 are being managed under the FDEP Petroleum Program and 30 are being managed under the RCRA Corrective Action Process. Cape Canaveral AS also has identified 46 areas of concern (AOCs). Of the 46 AOCs identified, 13 are currently proposed for NFRAP and 24 have been closed with regulatory approval.

The following discussion focuses on EELV activities at Cape Canaveral AS that have the potential to affect the ongoing investigations of IRP and AOC sites.

Concept A ROI

SLC-41. IRP Site DP-24 (Solid Waste Management Unit [SWMU] C047) is present at SLC-41. Hydrazine, diesel fuel, halogenated solvents, paints, thinners, trace metals, and waste oils may have been disposed of at the site. A RCRA Facility Investigation (RFI) has been conducted at this site.

In October 1996, an estimated 150,000 tons of polychlorinated biphenyl (PCB)-contaminated soil were identified at SLC-41. Approximately 25 percent of the contaminated soil was identified as containing PCB concentrations exceeding the regulated level of 50 ppm PCBs. The state of Florida regulates cleanup for industrial sites with contamination levels greater than 3 ppm.

Other EELV Facilities. IRP Site DP-60 (SWMU C095) is associated with Building 70500. Groundwater contamination may be present from past operations that required the use of solvents, oils, acids, and metals. Remedial investigation is in progress.

Concept B ROI

SLC-37. IRP Site C-L37 (SWMU 56) is present at SLC-37. This site consists of several areas where hydrazine, diesel fuel, RP-1, hydrocarbons, PCBs, solvents, and waste oils may have been disposed of. The site is currently undergoing an RFI under the IRP to determine if contamination is present in the soil and groundwater at the site. NASA is currently investigating this site in accordance with an MOA with the 45 SW. PCBs have been identified in the surface soil at the site. The AFSPC and NASA have determined what areas each agency will be responsible for; the PCB-contaminated soil will be remediated by the end of 1998.

3.6.3 **Vandenberg AFB**

The ROI for Vandenberg AFB includes the areas around SLC-3W and SLC-6, and areas adjacent to proposed EELV facility locations.

3.6.3.1 **Hazardous Materials Management.** Numerous types of hazardous materials are used to support the various missions and general maintenance operations at Vandenberg AFB. Hazardous materials utilized during current launch vehicle system activities are presented in Tables 3.6-1, 3.6-2, and 3.6-3. Vandenberg AFB requires all contractors using hazardous materials to submit a hazardous materials contingency plan prior to working on base.

In 1994, Vandenberg AFB implemented a HazMart (see Section 3.6.2.1). Distribution of hazardous materials is coordinated from a single issue point (Building 8317). Any unused materials are returned to the HazMart for reissue to another organization. Presently, all Air Force organizations participate in the HazMart, but contractor involvement is limited. Management of hazardous materials obtained directly from off-base suppliers by contractors is the responsibility of the individual contractor. The HazMart may be available to all base contractors.
Hazardous propellants for the 30 SW are controlled by United Paradyne, which handles the purchase, transport, temporary storage, and loading of hypergolic fuels and oxidizers. They are stored at the Hypergolic Storage Facility (Buildings 974 and 975) on South Vandenberg AFB.

Spills of hazardous materials are covered under the Hazardous Materials Emergency Response Plan, 30 SW Plan 32-4002, which ensures that adequate and appropriate guidance, policies, and protocols regarding hazardous material incidents and associated emergency response are available to all installation personnel.

3.6.3.2 **Hazardous Waste Management.** Hazardous wastes at Vandenberg AFB are regulated by RCRA (Title 40 CFR 260-280) and the California Environmental Protection Agency, Department of Toxic Substances Control, under the California Health and Safety Code, Title 22 Division 20, Chapter 6.5, Sections 25100 through 25159, and the California Administrative Code, Sections 25100 through 67188. These regulations require that hazardous waste be handled, stored, transported, disposed of, or recycled according to defined procedures.

The Vandenberg AFB Draft Hazardous Waste Management Plan (HWMP), 30 SW Plan 32-7043-A, implements the above regulations and outlines the procedures for disposing of hazardous waste. Implementing the procedures outlined in this plan ensures the proper identification, management, and disposition of hazardous waste on Vandenberg AFB, and compliance with applicable federal, state, and Air Force requirements.

All hazardous waste generated is labeled with the U.S. EPA identification number for Vandenberg AFB, under which it is transported, treated, and disposed of. All individuals or organizations at Vandenberg AFB are responsible for administering all applicable regulations and plans regarding hazardous waste, and for complying with applicable regulations regarding the temporary accumulation of waste at the process site.

Vandenberg AFB generated 2,008,174 pounds of hazardous waste in 1996. Typical hazardous wastes include various solvents, paints and primers, sealants, photo-developing solutions, adhesives, alcohol, oils, fuels, and various process chemicals. Hazardous wastes associated with current launch vehicle system activities are presented in Tables 3.6-4, 3.6-5, and 3.6-6. Hazardous waste is stored at its point of origin until the waste container is full, or until 60 days following the day the container first received waste (whichever is first). The waste is then transported to the permitted consolidated Collection Accumulation Point (CAP) for temporary storage for no longer than 30 days. Waste hypergolic fuel is stored at a separate consolidated Hypergolic Storage Facility CAP managed by United Paradyne. Consolidation of CAP functions helps to ensure that all legal requirements are met before transporting hazardous waste to the permitted storage facility.
Hazardous waste can be stored at the permitted storage facility (Building 3300) for up to 1 year from the date of accumulation. The permitted storage facility, operated by the DRMO, was issued a final RCRA Part B permit in 1996. DRMO serves as the agent to receive and store specified hazardous wastes and make arrangements for removal to off-base treatment, storage, or disposal facilities (TSDFs) in compliance with “cradle to grave” RCRA management requirements. Wastes not listed in the Part B permit must be shipped to an off-base TSDF prior to the 90-day storage limit.

Waste deluge water that has been used for fire and sound suppression is collected and tested by the Vandenberg AFB Aerospace Fuels Lab. If the water is not found to be hazardous, it is sent to the base IWTP. Hazardous wastewater is characterized in accordance with California Title 22, Section 66261 requirements and sent to the CAP.

The base has been working with the regulators to implement a Water Quality Initiative. The system would implement a closed-loop recycling process at the major launch complexes (see Section 3.5.2.2.)

3.6.3.3 **Pollution Prevention.** The 1996 Vandenberg AFB PPMP, 30 SW Plan 32-7080, satisfies requirements of the Pollution Prevention Act of 1990 (U.S. Air Force, 1996b). The PPMP also complies with requirements in DoD Directive 4210.15, AFI 32-7080, and the Air Force Installation PPPG. The PPMP establishes the overall strategy, delineates responsibilities, and sets forth specific objectives for reducing pollution of the ground, air, surface water, and groundwater. All installation organizations must abide by the policies and programs set forth in the PPMP. The purpose of the PPMP is to provide sufficient guidance for pollution prevention management on Vandenberg AFB. Specific goals include implementation of management practices that eliminate or reduce the use of hazardous materials, increase efficiency in the use of raw materials, protect natural resources, and encourage source reduction through recycling, treatment, and disposal practices.

3.6.3.4 **Installation Restoration Program.** Vandenberg AFB is not listed on the NPL. IRP sites at Vandenberg AFB are being addressed in a manner generally consistent with the CERCLA process.

As of the end of 1996, 36 IRP sites were in the remedial investigation/ feasibility study (RI/FS) stage including those undergoing Interim Remedial Actions (IRAs). In addition, 40 sites are in the Remedial Action (RA) phase. Sixty sites have been recommended for NFRAP, with state concurrence.

Additionally, 166 AOCs at Vandenberg AFB were identified in the Supplemental Preliminary Assessment Report (U.S. Air Force Space Command, 1995c). Of the 166 AOCs, 2 were identified as areas of special handling. The AOCs are currently in the site investigation (SI) phase to determine whether contamination is present. Additional assessment efforts will be undertaken by Vandenberg AFB to ascertain the potential environmental concerns associated with these areas. The AOCs will be further investigated and remediated, if required.

The following discussion focuses on proposed EELV activities at Vandenberg AFB that have the potential to affect IRP and AOC sites.

Concept A ROI

SLC-3W. IRP Site 6 (SLC-3W) is at the northwestern end of Alden Road at SLC-3W. Hazardous substances that may have been released include RP-1, UDMH, component flushing solvents (trichloroethylene [TCE], methylene chloride, and isopropyl alcohol), diesel fuel, waste oil, trace metals in deluge water, and paint residue in sandblast grit. In 1990, initial soil sampling was conducted at the site, and follow-up sampling was conducted in 1992. Based on the sampling results, IRP Site 6 was recommended for NFRAP, as all residual contaminants were found to be below levels that would pose an unacceptable risk to human health and the environment. A Preliminary Endangerment Assessment (PEA) report prepared for IRP Site 6 recommended that a NFRAP decision document be prepared and submitted for regulatory approval (Jacobs Engineering Group, Inc., 1995). The appropriate state agencies have concurred with the NFRAP finding. Any future environmental response actions will be conducted under the environmental compliance programs.

IRP Site 7 (Bear Creek Pond) is located west of Old Surf Road, just south of Bear Creek Pond. The pond area is the farthest downgradient portion of Bear Creek prior to Coast Road. At SLC-3E and SLC-3W, deluge water was released to Bear Creek Canyon. Contaminants of concern include hydrazine, solvents, lubricating oil, metals, and TCE. A Phase II RI Work Plan was completed for the site in 1996 to fill gaps identified in the Phase I data. Phase II RI field sampling and analyses have been conducted.

Two AOCs associated with the SLC-3 area were identified during the preliminary assessment/site investigation. AOC-66 is located at Building 765, a missile/space research facility with a substation and a transformer with detectable levels of PCBs. AOC-91, a 55-gallon waste oil drum, was associated with Building 780, the Water Pump House. The drum has been removed under a compliance removal action.

Other EELV Facilities. Building 7525, the Rocket Processing Building, is associated with AOC-143. In the past, a mixture of TCE and water was disposed of to grade. Currently, the building includes a paint spray booth, a hydraulic pumping station, and facilities for the use of solvents, photo-processing chemicals, and Freon.

Concept B ROI

SLC-6. There are no IRP sites located at SLC-6. However, AOC-89 is associated with Buildings 390A, 390M, 390T, and 391 within the SLC-6 area. Building 390 is actually composed of several structures labeled 390A-390T. Building 390A was constructed as an MST for the Manned Orbital program in 1969. Both past and present hydraulic leaks have been noted at this facility. Building 390M, a blast deflector made of concrete, is located west of Building 390A. Both photochemical waste and industrial wastewater releases have occurred within this facility. Building 390T was constructed in 1968 as a contaminated fuel holding area. Although no spills have been documented at this facility, it fits the definition of a potential SWMU under RCRA. Currently, this AOC is being investigated further to determine whether remediation is required.

Other EELV Facilities. Building 836, the NASA Building, is associated with IRP Site 19. Waste oils and solvents generated from operations at Building 836 were reportedly disposed of in a drainage ditch south of the building. A PEA report will be prepared for IRP Site 19. A TCE plume is present beneath the northeastern side of the building. Remediation of the plume should be completed by 2000.

3.7 HEALTH AND SAFETY

3.7.1 Risk Management Framework

3.7.1.1 **Introduction.** The risk management framework for health and safety issues consists of those regional and local elements that have been established to minimize or eliminate potential risk to the general public and on-site personnel as a result of operations. The ROI for health and safety includes the areas surrounding Cape Canaveral AS and Vandenberg AFB that could be affected by launch operations or a credible accident, and areas associated with the transportation of hazardous materials. Both Cape Canaveral AS and Vandenberg AFB have extensive experience in the operations associated with launch vehicles.

3.7.1.2 **Range Safety.** Range safety regulations at both Cape Canaveral AS and Vandenberg AFB are contained in EWR 127-1, Range Safety Requirements (U.S. Air Force, 1995a). The objective of the range safety program is to ensure that the general public, launch area personnel, foreign land masses, and launch area resources are provided an acceptable level of safety, and that all aspects of prelaunch and launch operations adhere to public laws. Range Safety reviews, approves, and through operation safety, monitors and imposes safety holds, when necessary, on all prelaunch and launch operations conducted on the ranges. This is to ensure that hazards associated with propellant, ordnance, and other hazards do not expose the general public to risks greater than those considered acceptable by public law or state documents.

EWR 127-1 is divided into seven chapters that address all aspects of range safety. Range safety is the responsibility of all 45 and 30 SW organizations, tenants, contractors, subcontractors, range users, and visitors to the ranges. Active range safety involvement in a program from the earliest concept phases through launch enhances the chances for a safe program. To implement this, the Air Force has developed the "Concept to Launch" process, which identifies key safety milestones to ensure that all aspects of safety are addressed. This process for new launch programs includes an introduction to range safety, tailoring of EWR 127-1 for specific program requirements, noncompliance resolution, flight analysis review, launch vehicle elements and ground support equipment design review, airborne range safety system review, facility design review, operation test review, final range safety approval for launch operations, safety critical launch operations, and final range safety clear to launch. These safety reviews are applicable to the launch vehicle, payload, support equipment, and facilities. The safety review procedure provides a means of substantiating compliance with program safety requirements and encompasses all systems analyses and testing as required by the DoD. Major safety documents must be prepared to meet the requirements of EWR 127-1. Among these documents are the following:

3.7.1.3 **Explosive Quantity-Distance Site Plan.** This site plan must be generated or updated for facilities used to store, handle, or process ordnance items or propellants. AFM 91-201, Explosive Safety Standards, and DOD-STD-6055.9, Ammunition and Explosives Safety Standards, are the governing documents for explosive siting. DoD Explosive Safety Board approval of this plan is required prior to construction of new facilities, and prior to the arrival of ordnance and propellants.

3.7.1.4 **Hazardous Materials Transportation Safety.** Hazardous materials such as propellant, ordnance, chemicals, and booster/payload components are transported to both ranges in accordance with DOT regulations for interstate shipment of hazardous substances (Title 49 CFR 100-199). Hazardous materials such as liquid rocket propellant are transported in specially designed containers to reduce the potential of a mishap should an accident occur. For some hazardous materials, each state may have its own required transportation routes, time of shipments, and permits. To date, no major accidents involving the shipment of hazardous materials associated with launch vehicles have occurred.

3.7.1.5 **Exposure Criteria.** Headquarters AFSPC Surgeon's Office (HQ AFSPC/SG) has either endorsed or recommended exposure criteria for some of the current solid and liquid rocket propellants and their combustion by-products. Health hazards may be created from propellant spills or from the passage of launch plumes/launch abort clouds. The chemicals chosen for these criteria are those estimated to present the most significant health concerns to the public and launch facility workers. The recommended and endorsed exposure criteria are factored into the exposure prediction and risk management models and the launch commit decisions used by the Range Safety functions at Cape Canaveral AS and Vandenberg AFB.

3.7.1.5.1 **Exposure Criteria for HCl, NO_2, HNO_3.** Hydrochloric acid (HCl), nitrogen dioxide (NO_2), nitric acid (HNO_3), and hydrazines may be present during both normal launches and launch aborts. The HCl is the byproduct of combustion of solid fuel and is the primary health hazard during normal launches with solid rocket motors (e.g., Titan IVB). During an abort, the primary health hazards are from NO_2, HNO_3, and hydrazines, if hydrazines are used as liquid propellants. The HCl may also be present during an abort from burning pieces of solid propellant. Both NO_2 and HNO_3 are formed from N_2O_4 in fireball-type chemical reactions during a launch abort. The N_2O_4 is carried in the upper stages of a launch vehicle and produces NO_2 and HNO_3 only during an explosion caused by an abort.

The HQ AFSPC/SG recommended exposure criteria for HCl, NO_2, and HNO_3 between December 1994 and November 1995. The recommendations for these three chemicals are currently under review by the National Academy of Science, National Research Council, Committee on Toxicology (NAS/NRC/COT). When the NAS/NRC/COT completes its review, the Headquarters Air Force Surgeon General (HQ AF/SG) will consider the NAS/NRC/COT recommendations for adoption as Air Force standards.

The HQ AFSPC/SG endorses the exposure criteria for hydrazines made in March 1993 by the Chief Scientist and Senior Toxicologist at the Air Force Armstrong Laboratory, Occupational and Environmental Health Directorate (AL/OE). Refinements to the exposure criteria for the hydrazines are currently under review and study by HQ AFSPC/SG.

Table 3.7-1 presents Tier 1, Tier 2, and Tier 3 HQ AFSPC/SG recommended exposure criteria for HCl, NO_2, and HNO_3, and also presents the exposure criteria for various hydrazines endorsed by HQ AFSPC/SG. Range Safety functions factor these exposure criteria into their specific risk management processes to arrive at launch commit decisions that protect installation personnel and the public.

3.7.1.5.2 **RP-1 and Liquid Oxygen (LO_x) Fuels.** RP-1 is hydrotreated kerosene, composed predominantly of saturated and olefin aromatics (over 96 percent), with the balance consisting of small amounts of 1-, 2-, and 3-ring aromatics. It is similar in composition to straight-run kerosene (CAS #8008-20-6), refined petroleum solvents (CAS #8032-32-4), and common jet propulsion (JP) fuels.

Table 3.7-1. HQ AFSPC/SG-Recommended and -Endorsed Exposure Criteria for Constituents in Rocket Motor Exhaust

	Tier 1[a]	Tier 2[b]	Tier 3[c]
HCl[f]	2 ppm (60 min)[d] 10 ppm[e]	10 ppm[e]	50 ppm[e]
N_2H_4 [g]	NR	2 ppm (60 min)[d]	40 ppm[e]
UDMH[g]	NR	5 ppm[e]	25 ppm[e]
A-50[g]	NR	5 ppm[e]	25 ppm[e]
MMH[g]	NR	0.52 ppm (60 min)[d]	25 ppm[e]
NO_2[f]	0.2 ppm (60 min)[d] 2 ppm[e]	2 ppm (60 min)[d] 4 ppm[e]	20 ppm (30 min)[d]
HNO_3[f]	0.3 ppm[e]	2.5 ppm (60 min)[d] 4 ppm[e]	25 ppm (30 min)[d]

Notes: (a) Tier 1 -- This exposure level and above is defined as the discomfort or mild effect level. There is little risk to the average person. This exposure poses no hazard to normal and healthy individuals. Sensitive individuals (i.e., asthmatics and bronchitics) may experience some adverse effects, which are reversible. Tier 1 represents exposure guidelines for sensitive members of the general public (off-base) who may involuntarily and unknowingly be exposed. Recommended action if this tier is exceeded is similar to a Stage 3 air pollution alert: Notify the public of the release through an advertised announcement particular to an event or a published annual notice that sensitive populations should be advised that there is a possibility of exposure to the effluent and advise of mitigating precautions.

(b) Tier 2 -- This exposure level and above is defined as the disability or serious effect level. All effects are reversible. There are no serious impacts on personnel's ability to complete the mission identified. There is some risk to an average individual. Military and employees voluntarily accept exposure up to Tier 2 concentrations. The consent implies knowledge of the exposure concentrations and the consequences of possible exposure. Tier 2 represents personnel who have knowledge of the event and understand the possibility and consequences of possible exposure (on-base personnel). Personnel are advised to seek immediate protection (shelter in place) or evacuate for concentrations exceeding the Tier 2 limit.

(c) Tier 3 -- This exposure level and above is defined as a life-threatening effect level. Irreversible harm may occur with possible impact on a person's ability to complete the mission. Personnel in an area (event personnel) where Tier 3 exposure may occur have given informed consent and are trained regarding the possible life-threatening situations. Exposures up to Tier 3 concentrations permit an individual to seek shelter or don respiratory protection. Concentrations predicted in excess of Tier 3 concentrations require immediate evacuation to prevent exposure.

(d) Time-weighted average (TWA) exposure concentration. The time period indicated is the time over which the concentration measurements will be measured and averaged.

(e) Ceiling limit. A peak concentration that must not be exceeded during the exposure period.

(f) Exposure criteria recommended by HQ AFSPC/SG

(g) Exposure criteria recommended by AL/OE and endorsed by HQ AFSPC/SG

A-50	=	Aerozine-50 (50 percent by weight unsymmetrical dimethylhydrazine and anhydrous hydrazine)
HCl	=	hydrochloric acid
HNO_3	=	nitric acid
HQ AFSPC/SG	=	Headquarters Air Force Space Command/Surgeon General
min	=	minutes
MMH	=	monomethyl hydrazine
NR	=	no recommendation
N_2H_4	=	anhydrous hydrazine
NO_2	=	nitrogen dioxide
ppm	=	parts per million
UDMH	=	unsymmetrical dimethylhydrazine

Currently, there are no regulatory health exposure limits or public exposure criteria for vapors of hydrotreated kerosene. However, both the National Institute for Occupational Safety and Health (NIOSH) and the NAS/NRC/COT have recommended exposure limits for individuals occupationally exposed to vapors of similar substances. NIOSH has established a 10-hour time-weighted average (TWA) Recommended Exposure Limit (REL) of 100 mg/m^3 for straight-run kerosene. For refined petroleum solvents (VM&P naphtha), NIOSH established a 10-hour TWA REL of 350 mg/m^3 and a 15-minute short-term exposure limit (STEL) of 1,800 mg/m^3. At the request of the Department of the Navy, the COT conducted an independent toxicological data review on jet propulsion fuels (JP-4, JP-5, and JP-8) to develop occupational exposure criteria for use in strategic sealift of already-fueled vehicles (Committee on Toxicology, National Research Council, 1996). The COT concurred with the Navy's selection of 350 mg/m^3 as a full-day TWA and recommended an interim STEL of 1000 mg/m^3 until further research could be conducted.

Based on available research data, it is reasonable to assume that an appropriate full-day occupational exposure limit for hydrotreated kerosene could range from 100 mg/m^3 to 350 mg/m^3, with a 15-minute STEL of 1000 mg/m^3. However, recommendations for public exposure limits cannot be established without further study.

3.7.1.6 **Toxic Release Contingency Plan (TRCP).** The TRCP may have to be updated to include program-specific launch vehicle, payload, ground-support equipment, and facility toxic material (propellants) at the ER, and Toxic Hazard Assessments (THA) at the WR. THAs are conducted to develop and control Toxic Hazard Zones (THZ) for each launch. THAs provide the appropriate safety clear areas for the storage, handling, and transfer of propellants; they also provide for protection of workers and the general public during vehicle processing and launch operations. The TRCP and THA must be updated prior to loading or storing the program toxic materials.

3.7.2 Cape Canaveral AS

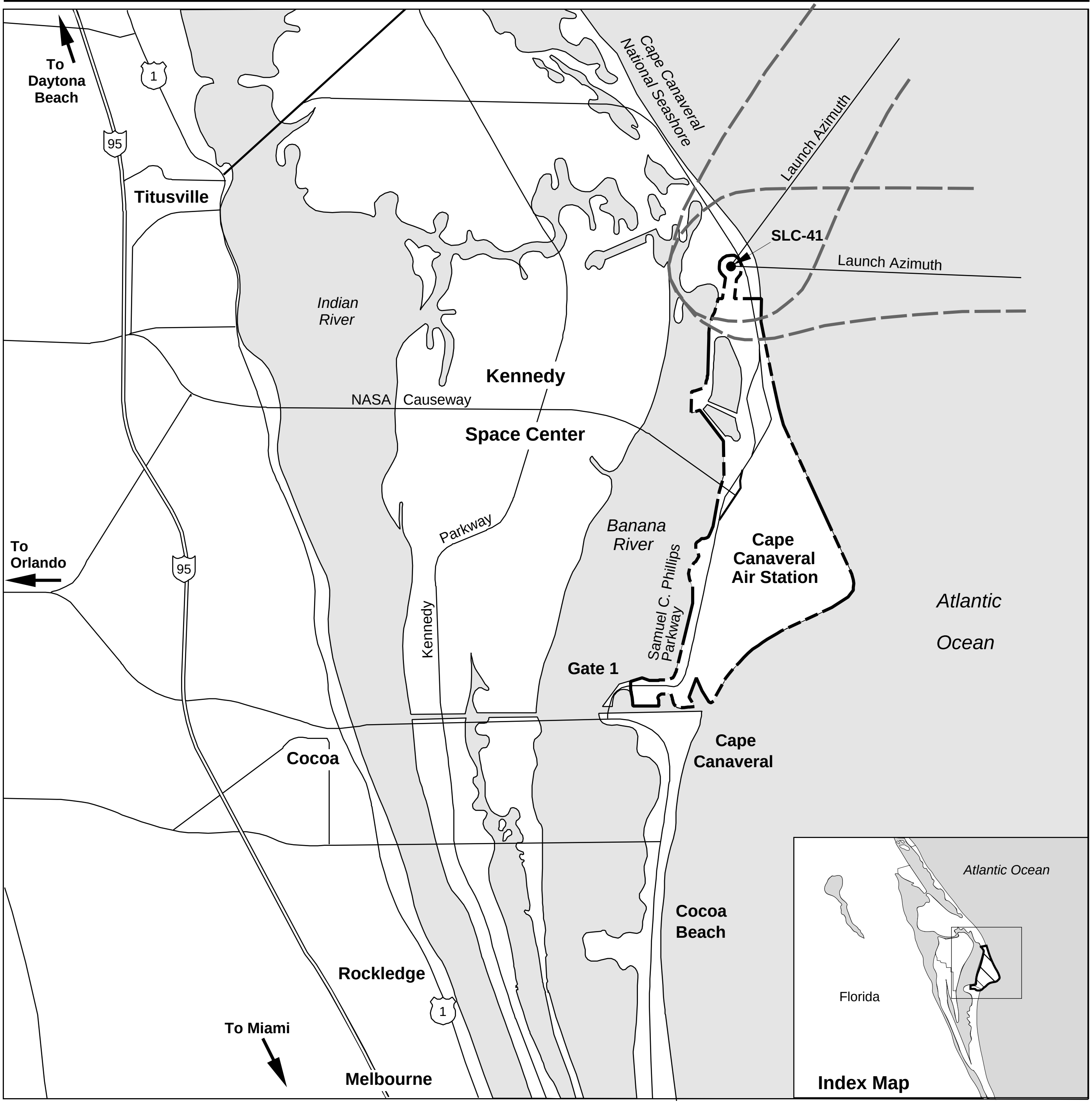
3.7.2.1 **Regional Safety.** The range contractor at Cape Canaveral AS, the city of Cape Canaveral, Brevard County, and the KSC have a mutual-aid agreement in the event of an on- or off-station emergency. Each organization may request equipment and manpower in the event of a fire or other emergency. Current procedures mandate that a representative of the Brevard County Emergency Management Staff sit in the ROCC during all launches (Wadzinski, 1997). Consequently, Brevard County Emergency Management can better respond to a launch emergency through improved communications with Cape Canaveral AS staff.

Prior to a launch, the 45 SW uses an air dispersion computer model to predict toxic plume concentrations and locations for normal and failure launch modes. A detailed description of the computer model is discussed in Section 3.7.2.2, On-Station Safety. During launch activities, communication is maintained with Brevard County Emergency Management, KSC, the Florida Marine Patrol, the U.S. Coast Guard, and the State Warning Point, Division of Emergency Management, in Tallahassee, Florida. Additionally, real-time video and audio of all launches are provided to all off-station agencies. Currently, in addition to the facsimiles discussed above, the 45 SW transmits facsimiles of general messages that describe plume effects and general emergency response procedures.

At the ER, Range Safety monitors launch surveillance areas to ensure that risks to people, aircraft, and surface vessels are within acceptable limits. Control areas and airspace are closed to the public as required. 45 SW Flight Analysis notifies the 45 Range Squadron prior to launch of the areas that are hazardous to aircraft (i.e., impact debris corridor). The 45 Range Squadron is responsible for disseminating a Notice to Airmen through the FAA, Miami Air Route Traffic Control Center. Restricted airspace areas will be active and controlled according to EWR 127-1 Range Safety Requirements, Safety Operating Instructions, 45 SW regulations, and FAA directives and regulations. Specifically, Miami Air Route Traffic Control Center will be advised by the 45 Range Squadron to close W-497A for all weather rocket launches. Control of air traffic in FAA-designated areas around the launch head will be maintained and coordinated between the Surveillance Control Officer, Aeronautical Control Officer, and Miami Air Route Traffic Control Center to ensure that aircraft shall not be endangered by launches. The Radar Approach Control radar at Patrick AFB and the Miami Air Route Traffic Control Center radar will survey for intruding aircraft within a 50-nautical-mile radius of the launch point beginning no later than 30 minutes prior to the scheduled launch time. Radar surveillance shall continue until instructed by the Surveillance Control Officer.

45 SW also ensures that a Notice to Mariners within the impact debris corridor is disseminated beginning 10 working days prior to launch. The United States Coast Guard (USCG) transmits Marine radio broadcast warnings to inform vessels of the effective closure time for the sea impact debris corridor. In addition, warning signs are posted in various Port Canaveral areas for vessels leaving the port. Figures 3.7-1 and 3.7-2 present impact debris corridors for a typical launch from SLC-41 and SLC-37, respectively.

Impact Debris Corridors. Flight termination boundaries (“destruct lines”), which protect impact limit lines, are established for each flight. These boundaries are computed to minimize potential debris impact on populated areas resulting from destruct action. Debris impacts are contained within the impact limit lines because the flight would be terminated to protect the public if the launch vehicle violates the flight boundaries. Vehicle trajectory deviations, obvious erratic flight, or other flight termination criteria which are unique for a particular mission would trigger the flight termination action. A



EXPLANATION

Cape Canaveral AS Boundary

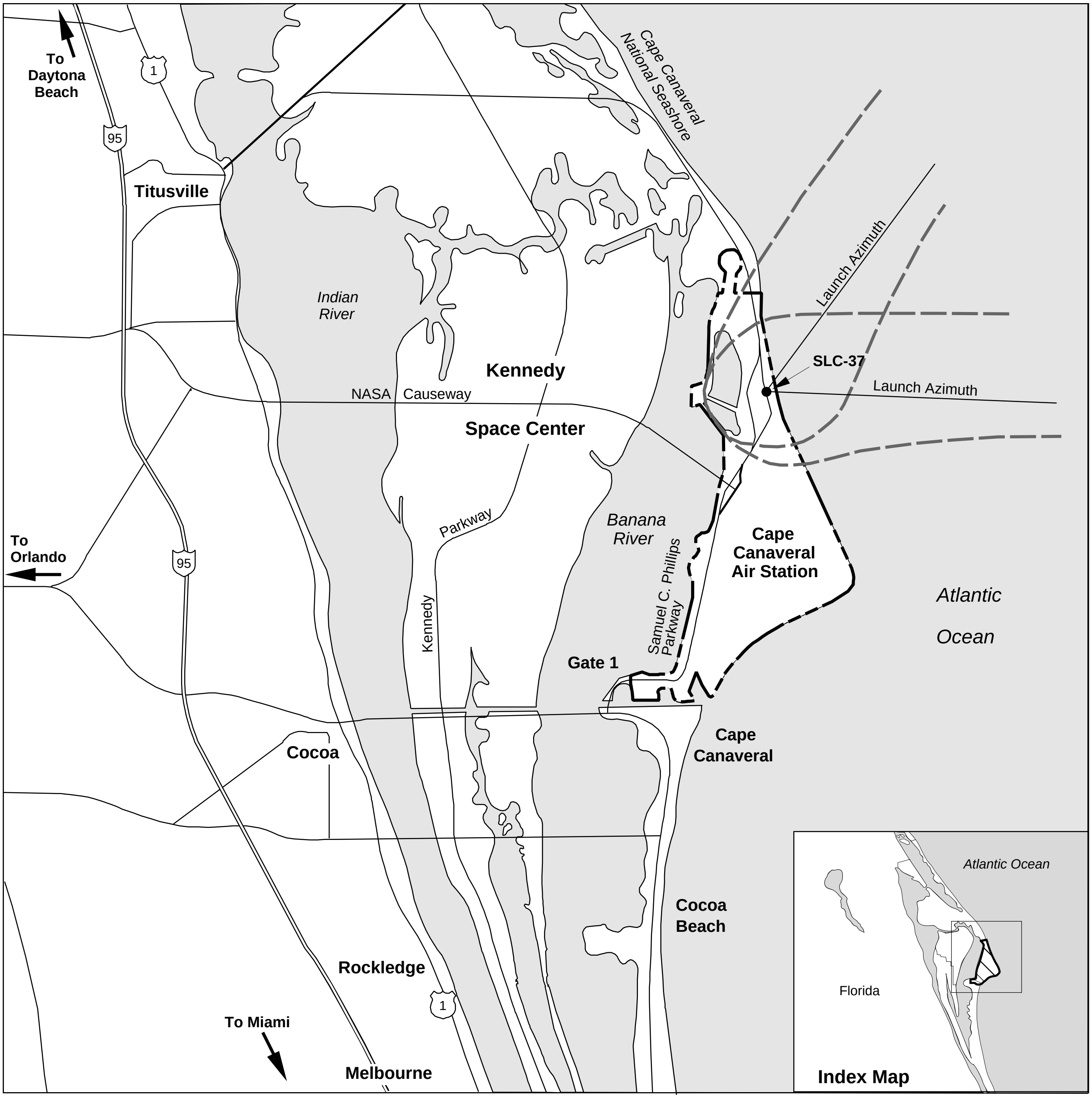
Impact Debris Corridor

Typical Impact Debris Corridors, SLC-41

0 1 2 4 Miles

Figure 3.7-1

EELV/117



EXPLANATION

Cape Canaveral AS Boundary

Impact Debris Corridor

0 1 2 4 Miles

Typical Impact Debris Corridors, SLC-37

Figure 3.7-2

EELV/117

debris hazard exists for normal launches, which results primarily from jettisoned payload fairings, stages, and other launch vehicle components. These hazards are all contained within the impact limit lines and the nominal impact areas are identified through Notices to Airmen and Mariners.

3.7.2.2 **On-Station Safety.** Launches are not allowed if an undue hazard exists for persons and property due to potential dispersion of hazardous materials or propagation of blast. The 45 SW has prepared a Toxic Hazard Control Plan that details the procedures to be used to control heated toxic gas hazards.

An air dispersion computer model, the Rocket Exhaust Effluent Diffusion Model (REEDM) (Bjorklund, 1990), is run to predict THCs associated with launches. It can also predict toxic plume concentrations and locations resulting from an actual abort during launch. Inputs to this model include predicted meteorological conditions, including rawinsonde balloon (a meteorological balloon used to provide wind speed and other data in the upper atmosphere) data, probable failure modes, and solid/liquid propellant emission estimates from the launch vehicle and/or facility. REEDM produces outputs in terms of peak concentration, time-averaged concentration of user-inputted time interval, and dosage estimates as required for the exposure criteria for each chemical species being analyzed. Three types of THCs are supported using REEDM: the Potential Hazard Corridor for a planned credible failure mode, the Emission Hazard Corridor for nominal emissions, and the Operational Hazard Corridor resulting from a failure mode that has actually occurred. THCs are predicted for launches to ensure that Cape Canaveral AS/KSC personnel and the general public will not be exposed to toxic gases that may adversely affect their health.

Prior to a launch, the air dispersion model Ocean Breeze Dry Gulch (OBDG), a model contained in the Meteorological and Range Safety Support (MARSS) System, is run to plot downwind concentrations of toxic gases during cold spills (i.e., spills or releases of toxic materials from storage tanks or that occur during loading or unloading of tanks).

The 45 Weather Squadron alerts Cape Canaveral AS as soon as possible concerning a potential hurricane strike. Cape Canaveral AS personnel are evacuated as appropriate according to updated weather information. All buildings, facilities, fuel handling systems, mobile launch support towers, and other above-ground structures have been constructed to withstand a wind velocity up to 105 miles per hour. Prior to a hurricane strike, launch vehicles are detanked and either transferred to an aboveground structure for protection or protected on the launch pad by enclosure within a mobile support tower.

Emergency responses to major peacetime accidents and natural disasters are covered by 45 Space Wing Oplan 32-1, Volume II. Emergency responses involving hazardous materials are covered by 45 Space Wing Oplan 32-3, Volume I. The Launch Disaster Control Group (LDCG) is an emergency response team formed prior to each launch and situated at a fallback location respond to launch accidents in order to save lives, protect property, control fires, limit the extent of damage, prevent adverse public relations, and return to normal launch operations as soon as possible after an accident. The Disaster Control Group (DCG) is an emergency response team that is activated for nonlaunch-related disasters at Cape Canaveral AS. The mission of the DCG is to minimize the loss of personnel and operational capability caused by wartime contingencies, peacetime disasters, and major accidents including those involving hazardous materials.

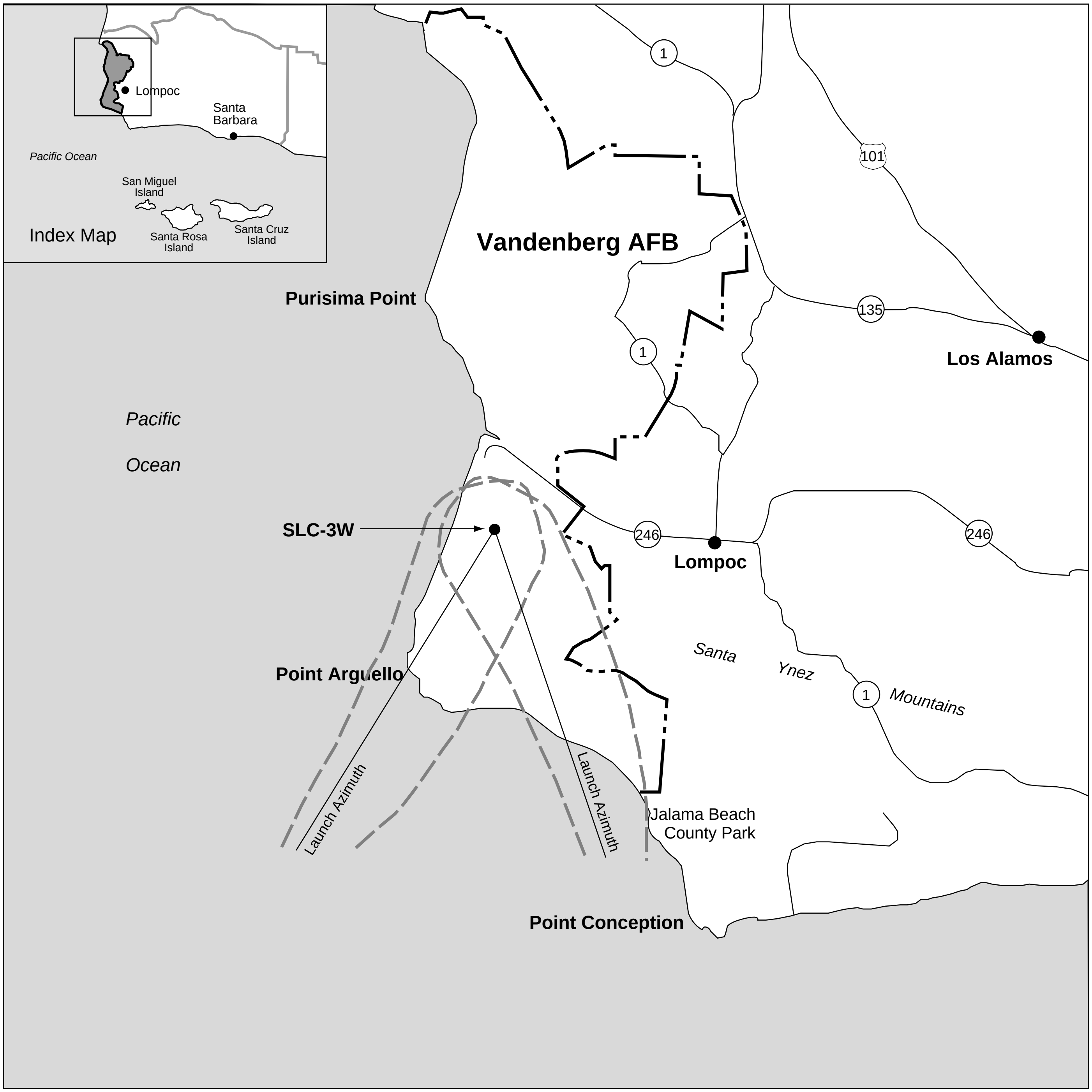
3.7.3 **Vandenberg AFB**

3.7.3.1 **Regional Safety.** Regionally, Santa Barbara County prepared a Hazardous Material Response Plan that is used for countywide disaster response. Cities and communities in the county are required to have their own emergency response plans that were incorporated by the county into a comprehensive Multihazard Functional Plan, which specifies actions to be taken in case of a local disaster. The city of Lompoc adopted its Multihazard Functional Plan in 1989 and amended it in 1994. Because of the potential for Vandenberg AFB operations to affect off-base areas, Vandenberg AFB plays a prime role in regional emergency planning (Environmental Science Associates, 1996; U.S. Air Force, 1989a).

The city of Lompoc and Vandenberg AFB have entered into a mutual aid agreement, which allows emergency units from either Lompoc or Vandenberg AFB to provide each other with assistance in the event of an emergency. A "hotline" exists between the city of Lompoc and Vandenberg AFB in order to immediately notify the city in case of a major accident on the base. In the event of an emergency involving a launch mishap in Lompoc, Vandenberg AFB would assume control and could set up a national defense area if protected material were involved in the accident.

In the event of a launch vehicle impacting other areas outside Vandenberg AFB, the On-Scene DCG from Vandenberg AFB would respond to the accident upon request of the county. County agencies would be used to help in the evacuation and possible fire control for such an incident. Military personnel would assume responsibility for disaster control in the immediate impact area.

Impact debris corridors have been established off the Santa Barbara County coast between Point Sal and Point Conception. These corridors were established to meet security requirements and reduce the hazard to persons and property during a launch-related activity. Impact debris corridors are established through the designation of debris impact areas for each specific launch. These corridors are plotted for all launches. Figures 3.7-3 and 3.7-4



EXPLANATION

Vandenberg AFB Boundary

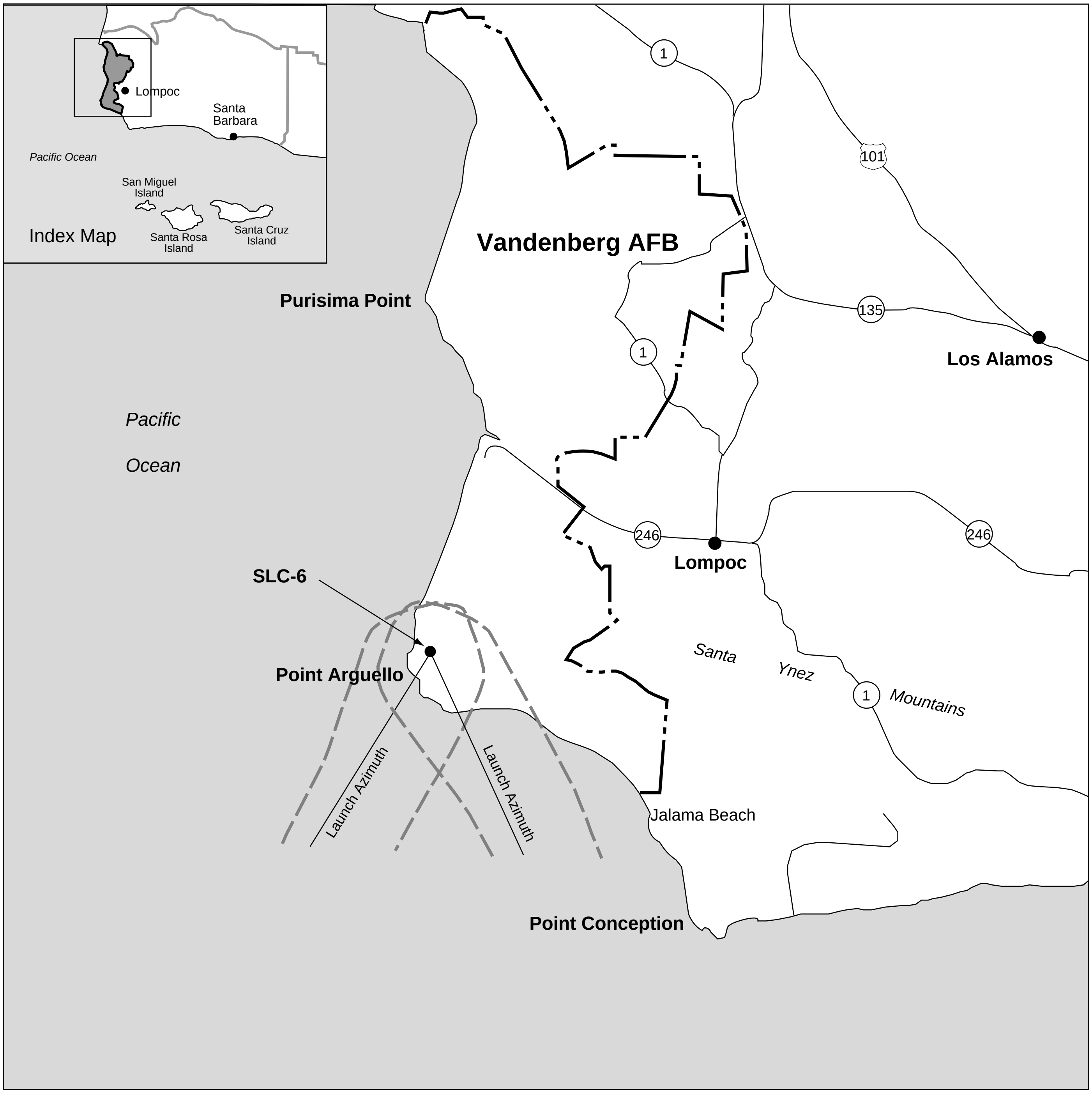
Impact Debris Corridor

0 1.25 2.5 5 Miles

Typical Impact Debris Corridors, SLC-3W

Figure 3.7-3

EEL/103



EXPLANATION

Vandenberg AFB Boundary

Impact Debris Corridor

0 1.25 2.5 5 Miles

Typical Impact Debris Corridors, SLC-6

Figure 3.7-4

EEL/105

present example impact debris corridors for a typical launch from SLC-3W and SLC-6, respectively.

Zone closures are announced daily over various radio frequencies and posted in harbors along the coast. 30 SW Flight Analysis notifies the 30 Range Squadron of areas that are hazardous to aircraft (i.e., impact debris corridors) for all normally jettisoned and impacting stages by 30 working days prior to launch. The 30 Range Squadron notifies the FAA, Los Angeles Center or Oakland Center, so that the information can be disseminated through a Notice to Airmen. Restricted airspace areas will be active and controlled according to EWR 127-1 Range Safety Requirements, Safety Operating Instructions, 30 SW regulations, and FAA directives and regulations. Control of air traffic in FAA-designated areas around the launch head will be maintained and coordinated between the Aeronautical Control Officer and FAA to ensure that aircraft shall not be endangered by launches. The Air Route Surveillance Radar will survey the restricted airspace beginning 15 minutes prior to the scheduled launch time and until the launch is complete.

30 SW also ensures that a Notice to Mariners within the impact debris corridor is disseminated beginning 30 working days prior to launch. Information regarding impact debris corridors is distributed to surface vessels when the 30 SW sends written notification of impact debris corridors to be published weekly in the USCG Long Beach Broadcast to Mariners. Broadcasts by USCG Long Beach provide the latest available hazard information to offshore surface vessels.

30 SW has developed procedures related to evacuating or sheltering personnel on offshore oil rigs during launch operations. These procedures pertain to offshore platforms located west of 120 degrees 15 minutes longitude. The 30 SW Chief of Safety notifies 30 Range Squadron of future launches, and 30 Range Squadron notifies the Minerals Management Service (MMS), Department of the Interior, to notify oil rig personnel of a future launch. The MMS will first notify the oil rig operator 10 to 15 days before a launch to prepare for possible sheltering or evacuation. The second notice is given 24 to 36 hours before the launch confirming the requirement to shelter or evacuate. The third notice is given by Frontier Control to provide final notice before, during, and after securing the operation. Additional notices are sent as required. Oil rig operators are notified to shelter or evacuate personnel according to REEDM models of toxic vapor plumes and potential impact of launch debris.

Jalama Beach and Ocean Beach county parks may be closed on the day of a launch from South Vandenberg AFB. The beaches are within the range safety zone that has been calculated for South Vandenberg AFB launches. All launches of the Atlas II and Delta II require the closure of Ocean Beach; all Titan II and Titan IV launches require closure of both parks. The closure of Jalama Beach County Park for high-azimuth launches began in 1997 due to changes in toxic hazard exposure criteria. Base flight safety requires that there be no overflight of civilian property on the coastline, and that there be no overflight of any of the Channel Islands, except San Miguel Island.

Although direct overflight of the beaches does not occur, there is the possibility of debris from a launch anomaly impacting the beaches. In order to protect park visitors, Vandenberg AFB, the County Parks Department, the County Sheriff, and the California Highway Patrol have agreed to close the parks upon request during launches affecting the beaches.

3.7.3.2 **On-Base Safety.** As discussed in Section 3.7.2.2, launches are not allowed if an undue hazard exists to persons and property due to potential dispersion of hazardous materials or propagation of blast. The 30 SW runs REEDM before a launch to estimate THCs. A description of REEDM is provided in Section 3.7.2.2. The procedure to estimate risk to Vandenberg AFB personnel and the general public through comparison of THC exposure concentrations to exposure criteria is the same as described in Section 3.7.2.2. Other safety procedures are similar to those described in Section 3.7.2.2, with the exception of those safety procedures described below. The air dispersion models Mountain Iron and AFTOX are run to plot downwind concentrations of toxic gases during cold spills.

Launch vehicle mishaps (i.e., accidents involving any launch vehicle operation) are handled by various emergency support teams on base. Some of these procedures include authorization to enter an accident area, control procedures for monitoring trains, and salvage procedures. Several distinct teams of qualified individuals are available to respond to emergencies that might occur during a launch. These teams include the Specialized Operation Support Team, the On-Scene Disaster Group, the Missile Potential Hazard Team, and the Launch Support Team.

The Southern Pacific Transportation Company (SPTC) railroad crosses Vandenberg AFB; SPTC owns the railroad property. Most launches fly over the railroad. 30 SW has procedures for train protection and subsequent “hold” or “proceed” decisions during launch operations.

Vandenberg AFB is located in Seismic Hazard Zone 4, which is the most severe seismic region. Consequently, the seismic design of all new or modified facilities, structures, and equipment shall be in accordance with all applicable Air Force standards (see Appendix E, Section 3.4.3.1). Equipment that has the potential to cause the following hazards must be designed to withstand an earthquake:

- Severe personal injury
- A catastrophic event
- Significant impact on space vehicle or missile processing and launch capability.

3.8 GEOLOGY AND SOILS

This section provides an overview of the physiography, geology, soils, and geologic hazards in the vicinity of Cape Canaveral AS and Vandenberg AFB. In general, the ROI is the regional geologic setting and the areas in the immediate vicinity of the launch complexes that could be affected by construction and launch operation activities.

3.8.1 Cape Canaveral AS

3.8.1.1 **Geologic Setting.** Cape Canaveral AS lies on a barrier island composed of relict beach ridges formed by wind and wave action. The island is 4.5 miles wide at its widest point. Its land surface ranges from sea level to 20 feet above mean sea level (MSL) at the harbor dredge disposal site near Port Canaveral. The average land surface elevation is approximately 10 feet above MSL. The higher naturally occurring elevations occur along the eastern portion of Cape Canaveral AS, with a gentle slope to lower elevations toward the marshlands along the Banana River.

The geology underlying Cape Canaveral AS can be generally defined by four stratigraphic units: the surficial sands, the Caloosahatchee Marl, the Hawthorn Formation, and the limestone formations of the Floridan aquifer (U.S. Air Force, 1991c). The surficial sands immediately underlying the surface are marine deposits that typically extend to depths of approximately 10 to 30 feet below the surface. The Caloosahatchee Marl underlies the surficial sands and consists of sandy shell marl that extends to a depth of 70 feet below the surface. The Hawthorn Formation, which consists of sandy limestone and clays, underlies the Caloosahatchee Marl and is the regional confining unit for the Floridan aquifer. This formation is generally 80 to 120 feet thick, typically extending to a depth of approximately 180 feet below the surface (U.S. Air Force, 1991c). Beneath the Hawthorn Formation lie the limestone formations of the Floridan aquifer, which extend several thousand feet below the surface at Cape Canaveral AS (U.S. Air Force, 1991c).

The principal geologic hazard in central Florida is sinkholes that develop when overlying soils collapse into existing cavities. Cape Canaveral AS is not located in an active sinkhole area, and the review of topographic maps did not reveal the presence of any sinkholes. The Canaveral Peninsula is not prone to sinkholes, since the limestone formations are over 100 feet below the ground surface, and confining units minimize recharge to the limestone (45 Space Wing, 1996b).

A seismological investigation conducted by the U.S. Department of Commerce shows that the underground structure in the heavy launch area is free of anomalies, voids, and faults (45 Space Wing, 1995c). Cape Canaveral AS is located in Seismic Hazard Zone 0 as defined by the Uniform Building Code (International Conference of Building Officials, 1991). Seismic Zone 0 represents a very low potential risk for large seismic events.

3.8.1.2 **Soils.** The three most prominent soil types at Cape Canaveral AS comprise the Canaveral-Palm Beach-Welaka Association. This association is made up of nearly level and gently sloping ridges interspersed with narrow wet sloughs that generally parallel the ridges. The soils have rapid permeability and low available water capacity due to the near-surface water table. This permeability rate allows water to rapidly dissipate into the ground. According to the General Plan, limitations to development are slight to moderate for light industrial uses. No problems associated with previous construction activities at the SLCs have been identified. Soils in the areas of SLC-41 and SLC-37 are not considered highly suitable for commercial agricultural uses. There are no prime or unique farmland soils on Cape Canaveral AS (Pan Am World Services, Inc., 1989).

3.8.2 Vandenberg AFB

3.8.2.1 **Geologic Setting.** The region encompassing South Vandenberg AFB lies within the Transverse Ranges Physiographic Province of California and is dominated by the Santa Ynez Mountains. The Pacific Ocean and Santa Barbara Channel lie west and southeast, respectively, of the mountains, and the Lompoc-Santa Ynez River Valley lies to the north. Topography within Vandenberg AFB is varied, ranging from sea level to about 2,000 feet MSL in the Santa Ynez Mountains.

Locally, within the area incorporating South Vandenberg AFB, bedrock at the surface consists of diatomaceous shale that has an approximate thickness of 1,600 feet, known as the Upper Monterey Formation. Marine terrace deposits varying in thickness from a few to several tens of feet unconformably overlie the Monterey Formation. Weathered material 1 to 5 feet thick covers most of the slope areas that have low to moderate gradients.

Numerous onshore and offshore faults have been mapped within the vicinity of Vandenberg AFB; most are inactive and not capable of surface fault rupture or of generating earthquakes (U.S. Air Force, 1989a). Four faults have been mapped on Vandenberg AFB: the Lion’s Head, Hosgri, Santa Ynez River, and Honda (U.S. Air Force, 1989d). The Lion’s Head Fault runs through North Vandenberg AFB, and the Hosgri, Santa Ynez, and Honda faults run through South Vandenberg AFB. Of the three faults on South Vandenberg AFB, only the Hosgri Fault is considered to be active (ruptured in the last 10,000 years). The Santa Ynez River Fault is approximately one-half mile south of SLC-3W. The Hosgri Fault is located approximately 7.5 miles northwest of SLC-3W and 2.5 miles northwest of SLC-6. The Honda fault is the closest fault to SLC-6, which is approximately 1.5 miles north.

The secondary effects of fault rupture are earthquake ground motions, or seismicity. The Western Transverse Ranges, inclusive of the continental borderlands, have historically been in a moderately high seismic region. Since 1900, within a 20-mile radius of the project area, there have been over 90 earthquakes with magnitudes ranging from 3.0 to 7.3 (U.S. Air Force, 1989a). Two earthquakes were notable, one in 1812 (M7.1), most likely epicentered in the Santa Barbara Channel, and the other in 1927 (M7.3), offshore near Point Arguello. The 1927 event may have occurred less than 20 miles west of South Vandenberg AFB. Vandenberg AFB is located in a Seismic Zone IV, as defined by the Uniform Building Code (International Conference of Building Officials, 1991), characterized by areas likely to sustain major damage from earthquakes, and corresponds to intensities of VIII or higher on the Modified Mercalli Scale.

Shallow failures (i.e., 5 to 10 feet deep) such as slumps, rock falls, debris or mud flows and deep-seated landslides have not been identified in the immediate EELV project area locations. From a geologic standpoint, natural slopes on or adjacent to the area have been stable for many hundreds of years, although modifications to slopes, such as those that have occurred at SLC-6, may change slope conditions. Geotechnical investigations are conducted during engineering design to determine potential unstable conditions, and recommendations are made for safe slope design (U.S. Air Force, 1989a).

3.8.2.2 **Soils.** Soil deposits occur on most slopes and surfaces where bedrock is not exposed. The deposits were developed by weathering of the underlying Monterey Formation and/or terrace deposits. Soil thickness varies throughout the area but is generally less than 3 feet. Because of the slope of the terrain on South Vandenberg AFB, drainage (surface run off) and erosion affect local soils. Soils in the areas of SLC-3W and SLC-6 are not considered highly suitable for commercial agricultural uses. There are no prime or unique farmland soils within proposed EELV operation areas at Vandenberg AFB.

Erosion of soils and bedrock materials is a continuing process caused by running water and wind. Soils within the area vary greatly, and those that are very sandy are more susceptible to erosion than are fine-grained deposits. Excessive erosion problems have occurred at several locations in the South Vandenberg AFB area, primarily associated with developed (graded) slopes (U.S. Air Force, 1989a). No problems associated with previous construction activities at the SLCs have been identified. Developed slopes are often stabilized to prevent erosion.

In the vicinity of SLC-3W, the Lompoc Terrace is cut by Spring Canyon (directly south of SLC-4), Bear Canyon (between SLC-3 and SLC-4), and Lompoc Canyon (east of SLC-3). The valley floors of these canyons are approximately 100 to 300 feet below the surrounding terrace surface. The ground surface elevation at SLC-3W ranges from 400 to 500 feet above MSL. Slopes within the SLC-3W security fence are mild (less than 10-percent slope), except for the area southeast of the SLC-3E retention basin, where there are 25-percent slopes. Soils in the vicinity of SLC-3W have moderate to rapid permeability. The site is well vegetated, reducing the potential for surface erosion (Jacobs Engineering Group, Inc., 1995).

The SLC-6 site is located on an elevated marine terrace adjacent to the lower slopes of the Santa Ynez Mountains. Developed portions of the site have been graded and do not reflect the original topography. Adjacent undeveloped areas slope gently to the west with an average gradient of about 5 percent. The site lies generally between 200 and 500 feet above MSL, with a total relief of about 300 feet from west to east. The SLC-6 area is bounded on the north and south by two drainages. The southerly drainage extends from a large canyon east of the site to a discharge point about 1 mile to the northwest. The northerly drainage, known as Red Roof Canyon, extends from developed slopes of SLC-6 northwest, to a discharge point over 1 mile from the site. Both drainages have steep side slopes. Some erosion of soils is evident at points along the drainages bounding the SLC-6 site. The erosion potential of most on-site soils is severe. Slope stabilization measures have been implemented, especially adjacent to Red Roof Canyon, where excessive erosion required cement gunnite to protect graded slopes (U.S. Air Force, 1989a).

3.9 WATER RESOURCES

Water resources include groundwater and surface water and their physical, chemical, and biological characteristics. Aquatic and wetland habitats and organisms are discussed under Section 3.14, Biological Resources. This section focuses on the potential effects of EELV development and operation on the physical and chemical factors that influence water quality and surface runoff. Effects from erosion are discussed in Section 3.8, Geology and Soils.

The federal Clean Water Act (CWA) is the primary law regulating water pollution. The CWA, as amended (P.L. 92-500), is administered by the U.S. EPA, which delegates authority to the appropriate state agency. The CWA defines the primary and secondary standards for water quality. Treated water discharged to surface water or to the ocean is subject to the requirements of a National Pollution Discharge Elimination System (NPDES) permit, which ensures that the water discharged meets water quality standards at the point of discharge. In addition, projects disturbing 5 acres or more are subject to NPDES permit requirements for storm water discharges during construction. This permit requires the preparation of a Storm Water Pollution Prevention Plan. Section 319 of the CWA requires states to assess nonpoint water pollution problems and to develop nonpoint source pollution management programs with controls to improve water quality. Section 404 of the CWA requires a permit from the USACE in order to locate a structure, excavate, or discharge dredged or fill material into Waters of the United States.

Executive Order (EO) 11988, Floodplain Management, directs federal agencies to avoid to the extent possible the long- and short-term adverse impacts associated with occupancy and modification of floodplains. AFI 32-7064 (Chapter 4, Floodplain Management and Wetlands Protection) requires the Air Force to prepare a Finding of No Practicable Alternatives (FONPA) before construction within a floodplain. The Deputy Assistant

Secretary (Environment, Safety, and Environmental Health) must approve the FONPA before initiation of construction activities.

3.9.1 Cape Canaveral AS

The ROI for groundwater includes the local aquifers that are directly or indirectly used by Cape Canaveral AS. The ROI for surface water is the drainage system/watershed in which the station is located. The St. John's River Water Management District (SJRWMD) issues the Environmental Resource Permit, which includes storm water and wetlands management, in coordination with the FDEP and the USACE. The U.S. EPA is responsible for management of the NPDES permit process and wastewater discharges.

3.9.1.1 **Groundwater.** Two aquifer systems underlie Cape Canaveral AS: the surficial and the Floridan aquifer systems. The surficial aquifer system, which comprises generally sand and marl, is under unconfined conditions and is approximately 70 feet thick. The water table in the aquifer is generally a few feet below the ground surface. Recharge to the surficial aquifer is principally by percolation of rainfall and runoff. Groundwater in the surficial aquifer at Cape Canaveral AS generally flows to the west, except along the extreme eastern coast of the peninsula.

A confining unit composed of clays, sands, and limestone separates the surface aquifer from the underlying Floridan aquifer. The confining unit is generally 80 to 120 feet thick. The relatively low hydraulic conductivity of the confining unit restricts the vertical exchange of water between the surface aquifer and the underlying confined Floridan aquifer.

The Floridan aquifer is the primary source of potable water in central Florida and is composed of several carbonate units with highly permeable zones. The top of the first carbonate unit occurs at a depth of approximately 180 feet below ground surface, and the carbonate units extend to a depth of several hundred feet. Groundwater in the Floridan aquifer at Cape Canaveral AS is highly mineralized.

Cape Canaveral AS receives its potable water from the city of Cocoa, which pumps water from the Floridan aquifer. According to the General Plan, this water supply is more than adequate to meet usage demands and water quality standards (45 Space Wing, 1995).

3.9.1.2 **Surface Water.** Cape Canaveral AS is situated on a barrier island that separates the Banana River from the Atlantic Ocean. The station is within the Florida Middle East Coast Basin. This basin contains three major bodies of water in proximity to the station: the Banana River to the immediate west, Mosquito Lagoon to the north, and the Indian River to the west, separated from the Banana River by Merritt Island. All three water bodies are estuarine lagoons, with circulation provided mainly by wind-induced currents.

Surface drainage at Cape Canaveral AS generally flows to the west into the Banana River, even near the eastern side of the peninsula.

Several water bodies in the Middle East Coast Basin have been designated as Outstanding Florida Water (OFW) in FAC 62-3, including most of Mosquito Lagoon and the Banana River, Indian River Aquatic Preserve, Banana River State Aquatic Preserve, Pelican Island National Wildlife Refuge, and Canaveral National Seashore. These water bodies are afforded the highest level of protection, and any compromise of ambient water quality is prohibited. The Indian River Lagoon System has also been designated an Estuary of National Significance by the U.S. EPA. Estuaries of National Significance are identified to balance conflicting uses of the nation's estuaries while restoring or maintaining their natural character. The Banana River has been designated a Class III surface water, as described by the CWA. Class III standards are intended to maintain a level of water quality suitable for recreation and the production of fish and wildlife communities. There are no wild and scenic rivers located on or near Cape Canaveral AS.

Floodplains are lowland and relatively flat areas adjoining inland and coastal waters that are subject to flooding. The 100-year floodplain is subject to a 1-percent or greater chance of flooding in any given year. On Cape Canaveral AS, the 100-year floodplain extends 7 feet above MSL on the Atlantic Ocean side, and 4 feet above MSL on the Banana River side. There are no 100-year floodplains within areas proposed for EELV construction at Cape Canaveral AS.

3.9.1.3 **Water Quality.** Surface water quality near Cape Canaveral AS and KSC is monitored at 11 long-term monitoring stations that are maintained by NASA. The FDEP has classified water quality in the Florida Middle East Coast Basin as "poor to good" based on the physical and chemical characteristics of the water, as well as whether they meet their designated use under FAC 62-3. The upper reaches of the Banana River adjacent to Cape Canaveral AS and the lower reaches of Mosquito Lagoon have generally good water quality due to lack of urban and industrial development in the area. However, recent studies by NASA indicate that certain parameters (i.e., primarily phenols and silver) consistently exceed state water quality criteria, with hydrogen ion concentration (pH), iron, and aluminum occasionally exceeding criteria. Nutrients and metals, when detected, have generally been below Class II standards (National Aeronautics and Space Administration, 1995c). Areas of poor water quality exist along the western portions of the Indian River, near the city of Titusville, and in Newfound Harbor in southern Merritt Island. Fair and poor water quality areas are influenced primarily by WWTP effluent discharges and urban runoff.

3.9.2 Vandenberg AFB

The ROI for groundwater includes the local aquifers that are directly or indirectly used by Vandenberg AFB. The ROI for surface water is the drainage system/watershed in which the base is located. In California, the state Water Resources Control Board and the Regional Water Quality Control Board (RWQCB) administer the CWA and state water regulations. The

Central Coast Region RWQCB is the local agency responsible for the Vandenberg AFB area. The RWQCB is responsible for management of the NPDES permit process for California.

The California Porter-Cologne Water Quality Act provides a framework for establishing beneficial uses of water resources and the development of local water quality objectives to protect these beneficial uses. State regulations require a Waste Discharge Requirement (WDR) for permitting discharge. A Report of Waste Discharge (RWD) (similar to an NPDES permit application) is required for actions that will involve discharge of waste to surface and/or groundwater. The California Porter-Cologne Water Quality Act implements the NPDES program for the state.

3.9.2.1 **Groundwater.** The main sources of potable water in the region are from the San Antonio Creek Valley groundwater basin, the Lompoc Plain groundwater basin, the Lompoc Upland groundwater basin, and the Lompoc Terrace groundwater basin. These groundwater basins are pumped for potable water for Vandenberg AFB and the surrounding communities. Activities at Vandenberg AFB are concentrated in the Lompoc subarea (Lompoc Plain, Lompoc Upland, and Lompoc Terrace groundwater basins) and the western portion of the San Antonio Creek Valley basin.

Historically, the entire water supply on South Vandenberg AFB has been provided by two wells in the Lompoc Terrace Aquifer. These wells have been pumped at a rate that exceeds the natural recharge of the two wells. This sustained over-withdrawal has resulted in a 0.4-foot decrease in the aquifer each year over the last 10 years. Launch complex process water use represented nearly 17 percent of this overdraft condition.

3.9.2.2 **Surface Water.** Four major drainages occur on Vandenberg AFB: Cañada Tortuga Creek, Bear Creek, Cañada Honda Creek, and Jalama Creek. There are numerous unnamed minor drainage basins containing seasonal and ephemeral streams. Drainage from these basins is predominantly to the west, toward the Pacific Ocean.

The Santa Ynez River forms the geomorphic boundary between North and South Vandenberg AFB. The major drainage for South Vandenberg AFB is Cañada Honda Creek, with a watershed of about 12 square miles. Springs associated with Cañada Honda Fault usually issue a minimal flow of water to the watershed. There are no permanent lakes, impoundments, rivers, or floodplains on South Vandenberg AFB; however, there are several streams that drain directly into the ocean. Jalama Creek is near and outside the southern boundary of the base. There are no 100-year floodplains within areas proposed for EELV construction at Vandenberg AFB.

Concept A ROI. In the vicinity of SLC-3W, the Lompoc Terrace is cut by Bear Canyon (southwest of SLC-3W) and Lompoc Canyon (east of SLC-3W). No perennial streams or springs exist on the SLC-3W site. Surface water from the site is directed toward Bear Creek Canyon.

Concept B ROI. No perennial streams or springs exist on the SLC-6 site. Erosion control ditches are used to direct surface water runoff created during storm events to a small arroyo on the north side of SLC-6. From this arroyo, the water flows toward the ocean and is either absorbed by the ocean or by soil before it reaches the ocean. Cañada Agua Viva is a south-flowing, perennial drainage located east of SLC-6 that is fed by two springs near Wild Horse Flats. Cañada Agua Viva has a watershed area of approximately 1 square mile.

3.9.2.3 **Water Quality.** Groundwater quality in the region meets all National Primary Drinking Water Regulation standards (U.S. Air Force, 1989a). Continued overdraft of the groundwater basins could lead to a degradation in the water table levels and a compaction of the basins. A slight decrease in water quality has been occurring in the region due to the use of water for irrigation. As this water flows through the soil back to the basin, it entrains salts and leads to a buildup of salts in the groundwater (U.S. Air Force, 1989a).

Groundwater monitoring is conducted for basins that are utilized for drinking water. Water in the San Antonio Valley Creek groundwater basin currently exceeds drinking water standards for total dissolved solids (TDS), manganese, and iron. The Lompoc Terrace groundwater contains constituents that exceed maximum contaminant levels (MCLs) for TDS. Groundwater is treated prior to its usage as potable water.

Watersheds are subject to on-base construction and agricultural runoff. San Antonio Creek, Santa Ynez River, and Shuman Canyon Creek also receive off-base agricultural runoff resulting in elevated dissolved solids, phosphates, and nitrates. Surface water is not directly used as a potable water supply at Vandenberg AFB. Ambient water quality sampling is performed by the Air Force.

3.10 AIR QUALITY (LOWER ATMOSPHERE)

This section describes air quality resources for the atmosphere at altitudes below 3,000 feet.

3.10.1 Federal Regulatory Framework

Air quality for both installations is regulated federally under Title 40 CFR 50 (National Ambient Air Quality Standards [NAAQS]), Title 40 CFR 51 (Implementation Plans), Title 40 CFR 61 and 63 (National Emission Standards for Hazardous Air Pollutants [NESHAPs]), and Title 40 CFR 70 (Operating Permits).

Title 40 CFR 50 (NAAQS). This regulation contains the NAAQS for primary and secondary criteria pollutants. The National Primary Ambient Air Quality Standards define the levels of air quality that the U.S. EPA judges as necessary to protect the public health with an adequate margin of safety. The National Secondary Ambient Air Quality Standards define levels of air quality that the U.S. EPA has determined to be necessary to protect the public welfare from any known anticipated adverse effects of a pollutant. There are standards for ozone (O_3), carbon monoxide (CO), NO_2, sulfur dioxide (SO_2), particulate matter equal to or less than 10 microns in diameter (PM_{10}), and lead (Pb).

Air quality in a given location is described as the concentration of various pollutants in the atmosphere, generally expressed in units of ppm or micrograms per cubic meter ($\mu g/m^3$), or in a pollution standard index. Air quality is determined by the type and amount of pollutants emitted into the atmosphere, the size and topography of the air basin, and the prevailing meteorological conditions. The significance of a pollutant concentration is determined by comparing it to federal and state ambient air quality standards.

According to U.S. EPA guidelines, an area with air quality better than the NAAQS is designated as being in attainment; areas with worse air quality are classified as nonattainment areas. A nonattainment designation is given to a region if the primary NAAQS for any criteria pollutant is exceeded at any point in the region for more than three days during a 3-year period. Pollutants in an area may be designated as unclassified when there is insufficient data for the U.S. EPA to determine attainment status.

The U.S. EPA is in the process of revising the NAAQS. New standards for ozone and particulate matter were published in the Federal Register on July 18, 1997. The new particulate standards are for particles less than 2.5 microns in diameter ($PM_{2.5}$). The standards are: an annual $PM_{2.5}$ standard of 15 micrograms per cubic meter ($\mu g/m^3$) based on a 3-year average of the arithmetic mean from community-oriented monitors (two monitors per urban area); a 24-hour standard set at 65 $\mu g/m^3$ based on the 3-year average of the 98^{th} percentile at each population-oriented monitor (one monitor per 1 million people) within an area; and a 24-hour PM_{10} standard based on the 99^{th} percentile of the 24-hour PM_{10} concentrations at each monitor within an area. The new ozone standard is 0.08 ppm, or 158 $\mu g/m^3$, based on the 3-year average of the fourth highest 8-hour average. Additionally, the 1-hour standard (0.12 ppm, or 235 $\mu g/m^3$) remains in effect until the area is in attainment.

As the new standards are implemented, areas will be reclassified based on their attainment of the new criteria. The U.S. EPA plans to set up 1,500 new monitors to collect $PM_{2.5}$ data that will result in reclassifications between 2002 and 2004. There is already sufficient data to designate areas for the new ozone standard. However, the Presidential Memorandum publishing the new standards states that the Clean Air Act (CAA) provides up to 3 years for state governors to designate an area according to their most recent air quality and up to 3 additional years to develop and implement a State Implementation Plan (SIP) to provide attainment of the new standard.

The main criteria pollutants considered in this EIS are ozone, CO, NO_2, SO_2, and PM_{10}. Airborne emissions of lead are not addressed in this EIS because there are no known lead emission sources in the regions or proposed for use in any of the EELV alternatives.

Ozone is a secondary pollutant formed in the atmosphere by photochemical reactions of previously emitted pollutants, or precursors. Ozone precursors are mainly nitrogen oxides (NO_x) and volatile organic compounds (VOCs). VOCs are defined by the U.S. EPA as compounds containing carbon, excluding CO, carbon dioxide (CO_2), carbonic acid, metallic carbonates, ammonium carbonate, and organic compounds found not to contribute to ozone-generating reactions. NO_x is the designation given to the group of all oxygenated nitrogen species, including NO_2, nitrous oxide (N_2O), nitric oxide (NO), nitrogen trioxide (NO_3), N_2O_4, nitric anhydride (N_2O_5), and nitrous anhydride (N_2O_3). Although all of these compounds can exist in the air, only N_2O, NO, and NO_2 are found in appreciable quantities.

Nitrogen dioxide is primarily formed by the conversion of NO to NO_2 in the presence of oxygen (either during combustion or in the atmosphere). NO is produced by fuel combustion in both stationary and mobile sources, such as automobiles and aircraft. The amount of production is dependent upon the combustion temperature conditions and the rate of exhaust gas cooling. Higher temperatures and rapid cooling rates produce greater quantities of NO.

Carbon monoxide is formed through several processes, including incomplete fuel combustion. Sulfur dioxide is primarily formed through the combustion of sulfur-containing fuels, such as coal or oil. Particulate emissions are formed from several sources including fuel combustion, material processing, and road dust.

The states will consider activities that produce emissions at Cape Canaveral AS and Vandenberg AFB in developing their emission budgets and SIPs for achievement and maintenance of the NAAQS. The process by which emissions of these attainment pollutants is prevented from creating a nonattainment condition is called Prevention of Significant Deterioration (PSD). This process limits the allowable ambient impact of emissions from new major stationary sources or major modifications to specific increments designed to prevent any substantial degradation of the area’s acceptable air quality. However, the PSD process currently applies only to ozone precursors (VOC and NO_x), NO_2, SO_2, and particulate emissions (not CO), and does not provide a mechanism for dealing with non-stationary sources such as motor vehicles and aircraft.

Title 40 CFR 51 (Implementation Plans). This regulation contains the requirements pertaining to implementation plans, which are prepared by state or federal authorities with the goal of meeting the NAAQS.

Title 40 CFR Part 51 Subpart 93 (General Conformity). This regulation requires federal actions to conform to any SIP approved or promulgated under Section 110 of the CAA. A conformity determination is required for each pollutant resulting from a federal action for which the total of direct and indirect emissions in a nonattainment or maintenance area would equal or exceed de minimis thresholds listed in Title 40 CFR 51.853. The requirements for conformity determinations are detailed in Subpart W. The Air Force has developed an Air Force Air Conformity Guide recommended for use when preparing a conformity applicability analysis and/or Conformity Determination.

Title 40 CFR Parts 61 and 63 (NESHAPs). The NESHAPs regulate stationary sources that were constructed or modified after the date of the publication of the regulations. These regulations require a written application for determination by the U.S. EPA of whether the stationary sources meet the regulation requirements. There is a variety of stationary sources specifically identified in the NESHAPs regulations; the standards for these sources are referred to as Maximum Available Control Technology (MACT) standards.

The NESHAPs regulations apply to specific types and sizes of equipment. The only section of the NESHAPs regulations that could apply to this analysis is Title 40 CFR 63 Subpart GG, which applies to facilities that manufacture or rework commercial, civil, or military aerospace vehicles or components and that are major sources of hazardous air pollutants (HAPs). These include cleaning operations, primer and topcoat application operations, depainting operations, chemical milling maskant application operations, and waste storage and handling operations.

Exemptions to this subpart include hazardous wastes that are subject to requirements of RCRA including specialty coatings, adhesives, adhesive bonding primers, or sealants at aerospace facilities; HAP or VOC contents less than 0.1 percent for carcinogens or 1.0 percent for noncarcinogens; and low-volume coatings.

This subpart gives the standards for cleaning operations, primer and topcoat application operations, depainting operations, chemical milling maskant application operations, and waste storage and handling operations. Also listed are the compliance dates and determinations, test methods and procedures, and monitoring, recordkeeping, and reporting requirements.

The owner or operator of an affected source is also subject to sections of Subpart A, including prohibited activities and circumvention (Section 63.4); construction and reconstruction (Section 63.5); and compliance with standards and maintenance requirements (Section 63.6). A startup, shutdown, and malfunction plan for an air pollution control device or equipment to control HAP emissions must be prepared and operated in accordance with Title 40 CFR 63.743(b).

Title 40 CFR 70 (Operating Permits). Title V of the Clean Air Act Amendments (CAAA) of 1990 requires all major sources to file an operating permit application. The operating permit incorporates all applicable federal requirements under the CAA affecting the respective sources. A major source is defined as a source that has the potential to (1) emit 100 tons per year of any regulated air pollutant within an area that is in attainment for that pollutant; (2) emit 10 tons per year of any one of the 189 HAPs; or (3) emit 25 tons per year of total HAPs. If the source is in a nonattainment area for a pollutant, the major source thresholds can be lower. For example, if the source is in a zone designated as a "serious" nonattainment area for ozone, the major source threshold for ozone precursors (NO_x and VOCs) is 50 tons per year rather than 100 tons per year.

On August 2, 1996, the U.S. EPA issued the memorandum *Major Source Determinations for Military Installations under the Air Toxics, New Source Review, and Title V Operating Permit Programs of the Clean Air Act.* This memorandum recommends procedures to divide military installations into sections when determining whether Title V and other air programs apply. For example, activities under the control of different military services can be considered to be in separate facilities.

Because potential emissions are above major source thresholds, Cape Canaveral AS is currently a major source with respect to Title 40 CFR 70 regulations. The Title V Operating Permit application has been submitted to the FDEP and is under review. This application treats Cape Canaveral AS as a single major facility. The station can continue operations until the review is complete.

Vandenberg AFB has entered into an agreement with the U.S. EPA as part of the Environmental Investment (ENVVEST) program. This program is designed to allow operational flexibility in reducing emissions and complying with environmental regulations. The program is the result of a November 1995 Memorandum of Agreement between DoD and the U.S. EPA on Regulatory Reinvention Pilot Projects (Project XL). On September 8, 1997, the proposed Project XL Final Project Agreement for Vandenberg AFB was published in the Federal Register.

As part of the ENVVEST program, Vandenberg AFB is being exempted from the requirements of Title 40 CFR 70. Instead, Vandenberg AFB has facility-specific operational and reporting requirements. Vandenberg AFB has committed to implementing "a phased program to reduce annual emissions of ozone precursors by at least 10 tons by November 30, 2002." This is expected to be accomplished through the reduction of emissions from boilers, furnaces, and process heaters.

Vandenberg AFB has prepared a final draft Major Source Determination, which reviewed the stationary source air emissions and used the EPA's Major Source Guidance for military installations to determine where the emissions were coming from and under whose control (Standard Industrial Classification [SIC] Code) the emissions fall. Following the inventory and assessment, the Santa Barbara County Air Pollution Control District (SBCAPCD) and

Vandenberg AFB determined that the base would be divided into separate source designations and the SBCACPD would implement a new rule capturing this decision. This rule, Rule 1301, was issued September 18, 1997. Currently, the stationary source designations are: Air Force Primary Mission, Remediation, NASA, Flight Line, Navy, Range Group, Amenities Group, Hospital Services, and Commercial Space.

Title 40 CFR 82 (Protection of Stratospheric Ozone). This regulation seeks to prevent damage to the ozone layer by Class I and Class II Ozone-Depleting Substances (ODSs) and contains subparts addressing production and consumption controls, servicing of motor vehicle air conditioners, bans on nonessential products, federal procurement, recycling and emissions reduction, and alternative compounds. The regulations relating to federal procurement state that safe alternatives to Class I and Class II ODSs shall be substituted to the maximum extent practicable. The regulations additionally require contractors to ensure compliance with Title 40 CFR 82 regulations, proper labeling, and reporting of the use of ODSs.

3.10.2 Cape Canaveral AS

3.10.2.1 **Florida Regulatory Framework.** Air quality for the Cape Canaveral AS area is regulated under FAC 62-200 et seq. Specific regulations that may be applicable to EELV activities include FAC 62-204.240 (Ambient Air Quality Standards), FAC 62-210 (Stationary Source General Requirements), FAC 62-212 (Stationary Source Preconstruction Permitting), FAC 62-213 (Operating Permits), and FAC 62-242 (Mobile Sources).

FAC 62-204.240 (Ambient Air Quality Standards). This rule lists the ambient air quality standards for Florida (Table 3.10-1). The Florida Ambient Air Quality Standards (FAAQS) are not significantly different from the NAAQS.

Table 3.10-1. National and Florida Ambient Air Quality Standards

Pollutant	Averaging Time	Florida Standards[a, b] ($\mu g/m^3$)	National Standards ($\mu g/m^3$)[c] Primary[d]	Secondary[e]
Ozone	1 Hour	235	235	235
Carbon Monoxide	8 Hours	10,000	10,000	----
	1 Hour	40,000	40,000	----
Nitrogen Dioxide	Annual	100	100[f]	Same as primary standard
Sulfur Dioxide	Annual	60	80	----
	24 Hours	260	365	----
	3 Hours	1,300	----	1,300
PM_{10}	Annual	50	50[f]	Same as primary standard
	24 Hours	150	150	Same as primary standard
Lead	Quarterly	1.5	1.5	Same as primary standard

Notes: (a) Florida standards for ozone, carbon monoxide, sulfur dioxide, nitrogen dioxide and PM_{10} are values that are not to be exceeded. The lead value is not to be equaled or exceeded.
(b) Values for standards are based on a reference temperature of 25 degrees Celsius (°C) and a reference pressure of 760 millimeters (mm) of mercury. All measurements of air quality are to be corrected to a reference temperature of 25°C and a reference pressure of 760 mm of mercury (1,013.2 millibars).
(c) National standards other than ozone and those based on annual averages or annual arithmetic means are not to be exceeded more than once a year. The ozone standard is attained when the expected number of days per calendar year, with maximum hourly average concentrations above the standards, is equal to or less than one. The lead and annual sulfur dioxide standards are not to be exceeded in a calendar year.
(d) National Primary Standards: The levels of air quality necessary to provide an adequate margin of safety to ensure protection of the public health.
(e) National Secondary Standards: The levels of air quality necessary to provide that the public welfare is safe from any known or anticipated adverse effects of pollutant.
(f) Calculated as arithmetic mean.

$\mu g/m^3$ = micrograms per cubic meter
PM_{10} = particulate matter equal to or less than 10 microns in diameter

Source: Title 40 Code of Federal Regulations 50 and Florida Administrative Code 62-204.240

FAC 62-210 (Stationary Source General Requirements). This rule establishes general requirements for stationary sources of air pollutant emissions and provides criteria for determining the need to obtain an air construction or air operation permit. It establishes public notice and reporting requirements and requirements relating to estimating emission rates and using air quality models. This chapter also sets forth special provisions related to compliance monitoring, stack heights, circumvention of pollution control equipment, and excess emissions.

FAC 62-212 (Stationary Source Preconstruction Permitting). The preconstruction review requirements for proposed new emissions units or facilities and proposed modifications are established in this rule. The requirements of this chapter apply to those proposed activities for which an air construction permit is required. This chapter includes general pre-construction review requirements and specific requirements for emissions units subject to PSD and nonattainment area preconstruction review. It also includes preconstruction review requirements applicable to specific emissions unit types.

FAC 62-213 (Operating Permits). This rule implements federal rule Title 40 CFR 70, which provides a comprehensive operation permit system for permitting major sources of air pollution (Title V sources). The amount and schedule of payment of the annual emissions fee are provided. For facilities operating under the terms of Title V air general permits, applicability, general procedures and conditions, and local air program requirements are explained. Also provided are permit requirements for all Title V sources, changes allowed at a source without necessitating a permit revision, allowable trading of emissions within a source, permit application compliance, permit issuance, renewal and revision, and permit review by the U.S. EPA and any affected states.

Because potential emissions are above major source thresholds, Cape Canaveral AS is currently a major source with respect to FAC 62-213 regulations. The Title V Operating Permit application has been submitted to the FDEP and is under review.

3.10.2.2 **Meteorology.** Cape Canaveral AS is on the northern portion of a barrier island on the Atlantic Ocean, situated midway up the Florida peninsula (28.5°N latitude). The climate at Cape Canaveral AS is best characterized as maritime-tropical with long, relatively humid summers and mild winters. This barrier island experiences moderate seasonal and daily temperature variations. Average annual temperature is 71°F with a minimum monthly average of 60°F in January and a maximum of 81°F in July. During the summer, the average daily humidity range is 70 to 90 percent. The winter is drier with humidity ranges of 55 to 65 percent; frosts are quite rare. Despite average drier conditions during the winter, most occurrences of fog (54 days of the year) occur during the winter and are associated with the passage of weather fronts.

The seasonal wind pattern is reflected in the speed and direction statistics presented in Table 3.10-2. During the winter, the prevailing winds steered by the jet stream aloft are frequently from the north and west, and the land-sea temperature diminishes, resulting in fewer easterly sea breezes that counter the prevailing westerly winds. As the jet stream retreats northward during the spring, the prevailing winds shift and come out of the south. During the summer and early fall, as the land-sea temperature difference increases and the Bermuda high-pressure region strengthens, the winds originate predominantly from the south and east.

Table 3.10-2. Climatological Data, Kennedy Space Center

	Surface Winds		Mean Number of Days Occurrence			
			Precipitation (inches) [a]			
Month	Prevailing Direction	Mean Speed (mph)	≥0.01	≥0.5	Thunder-storms	Fog Visibility <2 miles
January	NNW	8	7	2	1	9
February	N	8	7	2	2	7
March	SSE	8	8	2	3	7
April	E	9	5	1	3	4
May	E	8	8	2	8	3
June	E	7	12	3	13	2
July	S	6	11	4	16	2
August	E	6	11	3	14	2
September	E	6	13	4	10	2
October	E	8	11	3	4	3
November	N	7	7	2	1	6
December	NW	8	8	1	1	7
Annual	E	7	108	29	76	54
Years of Record	10	10	26	26	26	26

Note:	(a)		Snowfall has not occurred in 26 years.
	E	=	east
	mph	=	miles per hour
	N	=	north
	NNW	=	north northwest
	NW	=	northwest
	S	=	south
	SSE	=	south southeast

Source: U.S. Air Force, 1991e

Under normal midday weather conditions, surface mixing occurs over a layer with an average daily maximum value of 2,300 to 2,950 feet during the winter and 3,900 to 4,600 feet during the summer. The mixed layer is rarely capped by a strong temperature inversion. At the surface, easterly sea breezes with moderate speeds (5 to 10 miles per hour [mph]) and depths on the order of 500 to 1,000 feet occur nearly every day during the summer and early fall. Aloft, the prevailing winds are more westerly and northerly during the winter due to the southward migration of the jet stream.

Most periods of high winds and heavy rainfall occur during thunderstorms, which develop mainly from May through September (see Table 3.10-2). The Cape Canaveral AS region has the highest number of thunderstorms in the world during the summer months. On the average, there are thunderstorms on 76 out of 180 days. Over 70 percent of the annual 48 inches of rain occurs during the summer. During thunderstorms, wind gusts of more than 60 mph and rainfall of over 1 inch often occur in a one-hour period. Numerous lightning strikes to the ground occur (1,400 strikes per month over the 135-square-mile region surrounding Cape Canaveral). During such weather, flight activities at Cape Canaveral AS are often suspended. Hurricanes can also occur, normally between August and October. Landfall for hurricanes is relatively infrequent. Flight activities are suspended during hurricanes.

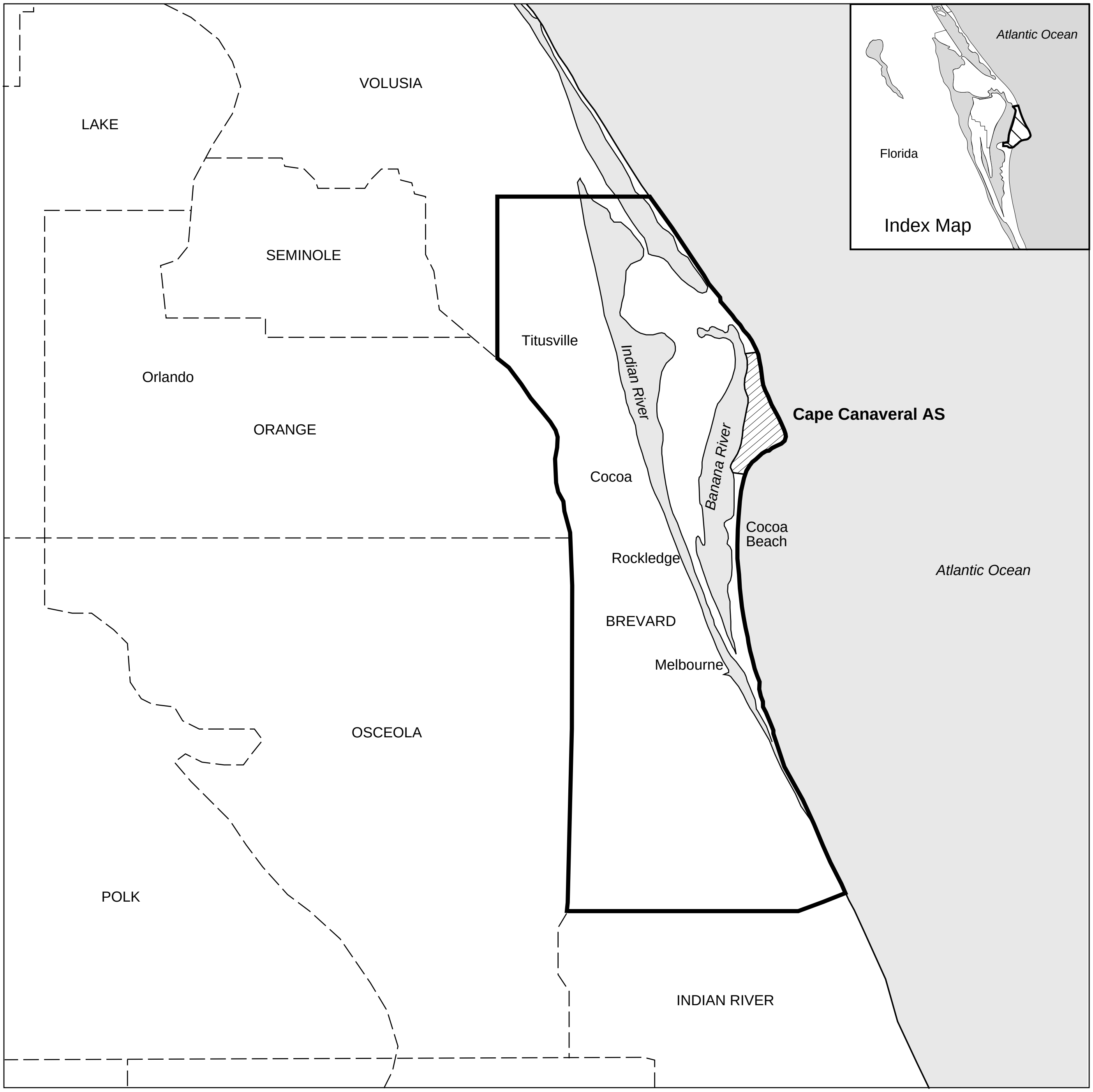
3.10.2.3 **Regional Air Quality.** Existing air quality is defined by air quality data and emissions information. Air quality data are obtained by examining records from air quality monitoring stations maintained by the FDEP. Information on pollutant concentrations measured for short-term (24 hours or less) and long-term (annual) averaging periods is extracted from the monitoring station data in order to characterize the existing air quality background of the area.

The FDEP classifies areas of the state that are in attainment or nonattainment of the FAAQS. In Florida, regional air quality is assessed at the county level. Cape Canaveral AS is in Brevard County (Figure 3.10-1), which has been designated by both the U.S. EPA and the FDEP to be in attainment for ozone SO_2, NO_x, CO, and PM_{10}. As discussed in Section 3.10.1, the NAAQS are being revised; these revisions may affect the attainment status of Brevard County.

The ROI for lower-atmosphere air quality resources may extend beyond the project boundaries (i.e., the launch complexes and other construction areas) to include those areas significantly affected by air dispersion and/or commuter traffic. This could include an area as large as the regional air quality basin (Brevard County) and may affect the maintenance of the NAAQS and the FAAQS for Brevard County.

Ambient air quality is measured at weather stations throughout Florida. The nearest weather station to Cape Canaveral AS, at the KSC, measures ozone NO_2, SO_2, PM_{10}, and CO. The nearest weather station that monitors lead level concentrations is the Orlando station in Orange County. Table 3.10-3 shows available 1995 hourly average ambient air concentrations for criteria pollutants.

In addition to regional impacts, emissions from specific sources can impact local air quality. If a specific source emits high levels of a pollutant, it can significantly increase the concentration of that pollutant in the vicinity of the



EXPLANATION

Counties

Brevard County

0 3.75 7.5 15 Miles

EELV/069

Air Quality Region of Influence, Cape Canaveral AS

Figure 3.10-1

Table 3.10-3. 1995 Average Ambient Air Concentrations for Criteria Pollutants Near Cape Canaveral AS

Pollutant	Averaging Time	Concentration ($\mu g/m^3$)
O_3	Hourly	57.4
NO_x	Hourly	11.4
	Yearly	1.4
SO_2	3 Hours	19.4
	24 Hours	5.8
PM_{10}	Hourly	15.0
Pb	Hourly	0.0
CO	Hourly	4,230
	8 Hours	2,640

CO = carbon monoxide
$\mu g/m^3$ = micrograms per cubic meter (approximate, converted from parts per million)
NO_x = nitrogen oxides
O_3 = ozone
Pb = lead
PM_{10} = particulate matter equal to or less than 10 microns in diameter
SO_2 = sulfur dioxide

source. Sources of criteria pollutants and sources of HAPs can have local air quality impacts.

3.10.2.4 **Air Emissions.** Emission inventory information for the affected environment was obtained from the FDEP and from Cape Canaveral AS. Inventory data for each pollutant are reported in tons per year in order to describe the baseline conditions of pollutant emissions in the area.

In July 1996, an Air Emissions Inventory report was completed for Cape Canaveral AS for calendar year 1994 (Radian International, 1996). This report lists emissions from all stationary sources at Cape Canaveral AS (Table 3.10-4), as well as from other activities, such as the generation of road dust.

A baseline launch emissions inventory has been generated for the applicable launch activities in 1995. The baseline emissions included in this inventory are specifically for the current launch vehicle systems (Atlas II, Delta II, and Titan IV), and associated support activities. This inventory includes estimates of emissions from the following key sources:

- Vehicle launch
- Vehicle preparation, assembly, and fueling
- Mobile sources such as support equipment, commercial transport vehicles (including trucks and aircraft), and personal vehicles
- Point sources such as heating/power plants, generators, incinerators, and storage tanks.

Table 3.10-4. Cape Canaveral AS Baseline Emissions[(a)]

	VOC	NO_x	CO	SO_2	PM_{10}
Existing Launch Program					
Vehicle Launches	0.0	13.3	0.0	0.0	144.1
Vehicle Preparation, Assembly, and Fueling	14.9	0.0	0.0	0.0	5.0
Mobile Sources	37.6	63.6	311.3	2.9	128.6
Point Sources	1.0	22.9	6.2	17.7	1.0
Total	53.6	99.8	317.5	20.6	278.6
Cape Canaveral AS 1994 Air Emissions Inventory Report[(b)]	104.4	382.9	274.5	102.6	75.5
Brevard County Point Source	107	11,514	991	26,492	340
Brevard County Area Source	24,876	14,608	133,752	1,032	34,750
Brevard County Total	24,983	26,122	134,743	27,524	35,090

Notes: (a) All emissions in tons per year for 1995 unless otherwise indicated.
(b) Includes stationary source emissions only.
AS = Air Station
CO = carbon monoxide
NO_x = nitrogen oxides
PM_{10} = particulate matter equal to or less than 10 microns in diameter
SO_2 = sulfur dioxide
VOC = volatile organic compound

Estimates are divided into two categories: emissions that are directly launch-related and infrastructure emissions. Launch-related emissions are estimated on a pounds-per-launch basis. Infrastructure emissions are estimated on a pounds-per-day basis and are assumed to take place regardless of the number of launches per year. Emission comparisons are summarized in Table 3.10-4 for criteria pollutants. Emissions from each of the key sources are calculated as described below.

Vehicle Launch. Table 3.10-5 lists expendable vehicle launches from Cape Canaveral AS in 1995. Actual launch emissions are estimated using kinetics and flowfield models as described below. Emissions predicted to be below 3,000 feet in altitude are included in the inventory totals. Emissions at altitudes above 3,000 feet are addressed in Section 3.11, Air Quality (Upper Atmosphere). Emissions are addressed only for those vehicles that would be replaced by EELV launches (Atlas II, Delta II, Titan IV).

A standard Two-Dimensional Kinetics (TDK) Nozzle Performance Computer Model (version 1993) models the engine performance to provide information on the mass flux out of the engine. The Standardized Plume Flowfield Model (SPF-3) is used to model after-burning to provide mass fractions of chemical products such as NO_x, carbon, and chlorine compounds found in some fuels as a function of atmospheric density and temperature.

Table 3.10-5. 1995 Launches, Cape Canaveral AS

Date	Vehicle	Launch Complex
January 10	Atlas IIAS	SLC-36B
January 28	Atlas IIA	SLC-36A
March 22	Atlas IIAS	SLC-36B
April 7	Atlas IIA	SLC-36
May 14	Titan IV	SLC-40
May 23	Atlas I	SLC-36B
May 31	Atlas IIA	SLC-36A
July 10	Titan IV	SLC-41
July 31	Atlas II	SLC-36A
August 5	Delta II	SLC-17
August 28	Atlas IIAS	SLC-36B
October 22	Atlas II	SLC-36A
November 6	Titan IV	SLC-40
December 2	Atlas IIAS	SLC-36B
December 15	Atlas IIA	SLC-36A
December 30	Delta II	SLC-17A

SLC = Space Launch Complex

Emission estimates were made using the launch trajectory information for LEO and geosynchronous orbit missions. The fraction of each propellant emitted below 3,000 feet, along with the height-dependent mass fractions from SPF-3, are used to estimate the emissions. Information on mission trajectory for each launch in Table 3.10-5 was not available, so an equal split between the two trajectories was assumed for each launch vehicle.

The emissions shown in Table 3.10-4 are totals for emissions from the selected 1995 launch vehicles. These data are useful for estimating the effect of these launches on regional air quality. In addition, the launches can impact local air quality by causing a short-term increase in pollutant concentrations near the launch site. These impacts are best addressed on a per-launch basis for each vehicle type. The relevant comparisons are presented in the analysis within Section 4.10.

Vehicle Preparation, Assembly, and Fueling. For the 15 launches included in the 1995 baseline, most of the preparation and assembly operations took place at Cape Canaveral AS. However, the majority of these activities do not produce air emissions. Emissions are estimated for solvent cleaning and sanding activities, which produce VOC and particulate emissions, respectively. Payload processing is not included in the vehicle preparation emissions estimates, as it is considered separate from the vehicle preparation activities.

For years prior to the baseline emissions year (1995), the rocket engines for each vehicle were sometimes flushed with chlorinated solvent (notably TCE). By 1995, efforts to replace the use of chlorinated solvents had progressed to the point where little or no chlorinated solvent was used for rocket engine cleaning.

ODSs are used for refrigeration, fire suppression, and some degreasing operations. Some emissions can occur from leakage from refrigeration and fire suppression systems as well as from evaporation during cleaning and degreasing. Total ODS emissions associated with the Atlas, Delta, and Titan operations are estimated to be 192 pounds for 1995 Cape Canaveral AS operations.

Fueling of hydrogen involves some venting of hydrogen through a flare. Each flare uses propane as auxiliary fuel. Emissions of combustion products from the hydrogen control flares are estimated using EPA AP-42 standard factors for external combustion; these emissions are very minor.

Emissions from RP-1 storage and fueling are estimated using U.S. EPA AP-42 emission factors. Estimates are made for working emissions, caused by filling and emptying the storage tanks, and breathing emissions, caused by daily warming and cooling of the tanks in the sunlight. Because RP-1 is not a very volatile fuel, emissions from RP-1 storage tanks are very small.

Emissions from hydrazine and N_2O_4 loading are controlled by a combination of sealed transfer systems, wet scrubbing, and oxidation. Emissions of hydrazine are listed as HAP emissions, discussed below. Emissions of N_2O_4 (a form of NO_x) are insignificant compared to other sources of nitrogen oxides.

After vehicle launch, the SLC must be cleaned and repaired. Surfaces are cleaned using an abrasive blaster; ablative coatings are applied, and painted surfaces are touched up or repainted. Particulate emissions from sandblasting are estimated based on estimated use and a particulate emission factor. VOC emissions from coatings are obtained from coating use quantity estimates.

Mobile Sources. Mobile emission sources include:

- Vehicle Deliveries and Miscellaneous Supply Traffic
- Vehicle Assembly and On-Site Transport
- Personal Automobile Use.

Vehicle Deliveries and Miscellaneous Supply Traffic

The Atlas, Delta, and Titan vehicle components were delivered by truck and airplane. Truck emissions are calculated using pounds of emissions per Vehicle Miles Traveled (VMT) for both on- and off-site trips. Emission factors are taken from the MOBILE 5a and PART5 computer models. Emissions from required escort cars for oversize loads are calculated similarly.

Because the ROI for Cape Canaveral AS includes all of Brevard County, transportation emissions are calculated for all vehicular traffic directly related to EELV activities that take place in Brevard County.

Deliveries made by truck are assumed to involve round-trip traffic to and from the northern county line (50 percent) or the southern county line (50 percent). It is assumed that travel would occur along Interstate 95 occurs.

Portions of the Atlas, Delta, and Titan vehicles are delivered by airplane. The Delta deliveries are made using a C-141 aircraft. Emissions from the C-141 aircraft associated with landing and take-off are calculated using the factors available in the computer model Emissions and Dispersion Modeling System (EDMS), Version 3.0. The Titan deliveries are made using a C-5 Galaxy aircraft. Emissions from the C-5 aircraft associated with landing and take-off and emissions of particulate matter are calculated using the factors available in the Calculation Methods for Criteria Air Pollutant Emission Inventories (Jagielski and O'Brien, 1994).

Vehicle Assembly and On-Site Transport

Assembly of vehicle components and on-site transport of the vehicle create emissions from mobile sources, several of which are standard vehicles (trucks, etc.). Emissions from these sources are estimated using VMT and the emission factors available in the MOBILE 5a and PART5 computer models. Other mobile sources (cranes, specialized transport vehicles) are not standard and therefore have no associated standard emission factors. Emissions from these vehicles are calculated using hours of operation, rated capacity (in horsepower), and the stationary source AP-42 emission factors for the appropriate engine types. Pollutant activities from these sources are relatively minor, and general estimates are used where specific data are not available.

Personal Automobile Use

Emissions from employee personal automobile use are calculated based on both on- and off-site emissions. Based on studies conducted for this EIS, employees' places of residence were identified and commuting distances calculated from the center of their resident cities to Cape Canaveral AS. Non-work trip VMT are also included in the total off-site VMT. The average vehicle ridership number is applied to VMT calculations. Emissions are calculated using VMT and the emission factors available in the MOBILE 5a and PART5 computer models. A surge in automobile traffic prior to launch, associated with pre-launch processing activities, is accounted for in the calculations.

Point Sources. Point sources include combustion sources, such as boilers and internal combustion engines. Emissions from other point sources such as spray booths and solvent cleaning equipment are included in the total emission calculations for vehicle preparation and assembly. Emissions from boilers and internal combustion engines are listed in the July 1996 Air Emissions Inventory report for Cape Canaveral AS (Radian International, 1996). The emissions from these sources are attributed to the Atlas, Delta, and Titan programs for use in this baseline emissions inventory.

Hazardous Air Pollutants. Emissions of HAPs have been quantified from emission sources addressed in the criteria pollutant section of this analysis. In quantifying emissions, HAP emissions can occur from three separate activities:

- Vehicle Launch (chlorine compounds)
- Fuel Loading (hydrazine)
- VOC solvent and coating usage (VOC HAPs such as toluene and methyl ethyl ketone).

Emissions of chemically active chlorine compounds (Cl_x) from vehicle launch are estimated using the TDK and SPF-3 models. These emissions include HCl, chlorine (Cl), and other chemically active compounds; chemically inactive compounds such as aluminum chlorides are treated as particulate matter (PM). Hydrazine emissions from fuel loading are estimated based on an estimated percentage loss during fueling and an estimated control efficiency for the wet scrubber/oxidizer vapor control systems. Emissions of VOC HAPs from solvent and coating usage are conservatively assumed to be 100 percent of the VOC emissions from these sources. Baseline emissions of HAPs for Cape Canaveral AS are summarized in Table 3.10-6.

Table 3.10-6. Cape Canaveral AS Baseline HAPs Emissions[(a)]

	Cl_x	Hydrazine fuels	VOC HAP
Vehicle Launches	72.3	0.0	0.0
Vehicle Fueling	0.0	<0.01	<0.01
Vehicle Coating/Solvent Use	0.0	0.0	14.9
Project Total	72.3	<0.01	14.9

Note: (a) All emissions in tons per year for 1995
Cl_x = chlorine compounds
HAP = hazardous air pollutant
VOC = volatile organic compound

3.10.3 **Vandenberg AFB**

3.10.3.1 **California Regulatory Framework.** Air quality for the Vandenberg AFB area is regulated under the California Code of Regulations (CCR), Title 17, Division 3, Chapter 1. Specific regulations of interest include CCR 17-Section 70200 (Ambient Air Quality Standards), and CCR 17-Section 93000 et seq. (Toxic Air Contaminants). Vandenberg AFB is also regulated by the SBCAPCD. Specific regulations of interest include Regulation II (Permits), Regulation X (NESHAPs) , and Regulation XIII (Operating Permits).

CCR 17-Section 70200. California Ambient Air Quality Standards (CAAQS). The California Air Resources Board (CARB) has developed ambient air quality standards (Table 3.10-7), which represent the maximum allowable atmospheric concentrations that may occur and still ensure protection to public health and welfare with a reasonable margin of safety.

CCR 17-93000 et seq. (Toxic Air Contaminants). Subchapter 7 of this regulation defines toxic air pollutants as well as HAPs (including hydrazine fuel). Subchapter 7.5 contains requirements for air toxics control measures; these requirements are industry-specific. Subchapter 7.6 (CCR 17-93300) incorporates by reference Health and Safety Code sections 44300-44394 (Part 6), which codify the requirements of the Air Toxics “Hot Spots” Information and Assessment Act of 1987.

Changes to the use of toxic and hazardous air pollutants on site may require the submission of an Air Toxic “Hot Spots” Questionnaire. The SBCAPCD may require Vandenberg AFB to file or update its AB-2588 toxic plan. In addition, Part 6 Chapter 3 (Section 44340) of the Air Toxics “Hot Spots” Information and Assessment regulations requires preparation and submission of a comprehensive emissions inventory plan.

SBCAPCD Regulations, Regulation II - Permits. This regulation requires that any person building, erecting, altering, or replacing any article, machine, equipment, or other contrivance, the use of which may cause the issuance of air contaminants, or the use of which may eliminate or reduce or control the issuance of air contaminants, shall first obtain authorization for such construction from the Control Officer in the form of an Authority to Construct Permit. This permit shall remain in effect until the permit to operate the equipment for which a permit application was filed is granted or denied or the application is canceled. The facility must have a permit to operate before equipment may be operated or used; a written permit shall be obtained from the Control Officer. The application must include information or analysis that will disclose the nature, extent, quantity, or degree of air contaminants the source may discharge. An application may also be necessary for equipment that is modified.

Table 3.10-7. National and California Ambient Air Quality Standards

Pollutant	Averaging Time	California Standards[a,c] ($\mu g/m^3$)	National Standards ($\mu g/m^3$)[b] Primary[d]	Secondary[e]
Ozone	1 Hour	180	235	Same as primary standard
Carbon Monoxide	8 Hours	10,000	10,000	----
	1 Hour	23,000	40,000	----
Nitrogen Dioxide	Annual	----	100[g]	Same as primary standard
	1 Hour	470	----	
Sulfur Dioxide	Annual	----	80	----
	24 Hours	105	365	----
	3 Hours	----	----	0.5 ppm (1,300 $\mu g/m^3$)
	1 Hour	655	----	----
PM_{10}	Annual	30[f]	50[g]	Same as primary standard
	24 Hours	50	150	Same as primary standard
Sulfates	24 Hours	25	----	----
Lead	30 Days	1.5	----	----
	Quarterly	----	1.5	Same as primary standard
Hydrogen Sulfide	1 Hour	42	----	----
Vinyl Chloride	24 Hours	26	----	----
Visibility-Reducing Particles[h]	8 Hours (10 a.m. to 6 p.m., Pacific Standard Time)	In a sufficient amount to produce an extinction coefficient of 0.23 per km due to particles when the relative humidity is less than 70 percent CARB Method V.		

Notes: (a) California standards for ozone, carbon monoxide, sulfur dioxide (1 hour and 24 hours), nitrogen dioxide, particulate matter less than 10 microns in diameter (PM_{10}), and visibility-reducing particles are values that are not to be exceeded. The sulfates, lead, hydrogen sulfide, and vinyl chloride standards are not to be equaled or exceeded.
(b) National standards other than ozone and those based on annual averages or annual arithmetic means are not to be exceeded more than once a year. The ozone standard is attained when the expected number of days per calendar year, with maximum hourly average concentrations above the standards, is equal to or less than one.
(c) Values for standards are based on a reference temperature of 25 degrees Celsius (°C) and a reference pressure of 760 millimeters (mm) of mercury. All measurements of air quality are to be corrected to a reference temperature of 25°C and a reference pressure of 760 mm of mercury (1,013.2 millibars).
(d) National Primary Standards: the levels of air quality necessary to provide an adequate margin of safety to ensure protection of the public health.
(e) National Secondary Standards: the levels of air quality necessary to provide that the public welfare is safe from any known or anticipated adverse effects of pollutant.
(f) Calculated as geometric mean.
(g) Calculated as arithmetic mean.
(h) This standard is intended to limit the frequency and severity of visibility impairment due to regional haze and is equivalent to a 10-mile nominal visual range when relative humidity is less than 70 percent.

CARB = California Air Resources Board
km = kilometer
$\mu g/m^3$ = micrograms per cubic meter
PM_{10} = particulate matter equal to or less than 10 microns in diameter
ppm = parts per million

Source: California Air Resources Board, 1992

In 1991, a Memorandum of Agreement (MOA) between the Air Force and the SBCAPCD designated Vandenberg AFB as a single stationary source. Under this MOA, new or modified sources would require Best Available Control Technology (BACT) and offsetting reduction of emissions elsewhere on base if emissions are increased at SLC-3W. Recent changes to the SBCAPCD regulations are affecting the regulatory framework for Vandenberg AFB, and the 1991 MOA may no longer be applicable.

Santa Barbara County Air Pollution Control District Regulation VII.702 (General Conformity). In October 1994, the SBCAPCD adopted Rule 702, taken verbatim from Subpart W, except for Section 51.860 (mitigation measures), in order to address General Conformity.

Santa Barbara County Air Pollution Control District Regulations, Regulation X (National Emission Standards for Hazardous Air Pollutants). This regulation incorporates the federal regulation for NESHAPs (Title 40 CFR 61 and 63) and provisions recently promulgated by the U.S. EPA as published in the Federal Register.

SBCAPCD Regulation X incorporates the federal NESHAPs regulations, including 40 CFR 63 Subpart GG (National Emission Standards for Aerospace Manufacturing and Rework Facilities).

Santa Barbara County Air Pollution Control District Regulations, Regulation XIII (Operating Permits). This regulation incorporates the federal regulation for Operating Permits under Title 40 CFR Part 70, which states that federally enforceable requirements include, but are not limited to, New Source Performance Standards (NSPS), PSD, New Source Review (NSR), NESHAPs, NAAQS, Maximum Available Control Technology (MACT) Standards, Title III Section 112, Title IV (Acid Deposition Control), and Title VI (Stratospheric Ozone Protection).

As discussed in Section 3.10.1, Vandenberg AFB has entered into an agreement with the U.S. EPA and SBCAPCD as part of the ENVVEST program. As part of this program, Vandenberg AFB has been exempted from the requirements of Title 40 CFR 70 and therefore from SBCAPCD Regulation XIII. Instead, Vandenberg AFB has facility-specific operational and reporting requirements.

3.10.3.2 **Meteorology.** Vandenberg AFB is situated on Point Arguello on the California coast in the western portion of Santa Barbara County. The climate is categorized as Mediterranean, or dry and subtropical. The coastal location of Vandenberg AFB experiences moderate seasonal and diurnal variation in temperature and humidity. Temperatures are mild, ranging from 45 degrees (°) Fahrenheit (F) to 85°F with an annual mean temperature of 55°F. Temperatures below freezing and above 100°F are rare. The rainy season extends from November to April. Annual precipitation is 13 inches with the most rain falling during February (2.6 inches) and the least during July (0.01 inch). The annual relative humidity is 77 percent. The driest periods occur during the fall, when Santa Ana winds can result in humidity as low as 10 percent.

The Point Arguello region consists of moderately complex terrain consisting of steep hills and valleys. Because of its terrain and the fact that it is bounded by the ocean on two sides, there is a geographically variable wind field at the surface. The mean annual wind speed in the area is 7 mph out of the northwest. The strongest winds occur during the winter and midday, and at ridge lines. Over half the time, the wind blows at speeds greater than 7 mph at the base. Calms are rare (less than 1 percent), and the lowest wind speeds occur during the evening and early morning hours. Easterly winds occur very infrequently and generally occur during the fall, when Santa Ana winds may invade the region for a day or two.

The diurnal weather pattern in the area is characterized by nighttime and early-morning low cloud cover and coastal fog. Cloud cover occurs almost half of the time. The fog burns off by mid-morning and is replaced by a sea breeze as the land begins to warm. Sea breezes are less frequent during the winter. The average visibility is the worst during July through September due to the occurrence of fog. During the winter, storms and fronts move through the area, resulting in gusty and rainy conditions. Thunderstorms are relatively infrequent, occurring two or three times each year.

The average annual ceiling height for the cloud cover is approximately 1,000 feet, but often depends on the height of the base of a capping inversion layer. The entire south-central coastal region experiences a persistent subsidence inversion due to a Pacific high-pressure region. The temperature inversion occurs below the 4,500-foot level and caps the planetary boundary layer, effectively disconnecting it from the free tropospheric air masses. The average maximum daily inversion height over Point Arguello ranges from 1,600 feet during the summer to 2,800 feet during the winter (Holzworth, 1964).

3.10.3.3 **Regional Air Quality.** Information on how existing air quality is defined is provided in Section 3.10.2.2.

The CARB classifies areas of the state that are in attainment or nonattainment of the CAAQS. In California, air quality is assessed on a county and regional basis. Vandenberg AFB is in Santa Barbara County, which is part of the South Central Coast Air Basin (SCCAB) (Figure 3.10-2). The SCCAB includes the counties of San Luis Obispo, Santa Barbara, and Ventura and has been designated by both the U.S. EPA and CARB as being in attainment of the NAAQS and CAAQS for SO_2, NO_x, and CO, but as in nonattainment for ozone. Vandenberg AFB has been designated by the U.S.

EXPLANATION

Counties

South Central Coast Air Basin

Air Quality Region of Influence Vandenberg AFB

0 12.5 25 50 Miles

Figure 3.10-2

EELV/068

EPA to be unclassified for PM_{10} but has been designated by CARB to be in nonattainment of CAAQS for PM_{10}.

The U.S. EPA uses two categories to designate areas with respect to PM_{10}. These designations are nonattainment (areas that do not meet national standards) and unclassified (areas that cannot be classified). The levels for state and national PM_{10} standards may differ. For Santa Barbara County, the state PM_{10} 24-hour standard is 50 $\mu g/m^3$. The national PM_{10} 24-hour standard is 150 $\mu g/m^3$. Vandenberg AFB is designated as in non-attainment with the state PM_{10} standard only.

According to the federal classification, the SCCAB is designated as being in the “moderate” ozone nonattainment category (ozone concentrations between 0.138 to 0.160 ppm). An area designated as “moderate” is subject to a number of requirements.

On September 2, 1997, the Federal Register published the EPA’s proposed reclassification (Title 40 CFR 81) of Santa Barbara County from a moderate ozone nonattainment area to a serious ozone nonattainment area. This reclassification was proposed because Santa Barbara County had failed to attain the 1-hour ozone NAAQS by the statutory deadline of November 15, 1996. The reclassification has since become final and places more stringent requirements on the area. As discussed in Section 3.10.1, the NAAQS are being revised; these revisions may also affect the attainment status of Santa Barbara County.

The ROI for lower-atmosphere air quality resources may extend beyond the project boundaries to include those areas significantly affected by air dispersion and/or commuter traffic. This could include an area as large as the regional air quality basin (South Central Coast Air Basin) and may affect the maintenance of the NAAQS and the CAAQS for the Vandenberg AFB area.

Ambient air quality is measured at weather stations throughout California. The nearest air station for monitoring these data is on Vandenberg AFB. No data are available for 1995 lead concentrations. Table 3.10-8 shows 1995 average ambient air concentrations for criteria pollutants.

3.10.3.4 **Air Emissions.** Emissions inventory information for the affected environment was obtained from the SBCAPCD, the CARB, and Vandenberg AFB. Inventory data for each pollutant are reported in tons per year in order to describe the baseline conditions of pollutant emissions in the area.

The existing SBCAPCD Emissions Questionnaire lists emissions from stationary sources. This information has been included in Table 3.10-9. These emissions are for all stationary sources at Vandenberg AFB.

Table 3.10-8. 1995 Average Ambient Air Concentrations for Criteria Pollutants at Vandenberg AFB

Pollutant	Averaging Time	Concentration, $\mu g/m^3$
O_3	Hourly	150
NO_x	Hourly	18
SO_2	Hourly	18
	3 Hours	10.5
	24 Hours	5.3
PM_{10}	24 Hours	75.5
CO	Hourly	2,500
	8 Hours	2,150

CO = carbon monoxide
$\mu g/m^3$ = micrograms per cubic meter (approximate, converted from parts per million)
NO_x = nitrogen oxides
O_3 = ozone
PM_{10} = particulate matter equal to or less than 10 microns in diameter
SO_2 = sulfur dioxide

Source: Santa Barbara County Air Pollution Control District, 1997.

Table 3.10-9. Vandenberg AFB Baseline Emissions[(a)]

	VOC	NO_x	CO	SO_2	PM_{10}
Existing Launch Programs					
Vehicle Launches	0.0	1.7	0.0	0.0	30.8
Vehicle Preparation, Assembly, and Fueling	2.3	0.0	0.0	0.0	0.7
Mobile Sources	33.8	30.0	354.5	2.0	101.5
Point Sources	0.2	8.1	1.2	0.6	0.5
Total	36.3	39.8	355.7	2.6	133.4
Vandenberg AFB Stationary Sources (Emissions Questionnaire)[(b)]	4.2	21.3	1.2	7.7	2.1
Santa Barbara County Point Source	1,350	418	2,108	585	145
Santa Barbara County Area Source	43,314	13,576	100,401	705	29,229
Santa Barbara County Total	44,664	13,994	102,509	1,290	29,374

Notes: (a) All emissions in tons per year for 1995.
(b) Includes stationary source emissions only.
CO = carbon monoxide
NO_x = nitrogen oxides
PM_{10} = particulate matter equal to or less than 10 microns in diameter
SO_2 = sulfur dioxide
VOC = volatile organic compound

A baseline launch emissions inventory has been generated for the applicable launch activities in 1995. The baseline emissions included in this inventory are specifically for current launch vehicle systems (Atlas II, Delta II, and

Titan IV), and support activities for the launch of those vehicles. This inventory includes estimates of emissions from the following key sources:

- Vehicle launch
- Vehicle preparation, assembly, and fueling
- Mobile sources such as support equipment, commercial transport vehicles (including trucks and aircraft), and personal vehicles
- Point sources such as heating/power plants, generators, incinerators and storage tanks.

Estimates are divided into two categories: emissions that are directly launch-related and infrastructure emissions. Launch-related emissions are estimated on a pounds-per-launch basis. Infrastructure emissions are estimated on a pounds-per-day basis and are assumed to take place regardless of the number of launches per year. Emissions comparisons are summarized in Table 3.10-9 for criteria pollutants.

Emissions from each of the key sources are calculated as described below.

Vehicle Launch. Table 3.10-10 lists vehicle launches from Vandenberg AFB in 1995. Emissions are addressed only for those vehicles being replaced (Atlas II, Delta II, Titan IV). Actual launch emissions are estimated using chemical reaction kinetics and flowfield models as described below. Emissions predicted to be below 3,000 feet in altitude are included in the inventory totals; emissions at altitudes above 3,000 feet are addressed in Section 3.11, Upper Atmosphere.

Table 3.10-10. 1995 Launches, Vandenberg AFB

Date	Vehicle	Launch Complex
March 24	Atlas E	SLC-3W
November 3	Delta II	SLC-2W
December 5	Titan IV	SLC-4E
April 3	Pegasus	L-1011
June 22	Pegasus XL	L-1011
August 15	Lockheed LLV	SLC-6

The standard TDK Nozzle Performance Computer Model is utilized to model the engine performance, as described in Section 3.10.2.2.

The emissions estimates presented in Table 3.10-9 are for normal launches and do not require any further modeling. Emission estimates were made using the launch trajectory information for LEO and GTO missions. The fraction of each propellant emitted below 3,000 feet, along with the height-dependent mass fractions from SPF-3, is used to estimate the emissions. Information on mission trajectory for each launch in Table 3.10-10 was not available, so for analysis purposes, it was assumed that 50 percent of launches would utilize a GTO trajectory, and 50 percent would utilize a LEO trajectory.

The emissions shown in Table 3.10-9 are totals for emissions from the selected 1995 launch vehicles and show the contribution of these launches to regional air quality. Local air quality impacts are addressed on a per-launch basis in the analysis within Section 4.10.

Vehicle Preparation, Assembly, and Fueling. For the two launches included in the 1995 baseline, much of the preparation and assembly operations took place at Vandenberg AFB. A discussion of emissions associated with these activities is provided in Section 3.10.2.2.

Total ODS emissions associated with the Atlas, Delta, and Titan operations are estimated to be 64 pounds for 1995 Vandenberg AFB operations.

Mobile Sources. Mobile emission sources are described in Section 3.10.2.2.

Vehicle Deliveries and Miscellaneous Supply Traffic

Methods and assumptions utilized to calculate emissions associated with these activities are described in Section 3.10.2.2.

Because the ROI for Vandenberg AFB includes all of the SCCAB, transportation emissions are calculated for all vehicular traffic that takes place in Santa Barbara, San Luis Obispo, and Ventura counties and is directly related to EELV activities.

Vehicle Assembly and On-Site Transport

Methods used to calculate emissions for these activities are described in Section 3.10.2.2.

Personal Automobile Use

Methods utilized to calculate emissions associated with these activities are described in Section 3.10.2.2.

Point Sources. Emissions from point sources such as spray booths and solvent cleaning equipment are included in the total emission calculations for vehicle preparation and assembly. Emissions from boilers and internal combustion engines are calculated based on the information provided in the 1995 Santa Barbara County Air Pollution Control District (APCD) Annual Emission Inventory Questionnaire. The emissions from these sources are attributed to the Atlas, Delta, and Titan programs for use in this baseline emissions inventory.

Hazardous Air Pollutants. Methods used to calculate HAPs emissions are described in Section 3.10.2.2. Baseline emissions of HAPs for Vandenberg AFB are summarized in Table 3.10-11.

Table 3.10-11. Vandenberg AFB Baseline HAPs Emissions[(a)]

	Cl_x	Hydrazine fuels	VOC HAP
Vehicle Launches	15.4	~0.0	0.0
Vehicle Fueling	0.0	>0.01	>0.01
Vehicle Coating/Solvent Use	0.0	0.0	2.3
Total	15.4	>0.01	2.3

Note: (a) All emissions in tons per year.
Cl_x = chlorine compounds
HAP = Hazardous Air Pollutant
VOC = volatile organic compound

3.11 AIR QUALITY (UPPER ATMOSPHERE)

The atmosphere above 3,000 feet in altitude has been divided into two tropospheric layers (lower troposphere and upper troposphere) and the stratosphere. Immediately above the well-mixed layer at the Earth's surface (below 3,000 feet) lies the lower troposphere (3,000 feet to 10,000 feet). Air quality dispersion modeling for ambient pollutant concentrations that directly impact ground-level monitoring sites was conducted over the first 10,000 feet above the ground. This modeling region includes the mixed layer and the lower troposphere. Near-source modeling was conducted over the first 10,000 feet and within several tens of kilometers from the launch pad using the REEDM air quality model (Brady et al., 1997). Near-source modeling was conducted to determine if there would be immediate significant contributions of pollutant concentrations to the ambient concentrations of criteria and toxic pollutants that affect U.S. EPA and state and county air quality management plans. The upper troposphere lies between altitudes of 10,000 and 49,000 feet, where regional to global-scale transport and dispersion of the rocket plume occurs. The stratosphere occupies altitudes between 49,000 and 164,000 feet.

3.11.1 Troposphere

The atmosphere above the mixed layer is generally referred to as the free troposphere. This portion of the atmosphere is continually stirred by the turbulence generally referred to as "weather". Removal of most of the rocket emissions from the free troposphere takes place over a period of less than a week, even at the top of the troposphere. Material is removed by rain-out and by vertical motions that bring material to the ground. With such removal processes, global buildup does not occur, and any potential air impact from rocket launches is confined to a spatial extent of less than several thousand kilometers downrange and downwind from the launch site.

The ROI for free tropospheric effects is essentially the same, regardless of the launch vehicle used.

Estimates of annual troposphere baseline emissions into the troposphere from Cape Canaveral AS and Vandenberg AFB were developed for 1995 and 1996. During this period, the most recent configurations of the Atlas, Delta, and Titan vehicles were launched (Table 3.11-1). These configurations include the Atlas IIAS, the Delta II 6825, and the Titan IV SRM. Five Atlas IIAS launches were made with strap-on SRMs during the 2-year period.

Table 3.11-1. Launch Summary

	1995		1996	
Vehicle	Vandenberg AFB	Cape Canaveral AS	Vandenber gAFB	Cape Canaveral AS
Atlas II	0	10	0	6
Delta II	1	2	2	7
Titan IV	1	3	2	2
Total	6	23	8	23

AFB = Air Force Base
AS = Air Station

Specific data describing the configurations of the vehicles launched from Cape Canaveral AS and Vandenberg AFB during 1995 and 1996 are provided in Table 3.11-2.

The emissions for each region were estimated from the following information:

(1) Total flight-time fraction for each engine in each layer
(2) The total propellant mass of each engine
(3) Each pollutant's far-field mass fraction of the nozzle exit mass flow.

The total propellant mass emitted into each layer is estimated from the first two items described above. The amount of a specific chemical was estimated using the far field mass fraction. After-burning occurs in the troposphere, so in the tropospheric layers, CO was entirely converted to CO_2, and significant amounts of NO_x were generated. The HCl/Cl ratio is altered by after-burning; the emissions were estimated as Cl_x for the sum of the two chemicals. Both compounds are toxic and are treated cumulatively in this analysis. All aluminum compounds emitted from SRMs were treated as PM_{10}.

Table 3.11-2. Summary of Atlas II, Delta II, and Titan IV Configurations Launched During 1995 and 1996

	Atlas IIA	Atlas IIAS	Delta II 7925	Titan IVA	Titan IVB
Core motor fuel type	LO_2/RP-1	LO_2/RP-1	LO_2/RP-1	N_2O_4/A-50	N_2O_4/A-50
Core motor fuel mass	348.4K lbs	348.4K lbs	212.6K lbs	335.5K lbs	338.4K lbs
Burn Duration	172 s	172 s	265 s	190 s	190 s
SRM Strap-on type	NA	Castor IVA	GEM	SRM	SRMU
Number of Strap-ons	NA	4	9	2	2
Fuel mass/ engine	NA	22.3K lbs	25.8K lbs	600K lbs	680K lbs
Burn duration	NA	56.2 s for each firing	63.0 s for each firing	122 s	137 s
Stage 1 fuel type	Same as core motor	Same as core motor	LO_2/RP-1	N_2O_4/A-50	N_2O_4/A-50
Stage 1 fuel mass	Included in core motor	Included in core motor	13.3K lbs	77.2K lbs	77.2k lbs
Burn duration	283 s	283 s	265 s	223 s	223 s
Stage 2 fuel type	LO_2/LH_2 (Centaur II)	LO_2/LH_2 (Centaur II)	A-50/N_2O_4	LO_2/LH_2 (Centaur II)	LO_2/LH_2 (Centaur II)
Stage 2 fuel mass	37.5K lbs	37.5K lbs	13.2K lbs	75.4K lbs	75.4K lbs
Burn duration	600 s	600 s	440 s	600 s	600 s

A-50 = Aerozine-50
Castor IVA = older solid rocket motor (Thiokol)
GEM = graphite-epoxy motor
HTPB = hydroxyl-terminated polybutadiene
K = 1,000
lbs = pounds
LH_2 = liquid hydrogen
LO_2 = liquid oxygen
NA = not applicable
N_2O_4 = nitrogen tetroxide
RP-1 = kerosene fuel (rocket propellant-1)
s = seconds
SRM = solid rocket motor
SRMU = solid rocket motor upgrade

The total flight-time fraction is a function of the flight trajectory, which varies with respect to the mission specifics such as payload, desired orbit (height, eccentricity), and engine configuration. Although there can be some initial flight trajectory variation, the range of trajectories is somewhat limited. As a result, two trajectories representing the envelope of vehicle trajectories were used to estimate the flight-time fractions for each vehicle given its elapsed design burn time. The elapsed times at the top of each atmospheric layer are summarized in Table 3.11-3. For analysis purposes, it was assumed that 50 percent of launches would utilize a GTO trajectory, and 50 percent would utilize a LEO trajectory.

Table 3.11-3. Flight Trajectories Used to Estimate the Fraction of Engine Burn Time in Each Layer

Layer Designation	Layer top elevation (feet)	Trajectory 1 (GTO) (seconds)	Trajectory 2 (LEO) (seconds)
Lower atmosphere	3,000	29	19
Lower troposphere	10,000	50	33
Upper troposphere	49,000	95	72
Stratosphere	164,000	173	155

GTO = Geosynchronous Transfer Orbit
LEO = Low Earth Orbit

The fraction of the propellant burned in the 3,000 to 10,000-foot layer is estimated using the engine burn duration and the trajectory residence time in the lower troposphere. The height-dependent mass fractions of the pollutant emissions resulting from each pound of propellant burned are obtained from predictions made using the after-burning flow field model (SPF-3). These fractions are used with the amount of propellant burned in each atmospheric layer to estimate the emissions of pollutants into the tropospheric layers. Table 3.11-4 summarizes the annual emissions of pollutants for launches from Cape Canaveral AS and Vandenberg AFB for 1995 and 1996. During after-burning, the majority of NO_x and CO_2 production occurs in the troposphere, whereas CO emissions are notable only in the stratosphere (see Section 3.11.2). Table 3.11-4 indicates that there are large differences in emission estimates at Vandenberg AFB between 1995 and 1996 (due to the different number of launches and vehicle type). Both years are presented for comparison; 1995 is used as the baseline year for consistency with the lower-atmosphere air quality discussion (see Section 3.10).

3.11.2 **Stratosphere**

Rocket launches can affect the atmosphere both in an immediate, episodic manner, and in a long-term, cumulative manner. The stratosphere is affected immediately after launch along the flight trajectory. Emissions from some types of launch vehicles significantly perturb the atmosphere along the launch trajectory at a range of a kilometer or less from the rocket passage. Ozone is temporarily reduced, an aerosol plume may be produced, and combustion products such as NO_x, chlorinated compounds, and reactive radicals can temporarily change the normal chemistry along the vehicle path.

The stratosphere exchanges mass with the troposphere beneath it at a relatively low rate. With no rain-out or other removal mechanisms, the rocket combustion products can build up in the stratosphere over time if there is a

Table 3.11-4. Troposphere Emissions from Launches at Cape Canaveral AS and Vandenberg AFB, 1995 and 1996 (tons/year)

Chemical of Concern	CCAS 1995 Emissions Lower Troposphere	CCAS 1995 Emissions Upper Troposphere	CCAS 1996 Emissions Lower Troposphere	CCAS 1996 Emissions Upper Troposphere	VAFB 1995 Emissions Lower Troposphere	VAFB 1995 Emissions Upper Troposphere	VAFB 1966 Emissions Lower Troposphere	VAFB 1966 Emissions Upper Troposphere
PM	103	388	100	385	26	107	64.1	245
NO_x	5.6	13.8	4.5	12.4	1	2.9	2.5	6.7
CO	0.0	20.2	0.0	18.4	0.0	3.8	0.0	8.7
Cl_x	52	196	51	195	13	54	32.3	123
VOC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SO_2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

CCAS = Cape Canaveral Air Station
CO = carbon monoxide
Cl_x = chloride compounds
NO_x = nitrogen oxides
PM = particulate matter
SO_2 = sulfur dioxide
VAFB = Vandenberg Air Force Base
VOC = volatile organic compound

sufficient launch rate. When deposited into the stratosphere, ideally sized particulates (0.15 to 0.4 microns in size) such as alumina aerosols can persist for months and circle the globe. Aerosols that exist in the stratosphere can assist in catalyzing the destruction of ozone.

Gaseous chlorine compounds can also be sequestered in the stratosphere in a form that at some later date can be converted and contribute to ozone destruction anywhere over the globe.

The ROI for stratospheric effects is essentially the same, regardless of which launch vehicle is being used.

The lower boundary of the stratosphere lies between altitudes of 32,800 and 49,000 feet above the Earth's surface (with an atmospheric pressure in the range of 100 to 200 millibars [mb]) at a temperature inversion known as the tropopause. The stratosphere extends up to nearly 164,000 feet (with an atmospheric pressure of about 1 mb). Although containing less than 20 percent of the atmosphere's mass, and despite having relatively little direct impact on weather at the surface, the composition of the stratosphere can strongly influence the attenuation of solar radiation reaching the Earth's surface. Perturbations in the trace gas composition of the stratosphere by high-flying aircraft and rockets can potentially affect how the stratosphere absorbs and scatters the sun's radiation incident at its top. The environment at the Earth's surface can be affected by either changes in UV radiation or by changes in the balance of outgoing and incoming long- and short-wave solar radiation, which maintains the Earth's present climate. The stratospheric ozone burden is of key importance because it has a major influence on the surface UV flux and is a significant contributor to the global climatic heat budget. Nearly as important as ozone is the stratosphere's aerosol burden, which also determines the degree of solar attenuation. Because it contains halogens (chlorine, bromine), the aerosol can also perturb the stratosphere's ozone mass budget. Other trace gases such as water vapor and CO_2 are greenhouse gases, which absorb solar radiation.

The Chemistry of the Stratosphere. The concentration profile of ozone varies with latitude. Most ozone is photochemically produced in the equatorial atmosphere and is transported polewards and downwards with time (Andrews et al., 1987). At 30° N latitude, which corresponds approximately to the latitude of the two launch facilities, the annual ozone peak concentrations occur at an altitude of approximately 70,000 feet. Ozone concentration varies seasonally, so that at 30° N latitude, the seasonal change in columnar ozone is on the order of 10-20 out of an average of 290 dobson units (World Meteorological Organization, 1989).

Considerable monitoring has found evidence of significant ozone decreases in both the Arctic and Antarctic polar regions (World Meteorological Organization, 1989). The most pronounced reductions, the so-called ozone "hole", occur during the spring near Antarctica. The cause is now known to be due chiefly to the appearance of at least one type of polar stratospheric cloud (PSC). PSCs form when the ambient air is sufficiently cold, sufficient water vapor is present, and when there is a sufficient lack of polewards mixing of warmer and drier air. A PSC acts to destroy ozone by freeing chlorine bound up in the chloro-nitrate pool via direct activation on frozen or super-cooled liquid surfaces within the cloud. The important reaction is: $ClONO_2 + HCl \rightarrow 2Cl + HNO_3$, through which the free chlorine and bromine rapidly destroy ozone in a catalytic cycle before being bound up again.

Injections of water and sulfur compounds can play a role in perturbing lower stratospheric ozone in the tropics and mid-latitudes without requiring extremely low temperatures for PSC formation. Water vapor, which can form PSCs, can also be injected into the lower stratosphere through the agency of intense cumulonimbus cloud systems. A single cloud can temporarily inject up to 100 metric tons of water or ice hydrometeors immediately above the tropopause (Cotton and Anthes, 1989). Much of the water and ice immediately precipitates out; however, some of the very smallest particles with very low fall velocities (e.g., submicron range) can persist for weeks.

Stratospheric aerosols can also originate from a number of terrestrial sources such as the sulfate produced by the oxidation of carbonyl sulfide diffusing up from the troposphere (Warneck, 1988). Volcanoes also directly inject aerosols and SO_2, which oxidizes to form a sulfate aerosol. Although the surface reactivity of such stratospheric aerosols may be relatively inefficient in catalyzing ozone destruction, the large mass injections by volcanic eruptions, such as El Chicón, can produce substantial temporary reductions in columnar ozone over the entire northern hemisphere (World Meteorological Organization, 1989).

Nitrogen and N_2O can also perturb stratospheric ozone through several processes. N_2O is released naturally from bacterial processes in the soil. Overfertilization can greatly increase the emission rate. N_2O is also released from the oceans, which may be its primary source (Warneck, 1988). N_2O is relatively inert with a chemical lifetime in the troposphere measurable in years. As it is slowly mixed into the stratosphere, it is photolyzed to produce excited atomic oxygen which, in turn, produces nitric oxide. NO reacts rapidly with ozone and is a net catalytic destroyer of ozone in a pure oxygen atmosphere. NO_x is also introduced directly into the stratosphere via direct injection by high-flying aircraft and rockets.

The impact of space shuttle launches on the stratosphere has been studied (Jackman et al., 1996). In the Jackman study, a total of nine space shuttle and three Titan IVB launches were assumed per year. Chlorine emissions were assumed to be in the form of HCl. Such a fleet of launches would result in emissions of 725 tons of chlorine per year. This amount is equal to only 0.25 percent of the 300,000 tons of chlorine per year released from the breakdown of industrial halocarbons.

The resulting peak launch impacts on ozone concentrations are on the order of 0.1 to 0.2 percent (roughly 1 part in a thousand) of the average concentrations and occur between 131,240 and 164,000 feet at nearly the same latitude as launch. This peak impact region is well above the region of maximum ozone concentration, so the impact of columnar ozone will be considerably smaller. The Jackman study indicates a worst-case impact of total (columnar integrated) ozone reductions of 0.014 percent.

The stratospheric chemistry of alumina surfaces under stratospheric conditions has also been studied (Meads et al., 1994). The results of this study indicated that the reaction probabilities for critical chlorine reactions are typically an order of magnitude less than those for ice and water-rich nitrate aerosols. However, the alumina surfaces are considerably more reactive than the sulfuric acid aerosols found in the lower stratosphere in mid-latitudes. As a result, for regions where PSCs and water or ice aerosols are rare, such as in the tropical and mid-latitudes, the alumina aerosol surfaces may play an important role in expediting ozone destruction by halogen species if a sufficient atmospheric loading occurs. However, compared with the sulfate aerosol loading, the alumina loading from rocket launches is less than 1 percent of the sulfate aerosol even when there have not been any recent volcanic eruptions. Significant depletion due to alumina aerosol would be expected to be relatively local and transient given the rapid horizontal rate of dispersion of the rocket plume after launch (Beiting, 1997).

In the unperturbed stratosphere, ozone is continuously being formed and destroyed. The destruction occurs by reactions with atomic oxygen (O), NO, hydroxyl, and ClO. Warneck (1988) indicates that 31 to 34 percent of ozone in the stratosphere is destroyed by NO, 20 to 26 percent by O, 21 to 29 percent by hydroxyl, and 18 to 20 percent by ClO. The normal cycling of water vapor per year through the stratosphere is approximately 350 million tons. Over 1 million tons of NO (as nitrous oxide [N_2O]) enter the stratosphere per year. Approximately 100,000 tons of natural chlorine (as methyl chloride) enter the stratosphere per year. These annual natural trace gas sources are orders of magnitude larger than the launch emissions resulting from present rocket use.

Stratospheric Impacts by Rocket Emissions. As discussed for the troposphere, annual stratosphere baseline emissions estimates from Cape Canaveral AS and Vandenberg AFB have been developed for 1995 and 1996, based on the data presented in Tables 3.11-1 and 3.11-2.

The emissions for each region were estimated using the same criteria as described for the troposphere emissions. After release, HCl in the stratosphere suffers two fates; it either precipitates out of the stratosphere as aerosol, or a small portion is repartitioned to free chlorine.
The estimated annual emissions of stratospheric-perturbing substances (SPSs) are presented in Table 3.11-5. Chlorine is the primary chemical of concern for ozone depletion. Over the 2-year period, Atlas IIAS launches contributed 4.4 percent of the chlorine emissions; 23.2 percent were due to the Delta II 6825; and 72.4 percent were due to the Titan IV SRM. Almost all after-burning conversion of rocket exhaust products occurs in the

troposphere. As a result, very little NO production occurs in the stratosphere, and CO emitted by combustion is no longer converted to CO_2 in the stratosphere.

Table 3.11-5. Stratosphere Emissions from Launch Operations at Vandenberg AFB and Cape Canaveral AS, 1995 and 1996 (tons/year)

	VAFB Emissions		CCAS Emissions	
Pollutant	1995	1996	1995	1996
PM	150	300	472	356
NO_x	0.6	1.2	1.8	1.2
CO	152	304	900	698
Cl_x	75	150	236	179

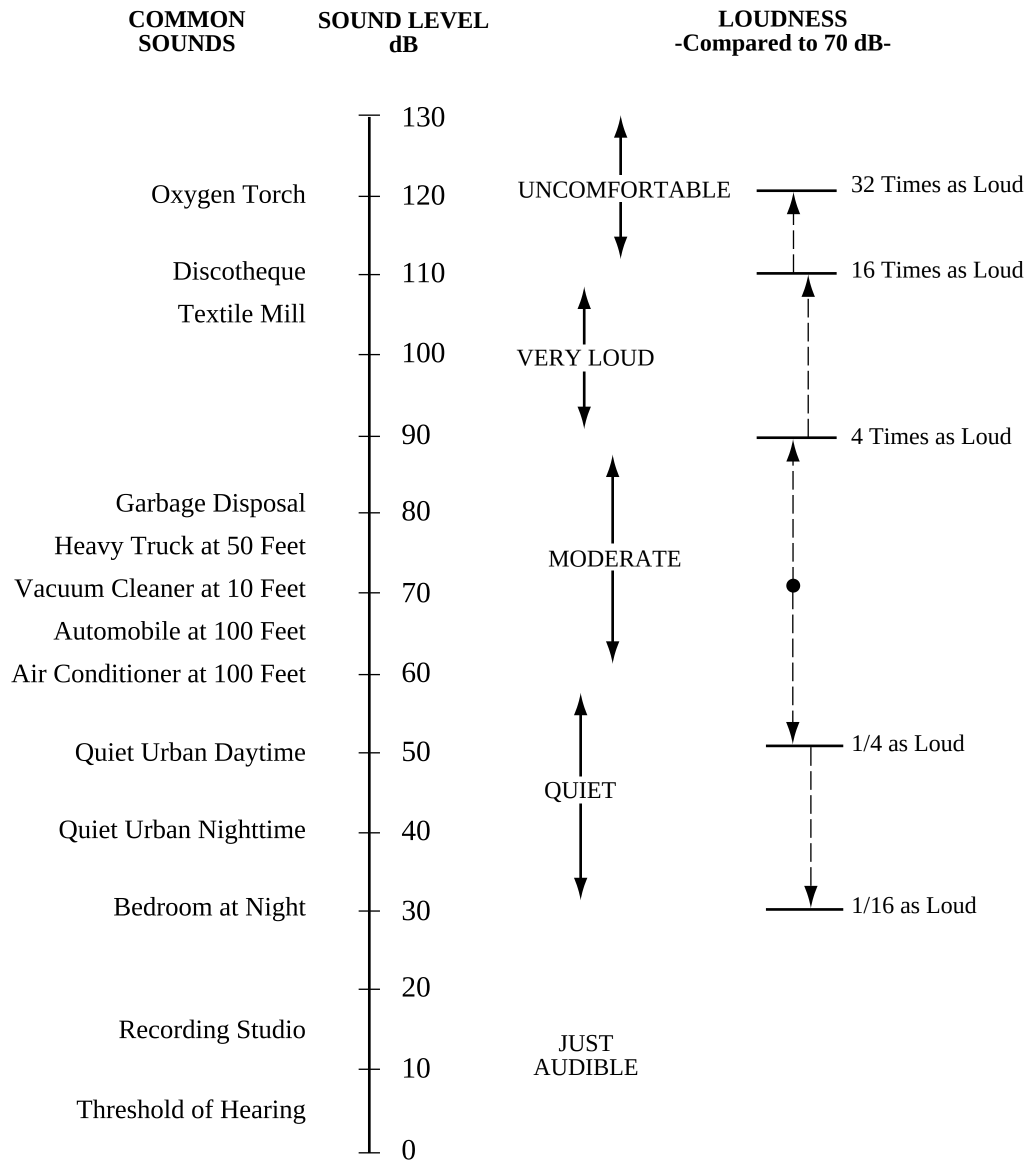
CCAS = Cape Canaveral Air Station
Cl_x = chlorine compounds
CO = carbon monoxide
NO_x = nitrogen oxides
PM = particulate matter
VAFB = Vandenberg Air Force Base

3.12 NOISE

Noise is usually defined as unwanted sound. It may be undesirable because it interferes with speech communication and hearing, is intense enough to damage hearing, or is simply annoying. High-amplitude noise can be unwanted because of potential structural damage. Noise is usually thought of as coming from man-made activities, but some natural sounds (e.g., from insects, animals, wind, waves) are considered to be noise.

The characteristics of sound include parameters such as amplitude, frequency, and duration. Sound can vary over an extremely large range of amplitudes. The decibel (dB), a logarithmic unit that accounts for the large variations in amplitude, is the accepted standard unit for the measurement of sound.

Different sounds may have different frequency content. When measuring sound to determine its effects on a human population, it is common to adjust the frequency content to correspond to the frequency sensitivity of the human ear. This adjustment is called A-weighting (American National Standards Institute, 1988). Sound levels that have been so adjusted are referred to as A-weighted sound pressure level (AWSPL). The unit is still dB, but the unit is sometimes written dBA or dB(A) for emphasis. Figure 3.12-1 summarizes typical A-weighted sound levels.



A-Weighted Sound Levels of Common Sounds

Figure F-1

Source: Handbook of Noise Control, C.M. Harris, Editor, McGraw-Hill Book Co., 1979

If structural damage is a concern, then the overall sound pressure level (OSPL) is used. This quantity has no frequency weighting and therefore includes low frequencies that are not audible but can affect structures.

Noise levels usually change with time. A number of descriptors have been developed that account for this and provide a cumulative measure of noise exposure (Appendix F). The most widely used cumulative measure is the day-night average sound level (L_{dn} or DNL), a day-long average of the AWSPL, with a 10-dB penalty applied at night, from 10 pm to 7 am. The state of California uses the Community Noise Equivalent Level (CNEL), which is similar to L_{dn} except that a penalty of 5 dB is also applied to noise in the evening, from 7 pm to 10 pm.

A quantity falling between single-event measures like AWSPL and cumulative measures like L_{dn} is the sound exposure level (SEL), a measure of the total sound from a single event combining the level of the sound with its duration. The formal definition of SEL is presented in Appendix F. For a sound with an effective duration of one second, SEL is equal to AWSPL. For sounds with longer effective duration, SEL is larger than AWSPL and thus reflects the greater intrusion of the longer sound.

The cumulative quantities L_{dn} and CNEL are based on sounds that occur on a regular basis, at least every day, and usually many times per day. An important part of the noise environment at both Cape Canaveral AS and Vandenberg AFB includes launches of existing launch vehicles. These events are relatively infrequent, at rates well below those needed for L_{dn} or CNEL to be meaningful. Emphasis in this EIS is therefore placed on single-event noise levels: AWSPL, OSPL, and SEL.

Three distinct noise events are associated with launch and ascent of a launch vehicle: on-pad rocket noise, in-flight rocket noise, and sonic boom. It is common to depict noise over an area by means of noise contours.

On-Pad Rocket Noise. On-pad rocket noise occurs when engines are firing but the vehicle is still on the pad. The rocket exhaust is usually turned horizontally by deflectors or an exhaust tunnel. Noise is highly directional, with maximum levels in lobes that are at about 45 degrees from the main direction of the deflected exhaust. Noise levels at the vehicle and within the launch complex are high. Because the sound source is at or near ground level, propagation from the rocket to off-site locations grazes along the ground and tends to experience significant attenuation over distance. On-pad noise levels are typically much lower than in-flight noise levels because sound propagates in close proximity to the ground and undergoes significant attenuation when the vehicle is on or near the pad.

In-Flight Rocket Noise. In-flight rocket noise occurs when the vehicle is in the air, clear of the launch pad, and the engine exhaust plume is in line with the vehicle. In the early part of the flight, when the vehicle's motion is primarily vertical, noise contours are circular. The sound source is also well above the ground and therefore experiences less attenuation as it propagates to large distances. The shapes of the contours for launch vehicle ascent are approximately circular, particularly for the higher levels near the center. The outer contours tend to be somewhat distorted. They can be stretched out in the launch direction or broadened across the launch direction, depending on specific details of the launch. Because the contours are approximately circular, it is often adequate to summarize noise by giving the sound levels at a few distances from the launch site. On-pad noise contours are much smaller than in-flight contours. Because in-flight noise is greater than on-pad noise, analysis in this study has concentrated on in-flight noise.

The major source of rocket noise is from mixing of the exhaust flow with the atmosphere, combustion noise in the combustion chamber, shock waves and turbulence in the exhaust flow, and occasional combustion noise from the post-burning of fuel-rich combustion products in the atmosphere. The emitted acoustic power from a rocket engine and the frequency spectrum of the noise can be calculated from the number of engines, their size and thrust, and their flow characteristics. Normally, the largest portion of the total acoustic energy is contained in the low-frequency end of the spectrum (1 hertz [Hz] to 100 Hz). Noise measurements conducted during a Titan IIID launch indicated that the maximum sound pressure levels occurred at around 20 to 50 Hz (U.S. Air Force, 1991).

To evaluate the potential noise impact associated with launch and ascent, it is necessary to consider not only the overall sound level but the frequency spectrum and the duration of exposure. High noise levels can cause annoyance and hearing damage. OSHA has established noise limits to protect workers at their work places. According to these standards, no worker shall be exposed to noise levels higher than 115 dBA. The exposure level of 115 dBA is limited to 15 minutes or less during an 8-hour work shift (U.S. Air Force, 1992). The OSHA standards are the maximum allowable noise levels for the personnel in the vicinity of the launch pad. Off the base, concerns for noise are community annoyance, damage to fragile structures, and adverse effects on animals.

Sonic Boom. Another noise characteristic of launch vehicles is that they reach supersonic (faster than the speed of sound) speeds and will generate sonic booms. A sonic boom, the shock wave resulting from the displacement of air in supersonic flight, differs from other sounds in that it is impulsive and very brief (less than 1 second for aircraft; up to several seconds for launch vehicles). Sonic booms are generally described by their peak overpressure in pounds per square foot (psf).

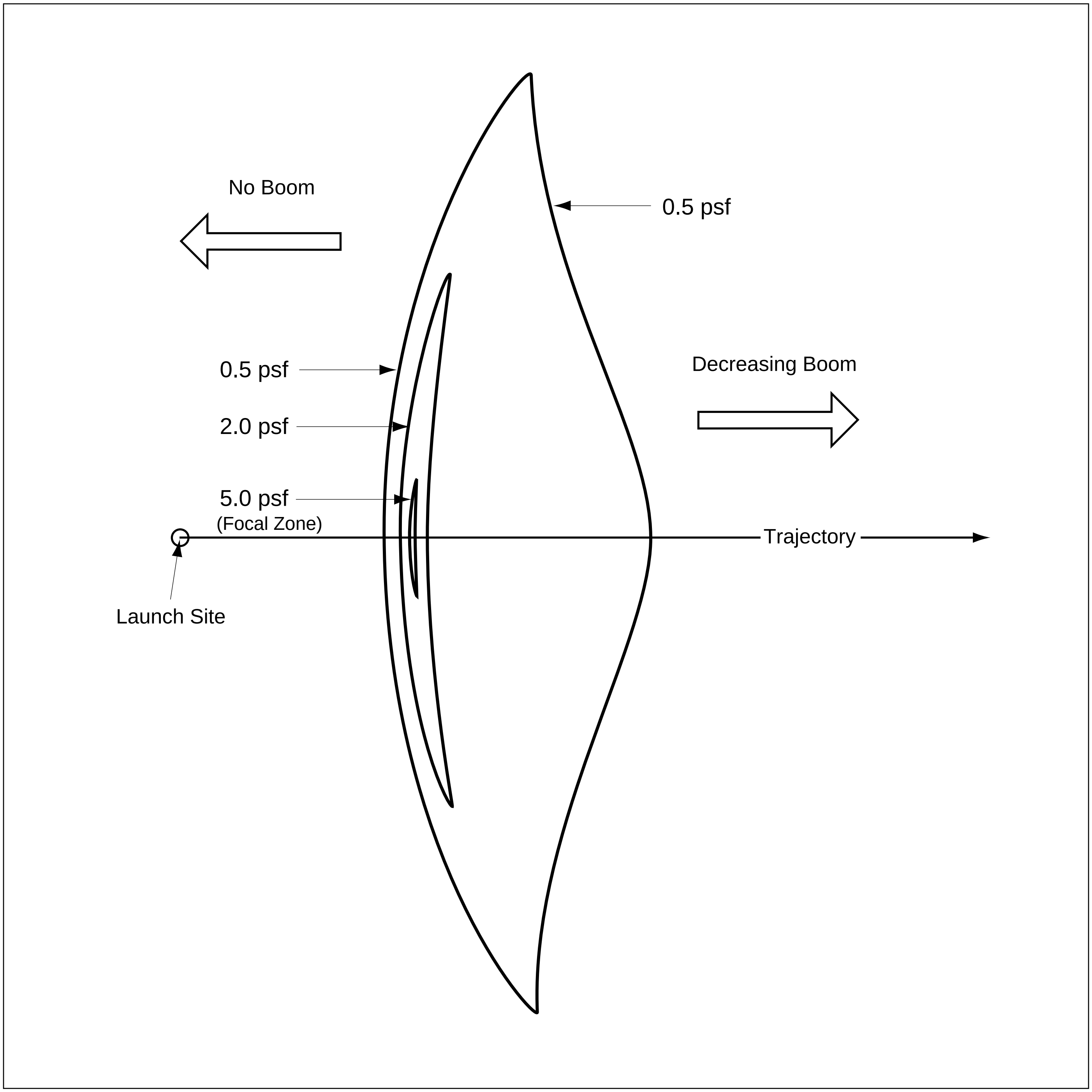
Figure 3.12-2 shows nominal noise contours for the sonic boom from a launch vehicle. The contour values represent psf, the unit used for sonic boom overpressures. The launch site is noted on the figure, and the launch direction is to the right. Regions within each contour experience overpressures equal to or greater than that denoted for the contour. The contours denote the peak pressure that occurs at each point over the course of the launch and do not represent noise at any one time. The sonic boom event at each position is brief, as noted in the preceding paragraph.

Because a sonic boom is not generated until the vehicle reaches supersonic speeds, some time after launch, the launch site itself does not experience a sonic boom. The crescent shape of the contours reflects this “after launch” nature of sonic boom. The entire boom footprint is downtrack, and the portions of the footprint to the side of the trajectory (up and down in the figure) represent the overpressures caused as the shock wave expands radially from the line of travel of the launch vehicle. There is actually no boom to the left of the contours shown, and the boom diminishes rapidly farther downtrack, to the right of the contours.

The 0.5-psf contour shown in Figure 3.12-2, although not to scale, has a shape similar to an actual low-overpressure sonic boom contour. The two higher contours, 2.0 and 5.0 psf, have been considerably distorted from typical actual contours for illustrative purposes. The crescent shape is correct, and the width across the trajectory (i.e., vertical height on the figure) relative to that of the 0.5-psf contour is approximately correct. However, their width and position in the direction along the trajectory are greatly exaggerated for illustrative purposes. Typically, the left edge of these higher overpressures would be very close to the left edge of the 0.5-psf contour and would not appear as a distinct line when plotted to any reasonable scale. The right edge of these contours would also be much closer to the left than shown and would often not appear as distinct lines. The concentration of these contours is due to focusing of the boom as the vehicle accelerates. The focal zone “super boom” region is within the 5.0-psf contour illustrated in Figure 3.12-2 and is very narrow (typically less than 100 yards).

It is common to calculate sonic boom footprints with the assumption that the ground is hard and does not significantly attenuate the boom. This is usually a good assumption for most of the footprint. However, near the edges of the footprint, the boom approaches the ground at a shallow angle and is attenuated by the same process discussed previously for on-pad rocket noise. This is typically important in the outermost 20 percent of the width of the outermost contour (the 0.5-psf contour in Figure 3.12-2). The attenuated sonic boom in this region sounds like rumbling or distant thunder, rather than the distinct double bang usually associated with sonic booms.

Appendix F contains more detailed descriptions of noise and sonic boom. Effects of sonic booms on wildlife are addressed in Section 4.14, Biological



EXPLANATION

psf Pounds per square foot

Not to Scale

EELV/095

Nominal Sonic Boom Contours for Ascent of a Launch Vehicle

Figure 3.12-2

Resources. The following two subsections describe the environments around each EELV launch site that may be affected by noise.

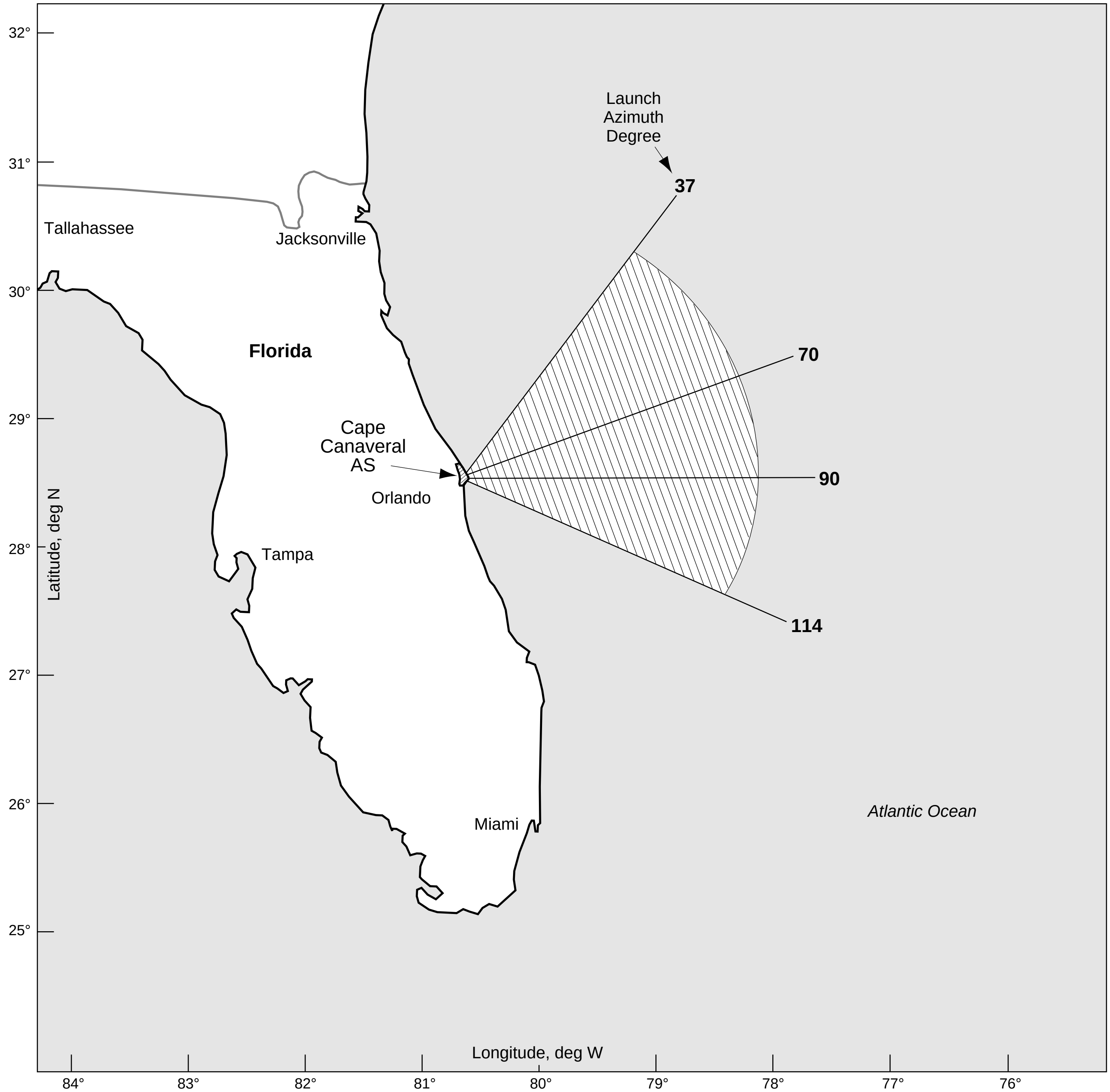
3.12.1 **Cape Canaveral AS**

Ambient Noise Levels Off Station. Most of the region surrounding Cape Canaveral AS is open water, with the Atlantic Ocean to the east and the Banana River to the west. Immediately north of Cape Canaveral AS is KSC; Port Canaveral is to the south. This relative isolation of the station reduces the potential for noise to affect adjacent communities. The closest residential areas to Cape Canaveral AS are to the south, in the cities of Cape Canaveral and Cocoa Beach. Expected sound levels in these areas are normally low, with higher levels occurring in industrial areas (Port Canaveral) and along transportation corridors. Residential areas and resorts along the beach would be expected to have low overall noise levels, normally about 45 to 55 dBA. Infrequent aircraft flyovers from Patrick AFB and rocket launches from Cape Canaveral AS would be expected to increase noise levels for short periods of time. Noise levels at KSC probably approximate those of any urban industrial area, reaching levels of 60 to 80 dBA. The launch of space vehicles from KSC does generate intense, but relatively short-duration, noise levels of low frequencies. The highest recorded levels are those associated with the space shuttle, which in the launch vicinity (i.e., on the pad and its supporting facilities) can exceed 160 dBA. Noise levels at Port Canaveral would be expected to be typical of those at an industrial facility, reaching levels of 60 to 80 dBA.

Noise and sonic boom patterns are oriented according to the launch azimuth. Azimuth is defined as the compass direction along which the launch vehicle's ground track lies in its early flight; inclination is the angle between the orbital plane of a space object and the plane of the Earth's equator. Figure 3.12-3 shows the range of potential launch azimuths from Cape Canaveral AS.

Ambient Noise Levels On Station. An additional source of noise in the area is the Cape Canaveral AS Skid Strip. Because of the infrequent use of the skid strip, noise generally does not affect public areas. Other less frequent but more intense sources of noise in the region are space launches from Cape Canaveral AS. Current launches include Atlas, Delta, Titan, and Trident.

Noise from a Delta II launched from SLC-17 was measured during a July 1992 launch at four locations (McInerny, 1993a). Measurements were taken downrange at nominal distances of 1,500, 2,000, and 3,000 feet from the launch pad. Table 3.12-1 shows the noise levels (OSPL, AWSPL, and A-weighted SEL) measured during the launch at each location, and pre-launch predicted OSPL. Because launches from Cape Canaveral AS would occur intermittently, the resulting noise would not cause an increase in the equivalent sound pressure level (L_{eq}) (the average sound level over a period of time) in nearby areas.



EXPLANATION

Range of potential launch azimuths

Azimuth - The compass direction along which the launch vehicle's ground track lies in its early flight

Potential Launch Azimuths, Cape Canaveral AS, Florida

0 16 32 64 Miles

Figure 3.12-3

EELV/092

Table 3.12-1. Measured Delta II Sound Levels, July 1992

	Noise Levels (dB)			
Distance from Pad (feet)	Predicted Maximum OSPL	Measured Maximum OSPL	Measured Maximum AWSPL	Measured A-weighted SEL
1,500	135.4	130.6	120.2	127.5
2,000	132.9	130.4	117.7	125.5
3,000	129.4	125.8	115.1	123.0

AWSPL = A-weighted sound pressure level
dB = decibel
OSPL = overall sound pressure level
SEL = sound exposure level (A-weighted)

Source: McInerny, 1993a

Following lift-off, launch vehicles gain altitude, pitch over, and accelerate quickly. When flight speed exceeds the speed of sound, shock waves develop. When these shock waves intersect with the ground, they are of environmental concern as sonic booms. Sonic booms produced during vehicle ascent occur over the Atlantic Ocean and are directed in front of the vehicle.

Peak overpressures from large vehicles such as the Titan IVB approach 10 psf in focal zones (Downing, 1996). Sonic booms generated from launches at Cape Canaveral AS do not impact developed areas (45 Space Wing, 1996b).

Concept A ROI. The ROI for Concept A includes on- and off-station areas described above. Noise levels at SLC-41 would be similar to those in an urbanized industrial area when operations are taking place, averaging about 50 to 60 dBA, due to ongoing activities. Nighttime noise levels occurring when the facility is not in use would be lower due to limited activity and would be similar to those expected to be found in rural areas. Noise levels at this site increase with the launch of the Titan IVB from this complex. Expected noise levels from the Titan IVB would be similar to those launched from Vandenberg AFB (see Section 3.12.2).

Concept B ROI. The ROI for Concept B includes the on- and off-station areas described above. Because SLC-37 is not in use, expected noise levels would be typical of those in a rural environment, averaging 40 to 45 dBA. Noise levels would be expected to increase due to periodic traffic, use of nearby buildings, and the infrequent event of a launch from another launch complex.

Concept A/B ROI. The ROI for Concept A/B includes the off- and on-station areas for Concepts A and B described previously.

3.12.2 **Vandenberg AFB**

Ambient Noise Levels Off Base. The area immediately surrounding Vandenberg AFB is mainly undeveloped and rural, as discussed in Section 3.3.2.1, Regional Land Use, with some unincorporated residential areas within the Lompoc and Santa Maria valleys. The two urban areas in the region are the cities of Lompoc and Santa Maria, which support a few localized industrial areas. Sound levels measured for most of the region are normally low, with higher levels appearing in industrial areas and along transportation corridors. Rural areas in the Lompoc and Santa Maria valleys would be expected to have low overall CNEL levels, normally about 40 to 45 dBA. Infrequent aircraft flyovers and rocket launches from Vandenberg AFB would be expected to increase noise levels for short periods of time (City of Lompoc, 1996).

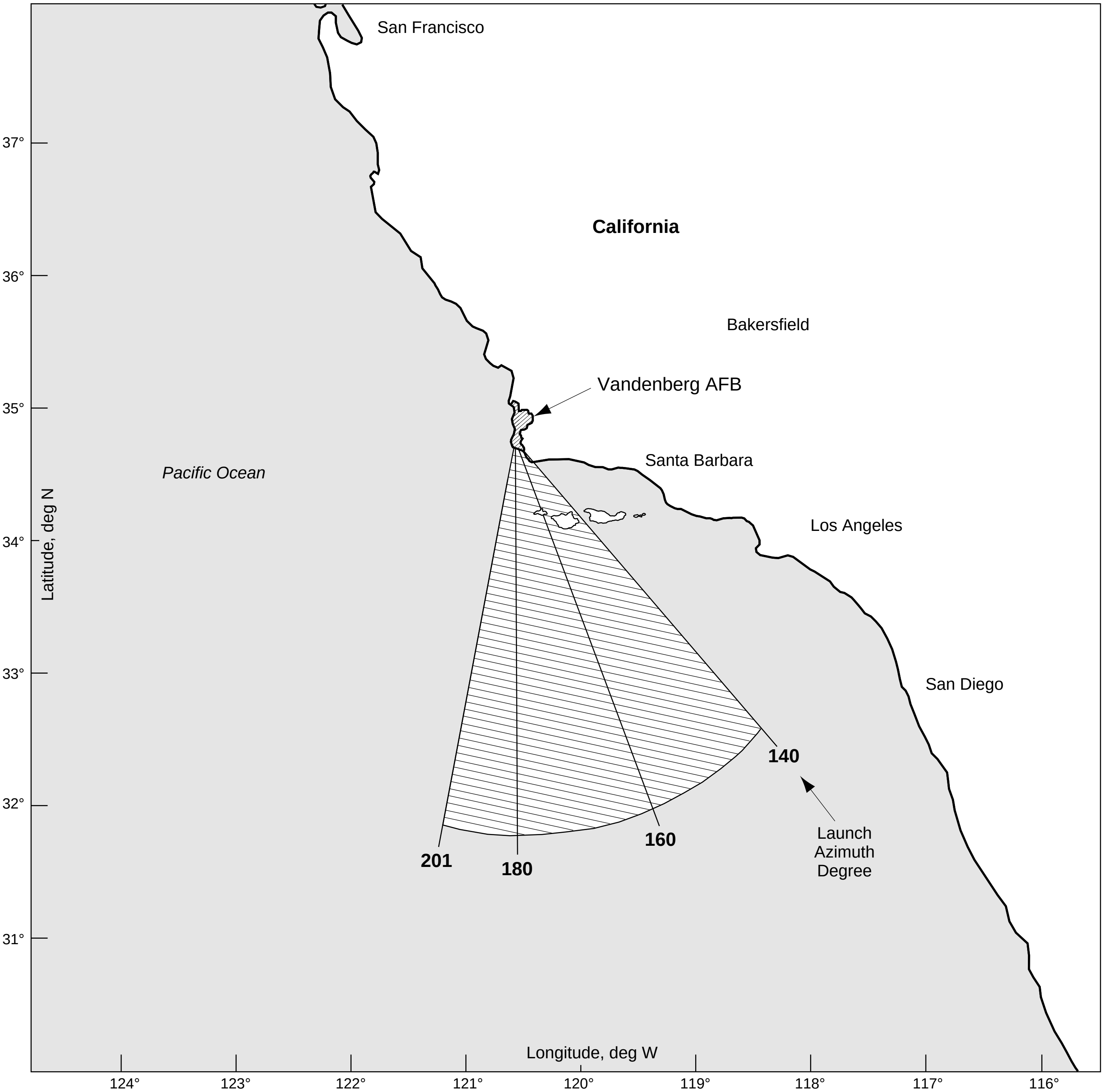
Urban areas are primarily affected by noise from automobiles, trucks, trains, and aircraft. CNEL contours have been measured based on typical sound levels in the Lompoc area. These contours show the highest CNEL levels (greater than 65 dBA) appearing around the Southern Pacific Railroad and major roadways, with lower CNEL levels (50 to 65 dBA) farther from main transportation corridors. Sound levels in Santa Maria are expected to be similar to those in Lompoc (City of Lompoc, 1996). Areas of higher localized noise levels would occur around stationary industrial sources. Presently, few of these stationary sources exist in the Lompoc and Santa Maria areas; consequently, overall sound levels are relatively low (U.S. Air Force, 1989a).

Ambient Noise Levels On Base. An additional source of noise in the area is the Vandenberg AFB Airfield, which follows state regulations concerning noise and maintains a CNEL equivalent to 65 dBA or lower for off-base areas. Two types of operations take place at this airfield: regular takeoffs and landings and touch-and-go maneuvers. Touch-and-go maneuvers are used for training purposes and create noise levels similar to regular aircraft takeoffs and landings (City of Lompoc, 1996).

Other less frequent, but more intense, sources of noise in the region are rocket launches from Vandenberg AFB. Current Minuteman and Delta II launch activities are from North Vandenberg AFB, and Titan IV and Atlas II launches are from South Vandenberg AFB.

Noise and sonic boom patterns are oriented according to the launch azimuth. Figure 3.12-4 shows the range of potential launch azimuths from Vandenberg AFB.

Noise levels in Lompoc and Santa Maria from Minutemen rocket launches would be expected to be a maximum of 49 dBA and 74 dBA, respectively (U.S. Air Force, 1987c). Noise from a Titan IV launched from SLC-4 in August 1993 (Do, 1994) was measured at six locations. The Titan IV is the



EXPLANATION

Range of potential launch azimuths

Azimuth - The compass direction along which the launch vehicle's ground track lies in its early flight

Potential Launch Azimuths, Vandenberg AFB, California

0 20 40 80 Miles

Figure 3.12-4

EELV/091

largest launch vehicle in the United States' military inventory and has the greatest potential for noise impacts. Measurement sites were located downrange at nominal distances of 2,700, 6,680, 11,200, 16,800, 19,000, and 43,129 feet from the launch pad. Data were tape recorded at all sites and processed into appropriate sound levels. Direct sound level meter measurements were made at 2,700, 11,200, and 19,000 feet. Table 3.12-2 shows the maximum noise levels during the launch measured at each location. Of interest is the measurement at the 43,129-foot site in the city of Lompoc: AWSPL was 88.0 dB, A-weighted SEL was 93.7 dB, and OSPL was 112.8 dB. Because launches from all of these facilities would occur intermittently, the resulting noise would not cause an increase in the average (L_{eq}, L_{dn} or CNEL) noise levels in nearby areas.

Table 3.12-2. Measured Titan IV Sound Levels, August 1993

	Noise Levels (dB)			
Distance from Pad (feet)	Measured Maximum OSPL	SLM Measured OSPL	Measured Maximum AWSPL	Measured A-weighted SEL
2,700	141.7	141.0	124.4	133.0
6,680	131.4	-	112.4	121.9
11,200	129.0	129.9	110.6	116.2
19,000	122.1	127.6	99.0	109.0
43,129[a]	112.8	-	88.0	93.7

Note: (a) In city of Lompoc
AWSPL = A-weighted sound pressure level
dB = decibel
OSPL = overall sound pressure level
SEL = sound exposure level (A-weighted)
SLM = sound level meter

Source: Do, 1994

The maximum sonic boom overpressure for the Titan IVB was calculated and measured to be about 10 psf (Downing, 1996). Because most launch azimuths at Vandenberg AFB are over the Pacific Ocean, sonic boom effects on human population centers have been minor.

As discussed in Section 3.3.2.2, Vandenberg AFB Land Use, North Vandenberg AFB contains most of the base facilities, and South Vandenberg AFB is largely undeveloped with some scattered facilities. Noise levels measured on North Vandenberg AFB are generally typical of levels in urban areas with little industrialization. Noise levels on South Vandenberg AFB would be expected to be similar to levels found in rural areas, except around active launch complexes, where noise levels during operations may be similar to those at an industrial site.

Concept A ROI. The ROI for Concept A includes the on- and off-base areas described above. Although the SLC-3W site is not currently in use, noise levels there would be similar to those in an urbanized industrial area because of activities at nearby SLC-3E, averaging about 50 to 60 dBA, due to ongoing activities. Nighttime noise levels would be lower due to limited activity and would be similar to those expected to be found in rural areas of South Vandenberg AFB, about 40 to 45 dBA. Noise levels would be expected to increase due to trains passing on the nearby Southern Pacific Railroad, aircraft flyover, or the infrequent event of a launch from another launch complex.

Concept B ROI. The ROI for Concept B includes the on- and off-base areas described above. Noise levels at the SLC-6 site would be similar to those in an urbanized industrial area when operations are taking place, averaging about 50 to 60 dBA due to ongoing activities. Nighttime noise levels would be lower due to limited activity and would be similar to those expected to be found in rural areas of South Vandenberg AFB, about 40 to 45 dBA. Noise levels would be expected to increase due to trains passing on the nearby Southern Pacific Railroad, aircraft flyover, the construction of the California Spaceport, or the infrequent event of a launch from another launch complex.

Concept A/B ROI. The ROI for Concept A/B includes the off- and on-base areas for Concepts A and B described above.

3.13 ORBITAL DEBRIS

Orbital debris is a concern as a potential collision hazard to spacecraft. De-orbiting debris (i.e., debris re-entering the atmosphere from orbit) is a potential concern as a source of deposition of small particles into the stratosphere, and a possible contributor to stratospheric ozone depletion. Large pieces of debris are of concern with respect to re-entry and eventual Earth impact. The term “orbital debris” or “space debris” is used to refer to all earth-orbiting objects except active satellites (spacecraft) (i.e., payloads performing some type of operation or mission). Earth-orbiting debris can be classified as either natural or man-made objects. Natural objects consist of meteoroid material that travels through space. The measured number of man-made debris particles exceeds that of the meteoroid material particles, except in the 0.0004- to 0.04-inch range. The following sections address man-made debris only.

Man-made debris consists of material left in Earth orbit from the launch, deployment, and deactivation of spacecraft. It exists at all inclinations and primarily at LEO altitudes of approximately 217 to 1,243 miles. Orbital debris moves in many different orbits and directions, at velocities ranging from 2.5 miles per second to over 4 miles per second (Office of Technology Assessment, 1990).

Although space debris is not explicitly mentioned in any U.S. legislation, an Executive Branch policy directive, *National Space Policy* (September 19, 1996), identifies the following guidance to support major U.S. space policy objectives:

The United States will seek to minimize the creation of space debris. NASA, the Intelligence Community, and the DoD, in cooperation with the private sector, will develop design guidelines for future government procurements of spacecraft, launch vehicles, and services. The design and operation of space tests, experiments and systems, will minimize or reduce accumulation of space debris consistent with mission requirements and cost effectiveness (Intersector Guidelines [2] Space Debris [a]).

3.13.1 **Characteristics of Orbital Debris**

Salient characteristics of orbital debris include the orbital regimes in which it is found; its sources; debris particle size; estimated population; altitude distribution; and orbital lifetime.

Orbital Regimes. The space around the Earth in which satellites operate is generally divided into four regimes: LEO, medium Earth orbit, geosynchronous Earth orbit, and "other." Most cataloged orbital debris occurs in LEO because most space activity, particularly commercial, has traditionally occurred at those altitudes. LEO occurs at altitudes less than 1,243 miles, with orbital periods of 127 minutes or less. The boundary between LEO and higher orbits is not well defined. Medium Earth orbit occurs between low and geosynchronous Earth orbits and is a semi-synchronous orbit with a period of approximately 12 hours. Geosynchronous Earth orbit is occupied by objects orbiting at an altitude of 22,238 miles, with an orbital period of approximately 24 hours. Geostationary Earth orbit is a special case of geosynchronous Earth orbit in which the object orbits above Earth's equator at an angular rotation speed equal to the rotation of the Earth. It thus appears to remain stationary with respect to a point on the equator. The fourth regime, "other," is defined by highly eccentric and geosynchronous transfer orbits that transit between LEO and higher orbital altitudes (Office of Technology Assessment, 1990).

Sources of Orbital Debris. Historically, the largest uncontrolled addition to orbital debris has been the breakup of launch vehicle upper stages (Loftus, 1989), which appears to be caused by pressure-vessel failure due to either deflagration or detonation of propellants remaining in the tanks, stress failure of the vessels, or reduction of pressure-vessel integrity by collision with meteoroids or other space objects (Loftus, 1989). In January 1981, a Delta second stage exploded in orbit, resulting in a large amount of orbital debris. Since 1981, however, a depletion burn to eliminate excess fuel after placing the payload in orbit has been performed on all Delta stages. Although explosions have occurred in the lower atmosphere, no orbital Delta stages have exploded since this practice was implemented, and future explosions of Delta stages in orbit are highly improbable (Kessler, 1989).

Debris Particle Size. Orbital debris particles can be characterized by size as follows:

- Small - Debris particles smaller than 0.4 inch in diameter. They are too small to be detected by sensors and are considered essentially “invisible.”

- Medium - Debris particles between 0.4 and 4 inches in diameter. These medium-sized particles are unlikely to be detected by the Space Surveillance Network.

- Large - Debris particles larger than 4 inches in diameter. This regime represents 5 percent of the total population of debris particles larger than 0.4 inch in size. Particles of this size can be tracked and cataloged by the Space Surveillance Network.

A worldwide array of sensors, the Space Surveillance Network, tracks large pieces of orbital debris through the use of radar and ground telescopes. The AFSPC currently maintains a catalog of almost 8,000 tracked objects in space that are 4 inches or larger in size. As of November 1, 1995, there were 5,747 objects in LEO, 134 in medium Earth orbit, 601 in geosynchronous Earth orbit, and 1,447 in the “other” orbital regime. Only objects that can be consistently tracked and whose source can be identified are entered into the catalog (Office of Science and Technology Policy, 1995).

Debris Population. What is known about the debris population is derived from the worldwide network of sensors (optical, electro-optical, conventional radar, phased-array radar, and interferometer sensors) that can detect objects in space of varying sizes. The National Research Council estimates that there are more than 10,000 objects greater than 4 inches in size in orbit (including the almost 8,000 tracked by AFSPC), tens of millions between 0.039 and 4 inches in size, and trillions less than 0.039 inch in size (National Research Council, 1995). However, there is no universal agreement on these numbers, with most analysts agreeing that neither the number nor the distribution of objects is well known. An estimated 99.5 percent of the orbital debris is between 0.039 and 4 inches in size, but 99.95 percent of the mass of orbital debris is estimated to consist of objects greater than 4 inches in size (Office of Science and Technology Policy, 1995).

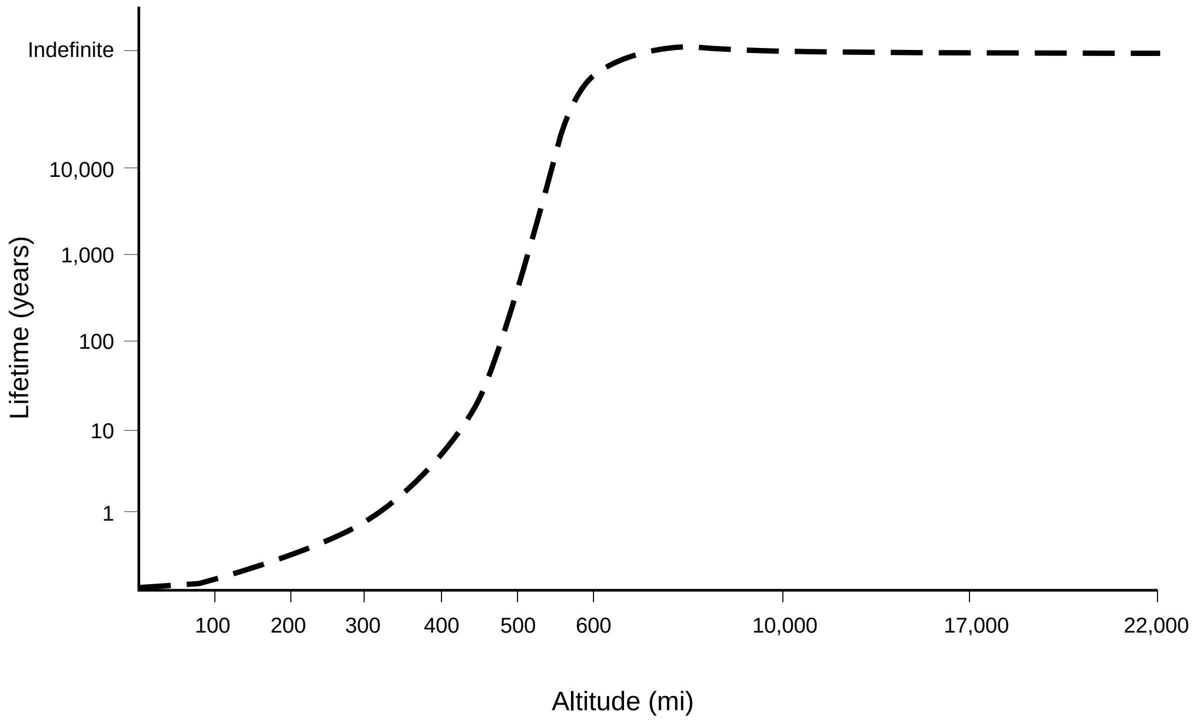
The quantity of orbital debris has been growing at a roughly linear rate, and growth is projected to continue into the future. Between 1981 and 1994, an average of 100 launches worldwide occurred annually (Office of Science and Technology Policy, 1995). A high-velocity collision between two objects could produce many objects, increasing the likelihood of additional collisions in that orbit. As additional collisions occur, the likelihood of additional collisions increases further, producing an exponential growth in the debris population (National Research Council, 1995). This mechanism is incorporated in NASA, European Space Agency, and Russian debris models, which predict an increasing probability of orbital collisions over time. However, it is not yet considered sufficiently validated by the DoD to incorporate into DoD models (Office of Science and Technology Policy, 1995).

Altitude Distribution. The altitude distribution of all orbiting debris is unknown due to tracking limitations. As the altitude increases, the minimum-sized detectable objects increase due to sensor limitations. With the exception of a slight concentration near the poles, objects are spread uniformly over the surface of the Earth (Kessler, 1988).

Orbital Lifetime/De-orbiting Debris. Orbiting objects lose energy through friction with the upper reaches of the atmosphere and various other orbit-perturbing forces. Over time, the object falls into progressively lower orbits and eventually falls to Earth. As the object's orbital trajectory draws closer to Earth, it speeds up and outpaces objects in higher orbits. Once the object enters the measurable atmosphere, atmospheric drag will slow it down rapidly and cause it either to burn up or deorbit and fall to Earth. For example, unless reboosted, satellites in circular orbits at altitudes of 124 to 248 miles re-enter the atmosphere within a few months. At 248- to 559-mile orbital altitudes, orbital lifetimes can exceed a year or more depending on the mass and area of the satellite. Above 559-mile altitudes, orbital lifetimes can be 500 years or more (Interagency Group [Space], 1989). Figure 3.13-1 shows the relationship between altitude and orbital lifetime.

Both satellite and orbital debris Earth orbit lifetimes are a function of drag and ballistic coefficients. The greater the mass per unit area of the object, the greater the ballistic coefficient and the less the object will react to atmospheric drag. For example, a fragment with a large area and low mass (e.g., aluminum foil) has a lower ballistic coefficient and will decay much faster (have a shorter orbital life) than a fragment with a small area and high mass (e.g., a ball bearing). The combination of a variable atmosphere and unknown ballistic coefficients of orbital debris make decay and re-entry prediction difficult and inexact (Interagency Group [Space], 1989).

Orbital lifetimes for objects in elliptical orbits can vary significantly from lifetimes of objects in circular orbits. For elliptical orbits, the lower the perigee altitude (the point in the orbit that is nearest to the center of the Earth), the greater the atmospheric drag effects. Therefore, considering a circular and an elliptical orbit with equal energies, an object in an elliptical orbit will have a higher apogee (the point in the orbit that is at the greatest distance from the center of the Earth) decay rate and a shorter on-orbit



Estimated Orbital Lifetime

Note: Lifetime is a function of atmospheric drag, ballistic coefficient, and solar activities.

Figure 3.13-1

lifetime (Interagency Group [Space], 1989). Solar-lunar perturbations act on debris in a highly elliptical orbit to either raise or lower the perigee, and therefore affect de-orbiting rates (Johnson, 1987).

3.13.2 **Uncertainty in the Orbital Debris Environment**

A large degree of uncertainty exists in understanding the current orbital debris environment. The uncertainties in assessing the debris environment include the number, density, mass, and the size of orbital debris. For orbital debris larger than 4 inches, it is generally accepted that the LEO environment has been measured reasonably adequately by space surveillance sensors, and these data provide a basic estimate of the orbital debris population.

Mathematical models of spacecraft or rocket body breakups are used to predict the size and number of fragments smaller than 4 inches. These predictions are then compared with limited telescope and special radar observations. The difference between the expected number of objects to be detected and the number actually observed becomes an estimate of the uncertainty of the populations. Based upon these data, the population density of the measured debris is known to an uncertainty factor of two to five, depending on the diameter of the debris. However, for debris 0.4 to 4 inches, there are no confirmed measurements, and the estimates are based on linear extrapolation, which has an uncertainty factor of 10 (Interagency Group [Space], 1989).

Uncertainties in the natural decay process add to the degree of overall uncertainty. Natural decay is usually the result of atmospheric drag, solar-lunar perturbations (for highly elliptical orbits), or solar radiation pressure (for very light objects). Solar flares affect the rate of debris decay and contribute to the uncertainty. A major parameter in orbital decay is atmospheric density at the altitude of the orbiting object, which is also a function of the level of solar activity at any given altitude. Therefore, the more accurate the solar activity and atmospheric density prediction, the more accurate the debris decay prediction. However, forecasting solar activity is not an exact science (Kessler, 1988).

Other factors that contribute substantially to the uncertainty in the orbital debris environment include lack of predictability in the level of future space activities, including the types of activities, and lack of understanding of the causes of explosion/collision-induced satellite breakups. As noted above, these breakup events are the major sources of orbital debris. As commercial and foreign agencies enter the space arena, there will be more opportunities for debris generation. Although the exact cause of most breakups is unknown, it is generally thought that they are most often the result of inadvertent mixing of hypergolic fuels, overheating of residual propellants, or deliberate fragmentation (Johnson, 1987).

3.13.3 **Hazards to Space Operations from Orbital Debris**

The effects of launch-vehicle-generated orbital debris impacts on other spacecraft would depend on the altitude, orbit, velocity, angle of impact, and mass of the debris. Debris less than about 0.004 inch in diameter can cause surface pitting and erosion. Over a long period of time, the cumulative effect of individual particles colliding with a satellite might become significant because the number of particles in this size range is very large in LEO. Long-term exposure of payloads to such particles is likely to cause erosion of exterior surfaces and chemical contamination, and may degrade operations of vulnerable components such as optical windows and solar panels. Debris between 0.004 and 0.4 inch in diameter would produce significant impact damage that can be serious, depending on system vulnerability and defensive design provisions. Objects larger than 0.4 inch in diameter can produce catastrophic damage. Although it is currently practical to shield against debris particles up to 0.4 inch in diameter (a mass of 0.05 ounce), for larger sizes of debris, current shielding concepts become impractical (Office of Science and Technology Policy, 1995).

Solid rocket motors eject aluminum oxide dust (typically less than 0.004 inch) into the orbital environment, and may release larger chunks of unburned solid propellant or slag. However, solid rocket motor particles typically either decay very rapidly, probably within a few perigee passages, or are dispersed by solar radiation pressure. Thus, the operational threat of solid rocket motor dust is probably limited to brief periods of time related to specific mission events (Office of Science and Technology Policy, 1995).

Orbital debris generated by launch vehicles contributes to the larger problem of pollution in space that includes radio-frequency interference and interference with scientific observations in all parts of the spectrum. For example, emissions at radio frequencies often interfere with radio astronomy observations (Office of Technology Assessment, 1990). Not only can orbital debris interfere with the performance of scientific experiments, but it can even accidentally destroy them (Scheraga, 1986).

3.14 BIOLOGICAL RESOURCES

The ROI for biological resources includes the native and introduced plants and animals within the area potentially affected by construction activities and launch operations. For discussion purposes, these are divided into vegetation, wildlife (including aquatic biota), threatened or endangered species, and sensitive habitats. Appendix G provides lists of plants and animals potentially occurring in the vicinities of Cape Canaveral AS (Table G-1) and Vandenberg AFB (Table G-2).

The vegetation and wildlife subsections focus on those species expected to be present in habitats adjacent to the project area sites, aquatic species that could be affected by water quality changes, and birds and mammals of the offshore waters, islands, estuaries, lagoons, and wildlife refuges that could be affected during launch operations. Sensitive species (i.e., former federal Category 2 species, state species of special concern, and regionally rare and declining species) are included in this discussion. Federally and state-listed threatened and endangered species are discussed under a separate subsection.

Sensitive habitats include wetlands, plant communities that are unusual or of limited distribution, and important seasonal use areas for wildlife (e.g., migration routes, breeding areas, crucial summer/winter habitats). They also include critical habitat as protected by the Endangered Species Act and sensitive ecological areas as designated by state or federal rulings.

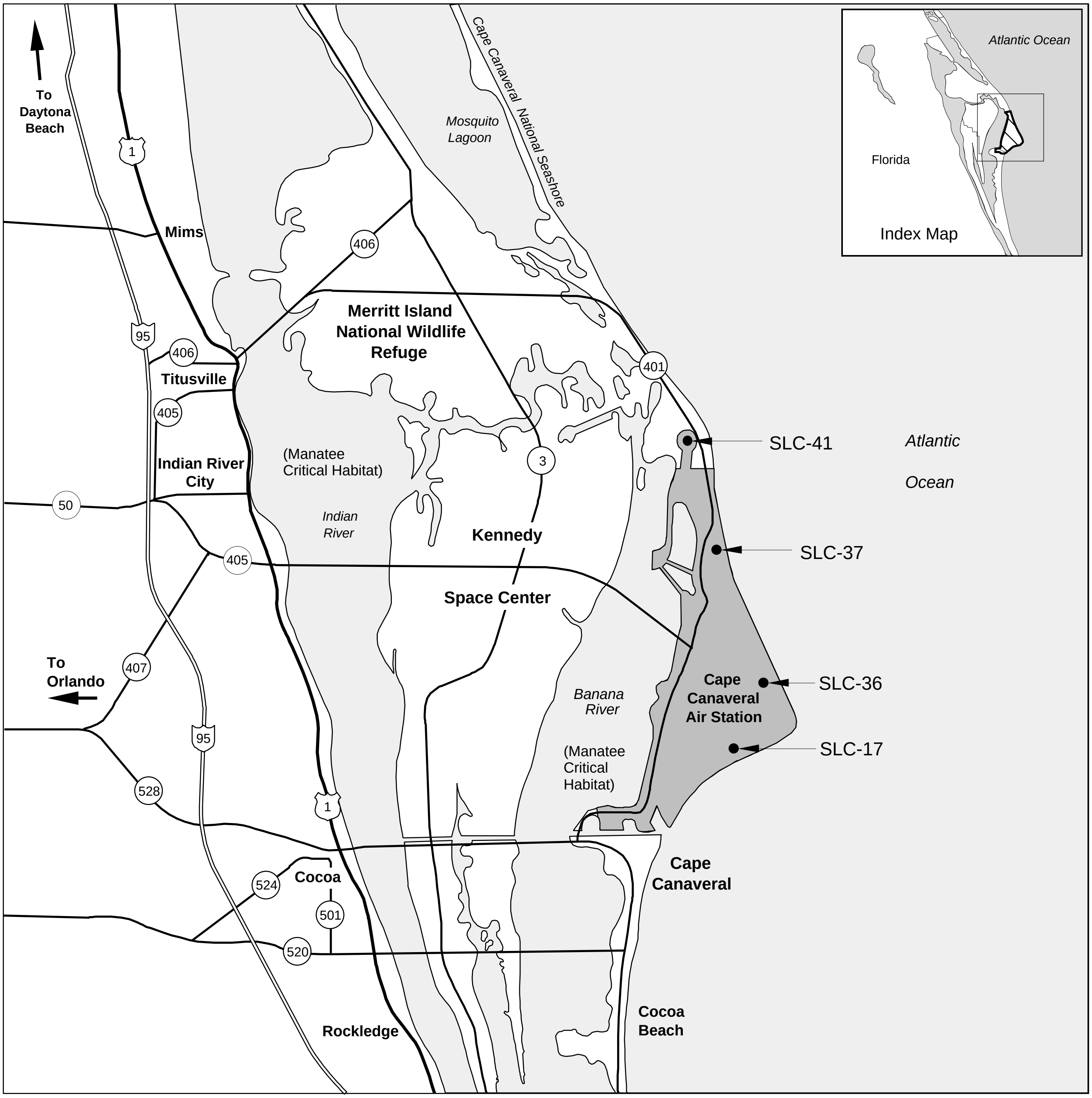
Information used in developing this section includes current and historical aerial photographs, numerous survey reports including wetland delineation survey reports, interviews with local experts, site visits in February and March 1997, National Wetlands Inventory data, and natural resource data.

3.14.1 **Cape Canaveral AS**

Cape Canaveral AS occupies 15,800 acres of coastal habitat on a barrier island complex that parallels Florida's mid-Atlantic coast. The ROI for biological resources consists of Cape Canaveral AS and the surrounding land and adjacent Atlantic Ocean vicinities that could be affected by construction activities and effects from launch operations. Included in the ROI are three major water bodies, other than the Atlantic Ocean, that could be subjected to indirect launch effects, depending on the prevailing wind direction: the Banana and Indian rivers and the Mosquito Lagoon (Figure 3.14-1).

3.14.1.1 **Vegetation.** Cape Canaveral AS has a series of ridges and swales parallel to the coastline that support several ecologically significant natural communities, even though the communities are highly fragmented by mission-related construction and clearing. At least 10 high-quality natural communities exist on Cape Canaveral AS: oak scrub, rosemary scrub, maritime hammock, coastal strand, coastal dunes, grasslands, seagrasses, and three wetland communities (hydric hammock, interdunal swales, and estuarine tidal swamps and marshes).

Vegetation on the station consists mainly of the indigenous Florida coastal scrub (including oak and rosemary scrub), and xeric and maritime hammocks. These scrub habitats contain the non-native nuisance plant, the Brazilian pepper, which invades these communities along disturbed areas, and then becomes established as it outcompetes native species. Coastal strand, coastal dune, and grasslands can be found along the 13 miles of shoreline



EXPLANATION

Biological Resource Features, Cape Canaveral AS, Florida

Figure 3.14-1

EELV/019

along the Atlantic Ocean. Seagrasses are found in the nearby rivers. Numerous wetlands and associated vegetation communities including hydric hammock, interdunal swales, and estuarine tidal swamps and marshes can be found on Cape Canaveral AS and its 12-mile shoreline along the Banana River. The remaining areas are associated with the cleared launch complexes and support facilities (National Aeronautics and Space Administration, 1996). Wetlands are discussed under Sensitive Habitats.

Oak scrub consists of densely growing shrubs that include myrtle oak, sand live oak, saw palmetto, and Chapman oak. Scrub is a fire-maintained community with hot, intense fires occurring every 20 to 80 years. Prior to modern development, these oak scrub communities would have burned frequently from lightning-strike fires. However, fire suppression has caused the scrub to become so densely vegetated that, if burned, it would result in a catastrophic fire that would completely remove the vegetation from the area. The Integrated Natural Resources Management Plan for Cape Canaveral AS includes a burn plan to manage scrub oak. Rare plants and animals can be found in such openings where fire or mechanical removal of trees has occurred (Florida Natural Areas Inventory, 1996b).

Maritime hammock is found on Cape Canaveral AS in two locations: on the east side, just landward of coastal strand, referred to as Atlantic maritime hammock, and on the west side of the peninsula, bordering the Banana River, referred to as Banana River maritime hammock. The largest stand of Atlantic maritime hammock occurs on the southern end of the station. Coastal strand typically contains sea oats (a state species of special concern) and is often integrated with scrub species from the coastal scrub communities. It often contains thickets of cabbage palm, saw palmetto, sea grapes, and tough buckthorn (Florida Natural Areas Inventory, 1996b).

Coastal dunes are inhospitable to many plants because of the constantly shifting substrate, salt deposition, abrasion from wind-blown sand, and effects of storm waves. The beaches south of Cape Canaveral AS have been eroding, while beaches to the north are enlarging. Cape Canaveral AS beaches are also enlarging, and several parallel dune lines and conspicuous offshore sand bars are supported. Sea oats, beach elder, railroad vine, beach croton, bitter panic grass, saltgrass, camphorweed, and beach cordgrass can often be found in coastal dune communities (Florida Natural Areas Inventory, 1996b).

Natural grasslands are rare in the areas of the launch complexes. These areas are subject to frequent disturbance from mowing and other human activities, and grasslands there typically comprise primarily exotic species.

Seagrasses, including Cuban shoal, manatee, and turtle grasses, are present in the northern Indian River system (including the Banana River).

Concept A ROI. Florida coastal scrub is the prevalent vegetation type surrounding SLC-41, although maritime hammock is found adjacent to the southern side of the complex (Figure 3.14-2). Mowed grasses and forbs are the predominant vegetation on SLC-41. Brazilian pepper dominates the Titan II Transporter Road margins, excluding all but the hardiest live oak, red cedar, wax myrtle, and cabbage palm. Woody vines are found entwined in the tree cover and include wild grape, pepper vine, and Virginia creeper. Coastal plain willow and giant leather fern characterize the Brazilian pepper transition into a wetland community, which is described in Section 3.14.1.4. Maritime hammock comprises 1.5 acres on the site and represents the only high-quality natural community on the project site.

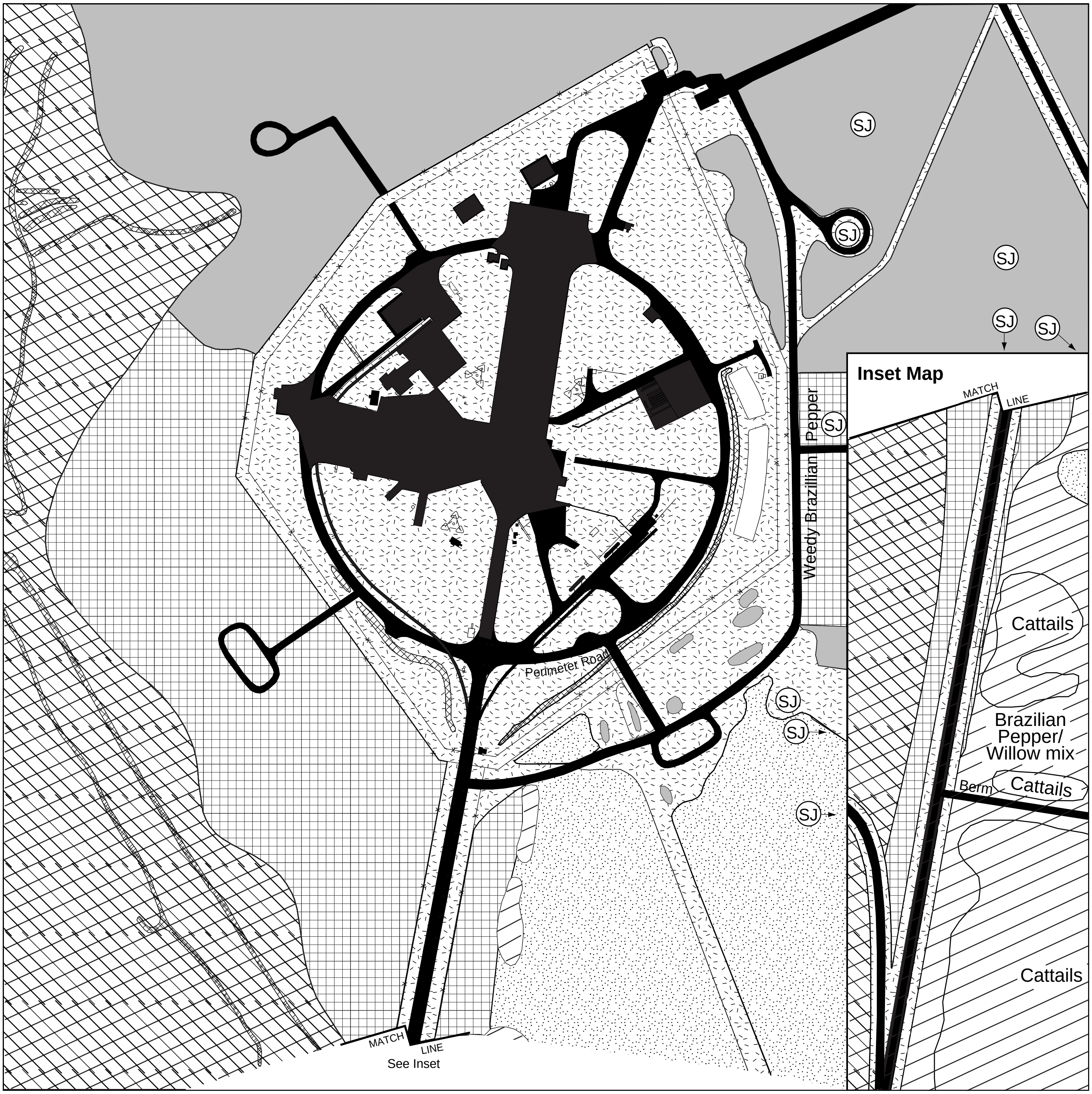
Concept B ROI. Florida coastal scrub is the prevalent vegetation type surrounding SLC-37 (Figure 3.14-3). Scrub habitat is also found along the entrance to SLC-37, although the Brazilian pepper is dominant along the roadways. Portions of SLC-37 within 200 feet of the beach area are within the influence of the coastal strand communities. The proposed HIF site location contains a coastal scrub community with dry grassy swales.

Myrtle oak, sand live oak, Chapman's oak, saw palmetto, sand cordgrass, prickly pear, and buckthorn dominate this vegetation type.

3.14.1.2 **Wildlife.** The coastal scrub and associated woodlands provide habitat for mammals including the white-tailed deer, armadillo, bobcat, feral hog, raccoon, long-tailed weasel, and round-tailed muskrat. The Florida mouse (a state species of special concern) requires open dry scrub habitat and could occur on Cape Canaveral AS.

Numerous land and shore birds are found at Cape Canaveral AS. In the maritime hammock, the little blue heron, the mourning dove, the gray catbird, the black-throated warbler, and the northern cardinal can be found. Burned hammock provides habitat for the rufous-sided towhee, the common yellow-throat, the northern mockingbird, the house wren, the downy woodpecker, and the osprey. Oak-hickory scrub is habitat for the blue and scrub jays, the mourning and common ground doves, and the red-bellied woodpecker, as well as many maritime hammock species. Shore birds include the black-necked stilt, the willet, the ruddy turnstone, the spotted sandpiper, gulls, the Caspian tern, the brown pelican, the roseate spoonbill, the wood stork, and the great blue heron. Turkey vultures, hawks including the red-tailed and the sharp-shinned hawks, the barn swallow, the fish crow, the common grackle, warblers, and sparrows are also found on Cape Canaveral AS.

Neotropical migrants observed on Cape Canaveral AS include eight species of warbler such as the blue-winged and black-and-white warblers, yellow-throated and red-eyed vireos, the eastern kingbird, the ovenbird, and the American redstart. Migrating raptors, including merlin, Cooper's hawk, and peregrine falcon, forage in the maritime hammock during fall and spring.



EXPLANATION

- Security Fence
- Scrub Jay territories
- Developed
- Drainage ditch (open water)
- Barren
- Brazillian Pepper
- Maritime Hammock
- Mowed or open grassland
- Oak or Coastal Scrub (FL Scrub Jay habitat)
- Saltwater marsh
- Wetland

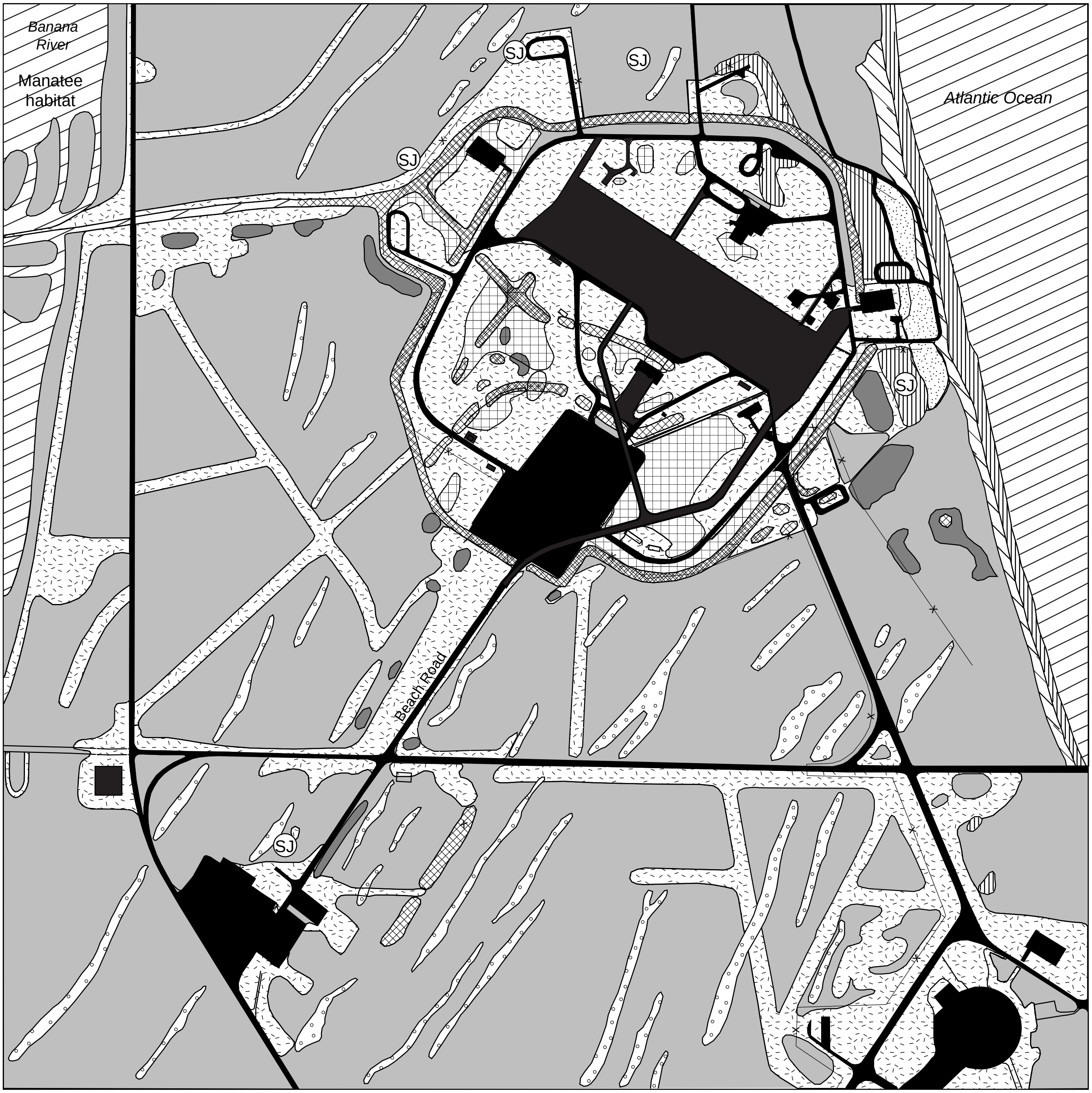
0 150 300 Feet

Source: Aerial photograph, Smith Environmental Services, 1997; Earth Tech, 1997; site visit, 1997.

SLC-41 Vegetation and Sensitive Habitat Cape Canaveral AS, Florida

Figure 3.14-2

EEL/114



EXPLANATION

HIF	Horizontal Integration Facility
SJ	FL Scrub Jay territories
	Swale
	Developed
	Open water
	Coastal dune vegetation
	Coastal strand vegetation
	Mowed or open grassland
	Oak or Coastal Scrub (FL Scrub Jay habitat)
	Open sand (Beach mouse habitat)
	Palmettos
	Wetlands/ wet areas
	Brazilian Pepper/ wax myrtle

0 200 400 800 Feet

Source: Aerial photograph interpretation following site visit, 1997; Earth Tech, 1997.

SLC-37 Vegetation and Sensitive Habitat Cape Canaveral AS, Florida

Figure 3.14-3

EEL/116

Numerous amphibians and reptiles have been observed at Cape Canaveral AS. Amphibians observed include the spade-foot and eastern narrow-mouth toads, squirrel and southern leopard frogs, and green treefrogs. Besides the common American alligator, reptiles observed include the Florida box turtle, the gopher tortoise, the Florida softshell, the green anole, the six-lined racerunner, the broadhead skink, the southern ringneck snake, the everglades racer, the eastern coachwhip, and the mangrove salt marsh snake.

The Cape Canaveral AS area is a transition zone between temperate and subtropical forms in terms of aquatic biota. Aquatic organisms found in the area are generally adapted to fluctuations in temperature and salinity. Numerous marine mammals can be found along the coast of Florida near Cape Canaveral AS and in the lagoons, including the bottlenose dolphin, the spotted dolphin, and the manatee. The seagrass beds in the northern Indian River system provide important nursery areas, shelter, and foraging habitat for a wide variety of fish and invertebrates, and for manatees. The Banana and Indian rivers and the Mosquito Lagoon provide habitat for marine worms, mollusks, and crustaceans. The Mosquito Lagoon, located approximately 6 miles northwest of Cape Canaveral AS, is considered an important shrimp nursery area. It also has the best oyster and clam harvesting in the area.

Within the Indian and Banana River systems, a number of saltwater fish species can be found. The bay anchovy is one of the dominant species inhabiting the lagoon system (U.S. Air Force,1987a). Other species known to occur include pipefish, goby, silver perch, lined sole, spotted seatrout, and oyster toadfish.

The small freshwater habitats found on Cape Canaveral AS contain bluegill, garfish, largemouth bass, killifishes, sailfin molly, and top minnow.

Concept A ROI. Wildlife on SLC-41 is mostly transient. The SLC is mostly developed (urban landscape).

Concept B ROI. Gopher tortoise burrows were found in many areas on SLC-37.

3.14.1.3 **Threatened and Endangered Species.** Cape Canaveral AS contains habitat utilized by a large number of federally and state-listed species. Listed species that are known to be present or near the station boundaries are presented in Table 3.14-1.

Six species of listed plants have been documented on Cape Canaveral AS (Florida Natural Areas Inventory, 1996b). Two of these species, Curtiss' milkweed (one occurrence) and the nodding pinweed (two occurrences), were identified in scrub habitat on the southern half of Cape Canaveral AS. These species are dependent on the clearings created by occasional fires and benefit from clearing for scrub jay habitat.

Table 3.14-1. Threatened, Endangered, and Candidate Species Occurring or Potentially Occurring at Cape Canaveral AS, Florida

Common Name	Scientific Name	Federal Status	State Status
Plants			
Giant leatherfern	*Acrostichum danaeifolium*	-	T
Curtiss' milkweed	*Asclepias curtissii*	-	E
Satin-leaf	*Chrysophyllum olivaeforme*	-	E
Coastal vervain	*Glandulareia maritima*	(C2)	E
Nodding pinweed	*Lechea cernua*	-	E
Hand fern	*Ophioglossum palmatum*	-	E
Golden polypody	*Phlebodium aurea*	-	T
Beach-star	*Remirea maritima*	-	E
Reptiles and Amphibians			
Gopher frog	*Rana capito*	C	SSC
American alligator	*Alligator mississippiensis*	T(S/A)	SSC
Eastern Indigo snake	*Drymarchon corais couperi*	T	T
Green sea turtle	*Chelonia mydas*	E	E
Loggerhead sea turtle	*Caretta caretta*	T	T
Leatherback sea turtle	*Dermochelys coriacea*	E	E
Atlantic (Kemp's) Ridley sea turtle	*Lepidochelys kempi*	E	E
Hawksbill sea turtle	*Eretmochelys imbricata imbricata*	E	E
Birds			
Wood stork	*Mycteria americana*	E	E
Bald eagle	*Haliaeetus leucocephalus*	T	T
Peregrine falcon	*Falco peregrinus*	E(S/A)	E
Florida scrub jay	*Aphelocoma coerulescens coerulescens*	T	T
Piping plover	*Charadrius melodus*	T	T
Least tern	*Sterna antillarum*	-	T
Southeastern American kestrel	*Falco sparverius paulus*	(C2)	T
Mammals			
Manatee	*Trichechus manatus*	E	E
Southeastern beach mouse	*Peromyscus polionotus niveiventris*	T	T
Finback whale	*Balaenoptera physalus*	E	E
Humpback whale	*Megaptera novaeangliae*	E	E
Northern right whale	*Eubalaena glacialis*	E	E
Sei whale	*Baeaenoptera borealis*	E	E
Sperm whale	*Physeter catodon*	E	E

C	=	candidate (former Category C1)
C2	=	former Category 2
E	=	endangered
SSC	=	state special concern species
(S/A)	=	listed by similarity of appearance to a listed species
T	=	threatened

Two listed plant species were found in maritime and hydric hammocks: hand fern (one occurrence) and the satin-leaf (not recorded when found). These communities are not fire-maintained and are threatened by the encroachment of exotic species, such as the Brazilian pepper. The hand fern is an epiphyte that exists in cabbage palmetto old leaf bases, which are present in moist hammock communities. It is extremely sensitive to habitat disturbance. The hand fern was found on the southern half of Cape Canaveral AS.

The remaining two listed plant species were also found in coastal dune, coastal interdunal swale, and coastal strand habitats, as well as in openings and disturbances in other communities: beach-star (five occurrences) and coastal vervain (ten occurrences). These species are colonizers of open, sandy areas provided by wind, fire, or storm overwash. The beach-star was found along sandy beaches. The coastal vervain was found along some roads and other areas on the station. None of the populations occurs near the roads or facilities proposed for EELV activities.

Listed animals in the vicinity of the launch complexes include the bald eagle, the southeastern American kestrel, the American alligator, the Atlantic loggerhead and green sea turtles along the Atlantic coastline; the southeastern beach mouse along the vegetation zones paralleling the beach and dune lines; the eastern indigo snake and the gopher frog in moist areas or in dry land gopher tortoise burrows; gopher tortoises in all habitats; the Florida scrub jay in Florida coastal scrub and slash pine stands; and the West Indian manatee along the Banana River (National Aeronautics and Space Administration, 1996).

The gopher tortoise is still common in some parts of its range although rare in others. Although this species is not formally listed by federal or state agencies, gopher tortoise habitat warrants special note because the burrows provide important habitat to numerous other protected species. The gopher tortoise was found in moderate densities on Cape Canaveral AS in areas of sandy, well-drained soils, primarily in coastal strand and dry clearings. The gopher tortoise prefers open habitats that have herbaceous plants for forage including disturbed areas such as recent burn areas, road shoulders, fence lines, and launch complexes. Gopher tortoises are tolerant of human presence.

The gopher frog is a candidate species found mainly in native xeric upland habitats, including xeric oak hammocks. It will often use gopher tortoise burrows as shelter. The egg masses are often laid within 4.5 centimeters of the water’s surface on emergent vegetation or on the bottom of shallow pools.

Although commonly found throughout Cape Canaveral AS, the American alligator is federally listed as threatened because it is similar in appearance to the American crocodile, which is not present on the station. The American alligator lives in fresh to brackish waters found in marshes, ponds, lakes, rivers, swamps, bayous, and large spring runs. It basks on land next to the water and digs dens and builds nests in river banks, lake margins, or marshes. The American alligator uses the dens for protection from cold or drought.

The threatened eastern Indigo snake has been found on Cape Canaveral AS and likely occurs throughout the station. It is known to occur in most types of hammocks, flatwoods, scrub, and swale marshes, often near wetlands, and is often associated with gopher tortoise burrows. Home ranges for males range from 191 to 360 acres; female home ranges are from 14 to 139 acres.

Green sea turtle breeding populations along the Florida and Pacific coasts and the Gulf Coast of Mexico are federally listed as endangered; all other populations are listed as threatened throughout its range worldwide. Pollution and human development are degrading the beach nesting and ocean feeding habitats for the green sea turtle in portions of its range. Nighttime lighting near beaches generally makes nesting on beaches unsuitable for successful reproduction. Development on the beaches sometimes forces nesting to occur too close to the tidal zone, which causes many nests to be destroyed by tidal inundation and erosion. Green sea turtles are present on the Florida coast from May to October (Mercadante, 1997) and are known to nest on Cape Canaveral AS beaches. Cape Canaveral AS has a lighting management program in place to minimize light impacts on sea turtle nesting beaches.

The threatened (federal and state listing) loggerhead sea turtle is relatively abundant and occupies most of the Florida coastline. The turtles nest on the beaches of Florida from May to October. It is possible that only the females are migratory; males are known to occupy Florida waters year-round. Loggerhead sea turtles are known to nest on Cape Canaveral AS beaches.

The endangered (federal and state listing) leatherback sea turtle population in Florida is small and is threatened by disturbances to natural lighting conditions, erosion, nest predation, and pollution along the beaches. Leatherback sea turtles occur mainly in the open sea, but some females can be found on the Florida beaches and utilize coastal waters from April to July. The leatherback sea turtle has been reported to nest on Cape Canaveral AS beaches (three occasions).

Although the Atlantic (Kemp’s) Ridley and the Hawksbill sea turtles are not known to nest on Cape Canaveral AS beaches, they have been known to occur in the waters off the Florida coast and near shore areas.

Wood storks forage in marshes, ponds, and lagoons and are year-round residents in the Cape Canaveral AS area, nesting in the treetops of mangrove swamps or by man-made impoundments.

As of 1995, the bald eagle has been down-listed to threatened throughout the continental United States, although the Florida population has been listed as threatened for years. They can be found year-round near the coast, rivers, and large lakes of Florida, but they do not breed on Cape Canaveral AS, although numerous active nests have been reported at the KSC. On rare occasions, bald eagles can be tolerant of human activity if it is not directed toward them. However, they typically need a one-quarter to one-half mile buffer between human activity and an active nest site to avoid disruption of breeding and nesting activities.

All free-flying peregrine falcons are federally listed as endangered (because of their similarity in appearance to the subspecies *Falco peregrinus anatum,* which is listed as endangered). The peregrine falcon migrates through the Florida area and can be found most of the year, except from mid-June to mid-August. The bird is basically tolerant of human presence.

The Florida scrub jay is a year-round resident that is very sedentary and territorial. Its habitat is in open oak scrub without a dense canopy, as well as palmetto, sand pine, and rosemary. Scrub jays nest in territories adjacent to several northern SLCs with successful nesting occurring March through June next to these launch facilities. As little as 5 to 10 acres of suitable habitat may support a mated pair (Fernald and Toland, 1991). Statewide average scrub jay territory size is 20 acres (U.S. Air Force, 1993b). The average on Cape Canaveral AS is approximately 13 acres. Without suitable habitat, scrub jays are susceptible to predation and have low nesting success. It is believed that 25 percent of the state’s total scrub jay population inhabits Cape Canaveral AS. Drier, more sparsely vegetated habitats are better for scrub jay management activities than wetter areas. The species can become habituated to human presence over time. The scrub jays near SLC-40 and SLC-41 were monitored for three years during Titan IVB launches (Larson et al., 1993). Launches occurred every three months from March to September at SLC-40, and once during June at SLC-41. No scrub jay mortalities were associated with these launches. The only distress shown by any birds within hours of a launch occurred when vegetation was burned or defoliated near a flame trench at SLC-40. The birds avoided this damaged area for one month. A study of the effects of construction on scrub jay territory size found that construction at SLC-41, resulting in a loss of 2.5 acres of scrub and 1.5 acres of mowed grass habitat, caused the average surrounding territories to decrease slightly in size (Larson, et al., 1993).

Least terns nest along sandy or gravelly beaches by SLC-46 and on gravel rooftops in an industrial area on Cape Canaveral AS, approximately 1 mile north of the jetty. They are very sensitive to disturbance when nesting.

Inhabiting Cape Canaveral AS from April to mid-October, they typically nest between May and June.

Piping plover nest in or near least tern colonies along the Atlantic coast from approximately March to August. There are no confirmed nesting areas on Cape Canaveral AS; however, they may overwinter in the area.

The Florida populations of the southeastern American kestrel may be year-round residents and were observed in the winter on Cape Canaveral AS. Found in open or partly open habitat in scrub, open forests, cultivated lands, and wooded streams, they have not been observed to breed on Cape Canaveral AS.

The Florida manatee is endemic in this region of Florida, occupying shallow coastal waters, estuaries, bays, and enters coastal rivers and lakes. Sheltered bays, coves, and canals are important environments for its reproductive activities. Manatees are semipermanent residents in the area but may migrate southward for the winter. Manatee critical habitat is present in the Banana River on Cape Canaveral AS and in the surrounding area (see Figure 3.14-1). Manatees are sensitive to human disturbance, and their survival is complicated by their low population densities, low reproductive rates, limited range, and high mortalities. Die-offs associated with red tides and unusually cold weather have occurred in Florida. However, the primary threat to the manatee is boat-propeller-inflicted injury.

Southeastern beach mouse populations on Cape Canaveral AS have been found at the launch complexes where the area is artificially open grassland. The coastal grasslands and strand communities provide the highest population densities at Cape Canaveral AS. Other habitat is the primary dune, although the sea oat vegetation is not as suitable for the beach mouse as the grassland.

Finback, humpback, northern right, sei, and sperm whales, all federally and state-listed as endangered, are pelagic mammals that are generally found from the shelf edge seaward. The whales move to northern temperate waters in the spring and toward the equator in the fall, migrating past Cape Canaveral AS and around the tip of Florida north of Cuba. The National Marine Fisheries Service (NMFS) is proposing to designate the water adjacent to the coast of Florida as critical habitat for the northern right whale.

Concept A ROI. Scrub jay nesting territories are adjacent to the eastern side of SLC-41 and are approximately 500 feet east of the site of the two proposed assembly facilities (see Figure 4.13-2). Although no sensitive species are known to reside on SLC-41, many sensitive species such as the manatee occur in the adjacent aquatic habitat. At the site of the proposed assembly facilities, two plants listed as threatened by the Florida Department of Agriculture and Consumer Services occur: the giant leather fern and the golden polypody. These plants are locally abundant, however, and are not listed as rare on Cape Canaveral AS by the Florida Natural Areas Inventory

(Smith Environmental Services, 1997). One American alligator was documented as using the cattail marshes and adjacent Brazilian pepper/willow wetland on the assembly facilities site, but this species is common on Cape Canaveral AS.

Concept B ROI. The gopher tortoise occurs on SLC-37 and could support numerous commensal species. The complex is also adjacent to Florida beach mouse habitat. Scrub jay nesting territories are adjacent to SLC-37, and scrub jays use the open habitat on the SLC for foraging. Scrub jay nesting territories are also present at the proposed HIF site.

3.14.1.4 **Sensitive Habitats.** Sensitive habitats on Cape Canaveral AS include wetlands, critical habitats for threatened and endangered species as defined by the Endangered Species Act, and the nearby Cape Canaveral National Seashore and Merritt Island National Wildlife Refuge.

Wetlands. Cape Canaveral AS contains many wetlands and associated vegetation communities including estuarine tidal (mangrove) swamps and marshes, hydric hammock, coastal interdunal swales, and man-made borrow pits and canals. A U.S. Fish and Wildlife Service (USFWS) National Wetlands Inventory conducted in 1994 identified a total of 2,235 acres of wetlands on Cape Canaveral AS. Specific wetland delineations for each concept have been conducted and are described in the site-specific discussions that follow.

Hydric hammocks occur along the Banana River on the western boundary of the station in lowland areas where the soils are generally saturated year-round but are inundated only for short periods after heavy rains. Hydric hammocks often transition into a sawgrass-willow or cattail marsh. Cabbage palm is present throughout the hammock, and live oak, American elm, and mulberry are present in the better-drained areas. Tropical species including the myrsine, twinberry, wild coffee, and white stopper can be found with strangler fig “strangling” cabbage palms. Ferns are abundant in many areas. The exotic Brazilian pepper has invaded even the most intact hydric hammock.

Coastal interdunal swales are found in the coastal dune areas and between areas of maritime hammock. These swales are saturated most of the year and support grasses and a few woody plants. Sedges, arrowhead, frog-fruit, sabatia, and fleabane can also be found. The drier swales support some woody plants including the wax myrtle, the live oak, the saw palmetto, and the groundsel tree. The listed coastal vervain can be found in the interdunal swales.

Cape Canaveral National Seashore. The Cape Canaveral National Seashore lies north of Cape Canaveral AS (see Figure 3.14-1). The least disturbed and undeveloped coastal segments remaining along Florida’s eastern shoreline were set aside in 1975 as part of the National Seashore to ensure preservation of these segments.

Merritt Island National Wildlife Refuge. The Merritt Island National Wildlife Refuge lies west of Cape Canaveral AS (see Figure 3.14-1). A large manatee aggregation site, attracting up to 200 manatees in the spring, is within the boundaries of the refuge. Other threatened or endangered species that inhabit the scrubby flatwoods of Merritt Island include the Florida scrub jay, the eastern indigo snake, and the southern bald eagle.

Critical Habitat. Manatee critical habitat, located in the Banana River system, includes the entire inland sections of the Indian and Banana rivers, and all waterways between the two rivers, with the exception of some man-made structures or impoundments not necessary to the normal needs of the manatee. The NMFS is proposing to designate the water adjacent to the coast of Florida as critical habitat for the northern right whale.

Indian River Lagoon. The Indian River Lagoon is home to more than 4,300 kinds of plants and animals. This unique estuary is actually three lagoons, the Mosquito Lagoon, the Banana River, and the Indian River (Pacetti, 1996). These "rivers" have no mouth or flowing current but are headwaters where flow begins, fed by rivers, canals, and streams. The lagoon has a gradation of brackish water (salt and fresh water mixed) to salt water where it opens to the ocean. This lagoon, which is listed as an Estuary of National Significance, contains more species than any other estuary in North America (2,965 animals, 1,350 plants, 700 fish, and 310 birds) (St. John’s River Water Management District, n.d.). Located along the Atlantic Flyway, it provides important migratory bird habitat. The lagoon contains one of the highest densities of nesting turtles in the western hemisphere (Pacetti, 1996), is a rich fishery, and is used by up to one third of the United States’ manatee population. Development along the shoreline and mosquito control practices have destroyed large areas of mangroves and seagrasses. Mangroves provide essential shoreline protection and nesting areas for rare lagoon birds, such as the wood stork and the roseate spoonbill.

The upper reaches of the Banana River adjacent to Cape Canaveral AS and the lower reaches of the Mosquito Lagoon have generally good water quality due to the lack of urban and industrial development in the area. However, as summarized in the water quality discussion, phenols and aluminum (found in liquid rocket fuels) and pH (a result of solid rocket fuel combustion) occasionally exceed state water quality criteria in these areas. Localized fish kills have been noted after space shuttle launches as a direct result of a temporary (several hours) and localized increase in acidity in the waters adjacent to the launch sites. The long-term effects that these pollutants will have on the estuaries of the area is unknown.

Concept A ROI. Wetlands near SLC-41 consist mainly of mixed salt-tolerant grasses, black mangroves, and sea oxeye daisy vegetation (National Aeronautics and Space Administration, 1995c). The mangrove swamps occur in a mosaic fashion on the northwestern edge of Cape Canaveral AS as it fringes the Banana River. A wetland delineation was conducted for the proposed assembly facilities site. Approximately 8.2 acres of the total

13.5-acre site are jurisdictional wetlands (Smith Environmental Services, 1997). These wetlands are isolated and extremely degraded. Exotic and nuisance plant species, primarily Brazilian pepper, coastal plain willows, and cattail, replaced the historical saltmarsh/mangrove plant communities after mosquito control and development in the area completely isolated the wetlands from the Banana River Lagoon. The disturbance created a wetland with extremely low natural community heterogeneity habitable by only a narrow range of fish and wildlife.

East of the access road to SLC-41, several areas have been impounded and flooded for mosquito abatement. These impounded areas are considered wetlands, although they are not of high quality.

A wood stork rookery was located approximately 1.4 miles north of SLC-41 (National Aeronautics and Space Administration, 1995c). This rookery was abandoned in 1991.

Concept B ROI. A wetland delineation was conducted from May to August 1997 (ENSR Corporation, 1997c). SLC-37 contains approximately 7 acres of drainage that are not protected as wetlands because they were constructed on dry land, but may be considered “other surface waters” by the SJRWMD and “Water of the United States” by the USACE (see Figure 3.14-3). The vegetation in these ditches consists of Brazilian pepper, wax myrtle, cattail, duckweed species, leather fern, and water primrose.

SLC-37 is also surrounded by an upland ditch that ultimately connects to the Banana River to the west. This wetland contains cattail and water primrose.

Wetlands were also delineated at the proposed HIF site. Two small, isolated swales of approximately 0.31 and 0.37 acre are on the site (see Figure 3.14-3). They contain sawgrass, sand cordgrass, climbing hempvine, marsh fleabane, wax myrtle, and saltbush. These wetlands have been impacted by changes in the natural hydrology and do not maintain a high functional value (ENSR Corporation, 1997c).

3.14.2 **Vandenberg AFB**

The ROI for biological resources consists of Vandenberg AFB, the adjacent Pacific Ocean, and the northern Channel Islands (Figure 3.14-4).

EXPLANATION

Base Boundary

246 State Route

Marine Ecological Reserve

0 .5 1 2 Miles

Biological Resource Features, Vandenberg AFB, California

Figure 3.14-4

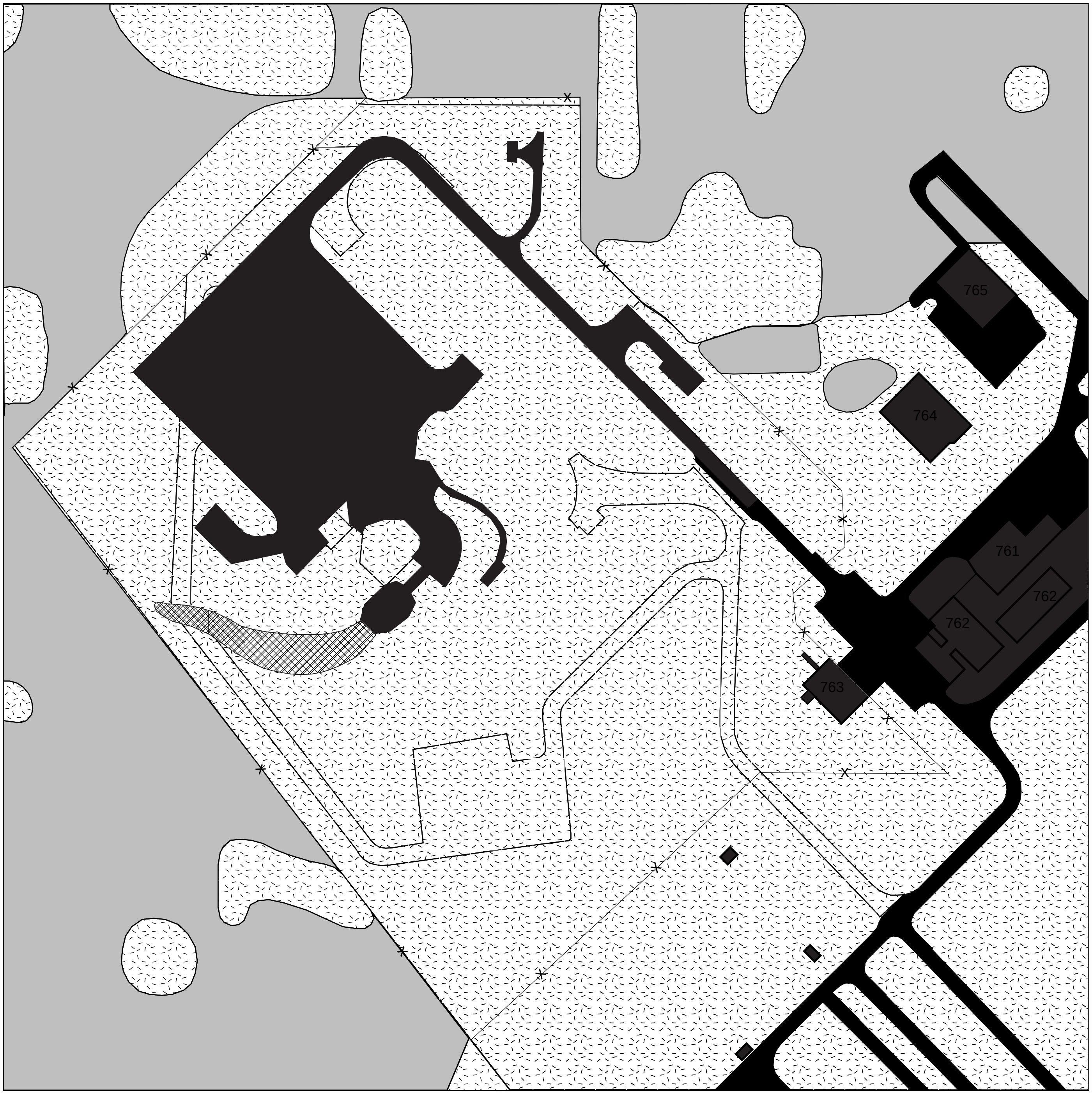
EELV/106

Vegetation. Vandenberg AFB occupies a transition zone between the cool, moist conditions of northern California and the semi-desert conditions of southern California. Many plant species and plant communities reach their southern or northern limits in this area. Natural vegetation types on Vandenberg AFB include southern foredunes; southern coastal, central dune, central coastal, and Venturan coastal sage scrub; chaparral including central maritime chaparral; coast live oak woodland and savanna; grassland; tanbark oak and southern bishop pine forest; and wetland communities including coastal salt marsh and freshwater marsh, riparian forests, scrub, and vernal pools (U.S. Air Force, 1989a).

Under the No-Action Alternative, Atlas IIA, Delta II, and Titan IVB launches would continue from SLC-3E, SLC-2W, and SLC-4E, respectively. Within this section, the descriptions of SLC-3E and SLC-4E are included within the Concept A and B ROI descriptions. Because SLC-2W is located on North Vandenberg AFB, the ROI for this site is described separately within each subsection. The undeveloped areas of SLC-2W contain sparse vegetation that can be described as coastal dune scrub. Central dune scrub has been defined by Holland (1986) as a "dense coastal scrub community of scattered shrubs, subshrubs, and herbs generally less than one meter tall and often developing considerable cover." This plant community is characterized by species suited to central California’s coastal dune environments, such as mock heather, dune lupine, California sage brush, deerweed, and dune mint. Dune mint is a federally listed Category 2 species and is on California Native Plant Society List 1B (plants rare and endangered in California and elsewhere) (National Aeronautics and Space Administration, 1993).

Concept A ROI. Plant communities in the vicinity of SLC-3 include coastal sage scrub, grassland and disturbed areas, mixed grassland-coastal sage scrub, riparian woodland and associated emergent vegetation, Burton Mesa chaparral (central maritime chaparral), and non-native woodland (Figure 3.14-5) (U.S. Air Force, 1991f). The coastal sage scrub community is dominated by California sagebrush, coyote brush, mock heather, poison oak, Lompoc bush monkeyflower, and giant wild rye. Two former Category 2 species, black-flowered figwort and Kellogg's horkelia, occur in the coastal sage scrub community and are known to occur near SLC-3 (U.S. Air Force, 1991f).

The grassland community is dominated by non-native grasses including brome, veldtgrass, wild oats, and fescue. It may also include native perennial needle grasses and scattered small shrubs, such as cudweed aster and California sagebrush. Native and non-native forbs associated with the grassland include lupine, owl's clover, blue-eyed grass, and tomcat clover. This plant community occurs on disturbed sites. More substantially disturbed areas, such as SLC-3, are dominated by veldtgrass, black mustard, filaree, hottentot fig, and California goosefoot. Mowed weedy areas occur within the SLC-3 security fence and along road shoulders (U.S. Air Force, 1991f).



EXPLANATION

- Coastal Sage Scrub
- Barren
- Developed
- Electrical line
- Grasslands
- Wetland (Willow Riparian)

SLC-3W Vegetation and Sensitive Habitat Vandenberg AFB, California

0 60 120 240 Feet

Source: Bionetics Corporation, 1988; site visit, 1997.

Figure 3.14-5

The mixed grassland-coastal sage scrub community is a transitional area between grassland, the primary plant community in disturbed areas, and coastal sage scrub, which is the next successional stage in plant community development. The area contains a mosaic of grassland and coastal sage scrub (U.S. Air Force, 1991f).

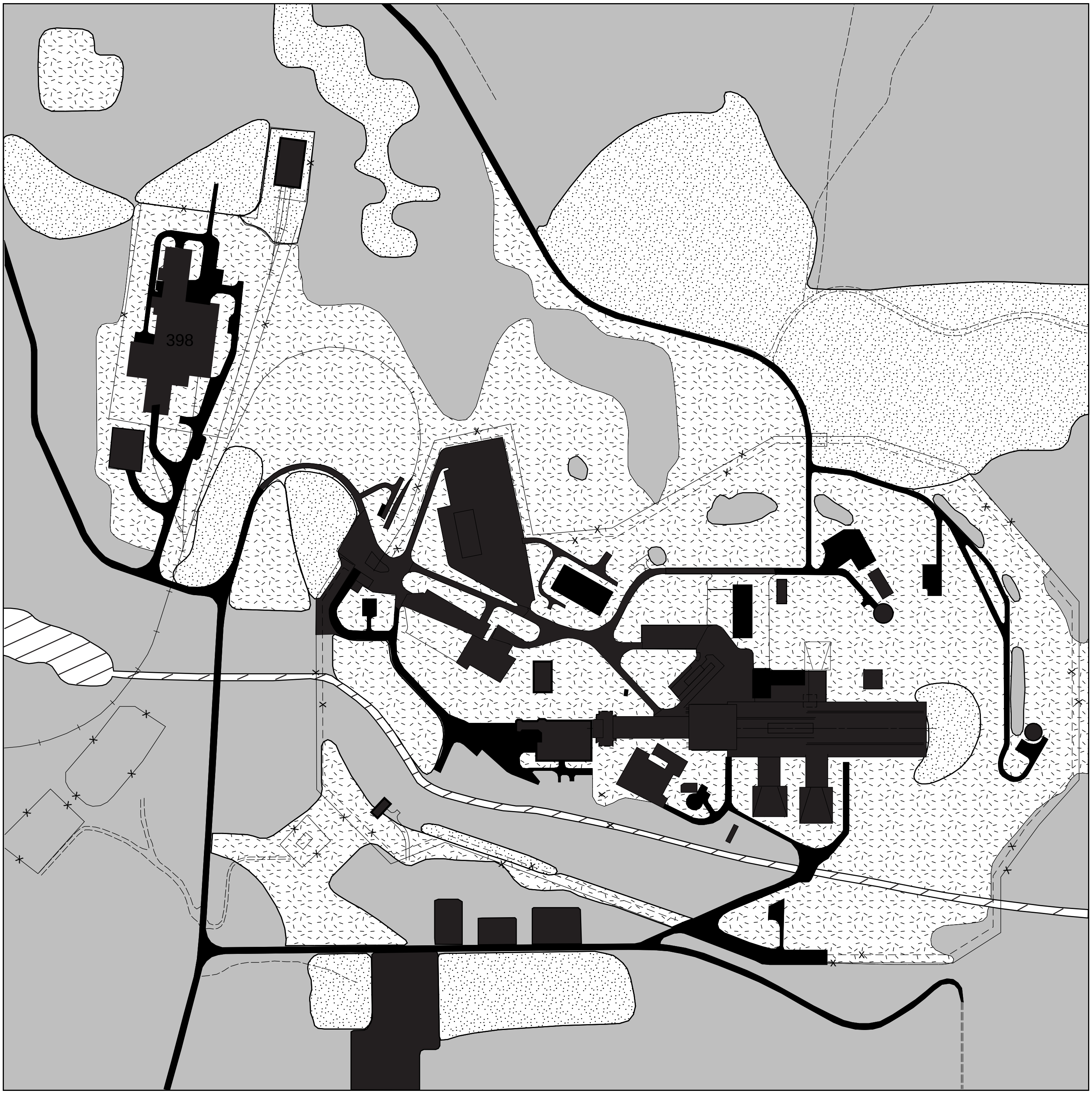
A riparian woodland community dominated by willows is adjacent to SLC-3 along Bear Creek and associated spring and seeps in tributary canyons, and in a small drainage ditch at the foot of the SLC-3W retention basin. In places, the riparian woodland plant community contains a dense understory of twinberry, blackberry, stinging nettle, and poison oak (U.S. Air Force, 1991f).

Burton Mesa chaparral near SLC-3 is characterized by dense shrubs such as Santa Cruz Island oak, chamise, coast ceanothus, Santa Barbara ceanothus, Purisima manzanita, shagbark or sand mesa manzanita, and Lompoc bush monkeyflower. A number of perennial and annual herbaceous plants also occurs in the Burton Mesa chaparral community. Species composition and vegetative cover vary among sites dependent on the shrub density. Several of the shrubs found in Burton Mesa chaparral are local endemics, including the shagbark manzanita and the coast and Santa Barbara ceanothus (U.S. Air Force, 1991f). Blochman's or dune delphinium is a former Category 2 species that has been found in coastal chaparral on South Vandenberg AFB (Oyler et al., 1995).

Several non-native woodlands occur near SLC-3, the most common of which are tall, often monotypic stands of planted blue eucalyptus. Two stands occur near SLC-3 adjacent to Bear Creek. The blue eucalyptus leaf litter contains toxins that prevent germination of many plants. Planted stands of Monterey cypress also occur along Bear Creek. The edges of woodlands and clearings contain a sparse herbaceous cover dominated by wild oats, black mustard, and veldtgrass (U.S. Air Force, 1991f).

A survey of SLC-3W, associated intersections requiring modifications, and the disturbance at Building 7525 was conducted (Fugro West, Inc., 1996). The vegetation in these areas is dominated by non-native plants such as hottentot fig, veldtgrass, filaree, plantain, and ripgut grass. The most common native species in areas less disturbed include California sagebrush, heather goldenbush, California buckwheat, common cudweed aster, and dune lupine.

Concept B ROI. Plant communities in the vicinity of SLC-6 include central coastal sage scrub, chaparral including maritime chaparral, grassland, riparian wetlands, eucalyptus (non-native woodlands), and ruderal areas (Figure 3.14-6). Ruderal vegetation is characterized by disturbance-tolerant, mostly non-native species, primarily introduced grasses such as brome, veldtgrass, wild oats, and fescues. In addition to these plant communities, north-facing



EXPLANATION

- Double Fence (If required)
- Security Fence
- HIF — Horizontal Integration Facility
- Developed
- Barren
- Coastal Sage Scrub
- Grassland
- Wetland

0 145 290 580 Feet

Source: Bionetics Corporation, 1988; site visit, 1997.

SLC-6 Vegetation and Sensitive Habitat Vandenberg AFB, California

Figure 3.14-6

EELV/113

slopes dominated by monkeyflower, coyote bush, and California sagebrush with Indian paintbrush, fern, miner's lettuce, and dudleya in the understory are located south of SLC-6. These represent a residual north-coastal flora comprising species more widespread 10,000 years ago during a cooler, moister period (U.S. Air Force, 1978).

Crisp and San Luis Obispo monardellas are two former Category 2 species found in sandy areas. Both have been reported to be present near SLC-6 (Oyler et al., 1995).

The boathouse area is dominated by non-native grassland with scattered coyote brush, California sagebrush, goldenbush, and herbs including vetch and locoweed. The area has been subject to cattle grazing for at least the past 60 years (U.S. Air Force, 1989a). Coastal strand occurs along Vandenberg AFB's beaches. Native beach plants include beach saltbush, sea rocket, sand verbena, beach morning-glory, and beach burr. European beachgrass and ice plant, non-native species, are pervasive and spreading on most Vandenberg AFB beaches (Persons and Applegate, 1996).

The Boathouse Embayment includes three types of subtidal habitats. A rocky boulderfield covers the shoreward half of the bay, and a sandy bottom habitat occurs in the outer portion. The caissons, pilings, and riprap are the third habitat type in the bay. Dense algal growths cover much of the rocky substrate habitat within the embayment. These consist primarily of red algae, several species of brown algae, and two species of green algae. Surfgrass is also common (U unincorporated Brevard**3.14.2.2** County was 178,457.Vandenberg AFB **TC "3.2.2Vandenberg AFB" \l3Vandenberg AFB is in the western part of unincorporated Santa Barbara County, California. The Santa Ynez River and SR 246 divide the base into North and South Vandenberg AFB. North Vandenberg AFB generally includes the de**veloped portions **of the base, whereas South Vandenberg AFB includes primarily open space. The city of Lompoc lies to the east, the city of Santa Maria to the northeast, and the city of Guadalupe to the north. Two** unincorporated communities, Vandenberg Village and Mission Hills, are north of the city of Lompoc, and the unincorporated community of Orcutt is north of the base.Employment TC "3.2.2.1 Employment" \l4. In 1997, there were 229,107 total jobs within Santa Barbara County (Table 3.2-3). The number of jobs in the county grew at an average annual rate of 2.3 percent between 1975 and 1990. By comparison, the number of jobs in the state of California grew at an average annual rate of 2.5 percent during the same period. Between 1990 and 1997, the rate of county job growth averaged 2.4 percent annually.Table 3.2-3. Summary of Economic Indicators, Santa Barbara County, California, Estimates for 1975, 1990, 1994, 1997 and Forecasts for 1998, 2000, 2001, 2007, 2015 TC "3.2-3 Summary of Economic Indicators, Santa Barbara County, California, Estimates for 1975, 1990, 1994, 1997 and Forecasts for 1998, 2000, 2001, 2007, 2015" \ft19751990199419971998200020072015Total Jobs(a)137,2***
****

****
****
****
**Honda Creek. The California horned lizard and the California legless lizard are former Category 2 species found on South Vandenberg AFB (Christopher, 1996a,b).

Several sensitive species may forage on coastal sage scrub and chaparral habitats. These include the northern harrier, the merlin, and the short-eared owl (all special concern species); the white-tailed kite and the tree swallow (both regionally rare); the Cooper's hawk and the prairie falcon (both special concern species and regionally rare); and the ferruginous hawk (former Category 2 and special concern species) (U.S. Air Force, 1991f).

Bell's sage is a former Category 2 and special concern species found in open Burton Mesa chaparral. A population has been identified at a location east of Lompoc Canyon, approximately 2 miles inland.

Three regionally rare and declining bird species (the Swainson's thrush, the warbling vireo, and the Wilson's warbler) nest in the Bear Creek riparian woodland. The Cooper's hawk (a special concern and regionally rare species) may also nest along Bear Creek. Both riparian woodland and non-native planted tree groves attract migrating flycatchers, kinglets, vireos, warblers, sparrows, and orioles. Several species of hawks, owls, and other common raptors roost and nest in the planted non-native tree groves (U.S. Air Force, 1991f).

Burrowing owls (former Category 2 and special concern species) prefer dry, open, grassy, usually treeless plains, occasionally with gently rolling hills. This species utilizes the same habitat for breeding and wintering. Although suitable habitat occurs on Vandenberg AFB, it appears that this species no longer nests there and is now only an uncommon-to-rare winter visitor to grassland and open scrub habitats. California horned larks (former Category 2 and special concern species) breed in grasslands in the Sudden Flats area (U.S. Air Force, 1994c). Loggerhead shrikes (former Category 2 and special concern species) prefer open country with lookout posts, scattered trees, and low scrub vegetation, and have been observed on South Vandenberg AFB (U.S. Air Force, 1994c). The grasshopper sparrow is a regionally rare bird that may forage in grasslands near SLC-6 (U.S. Air Force, 1989a).

The Santa Barbara Channel is located along the Pacific Flyway, at a biogeographical boundary between warm southern and cold northern ocean waters. As a result, an abundance and diversity of marine birds is found along the offshore waters and Channel Islands. As many as 30 species of seabirds are known to occur in the open ocean water of the continental shelf. The elegant tern (former Category 2 and special concern species) is a coastal area post-breeding visitor during late summer and early fall (U.S. Air Force, 1991f). Long-billed curlews (former Category 3 and special concern species) typically winter in coastal areas and are found at South Vandenberg AFB.

The Channel Islands are inhabited by breeding colonies of marine birds, with the largest colonies on San Miguel Island. These include Leach's and ashy storm-petrels; Brandt's, double-crested, and pelagic cormorants; pigeon guillemots; and Cassin's auklets. California's only nesting colony of brown pelicans occurs on Anacapa Island and an islet adjacent to Santa Cruz Island (U.S. Air Force, 1992b). Nesting sites for some of these species are also documented to exist on the mainland. These include Point Pedernales, Destroyer Rock, Point Arguello, Rocky Point, and Point Conception (see Figure 3.14-4) (U.S. Air Force, 1991f).

California sea lions and northern fur, northern elephant, and harbor seals use the northern Channel Islands as haul-out (resting), mating, and pupping areas. The largest concentrations occur on San Miguel Island. Harbor seals haul out at a total of 19 sites between Point Sal and Jalama Beach. Purisima Point and Rocky Point are the primary haul-out sites on Vandenberg AFB. California sea lions do not breed on Vandenberg AFB. However, Point Sal is used heavily as a haul-out site. San Miguel and San Nicolas islands are the major rookeries for California sea lions and northern elephant seals. Northern elephant seals are periodically observed on Vandenberg AFB. Effects to marine mammals have been monitored over several years from Vandenberg AFB launches and are described in Chapter 4.0.

Small-toothed whales including bottlenose, common and Pacific white-sided dolphins, and killer whales are common near Vandenberg AFB and in the Channel Islands. The gray whale (a former federally listed endangered species, now designated as recovered) is found close to shore off South Vandenberg AFB during migration from Baja, California, to the Bering Sea, between December and May and returns to Baja in November and December (U.S. Air Force, 1991f). Minke whales have been reported within a few miles of the leeward sides of San Miguel, Santa Rosa, Santa Cruz, and Anacapa islands.

A request, under Section 101(a)(5)(A) of the Marine Mammal Protection Act of 1972, as amended, for a letter of authorization for the incidental take of marine mammals during programmatic operations at Vandenberg AFB was submitted to the NMFS in July 1997 (Appendix H). If approved, Vandenberg AFB will be allowed incidental take for up to 20 space launches per year for the next 5 years.

Wildlife in the vicinity of SLC-2W consists of common regional animals as well as those species found in coastal environments. More common wildlife that may occur at SLC-2W include mule deer, jackrabbits, cottontails, and predatory animals such as the bobcat and the coyote. A high diversity of bird species may occur at SLC-2W.

Concept A ROI. Coyote and California ground squirrel burrows were observed throughout the site. Numerous birds observed foraging on site included the Northern harrier, the red-shouldered hawk, the red-tailed hawk, the American kestrel, the Anna's hummingbird, and the California towhee. The regionally rare mountain lion is expected to occur in the chaparral and riparian woodlands near SLC-3W.

Concept B ROI. Burrowing owls have been sighted near the boathouse area (Holmgren and Collins, 1995). Animals of the exposed rocky intertidal area in the Boathouse Embayment include the California mussel; the Pacific goose barnacle; and the common, purple, and ocher seastars. Abalone are also found in this area. Biological diversity within the embayment is highest in the rocky boulderfield habitat, which includes 12 species of benthic invertebrates, the most abundant being the snail *Mitrella carinata* and the seastar *Patiria miniata*. Subtidal sandy bottom surfaces within the embayment contain many benthic and infaunal invertebrates beneath the surface. Two polychaete worms, the burrowing shrimp and the clam *Tellina modesta*, are the most abundant. At least 297 species of fish occur in the Point Arguello region. Many of these pass through the mouth of the embayment. These consist mainly of inshore schooling species such as walleye surfperch, topsmelt, and pile surfperch (U.S. Air Force, 1978). Sea otters, seals, and sea lions also use the waters off Point Arguello.

3.14.2.3 **Threatened and Endangered Species.** A number of threatened and endangered species is known or expected to occur on Vandenberg AFB and in the adjacent offshore waters. Table 3.14-2 lists all of the federally and state-listed threatened and endangered species, species proposed for federal listing as threatened or endangered, and candidate species for federal listing (former Category 1 species) that are known to occur or that may potentially occur in the Vandenberg AFB area. Species that are known or expected to occur on South Vandenberg AFB are discussed in more detail below. Former federal candidate Category 2 species, state species of special concern, and regionally rare and declining species on South Vandenberg AFB are discussed under the Vegetation and Wildlife subsections.

Several sensitive plant species may occur in coastal dune scrub near SLC-2W. Surf thistle and beach spectaclepod are found on active dunes near SLC-2W. Beach spectaclepod is found in dunes near the community of

Table 3.14-2. Threatened, Endangered, and Candidate Species Occurring or Potentially Occurring at Vandenberg AFB, California

Common Name	Scientific Name	Federal Status	State Status
Plants			
Beach layia	*Layia carnosa*	E	E
Gambel's watercress	*Rorippa gambelli*	E	T
Seaside's bird's beak	*Cordylanthus rigidus* ssp. *littoralis*	-	E
Lompoc yerba santa	*Eriodictyon capitatum*	C	R
Beach spectaclepod	*Dithyrea maritima*	-	T
La Graciosa thistle	*Cirsium loncholepis*	C	T
Surf thistle	*Cirsium rhothophilum*	C	T
Fish			
Unarmored threespine stickleback	*Gasterostreus aculeatus williamsonii*	E	E
Tidewater goby	*Eucyclogobius newberryi*	E	-
Steelhead trout	*Oncorhynchus mykiss irideus*	E	-
Reptiles and Amphibians			
California red-legged frog	*Rana aurora draytonii*	T	SC
Green sea turtle	*Chelonia mydas*	T	-
Loggerhead sea turtle	*Caretta caretta*	T	-
Pacific Ridley sea turtle	*Lepidochelys olivacea*	T	-
Leatherback sea turtle	*Dermochelys coriacea*	E	-
Birds			
California brown pelican	*Pelacanus occidentalis californicus*	E	E
Bald eagle	*Haliaeetus leucocephalus*	T	E
American peregrine falcon	*Falco peregrinus anatum*	E	E
California black rail	*Laterallus jamaicensis coturniculus*	-	T
Western snowy plover	*Charadrius alexandrinus nivosus*	T	SC
California least tern	*Sterna antillarum browni*	E	E
Western yellow-billed cuckoo	*Coccyzus americanus occidentalis*	-	E
Southwestern willow flycatcher	*Empidonax traillii extimus*	E	E
Least Bell's vireo	*Vireo bellii pusillus*	E	E
Belding's savannah sparrow[a]	*Passerculus sandwichensis beldingi*	-	E
Mountain plover	*Charadrius montanus*	C	-
Mammals			
Guadalupe fur seal	*Arctocephalus townsendi*	T	T
Steller sea lion	*Eumetopias jubatus*	T	-
Southern sea otter	*Enhydra lutris nereis*	T	-
Sei whale	*Balaenoptera borealis*	E	-
Blue whale	*Balaenoptera musculus*	E	-
Finback whale	*Balaenoptera physalus*	E	-
Humpback whale	*Megaptera novaeangliae*	E	-
Right whale	*Balaena glacialis*	E	-
Sperm whale	*Physeter catodon*	E	-

Note: (a) Taxonomic status of subspecies is pending.
C = candidate (former Category C1)
E = endangered
R = rare (state designation)
SC = special concern (state designation)
T = threatened

Surf. Surf thistle is found in dunes and sandy bluffs along the coast between Surf and Point Arguello. The beach layia is found 1.3 miles west of SLC-3W.

Several other listed plant species, the Gambel's watercress, the seaside's bird's beak, the Lompoc yerba santa, and the La Graciosa thistle, are not known to occur on South Vandenberg AFB, although they may occur on North Vandenberg AFB or in the overall vicinity (Oyler et al., 1995).

The unarmored threespine stickleback (fish) occurs on South Vandenberg AFB only as a transplanted population in C a ñ a d a Honda Creek (U.S. Air Force, 1991f) but also in San Antonio Creek on North Vandenberg AFB. The tidewater goby occurs on South Vandenberg AFB in the coastal lagoon and creek channel at Jalama Creek and has been observed in C a ñ a d a Honda Creek (U.S. Air Force, 1994c).

The southern steelhead trout, which was proposed for listing as federally endangered in August 1996, occurs in the Santa Ynez River and potentially in C a ñ a d a Honda Creek. However, none was identified during surveys conducted in 1994 and 1995. The California red-legged frog has been found in C a ñ a d a Honda and Jalama creeks on South Vandenberg AFB (U.S. Air Force, 1994c) and is reported to inhabit nearly all permanent lakes, streams, and ponds on Vandenberg AFB. In addition, red-legged frogs have been found in the retention ponds near SLC-6. Bear Creek does not support the deeper pool habitats essential for the survival of the red-legged frog (U.S. Air Force, 1991f). The California tiger salamander (federal candidate [former Category 1] and special concern species) is not known to occur on South Vandenberg AFB (Christopher, 1996a).

Several federally listed bird species occur on South Vandenberg AFB. The southern bald eagle formerly nested in the Channel Islands and coastal Santa Barbara County but is now only a fall and winter visitor to these areas (U.S. Air Force, 1991f). The American peregrine falcon nests on rocky coastal cliffs on South Vandenberg AFB and the nearby Channel Islands and forages over the adjacent terraces and flats. Migrating and wintering individuals are also found at Vandenberg AFB.

California brown pelicans nest on the Channel Islands. They are found year-round in the coastal waters of Vandenberg AFB and roost at Point Pedernales, Destroyer Rock, Point Arguello, Rocky Point, and the Boathouse Breakwater (U.S. Air Force, 1994c). Brown pelicans generally forage close to shore, although they may venture farther out to sea during calm weather. While brown pelicans may use different sites to rest during the day, they return to land at night to roost in large numbers at particular sites. During the last quarter century, brown pelican nesting in California has been restricted to the offshore Channel Islands (National Aeronautics and Space Administration, 1993). California least terns nest from mid-April to August in sand dunes on North Vandenberg AFB but use the offshore water areas of

South Vandenberg AFB for foraging and during migration (U.S. Air Force, 1991f).

The western snowy plover nests from March to September on approximately 12 miles of Vandenberg AFB beaches, from approximately 3.5 miles south of the Santa Ynez River mouth to approximately 1 mile north and on several miles of beaches and dunes from Purisima Point northward. This species nests in the vicinity of tidal waters in open to barren areas but does not nest colonially (Persons and Applegate, 1996). Western snowy plovers occur on the mainland coast, peninsulas, off-shore islands, and adjacent bays and estuaries. While adult western snowy plovers experienced a decline from the late 1970s to the late 1980s, the Vandenberg AFB population has remained relatively unchanged. The snowy plover winters at these locations and at Jalama Beach. Between March 1 and September 30 of each year, Vandenberg AFB limits recreational access to plover and least tern breeding beaches. This restriction is enforced by Vandenberg AFB game warden patrols.

The Least Bell's vireo, which nest on the upper Santa Ynez River, do not breed on Vandenberg AFB but may visit riparian woodlands at Cañada Honda, Spring, and Bear creeks (U.S. Air Force, 1991f). Southwestern willow flycatchers also breed along the Santa Ynez River but do not nest on South Vandenberg AFB, although Bear Creek apparently provides suitable habitat for this species (Holmgren and Collins, 1995). The western yellow-billed cuckoo is a bird of riparian habitats; occasional transients may forage in the Bear Creek willow woodlands (U.S. Air Force, 1991f). The California black rail and the Belding's savannah sparrow may occur at the Santa Ynez River estuary but are not known to occur any farther south on Vandenberg AFB (Holmgren and Collins, 1995; U.S. Air Force, 1991f). The mountain plover winters annually at the airfield on Vandenberg AFB.

The southern sea otter breeds year-round at Purisima Point off North Vandenberg AFB. No permanent population exists on South Vandenberg AFB, but sea otter are occasionally found feeding in kelp beds offshore (U.S. Air Force, 1994c). The southern sea otter is a federally threatened and state-listed rare species. These marine mammals tend to occupy relatively small ranges; the males of the species range slightly farther. Southern sea otters inhabit intertidal and shallow subtidal zones and are commonly associated with areas sustaining kelp beds. Breeding and pupping occur year-round. Factors attributed to the decline of and continued reduced numbers of southern sea otter populations include overharvesting until the first half of this century, gill and trammel netting mortalities, and limited food availability (National Aeronautics and Space Administration, 1993). The Guadalupe fur seal and the Stellar sea lion are very rare visitors to the Vandenberg AFB area. The Guadalupe fur seal was formerly abundant on the Channel Islands but is now only a rare summer visitor to San Miguel Island. Stellar sea lions used to breed on San Miguel Island, but none have been seen there since 1985.

Six species of endangered whales (the sei, blue, finback, humpback, right, and sperm) may occur in the offshore waters (U.S. Air Force, 1991f). In addition, four species of sea turtles (the green sea turtle, the loggerhead sea turtle, the Pacific Ridley sea turtle, and the leatherback sea turtle) may also occur in the offshore waters (U.S. Air Force, 1991f).

Two federally listed endangered species (the California least tern and the brown pelican) and two federally listed threatened species (the western snowy plover and the southern sea otter) occur in the vicinity of SLC-2W.

Concept A ROI. A population of endangered beach layia was located along Coast Road, approximately 1.3 miles west of SLC-3 (Oyler et al., 1995), which is adjacent to Bear Creek and near Cañada Honda Creek and the Santa Ynez River. These habitats support numerous sensitive species. No known sensitive species are known to be present at SLC-3W; however, suitable habitat is present at Bear Creek and Coast roads for sensitive plants that occur in the dune scrub habitats.

Concept B ROI. SLC-6 is near Cañada Honda Creek and cliffs, both of which support sensitive species. Peregrine falcons have been observed foraging over SLC-6 and occasionally roosting on structures at the complex on SLC-6 (Read, 1997). Red-legged frogs are known to occur in the retention ponds near the complex.

3.14.2.4 **Sensitive Habitats.** This analysis uses the Santa Barbara County Local Coastal Plan definition of environmentally sensitive habitat:

> ...any area in which plant or animal life or their habitats are either rare or especially vulnerable because of their special nature or role in an ecosystem and which could be easily disturbed or degraded by human activities and developments.

Designated environmentally sensitive habitat in the ROI with the potential to be affected by the EELV program include butterfly trees, marine mammal hauling grounds, seabird nesting and roosting areas, white-tailed kite habitat, Burton Mesa chaparral, and wetlands including streams/riparian woodlands (U.S. Air Force, 1991f).

Butterfly Trees. The Monarch butterfly is a regionally rare and declining insect known to overwinter in the eucalyptus and cypress groves along Bear Creek near SLC-3 (U.S. Air Force, 1991f). Another major monarch overwintering area is located in Spring Canyon near SLC-3 (Read, 1997). The “butterfly trees” are protected as a monarch wintering habitat that is declining in California.

Marine Mammal Hauling Grounds. There are 3 miles of coastline between Oil Well Canyon and Point Pedernales designated as a marine ecological reserve. This includes a beach area south of Rocky Point used by harbor seals as haul-out and pupping areas. Vandenberg AFB and the California Department of Fish and Game have an MOA to limit access to this area to scientific research and military operations (U.S. Air Force, 1994c).

Seabird Nesting and Roosting Areas. Seabird nesting and roosting areas located on the Channel Islands and on South Vandenberg AFB are discussed under Wildlife, Section 3.14.2.2.

White-tailed Kite Habitat. White-tailed kite foraging habitat includes grassland and open coastal sage scrub. Kites are expected to forage in these habitats on South Vandenberg AFB primarily during the fall and winter. Potential roosting and nesting habitat occur in the willow, blue eucalyptus, and cypress trees along Bear Creek (U.S. Air Force, 1991f) and in the riparian habitat along the Santa Ynez River (Read, 1997).

Wetlands. Wetlands mapped by the USFWS on South Vandenberg AFB include areas along Bear, Spring, and C a ñ a d a Honda creeks; along the coast; and Lompoc, Grey, and Red Roof canyons (U.S. Department of the Interior, U.S. Fish and Wildlife Service, 1995).

C a ñ a d a Honda Creek Habitat. C a ñ a d a Honda Creek is the largest stream on South Vandenberg AFB (U.S. Air Force, 1988b). A perennially flowing stream, C a ñ a d a Honda Creek provides significant habitat for many wildlife species and for listed fish species. The stream supports a dense cover of vegetation, including riparian plant species such as arroyo willow, coyote brush, creek nettle, and bullrushes. Tule, cattails, and green algae densities increase as the stream nears the interface with the Pacific Ocean (U.S. Air Force, 1985; 1988b).

C a ñ a d a Honda Creek has the most diverse assemblage of invertebrate species (approximately 25 species) on Vandenberg AFB. The more common of these invertebrates include stonefly, caddisfly, various snails, and amphipod crustaceans. This diversity of invertebrates is likely present because of the perennial nature of the stream and the density of riparian vegetation found within and on the banks of C a ñ a d a Honda Creek (U.S. Air Force, 1988b).

An introduced population of the federally listed endangered fish, unarmored threespine stickleback, persists in the perennially flowing portions of the stream (U.S. Air Force, 1988b).

Amphibians and reptiles occurring at C a ñ a d a Honda Creek include the western toad, the Pacific treefrog, the Pacific chorus frog, the red-legged frog, the western pond turtle, the common kingsnake, the common garter snake and the two-striped garter snake. Red-legged frog, western pond turtle, and western garter snake populations have declined because of habitat loss/alteration, harvesting for food, and/or introduced predators. The red-legged frog is federally listed as threatened under the Endangered Species Act; western pond turtles and two-striped garter snakes were formerly listed as federal Category 2 candidates. During summer, when the water flow decreases and portions of this stream become intermittent, amphibian and reptile populations may be reduced or localized to perennially inundated sections of the stream (Christopher, 1996a,b).

C a ñ a d a Honda Creek is an important environment for bird species as well. Avian species that may occur at this creek include woodpeckers, western wood peewees, common yellowthroats, and song sparrows. Winter migrants that may utilize this riparian corridor include ruby-crowned kinglets, hermit thrushes, and yellow-rumped warblers. Because of alteration or loss of riparian areas, bird species that depend on these habitats have declined in population. Yellow-billed cuckoos, long-eared owls, and willow flycatchers are among these dwindling bird species. Another reason for declines in these populations is brood parasitism by brown-headed cowbirds (U.S. Air Force, 1988b).

C a ñ a d a Honda Creek also provides a suitable environment for many mammalian species. Smaller mammals that may be found at C a ñ a d a Honda Creek include deer mice, dusky-footed woodrats, and Trowbridge shrews. Larger mammals commonly occurring in riparian woodlands include Virginia opossums, raccoons, striped skunks, and mule deer (U.S. Air Force, 1988b).

Santa Ynez River. The Santa Ynez River watershed drains approximately 900 square miles of land; approximately 45 square miles occurs on Vandenberg AFB (U.S. Air Force, 1988a). This river supports many sensitive species and becomes intermittent during the summer as water levels drop. This, along with high nutrient levels, supports dense, semi-aquatic plant growth. Invertebrate fauna are relatively less abundant and diverse than at C a ñ a d a Honda Creek, where water flows year-round, although invertebrates such as oligocheate worms can thrive in the Santa Ynez River (U.S. Air Force, 1988b).

In contrast, vertebrate fauna are more diverse and abundant in the Santa Ynez River than in any other stream on Vandenberg AFB. Fish that are known to occur in the Santa Ynez River include mosquito fish, threespine sticklebacks, bass, bluegill sunfish, fathead minnows, arroyo chubs, and tidewater goby. The mouth of the Santa Ynez River forms a lagoon that periodically varies in temperature and salinity depending on the time of year and tidal fluctuations. Because this lagoon is often brackish, marine fish may be found including Pacific herring, starry flounder, and tidewater goby. A small extant native population of anadromus steelhead trout utilizes the Santa Ynez River watershed during spawning and early development (U.S. Air Force, 1988b).

The diversity of amphibian and reptile species on the Santa Ynez River is greater than that found on C a ñ a d a Honda Creek. In addition to those amphibian and reptile species found on C a ñ a d a Honda Creek (such as the western toad, the western pond turtle, the red-legged frog, the Pacific chorus frog, and the common garter snake), the Santa Ynez River supports bullfrogs, western terrestrial garter snakes, and common kingsnakes (Christopher, 1996). Gopher snakes occur in neighboring areas and may utilize this riparian area, preying on birds, small mammals, and other amphibian and reptile species.

Birds may occur among similar riparian environments such as the C a ñ a d a Honda Creek and the Santa Ynez River. Hairy and downy woodpeckers, as well as southwestern willow flycatchers, black phoebes, western wood peewees, warbling vireos, and black-headed grosbeaks, may be found in the Santa Ynez riparian corridor (U.S. Air Force, 1988c).

Mammal species associated with the Santa Ynez River tend to be similar to those at C a ñ a d a Honda Creek. In addition to those mentioned as present at C a ñ a d a Honda Creek, brush rabbits, bobcats, and feral pigs may be present (U.S. Air Force, 1988b).

Burton Mesa Chaparral. Burton Mesa chaparral occurs near SLC-3 and is considered a regionally rare and declining plant community with a highly localized occurrence (U.S. Air Force, 1991f). Several of the shrubs found in Burton Mesa chaparral on Vandenberg AFB are local endemics, including the shagbark manzanita and the coast and Santa Barbara ceanothus (U.S. Air Force, 1991f). The Bell's sage sparrow, a species of federal concern, is associated with Burton Mesa chapparal on North and South Vandenberg AFB.

Other Sensitive Plant Communities. Several plant communities that occur on Vandenberg AFB are considered sensitive because they contain sensitive plant species and/or are of limited extent. These include riparian woodland and associated freshwater herbaceous vegetation (U.S. Air Force, 1991f). These communities occur near SLC-3 and are described under Vegetation, Section 3.14.2.1.

Concept A ROI

Wetlands. An arroyo willow wetland has been identified in a drainage downstream of a concrete holding pond on SLC-3W (see Figure 4.13-5). Bear Creek Canyon wetlands are located adjacent to SLC-3. A small drainage ditch at the foot of the SLC-3W retention basin supports a willow scrub wetland.

Concept B ROI

Wetlands. Wetlands mapped by the USFWS include the evaporation and percolation ponds at SLC-6 (U.S. Department of the Interior, U.S. Fish and Wildlife Service, 1995). Three sites at SLC-6 exhibit wetland characteristics: a man-made ditch east of the former storage pad facility, a man-made trench south of the retention ponds, and a drainage south of the launch pad (see Figure 3.14-6). The first two locations have man-induced hydrology and are of low habitat value due to low vegetative cover and location, although the red-legged frog has recently been found at these locations (U.S. Air Force, 1994c). A field survey of the third wetland identified small patches of arroyo willow in a drainage that qualifies as a willow riparian wetland (ENSR Corporation, 1997b).

3.15 CULTURAL RESOURCES

Cultural resources include prehistoric and historic sites, structures, districts, artifacts, or any other physical evidence of human activity considered important to a culture, subculture, or community for scientific, traditional, religious, or any other reasons. For ease of discussion, cultural resources have been divided into archaeological resources (prehistoric and historic), historic buildings and structures, and native populations/traditional resources (e.g., Native American sacred or ceremonial sites). For Vandenberg AFB, the cultural resources section also discusses a fourth category, paleontological resources. There is no scientific or physical evidence for this category of resources at Cape Canaveral AS.

Regulatory Framework. Numerous laws and regulations require that possible effects to cultural resources be considered during the planning and execution of federal undertakings. These laws and regulations stipulate a process of compliance, define the responsibilities of the federal agency proposing the action, and prescribe the relationship among other involved agencies (e.g., the State Historic Preservation Officer [SHPO] and the Advisory Council on Historic Preservation). In addition to the NEPA, the primary laws that pertain to the treatment of cultural resources during environmental analysis are the National Historic Preservation Act (NHPA) (especially Sections 106 and 110) the Archaeological Resources Protection Act (ARPA), the American Indian Religious Freedom Act (AIRFA), and the Native American Graves Protection and Repatriation Act (NAGPRA).

Only those cultural resources determined to be potentially significant under the above-cited legislation are subject to protection from adverse impacts resulting from an undertaking. To be considered significant, a cultural resource must meet one or more of the criteria established by the National Park Service that would make that resource eligible for inclusion in the National Register of Historic Places (National Register). The term "eligible for inclusion in the National Register" includes all properties that meet the National Register listing criteria, which are specified in the Department of the Interior regulations Title 36 CFR 60.4 and National Register Bulletin 15.

Therefore, sites not yet evaluated may be considered potentially eligible for inclusion in the National Register and, as such, are afforded the same regulatory consideration as nominated properties. Whether prehistoric, historic, or traditional, significant cultural resources are referred to as "historic properties."

Region of Influence. For the purposes of this analysis, the term ROI is synonymous with the “area of potential effect” as defined under cultural resources legislation. In general, the ROI for cultural resources at each location, and for each concept, encompasses all areas requiring ground disturbance (e.g., areas of new facility/utility construction) and all buildings or structures requiring modification, renovation, demolition, or abandonment. The specific cultural resources ROIs for each concept at each location are described for Cape Canaveral AS in Sections 2.1.1.10 and 2.1.2.10 and for Vandenberg AFB in Sections 2.1.1.7 and 2.1.2.7. The Concept A/B ROI at each installation will encompass all of the facilities described in both the Concept A and Concept B ROIs.

3.15.1 **Cape Canaveral AS**

3.15.1.1 **Prehistoric and Historic Archaeological Resources.** Archaeological investigations at Cape Canaveral AS indicate that human occupation of the area first occurred approximately 4,000 years ago. Early settlement was focused within the Banana River salt marsh environment; however, over time, site distribution and size fluctuated, and there is archaeological evidence that the entire peninsula was exploited for a wide variety of marine, estuarine, and terrestrial resources. Occupation of the area is divided into seven cultural periods: the Archaic Period, the Orange Period, the Transitional Period, the Malabar I, IIA, and IIB Periods, and the Protohistoric or Seminole Period.

European exploration and contact with native populations of the Florida coast began in the 15th century; however, Ponce de Leon's discovery of St. Augustine in 1513 is the first known documentation of these activities. Numerous Spanish treasure ships navigated the area throughout the 1500s, and in 1564, a French colony was established near the mouth of the St. John’s River. Hostilities developed between the French and Spanish, and although the native populations remained somewhat independent of these activities, displacement from their native lands, European diseases, and slavery ultimately resulted in their dispersal and demise. By the 1760s, the Cape Canaveral area was inhabited by only a few Spaniards and, according to historical accounts, the area remained sparsely populated until 1843 when a lighthouse was established. Historic homesteading followed, and by 1880, several citrus farms existed along the Banana River. Maritime activities increased during the early 1900s, and additional homesteads and roads were established between the Banana River and the Atlantic coastline. Fishing, gardening, berry gathering, beekeeping, and fruit farming all flourished until the late 1940s when the U.S. government began purchasing land on the peninsula for the establishment of a long-range proving ground and missile test center.

Numerous archaeological surveys have been conducted at Cape Canaveral AS (Bense and Philips, 1990; Cantley et al., 1994; Le Baron, 1884; Levy et al., 1984; Long, 1967; Moore, 1922; Rouse, 1951; Stirling, 1935; U.S. Army Corps of Engineers, 1988, 1989, 1990b, 1991; and Wiley, 1954). In 1992, the USACE synthesized data from several of these studies and developed a cultural resources sensitivity map for Cape Canaveral AS (New South Associates, 1996). Fifty-six prehistoric and historic archaeological sites have been recorded; 19 of these sites have been identified as potentially eligible for listing in the National Register.

3.15.1.2 **Historic Buildings and Structures.** In 1949, the Cape Canaveral Long-Range Proving Ground was formally established under the direction of the Air Force. Construction of the first missile launch pads, support facilities, and down-range tracking stations began in 1950, and throughout that decade military facilities and activities developed at a rapid pace. Various cruise-type missiles were tested during these years and the installation began to support the Intermediate Range and intercontinental ballistic missile (ICBM) programs. Activity at the installation peaked in 1966 with more than 30 operational launch complexes; however, over the next 10 years, programs and operations began to decline. Launch complexes and support buildings that had served their purposes were adapted to other uses (e.g., facilities supporting manned and unmanned space exploration, including NASA's Viking missions to Mars and Voyager missions to the outer planets), deactivated or put on standby status. Current launch programs include ballistic missile operations and government and commercial launch operations (New South Associates, 1996).

Historic building and structure surveys at Cape Canaveral AS include those conducted by the National Park Service (1980); Resource Analysts, Inc. of Bloomington, Indiana (Barton et al., 1983); and the USACE Construction Engineering Research Laboratories (CERL) (McCarthy et al., 1994; Turner et al., 1994). Of these surveys, 14 National Register-listed or -eligible historic buildings and structures have been identified (New South Associates, 1996). Seven of the 14 properties (6 launch complexes [5/6, 13 MST, 14, 19, 26, 34] and the original Mission Control Building) comprise a National Historic Landmark district associated with the Man in Space program. The remaining seven properties are Launch Complexes 1/2, 3/4, 17, 21/22, 25, 31/32, and the Cape Canaveral Lighthouse, all of which are considered eligible for inclusion in the National Register.

3.15.1.3 **Native Populations/Traditional Resources.** At the time of European contact, the Cape Canaveral and Banana River areas were populated by tribal groups of the Ais Indian tribe. Settlements were described by early explorers as sparse and isolated, and historical accounts indicate that they remained so well into the eighteenth century (New South Associates, 1993). The Ais settlements closest to Cape Canaveral AS were the Ulumay villages along the Banana River. The settlements were numerous, changed with the seasons, and reflected a fishing and gathering subsistence; agriculture was not practiced. Dwellings were temporary, and tools and utensils were typically fashioned of conch shell or gourds.

After European contact, the Ais had easy access to trade items and precious metals from the Spanish and French. Because of their proximity to the Straits of Florida, they also took advantage of the numerous shipwrecks along the Florida coast. Wrecks were looted for their treasure, and survivors were typically taken in as slaves and later bartered back to the Europeans. As described above, by 1760, few Ais remained, their disappearance attributable to European diseases, encroachment of their land, and enslavement. A few are believed to have moved into southern Florida where they may have banded with other tribes to ultimately form the Seminole culture. Today, there are no known direct descendants of the Ais tribe remaining; the Seminole and Micosukee Tribes are recognized as the appropriate Native American cultures for consultation during the treatment of Ais remains.

Significant traditional sites are subject to the same regulations and are afforded the same protection as other types of historic properties. Traditional resources associated with the Ais could include archaeological sites, burial sites, mounds, ceremonial areas, caves, hillocks, water sources, plant habitat or gathering areas, or any other natural area important to this culture for religious or heritage reasons. By their nature, traditional resources sites often overlap with (or are components of) archaeological sites. As such, the National Register-listed or -eligible sites (as well as any archaeologically sensitive areas) could also be considered traditional sites or could contain traditional resources elements.

Historic Property Status within the Concept A ROI. Within the proposed direct ground-disturbing areas for Concept A, no National Register-listed or -eligible prehistoric or historic archaeological sites have been identified. However, within the ROI for this concept, archaeologically sensitive areas as well as one National Register-eligible prehistoric site (8BR914, located near SLC-41) have been recorded (Appendix I). Of the identified National Register-listed or -eligible buildings and structures, none is currently within the cultural resources ROI for Concept A. A recent assessment of the historical significance of SLC-41, Hangar J, and Building 75251 indicates that none of these facilities is likely to be eligible for listing in the National Register; concurrence from the Florida SHPO is pending.

Historic Property Status within the Concept B ROI. Within the proposed direct ground-disturbing areas for Concept B, no National Register-listed or -eligible prehistoric or historic archaeological sites have been identified. However, within the ROI for this concept, archaeologically sensitive areas encompassing three National Register-eligible prehistoric and/or historic archaeological sites have been recorded. The sites are 8BR82A, 8BR83, and 8BR221, located near SLC-37 (see Appendix I).

Of the identified National Register-listed or eligible buildings and structures, none is currently within the cultural resources ROI for Concept B. A recent assessment of the historical significance of Hangar C (Building 1348) indicates that it has been found to be associated with events and persons significant in American History and the history of Cape Canaveral AS. Concurrence from the Florida SHPO is pending regarding the assessment of Hangar C.

3.15.2 Vandenberg AFB

3.15.2.1 **Prehistoric and Historic Archaeological Resources.** Archaeological investigations of Vandenberg AFB indicate that human occupation of the area first occurred approximately 9,000 years ago. Early settlement was characterized by a hunting and gathering existence; however, over time, coastal villages began to develop that were occupied a large part of the year. Development of the plank canoe around Anno Domini (A.D.) 500 increased travel by some of the Chumash groups to the Channel Islands and encouraged ocean fishing; however, full development of the indigenous culture did not occur until approximately A.D 1150 when a number of permanent and semi-permanent villages with populations of 200 to 600 were established (Environmental Solutions, 1990). The three major cultural periods recognized in the prehistory of the Vandenberg AFB area are the Early Period (7000-1500 B.C.), the Middle Period (1500 B.C.-A.D. 1000), and the Late Period (1000-1850 A.D.). From the Late Period until the present, the area has supported populations of Native American peoples speaking dialects of the Chumash language.

European exploration of the area began in the middle 1500s; however, colonization (by the Spanish) did not take place until around 1788 with the establishment of Mission La Purisima Concepcion and Mission Santa Ynez. By the middle 1800s, most of the mission lands had been transferred into secular ranchos with a large portion of the area of South Vandenberg AFB included in the Lompoc Rancho Mexican land grant; several farms and ranches operated on the Lompoc Terrace between 1880 and the 1930s (Versar, Inc., 1991). In 1941, the U.S. Army acquired most of the land area now known as Vandenberg AFB to construct Camp Cooke; the installation was renamed Vandenberg AFB in 1958.

Numerous archaeological surveys have been conducted at Vandenberg AFB, and over 2,000 prehistoric and historic archaeological sites have been recorded within the boundary of the installation. Recorded sites span the entire time period described above and are highly variable in function and content. Prehistoric site types include dense shell middens, scatters of stone tools and debris, concentrations of ground stone milling tools, village sites, stone quarries, and temporary encampments (Environmental Solutions, Inc., 1990). Historic site types are varied and reflect activities associated with mission establishment, ranching, and military activities.

3.15.2.2 **Historic Buildings and Structures.** In 1941, the U.S. Army acquired 92,000 acres along the California coast between Point Sal and Point Arguello as a new military reservation (Camp Cooke). During the first five years, a variety of military activities took place at the installation, including use of a portion of the facility as a World War II prisoner of war camp between 1944 and 1946. In mid-1946, the installation was placed in caretaker status and most of the land leased for agriculture; however, by 1950, the base had been reactivated to support armored infantry training for the Korean War (Versar, Inc., 1991). In 1957, the northern 65,000 acres of Camp Cooke were transferred to the U.S. Air Force and became known as Cooke AFB; it was renamed Vandenberg AFB in 1958 when the Strategic Air Command became the host command for the installation. The southern portion of the installation (approximately 20,000 acres) was controlled by the Navy as the Naval Missile Test Facility at Point Arguello until 1964, when it was also transferred to the Air Force. The present extent of the installation was completed in 1966, when an additional 15,000 acres was purchased from the Sudden Ranch.

Selected as the location for the construction of facilities to launch several types of intermediate and long-range ballistic missiles (e.g., Atlas, Thor, Titan), Vandenberg AFB missions have been largely associated with the launch of military and civilian payloads since the mid-1950s. In addition, Terrier and Hawk missile training exercises and launches of Nike/Asp sounding rockets took place between 1958 and 1960. SLC-3 (East and West), which is eligible for listing in the National Register, was originally constructed for the Air Force's space program under the supervision of the Navy and was designed to accommodate the Atlas D missile (Tri-Services Cultural Resources Research Center, 1996). Construction of SLC-6, which has been determined ineligible for listing in the National Register, began in the late 1950s as part of the Manned Orbiting Laboratory Project. The Space Transportation System launch facilities (including SLC-6) were constructed in the early 1980s; however, the project was suspended, and later canceled in 1986. The 30 SW is currently the host command at Vandenberg AFB and manages the WR, which conducts west coast military and civilian space and missile launch operations.

3.15.2.3 **Native Populations/Traditional Resources.** At the time of European contact, the Vandenberg AFB area was populated by peoples speaking one of the major languages (Purisimeno) of the Chumashan branch of the Hokan language family (Gibson, 1991). Explorers found the Chumash society quite complex with a variety of settlement patterns, customs, and beliefs and a currency-based economy. Villages were numerous and typically consisted of domed houses, granaries, ceremonial areas, game fields, and a burial ground. Tools were made of bone, shell, or steatite, and primary subsistence was from marine resources, the gathering of acorns, and small game. One of the most significant of the Chumash settlements in the vicinity of South Vandenberg AFB is the village of Nocto (currently identified as archaeological site #SBA-210), approximately 2 miles south of SLC-6; Nocto consisted of ten houses and is believed to have supported between 60 and

70 residents (Glassow, 1990). Additional Purisimeno villages were also located in the area now encompassed by North Vandenberg AFB.

For nearly 200 years after the first explorers made contact, the Chumash life and culture continued without European interference. However, in the mid-18th century, the Spanish began to colonize the area and establish missions. When it became apparent that the Chumash were not willing to give up their traditions and embrace Christianity, the priests and the Spanish military captured many of the Chumash and forced them to live and work at the missions. By 1833, thousands of Chumash had died from European-introduced diseases, many of their villages were abandoned, and many others had fled the area. Changes in governmental administration of the area (i.e., from mission rule to Mexican government rule, and, ultimately, to United States rule) did little to improve the living conditions of the Chumash peoples, and by 1850, the formerly vast and powerful Chumash nation was reduced to several small groups. In 1901, the U.S. government ceded 75 acres of reserved land next to the Santa Ynez mission to the Chumash. The Santa Ynez Reservation is the only land held by the Chumash today (Gibson, 1991); it is located approximately 20 miles east of Vandenberg AFB. Vandenberg AFB has maintained a cooperative and interactive relationship with the Chumash Indians for many years.

There are numerous traditional resources sites associated with the Chumash at Vandenberg AFB including prehistoric villages and campsites, rock art panels, burial sites, resource gathering areas, trails, and wetlands. In addition, there is a specifically identified traditional cultural property in the vicinity of Point Conception, referred to by some within the Chumash culture as the Western Gate because of its role in Chumash beliefs about death and the afterlife.

3.15.2.4 **Paleontological Resources.** Paleontological resources include examples of ancient organic life preserved as fossils. Fossils found in the vicinity of Vandenberg AFB include remains of both vertebrate and invertebrate animals. Remnants of Pleistocene Epoch (a period of time between 2 million and 8,000 years ago) terraces are found on South Vandenberg AFB, especially on the low marine terrace known as Sudden Flats, which extends west to the U.S. Coast Guard Lifeboat Rescue Station and Lookout Tower. Fossil remains found in this area include mammoth and horse fossils approximately 45,000 years old.

Historic Property Status within the Concept A ROI. Vandenberg AFB has completed archaeological surveys and inventories of the entire installation that satisfy the requirements of Section 110 of the NHPA. Approximately 2,200 prehistoric and historic sites have been identified and recorded, and a comprehensive survey report is in progress (Environmental Solutions, Inc., 1990; Glassow, 1990; Versar, Inc., 1991). Three archaeological sites have been identified in the vicinity of SLC-3; however, none of the three is located within the SLC-3W fenceline (Versar, Inc., 1991), and all three have been determined ineligible for inclusion in the National Register. In addition, no sites are located within the immediate areas where intersection widening would occur or where power poles require raising. However, the corner of Coast and Bear Creek roads is near known sites, one of which is National Register-eligible (Site #SBA 534). There are also no recorded sites in the direct construction areas associated with the modification of the entrance/exit driveway to Building 7525 or the construction area for the new USF (within the SLC-3W fallback area).

The entirety of Vandenberg AFB has been evaluated for historic buildings and structures potentially eligible for inclusion in the National Register. Specific features of SLC-3W (the MST and umbilical mast, the retention basin and deluge channel, and Building 770) have been determined eligible under the Cold War historic context (Tri-Services Cultural Resources Research Center, 1996).

There are no recorded fossils in the immediate vicinity of SLC-3W and no National Natural Landmarks within the Concept A ROI.

Historic Property Status within the Concept B ROI. Vandenberg AFB has completed archaeological surveys and inventories of the entire installation that satisfy the requirements of Section 110 of the NHPA. Approximately 2,200 prehistoric and historic sites have been identified and recorded, and a comprehensive survey report is in progress (Environmental Solutions, Inc., 1990; Glassow, 1990; Versar, Inc., 1991). Fifteen sites have been recorded near SLC-6; six have been recommended as eligible for inclusion in the National Register, and one (Site #SBA 2032) is near the location for the HIF. Underwater survey of the boathouse dock harbor did not identify any underwater archaeological resources (U. S. Department of the Interior, National Park Service, 1978).

All of the SLC-6 buildings and structures (inside and outside the fenceline) have been evaluated for eligibility for inclusion in the National Register and have been determined ineligible. Other facilities within the ROI for Concept B that have been determined eligible for inclusion in the National Register include the Point Arguello U. S. Coast Guard Lifeboat Rescue Station and Lookout Tower (adjacent to the South Vandenberg AFB Boat Dock).

The closest identified traditional resource site to the Concept B ROI is archaeological site #SBA 210, the site of the prehistoric village of Nocto (two miles south of SLC-6). However, site #SBA 2032, which is near the area proposed for the HIF (within the SLC-6 complex), may be associated with the village of Nocto, and may be a traditional resources site as well.

Fossils recorded near SLC-6, but not directly within the ROI, include fish, crab, and whale bone (U.S. Air Force, 1989a). There are no National Natural Landmarks within the Concept B ROI.

3.15.3 No-Action Alternative

Cape Canaveral AS ROI. The No-Action Alternative ROI at Cape Canaveral AS encompasses SLCs 17, 36, 40, and 41, all of which currently support the launch programs that would be replaced with implementation of the EELV program. Under the No-Action Alternative, these facilities would continue to be utilized to support those programs; however, none of these facilities would require modification. The National Register status of SLCs 17, 36, 40, and 41 is as follows: SLC-17 is eligible for listing on the National Register and is currently undergoing Historic American Buildings Survey/Historic American Engineering Record (HABS/HAER) recordation. SLC-36 is also eligible for inclusion in the National Register (New South Associates, 1996), and HABS/HAER recordation is complete. SLC-40 remains unevaluated; however, it was completely renovated in 1993, and all of its original primary components have been demolished. The historical significance of SLC-41 has been recently assessed, and it is unlikely that it is eligible for listing in the National Register; Florida SHPO concurrence is pending.

Vandenberg AFB ROI. The No-Action Alternative ROI at Vandenberg AFB encompasses SLCs 2W, 3E, and 4E, all of which currently support the launch programs that would be replaced with implementation of the EELV program. Under the No-Action Alternative, these facilities would continue to be utilized to support those programs; however, none of the facilities would require modification. SLCs 2W and 3E have been evaluated for their eligibility for inclusion in the National Register, and specific components of each complex have been determined eligible (see Appendix I).

3.16 ENVIRONMENTAL JUSTICE

EO 12898, Environmental Justice, was issued by the President on February 11, 1994. Objectives of the EO, as it pertains to this EIS, include development of federal agency implementation strategies, identification of minority and low-income populations where proposed federal actions have disproportionately high and adverse human health and environmental effects, and participation of minority and low-income populations. Accompanying EO 12898 was a Presidential Transmittal Memorandum that referenced existing federal statutes and regulations to be used in conjunction with EO 12898. The memorandum addressed the use of the policies and procedures of the NEPA. Specifically, the memorandum indicates that, "Each Federal agency shall analyze the environmental effects, including human health, economic and social effects, of Federal actions, including effects on minority communities and low-income communities, when such analysis is required by the NEPA 42 U.S.C. Section 4321, et seq." Although an environmental justice analysis is not mandated by NEPA or by AFI 32-7061, DoD has directed that NEPA will be used as the primary approach to implement the provision of the EO.

Although EO 12898 provides no guidelines as to how to determine concentrations of minority or low-income populations, the demographic analysis provides information on the approximate locations of minority and low-income populations in the area potentially affected by the EELV program at Cape Canaveral AS and Vandenberg AFB. Most environmental impacts resulting from the Proposed Action would be expected to occur within Brevard County, Florida, and Santa Barbara County, California.

The 1990 Census of Population and Housing reports numbers of both minority and poverty residents. Minority populations included in the census are identified as Black; American Indian, Eskimo, or Aleut; Asian or Pacific Islander; Hispanic; or Other. Poverty status (used in this EIS to define low-income status) is reported as the number of families with income below poverty level ($12,764 for a family of four in 1989, as reported in the 1990 Census of Population and Housing).

3.16.1 **Cape Canaveral AS**

Most environmental impacts resulting from the Proposed Action at Cape Canaveral AS would be expected to occur within Brevard County, Florida. Based upon the 1990 Census of Population and Housing, Brevard County had a population of 398,978 persons. Of this total, 49,681 persons, or 12.45 percent, were minority, and 35,815 persons, or 9.13 percent, were low-income.

3.16.2 **Vandenberg AFB**

Most environmental impacts resulting from the Proposed Action at Vandenberg AFB would be expected to occur within Santa Barbara County, California. Based upon the 1990 Census of Population and Housing, Santa Barbara County had a population of 369,608 persons. Of this total, 124,534 persons, or 33.69 percent, were minority, and 45,226 persons, or 12.76 percent, were low-income.

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4.0 ENVIRONMENTAL CONSEQUENCES

4.1 INTRODUCTION

This chapter discusses the potential environmental consequences associated with the Proposed Action and the No-Action Alternative. To provide the context in which potential environmental impacts may occur, discussions of potential changes to the local communities, including employment and population, land use and aesthetics, transportation networks, and public utility systems, are included in this chapter. In addition, issues related to current and future management of hazardous materials and wastes and health and safety practices are discussed. Impacts to the physical and natural environment are evaluated for geology and soils, water resources, air quality, noise, orbital debris, biological resources, and cultural resources. An environmental justice analysis was conducted to examine potential disproportionately high and adverse impacts to low-income and minority populations. Environmental impacts may occur as a direct result of the proposed activities or as an indirect result of changes within the local communities.

Each section within this chapter discusses a separate resource area and describes the potential impacts resulting from implementation of the Proposed Action and No-Action Alternative. Mitigation measures are described, where applicable. The Proposed Action includes a discussion of the impacts of implementing the Concept A, Concept B, or Concept A/B EELV launch programs at Cape Canaveral AS and Vandenberg AFB. Each section also includes an analysis of the impacts resulting from the No-Action Alternative, which is the continuation of current launch vehicle programs to meet the requirements of government spacelift transportation programs under the NMM.

Means of mitigating substantial adverse environmental impacts that may result from implementation of the Proposed Action or No-Action Alternative are discussed as required by NEPA. Potential mitigation measures are described for those components likely to experience substantial and adverse changes under the Proposed Action or No-Action Alternative. Potential mitigation measures depend upon the particular resource affected. In general, however, mitigation measures are defined in CEQ regulations as actions that include:

- Avoiding the impact altogether by not taking an action or by not performing certain aspects of the action

- Minimizing the impacts by limiting the degree or magnitude of the action and its implementation

- Rectifying the impact by repairing, rehabilitating, or restoring the affected environment

- Reducing or eliminating the impact over time through preservation and maintenance operations during the life of the action

- Compensating for the impact by replacing or providing substitute resources or environments.

Mitigation measures that are clearly required by law or standard industry practices are generally considered to be part of the Proposed Action. Additional potential mitigation measures beyond those clearly required by law or standard practices are described under each resource area, where impacts have been identified. Such measures include those the Air Force could implement or those discretionary mitigations or choices available to other governmental bodies (such as permit conditions, etc.).

4.2 COMMUNITY SETTING

This section describes direct and indirect changes in employment and population and effects on the socioeconomic environment for the Proposed Action and No-Action Alternative.

4.2.1 Proposed Action

To identify the potential socioeconomic effects associated with construction and operation activities for the Proposed Action, estimated program-related employment and population information was obtained. The analysis included direct jobs (i.e., work directly for associated EELV activities) and indirect jobs (i.e., jobs created by goods and services purchased in the local communities). The direct and indirect job estimates and associated population numbers were calculated in conformance with established economic estimating guidelines for such analysis (U.S. Bureau of Economic Analysis, 1997c). Initial changes in economic activity in each region were used as inputs to a socioeconomic modeling system that utilizes the Regional Input-Output Modeling System (RIMS II) to provide estimates of total employment. All years referred to in this section are federal fiscal years (October through September), unless otherwise indicated.

4.2.1.1 Concept A

4.2.1.1.1 Concept A, Cape Canaveral AS

Employment. The number of direct and indirect jobs associated with launch activities at Cape Canaveral AS is anticipated to increase by up to 251 jobs during construction of EELV facilities between 1998 and 2000. Employment would decline from 1,210 under the Atlas IIA, Delta II, and Titan IVB launch programs to 240 when the EELV program is fully staffed in 2007 (Table 4.2-1). Although full staffing for Concept A launch activities would occur in 2003 at Cape Canaveral AS, for consistency within this EIS, the year 2007 has been selected for analysis purposes.

Table 4.2-1. Jobs and Worker Migration - Concept A, Cape Canaveral AS

	1997	1998	2000	2007
Total Jobs[(a)]	2,306	2,557	1,597	457
Direct	1,210	1,362	855	240
Construction	0	152	130	0
Operation	1,210	1,210	725	240
Current Operation	1,210	1,210	605	0
EELV Operation	0	0	120	240
Indirect	1,096	1,195	742	217
Construction-related	0	99	85	0
Operation-related	1,096	1,096	657	217
Current Operation-related	1,096	1,096	548	0
EELV Operation-related	0	0	109	217
Net Change in Total Jobs	0	251	-709	-1,849

Note: (a) Includes full- and part-time jobs.
EELV = Evolved Expendable Launch Vehicle

Source: Estimates prepared for this study.

The number of indirect jobs associated with government launches supported within Brevard County would be reduced from its 1997 level of 1,096 to 217 by 2007.

By 2007, there would be a net decline of 970 direct and 879 indirect jobs within Brevard County, associated with the replacement of Atlas IIA, Delta II, and Titan IVB launch operations; however, employment in Brevard County is forecasted to increase from 231,553 in 1997 to 285,540 in 2007 (see Table 3.2-1). It was assumed that only 10 percent of the current launch program employees would leave Brevard County. Some of the workers approaching retirement age might decide to retire, but most of these workers would likely search for another job. The remaining 1,741 employees would be assumed to be transferred to EELV program operations, transferred by their employer to another business location, or seek other employment.

Population. The total number of persons associated with launch activities at Cape Canaveral AS (including all direct and indirect workers, plus members of their households) is anticipated to increase from its 1997 level of 6,227 to 6,904 during construction of EELV facilities, and then decline to a level of 1,235 when the EELV program is fully staffed in 2007 (Table 4.2-2). The population attributable to direct operation jobs would be reduced from 3,267 under the existing launch programs to 648 under the EELV program at full

Table 4.2-2. Total Population by Type of Job - Concept A, Cape Canaveral AS

	1997	1998	2000	2007
Total Persons, by type of job[(a)]	6,227	6,904	4,312	1,235
Direct	3,267	3,677	2,309	648
Construction	0	410	351	0
Operation	3,267	3,267	1,958	648
Current Operation	3,267	3,267	1,634	587
EELV Operation	0	0	324	0
Indirect	2,960	3,228	2,003	587
Construction-related	0	268	230	0
Operation-related	2,960	2,960	1,773	587
Current Operation-related	2,960	2,960	1,480	0
EELV Operation-related	0	0	294	587

Note: (a) Total population includes all workers holding direct or indirect jobs, plus their household members (assuming an average household size of 2.7 persons).
EELV = Evolved Expendable Launch Vehicle

Source: Estimates prepared for this study.

employment; however, population in Brevard County is forecasted to increase from 460,824 in 1997 to 557,856 in 2007 (see Table 3.2-2).

The population attributable to indirect jobs resulting from launch programs within Brevard County would be reduced from its 1997 level of 2,960 to 587 by 2007. A temporary increase of 678 people in 1998 would be attributable to direct and indirect workers during the construction of EELV facilities.

The majority of the population attributable to EELV government activities would reside within the unincorporated area of Brevard County (with most of the direct population in unincorporated communities near Cape Canaveral AS), and in the cities of Cape Canaveral, Cocoa, Cocoa Beach, and Rockledge, which are all within 14 miles of Cape Canaveral AS. Much of the population effect in other cities, including Titusville (21 miles from Cape Canaveral AS), and Melbourne and Palm Bay (both 35 miles away), would be attributable to indirect workers. Some workers, both direct and indirect, would locate their households outside of Brevard County, principally in communities in Orange County, approximately 25 miles west of Cape Canaveral AS.

By 2007, there would be a net decline in population of 2,619 persons from direct jobs and 2,373 from indirect jobs within Brevard County. Incorporated cities within the ROI would lose the majority of residents leaving the county. It is assumed that only 10 percent of residents from the current launch operations would leave the ROI.

4.2.1.1.2 **Concept A, Vandenberg AFB**

Employment. The number of direct and indirect jobs associated with launch activities at Vandenberg AFB is anticipated to increase slightly during construction of EELV facilities from 1,500 to 2,128 in 2000. Employment would decline thereafter as the requirement for direct operation workers is reduced from 646 under the existing launch systems to 135 in 2007 (Table 4.2-3); however, employment in Santa Barbara County is forecasted to increase from 229,107 in 1997 to 271,380 in 2007 (see Table 3.2-3). Although full staffing for Concept A launch activities would occur in 2006 at Vandenberg AFB, for consistency within this EIS, the year 2007 has been selected for analysis purposes.

The number of indirect jobs within Santa Barbara County would be reduced from its 1997 level of 854 to 179 by 2007. The number of indirect jobs would increase slightly in 2000 during construction of EELV facilities (see Table 4.2-3).

Table 4.2-3. Jobs and Worker Migration - Concept A, Vandenberg AFB

	1997	1998	2000	2007
Total Jobs[(a)]	1,500	1,500	2,128	314
Direct	646	646	964	135
Construction	0	0	318	0
Operation	646	646	646	135
Current Operation	646	646	646	0
EELV Operation	0	0	0	135
Indirect	854	854	1,164	179
Construction-related	0	0	310	0
Operation-related	854	854	854	179
Current Operation-related	854	854	854	0
EELV Operation-related	0	0	0	179
Net Change in Total Jobs	0	0	628	-1,187

Note: (a) Includes full- and part-time jobs.
EELV = Evolved Expendable Launch Vehicle

Source: Estimates prepared for this study.

By 2007, there would be a net decline of 1,187 direct and indirect jobs within Santa Barbara County. Only 10 percent of unemployed workers would leave the county. As discussed in Section 4.2.1.1.1, some workers would retire; others would search for another job.

Population. The total number of persons associated with launch activities at Vandenberg AFB (including all direct and indirect workers, plus members of their households) is anticipated to increase from a 1997 level of 4,051 to 5,746 during construction of EELV facilities, and decline to a level of 847 by 2007 (Table 4.2-4). The population attributable to direct operation jobs

Table 4.2-4. Total Population by Type of Job - Concept A, Vandenberg AFB

	1997	1998	2000	2007
Total Persons, by type of job[(a)]	4,051	4,051	5,746	847
Direct	1,744	1,744	2,603	365
Construction	0	0	859	0
Operation	1,744	1,744	1,744	365
Current Operation	1,744	1,744	1,744	0
EELV Operation	0	0	0	365
Indirect	2,307	2,307	3,143	482
Construction-related	0	0	836	0
Operation-related	2,307	2,307	2,307	482
Current Operation-related	2,307	2,307	2,307	0
EELV Operation-related	0	0	0	482

Note: (a) Total population includes all workers holding direct or indirect jobs, plus their household members (assuming an average household size of 2.7 persons).
EELV = Evolved Expendable Launch Vehicle

Source: Estimates prepared for this study.

would be reduced from 1,744 under the existing launch programs to 365 under the EELV program; however, population in Santa Barbara County is forecasted to increase from 399,988 in 1997 to 445,415 in 2007 (see Table 3.2-4).

The population attributable to indirect jobs within Santa Barbara County would be reduced from its 1997 level of 2,307 to 482 by 2007. A small increase in the population attributable to indirect workers would occur during construction in 2000.

The majority of the population attributable to the EELV program would reside within the unincorporated area of Santa Barbara County (with most of the direct population located in unincorporated communities near Vandenberg AFB), and in the cities of Santa Maria and Lompoc, both of which are within 18 miles of Vandenberg AFB. Much of the population effect in other cities, including Santa Barbara (64 miles from Vandenberg AFB) and Carpinteria (76 miles), would be attributable to indirect workers. Some workers, both direct and indirect, would locate their households outside of Santa Barbara County, principally in communities in San Luis Obispo County, approximately 25 miles north of Vandenberg AFB.

4.2.1.2 **Concept B**

4.2.1.2.1 **Concept B, Cape Canaveral AS**

Employment. The number of direct and indirect jobs associated with launch activities at Cape Canaveral AS is anticipated to increase by up to 328 jobs during construction of EELV facilities in 2000. Employment would decline thereafter as the requirement for direct operation workers is reduced from

1,210 under the existing launch programs to 540 when the EELV program is fully staffed in 2007 (Table 4.2-5).

Table 4.2-5. Jobs and Worker Migration - Concept B, Cape Canaveral AS

	1997	1998	2000	2007
Total Jobs[(a)]	2,306	2,518	2,260	1,029
Direct	1,210	1,338	1,208	540
Construction	0	128	220	0
Operation	1,210	1,210	1,043	540
Current Operation	1,210	1,210	908	0
EELV Operation	0	0	135	540
Indirect	1,096	1,180	1,052	489
Construction-related	0	84	108	0
Operation-related	1,096	1,096	944	489
Current Operation-related	1,096	1,096	822	0
EELV Operation-related	0	0	122	489
Net Change in Total Jobs	0	212	-46	-1,277

Notes: (a) Includes full- and part-time jobs.
EELV = Evolved Expendable Launch Vehicle

Source: Estimates prepared for this study.

The number of indirect jobs supported within Brevard County would be reduced from its 1997 level of 1,096 to 489 by 2007; however, employment in Brevard County is forecasted to increase from 231,553 in 1997 to 285,400 in 2007 (see Table 3.2-1).

By 2007, there would be a net decline of 670 direct and 607 indirect jobs within Brevard County. With implementation of the EELV program and the associated reduction of 1,277 jobs, it was assumed that only 10 percent of the current residents would leave Brevard County. As discussed in Section 4.2.1.1, some workers would retire; others would search for another job. It was assumed that a small percentage of current residents would leave the county to search for other job opportunities or to retire. Most of the 1,247 persons who would change jobs would be transferred to support EELV program operations, transferred by their employer to another business location, or seek other employment.

Population. The total number of persons associated with launch activities at Cape Canaveral AS (including all direct and indirect workers, plus members of their households) is anticipated to increase from its 1997 level of 6,227 to 6,800 during construction of EELV facilities, and decline to a level of 2,779 persons by 2007 (Table 4.2-6). The population attributable to direct operation jobs would be reduced from 3,267 under the existing launch programs to 1,458 under the EELV program.

Table 4.2-6. Total Population by Type of Job - Concept B, Cape Canaveral AS

	1997	1998	2000	2007
Total Persons, by type of job[(a)]	6,227	6,800	6,102	2,779
Direct	3,267	3,614	3,260	1,458
Construction	0	347	446	0
Operation	3,267	3,267	2,815	1,458
Current Operation	3,267	3,267	2,450	0
EELV Operation	0	0	365	1,458
Indirect	2,960	3,186	2,841	1,321
Construction-related	0	227	292	0
Operation-related	2,960	2,960	2,550	1,321
Current Operation-related	2,960	2,960	2,550	0
EELV Operation-related	0	0	330	1,321

Note: (a) Total population includes all workers holding direct or indirect jobs, plus their household members (assuming an average household size of 2.7 persons).
EELV = Evolved Expendable Launch Vehicle

Source: Estimates prepared for this study.

The population attributable to indirect jobs within Brevard County would be reduced from its current level of 2,960 to 1,321 by 2007. A small increase in the population of 292 attributable to indirect workers would occur in the year 2000 during construction of EELV facilities.

The majority of the population associated with Concept B would reside within the unincorporated area of Brevard County (see Section 4.2.1.1.1).

By 2007, there would be a net decline in population of 3,448 persons within Brevard County; however, population in Brevard County is forecasted to increase from 460,824 in 1997 to 557,856 in 2007 (see Table 3.2-2).

4.2.1.2.2 **Concept B, Vandenberg AFB**

Employment. The number of direct and indirect jobs associated with launch activities at Vandenberg AFB is anticipated to increase slightly during construction of EELV facilities in 1998 through 2000 from 1,500 to 1,714. Employment would decline thereafter as the requirement for direct operation workers is reduced from 646 under the existing launch programs to 400 in 2007 (Table 4.2-7).

The number of indirect jobs supported within Santa Barbara County would be reduced from its 1997 level of 854 to 529 by 2007.

During construction of EELV facilities in 2000, there would be a net increase of up to 108 direct and 105 indirect jobs within Santa Barbara County. By 2007, there would be a net decline of 571 direct and indirect jobs within Santa Barbara County; however, employment in Santa Barbara County is

Table 4.2-7. Jobs and Worker Migration - Concept B, Vandenberg AFB

	1997	1998	2000	2007
Total Jobs[(a)]	1,500	1,625	1,714	929
Direct	646	709	754	400
Construction	0	63	108	0
Operation	646	646	646	400
Current Operation	646	646	646	0
EELV Operation	0	0	0	400
Indirect	854	916	960	529
Construction-related	0	61	105	0
Operation-related	854	854	854	529
Current Operation-related	854	854	854	0
EELV Operation-related	0	0	0	529
Net Change in Total Jobs	0	124	213	-571

Note: (a) Includes full- and part-time jobs.
EELV = Evolved Expendable Launch Vehicle

Source: Estimates prepared for this study.

forecasted to increase from 229,107 in 1997 to 271,380 in 2007 (see Table 3.2-3).

By 2007, 571 current Santa Barbara County residents would lose direct or indirect jobs associated with current launch operations, but most of them would remain in the county. It was assumed that only 10 percent would leave the county in search of other job opportunities, to retire, or would be transferred by their current employer.

Population. The total number of persons associated with government launch activities at Vandenberg AFB (including all direct and indirect workers, plus members of their households) is anticipated to increase from its current level of 4,051 to 4,626 by the year 2000 during construction of EELV facilities, and then decline to a level of 2,508 persons by 2007. The population attributable to direct operation jobs would be reduced from 1,744 under the current launch programs to 1,080 under the EELV program (Table 4.2-8).

The population attributable to indirect jobs within Santa Barbara County would be reduced from its 1997 level of 2,307 to 1,428 by 2007. A small increase in the population attributable to indirect workers would occur during construction of the EELV facilities.

The majority of the population attributable to Concept B would reside within the unincorporated area of Santa Barbara County (see Section 4.2.1.2.1).

By 2007, there would be a net decline in population of 1,543 persons within Santa Barbara County; however, the county population is forecasted to increase from 399,988 in 1997 to 445,415 in 2007 (see Table 3.2-4). With implementation of the EELV program and the associated reduction of 1,543

Table 4.2-8. Total Population by Type of Job - Concept B, Vandenberg AFB

	1997	1998	2000	2007

Total Persons, by type of job[(a)]	4,051	4,387	4,626	2,508
Direct	1,744	1,914	2,036	1,080
Construction	0	170	292	0
Operation	1,744	1,744	1,744	1,080
Current Operation	1,744	1,744	1,744	0
EELV Operation	0	0	0	1,080
Indirect	2,307	2,472	2,591	1,428
Construction-related	0	166	284	0
Operation-related	2,307	2,307	2,307	1,428
Current Operation-related	2,307	2,307	2,307	0
EELV Operation-related	0	0	0	1,428

Note: (a) Total population includes all workers holding direct or indirect jobs, plus their household members (assuming an average household size of 2.7 persons).
EELV = Evolved Expendable Launch Vehicle

Source: Estimates prepared for this study.

residents, only 11 percent of the residents would be assumed to leave the ROI. The incorporated cities within the ROI would lose the majority of residents assumed to leave the county.

4.2.1.3 **Concept A/B**

4.2.1.3.1 **Concept A/B, Cape Canaveral AS**

Employment. The number of direct and indirect jobs associated with launch activities at Cape Canaveral AS is anticipated to increase slightly during construction of EELV facilities between 1998 and 2000. Employment would decline thereafter as the requirement for direct operation workers is reduced from 1,210 under the Atlas IIA, Delta II, and Titan IVB launch programs to 590 in 2007 at full employment (Table 4.2-9).

The number of indirect jobs associated with launches supported within Brevard County would be reduced from its 1997 level of 1,096 to 534 in 2007 at full employment; however, employment in the county is forecasted to increase from 231,553 in 1997 to 285,540 in 2007 (see Table 3.2-1). A small increase in the number of indirect jobs would occur in 2000 during construction of EELV facilities.

Additionally, there would be a net increase of up to 295 direct and 193 indirect jobs within Brevard County. At full employment in 2007, there would be a net decline of 1,182 jobs.

Population. The total number of persons associated with launch activities at Cape Canaveral AS (including all direct and indirect workers, plus members of their households) is anticipated to increase from its 1997 level of 6,227 to

Table 4.2-9. Jobs and Worker Migration - Concept A/B, Cape Canaveral AS

	1997	1998	2000	2007
Total Jobs[(a)]	2,306	2,769	2,499	1,124
Direct	1,210	1,490	1,350	590

Construction	0	280	295	0
Operation	1,210	1,210	1,055	590
Current Operation	1,210	1,210	908	0
EELV Operation	0	0	148	590
Indirect	1,096	1,279	1,149	534
Construction-related	0	183	193	0
Operation-related	1,096	1,096	956	534
Current Operation-related	1,096	1,096	822	0
EELV Operation-related	0	0	134	534
Net Change in Total Jobs	0	463	193	-1,182

Note: (a) Includes full- and part-time jobs.
EELV = Evolved Expendable Launch Vehicle

Source: Estimates prepared for this study.

7,477 during construction of EELV facilities, and then decline to a level of 3,036 at full employment in 2007; however, the Brevard County population is forecasted to increase from 460,824 in 1997 to 557,856 in 2007 (see Table 3.2-2). The population attributable to direct operation jobs would be reduced from 3,267 under the current launch programs to 1,593 by 2007 (Table 4.2-10).

Table 4.2-10. Total Population by Type of Job - Concept A/B, Cape Canaveral AS

	1997	1998	2000	2007
Total Persons, by type of job[(a)]	6,227	7,477	6,747	3,036
Direct	3,267	4,023	3,645	1,593
Construction	0	756	797	0
Operation	3,267	3,267	2,849	1,593
Current Operation	3,267	3,267	2,450	0
EELV Operation	0	0	398	1,593
Indirect	2,960	3,454	3,102	1,443
Construction-related	0	495	521	0
Operation-related	2,960	2,960	2,580	1,443
Current Operation-related	2,960	2,960	2,220	0
EELV Operation-related	0	0	361	1,443

Note: (a) Total population includes all workers holding direct or indirect jobs, plus their household members (assuming an average household size of 2.7 persons).
EELV = Evolved Expendable Launch Vehicle

Source: Estimates prepared for this study.

The majority of the population attributable to Concept A/B would reside within the unincorporated area of Brevard County (see Section 4.2.1.1.1).
By 2007, there would be a net decline in population of 3,191 persons with implementation of the EELV program. There would be an increase of 1,250 persons during construction activities. The incorporated cities within the ROI would lose the majority of the 10 percent of workers that are assumed to leave the ROI.

4.2.1.3.2 **Concept A/B, Vandenberg AFB**

Employment. The number of direct and indirect jobs associated with launch activities at Vandenberg AFB is anticipated to increase slightly during construction activities associated with the EELV program from 1998 until 2002. Employment would decline thereafter as the requirement for direct operation workers is reduced from 646 to 415 at full EELV employment in 2007 (Table 4.2-11).

Table 4.2-11. Jobs and Worker Migration - Concept A/B, Vandenberg AFB

	1997	1998	2000	2007
Total Jobs[(a)]	1,500	1,625	2,341	964
Direct	646	709	1,072	415
Construction	0	63	426	0
Operation	646	646	646	415
Current Operation	646	646	646	0
EELV Operation	0	0	0	415
Indirect	854	916	1,269	549
Construction-related	0	61	415	0
Operation-related	854	854	854	549
Current Operation-related	854	854	854	0
EELV Operation-related	0	0	0	549
Net Change in Total Jobs	0	124	841	-536

Note: (a) Includes full- and part-time jobs.
EELV = Evolved Expendable Launch Vehicle

Source: Estimates prepared for this study.

The number of indirect jobs within Santa Barbara County would be reduced from its 1997 level of 854 to 549 by 2007. A small increase of 415 indirect jobs would occur in 2000 during construction of EELV facilities.

During construction of EELV facilities, there would be a total net increase of 841 jobs within Santa Barbara County. By 2007, there would be a net decline of 536 direct and indirect jobs; however, employment in Santa Barbara County is forecasted to increase from 229,107 in 1997 to 271,380 in 2007 (see Table 3.2-3).

By 2007, 536 residents would lose direct and indirect jobs associated with current launch programs. It was assumed that only 10 percent of current residents would leave the county.

Population. The total number of persons associated with Vandenberg AFB launch activities (including all direct and indirect workers, plus members of their households) is anticipated to increase from a 1997 level of 4,051 to 6,322 by 2000 during the construction of EELV facilities. The population would decline thereafter to a level of 2,602 by 2007 (Table 4.2-12). The population attributable to direct operation jobs would be reduced from 1,744 under the current launch programs to 1,212 during peak EELV launch operations in 2007.

Table 4.2-12. Total Population by Type of Job - Concept A/B, Vandenberg AFB

	1997	1998	2000	2007
Total Persons, by type of job[(a)]	4,051	4,387	6,322	2,602
Direct	1,744	1,914	2,895	1,212
Construction	0	170	1,150	0
Operation	1,744	1,744	1,744	1,121
Current Operation	1,744	1,744	1,744	0
EELV Operation	0	0	0	1,121
Indirect	2,307	2,472	3,427	1,482
Construction-related	0	166	1,120	0
Operation-related	2,307	2,307	2,307	1,482
Current Operation-related	2,307	2,307	2,307	0
EELV Operation-related	0	0	0	1,482

Note: (a) Total population includes all workers holding direct or indirect jobs, plus their household members (assuming an average household size of 2.7 persons).
EELV = Evolved Expendable Launch Vehicle

Source: Estimates prepared for this study.

The population attributable to indirect jobs within Santa Barbara County would be reduced from its 1997 level of 2,307 to 1,482 by 2007; however, the Santa Barbara County population is forecasted to increase from 399,988 in 1997 to 445,415 in 2007 (see Table 3.2-4). A small increase in the population attributable to indirect workers would occur during construction of the EELV facilities.

The majority of the population attributable to the EELV program would reside within the unincorporated area of Santa Barbara County (see Section 4.2.1.2.1).

4.2.2 **No-Action Alternative**

4.2.2.1 **Cape Canaveral AS**

Employment. Under the No-Action Alternative, the number of direct jobs associated with launch activities at Cape Canaveral AS is anticipated to remain at its 1997 level of 1,210 through 2007 with continuation of the Atlas IIA, Delta II, and Titan IVB launch systems. The number of indirect jobs associated with current launch programs within Brevard County would remain at its 1997 level of 1,096 through 2007. Total employment in Brevard County is forecasted to increase from 231,553 to 285,540 between 1997 and 2007.

Population. The total number of persons associated with launch activities at Cape Canaveral AS (including all direct and indirect workers, plus members of their households) is anticipated to remain at its 1997 level of 6,227 through 2007 under the No-Action Alternative. The population attributable to direct and indirect jobs associated with current launch programs would remain at its

1997 level of 3,267 and 2,960, respectively. The Brevard County population is forecasted to increase from 460,824 to 557,856 between 1997 and 2007.

The majority of the population attributable to the existing launch programs resides within the unincorporated area of Brevard County (with most of the direct population in unincorporated communities near Cape Canaveral AS), and in the cities of Cape Canaveral, Cocoa, Cocoa Beach, and Rockledge. Much of the population effect in other cities, including Titusville, Melbourne, and Palm Bay, is attributable to indirect workers. Some workers, both direct and indirect, locate their households outside of Brevard County, principally in communities in Orange County.

4.2.2.2 **Vandenberg AFB**

Employment. Under the No-Action Alternative, the number of direct jobs associated with government launch activities at Vandenberg AFB is anticipated to remain at its 1997 level of 646 through 2007 with continuation of the Atlas IIA, Delta II, and Titan IVB launch systems. The number of indirect jobs associated with current launch programs within Santa Barbara County would remain at its current level of 854 through 2007 under the No-Action Alternative. Total employment in Santa Barbara County is forecasted to increase from 229,107 to 271,380 between 1997 and 2007.

Population. The total number of persons associated with launch activities at Vandenberg AFB (including all direct and indirect workers, plus members of their households) is anticipated to remain at its 1997 level of 4,051 through 2007 under the No-Action Alternative. The population attributable to direct and indirect jobs associated with current launch programs would remain at its 1997 level of 1,744 and 2,307, respectively. The Santa Barbara County population is forecasted to increase from 399,988 to 445,415 between 1997 and 2007.

The majority of the population attributable to the current launch programs resides within the unincorporated area of Santa Barbara County (with most of the direct population in unincorporated communities near Vandenberg AFB), and in the cities of Santa Maria and Lompoc. Much of the population effect in other cities, including Santa Barbara and Carpinteria, is attributable to indirect workers. Some workers, both direct and indirect, locate their households outside of Santa Barbara County, principally in communities in San Luis Obispo County.

4.3 LAND USE AND AESTHETICS

4.3.1 Proposed Action

4.3.1.1 **Concept A**

4.3.1.1.1 **Concept A, Cape Canaveral AS**

Regional Land Use. Concept A activities would be compatible with existing and planned land uses in the ROI; therefore, incompatible land uses would not result.

Cape Canaveral AS Land Use. Construction and operation activities associated with Concept A would occur primarily at SLC-41, an area that is currently designated for space launch activities. Proposed EELV uses would be consistent with the Base Comprehensive Plan and the mission of the Air Force at Cape Canaveral AS as "the best source of development space for new launch facilities is the old pads, remediated and rebuilt" (45 Space Wing, 1995c). The proposed EELV launch program would not result in conversion of prime agricultural land or cause a decrease in the utilization of land.

Coastal Zone Management. SLC-41 does not lie within the FCMA no-development zone, so construction and modification of facilities is consistent with the FCMA. Additionally, the contractor would coordinate with 45 SW Civil Engineering prior to design of EELV facilities to ensure adherence to all siting standards. However, SLC-41 does lie within the coastal zone and is subject to a federal coastal zone consistency determination as outlined in the FCMA, which is administered by the FDCA. The effects of the EELV program on the coastal zone have been evaluated, and the Air Force has determined that the EELV program is consistent with the FCMA. The FDCA has concurred with this determination in its correspondence dated March 2, 1998.

Recreation. EELV launches would not result in a loss of public recreation activities in the area because there are no public beaches in the launch area on Cape Canaveral AS. Neither public beaches nor other public facilities would be closed as a result of launch activities; however, recreational fishing activities available to KSC and Cape Canaveral AS personnel may be restricted during a launch. This restriction would be temporary and is not considered an adverse impact because limitations due to launch activities are routine at the installation.

Aesthetics. Views of Cape Canaveral AS from public beaches, marine vessels, and surrounding communities would be altered slightly by new construction at SLC-41. However, views of Cape Canaveral AS are primarily limited to marine traffic on the east and west and distant off-site beach areas and small communities to the south. Although EELV activities at SLC-41 would consist of modification and demolition of existing structures, abandonment of buildings, and construction of new facilities, the aesthetic view of the site, an existing launch facility, would not change noticeably as a result of these activities. In addition, all views are distant views. Therefore, construction and operations under Concept A would not affect the area's aesthetic quality nor would they obscure any scenic views.

No adverse land use impacts are anticipated from Concept A EELV activities at Cape Canaveral AS; therefore, no mitigation measures would be required.

4.3.1.1.2 Concept A, Vandenberg AFB

Regional Land Use. Concept A activities would be compatible with existing and planned land uses in the ROI; therefore, incompatible land uses would not result.

Vandenberg AFB Land Use. Construction and operations associated with Concept A would occur primarily at SLC-3W, an area currently designated for space launch activities. Proposed EELV uses would be consistent with the Base Comprehensive Plan and the Air Force mission at Vandenberg AFB. The proposed EELV activities would not result in conversion of prime agricultural land or cause a decrease in land utilization.

Coastal Zone Management. As defined in the Coastal Zone Management Plan (CZMP), federal activities in, or affecting, a coastal zone must be consistent with the CZMP. Since the EELV program would result in public beach closures, a coastal zone consistency determination is required to support EELV program activities. The California Coastal Commission administers the CZMP. The effects of the EELV program on the coastal zone have been evaluated. The Air Force has submitted a Coastal Zone Consistency Determination for the EELV program to the California Coastal Commission for review.

Recreation. Under Concept A, Ocean Beach County Park would be closed for all launches from SLC-3W. Jalama Beach County Park would be closed for low-azimuth launches (180 degrees or less). A maximum of 10 launches would occur during the peak year (2007). The parks would be closed following the procedures described in Section 3.3.2.4.

Aesthetics. Views of Vandenberg AFB from public beaches, marine vessels, and railroad tracks would be slightly altered by Concept A construction activities. The nearest public views are those seen by passengers aboard the Southern Pacific Railroad line that runs through the base. Views of South Vandenberg AFB are limited by topography. Although EELV operations at SLC-3W would require modification and demolition of existing structures, abandonment of buildings, and construction of new facilities, the aesthetic view of the site, an existing launch facility, would not change noticeably as a result of these activities. In addition, most public views are distant views. Therefore, construction and operations under Concept A would not alter the aesthetic quality of the area nor would they obscure any scenic views. Prior to design of EELV facilities, the contractor would coordinate with 30 SW Civil Engineering to ensure adherence to facility design standards.

Other than beach closures, no land use impacts are anticipated; therefore, no mitigation measures are required.

4.3.1.2 Concept B

4.3.1.2.1 Concept B, Cape Canaveral AS

Regional Land Use. As discussed in Section 4.3.1.1.1, under Regional Land Use, the EELV program would be compatible with existing and planned land uses in the ROI; therefore, incompatible land uses would not result.

Cape Canaveral AS Land Use. Construction and operation activities associated with Concept B would occur primarily at SLC-37, an area currently designated for space launch activities. As discussed in Section 4.3.1.1.1, under Cape Canaveral AS Land Use, no impacts to land use on Cape Canaveral AS are expected from EELV activities.

Coastal Zone Management. SLC-37 does not lie within the no-development zone, so construction and modification of facilities is consistent with the FCMA. Additionally, the contractor would coordinate with 45 SW Civil Engineering prior to design of EELV facilities to ensure adherence to all siting standards. As discussed in Section 4.3.1.1.1, under Coastal Zone Management, the Air Force has determined that the EELV program is consistent with the FCMA, and the FDCA has concurred with this determination in its correspondence dated March 2, 1998.

Recreation. Recreation impacts resulting from Concept B implementation at SLC-37 would be similar to those described in Section 4.3.1.1.1, under Recreation.

Aesthetics. Aesthetic impacts at SLC-37 resulting from Concept B would be similar to those described under Section 4.3.1.1.1, under Aesthetics.

No adverse land use impacts are anticipated from EELV activities; therefore, no mitigation measures would be required.

4.3.1.2.2 **Concept B, Vandenberg AFB**

Regional Land Use. As discussed in Section 4.3.1.1.2, under Regional Land Use, the EELV program would be compatible with existing and planned land uses in the ROI; therefore, incompatible land uses would not result.

Vandenberg AFB Land Use. Construction and operation activities associated with Concept B would occur primarily at SLC-6, an area currently designated for space launch activities. As discussed in Section 4.3.1.1.2, under Vandenberg AFB Land Use, no impacts to land use on Vandenberg AFB are expected from EELV activities.

Coastal Zone Management. As discussed under Section 4.3.1.1.2, under Coastal Zone Management, a Coastal Zone Consistency Determination for EELV activities has been submitted to the California Coastal Commission for review.

Recreation. Under Concept B, Ocean Beach County Park would not be closed during SLC-6 launches. Jalama Beach County Park would be closed for low-azimuth launches (less than 180 degrees). A maximum of 10 launches would occur during the peak year (2007). The park would be closed following the procedures described in Section 3.3.2.4.

Aesthetics. Aesthetic impacts at SLC-6 resulting from Concept B would be similar to those described under Section 4.3.1.1.2, under Aesthetics.

Other than beach closures, no land use impacts are anticipated; therefore, no mitigation measures would be required.

4.3.1.3 **Concept A/B**

4.3.1.3.1 **Concept A/B, Cape Canaveral AS**

Regional Land Use. As discussed in Sections 4.3.1.1.1 and 4.3.1.2.1, under Regional Land Use, the EELV program would be compatible with existing and planned land uses in the ROI; therefore, incompatible land uses would not result.

Cape Canaveral AS Land Use. Construction and operation activities associated with Concept A/B would occur primarily at SLC-41 and SLC-37, areas currently designated for space launch activities. As discussed in Sections 4.3.1.1.1 and 4.3.1.2.1, under Cape Canaveral AS Land Use, no impacts to land use on Cape Canaveral AS are expected from EELV activities.

Coastal Zone Management. A federal coastal zone consistency determination as discussed in Sections 4.3.1.1.1 and 4.3.1.2.1, under Coastal Zone Management, would be required for Concept A/B activities.

Recreation. Recreation impacts resulting from implementation of Concept A/B at SLC-41 and SLC-37 would be similar to those described under Concepts A and B, Sections 4.3.1.1.1 and 4.3.1.2.1, under Recreation.

Aesthetics. Aesthetic impacts at SLC-41 and SLC-37 resulting from Concept A/B would be similar to those described under Sections 4.3.1.1.1 and 4.3.1.2.1, under Aesthetics.

No adverse land use impacts are anticipated from EELV activities; therefore, no mitigation measures would be required.

4.3.1.3.2 **Concept A/B, Vandenberg AFB**

Regional Land Use. As discussed in Sections 4.3.1.1.2 and 4.3.1.2.2, under Regional Land Use, the EELV program would be compatible with existing and planned land uses in the ROI; therefore, incompatible land uses would not result.

Vandenberg AFB Land Use. Construction and operation activities associated with Concept A/B would occur primarily at SLC-3W and SLC-6, areas currently designated for space launch activities. As discussed in Sections 4.3.1.1.2 and 4.3.1.2.2, under Vandenberg AFB Land Use, no impacts to land use on Vandenberg AFB are expected from EELV activities.

Coastal Zone Management. As discussed in Sections 4.3.1.1.2 and 4.3.1.2.2, under Coastal Zone Management, a coastal zone consistency determination for EELV activities will be prepared.

Recreation. Under Concept A/B, Ocean Beach County Park would be closed for all launches from SLC-3W. As discussed in Sections 4.3.1.1.2 and 4.3.1.2.2, low-azimuth launches from SLC-3W (180 degrees or less) and SLC-6 (less than 180 degrees) would require closure of Jalama Beach County Park. A maximum of 7 launches would occur from each launch complex during the peak year (2007). The parks would be closed following the procedures described in Section 3.3.2.4.

Aesthetics. Aesthetic impacts at SLC-3W and SLC-6 resulting from Concept A/B would be similar to those described under Sections 4.3.1.1.2 and 4.3.1.2.2, under Aesthetics.

Other than unavoidable beach closures, no other land use impacts are anticipated; therefore, no mitigation measures would be required.

4.3.2 No-Action Alternative

4.3.2.1 **Cape Canaveral AS.** Under the No-Action Alternative, no changes in land use are proposed, and no construction or modification of facilities would occur; therefore, no impacts to land use and aesthetics are expected.

4.3.2.2 **Vandenberg AFB.** Under the No-Action Alternative, county beaches would continue to be closed for as many as six launches per year. No mitigation measures are available to reduce this impact. No other land use and aesthetics impacts are anticipated because no changes in land use and no construction or modification of facilities is proposed.

4.4 TRANSPORTATION

This section describes the effects on key roadways and railroads expected to be impacted by the Proposed Action and No-Action Alternative.

4.4.1 Proposed Action

The ADT generated by the EELV program proposed for Cape Canaveral AS and Vandenberg AFB is expected to be less than 50 percent of the ADT generated by the current launch activities that would be replaced by this project. As a result, traffic volumes generated under the Proposed Action on the key roadways used to support the EELV program should be less than those under the existing launch programs.

Roadways

The effects on roadway traffic were assessed by estimating the number of trips generated by employees, visitors, and service vehicles associated with construction and operations. These trips were distributed to the roadway system based on existing travel patterns. This analysis is based on existing data on roadway capacities, existing and projected traffic volumes and patterns, and standards established by state local transportation agencies. Trip generation was estimated by applying the trip rates from the ITE Trip Generation Manual, 5th Edition, combined with other project trip generation data, to obtain daily traffic volumes. Peak-hour traffic volumes generated under the Proposed Action were distributed to the installation and local road networks using trip distribution patterns from current launch programs. To determine traffic effects from the Proposed Action on local roadways, traffic volumes from each EELV concept were compared to the baseline year (1996).

Railways

Railroad lines in the Cape Canaveral AS area fall outside the launch pad safety corridor for the station. The main line of the Southern Pacific Railroad passes through the launch pad safety corridor at Vandenberg AFB. An average of four passenger and eight freight trains pass through Vandenberg AFB each day. Launches from Vandenberg AFB are coordinated with the railroad. Therefore, no impacts to railroad systems are expected at either location.

4.4.1.1 **Concept A.** Direct and indirect traffic impacts were determined for key local roadways related to Concept A and are discussed in this section. Under Concept A, project-related traffic is expected to increase slightly during construction of EELV facilities between 1998 and 2000, but to decline during the operational phase as employment decreases.

4.4.1.1.1 **Concept A, Cape Canaveral AS.** At the peak period of the construction phase, peak-hour traffic generated by construction workers would add approximately 250 vehicles to Samuel C. Phillips Parkway/Hangar Road. Approximately 50 vehicles would exit Cape Canaveral AS to the west on the NASA Causeway, and the remaining 200 vehicles would continue south and exit Cape Canaveral AS at Gate 1. This construction traffic is likely to increase the peak-hour traffic to approximately 2,100 vehicles on Samuel C. Phillips Parkway/Hangar Road, which would continue to operate at LOS A (Table 4.4-1). Although the local road system would experience a temporary increase in traffic, the increase is not expected to change projected LOS on key local roads.

By 2015, EELV activities would be expected to generate approximately 150 trips during the evening peak hour on Samuel C. Phillips Parkway. Approximately 50 vehicles would exit Cape Canaveral AS to the west by way of the NASA Causeway, and the remaining 100 vehicles would continue south and exit Cape Canaveral AS at Gate 1 (see Table 4.4-1). The roadway would continue to operate at LOS A. No measurable changes in peak-hour traffic are expected on Samuel C. Phillips Parkway/Hangar Road north of the project area. The local road system would experience a reduction in traffic entering and exiting the station. The reductions are not expected to change projected LOS on key local roads. No adverse impacts are anticipated; therefore, no mitigation measures would be required.

4.4.1.1.2 **Concept A, Vandenberg AFB.** At the peak period of the construction phase of the project, peak-hour traffic generated by construction workers would add approximately 350 vehicles to Coast and Bear Creek roads. This construction traffic is likely to increase the PHV on these roads from the project location to Ocean Avenue (Table 4.4-2). The LOS on Bear Creek Road would change from A to B. When distributed to the local road system, the construction-related traffic would increase the PHV exiting the base by approximately 200 vehicles at each exit location, Ocean Avenue and the Santa Maria Gate. This temporary increase in the peak-hour traffic due to construction activities would not have a long-range measurable effect on the projected LOS of any local road segments.

Table 4.4-1. Peak-Hour Volumes - Concept A, Cape Canaveral AS

Roadway	Segment/ No. of Lanes	Capacity (vehicles per hour)	1996[(a)] PHV	1996 LOS	2000 PHV	2000 LOS	2015 PHV	2015 LOS
SR A1A	Samuel C. Phillips Parkway, south; 4-lane	8,000	3,950	C	4,300	C	5,300	C
SR A1A	Samuel C. Phillips Parkway, east; 4-lane	8,000	3,750	B	3,900	B	3,850	B
NASA Causeway	Between U.S. 1 and Samuel C. Phillips Parkway; 4-lane	8,000	1,750	A	1,850	A	1,750	A
Samuel C. Phillips Parkway/ Hangar Road	Between SR 401 (Gate 1) and SR 401 (Gate 6) on CCAS 4-lane	8,000	1,900	A	2,100	A	1,350	A

Note: (a) Peak-hour volume based on 10 percent of average daily traffic from Brevard County traffic counts.
CCAS = Cape Canaveral Air Station
LOS = level of service
NASA = National Aeronautics and Space Administration
PHV = peak-hour volume
SR = State Route
U.S. = U.S. Highway

Source: Brevard County, undated

Table 4.4-2. Peak-Hour Volumes - Concept A, Vandenberg AFB

Roadway	Segment/ No. of Lanes	Capacity (vehicles per hour)	1996[(a)] PHV	1996 LOS	2000 PHV	2000 LOS	2015 PHV	2015 LOS
Coast Road	Between SLC-6 and Bear Creek Road; 2-lane	2,800	350	A	350	A	0	A

Bear Creek Road	Between Coast Road and Ocean Avenue; 2-lane	2,800	350	A	700	B	100	A
13th Street	Between Ocean Avenue and Santa Maria Gate; 2-lane	2,800	1,550	D	1,700	D	1,400	D
Ocean Avenue	Between Bear Creek Road and SR; 4-lane	8,000	250	A	400	A	100	A
SR 1	Between Santa Maria Gate and SR 135; 4-lane	8,000	1,550	B	1,700	B	1,400	B

Note: (a) Peak-hour volume based on 10 percent of average daily traffic from Santa Barbara County traffic counts.
LOS= level of service
PHV= peak-hour volume
SLC = Space Launch Complex
SR = State Route

Source: Santa Barbara County Planning Department, 1996

By 2015, EELV program activities are expected to generate approximately 100 trips during the evening peak hour. Peak-hour traffic on Coast and Bear Creek roads is expected to decline. The LOS on these roads would remain the same or improve as a result of the reduced peak-hour traffic volume (see Table 4.4-2). Approximately 52 percent of the project-related traffic, or 50 vehicles, is expected to travel east on Ocean Avenue from Bear Creek Road toward Lompoc and SR 246. The remaining 50 vehicles would travel north on 13th Street, exiting the base at the Santa Maria Gate. As a result, it is estimated that approximately 250 fewer vehicles would enter the local road system at each of the base gates. Although the local road system would experience a reduction in traffic, the reductions are not expected to change projected LOS. No adverse impacts are anticipated; therefore, no mitigation measures would be required.

4.4.1.2 **Concept B.** Direct and indirect traffic impacts were determined for key local roadways related to Concept B and are discussed in this section. Under Concept B, project-related traffic is expected to increase slightly during construction of EELV facilities between 1998 and 2000, but decline during the operational phase as employment decreases.

4.4.1.2.1 **Concept B, Cape Canaveral AS.** At the peak period of the construction phase of the project, peak-hour traffic generated by construction workers would add approximately 250 vehicles to Samuel C. Phillips Parkway/Hangar Road. Approximately 50 vehicles would exit Cape Canaveral AS to the west on the NASA Causeway, and the remaining 200 vehicles would continue south and exit Cape Canaveral AS at Gate 1 (Table 4.4-3). This construction traffic is likely to increase the PHV on Samuel C. Phillips Parkway/Hangar Road south of the project location to approximately 2,100 vehicles. Samuel C. Phillips Parkway/Hangar Road would continue to operate at LOS A. Although the local road system would experience an increase in traffic, the increase is not expected to change projected LOS on key local roads.

By 2015, EELV program activities are expected to generate approximately 350 trips during the evening peak hour on Samuel C. Phillips Parkway; the LOS would not be affected by the reduced traffic volume. Approximately 50 vehicles would exit Cape Canaveral AS to the west on the NASA Causeway, and the remaining 300 vehicles would continue south and exit Cape Canaveral AS at Gate 1 (see Table 4.4-3). No measurable changes in peak-hour traffic volume are expected on Samuel C. Phillips Parkway/Hangar Road north of the project area. The local road system would experience a reduction in traffic entering and exiting the station, but LOS on key local roads would not change. No adverse impacts are anticipated; therefore, no mitigation measures would be required.

Table 4.4-3. Peak-Hour Volumes - Concept B, Cape Canaveral AS

Roadway	Segment/No. of Lanes	Capacity (vehicles per hour)	1996[(a)] PHV	2000 PHV	2000 LOS	2015 PHV	2015 LOS
SR A1A	Samuel C. Phillips Parkway, south; 4-lane	8,000	3,950	4,300	C	5,350	C
SR A1A	Samuel C. Phillips Parkway, east; 4-lane	8,000	3,750	3,900	B	3,950	B
Samuel C. Phillips Parkway/ Hangar Road	Between SR 401 (Gate 1) and SR 401 (Gate 6) on CCAS 4-lane	8,000	1,900	2,100	A	1,500	A
NASA Causeway	Between U.S. 1 and Samuel C. Phillips Parkway; 4-lane	8,000	1,750	1,850	A	1,800	A

Note: (a) Peak-hour volume based on 10 percent of average daily traffic from Brevard County traffic counts.
CCAS = Cape Canaveral Air Station
LOS = level of service
NASA = National Aeronautics and Space Administration
PHV = peak-hour volume
SR = State Route
U.S. = U.S. Highway

Source: Brevard County, undated

4.4.1.2.2 **Concept B, Vandenberg AFB.** At the peak period of the construction phase of the project, peak-hour traffic generated by construction workers would add approximately 150 vehicles to Coast and Bear Creek roads. This construction traffic is likely to increase the PHV on these roads from the project location to Ocean Avenue (Table 4.4-4). The LOS on Bear Creek Road would change from A to B. When distributed to the local road system, the construction-related traffic would increase the PHV exiting the base by approximately 50 vehicles at each exit location, Ocean Avenue and the Santa Maria Gate. This increase in the peak-hour traffic would not have a permanent measurable effect on the projected LOS for any local road segments.

By 2015, EELV activities are expected to generate approximately 250 trips during the evening peak hour. Peak-hour traffic on Bear Creek Road is expected to decline, but the LOS would not change (see Table 4.4-4). Approximately 52 percent of the project-related traffic, or 150 vehicles, is expected to travel east on Ocean Avenue from Bear Creek Road towards Lompoc and SR 246. The remaining 100 vehicles would travel north on 13th Street, exiting the base at the Santa Maria Gate. As a result, it is estimated that approximately 150 fewer vehicles would enter the local road system at each of the base gates. Although the local road system would experience a reduction in traffic, the reductions are not expected to change projected LOS. No adverse impacts are anticipated; therefore, no mitigation measures would be required.

Table 4.4-4. Peak-Hour Volumes - Concept B, Vandenberg AFB

Roadway	Segment/No. of Lanes	Capacity (vehicles per hour)	1996 PHV[a]	2000 PHV	2000 LOS	2015 PHV	2015 LOS
Coast Road	Between SLC-6 and Bear Creek Road; 2-lane	2,800	50	50	A	50	A
Bear Creek Road	Between Coast Road and Ocean Avenue; 2-lane	2,800	350	500	B	250	A
13th Street	Between Ocean Avenue and Santa Maria Gate; 2-lane	2,800	1,550	1,600	D	1,500	D
Ocean Avenue	Between Bear Creek Road and SR 1; 4-lane	8,000	250	300	A	200	A
SR 1	Between Santa Maria Gate and SR 135; 4-lane	8,000	1,550	1,600	B	1,500	B

Note: (a) Peak-hour volume based on 10 percent of average daily traffic from Santa Barbara County traffic counts.
LOS = level of service
PHV = peak-hour volume
SLC = Space Launch Complex
SR = State Route

Source: Santa Barbara County Planning Department, 1996

4.4.1.3 **Concept A/B.** Direct and indirect traffic impacts were determined for key local roadways related to Concept A/B and are discussed in this section. Under Concept A/B, project-related traffic is expected to increase slightly during construction activities related to EELV and to decline during operations.

4.4.1.3.1 **Concept A/B, Cape Canaveral AS.** During construction, peak-hour traffic generated by construction workers would add approximately 500 vehicles to Samuel C. Phillips Parkway/Hangar Road. This construction traffic is likely to increase PHV on Samuel C. Phillips Parkway/Hangar Road south of the project location to approximately 2,300 vehicles. The LOS on Samuel C. Phillips Parkway/Hangar Road would remain at LOS A. Approximately 100 vehicles would exit Cape Canaveral AS to the west by way of the NASA Causeway, and the remaining 400 vehicles would continue south and exit Cape Canaveral AS at Gate 1 (Table 4.4-5). The construction-related traffic would create a temporary increase in the peak-hour traffic and the LOS on SR A1A east of the station would change from B to C.

By 2015, EELV program activities would be expected to generate approximately 400 trips during the peak evening hour. Peak-hour traffic on Samuel C. Phillips Parkway is expected to decline; however, the LOS would not be affected by the reduced traffic volume. Approximately 100 vehicles would exit Cape Canaveral AS to the west on the NASA Causeway, and the remaining 300 would continue south and exit Cape Canaveral AS at Gate 1

Table 4.4-5. Peak-Hour Volumes - Concept A/B, Cape Canaveral AS

Roadway	Segment/No. of Lanes	Capacity (vehicles per hour)	1996[(a)] PHV	2000 PHV	2000 LOS	2015 PHV	2015 LOS
SR A1A	Samuel C. Phillips Parkway, south; 4-lane	8,000	3,950	4,400	C	5,350	C
SR A1A	Samuel C. Phillips Parkway, east; 4-lane	8,000	3,750	4,050	C	4,000	B
Samuel C. Phillips Parkway/ Hangar Road	Between SR 401 (Gate 1) and SR 401 (Gate 6) on CCAS 4-lane	8,000	1,900	2,300	A	1,550	A
NASA Causeway	Between U.S. 1 and Samuel C. Phillips Parkway; 4-lane	8,000	1,750	1,800	A	1,800	A

Note: (a) Peak-hour volume based on 10 percent of average daily traffic from Brevard County traffic counts.
CCAS = Cape Canaveral Air Station
LOS = level of service
NASA = National Aeronautics and Space Administration
PHV = peak-hour volume
SR = State Route
U.S. = U.S. Highway

Source: Brevard County, undated

(see Table 4.4-5). No measurable changes in peak-hour traffic are expected on Samuel C. Phillips Parkway/Hangar Road north of the project area. Although the local road system would experience a reduction in traffic, the reductions are not expected to change projected LOS. No adverse impacts are anticipated; therefore, no mitigation measures would be required.

4.4.1.3.2 **Concept A/B, Vandenberg AFB.** At the peak period of the construction phase of the project, peak-hour traffic generated by construction workers would add approximately 500 vehicles to Coast and Bear Creek roads. This construction traffic is likely to increase the PHV on these roads from the project location to Ocean Avenue (Table 4.4-6). The LOS on Bear Creek Road would change from A to C, and the LOS on 13th Street would change from D to E. When distributed to the local road system, the construction-related traffic would increase PHV exiting the base by approximately 250 vehicles at each exit location, Ocean Avenue and the Santa Maria Gate. During EELV construction activities, the LOS on Ocean Avenue would temporarily change.

By 2015, EELV program activities are expected to generate approximately 300 trips during the evening peak hour. Peak-hour traffic on Coast and Bear Creek roads is expected to decline. The LOS on Bear Creek Road would improve from LOS C to LOS A, and the LOS on 13th Street would improve from LOS E to LOS D (see Table 4.4-6). Approximately 52 percent of the project-related traffic, or 150 vehicles, is expected to travel east on Ocean

Table 4.4-6. Peak-Hour Volumes - Concept A/B, Vandenberg AFB

Roadway	Segment/No. of Lanes	Capacity (vehicles per hour)	1996 PHV[(a)]	2000 PHV	2000 LOS	2015 PHV	2015 LOS
Coast Road	Between SLC-6 and Bear Creek Road; 2-lane	2,800	350	350	A	50	A
Bear Creek Road	Between Coast Road and Ocean Avenue; 2-lane	2,800	350	850	C	300	A
13th Street	Between Ocean Avenue and Santa Maria Gate; 2-lane	2,800	1,550	1,800	E	1,500	D
Ocean Avenue	Between Bear Creek Road and SR 1; 4-lane	8,000	250	500	B	200	A
SR 1	Between Santa Maria Gate and SR 135; 4-lane	8,000	1,550	1,800	B	1,500	B

Note: (a) Peak-hour traffic based on 10 percent of average daily traffic from Santa Barbara County traffic counts.
LOS = level of service
PHV= peak-hour volume
SLC = Space Launch Complex
SR = State Route

Source: Santa Barbara County Planning Department, 1996

Avenue from Bear Creek Road toward Lompoc and SR 246. The remaining 150 vehicles would travel north on 13th Street, exiting the base at the Santa Maria Gate. As a result, it is estimated that approximately 150 fewer vehicles would enter the local road system at each of the exits as a result of Concept A/B implementation. No adverse impacts are anticipated; therefore, no mitigation measures would be required.

4.4.2 No-Action Alternative

Direct and indirect traffic impacts determined for key local roadways related to the No-Action Alternative are discussed in this section. Project-related traffic would continue at existing volumes throughout the analysis period, and there would be no changes to the existing roadways within the ROI as a result of launch vehicle programs.

4.4.2.1 **Cape Canaveral AS.** Traffic volumes on key local roadways at Cape Canaveral AS under the No-Action Alternative would include the current traffic generated by existing launch operations. Existing launch operations are estimated to contribute approximately 800 vehicles to the peak-hour volume on Samuel C. Phillips Parkway/Hangar Road. Approximately 150 vehicles exit the station on the NASA Causeway, with the remaining vehicles using the southern gate at SR 401. The launch-related traffic comprises approximately

40 percent of the peak-hour traffic on Samuel C. Phillips Parkway/Hangar Road, which is expected to continue to operate at LOS A under the No-Action Alternative (Table 4.4-7).

Table 4.4-7. Peak-Hour Volumes - No-Action Alternative, Cape Canaveral AS

Roadway	Segment/No. of Lanes	Capacity (vehicles per hour)	1996[(a)] PHV	2000 PHV	2000 LOS	2015 PHV	2015 LOS
SR A1A	Samuel C. Phillips Parkway, south; 4-lane	8,000	3,950	4,200	C	5,500	C
SR A1A	Samuel C. Phillips Parkway, east; 4-lane	8,000	3,750	3,800	B	4,200	C
Samuel C. Phillips Parkway/ Hangar Road	Between SR 401 (Gate 1) and SR 401 (Gate 6) on CCAS 4-lane	8,000	1,900	1,900	A	1,900	A
NASA Causeway	Between U.S. 1 and Samuel C. Phillips Parkway; 4-lane	8,000	1,750	1,800	A	1,900	A

Note: (a) Peak-hour volume based on 10 percent of average daily traffic from Brevard County traffic counts.

CCAS = Cape Canaveral Air Station
LOS = level of service
NASA = National Aeronautics and Space Administration
PHV = peak-hour volume
SR = State Route
U.S. = U.S. Highway

Source: Brevard County, undated

4.4.2.2 **Vandenberg AFB.** Traffic volumes on key local roadways at Vandenberg AFB under the No-Action Alternative would include the current traffic generated by existing launch operations, which are estimated to contribute approximately 350 vehicles to the peak-hour volume on Coast and Bear Creek roads. Approximately 200 vehicles exit the base at Ocean Avenue, east toward Lompoc and SR 246. The remaining 150 vehicles travel north on 13th Street and exit the base at the Santa Maria Gate (Table 4.4-8).

4.5 UTILITIES

The utility systems addressed in this analysis include the facilities and infrastructure used for potable water supply, wastewater collection and treatment, solid waste disposal, and electricity. Direct and indirect changes in future utility consumption for the Proposed Action and the No-Action Alternative were estimated based on project-related requirements and per capita average daily use within the applicable ROI.

Table 4.4-8. Peak-Hour Volumes - No-Action Alternative, Vandenberg AFB

Roadway	Segment/No. of Lanes	Capacity (vehicles per hour)	1996 PHV[(a)]	2000 PHV	2000 LOS	2015 PHV	2015 LOS
Coast Road	Between SLC-6 and Bear Creek Road; 2-lane	2,800	350	350	A	350	A
Bear Creek Road	Between Coast Road and Ocean Avenue; 2-lane	2,800	350	350	A	350	A
13th Street	Between Ocean Avenue and Santa Maria Gate; 2-lane	2,800	1,550	1,550	D	1,750	D
Ocean Avenue	Between Bear Creek Road and SR 1; 4-lane	8,000	250	250	A	250	A
SR 1	Between Santa Maria Gate and SR 135; 4-lane	8,000	1,550	1,550	B	2,150	B

Note: (a) Peak-hour traffic based on 10 percent of average daily traffic from Santa Barbara County traffic counts.
LOS = level of service
PHV = peak-hour volume
SLC = Space Launch Complex
SR = State Route

Source: Santa Barbara County Planning Department, 1996

4.5.1 Proposed Action

This section describes direct and indirect changes in utility consumption for the Proposed Action. Impacts for each utility system were determined for the average construction period and for peak launch periods. Under the Proposed Action, direct and indirect project-related employment and population are expected to decrease (see Section 4.2). As a result, demands on those utilities affected by changes in population and employment within each region would also decrease from the amounts expected to occur under the No-Action Alternative. Additional facilities required by the Proposed Action are expected to create minimal increases for some utilities. However, these project-related fluctuations in utility usage would be small in comparison to changes associated with projected growth within each region.

4.5.1.1 Concept A

4.5.1.1.1 Concept A, Cape Canaveral AS

Water Supply. During construction, potable water usage would be greater than that required under the No-Action Alternative. As a result, average daily water consumption on Cape Canaveral AS would increase slightly between

1998 and 2000. The current average demand is approximately 0.75 MGD and the system has a capacity of 3 MGD; no impacts are anticipated during construction.
Employment decreases as a result of implementing Concept A would reduce the requirements for potable water on station by approximately 43,700 gpd by 2015, or approximately 6 percent. Deluge water required to support launches would consume approximately 1.3 million gallons during the peak launch year (2015). This is 0.3 million gallon less than that estimated for the No-Action Alternative, or an 18-percent decrease. Reductions in potable water from domestic and industrial uses under Concept A would be approximately 45,200 gpd, and no impacts to the potable water system are expected on station. Recycling of industrial wastewater would further reduce the use of potable water for launch operations. Project-related population decreases within the ROI would reduce potable water consumption off-station by approximately 60,300 gpd. These changes in potable water requirements are not expected to have any impacts on regional water systems, and the systems would continue to operate within capacity.

Wastewater. Construction of facilities would increase wastewater generation between 1998 and 2000. The current system has a permitted capacity of 0.8 MGD and a peak daily flow of approximately 0.3 MGD. The increase can be absorbed by the existing system, and no impacts are anticipated.

During the operational phase, employment on station would decrease and the amount of wastewater would decrease. By the peak launch year (2015), wastewater generation is expected to be reduced by approximately 43,700 gpd, which would result in an on-station reduction of wastewater requiring treatment and disposal of approximately 7 percent. The amount of wastewater associated with Concept A launches would be approximately 264,000 gallons less than that estimated for the No-Action Alternative in 2015. During that year, approximately 80 percent of deluge water, or 1,086,000 gallons, used during launch activities would be recycled or transported to an approved and permitted facility off site.

Population decreases would reduce wastewater generation within the ROI and would result in a reduction of the requirements for wastewater treatment and disposal off station by approximately 40,200 gpd. Regional systems would continue to operate within capacity, and no impacts are anticipated.

Solid Waste. Approximately 3,540 tons of construction debris are expected to be generated over the 3 1/2-year construction period as a result of facility demolition, construction, and modification. Approximately 3,100 tons consisting of concrete (650 tons), structural steel (2,200 tons), and miscellaneous rails, fencing, piping, and wire (250 tons) would be generated by project demolition activities. The concrete would be reused as structural fill; the remainder of the construction materials would be recycled. The remaining 440 tons consisting of crating, packaging, sheet rock, roofing material, and trash would be generated over the life of the construction

activities at an average rate of 0.35 ton per day and would be disposed of in existing sanitary landfills permitted to accept the waste.
During the operational phase, solid waste generated would be approximately 1.9 tons per day less than that of the No-Action Alternative, reducing the amount of solid waste generated on station by approximately 23 percent in 2015. Project-related population decreases within the ROI would reduce the generation of solid waste by approximately 1.4 tons per day. The combined reduction is expected to reduce the amount of solid waste disposed in the Brevard County Landfill by 3.3 tons per day in 2015, which would be a beneficial impact on solid waste disposal facilities within the region.

Electricity. Increases in electrical consumption during construction are expected to be minimal. During the operational phase, electricity consumption would increase slightly as the result of new facilities being operated on the station. However, this increase in electrical consumption would not impact the station's electrical distribution system. No measurable changes in electrical consumption as a result of Concept A are expected to occur off station within the ROI. Therefore, no impacts to electrical consumption are expected.

4.5.1.1.2 **Concept A, Vandenberg AFB**

Water Supply. During construction, potable water usage would exceed that required under the No-Action Alternative. As a result, average daily water consumption on Vandenberg AFB would increase slightly between 2000 and 2002. The existing system would be capable of absorbing the increase, and no impacts are anticipated during construction.

By 2007, employment decreases as a result of Concept A implementation would reduce the requirements for potable water on base by approximately 23,000 gpd, or approximately 0.7 percent. Deluge water requirements for launch activities are expected to be 590,000 gallons, approximately 115,000 gallons less than that needed under the No-Action Alternative during the peak launch year (2007). Recycling of industrial wastewater would further reduce the use of potable water for launch operations. Reductions in potable water from domestic and industrial uses under Concept A would be approximately 24,000 gpd, and no impacts to the potable water system would occur on the base. Project-related population decreases within the ROI would reduce potable water consumption by approximately 36,600 gpd. These changes are not expected to have any impacts on regional water systems, and the systems would continue to operate within capacity.

Wastewater. Construction of facilities to support Concept A would slightly increase wastewater generation between 2000 and 2002. The existing system is capable of absorbing the increase. Therefore, no impacts are anticipated during construction.

During the operational phase of EELV, employment on base as a result of Concept A would decrease and the amount of wastewater generated would be reduced. By the peak launch year (2007), daily wastewater generation is expected to be reduced by approximately 23,000 gpd, which would result in an on-base reduction of wastewater requiring treatment and disposal of approximately 1.8 percent.

Project-related population decreases would reduce wastewater generation within the project's ROI and would result in a reduction of the requirements for wastewater treatment and disposal off base by 24,400 gpd. The combined reduction is expected to reduce the amount of wastewater treatment and disposal in Lompoc Regional WWTP by 47,400 gpd by 2007. These reductions in wastewater are not expected to impact wastewater treatment and disposal facilities.

Deluge water used during launch activities would be recycled or transported by tanker truck from the origination point to a permitted treatment facility off site. The wastewater generation associated with Concept A launches would be 115,000 gallons less than that estimated for the No-Action Alternative in 2007.

Solid Waste. Approximately 4,900 tons of construction debris are expected to be generated over the 25-month construction period as a result of facility demolition, construction, and modification. Approximately 4,600 tons consisting of concrete (1,500 tons), asphalt (500 tons), structural steel (1,600 tons), and miscellaneous rails, fencing, piping, and wire (1,000 tons) would be generated by demolition activities in the first 3 months of the project. The concrete would be reused as structural fill; the remainder of the construction materials would be recycled. The remaining 300 tons consisting of crating, packaging, sheet rock, roofing material, and trash would be generated over the life of the construction activities at an average rate of 0.4 ton per day and would be disposed of in existing sanitary landfills permitted to accept the waste.

During the operational phase, the amount of solid waste generated would be approximately 1 ton per day, or approximately 1.7 percent less than that of the No-Action Alternative. Project-related population decreases within the ROI related to Concept A would reduce the generation of solid waste by approximately 0.9 ton per day by 2007, which would be a beneficial impact on the solid waste disposal facilities within the region.

Electricity. Increases in electrical consumption during construction are expected to be minimal. During the operational phase, electricity consumption would increase slightly as the result of new facilities being operated on the base. However, the increase in electrical consumption would not impact the base's electrical distribution system. No measurable changes in electrical consumption as a result of Concept A are expected to occur off base within the ROI. Therefore, no impacts to electrical consumption are expected.

4.5.1.2 **Concept B**

4.5.1.2.1 **Concept B, Cape Canaveral AS**

Water Supply. During construction, potable water use would be approximately 3,300 gpd greater than use by existing launch programs, and average daily water consumption on Cape Canaveral AS would increase by less than one-half percent. No impacts are anticipated.

Project-related employment decreases would reduce the requirements for potable water on station by approximately 30,200 gpd, or approximately 4 percent, by 2015. There are currently no plans to use deluge water for Concept B launches. However, IPS water and washdown of the pad after a launch using solid boosters would consume approximately 3,055,000 gallons of potable water during the peak launch year, which would increase annual water requirements by 1.4 million gallons over the No-Action Alternative in 2015. This is equivalent to approximately 4,000 gpd. Reductions in potable water from domestic and industrial uses under Concept B would be approximately 26,400 gpd, and no impacts to the potable water system on the station would occur. Recycling of industrial wastewater would further reduce the use of potable water during launch operations. Project-related population decreases within the ROI would reduce potable water consumption off-station by approximately 42,800 gpd. These changes in potable water requirements are not expected to have any impacts on regional water systems, and the systems would continue to operate within capacity.

Wastewater. Construction of facilities to support Concept B would generate approximately 2,000 gallons of wastewater each day between 1998 and 2000, adding less than one-half of 1 percent to the wastewater disposal and treatment facility on Cape Canaveral AS. The WWTP would continue to operate within capacity, and no impacts are anticipated during construction.

During the operational phase, employment on station as a result of Concept B implementation would decrease and therefore would reduce the generation of wastewater. By the peak launch year (2015), wastewater generation is expected to be reduced by approximately 30,200 gpd, which would result in an on-station reduction of wastewater requiring treatment and disposal of approximately 5 percent. Wastewater generation associated with Concept B launches would be 1,400,000 gallons more than estimated for the No-Action Alternative in 2015. The IPS and washdown water used during launch activities would be recycled or transported to a permitted treatment facility off site. The daily peak flow is expected to be approximately 0.57 MGD and the WWTP would continue to operate within its permitted capacity. Project-related population decreases would reduce wastewater generation within the ROI and would result in a reduction of the requirements for wastewater treatment and disposal off station by approximately 28,500 gpd. Regional systems would continue to operate within capacity, and no impacts are anticipated.

Solid Waste. Approximately 6,240 tons of construction debris are expected to be generated over the 2-year construction period as a result of facility demolition, construction, and modification. Approximately 5,830 tons consisting of concrete (3,900 tons), asphalt (1,650 tons), and fire brick (280 tons) would be recycled. The concrete would be taken to a concrete recycler to be recycled as aggregate. The asphalt would be recycled for use for road construction activities, and the fire brick would be sold on the local market. The wood (120 tons), paper (10 tons), and copper and miscellaneous metal (80 tons) would be recycled to local markets. The miscellaneous garbage (200 tons) would be disposed of in existing sanitary landfills permitted to receive the waste. The construction debris expected to be landfilled is estimated at approximately 0.6 ton per day for the 2-year construction period.

During the operational phase, solid waste generated would be less than that of the No-Action Alternative by approximately 1.3 tons per day. This would reduce the amount of solid waste generated on station by approximately 16 percent in 2015. Project-related population decreases within the ROI would reduce the generation of solid waste by approximately 1 ton per day. The combined reduction is expected to reduce the amount of solid waste disposed in the Brevard County Landfill by 2.3 tons per day in 2015, which would be a beneficial impact on the solid waste disposal facilities within the region.

Electricity. Increases in electrical consumption during construction are expected to be minimal. During the operational phase, electricity consumption would increase slightly as the result of new facilities being operated on the station. However, this increase in electrical consumption would not impact the station’s electrical distribution system. No measurable changes in electrical consumption as a result of Concept B activities are expected to occur off station within the ROI. Therefore, no impacts to electrical consumption are expected.

4.5.1.2.2 **Concept B, Vandenberg AFB**

Water Supply. During construction, potable water usage would exceed that required by the No-Action Alternative. As a result, average daily water consumption on Vandenberg AFB would increase slightly between 1998 and 2001. The existing system would be capable of absorbing the increase, and no impacts are anticipated during construction.

By 2007, employment decreases as a result of Concept B implementation would reduce the requirements for potable water on base by approximately 11,100 gpd, or approximately 0.3 percent, by 2007. There are currently no plans to use deluge water for Concept B launches. However, use of IPS and washdown water at the pad after a launch using solid boosters would consume approximately 1,310,000 gallons of potable water during the peak launch year. Water usage associated with Concept B launches would increase by 605,000 gallons over the water estimated for the No-Action Alternative by 2007. The increased water requirement is equivalent to 2,000 gpd. Recycling of industrial wastewater would further reduce the use of potable water for launch operations. Reductions in potable water from domestic and industrial uses under Concept B would be approximately 11,000 gpd, and no impacts to the potable water system would occur on the base. Project-related population decreases within the ROI would reduce potable water consumption by approximately 18,800 gpd off base. These changes are not expected to have any impacts on regional water systems, and the systems would continue to operate within capacity.

Wastewater. Construction of facilities to support Concept B would generate approximately 2,000 gallons of wastewater each day between 1998 and 2001. As a result, the additional wastewater would add less than one-half of 1 percent to the wastewater disposal and treatment facility. The existing system is capable of absorbing the increase. Therefore, no impacts are anticipated during construction.

During the operational phase, employment on base as a result of Concept B implementation would decrease and the amount of wastewater generated would be reduced. By the peak launch year (2007), daily wastewater generation is expected to be reduced by approximately 11,100 gpd, which would result in an on-base reduction of wastewater requiring treatment and disposal of approximately 0.9 percent.

Project-related population decreases would reduce wastewater generation within the ROI and would result in a reduction of the requirements for wastewater treatment and disposal off base by 12,500 gpd. The combined reduction is expected to reduce the amount of wastewater treatment and disposal in Lompoc Regional WWTP by 23,600 gpd in 2007. Reductions in wastewater from domestic uses are not expected to exceed current operations, and no impacts to wastewater treatment and disposal would occur within the region.

Water associated with Concept B launches would be 605,000 gallons more than the water estimated for the No-Action Alternative in 2007. However, industrial wastewater would be recycled or transported off site to permitted treatment facilities, and would not be discharged to the IWTP.

Solid Waste. Approximately 12,400 tons of construction debris are expected to be generated over the 30-month construction period as a result of facility demolition, construction, and modification. The majority of the construction debris would consist of concrete (11,250 tons), which would be crushed and reused as aggregate to fill the abandoned flame duct on the project site. The remaining construction materials consisting of wood (120 tons), copper (18 tons), and structural steel (800 tons) would be generated at a rate of approximately 1 ton per day, which would be stockpiled and recycled. The miscellaneous garbage (200 tons) would be generated over the life of the construction activities at an average rate of 0.25 ton per day and would be disposed in existing sanitary landfills permitted to accept the waste.

During the operational phase, the amount of solid waste generated would be approximately 0.5 ton per day less than that of the No-Action Alternative. This would reduce the amount of solid waste generated on base by approximately 0.8 percent by 2007. Project-related population decreases within the ROI related to the Concept B program would reduce the generation of solid waste by approximately 0.4 ton per day in 2007, which would be a beneficial effect on the solid waste disposal facilities within the region.

Electricity. Increases in electrical consumption during construction are expected to be minimal. During the operational phase, electricity consumption would increase slightly as the result of new facilities being operated on the base. However, the increase in electrical consumption would not impact the base's electrical distribution system. No measurable changes in electrical consumption as a result of Concept B activities are expected to occur off base within the ROI. Therefore, no impacts to electrical consumption are expected. No adverse impacts are anticipated; therefore, no mitigation measures would be required.

4.5.1.3 **Concept A/B**

4.5.1.3.1 **Concept A/B, Cape Canaveral AS**

Water Supply. During construction, potable water use would be greater than use by existing systems, and average daily water consumption on Cape Canaveral AS would increase slightly. No impacts are anticipated.

Project-related employment decreases would reduce the requirements for potable water on station by approximately 27,900 gpd by 2015, or approximately 3.7 percent. Water required to support launches would consume approximately 2,392,000 gallons of potable water during the peak launch year. This is approximately 734,000 gallons of potable water usage more than estimated for the No-Action Alternative, or a 45-percent increase. The increased water consumption is equivalent to approximately 2,000 gpd. As a result, potable water from domestic and industrial uses under Concept A/B would be approximately 28,000 gpd less than that expected by the No-Action Alternative, and no impacts to the potable water system on the station would occur. Recycling of industrial wastewater would further reduce the use of potable water for launch operations. Project-related population decreases within the ROI would reduce potable water consumption off station by approximately 43,000 gpd. These changes in potable water requirements are not expected to have any impacts on regional water systems, and the systems would continue to operate within capacity.

Wastewater. Construction of facilities to support Concept A/B would slightly increase wastewater generation between 1998 and 2000.

During the operational phase, employment on station as a result of Concept A/B would decrease and therefore would reduce the generation of wastewater. By the peak launch year, wastewater generation is expected to be reduced by approximately 27,900 gpd, which would result in an on-station reduction of wastewater requiring treatment and disposal of approximately 4.5 percent. The total amount of wastewater associated with Concept A/B launches would be 737,000 gallons more than that estimated for the No-Action Alternative by 2015. Industrial wastewater would be recycled or transported to an approved permitted industrial wastewater treatment facility off site. Project-related population decreases would reduce wastewater generation within the ROI and would result in a reduction of the requirements for wastewater treatment and disposal off station by approximately 28,700 gpd. Regional systems would continue to operate within capacity and no impacts are anticipated.

Solid Waste. Approximately 9,800 tons of construction debris are expected to be generated over the 3 1/2-year construction period as a result of facility demolition, construction, and modification. The majority of the construction debris would be concrete (4,550 tons), which would be crushed and reused as aggregate and structural fill on the project site. The other construction materials consisting of wood (120 tons), asphalt (1,650 tons), structural steel (2,200 tons), fire brick (280 tons), paper (10 tons), and copper and miscellaneous metal (330 tons) would be recycled. The remaining 640 tons consisting of crating, packaging, sheet rock, roofing material, and miscellaneous garbage would be generated over the life of the construction activities at an average rate of 0.7 ton per day, and would be disposed of in sanitary landfills permitted to accept the waste.

During the operational phase, solid waste generated by the employees would decrease over that of the No-Action Alternative by approximately 1.2 tons per day. This would reduce the amount of solid waste generated on station by approximately 15 percent by 2015. Project-related population decreases within the ROI would reduce the generation of solid waste by approximately 1 ton per day. The combined reduction is expected to reduce the amount of solid waste disposed in the Brevard County Landfill by 2.2 tons per day in 2015, which would be a beneficial impact on the solid waste disposal facilities within the region.

Electricity. Increases in electrical consumption during construction are expected to be minimal. During the operational phase, electricity consumption would increase slightly as the result of new facilities being operated on the station. However, this increase in electrical consumption would not impact the station’s electrical distribution system. No measurable changes in electrical consumption as a result of Concept A/B activities are expected to occur off station within the ROI. Therefore, no impacts to electrical consumption are expected.

4.5.1.3.2 **Concept A/B, Vandenberg AFB**

Water Supply. During construction, potable water usage would exceed that required under the No-Action Alternative. As a result, average daily water consumption on Vandenberg AFB would increase slightly between 1998 and

2002. The existing system would be capable of absorbing the increase and no impacts are anticipated during construction.

Employment decreases as a result of Concept A/B implementation would reduce the requirements for potable water on base by approximately 10,400 gpd by 2007, or approximately 0.3 percent. Water requirements for launch activities are expected to be 1,288,000 gallons, approximately 583,000 gallons more than needed under the No-Action Alternative during the peak launch year. This is equivalent to approximately 2,000 gpd. Reductions in potable water from domestic and industrial uses under Concept A/B would be approximately 8,400 gpd, and no impacts to the potable water system would occur on the base. Project-related population decreases within the ROI would reduce potable water consumption by approximately 20,000 gpd off base. These changes are not expected to have any impacts on regional water systems, and the systems would continue to operate within capacity.

Wastewater. Construction of facilities to support Concept A/B would increase the generation of wastewater between 1998 and 2002. The existing system would be capable of absorbing the increase. Therefore, no impacts are anticipated during construction.

During the operational phase, employment on base as a result of Concept A/B implementation would decrease and the amount of wastewater generated would be reduced. By the peak launch year, daily wastewater generation is expected to be reduced by approximately 10,400 gpd, which would result in an on-base reduction of wastewater requiring treatment and disposal of approximately 0.8 percent.

Project-related population decreases would reduce wastewater generation within the project's ROI and would result in a reduction of the requirements for wastewater treatment and disposal off base by 13,300 gpd. The combined reduction is expected to reduce the amount of wastewater treatment and disposal in Lompoc Regional WWTP by 23,700 gpd in 2007. These reductions are not expected to impact wastewater treatment and disposal facilities.

Wastewater associated with Concept A/B launches would be 583,000 gallons more than the wastewater estimated for the No-Action Alternative. Wastewater from launch activities would be recycled or transported off site to an approved, permitted treatment facility.

Solid Waste. Approximately 17,300 tons of construction debris are expected to be generated over the 2 1/2-year construction period as a result of facility demolition, construction, and modification. The majority of construction debris would be concrete (12,750 tons), which would be crushed and reused as aggregate to fill the abandoned flame duct and structural fill on the project site. The other construction materials consisting of wood (120 tons), copper (18 tons), asphalt (500 tons), structural steel (2,400 tons), and miscellaneous rails, fencing, piping, and wire (1,000 tons) would be recycled. The remaining 500 tons consisting of crating, packaging, sheet rock, roofing material, and miscellaneous garbage would be generated over the life of the construction activities at an average rate of 0.6 ton per day and would be disposed of in sanitary landfills permitted to accept the waste.

During the operational phase, the amount of solid waste generated would be approximately 0.5 ton per day less than that of the No-Action Alternative. This would reduce the amount of solid waste generated on base by approximately 0.8 percent by 2007. Project-related population decreases within the ROI related to Concept A/B would reduce the generation of solid waste by approximately 0.5 ton per day, which would be a beneficial impact on the solid waste disposal facilities within the region.

Electricity. Increases in electrical consumption during construction are expected to be minimal. During the operational phase, electricity consumption would increase slightly as the result of new facilities being operated on the base. However, this increase in electrical consumption is not expected to impact the base's electrical distribution system. No measurable changes in electrical consumption as a result of Concept A/B activities are expected to occur off base within the ROI. Therefore, no impacts to electrical consumption are expected.

4.5.2 No-Action Alternative

4.5.2.1 Cape Canaveral AS

Utility consumption for government launch programs at Cape Canaveral AS would continue at current levels, as described in Section 3.5.1, and all systems would continue to operate within capacity. No impacts are anticipated.

4.5.2.2 Vandenberg AFB

Utility consumption for government launch programs at Vandenberg AFB would continue at current levels, as described in Section 3.5.2, and all systems would continue to operate within capacity. No impacts are anticipated.

4.6 HAZARDOUS MATERIALS AND HAZARDOUS WASTE MANAGEMENT

This section addresses potential environmental impacts caused by hazardous materials/waste management practices associated with the Proposed Action and No-Action Alternative, including the potential impacts on the ongoing remediation activities at existing contaminated sites.

The Air Force will continue to remediate all contamination associated with sites proposed for use under the EELV program. Delays or restrictions on facility use or launch sites may occur depending on the extent of contamination and the results of remedial actions determined for contaminated sites.

Regulatory standards and guidelines have been applied in determining the potential impacts associated with the use of hazardous materials and the generation of hazardous wastes. The following criteria were used to identify potential impacts:

- Amount of hazardous materials brought onto the installations to support the EELV program that could result in exposure to the environment or public through release or disposal practices

- Hazardous waste generation that could increase regulatory requirements

- Pollution prevention practices to be utilized during the EELV program to prevent and/or improve environmental impacts associated with launch operations

- EELV program activities that would affect IRP activities.

4.6.1 **Proposed Action**

4.6.1.1 **Concept A**

Activities proposed under Concept A were analyzed for their potential to impact the existing hazardous material and waste management programs. The impact analysis was conducted by comparing the amount of hazardous materials/waste associated with the EELV program to quantities utilized for current launch vehicle systems. Table 4.6-1 presents the quantities of hazardous waste that would be generated under Concept A.

Table 4.6-1. Hazardous Waste Generated Per Launch, Concept A[(a)]

RCRA Hazardous Waste	Quantity (lbs) MLV	Quantity (lbs) HLV
Ignitable DOO1 RCRA Wastes	980	1,340
Halogenated Solvents FOO1/FOO2 RCRA Wastes	0	0
Toxic DOO4 EPA Wastes	40	110
Corrosive DOO2 RCRA Waste	5,500	5,500
Commercial Chemical Products (U) RCRA Wastes	3,100	3,100
Acutely Hazardous Waste (P) RCRA Wastes	0	0
Reactive DOO3 RCRA Wastes	500	500
State-Regulated Wastes	0	0
Miscellaneous Wastes	50	50
Total	10,170	10,600

Note: (a) Data provided by contractor.
HLV = heavy lift variant
lbs = pounds
MLV = medium lift variant
RCRA = Resource Conservation and Recovery Act

4.6.1.1.1 Concept A, Cape Canaveral AS

Hazardous Materials Management. The types of hazardous materials proposed for use for Concept A activities would be similar to those used at Cape Canaveral AS for current launch vehicle programs. Table 4.6-2 provides a comparison of hazardous materials to be used per launch and in the peak year (2015) for Concept A with the quantities utilized for current launch vehicle systems.

Implementation of Concept A would increase the amount of hazardous materials used on Cape Canaveral AS by approximately 190,000 pounds per year. This increase in hazardous material use is due to the increased number of annual launches under Concept A compared to current programs.

Although launch rates would increase, less processing would occur on site. Launch vehicle components would be shipped to Cape Canaveral AS in flightworthy condition, reducing on-site prelaunch preparations. Payload

Table 4.6-2. Total Hazardous Materials Used for Concept A and for Current Launch Vehicle Systems, Cape Canaveral AS[a]

Launch Vehicle System	Number of Launches	Hazardous Materials Used (lbs/launch)	Total Hazardous Materials Used in 2015 (lbs)
EELV Concept A[b]			374,830
MLV	22	15,850	
HLV	1	26,130	
No-Action Alternative[b][c]			184,520
Atlas IIA	7	17,670	
Delta II	3	7,210	
Titan IVB	1	39,200	

Notes: (a) Table does not include propellants.
(b) Data provided by contractor.
(c) Government launches only; no commercial launches included.
EELV = Evolved Expendable Launch Vehicle
HLV = heavy lift variant
lbs = pounds
MLV = medium lift variant

fairings would arrive cleaned, bagged, and ready for storage. No cleaning of payload fairings would occur on site, reducing the amount of hazardous materials utilized for on-site launch processing.

The amount of liquid propellants stored on the installation would increase due to the increased number of launches; no solid rocket motor propellant would be utilized. Table 2.1-1 and 2.2-2 list propellant quantities for Concept A and the No-Action Alternative, respectively.

Cape Canaveral AS has the mechanisms in place to store and manage the increased quantity of hazardous materials, including liquid propellants. All activities would be conducted in accordance with existing regulations for the use and storage of hazardous materials.

Section 4.7, Health and Safety, describes impacts associated with transportation of hazardous materials/fuels.

Hazardous Waste Management. The types of hazardous waste generated under Concept A would be similar to wastes generated by current launch vehicle systems. Table 4.6-3 provides a comparison of the quantities of hazardous waste generated per launch and in the peak year (2015) for Concept A to the quantities generated by current programs.

Implementation of Concept A would increase the amount of hazardous waste generated on Cape Canaveral AS by approximately 83,000 pounds per year. This increase in hazardous waste generation is due to the increased number of annual launches under Concept A.

Table 4.6-3. Total Hazardous Waste Generation for Concept A and for Current Launch Vehicle Systems, Cape Canaveral AS[(a)]

Launch Vehicle System	Number of Launches	Hazardous Waste Generated (lbs/launch)	Total Hazardous Waste Generated in 2015 (lbs)
EELV Concept A[(b)]			234,340
MLV	22	10,170	
HLV	1	10,600	
No-Action Alternative[(b)(c)]			151,300
Atlas IIA	7	9,240	
Delta II	3	16,810	
Titan IVB	1	36,190	

Notes: (a) Table does not include propellants.
(b) Data provided by contractor.
(c) Government launches only; no commercial launches included.
EELV = Evolved Expendable Launch Vehicle
HLV = heavy lift variant
lbs = pounds
MLV = medium lift variant

Cape Canaveral AS has the mechanisms in place to store, manage, and dispose of hazardous waste, including additional propellant waste. In lieu of utilizing existing government hazardous waste storage and disposal facilities, the contractor may be directly responsible for disposal of hazardous wastes. If so, the contractor would be responsible for ensuring that the management and disposal of all hazardous wastes would be conducted in accordance with all applicable federal, state, and local regulations. Since wastes from Concept A would be similar to wastes currently handled by Cape Canaveral AS, no adverse impacts are anticipated.

Pollution Prevention. As required under Air Force pollution prevention goals, Cape Canaveral AS must reduce hazardous waste disposal by 50 percent from their 1992 baseline. The increased volume of hazardous waste generation under Concept A could affect the installation's ability to meet and maintain this goal. Concept A activities should be coordinated with installation environmental personnel to reduce the impact of increased hazardous waste on pollution prevention goals.

No Class I ODSs would be used for any Concept A activities at Cape Canaveral AS. The only potential use for Class II ODSs is the use of refrigerants in the heating, ventilation and air conditioning (HVAC) system. Shipping components to the launch site in flightworthy condition and minimizing prelaunch processing would reduce pollution at the site. A stated objective for the EELV program is to seek opportunities to eliminate or minimize use of hazardous materials throughout the life cycle of the program. As required under the contract, the contractors have developed a Hazardous Materials Management Report to outline strategies to minimize the use of Class II ODSs and EPCRA 313 chemicals. This plan is to be applied throughout the design of each launch vehicle, incorporating trade studies and emphasizing reduction of hazardous materials to be used on government installations. Current projections of hazardous material usage do not yet reflect the results of all pollution prevention efforts, which will continue to mature throughout the development of each system.

Installation Restoration Program. The PCB-contaminated soil at SLC-41 will be addressed prior to commencement of EELV construction activities. Some areas of contamination may be paved over (capped) prior to construction in lieu of disturbing the contaminated soil. Prior to beginning construction at SLC-41, activities would be coordinated through IRP personnel to minimize impacts to remediation activities and EELV program activities.

Although groundwater contamination is present at the VIB (Building 70500), no construction is proposed at this site under the EELV program. IRP investigations at the VIB would not be impacted by Concept A activities.

Compliance with all applicable federal, state, local, and Air Force regulations regarding the use, storage, handling, and disposal of hazardous substances would reduce the potential for impacts; therefore, no mitigation measures would be required.

4.6.1.1.2 **Concept A, Vandenberg AFB**

Hazardous Materials Management. The types of hazardous materials proposed for use for Concept A activities would be similar to those used at Vandenberg AFB for current launch vehicle programs. Table 4.6-4 provides a comparison of the quantities of hazardous materials to be used per launch and in the peak year (2007) for Concept A with the quantities utilized for current launch vehicle systems.

Implementation of Concept A would increase the amount of hazardous materials used on Vandenberg AFB by approximately 84,000 pounds per year. This increase in hazardous material use is due to the increased number of annual launches under Concept A compared to current programs. Although launch rates are scheduled to increase, less processing would occur on site, as discussed in Section 4.6.1.1.1.

The amount of liquid propellant stored on the installation would increase due to the increase in number of launches; no solid rocket motor propellant would be required. Tables 2.1-1 and 2.2-2 list propellant quantities for Concept A and the No-Action Alternative, respectively.

Vandenberg AFB has the mechanisms in place to store and manage the increased quantity of hazardous materials, including liquid propellant. All activities would be conducted in accordance with existing regulations for the use and storage of hazardous materials.

Table 4.6-4. Total Hazardous Materials Used for Concept A and for Current Launch Vehicle Systems, Vandenberg AFB[(a)]

Launch Vehicle System	Number of Launches	Hazardous Materials Used (lbs/launch)	Total Hazardous Materials Used in 2007 (lbs)
EELV Concept A[(b)]			158,500
MLV	10	15,850	
HLV	0	26,130	
No-Action Alternative[(b)(c)]			74,640
Atlas IIA	3	17,670	
Delta II	3	7,210	
Titan IVB	0	39,200	

Notes: (a) Table does not include propellants.
(b) Data provided by contractor.
(c) Government launches only; no commercial launches included.
EELV = Evolved Expendable Launch Vehicle
HLV = heavy lift variant
lbs = pounds
MLV = medium lift variant

Section 4.7, Health and Safety, describes impacts associated with transportation of hazardous materials/fuels.

Hazardous Waste Management. The types of hazardous waste generated under Concept A would be similar to wastes generated by current launch vehicle systems. Table 4.6-5 provides a comparison of the quantities of hazardous waste generated per launch and in the peak year (2007) for Concept A to the quantities generated by current programs.

Table 4.6-5. Total Hazardous Waste Generation for Concept A and for Current Launch Vehicle Systems, Vandenberg AFB[(a)]

Launch Vehicle System	Number of Launches	Hazardous Waste Generated (lbs/launch)	Total Hazardous Waste Generated in 2007 (lbs)
EELV Concept A[(b)]			101,700
MLV	10	10,170	
HLV	0	10,600	
No-Action Alternative[(b)(c)]			78,150
Atlas IIA	3	9,240	
Delta II	3	16,810	
Titan IVB	0	36,190	

Notes: (a) Table does not include propellants.
(b) Data provided by contractor.
(c) Government launches only; no commercial launches included.
EELV = Evolved Expendable Launch Vehicle
HLV = heavy lift variant
lbs = pounds
MLV = medium lift variant

Implementation of Concept A would increase the amount of hazardous waste generated on Vandenberg AFB by approximately 23,500 pounds per year.

This increase in hazardous waste generation is due to the increased number of annual launches under Concept A compared to current programs. In lieu of utilizing existing government hazardous waste storage and disposal facilities, the contractor may be directly responsible for disposal of hazardous wastes. If so, the contractor would be responsible for ensuring that the management and disposal of all hazardous wastes would be conducted in accordance with all applicable federal, state, and local regulations. Since wastes from Concept A would be similar to wastes currently handled by Vandenberg AFB, no adverse impacts are anticipated.

Pollution Prevention. Pollution prevention impacts on Vandenberg AFB from Concept B activities are the same as discussed for Cape Canaveral in Section 4.6.1.1.1.

Installation Restoration Program. Regulatory concurrence has been obtained on the NFRAP for IRP Site 6, located at SLC-3W. EELV construction activities would not impact investigations at the site. EELV activities are not expected to impact investigations at IRP Site 7, Bear Creek Pond.

There are several AOCs associated with the SLC-3 area and one AOC at Building 7525 that could delay proposed EELV construction activities. It has not yet been determined whether these sites require remediation; further investigations are planned.

Compliance with all applicable federal, state, local, and Air Force regulations regarding the use, storage, handling, and disposal of hazardous substances would reduce the potential for impacts; therefore, no mitigation measures would be required.

4.6.1.2 **Concept B**

Activities proposed under Concept B were analyzed for their potential impacts on the existing hazardous material and waste management programs from associated hazardous material usage and waste generation. The impact analysis was conducted by comparing the amount of hazardous material/ waste associated with the EELV program to quantities utilized for current launch vehicle systems. Table 4.6-6 presents the quantities of hazardous waste that would be generated under Concept B.

4.6.1.2.1 **Concept B, Cape Canaveral AS**

Hazardous Materials Management. The types of hazardous materials proposed for use for Concept B activities would be similar to those used at Cape Canaveral AS for current launch vehicle programs. Table 4.6-7 provides a comparison of hazardous materials to be used per launch and in

Table 4.6-6. Hazardous Waste Generated Per Launch, Concept B[(a)]

Hazardous Waste Generated Per Launch	Quantity (lbs)
Ignitable DOO1 RCRA Wastes	3,570
Halogenated Solvents FOO1/FOO2 RCRA Wastes	0
Non-halogenated Solvents FOO3/FOO4/F005 RCRA	890
Corrosive DOO2 RCRA Wastes	5,500
Toxic DOO4-DOO12 RCRA Wastes	1,700
Commercial Chemical Products (U) RCRA Wastes	430
Acutely Hazardous Waste (P) RCRA Wastes	0
Reactive DOO3 RCRA Wastes	20
State-Regulated Wastes[(b)]	10,500
Miscellaneous (Remediation) Wastes	4,340
Total	26,950

Notes: (a) Data provided by contractor.
(b) Vandenberg AFB only.
lbs = pounds
RCRA = Resource Conservation and Recovery Act

Table 4.6-7. Total Hazardous Materials Used for Concept B and for Current Launch Vehicle Systems, Cape Canaveral AS[(a)]

Launch Vehicle System	Number of Launches	Hazardous Materials Used (lbs/launch)	Total Hazardous Materials Used in 2015 (lbs)
EELV Concept B[(b)]			205,390
MLV	22	8,930	
HLV	1	8,930	
No-Action Alternative[(b)(c)]			184,520
Atlas IIA	7	17,670	
Delta II	3	7,210	
Titan IVB	1	39,200	

Notes: (a) Table does not include propellants.
(b) Data provided by contractor.
(c) Government launches only; no commercial launches included.
EELV = Evolved Expendable Launch Vehicle
HLV = heavy launch vehicle
lbs = pounds
MLV = medium launch vehicle

the peak year (2015) for Concept B with the quantities utilized for current launch vehicle systems.

Implementation of Concept B would increase the amount of hazardous materials used on Cape Canaveral AS by approximately 21,000 pounds per year. This increase is due to the increased number of annual launches under Concept B. Although launch rates are scheduled to increase, less processing would occur on site, as discussed in Section 4.6.1.1.1.

Quantities of propellant stored on the installation would increase due to the increase in launches. Tables 2.1-6 and 2.2-2 list propellant quantities for Concept B and the No-Action Alternative, respectively.

Cape Canaveral AS has the mechanisms in place to store and manage hazardous materials, including hazardous propellants. All activities would be conducted in accordance with existing regulations for the use and storage of hazardous materials.

Section 4.7, Health and Safety, describes impacts associated with transportation of hazardous materials/fuels.

Hazardous Waste Management. The types of hazardous waste generated under Concept B would be similar to wastes generated by current launch vehicle systems. Table 4.6-8 provides a comparison of the quantities of hazardous waste generated per launch and in the peak year (2015) for Concept B to the quantities generated by current programs.

Table 4.6-8. Total Hazardous Waste Generation for Concept B and for Current Launch Vehicle Systems, Cape Canaveral AS[a]

Launch Vehicle System	Number of Launches	Hazardous Waste Generated (lbs/launch)	Total Hazardous Waste Generated in 2015 (lbs)
EELV Concept B[b][d]			378,350
MLV	22	16,450	
HLV	1	16,450	
No-Action Alternative[b][c]			151,300
Atlas IIA	7	9,240	
Delta II	3	16,810	
Titan IVB	1	36,190	

Notes: (a) Table does not include propellants.
(b) Data provided by contractor.
(c) Government launches only; no commercial launches included.
(d) Does not include Vandenberg AFB State-Regulated Waste.
EELV = Evolved Expendable Launch Vehicle
HLV = heavy launch vehicle
lbs = pounds
MLV = medium launch vehicle

Implementation of Concept B would increase the amount of hazardous waste generated on Cape Canaveral AS by approximately 230,000 pounds per year. This increase in hazardous waste generation is due to the increased number of annual launches under Concept B compared to current programs.

The additional hazardous waste generated by Concept B activities would be handled as discussed in Section 4.6.1.1.1. Since wastes from Concept B would be similar to wastes currently handled by Cape Canaveral AS, no adverse impacts are anticipated.

Pollution Prevention. Pollution prevention impacts on Cape Canaveral AS from Concept B activities are the same as discussed for Concept A in Section 4.6.1.1.1.

Installation Restoration Program. NASA is currently investigating activities at the SLC-37 IRP site. EELV program activities and remediation activities could conflict depending on the results of the investigation and program schedules. Prior to EELV construction activities at SLC-37, coordination with IRP personnel would occur in order to minimize impacts to remediation activities and EELV program activities.

4.6.1.2.2 **Concept B, Vandenberg AFB**

Hazardous Materials Management. The types of hazardous materials proposed for use for Concept B activities would be similar to those used at Vandenberg AFB for current launch vehicle programs. Table 4.6-9 provides a comparison of hazardous materials to be used per launch and in the peak year (2007) for Concept B with the quantities utilized for current launch vehicle systems.

Table 4.6-9. Total Hazardous Materials Used for Concept B and for Current Launch Vehicle Systems, Vandenberg AFB[(a)]

Launch Vehicle System	Number of Launches	Hazardous Materials Used (lbs/launch)	Total Hazardous Materials Used in 2007 (lbs)
EELV Concept B[(b)]			89,300
MLV	8	8,930	
HLV	2	8,930	
No-Action Alternative[(b)(c)]			74,640
Atlas IIA	3	17,670	
Delta II	3	7,210	
Titan IVB	0	39,200	

Notes: (a) Table does not include propellants.
(b) Data provided by contractor.
(c) Government launches only; no commercial launches included.
EELV = Evolved Expendable Launch Vehicle
HLV = heavy launch vehicle
lbs = pounds
MLV = medium launch vehicle

Implementation of Concept B would increase the amount of hazardous materials used on Vandenberg AFB by approximately 15,000 pounds per year. This increase in hazardous materials is due to the increased number of annual launches under Concept B compared to current programs. Although launch rates are scheduled to increase, less processing would occur on site, as discussed in Section 4.6.1.1.1.

Propellant quantities stored on the installation would increase due to the expanded launch schedule. Tables 2.1-6 and 2.2-2 list propellant quantities for Concept B and the No-Action Alternative, respectively.

Vandenberg AFB has the mechanisms in place to legally store and manage hazardous materials, including hazardous propellants. All activities would be conducted in accordance with existing regulations for the use and storage of hazardous materials.

Section 4.7, Health and Safety, describes impacts associated with transportation of hazardous materials/fuels.

Hazardous Waste Management. The types of hazardous waste generated under Concept B would be similar to wastes generated by current launch vehicle systems. Table 4.6-10 provides a comparison of the quantities of hazardous waste generated per launch and in the peak year (2007) for Concept B to the quantities generated by current programs.

Table 4.6-10. Total Hazardous Waste Generation for Concept B and for Current Launch Vehicle Systems, Vandenberg AFB[a]

Launch Vehicle System	Number of Launches	Hazardous Waste Generated (lbs/launch)	Total Hazardous Waste Generated in 2007 (lbs)
EELV Concept B[b]			269,500
MLV	8	26,950	
HLV	2	26,950	
No-Action Alternative[b][c]			78,150
Atlas IIA	3	9,240	
Delta II	3	16,810	
Titan IVB	0	36,190	

Notes: (a) Table does not include propellants.
(b) Data provided by contractor.
(c) Government launches only; no commercial launches included.
EELV = Evolved Expendable Launch Vehicle
HLV = heavy launch vehicle
lbs = pounds
MLV = medium launch vehicle

Implementation of Concept B would increase the amount of hazardous waste generation on Vandenberg AFB by approximately 190,000 pounds per year. This increase in hazardous waste generation is due to the increased number of annual launches.

The additional hazardous waste generated from Concept B activities would be managed as discussed in Section 4.6.1.1.2. Since wastes from Concept B would be similar to wastes currently handled by Vandenberg AFB, no adverse impacts are anticipated.

Pollution Prevention. Pollution prevention impacts on Vandenberg AFB from Concept B activities are the same as discussed for Concept A, Cape Canaveral AS, in Section 4.6.1.1.1.

Installation Restoration Program. IRP investigations will continue at AOC-89 at SLC-6. EELV activities and remediation activities could conflict depending on the results of the investigations. However, remediation, if necessary, could likely be implemented without interfering with the EELV program schedule. 30 CES/CEV would be contacted prior to any construction or modification near an IRP site. Measures should be taken to ensure worker safety during remediation if construction and modification is occurring simultaneously with clean-up activities.

4.6.1.3 Concept A/B

Concept A/B was analyzed for its potential impacts on the existing hazardous material and waste management programs from associated hazardous material usage and waste generation. Impact analysis was conducted by comparing the amount of hazardous material/waste associated with the EELV program to current launch vehicle quantities.

4.6.1.3.1 Concept A/B, Cape Canaveral AS

Hazardous Materials Management. The types of hazardous materials proposed for use for Concept A/B activities would be similar to those used at Cape Canaveral AS for current launch vehicle programs. Table 4.6-11 provides a comparison of hazardous materials to be used per launch and in the peak year (2015) for Concept A/B with the quantities utilized for current launch vehicle systems.

Implementation of Concept A/B would increase the amount of hazardous materials used on Cape Canaveral AS by approximately 148,000 pounds per year. This increase in hazardous material use is due to the increased number of annual launches.

Although launch rates are scheduled to increase, less processing would occur on site, as discussed in Section 4.6.1.1.1.

Propellant quantities stored on the installation would increase due to the expanded launch schedule. However, since solid rocket motors would not be used for Concept A, the number of solid propellants stored on Cape Canaveral AS would be reduced. Tables 2.1-1, 2.1-6, and 2.2-2 list

Table 4.6-11. Total Hazardous Materials Used for Concept A/B and for Current Launch Vehicle Systems, Cape Canaveral AS[(a)]

Launch Vehicle System	Number of Launches	Hazardous Materials Used (lbs/launch)	Total Hazardous Materials Used in 2015 (lbs)
Concept A/B Total			332,420
EELV Concept A[(b)]			
MLV	12	15,850	
HLV	1	26,130	
EELV Concept B[(b)]			
MLV	11	8,930	
HLV	2	8,930	
No-Action Alternative[(b)(c)]			184,520
Atlas IIA	7	17,610	
Delta II	3	7,210	
Titan IVB	1	39,200	

Notes: (a) Table does not include propellants.
(b) Data provided by contractor.
(c) Government launches only; no commercial launches included.
EELV = Evolved Expendable Launch Vehicle
HLV = heavy lift variant (Concept A); heavy launch vehicle (Concept B)
lbs = pounds
MLV = medium lift variant (Concept A); medium launch vehicle (Concept B)

propellant quantities for Concept A, Concept B, and the No-Action Alternative, respectively.

Although additional launches would increase the amount of hazardous materials stored on base, Cape Canaveral AS has the mechanisms in place to legally store and manage the materials. All activities would be conducted in accordance with existing regulations for the use and storage of hazardous materials.

Section 4.7, Health and Safety, describes impacts associated with transportation of hazardous materials/fuels.

Hazardous Waste Management. The types of hazardous waste generated under Concept A/B would be similar to wastes generated by current launch vehicle systems. Table 4.6-12 provides a comparison of the quantities of hazardous waste generated per launch and in the peak year (2015) for Concept A/B to the quantities generated by current programs.

Implementation of Concept A/B would increase the amount of hazardous waste generated on Cape Canaveral AS by approximately 195,000 pounds per year. This increase in hazardous waste generation is due to the increased number of annual launches.

Table 4.6-12. Total Hazardous Waste Generated for Concept A/B and for Current Launch Vehicle Systems, Cape Canaveral AS[(a)]

Launch Vehicle System	Number of Launches	Hazardous Waste Generated (lbs/launch)	Total Hazardous Waste Generated in 2015 (lbs)
Concept A/B Total			346,490
EELV Concept A[(b)]			
MLV	12	10,170	
HLV	1	10,600	
EELV Concept B[(b)]			
MLV	11	16,450	
HLV	2	16,450	
No-Action Alternative[(b)(c)]			151,300
Atlas IIA	7	9,240	
Delta II	3	16,810	
Titan IVB	1	36,190	

Notes: (a) Table does not include propellants.
(b) Data provided by contractor.
(c) Government launches only; no commercial launches included.
EELV = Evolved Expendable Launch Vehicle
HLV = heavy lift variant (Concept A); heavy launch vehicle (Concept B)
lbs = pounds
MLV = medium lift variant (Concept A); medium launch vehicle(Concept B)

The additional hazardous waste generated by Concept A/B activities would be handled as discussed in Section 4.6.1.1.1. Since wastes from Concept A/B would be similar to wastes currently handled by Cape Canaveral AS, no adverse impacts are anticipated.

Pollution Prevention. Pollution prevention impacts on Cape Canaveral AS from Concept A/B activities are the same as discussed for Concept A in Section 4.6.1.1.1.

Installation Restoration Program. Both concepts would move forward under Concept A/B; therefore, effects on the IRP would be similar to the combined effects described in Sections 4.6.1.1.1 and 4.6.1.2.1.

4.6.1.3.2 **Concept A/B, Vandenberg AFB**

Hazardous Materials Management. The types of hazardous materials proposed for use for Concept A/B activities would be similar to those used at Vandenberg AFB for current launch vehicle programs. Table 4.6-13 provides a comparison of hazardous materials to be used per launch and in the peak year (2007) for Concept A/B with the quantities utilized for current launch vehicle systems.

Table 4.6-13. Total Hazardous Materials Used for Concept A/B and for Current Launch Vehicle Systems, Vandenberg AFB[a]

Launch Vehicle System	Number of Launches	Hazardous Materials Used (lbs/launch)	Total Hazardous Materials Used in 2007 (lbs)
Concept A/B Total			173,460
EELV Concept A[b]			
MLV	7	15,850	
HLV	0	26,130	
EELV Concept B[b]			
MLV	5	8,930	
HLV	2	8,930	
No-Action Alternative[b][c]			74,640
Atlas IIA	3	17,670	
Delta II	3	7,210	
Titan IVB	0	39,200	

Notes: (a) Table does not include propellants.
(b) Data provided by contractor.
(c) Government launches only; no commercial launches included.
EELV = Evolved Expendable Launch Vehicle
HLV = heavy lift variant (Concept A); heavy launch vehicle (Concept B)
lbs = pounds
MLV = medium lift variant (Concept A); medium launch vehicle (Concept B)

Implementation of Concept A/B would increase the amount of hazardous materials used on Vandenberg AFB by approximately 98,800 pounds per year. This increase in hazardous material use is due to the increased number of annual launches.

Although launch rates are scheduled to increase, less processing would occur on site, as discussed in Section 4.6.1.1.1.

Propellant quantities stored on the installation would increase due to the expanded launch schedule. However, since solid rocket motors are not used for Concept A, the amount of solid propellants stored on Vandenberg AFB would be reduced. Tables 2.1-1, 2.1-6 and 2.2-2 list propellant quantities for Concept A, Concept B, and the No-Action Alternative, respectively.

Vandenberg AFB has the mechanisms in place to legally store and manage hazardous materials, including hazardous propellants. All activities would be conducted in accordance with existing regulations for the use and storage of hazardous materials.

Impacts associated with transportation of hazardous materials/fuels are described in Section 4.7, Health and Safety.

Hazardous Waste Management. The types of hazardous waste generated under Concept A/B would be similar to wastes generated by current launch vehicle systems. Table 4.6-14 provides a comparison of the quantities of hazardous waste generated per launch and in the peak year (2007) for Concept A to the quantities generated by current programs.

Table 4.6-14. Total Hazardous Waste Generated for Concept A/B and for Current Launch Vehicle Systems, Vandenberg AFB[a]

Launch Vehicle System	Number of Launches	Hazardous Waste Generated (lbs/launch)	Total Hazardous Waste Generated in 2007 (lbs)
Concept A/B Total			259,840
EELV Concept A[b]			
MLV	7	10,170	
HLV	0	10,600	
EELV Concept B[b]			
MLV	5	26,950	
HLV	2	26,950	
No-Action Alternative[b][c]			78,150
Atlas IIA	3	9,240	
Delta II	3	16,810	
Titan IVB	0	36,190	

Notes: (a) Table does not include propellants.
(b) Data provided by contractor.
(c) Government launches only; no commercial launches included.
EELV = Evolved Expendable Launch Vehicle
HLV = heavy lift variant (Concept A); heavy launch vehicle (Concept B)
lbs = pounds
MLV = medium lift variant (Concept A); medium launch vehicle (Concept B)

Implementation of Concept A/B would increase the amount of hazardous waste generated on Vandenberg AFB by approximately 180,000 pounds per year. This increase in hazardous waste generation is due to the increased number of annual launches.

The additional hazardous waste generated by Concept A/B activities would be handled as discussed in Section 4.6.1.1.1. Wastes from Concept A/B would be of similar nature to wastes currently handled by Vandenberg AFB; therefore, no adverse impacts are anticipated.

Pollution Prevention. Pollution prevention impacts on Vandenberg AFB from Concept A/B activities are the same as discussed for Cape Canaveral Concept A in Section 4.6.1.1.1.

Installation Restoration Program. Both concepts would move forward under Concept A/B; therefore, effects on the IRP would be similar to the combined effects described in Sections 4.6.1.1.1 and 4.6.1.2.1.

4.6.2 No-Action Alternative

4.6.2.1 Cape Canaveral AS

Under the No-Action Alternative, types and amounts of hazardous materials and hazardous waste would be similar to those used and generated on the installation under current operations. These amounts are listed in Section 3.6, Tables 3.6-1 through 3.6-6.

4.6.2.2 Vandenberg AFB

Under the No-Action Alternative, types and amounts of hazardous materials and hazardous waste would be similar to those used and generated on the installation, as under current operations. These amounts are listed in Section 3.6, Tables 3.6-1 through 3.6-6.

4.7 HEALTH AND SAFETY

4.7.1 Proposed Action

4.7.1.1 Concept A

4.7.1.1.1 Concept A, Cape Canaveral AS

Regional Safety. Cape Canaveral AS regional safety programs and emergency response procedures for Concept A launch operations would be the same as described in Section 3.7.2.1, unless otherwise noted below.

A System Safety Program Plan (SSPP) would be prepared prior to EELV launch activities to identify and evaluate potential hazards and reduce associated risks to a level acceptable to Range Safety.

Impact debris corridors would be updated to provide EELV-specific parameters due to vehicle and payload configurations. An EELV-specific debris impact area would be calculated.

Hazardous materials, such as propellants, ordnance, and booster/payload components, would be transported in accordance with DOT regulations for interstate shipment of hazardous substances (Title 49 CFR 100-199) to ensure the shipment would not catch fire, explode, or release toxic materials. Liquid propellants used to fuel launch vehicle components would be shipped via land from manufacturing locations in the United States directly to Cape Canaveral AS. Propellants would be shipped in one of the following containers:

- MMH **-** DOT-specification MC 338 stainless steel cargo tank; non-DOT-specification 4BW stainless steel cylinder

- N_2O_4 - DOT-specification MC 338 stainless steel cargo tank; DOT-specification 105J500W stainless steel rail tank car; DOT-specification 110W500 stainless steel multi-unit tank car tanks

- RP-1 - MC 301 and MC 302 cargo tank; 1A1 drum

- LO_2; LH_2 - MC 338 cargo tank.

Special handling requirements for shipment of MMH and N_2O_4 include following certified and approved routes, extensive driver qualifications, and various state notification requirements.

On-Station Safety. On-station safety programs for Concept A launch operations would be the same as on-station safety programs for the current launch operations described in Section 3.7.2.2, unless otherwise noted herein.

For Concept A launches using the SUS, NO_2 and MMH are generated and concentrations would be predicted using REEDM prior to a launch to determine a THC. THC exposure concentrations for NO_2 and MMH would be compared to local risk management models and launch commit decision criteria. As a result of this comparison and risk estimation, emergency response would be provided as described in Section 3.7.2.2. No launch would occur if undue hazard existed for persons and property.

A summary of REEDM-predicted ambient air concentrations for NO_x and hydrazine compounds to assess air quality impacts during nominal and aborted Concept A launches is presented in Section 4.10.1.1.2 and Appendix J. The REEDM-predicted concentrations used in this report are screening concentrations only; a systematic search for worst-case meteorology was not conducted. Other conditions during actual launches will result in predicted concentrations somewhat different from these values. It is conservatively assumed that all NO in NO_x would be converted to NO_2. Table 4.7-1 summarizes a comparison of REEDM-predicted peak NO_2 concentrations from a nominal and aborted launch to AFSPC/SG-endorsed exposure criteria. Peak concentrations for the REEDM prediction in this report are less than the Tier 1 ceiling limit.

Table 4.7-1. Comparison of REEDM-Predicted NO_2 Air Concentrations to Recommended Exposure Criteria, Concept A

Vehicle	NO_2 Peak Puff Concentration (ppm)		Tier 1 Exposure Criteria (ppm)
	Nominal Launch	Abort	Ceiling Limit
MLV-D	0.114	0.718	2
MLV-A	0.114	*	2
HLV-L	0.162	0.348	2
HLV-G	0.162	*	2

HLV = heavy lift variant
MLV = medium lift variant
NO_2 = nitrogen dioxide
ppm = parts per million
REEDM = Rocket Exhaust Effluent Diffusion Model
* = negligible concentration

Table 4.7-2 summarizes a comparison of REEDM-predicted MMH concentrations to exposure criteria. Average 30-minute MMH concentrations are compared to the Tier 2 60-minute TWA, which is the most protective for exposure criteria. Tier 1 exposure criteria do not exist. Average 60-minute MMH concentrations would be less than the average 30-minute concentrations. Average 30-minute MMH concentrations as predicted for the REEDM parameters used in this report do not exceed the Tier 2 value. Using procedures established for existing launch systems, risks to installation personnel and the general public would be minimized to acceptable levels during normal and aborted launches, in accordance with EWR 127-1.

Table 4.7-2. Comparison of REEDM-Predicted MMH Air Concentrations to Recommended Exposure Criteria, Concept A

Vehicle	MMH Peak Puff Concentration (ppm)		Tier 2 Exposure Criteria (ppm)[(a)]
	Nominal Launch	Abort	60-Minute TWA
MLV-D	N/A	0.025	0.52
MLV-A	N/A	*	0.52
HLV-L	N/A	0.015	0.52
HLV-G	N/A	*	0.52

Note: (a) Tier 1 exposure criteria do not exist.
HLV = heavy lift variant
MLV = medium lift variant
MMH = monomethyl hydrazine
N/A = not available
ppm = parts per million
REEDM = Rocket Exhaust Effluent Diffusion Model
TWA = time-weighted average
* = negligible concentration

During nominal launch of a vehicle fueled by RP-1 and LO_X, primary combustion products are CO, hydrogen gas (H_2), and water (H_2O). Inefficient combustion resulting from fuel-rich mixtures could produce small amounts of soot and polyaromatic hydrocarbons composed of four carbons or less. However, the amounts of soot and polyaromatic hydrocarbons released during a nominal launch of the EELV Concept A are considered to be insignificant. This is attributable to the fact that 1) all of the fuel is combusted in the closed-cycle engine's main chamber; 2) the high pressures of the combustion chamber minimize the tendency of soot formation; and 3) unburned hydrocarbons potentially surviving the high temperatures of the combustion chamber would be afterburned outside of the nozzle. Therefore, of primary concern to the general public is potential exposure to cold spill vapors of RP-1 released during fueling or storage prior to launch.

A description of fire protection, alarm, and fire suppression systems is provided in Section 2.1.1.4. As stated in Section 2.1.1.4, the facilities associated with Concept A launches would be sited to meet ESQD criteria. The FTS for Concept A vehicles is described in Section 2.1.1.1.

4.7.1.1.2 **Concept A, Vandenberg AFB**

Regional Safety. Vandenberg AFB regional safety programs for Concept A launch systems would be the same as regional safety programs for the current launch systems as described in Section 3.7.3.1 and 4.7.1.1.1.

Transportation of hazardous materials would occur as described in Section 4.7.1.1.1 for Cape Canaveral AS.

On-Base Safety. On-base safety programs for Concept A launch systems would be the same as on-base safety programs for the current launch systems described in Section 3.7.3.2, unless otherwise noted below.
As discussed in Section 4.7.1.1.1, NO_2 and MMH would be predicted using REEDM prior to a launch to determine a THC for Concept A launches using the SUS, and compared to local risk management model and launch commit decision criteria. No launch would occur if undue hazards existed for persons and property.

The REEDM-predicted NO_x and MMH air concentrations used to assess air quality impacts for nominal and aborted Concept A launches, presented in Section 4.10.1.1.1, are very similar for Vandenberg AFB (i.e., less than 5 percent difference). Therefore, the conclusions drawn in Section 4.7.1.1.1 regarding comparison of REEDM-predicted NO_x and hydrazine compound air concentrations to exposure criteria are the same. Using procedures established for existing launch systems, risks to installation personnel and the general public would be minimized to acceptable levels during normal and aborted launches, in accordance with EWR 127-1.

Primary combustion products associated with the Concept A launch vehicle would be the same as described in Section 4.7.1.1.1 for Cape Canaveral AS.

Specific fire protection systems, FTSs, and ESQD criteria for Concept A launches are the same as those presented in Section 4.7.1.1.1 for Cape Canaveral AS.

4.7.1.2 **Concept B**

4.7.1.2.1 **Concept B, Cape Canaveral AS**

Regional Safety. Cape Canaveral AS regional safety programs for Concept B launch operations would be the same as regional safety programs for the current launch operations as described in Section 3.7.2.1 and 4.7.1.1.1.

Transportation of hazardous materials would occur as described in Section 4.7.1.1.1 for Cape Canaveral AS.

On-Station Safety. On-station safety programs for Concept B launch operations would be the same as on-station safety programs for the current launch operations described in Section 3.7.2.2, unless otherwise noted herein.

Concentrations of NO_2, HCl, and A-50 would be predicted using REEDM prior to a launch to determine a THC for Concept B launches using the HUS. Similarly, HCl concentrations would be predicted for DIV-M+ vehicle launches. THC exposure concentrations for these chemicals would be compared to local risk management models and launch commit decision criteria. As a result of this comparison and risk estimation, emergency response procedures would be implemented as described in Section 3.7.2.2. No launch would occur if undue hazards existed for persons and property.

A summary of REEDM-predicted ambient air concentrations for NO_x, HCl, and A-50 to assess air quality impacts during normal and aborted Concept B launches is presented in Section 4.10.1.2.1. As described in Section 4.7.1.1.1, the REEDM-predicted concentrations used in this report are screening concentrations only; a systematic search for worst-case meteorology was not conducted. Other conditions during actual launches will result in predicted concentrations somewhat different from these values. It is conservatively assumed that all NO in NO_x would be converted to NO_2.

Tables 4.7-3, 4.7-4, and 4.7-5 summarize a comparison of REEDM-predicted NO_2, HCl, and A-50 concentrations, respectively, to AFSPC/SG-endorsed exposure criteria. Estimated NO_2 and HCl exposure peak concentrations do not exceed the Tier 1 ceiling limit, which is the most protective for exposure criteria. Estimated A-50 peak exposure concentrations for the REEDM prediction in this report do not exceed the Tier 2 ceiling limit, which is the

Table 4.7-3. Comparison of REEDM-Predicted NO_2 Air Concentrations to Recommended Exposure Criteria, Concept B

Vehicle	NO_2 Peak Puff Concentration (ppm)		Tier 1 Exposure Criteria (ppm)
	Nominal Launch	Abort	Ceiling Limit
DIV-S	0.099	0.426	2
DIV-M	0.109	*	2
DIV-M+	0.119	*	2
DIV-H	0.020	*	2

DIV-H = heavy launch vehicle
DIV-M = medium launch vehicle
DIV-M+ = medium launch vehicle with solid rocket motor strap-ons
DIV-S = small launch vehicle
NO_2 = nitrogen dioxide
ppm = parts per million
REEDM = Rocket Exhaust Effluent Diffusion Model
* = negligible concentration

Table 4.7-4. Comparison of REEDM-Predicted HCl Concentrations to Recommended Exposure Criteria, Concept B

Vehicle	HCl Peak Puff Concentration (ppm)		Tier 1 Exposure Criteria Ceiling Limit (ppm)
	Nominal Launch	Abort	Ceiling Limit
DIV-S	0.0	0.0	10
DIV-M+	0.293	0.023	10

DIV-M+ = medium launch vehicle with solid rocket motor strap-ons
DIV-S = small launch vehicle
HCl = hydrochloric acid
ppm = parts per million
REEDM = Rocket Exhaust Effluent Diffusion Model

Table 4.7-5. Comparison of REEDM-Predicted A-50 Air Concentrations to Recommended Exposure Criteria, Concept B

Vehicle	A-50 Peak Puff Concentration (ppm)		Tier 1 Exposure Criteria (ppm)(a)
	Nominal Launch	Abort	Ceiling Limit)
DIV-S	N/A	0.039	5
DIV-M	N/A	*	5
DIV-M+	N/A	*	5
DIV-H	N/A	*	5

Note: (a) Tier 1 exposure criteria do not exist.
DIV-H = heavy launch vehicle
DIV-M = medium launch vehicle
DIV-M+ = medium launch vehicle with solid rocket motor strap-ons
DIV-S = small launch vehicle
N/A = not available
ppm = parts per million
REEDM = Rocket Exhaust Effluent Diffusion Model
* = negligible concentration

most protective for exposure criteria. Tier 1 values have not been recommended for hydrazine. Using procedures for existing launch systems, risks to installation personnel and the general public would be minimized to acceptable levels during normal and aborted launches, in accordance with EWR 127-1.

A description of fire protection, alarm, and fire suppression systems is provided in Section 2.1.2.4. As stated in Section 2.1.2.4, facilities associated with Concept B launches would be designed to meet ESQD criteria. The FTS for Concept B vehicles is described in Section 2.1.2.1.

4.7.1.2.2 **Concept B, Vandenberg AFB**

Regional Safety. Vandenberg AFB regional safety programs for Concept B launch operations would be the same as regional safety programs for the current launch operations as described in Section 3.7.2.1 and 4.7.1.1.1.

Transportation of hazardous materials would occur as described in Section 4.7.1.1.1 for Cape Canaveral AS.

On-Base Safety. On-base safety programs for Concept B launch operations would be the same as on-base safety programs for the current launch operations described in Section 3.7.2.2, unless otherwise noted herein. Specific FTS, ESQD criteria, and site security measures for Concept B launches are the same as those presented in Section 4.7.1.2.1 for Cape Canaveral AS. The fire protection systems are the same as those described in Section 4.7.1.2.1, except at Vandenberg AFB, where an existing tank above the launch complex would be utilized for fire suppression.

As discussed in Section 4.7.1.2.1, NO_2, HCl (for the DIV-M+ and DIV-S vehicles), and A-50 concentrations would be predicted using REEDM prior to a launch to determine a THC for applicable Concept B launches. Section 4.7.1.1.1 discusses risk estimation through comparison of NO_2, HCl, and A-50 exposure concentrations to Tier 1, Tier 2, and Tier 3 exposure criteria.

The REEDM-predicted NO_x, HCl, and A-50 air concentrations to assess air quality impacts for nominal and aborted Concept B launches, presented in Section 4.10.1.2.1, are similar for Vandenberg AFB (i.e., less than 5 percent difference). Therefore, the conclusions drawn in Section 4.7.1.2.1 regarding comparison of REEDM-predicted NO_x, HCl, and A-50 air concentrations to exposure criteria are the same. Using procedures established for existing launch systems, risks to installation personnel and the general public would be minimized to acceptable levels during normal and aborted launches, in accordance with EWR 127-1.

4.7.1.3 **Concept A/B**

4.7.1.3.1 **Concept A/B, Cape Canaveral AS**

Regional Safety. Cape Canaveral AS regional safety programs for Concept A/B launch operations would be the same as regional safety programs for Concept A (Section 4.7.1.1.1) and Concept B (Section 4.7.1.2.1) launch.

On-Station Safety. Cape Canaveral AS on-station safety programs for Concept A/B launch operations would be the same as on-station safety programs for Concept A (Section 4.7.1.1.1) and Concept B (Section 4.7.1.2.1) launch operations. Conclusions regarding REEDM-predicted toxic air concentrations to assess air quality impacts for nominal and aborted launches would be the same as for Concept A and Concept B launch operations. Using procedures established for existing launch systems, risks to installation personnel and the general public would be minimized to acceptable levels during normal and aborted launches, in accordance with EWR 127-1.

4.7.1.3.2 **Concept A/B, Vandenberg AFB**

Regional Safety. Vandenberg AFB regional safety programs for Concept A/B launch operations would be the same as regional safety programs for Concept A (Section 4.7.1.1.2) and Concept B (Section 4.7.1.2.2) launch operations.

On-Base Safety. Vandenberg AFB on-base safety programs for Concept A/B launch operations would be the same as on-base safety programs for Concept A (Section 4.7.1.1.2) and Concept B (Section 4.7.1.2.2) launch operations. Conclusions regarding REEDM-predicted toxic air concentrations to assess air quality impacts for nominal and aborted launches would be the same as for Concept A and Concept B launch operations. Using procedures established for existing launch systems, risks to installation personnel and the general public would be minimized to acceptable levels during normal and aborted launches, in accordance with EWR 127-1.

4.7.2 **No-Action Alternative**

4.7.2.1 **Cape Canaveral AS.** The current regional and on-station safety programs described in Section 3.7.2 would remain in effect. Some vehicles would utilize solid rocket motors and would therefore produce an HCl toxic plume. Tables 4.7-6, 4.7-7, and 4.7-8 provide a summary comparison of REEDM-predicted NO_2, HCl, and A-50 concentrations, respectively, for the No-Action Alternative vehicles to AFSPC/SG-endorsed exposure criteria. Estimated NO_2 and HCl exposure peak concentrations do not exceed the Tier 1 ceiling limit. Tier 1 values have not been recommended for hydrazine.

Table 4.7-6. Comparison of REEDM-Predicted NO_2 Air Concentrations to Recommended Exposure Criteria, No-Action Alternative

Vehicle	NO_2 Peak Puff Concentration (ppm)		Tier 1 Exposure Criteria (ppm)
	Nominal Launch	Abort	Ceiling Limit
Delta II	N/A	N/A	2
Titan IV	N/A	14.24	2

N/A = not available
NO_2 = nitrogen dioxide
ppm = parts per million
REEDM = Rocket Exhaust Effluent Diffusion Model

Table 4.7-7. Comparison of REEDM-Predicted HCl Concentrations to Recommended Exposure Criteria, No-Action Alternative

Vehicle	HCl Peak Puff Concentration (ppm)		Tier 1 Exposure Criteria Ceiling Limit (ppm)
	Nominal Launch	Abort	Ceiling Limit
Delta II	1.82	N/A	10
Titan IV	N/A	N/A	10

HCl = hydrochloric acid
N/A = not available
ppm = parts per million
REEDM = Rocket Exhaust Effluent Diffusion Model

Table 4.7-8. Comparison of REEDM-Predicted A-50 Air Concentrations to Recommended Exposure Criteria, No-Action Alternative

Vehicle	A-50 Peak Puff Concentration (ppm)		Tier 1 Exposure Criteria (ppm)[(a)]
	Nominal Launch	Abort	Ceiling Limit
Delta II	N/A	N/A	5
Titan IV	N/A	0.90	5

Note: (a) Tier 1 exposure criteria do not exist.
N/A = not available
ppm = parts per million
REEDM = Rocket Exhaust Effluent Diffusion Model

Using procedures established for existing launch systems, risks to installation personnel and the general public would be minimized to acceptable levels during normal and aborted launches, in accordance with EWR 127-1.

4.7.2.2 **Vandenberg AFB.** The current regional and on-station safety programs described in Section 3.7.2 would remain in effect. Some vehicles would utilize solid rocket motors and would therefore produce an HCl toxic plume. As described in Section 4.7.2.1, Tables 4.7-6, 4.7-7, and 4.7-8 provide a summary comparison of REEDM-predicted NO_2, HCl, and A-50 concentrations, respectively, for the No-Action Alternative vehicles to AFSPC/SG-endorsed exposure criteria. Estimated NO_2 and HCl exposure peak concentrations do not exceed the Tier 1 ceiling limit. Tier 1 values have not been recommended for hydrazine.

Using procedures established for existing launch systems, risks to installation personnel and the general public would be minimized to acceptable levels during normal and aborted launches, in accordance with EWR 127-1.

4.8 GEOLOGY AND SOILS

4.8.1 Proposed Action

4.8.1.1 Concept A

4.8.1.1.1 Concept A, Cape Canaveral AS

Geologic Setting. EELV program activities would require modification of existing facilities and construction of new facilities at SLC-41, which has been extensively altered in the past. Major modifications would include changing the existing site topography through excavation and grading, as required, to support modifications to the transporter track system, and facility modifications and new construction. Construction of EELV facilities at SLC-41 would substantially alter the topography of the site beyond changes that result from natural erosion or deposition. Construction of these facilities would not change the physiography of the region, nor would it impact any unique geologic features or geologic features of unusual scientific value.

Soils. Construction would occur primarily within the previously disturbed SLC-41 site and along existing road corridors. Depending on final design and grading plans, approximately 24,000 cubic yards of cut and fill material would be required. Unsuitable cut material would be removed from the project area to a spoil site located off station or at other approved locations. The earthwork required to construct the launch facility would uncover and disturb soils and increase the potential for wind and water erosion of these exposed soils.

Appropriate measures to reduce wind and water erosion would be implemented. Grading and construction procedures would be designed to minimize topographic changes. The design would include balancing the amount of cut and fill to maximize the use of local material, where possible. Additional measures for erosion control may include temporary seeding (for areas of the site where disturbance has temporarily ceased), permanent seeding, mulching, sod stabilization, and vegetative buffer strips. Sediment and erosion controls can also include engineered structures to divert or store flow, or limit runoff. These devices include earth dikes that channel flow to desired locations; silt fences to intercept sediment; drainage swales; sediment traps; check dams; level spreaders; subsurface drains; and other structures used to control or direct surface discharge and limit/control erosion.

The Environmental Resources Permit and Storm Water Pollution Prevention Plan would include specific measures that would be implemented to control both wind and water erosion of soils before and during construction activities. Sediment and erosion controls generally address pollutants in storm water generated from the site during construction. Storm water management measures are generally implemented before and during construction and primarily result in reductions of pollutants in storm water. Storm water management measures may include infiltration of runoff on site; flow attenuation by vegetation or natural depressions; outfall velocity dissipation devices; storm water retention structures and artificial wetlands; and storm water detention structures. For many sites, a combination of these controls may be appropriate. Additional measures include best management practices.

Utilization of SLC-41 for the EELV program would have a beneficial impact upon soils. Currently, SLC-41 is used to launch Titan IVB rockets, which use solid rocket propellants. The ground cloud created by solid rocket propellant causes deposition of HCl and aluminum oxide on the soil adjacent to the launch site, resulting in temporary acidification and an increase of aluminum in soils. Concept A launch vehicles would only use liquid fuels, which would vaporize during launch, thus no deposition on the soil or temporary acidification would occur.

Launch anomalies could result in impacts to near-field soils due to contamination from rocket propellant. In the unlikely occurrence of a launch anomaly, any spilled propellant would be collected and disposed of by a certified disposal subcontractor in accordance with the SPCC Plan. Contaminated soils would be removed and treated as hazardous waste in accordance with federal, state, and local regulations. Short-term impacts to soils may result, but long-term impacts would not be significant.

Standard construction practices and adherence to permit requirements would minimize adverse impacts to geology and soils; therefore, no mitigation measures would be required.

4.8.1.1.2 **Concept A, Vandenberg AFB**

Geologic Setting. EELV program activities would require modification of existing facilities and construction of new facilities at SLC-3W, which has been extensively altered in the past. Construction of EELV facilities at SLC-3W would substantially alter the topography of the site beyond those changes that would result from natural erosion or deposition. Construction of these facilities would not change the physiography of the region, nor would it impact any unique geologic features or geologic features of unusual scientific value.

Geologic concerns in the Vandenberg AFB area are the potential effects of erosion and landslides, primarily related to cut and fill activities during project construction, and earthquakes that could occur during program operations.

The SLC-3W site is not in a potential landslide area or near sand dunes (U.S. Air Force, 1989a). The nearest active fault, the Hosgri Fault, 2.5 miles northwest of the site, is capable of causing sustained ground shaking and/or surface rupture. Construction of new facilities and/or modification of existing facilities would incorporate earthquake-resistant design as required by building codes to reduce the potential for impacts from a seismic event, including surface rupture. Site foundations would incorporate site-specific engineering designs appropriate to maintain structural integrity during extended periods of ground shaking.

Soils. Construction would occur primarily within the existing fenceline of the previously disturbed SLC-3W area. Depending on final design and grading plans, approximately 142,000 cubic yards of cut and fill material would be required. The fill material would most likely come from the Manzanita Borrow Area on Vandenberg AFB. Unsuitable cut material would be returned to the embankment cut, which would be regraded prior to site revegetation. Some spoil material would be disposed of in the on-base landfill. The earthwork required for new construction would uncover and disturb soils and increase the potential for wind and water erosion of these exposed soils.

Appropriate measures to reduce wind and water erosion at the stock pile and construction sites would be implemented (see Section 4.8.1.1.1).

Launch anomaly impacts would be similar to those described in Section 4.8.1.1.1, under Soils.

Standard construction practices and adherence to permit requirements would minimize adverse impacts to geology and soils; therefore, no mitigation measures would be required.

4.8.1.2 **Concept B**

4.8.1.2.1 **Concept B, Cape Canaveral AS**

Geologic Setting. EELV program activities would require modification of existing facilities and construction of new facilities at SLC-37, which has been altered extensively in the past. Major modifications at the site would include changing the existing site topography through excavation and grading. Construction of EELV facilities at SLC-37 would substantially alter the topography of the site beyond those changes that would result from natural erosion or deposition. Construction of these facilities would not change the physiography of the region, nor would it impact any unique geologic features or geologic features of unusual scientific value.

Soils. Construction would occur primarily within the previously disturbed SLC-37 area or along existing road corridors. Depending on final design and grading plans, approximately 10,000 to 18,000 cubic yards of material would be excavated, and 220,000 to 360,000 cubic yards of fill would be required. Fill material would come from the East Trident Spoil Area on station. Unsuitable cut material would be removed from the project area to a spoil site located on Cape Canaveral AS, or to other approved locations. The earthwork required to construct the launch facility would uncover and disturb soils and increase the potential for wind and water erosion of these exposed soils.

Appropriate measures to reduce wind and water erosion at the stock pile and construction sites would be implemented (see Section 4.8.1.1.1).

Launch anomaly impacts would be similar to those described in Section 4.8.1.1.1, under Soils.

For some small vehicle missions, a third stage containing solid propellant would be utilized. However, this stage would fire in orbit, and no acid deposition of solid propellants on soils would occur.

Under Concept B, only the commercial DIV-M+ launch vehicle would utilize solid rocket motors. A maximum of eight DIV-M+ commercial launches would occur per year under Concept B. The DIV-M^+ launch vehicle would use IPS water instead of deluge water. The IPS water would not actively mix with the exhaust cloud created by solid rocket motors, and therefore, a large acid cloud would not be produced. Impacts from the use of solid rocket motors would result in the deposition of HCl and aluminum oxide particulates on soils near the launch pad.

During a Delta II launch on November 4, 1995, pH in the surrounding air was monitored to detect any changes caused by HCl vapors or deposition. The nearest test strips were placed at the perimeter of the launch pad at a minimum distance of 100 yards from the launch vehicle. Launch conditions were calm, which would yield maximum HCl deposition. No pH changes were observed on any test strips, and there was no evidence of acid deposition. The lack of pH change associated with the small ground cloud indicates that even with exposure to the concentrated cloud, acid deposition would be minimal (ENSR Corporation, 1996).

The potential deposition of HCl and aluminum oxide per launch is expected to be minimal. No measurable direct or indirect, short- or long-term effects on soil chemistry are expected as a result of Concept B launch activities.

The Port of Canaveral Dock would be utilized for receiving/unloading of EELV program components. This dock has recently been modified and would meet the requirements of the EELV program. However, if this dock were unavailable to the EELV program, the U.S. Air Force Roll-On/Roll-Off Dock would be utilized. This dock would require limited dredging to accommodate the turning radius of the transport vehicle/dolly in the egress area. Dredging would occur in previously dredged areas only, thus eliminating impacts to undisturbed sediments.

Standard construction practices and adherence to permit requirements would minimize adverse impacts to geology and soils; therefore, no mitigation measures would be required.

4.8.1.2.2 **Concept B, Vandenberg AFB**

Geologic Setting. EELV program activities would require modification of existing facilities and construction of new facilities at SLC-6, which has been altered extensively in the past. Major modifications would include changing the existing site topography through excavation and grading. Construction of EELV facilities at SLC-6 would substantially alter the topography of the site beyond those changes that would result from natural erosion or deposition. Construction of these facilities would not change the physiography of the region, nor would it impact any unique geologic features or geologic features of unusual scientific value.

Geologic concerns in the Vandenberg AFB area are the potential effects of erosion and landslides, primarily related to cut and fill activities during project construction, and earthquakes that could occur during program operations.

The nearest active fault, the Hosgri Fault, 7.5 miles northwest of the site, is capable of causing sustained ground shaking and/or surface rupture. Construction of new facilities or modification of existing facilities would incorporate earthquake-resistant design as required by building codes to reduce the potential of significant impacts occurring from a seismic event, including surface rupture. Site foundations would incorporate site-specific engineering designs appropriate to maintain structural integrity during extended periods of ground shaking.

The SLC-6 site is not located near sand dunes, but it is in a potential landslide area (U.S. Air Force, 1989a). SLC-6 is approximately 1.5 miles from the coast; therefore, it is unlikely that the site would be subject to slope failures of the sea cliff. The site has experienced previous erosion near the drainages bounding the site. This erosion problem has subsequently been stabilized. The SLC-6 launch complex has not experienced landsliding in the past.

Soils. SLC-6 is underlain by soils that have a high erosion potential. An erosion control program, conducted as part of site maintenance activities for SLC-6, has stabilized most slopes so that erosion has been minimized.

Construction would occur primarily within the previously disturbed SLC-6 area or along existing road corridors. Depending on final design and grading plans, approximately 4,500 to 7,500 cubic yards of material would be excavated and 80,000 to 135,000 cubic yards of fill material would be required at SLC-6. Fill material would most likely come from the Vandenberg AFB Manzanita Borrow Area. Unsuitable cut material would be removed from the project area to the Manzanita Spoil Site, or to other approved locations. Topsoil would be removed and stockpiled on site for re-spreading on disturbed areas for revegetation and erosion control after completion of construction. The earthwork required to construct the launch facility would uncover and disturb soils and increase the potential for wind and water erosion of these exposed soils.

Appropriate measures to reduce wind and water erosion at the stock pile and construction sites would be implemented (see Section 4.8.1.1.1).

Launch anomaly impacts would be similar to those described in Section 4.8.1.1.1, under Soils.

For some small-vehicle missions, under Concept B, a third stage containing solid propellant would be utilized. However, this stage would fire in orbit and no deposition of solid propellants on soils would occur.

Under Concept B, only the commercial DIV-M+ launch vehicle would utilize solid rocket motors. A maximum of four DIV-M+ commercial launches would occur per year under Concept B. Impacts from the use of solid rocket propellants are described in Section 4.8.1.2.1, under Soils.

The South Vandenberg AFB boat dock area would be utilized for receiving/unloading of EELV components. The harbor channel would be dredged to the level of its prior dredging depth, thus eliminating impacts to undisturbed sediments. Approximately 20,000 cubic yards of sediment would be dredged; dredged material would be disposed of in accordance with USACE permit requirements, which allow for bringing the dredge material to shore and then hauling it away by truck or rail to an appropriate landfill for disposal.

Standard construction practices and adherence to permit requirements would minimize adverse impacts to geology and soils; therefore, no mitigation measures would be required.

4.8.1.3 **Concept A/B**

4.8.1.3.1 **Concept A/B, Cape Canaveral AS**

Geologic Setting. Under Concept A/B, both SLC-41 and SLC-37 would be utilized for EELV activities. Impacts to physiography and geology for these sites would be similar to the combined effects discussed for Concepts A and B in Sections 4.8.1.1.1 and 4.8.1.2.1, under Geologic Setting.

Soils. Under Concept A/B, both SLC-41 and SLC-37 would be utilized. Impacts to soils at these sites would be similar to the combined effects discussed for Concepts A and B in Sections 4.8.1.1.1 and 4.8.1.2.1, under Soils.

As discussed in Sections 4.8.1.1.1 and 4.8.1.2.1, standard construction practices and adherence to permit requirements would minimize adverse impacts to geology and soils. Therefore, no impacts are anticipated, and no mitigation measures would be required.

4.8.1.3.2 **Concept A/B, Vandenberg AFB**

Geologic Setting. Under Concept A/B, both SLC-3W and SLC-6 would be utilized. Impacts to physiography and geology at these sites would be similar to the combined effects discussed for Concepts A and B in Sections 4.8.1.1.2 and 4.8.1.2.2, under Geologic Setting.

Soils. Under Concept A/B, both SLC-3W and SLC-6 would be utilized. Impacts to soils for these sites are discussed under Sections 4.8.1.1.2 and 4.8.1.2.2, under Soils.

As discussed in Sections 4.8.1.1.2 and 4.8.1.2.2, standard construction practices and adherence to permit requirements would minimize adverse impacts to geology and soils. Therefore, no impacts are anticipated, and no mitigation measures would be required.

4.8.2 **No-Action Alternative**

4.8.2.1 **Cape Canaveral AS**

Under the No-Action Alternative, no new construction or facility modification would occur. A maximum of 11 launches per year would take place. Since existing programs utilize solid rocket propellant, the potential impact to soils is greater than that of either Concept A (only liquid fuels) or B (smaller amount of launches utilizing solid rocket propellant) of the EELV program. However, impacts to soils are temporary and minimal, as described in Section 4.8.1.2.1, under Soils. No adverse impacts to geology or soils are expected from continuation of existing launch programs.

4.8.2.2 **Vandenberg AFB**

A maximum of six launches per year would occur under this concept. Some of these launches would use solid rocket propellant. Impacts from the No-Action Alternative at Vandenberg AFB would be similar to the impacts described in Section 4.8.2.1, Cape Canaveral AS.

4.9 WATER RESOURCES

Impacts to water resources could result from any of the following project-related effects:

- Degradation of surface or groundwater quality such that existing use would be impaired
- Interference with natural drainage patterns
- A shortage in the water supply system
- Development within a 100-year floodplain.

Potential impacts to wetlands are discussed under Section 4.14, Biological Resources.

4.9.1 Proposed Action

4.9.1.1 Concept A

4.9.1.1.1 Concept A, Cape Canaveral AS

Groundwater. The majority of water used for Concept A would be deluge water (50,000 gallons per launch) and acoustic suppression water (3,000 to 9,000 gallons per launch) for a maximum of 59,000 gallons per launch. Smaller amounts of water would be utilized for launch complex washdown, fire suppressant, and potable uses. During the peak launch year (2015), Concept A launch activities (23 launches) would require approximately 1,357,000 gallons of water.

The city of Cocoa, which pumps water from the Floridan aquifer, is contracted to supply 6,500,000 gpd of water per day to Cape Canaveral AS and Patrick AFB. Maximum water use at Cape Canaveral AS and Patrick AFB is 1,000,000 and 3,800,000 gpd, respectively, which includes water to support current launch programs (45 Space Wing, 1995). Concept A would not noticeably affect the quantity of water available to Cape Canaveral AS or the surrounding area or increase the amount of water withdrawn from the Floridan aquifer on a daily basis. With the discontinuation of the current systems, water demand would be reduced. According to the general plan for Cape Canaveral AS, the city of Cocoa has sufficient adequacy and reliability of supply sources to meet usage demands and water quality standards (45 Space Wing, 1995). Therefore, adverse impacts to groundwater resources are not expected, and no mitigation measures would be required.

Surface Water. Grading around SLC-41 for the proposed EELV program would alter the existing surface drainage patterns at the site through excavation, grading, and the creation of impervious surfaces. This site has been previously disturbed, so natural drainage patterns no longer exist. Design of the proposed project would not substantially alter the existing drainage course. Therefore, adverse impacts to natural drainages are not anticipated.

Impacts from erosion, and specific measures to control both wind and water erosion of soils during and after construction, are addressed in Section 4.8.1.1.1, under Geology and Soils.

Since the construction area for the EELV program is greater than 5 acres, an NPDES permit for storm water discharge associated with construction activity would also be required. The objectives of this permit are to: (1) identify pollutant sources that may affect the quality of discharges of storm water associated with construction activities; and (2) identify, construct, and implement storm water pollution preventive measures and best management practices to reduce pollutants in storm water discharges from the construction site both during and after construction. This permit would require implementation of storm water control measures to reduce potential impacts to surface water.

Standard construction practices and adherence to permit requirements and applicable regulations would minimize adverse impacts to water resources; therefore, no mitigation measures would be required.

Water Quality. Water quality in the area of SLC-41 could be affected as a result of contamination of surface waters by the launch exhaust cloud. However, Concept A launches would utilize liquid propellants only, which would result in fewer impacts to water quality than the current launch vehicle systems that utilize solid rocket propellant. Liquid propellant is rapidly combusted during a launch and almost completely burned. Therefore, very little propellant would be deposited on the launch pad or in the surrounding area. Adverse impacts to surface water and groundwater quality resulting from the exhaust cloud are not expected.

Launches would require use of deluge and acoustic suppression water. Approximately 10,000 of the 59,000 gallons of deluge and acoustic suppression water used per launch would be vaporized, or percolate into the soil, during launch. Residual deluge water generated during vehicle launches is a potential source of contamination to adjacent surface waters and groundwater. However, deluge water would be retained in the flame duct after launches, tested for water quality characteristics, and released to grade in accordance with the FDEP Industrial Wastewater Discharge permit requirements. Deluge water would be released at a controlled rate to ensure that water percolates into the ground. If contaminant concentrations in the treated deluge water are too high, and the water cannot be released to grade, it would be released to the WWTP. Wastewater would be disposed of in accordance with applicable federal, state, and local regulations. Storm water runoff prior to washdown would be contained to avoid the potential for impacts to surface water resources. Storm water runoff would be tested and treated, if necessary, prior to release. Soils in the vicinity of SLC-41 have a very rapid permeability rate and should be able to handle all water releases associated with launches at this site. Adverse impacts to surface water and groundwater quality resulting from deluge and storm water runoff are not anticipated.

Under normal flight conditions, vehicle stages that do not reach orbit have trajectories that result in ocean impact. Stages that reach initial orbit would eventually re-enter the atmosphere as a result of orbital decay. Corrosion of stage hardware would contribute various metal ions to the water column. Due to the slow rate of corrosion in the deep-ocean environment and the large quantity of water available for dilution, toxic concentrations of metals are not likely to occur. Relatively small amounts of propellant would also be released into the ocean along with the various spent stages. Because of the limited number of launch events scheduled, the small amount of residual propellants present, and the large volume of water available for dilution, no adverse impacts are expected from the re-entry of spent stages.

On-pad accidental or emergency releases of small quantities of propellants are unlikely to occur. However, if there is a release, spilled propellants would be collected and disposed of by a certified disposal subcontractor in accordance with the SPCC plan. Potential contamination of groundwater and/or surface water resulting from accidental or emergency spills of propellants during fueling would be minimized through adherence to strict safety procedures. Potential leakage or spills from propellant storage tanks would be contained in holding basins that surround the tanks. Any accidental or emergency release of propellants after fueling would be collected in the flume located directly beneath the launch vehicle and channeled to an impermeable concrete catch basin. Contaminants collected in the catch basin would be disposed of in accordance with appropriate state and federal regulations. No discharges of contaminated water are expected to result from EELV operations at SLC-41, and no adverse impacts to water quality are anticipated.

Launch anomalies could result in impacts to local water bodies due to contamination from rocket propellant. In the unlikely occurrence of a launch anomaly, spilled propellant could enter water bodies close to the launch pad. At Cape Canaveral AS, they could enter the Atlantic Ocean or the Banana River. Short-term impacts to the near-shore environments may result, but long-term impacts would not be significant due to the buffering capacity of the Atlantic Ocean and Banana River.

Adherence to permit requirements and applicable regulations would minimize adverse impacts to water quality; therefore, no mitigation measures would be necessary.

4.9.1.1.2 Concept A, Vandenberg AFB

Groundwater. Until recently, the potable water supply for Vandenberg AFB was obtained solely from groundwater sources. These sources had been affected by a severe overdraft. Vandenberg AFB now receives supplemental potable water from the State Water Project, which does not draw from aquifers in the area. This will relieve the overdraft situation and allow the aquifer to eventually recharge. EELV program activities are not expected to affect groundwater resources, and no mitigation measures would be required.

Surface Water. Vandenberg AFB can purchase up to 1.46 billion gallons of water per year from the State Water Project. During the peak launch year (2007), Concept A launch activities (10 launches) would require approximately 590,000 gallons of water. Concept A activities would not noticeably affect the quantity of water available to Vandenberg AFB or the surrounding area.

Grading for new construction around SLC-3W would alter the existing surface drainage patterns at the site through excavation, grading, and the creation of impervious surfaces. This site has been previously disturbed, so natural drainage patterns no longer exist. Design of the new facilities would not substantially alter the existing drainage courses. Therefore, adverse impacts to natural drainages are not anticipated. Impacts from erosion are addressed in Section 4.8, under Soils and Geology.

Because the construction area for the EELV program is greater than 5 acres, a NPDES permit for storm water discharge associated with construction activity would be required (see Section 4.9.1.1.1, under Surface Water). This permit would require implementation of storm water control measures to prevent impacts to surface water.

Standard construction practices and adherence to permit requirements and regulations would minimize adverse impacts to water resources; therefore, no mitigation measures would be required.

Water Quality. Water quality in the area of SLC-3W could be affected as a result of contamination of surface waters by the exhaust cloud. As described in Section 4.9.1.1.1, under Water Quality, Concept A launches would use only liquid propellant, which would result in fewer impacts to water quality than the current launch vehicles, which utilize solid rocket propellant. Adverse impacts to surface water and groundwater quality resulting from the exhaust cloud are not expected.

Launches would require use of deluge and acoustic suppression water. Approximately 10,000 of the 59,000 gallons of deluge water used per launch would be vaporized, or percolate into the soil, during launch. Residual deluge water generated during vehicle launches is a potential source of contamination to adjacent surface waters and groundwater; however, no direct discharge is expected to occur during launches from SLC-3W. After a launch, the launch pad would be washed down. Deluge and washdown water would be collected, tested, and treated, if necessary, prior to recycling or disposal. If the water is classified as hazardous, it would be containerized and disposed of properly. Storm water runoff prior to washdown would be contained and tested, prior to recycling or disposal, to avoid the potential for impacts to surface water resources. Adverse impacts to surface water and groundwater resulting from deluge or storm water runoff are not anticipated.

Potential impacts from vehicle stages that do not reach orbit, on-pad accidental or emergency releases of propellants, and launch anomalies are discussed in Section 4.9.1.1.1, under Water Quality. No adverse impacts are anticipated.

Adherence to permit requirements and regulations would minimize adverse impacts to water quality; therefore, no mitigation measures would be required.

4.9.1.2 **Concept B**

4.9.1.2.1 **Concept B, Cape Canaveral AS**

Groundwater. Concept B launches would not require the use of deluge water. However, 125,000 gallons of IPS water would be used per launch. An additional 30,000 gallons of launch pad washdown water would be used for DIV-M+ launches only. IPS water would be sprayed from a ring below the main engine into the flame duct for approximately 3 to 4 minutes to minimize the back pressure from the initial ignition of the main engine. During the peak year (2015), Concept B launch activities (23 launches, 6 of which are DIV-M+ launches) would require approximately 3,055,000 gallons of water.

As stated in Section 4.9.1.1.1, Groundwater, the city of Cocoa is contracted to supply 6,500,000 gpd to Cape Canaveral AS and Patrick AFB. This quantity includes water to support current launch programs. Concept B would not significantly affect the quantity of water available to Cape Canaveral AS or the surrounding area or noticeably increase the amount of water withdrawn from the Floridan aquifer on a daily basis. With the discontinuation of current launch vehicle operations, water demand would be reduced. According to the general plan, the City of Cocoa has sufficient adequacy and reliability of supply sources to meet usage demands and water quality standards (45 Space Wing, 1995). Therefore, adverse impacts to groundwater are not expected, and mitigation measures would not be required.

Surface Water. Grading around SLC-37 would alter the existing surface drainage patterns at the site through excavation, grading, and the creation of impervious surfaces. This site has been previously disturbed, so natural drainage patterns no longer exist. Design of the proposed facilities would not substantially alter the existing drainage course. Therefore, adverse impacts to natural drainages are not anticipated. Impacts from erosion are addressed in Section 4.8, under Soils and Geology.

Since the construction area for the EELV program is greater than 5 acres, an NPDES permit for storm water discharge associated with construction activity is required (see Section 4.9.1.1.1, under Surface Water). This permit would require implementation of storm water control measures to prevent impacts to surface water. The permit would be issued by the U.S. EPA.

The discharge of dredged or fill material into, or the excavation of soils from, Waters of the United States, which include special aquatic sites such as wetlands, is regulated under Section 404 of the CWA (U.S. Environmental Protection Agency, 1987). Construction for Concept B would require a permit under Section 404 of the CWA and Section 10 of the Rivers and Harbors Act of 1899 from the USACE. Section 404 requires that measures be taken to: (1) avoid and (2) minimize impacts to Waters of the United States. In the 404 permit, a mitigation monitoring plan would be developed in coordination with appropriate resource agencies, and a final plan would be approved by the USACE. Given compliance with 404 permit regulations, no adverse impacts to water resources are expected.

Standard construction practices and adherence to permit requirements and applicable regulations would minimize impacts to water resources; therefore, no mitigation measures would be required.

Water Quality. Launches would require the use of 125,000 gallons of IPS water per launch. An additional 30,000 gallons of washdown water per launch would be used for DIV-M+ vehicle launches. Residual water is a potential source of contamination to adjacent surface waters and groundwater; however, no direct discharge is expected to occur during launches from SLC-37. IPS and washdown water would be retained in the flame duct after launches, tested for water quality characteristics, and recycled, disposed of in accordance with the FDEP Industrial Wastewater Discharge permit requirements, or disposed of in a permitted industrial wastewater treatment facility off site. Wastewater would be disposed of in accordance with applicable federal, state, and local requirements. Storm water runoff prior to washdown would be contained to avoid the potential for impacts to surface water resources. Storm water runoff would be tested and treated, if necessary, prior to release. Soils in the vicinity of SLC-37 have a very rapid permeability rate and should be able to handle all water releases associated with launches at this site. Adverse impacts to surface water and groundwater resulting from IPS, washdown, or storm water runoff are not anticipated.

Dewatering may be necessary during construction activities. If dewatering is required, water would be allowed to percolate to grade; it would not be discharged to surface waters prior to acquisition of a dewatering permit.

Potential impacts from vehicle stages that do not reach orbit, on-pad accidental and emergency releases of propellant, and launch anomalies are discussed in Section 4.9.1.1.1, under Water Quality. No adverse impacts are anticipated.

For some small vehicle missions, a third stage containing solid propellant would be utilized. However, this stage would ignite in orbit, and no deposition of propellant on surface waters would occur. Therefore, no adverse impacts to water quality are anticipated.

Under Concept B, only the commercial DIV-M+ launch vehicles would utilize solid rocket motors. A maximum of eight DIV-M+ launches would occur in 1 year. The DIV-M+ launch vehicle would require no deluge water; instead it would use IPS water, which does not actively mix with the exhaust from the solid rocket motors and, therefore, does not produce a large acid cloud. HCl is released during launch, but the deposition is concentrated near the pad. The acid is not expected to travel more than several hundred meters laterally (ENSR Corporation, 1996).

During a Delta II launch on November 4, 1995, pH in the surrounding air was monitored to detect any changes caused by HCl vapors or deposition. The nearest test strips were placed at the perimeter of the launch pad at a minimum distance of 100 yards from the launch vehicle. Launch conditions were calm, which would yield the highest HCl deposition. No pH changes were observed on any test strips, and there was no evidence of acid deposition. The lack of pH change associated with the small ground cloud indicates that even with exposure to the concentrated cloud, acid deposition would be minimal (ENSR Corporation, 1996).

Because the DIV-M+ is evolved from the Delta launch vehicle and would use the same type of IPS system as the Delta II, impacts from deposition of HCl are considered to be minimal. Aluminum oxide is relatively insoluble because of the low or high pH of local surface waters and is not expected to cause elevated aluminum levels. Therefore, no adverse impacts to surface water are expected from the use of the solid rocket motors, and no mitigation measures are required.

Exhaust cloud deposits and propellant residues remain on the pad and are deposited in near-field soils after a launch. These residues would be washed from the pad during post-launch washdown or by storm water, which would be retained in catch basins. This water would then be analyzed, recycled, discharged to percolation ponds if it meets regulatory requirements, or disposed of in a permitted industrial wastewater treatment facility off site. If contaminant concentrations are too high and the water cannot be released to grade, it would be treated, and a determination would be made for appropriate disposal. Wastewater would be disposed of in accordance with applicable federal, state, and local regulations. Thus, Concept B launches would not adversely affect groundwater quality in the surficial aquifer.

Launch anomalies could result in impacts to local water bodies due to contamination from rocket propellant. In the unlikely occurrence of a launch anomaly, spilled propellant could enter water bodies close to the launch pad. At Cape Canaveral AS, propellant could enter the Atlantic Ocean or the Banana River. Potential contamination would primarily occur from solid rocket motor propellant. Solid propellant would cause contamination in the form of acidification from HCl and the deposition of aluminum oxide. Recovered solids would be removed from near-shore ocean and/or river environments and treated as hazardous waste in accordance with federal, state, and local regulations. Short-term impacts to the near-shore environments may result, but long-term impacts would not be significant due to the buffering capacity of the Atlantic Ocean and Banana River.

Adherence to permit requirements and applicable regulations would minimize adverse impacts to water quality; therefore, no mitigation measures would be required.

4.9.1.2.2 **Concept B, Vandenberg AFB**

Groundwater. Water required to support EELV programs would be supplied from the State Water Project and not from local wells in the area. No adverse impacts to groundwater resources are anticipated, and no mitigation measures would be required.

Surface Water. As discussed in Section 4.9.2.1.2, Concept B launches would not utilize deluge water. However, 125,000 gallons of IPS water would be required per launch. An additional 30,000 gallons of washdown water would be required for DIV-M+ launches only. During the peak year (2007), Concept B launch activities (10 launches, 2 of which are DIV-M+ launches) would require approximately 1,310,000 gallons of water. Concept B activities would not noticeably affect the quantity of water available to Vandenberg AFB or the surrounding area.

Surface water around SLC-6 drains through erosion control ditches into a small arroyo located on the north side of SLC-6. Grading would alter the existing surface drainage patterns at the site through excavation, grading, and the creation of impervious surfaces. This site has been previously disturbed, so natural drainage patterns no longer exist. Design of the proposed facilities would not substantially alter the existing drainage courses on the site. Therefore, adverse impacts to natural drainages are not anticipated. Impacts from erosion are addressed in Section 4.8, under Geology and Soils.

Since the construction area for the EELV program is greater than 5 acres, an NPDES permit for storm water discharge associated with construction activity would be required (see Section 4.9.1.1.1, under Surface Water). This permit would require implementation of storm water control measures to prevent impacts to surface water.

Impacts related to dredging are addressed in Section 4.9.1.2.1, under Surface Water. This discussion includes mitigation measures to prevent impacts.

Standard construction practices and adherence to permit requirements and applicable regulations would minimize adverse impacts to water resources; therefore, no mitigation measures would be required.

Water Quality. Launches would require the use of approximately 125,000 gallons of IPS water and an additional 30,000 gallons of washdown water for DIV-M+ launches. Residual water is a potential source of contamination to adjacent surface waters and groundwater; however, no direct discharge is expected to occur during launches from SLC-6. IPS and washdown water would be collected, tested, and treated, if necessary, prior to recycling or disposal. If the water is classified as hazardous, it would be containerized and disposed of properly to avoid the potential for impacts to surface water resources. Adverse impacts to surface water or groundwater resulting from IPS or washdown water runoff are not anticipated.

Dewatering may be necessary during construction activities. If dewatering is required, water would be allowed to percolate to grade; it would not be discharged to surface waters prior to acquisition of a dewatering permit.

Potential impacts from vehicle stages that do not reach orbit, on-pad accidental or emergency releases, and launch anomalies are discussed in under Section 4.9.1.1.1, Water Quality. No adverse impacts are anticipated.

For some small-vehicle missions under Concept B, a third stage containing solid propellant would be utilized. However, this stage would ignite in orbit, and no deposition of propellant on surface waters would occur. Therefore, no adverse impacts to water quality are anticipated.

Under Concept B activities, only the commercial DIV-M+ launch vehicle would utilize solid rocket motors. A maximum of four DIV-M+ commercial launches would occur in 1 year. Impacts would be the same as described in Section 4.9.1.1.1, under Water Quality.

In studies conducted at SLC-2W, some trace metals were identified in surface soils near the pad. The amounts were so small that it was hard to determine whether they were background metals or were derived from launch activities. Based on the lack of substantial accumulation of metals and other surface contaminants at the site, it was assumed that they are neither deposited in appreciable amounts nor accumulate over time. In addition, the lack of high concentrations of metals downgradient of the pad suggests no long-term accumulation of such contaminants off site (ENSR Corporation, 1996). Based on these findings, aluminum oxide deposits are not expected to cause elevated aluminum levels in nearby soils or water bodies. Therefore, adverse water quality impacts to surface water are not expected.

Exhaust cloud deposits and propellant residues remain on the pad and are deposited in near-field soils after a launch. These residues would be washed from the pad by a post-launch washdown or by storm water, which would be retained in catch basins. This water would then be analyzed and treated prior to disposal as industrial wastewater at the SLC-6 treatment plant. Concept B wastewater and storm water would not be allowed to percolate into the local groundwater. Therefore, no adverse impacts to groundwater are anticipated.

Adherence to permit requirements and applicable regulations would minimize adverse impacts to water quality; therefore, no mitigation measures would be required.

4.9.2 **Concept A/B**

4.9.2.1 **Concept A/B, Cape Canaveral AS**

Groundwater. Impacts to groundwater would be similar to the combined effects for Concepts A and B discussed in Sections 4.9.1.1.1 and 4.9.1.2.1. During the peak launch year (2015), Concept A/B launch activities (13 Concept A launches and 13 Concept B launches [4 of which are DIV-M+ launches]) would require approximately 2,392,000 gallons of water. Concept A/B launches would not noticeably affect the quantity of water available to Cape Canaveral AS or the surrounding area, or increase the amount of water withdrawn from the aquifer on a daily basis. With the discontinuation of current launch vehicle operations, water demand would be reduced. Therefore, adverse impacts to groundwater are not anticipated, and mitigation measures would not be required.

Surface Water. Impacts to surface water would be similar to those discussed in Sections 4.9.1.1.1 and 4.9.1.2.1, under Surface Water. No adverse impacts are anticipated.

As discussed in Sections 4.9.1.1.1 and 4.9.1.2.1, under Surface Water, standard construction practices and adherence to permit requirements and applicable regulations would minimize adverse impacts to water resources; therefore, no mitigation measures would be required.

Water Quality. Impacts to water quality would be similar to those discussed in Sections 4.9.1.1.1 and 4.9.1.2.1, under Water Quality. No adverse impacts to groundwater or surface water quality are anticipated; therefore, no mitigation measures would be required.

4.9.2.2 **Concept A/B, Vandenberg AFB**

Groundwater. As described in Section 4.9.1.1.2, under Groundwater, water required to support EELV programs would be supplemented by the State Water Project. No adverse impacts to groundwater resources are anticipated from Concept A/B activities, and no mitigation measures would be required.

Surface Water. During the peak launch year (2007), Concept A/B launch activities (7 Concept A launches and 7 Concept B launches [4 of which are DIV-M+ launches]) would require approximately 1,288,000 gallons of water. Impacts would be similar to those described in Section 4.9.1.2.2, under Surface Water. Concept A/B launches would not noticeably affect the quantity of water available to Vandenberg AFB or the surrounding area. Existing water use includes current launch vehicles, so impacts to water use would likely be less than anticipated. Impacts to surface water would be similar to those discussed in Sections 4.9.1.1.2 and 4.9.1.2.2, Surface Water.

As discussed under Sections 4.9.1.1.2 and 4.9.1.2.2, Surface Waters, standard construction practices and adherence to permit requirements and applicable regulations would minimize adverse impacts to water resources; therefore, no mitigation measures would be required.

Water Quality. Impacts to water quality would be similar to those discussed in Sections 4.9.1.1.2 and 4.9.1.2.2, Water Quality. No adverse impacts to groundwater or surface water quality are anticipated; therefore, no mitigation measures would be required.

4.9.3 No-Action Alternative

4.9.3.1 Cape Canaveral AS

Groundwater. Under the No-Action Alternative, a maximum of approximately 1,655,000 gallons of water would be required to support 11 launches. Water requirements for the No-Action Alternative and Proposed Action Vehicle launches at Cape Canaveral AS are provided in Table 4.9-1. The No-Action Alternative would not significantly affect the quantity of water available to Cape Canaveral AS or the surrounding area or increase the amount of water withdrawn from the Floridan aquifer on a daily basis. Impacts to groundwater are not anticipated, and mitigation measures would not be required.

Table 4.9-1. Total Water Usage Per Launch and During Peak Year, Cape Canaveral AS

Launch Vehicle System	Maximum Water Usage Per Launch (gallons)	Number of Launches (2015)	Total Maximum Water Usage (gallons) (2015)
Concept A			1,357,000
MLV	59,000	22	
HLV	59,000	1	

Concept B			3,055,000
DIV-S	125,000	9	
DIV-M	125,000	7	
DIV-M+	155,000	6	
DIV-H	125,000	1	
Concept A/B			2,392,000
Concept A			
MLV	59,000	12	
HLV	59,000	1	
Concept B			
DIV-S	125,000	3	
DIV-M	125,000	4	
DIV-M+	155,000	4	
DIV-H	125,000	2	
No-Action Alternative[(a)]			1,655,000
Atlas IIA	200,000	7	
Delta II	35,000	3	
Titan IVB	150,000	1	

Note: (a) Government launches only; no commercial launches included.
DIV-H = heavy launch vehicle
DIV-M = medium launch vehicle
DIV-M+ = medium launch vehicle with solid rocket motor strap-ons
DIV-S = small launch vehicle
HLV = heavy lift variant
MLV = medium lift variant

Surface Water. Adverse impacts to surface water are not anticipated since no construction or modification of facilities is planned; therefore, no mitigation measures would be required.

Water Quality. The existing launch vehicles use solid rocket propellant, so impacts from the No-Action Alternative would be similar to those described under Section 4.9.1.2.1, Water Quality. Adverse impacts to surface and groundwater quality are not anticipated; therefore, no mitigation measures would be required.

4.9.3.2 **Vandenberg AFB**

Groundwater. As stated in Section 4.9.1.1.2, Groundwater, Vandenberg AFB has sufficient water to support No-Action Alternative launches. No adverse impacts to groundwater resources are expected, and no mitigation measures would be required.

Surface Water. Under the No-Action Alternative, a maximum of 705,000 gallons of water would be required to support 6 launches. Water requirements for the No-Action Alternative and Proposed Action vehicle launches at Vandenberg AFB are provided in Table 4.9-2. The No-Action Alternative would not significantly affect the quantity of water available to Vandenberg AFB or the surrounding area. Adverse impacts to surface water are not anticipated; therefore, no mitigation measures would be required.

Water Quality. Some of the existing launch vehicles use solid rocket propellant, so impacts from the No-Action Alternative would be similar to those described under Section 4.9.1.2.2, under Water Quality. Adverse impacts to surface and groundwater quality are not anticipated; therefore, no mitigation measures would be required.

4.10 AIR QUALITY (LOWER ATMOSPHERE)

4.10.1 Proposed Action

Air quality impacts could occur during facility construction, pre- and post-launch processing operations, and from vehicle launch. Effects from vehicle launch on the lower atmosphere are addressed in this section; effects from vehicle launch on the upper atmosphere are addressed in Section 4.11.

Construction-related impacts could result from construction equipment (exhaust emissions) and construction activities (fugitive dust emissions) over an intermittent period of about two years (beginning as early as 1998 and ending as late as 2002).

Table 4.9-2. Total Water Usage Per Launch and During Peak Year, Vandenberg AFB

Launch Vehicle System	Maximum Water Usage Per Launch (gallons)	Number of Launches (2015)	Total Maximum Water Usage (gallons) (2015)
Concept A			590,000
MLV	59,000	10	
HLV	59,000	0	
Concept B			1,310,000
DIV-S	125,000	3	
DIV-M	125,000	3	
DIV-M+	155,000	2	
DIV-H	125,000	2	
Concept A/B			1,288,000
Concept A			
MLV	59,000	7	
HLV	59,000	0	
Concept B			
DIV-S	125,000	0	
DIV-M	125,000	1	
DIV-M+	155,000	4	
DIV-H	125,000	2	
No-Action Alternative[(a)]			705,000
Atlas IIA	200,000	3	
Delta II	35,000	3	
Titan IVB	150,000	0	

Note: (a) Government launches only; no commercial launches included.
DIV-H = heavy launch vehicle
DIV-M = medium launch vehicle
DIV-M+ = medium launch vehicle with solid rocket motor strap-ons
DIV-S = small launch vehicle
HLV = heavy lift variant
MLV = medium lift variant

Operational impacts could occur from: (1) mobile sources such as support vehicles, commercial transport vehicles, and personal vehicles; (2) point sources such as heating/power plants, generators, storage tanks, and flares; (3) processes such as solvent cleaning, coating, and post-launch pad cleanup; and (4) vehicle launch.

Construction activities include renovation of existing structures and roads, construction of new facilities, and demolition of existing facilities. Analysis of construction emission sources includes estimating the amount of uncontrolled fugitive dust that would be emitted from disturbed surface areas and gaseous emissions from construction equipment and construction workers' vehicles.

Transportation emissions were calculated based on expected deliveries, support vehicle operation, and personal vehicle traffic. Results were compared to existing mobile source emissions.

No new major point sources are necessary to support the EELV program. Emission sources that would be required are typical of light industrial activities already occurring at Cape Canaveral AS and Vandenberg AFB (e.g., power generators, utility boilers, shop activities, painting and surface coating operations, solvent degreasing, vehicle assembly, fuels storage). Emissions were calculated for these activities and compared to existing conditions.

Launch emissions were modeled to determine their impact on the ambient air quality concentrations in the lower troposphere. This modeling was conducted using the REEDM air quality dispersion model (Brady et al., 1997). The REEDM-predicted concentrations used in this report are screening concentrations only; a systematic search for worst-case meteorology was not conducted. Other conditions during actual launches will result in predicted concentrations somewhat different from these values. The REEDM model predicts the incremental increases in the concentrations of criteria and toxic pollutants. These increases were compared with federal and state ambient air quality standards. The following sections describe additional emission models used for each location.

Several launches, each with its associated support activities, would occur each year. The criteria pollutant emissions were totaled for the peak launch year, and this total was compared with regional annual air emissions and regulatory thresholds.

The health effects of air pollution differ among pollutants, which are sometimes referred to as contaminants of concern. SO_2, NO_x, and PM_{10} are respiratory irritants. Particulate matter may also interfere with oxygen exchange within the human respiratory system as a result of deposition of respirable particles in the lungs. CO decreases the ability of the blood to carry oxygen. VOCs include several different compounds that may have varying health effects. HAPs are specific VOCs and particulates posing acute or chronic health hazards. HAPs associated with pre-launch and post-launch processing include organic HAPs from solvent and coating use and hydrazine from vehicle fueling. Organic HAPs have compound-specific health hazards, such as irritation of the eyes, nose, and throat; dizziness; headaches; and nausea. Chronic (long-term) exposure can cause damage to internal organs; some organic HAPs are suspected carcinogens. Hydrazine can irritate eyes, nose, throat, and skin, and is a suspect carcinogen. Caustic or acidic pollutants, such as NH_3 or HCl, can also irritate mucus membranes.

In addition to causing direct health effects, VOCs and NO_x participate in photochemical reactions to cause ground-level ozone (smog), a respiratory irritant.

4.10.1.1 Concept A

4.10.1.1.1 **Concept A - Cape Canaveral AS.** Potential air quality impacts from Concept A operations could result from the general sources described in Section 4.10.1. Vehicle components would be delivered by truck and airplane; emissions from both forms of delivery have been calculated and compared to existing mobile source emissions. Fuels used in the Concept A vehicles would include kerosene fuel (RP-1), cryogenic gases (LO_2 and LH_2), hydrazines (MMH and N_2H_4), N_2O_4, and a small amount of PG-2. Emissions from the handling and storage of these fuels have been calculated and compared to existing emissions.

Facility Construction

Emissions generated by facility construction activities would be in the form of either gaseous or particulate pollutant emissions. Gaseous emissions would occur from heavy-duty construction equipment and vehicle travel to and from the site by construction workers. Emissions would consist primarily of combustion products. Particulate matter in the form of dust emissions would also be generated during the construction phase from excavation, earth moving, construction of buildings, and traffic on unpaved surface areas.

Facility construction for Concept A at Cape Canaveral AS would involve extensive renovation and some new construction at SLC-41. The disturbed area would total 9.6 acres (net of buildings), including 5.6 acres of the SLC-41 site and the 4 acres south of the site associated with construction of the assembly facilities and transporter rail. All calculations were made on the basis of average emissions per year over the construction period.

New and renovated structures within the disturbed acreage would include four support operations buildings and five gas or propellant storage/handling facilities. Additional buildings on station, but remote from the launch site, have also been scheduled for renovations and were included in all calculations. Square footage of all individual structures has been estimated from scale site plan drawings considering facilities with similar purposes at other military properties. Total new building floor space would be approximately 369,800 square feet. The surface area associated with paving modifications includes the sum of a factor for new pavement related to new building construction, plus all pavement that would be renovated for road and utility improvements. Sources for construction factors include The R. S. Means Building Construction Cost Data Index (1997) and actual ratios from at other government facilities (see Appendix J). Construction-related emissions for Concept A activities are provided in Table 4.10-1.

Local concentrations of criteria pollutants would increase during the construction phase. The PM_{10} emissions during the construction period would cause slightly elevated levels of PM_{10} in the immediate vicinity of the

Table 4.10-1. Construction-Related Emissions - Concept A, Cape Canaveral AS Average Annual Emissions Over Construction Period

	VOC	NO_x	CO	SO_2	PM_{10}
Grading Equipment (lbs/day)	1.2	7.7	1.7	0.5	1.3
Asphalt Paving (lbs/day)	0.0	0.0	0.0	0.0	0.0
Stationary Equipment (lbs/day)	31.7	25.9	5.6	1.7	1.5
Mobile Equipment (lbs/day)	30.2	301.0	306.1	17.2	22.7
Architectural Coatings (lbs/day)	35.4	0.0	0.0	0.0	0.0
Total Emissions (lbs/day)	99.0	337.6	313.4	19.4	25.5
Total Emissions (tpy)	11.4	38.8	36.0	2.2	2.9
Construction Commuter Automobiles (tpy)	1.7	2.7	12.9	0.1	6.4
Total Construction-Related Activities (tpy)	13.1	41.5	48.9	2.3	9.3
Brevard County 1995 Total (tpy, for comparison)	24,983	26,122	134,743	27,524	35,090

CO = carbon monoxide
lbs = pounds
NO_x = nitrogen oxides
PM_{10} = particulate matter equal to or less than 10 microns in diameter
SO_2 = sulfur dioxide
tpy = tons per year
VOC = volatile organic compound

work site. However, particulate matter concentrations would fall off rapidly with distance from the construction site; the distance of particulate fallout would depend on the wind speed at the time. Further, these increased concentrations would occur only temporarily, during construction, and would decrease again after construction is completed.

Dust from construction activities should have minimal impacts on local communities either on or off site, based on the assumption that the dust from construction would be periodic and disperse relatively quickly. Exposure to nuisance dust above permissible exposure limits (established occupational health and safety standards) would be possible but unlikely (based on historical and expected construction activities). If exceedance of exposure limit is established, health and safety procedures would need to be implemented by the construction contractor(s) to minimize emission or exposure to dust (e.g., respirator protection, limit access to working zones) and to maintain compliance with OSHA requirements. Environmental regulations may require use of wetting agents applied to road surfaces to minimize total suspended particles.

Brevard County currently meets the FAAQS and NAAQS for ozone, SO_2, NO_x, CO, and PM_{10}. Because the area is in attainment for these pollutants, the FDEP has not been required to establish specific emission reduction measures. Construction emissions of criteria pollutants would not be sufficient to jeopardize the attainment status for these pollutants. Baseline emissions in Brevard County are below the levels that would cause nonattainment, and the peak-year construction emissions are only a small fraction of the baseline.

The U.S. EPA is currently drafting a revised NAAQS, which would include a lower standard for ozone, and a standard for particles less than 2.5 microns in diameter ($PM_{2.5}$). Based on the new NAAQS, the attainment status of Brevard County may change, particularly for ozone. Given this situation, emissions of ozone precursors (VOC and NO_x) should be minimized to prevent impacts relative to standards and regulatory thresholds that could apply in the future.

Although no impacts have been identified, emissions could be reduced by implementing standard procedures, such as vigorous water application during ground-disturbing activities, which would be utilized to mitigate fugitive dust emissions by at least 50 percent (U.S. Environmental Protection Agency, 1985). Decreasing the time period during which newly graded sites are exposed to the elements, coupled with the use of windbreaks, could further minimize airborne dust concentrations. Efficient scheduling of equipment use, implementation of a phased construction schedule to reduce the number of units operating simultaneously, and performance of regular vehicle engine maintenance could mitigate combustive emission impacts. Implementation of these measures could reduce combustive emission and air quality effects from construction activities associated with the Proposed Action by 10 to 25 percent. Emissions of VOC from architectural coatings could be mitigated by selecting coatings with low VOC content.

Operations

Pre- and Post-Launch Processing. Pre- and post-launch processing would result in minor amounts of air emissions from the following activities:

- Vehicle preparation, and assembly
- Vehicle fueling
- Mobile sources such as support equipment, commercial transport vehicles (including trucks and aircraft), and personal vehicles
- Point sources such as heating/power plants, generators, incinerators and storage tanks.

Emissions from pre- and post-launch processing include criteria pollutants and toxic or irritant pollutants (including HAPs). Emissions of criteria pollutants could cause or contribute to the nonattainment of NAAQS or FAAQS for the region. Emissions of pollutants can also cause localized health effects.

Vehicle Preparation and Assembly. The manufacturing of Concept A vehicle components occurs off site, and emissions have not been included in the scope of this EIS. The components arrive complete, requiring only final on-site safety and quality checks prior to assembly.

Some chemical use occurs in the vehicle preparation and assembly stages, as described in Section 4.6, Hazardous Materials and Hazardous Waste Management. Some of the materials used would evaporate, resulting in air emissions. Examples of these air emissions sources include: solvents from adhesives and coatings, methylene chloride from paint remover, and isopropanol for surface cleaning. Spray painting could cause a small amount of particulate emissions from airborne paint particles; however, these emissions are expected to be minimal.

In addition to chemical usage, some air emissions could be generated from mechanical processing. For example, grinding and sanding operations could release particulate emissions. However, there would be no large-scale operations that would generate air emissions, and therefore emissions from mechanical processing are expected to be minimal.

Permitting for specific pieces of preparation and assembly equipment must be addressed under the Florida permitting requirements (FAC 62-210 through 213). Each piece of equipment must comply with the emission, opacity, odor, and toxics limits in these regulations.

Cape Canaveral AS has submitted a Title V Operating Permit application, which is under review by the FDEP. If the EELV program proceeds prior to the completion of FDEP review of the application, new stationary sources associated with the program would require permitting under the existing construction and operating permit program. Cape Canaveral AS could then change the Title V Operating Permit application to accurately reflect any new equipment. If the EELV program is implemented after completion of the FDEP review, new stationary source equipment would either be addressed or documented as minimal under the operating permit program. To address the changes, an amendment to the Operating Permit would be required. If the changes are minimal, they could be implemented without a permit revision.

The contractor has committed to implementing the EELV program without the use of any Class I ODSs. The use of Class II ODSs (for refrigeration, etc.) would be minimized or eliminated.

Emissions of VOC from chemical use could be reduced by limiting the overall chemical usage in preparation at Cape Canaveral AS. Chemical substitution could minimize the usage of HAPs; emissions of VOC and particulates from post-launch refurbishment could be mitigated by designing the SLC to minimize refurbishment. Emissions of VOCs from architectural coatings could be mitigated by selecting coatings with low VOC content.

Vehicle Fueling. Fueling of hydrogen for the CUS would involve some venting of hydrogen during bulk fuel transfer, fuel system checkout, and post-launch fuel system purging. Vented hydrogen would be controlled using a flare, which uses propane as auxiliary fuel. Emissions of combustion products from the hydrogen control flares were estimated using EPA AP-42 standard factors for external combustion. Emission rates would be very small (significantly less than 1 ton/year of all pollutants).

EPA AP-42 emission factors have been used to estimate emissions from RP-1 storage and fueling for the common booster(s). Estimates have been made for working emissions, caused by filling and emptying the storage tanks (including line purges), and breathing emissions, caused by daily warming and cooling of the tanks in the sunlight. Because RP-1 is not a very volatile fuel, emissions from RP-1 storage tanks are small (about 50 pounds per year). Currently, it is not anticipated that vapor control would be necessary for RP-1 storage and transfer equipment at Cape Canaveral AS. The final determination for control requirements would depend on the results of the Florida permitting process.

Emissions from hydrazine and N_2O_4 loading would be controlled by a combination of sealed transfer systems, wet scrubbing, and oxidation. The loading of MMH used in the SUS would be controlled using the existing fuel vapor incineration system (FVIS), which uses propane and excess air to oxidize the MMH into CO_2, nitrogen gas, and water. The FVIS is currently being used for the Titan IVB program to control emissions of A-50. The loading of N_2O_4 used in the SUS would be controlled using the existing oxidizer vapor scrubber system (OVSS), which uses a 25-percent sodium hydroxide solution as the scrubbing medium in a 4-tower, 1,500-gallon scrubber system. The sodium hydroxide solution converts N_2O_4 into aqueous sodium nitrate and aqueous sodium nitrite.

Hydrazine emissions are listed as HAP emissions. Emission rates of N_2O_4 are minimal compared to other sources of nitrogen oxides (much less than 1 ton per year).

After vehicle launch, the SLC must be cleaned and repaired. Surfaces are cleaned using an abrasive blaster, applying ablative coatings, and touching up or repainting painted surfaces. Particulate emissions from sandblasting have been estimated based on estimated abrasive use and a particulate emission factor. VOC emissions from coatings were obtained from the chemical usage described in Section 4.6, Hazardous Materials and Hazardous Waste Management, and an estimated evaporation rate.

Emissions could be reduced by using sealed transfer systems, wet scrubbing, and oxidation when loading hydrazine and N_2O_4. The final determination for control devices would depend on the results of the Florida permitting process.

Mobile Sources. Mobile sources of emissions for the baseline include vehicle deliveries, vehicle assembly and on-site transport, and personal automobile use and miscellaneous supply traffic.

Vehicle Deliveries. Concept A vehicle components would be delivered by truck and airplane. Truck emissions have been calculated using pounds of emissions per vehicle mile traveled. Emission factors were taken from the MOBILE 5a and PART5 computer models; emissions from required escort cars for oversized loads were calculated similarly.

Because the ROI for Cape Canaveral AS includes all of Brevard County, transportation emissions have been calculated for all Brevard County vehicular traffic that would be directly related to the EELV program.

Deliveries made by truck were assumed to involve round-trip traffic to and from the northern county line (50 percent) or the southern county line (50 percent). Travel along Interstate 95 was assumed.

It was assumed that aircraft deliveries would be made using a C-17 aircraft. Emissions from the C-17 aircraft were calculated using C-17A aircraft emission factors associated with landing and take-off. These factors are from Pratt & Whitney calculations and Procedures for Emission Inventory Preparation, Volume IV: Mobile Sources, "Modifications to Guidance Document, Chapter 5: Emissions from Aircraft" (U.S. Environmental Protection Agency, 1991). Aircraft would be used to transport boosters and CUSs. It was assumed that one aircraft would be used for each component delivered.

Vehicle Assembly and On-Site Transport. Assembly of the vehicle components and on-site transport of the vehicle involves emissions from mobile sources, several of which are standard vehicles (trucks, forklifts). Emissions from these sources were estimated using VMT and the emission factors available in the MOBILE 5a and PART5 computer models. Other mobile sources (cranes, specialized transport vehicles) are not standard and have no associated standard emission factors. Emissions from these vehicles have been calculated using hours of operation, rated capacity (in horsepower), and the stationary source AP-42 emission factors for the appropriate engine types. Pollutant activities from these sources are relatively minor, and general estimates were used where specific data were not available.

Personal Automobile Use and Miscellaneous Supply Traffic. Emissions from automobile use and supply traffic were calculated based on both on-site and off-site emissions. The method of calculation is based on VMT and the emission factors available in MOBILE5a and PART5 computer models, discussed in detail in Section 3.10.2. A surge in automobile traffic prior to launch has been accounted for in the calculations.

Emissions from mobile sources could be mitigated by minimizing trip occurrences and trip lengths, and by improving emissions controls on mobile sources. Potential operational mitigation measures would focus on land use or transportation planning and management measures to reduce motor vehicle pollution. Types of potential mitigation measures would include: (1) use of centralized parking areas and shuttle systems to reduce personal vehicle use on station; (2) promotion of carpools and vanpools by providing a rider matching service, preferential parking, and financial incentives; (3) improvements such as bicycle lanes, storage facilities, and showers to increase the use of bicycling as a mode of transportation; and (4) on-station location of facilities that would reduce the need for off-station travel (e.g., childcare facilities, cafeterias, postal machines, automated tellers). These measures would reduce VMT, vehicle trips, and peak-hour travel, and therefore reduce both regional and localized vehicle-related emissions of criteria pollutants.

Point Sources. Point sources would include combustion sources, such as boilers and internal combustion engines. There would be no new fuel-fired boilers or heaters for this concept; some existing equipment would be used. However, some propane combustion would be required for operation of the hydrogen control flare and the FVIS. Emissions from other point sources such as spray booths and solvent cleaning equipment have been included in the total emission calculations for vehicle preparation and assembly. Permitting for specific pieces of preparation and assembly equipment must be addressed under the Florida permitting requirements (FAC 62-210 through 213). Stationary sources must be addressed under the Title V program to determine whether a Title V permit modification would be required.

Emissions from boilers and other external combustion sources were estimated based on the program's estimated utility requirements. Propane usage is provided in therms per day, and EPA AP-42 emission factors were used to calculate emission estimates from combustion of propane.

Emissions from internal combustion sources have been estimated based on the use of three emergency generators (two 1,000 kW and one 350 kW) operating an assumed 52 hours/year (one weekly one-hour test); and three small engines (welders, compressors) of 50-brake horsepower each, operating an assumed 500 hours/year. EPA AP-42 emission factors have been used to calculate emissions estimates from combustion of these sources.

The duration and magnitude of emissions associated with vehicle preparation and assembly are such that any increase in localized air pollutant concentrations would be relatively small and short-lived. Local effects would be consistent with the effects from similar light industrial activities. Exposure to pollutant levels in the ambient air above permissible exposure limits would be possible but unlikely (based on similar historical and expected operational activities). Any health risks would more likely be associated with improper ventilation of pollutants. Health risks to on-site personnel could be minimized by providing proper ventilation of pollutants and compliance with OSHA requirements.

Regional impacts affecting maintenance of ambient air quality standards must be addressed in combination with other sections of the program. These impacts are addressed under Regional Air Quality Impacts, and are summarized in Table 4.10-5.

Launch Activities

Launch Emissions. The rapid combustion of fuel during vehicle launch produces emissions. The release of unburned fuel and the generation of NO_x from the heat generated by launch also produce emissions. In addition, the baking and scouring effect of the launch exhaust on the launch pad may produce a small amount of particulates and combustion product emissions.

Concept A launch vehicles would use a booster that burns RP-1 and LO_2. The composition of the after-burning emissions is very similar to that of the Atlas IIA core booster. The RD-180 engine used for Concept A launches has a more efficient design and should emit lower quantities of soot and unburned aromatic hydrocarbons from unburned propellant than other motors currently using RP-1. In contrast to the Atlas and Delta RP-1/LO_x engines, the RD-180 is a staged, closed-cycle combustion engine, which burns all fuel in the main combustion chamber, thus reducing the potential for soot formation. Unburned hydrocarbons that might survive the high temperatures of the combustion chamber would be afterburned in the hot region in the plume outside the engines. In addition, the RD-180 does not have a gas generator side flow, and the main combustion chamber operates at a much higher pressure than those of the Atlas engines; therefore, soot emissions would be reduced. Launches from Cape Canaveral AS are primarily GTO missions, and the flight trajectory typical of such a mission was used to estimate the amount of booster mass emitted into the lower atmosphere (0-3,000 feet). The launch vehicles would spend 29 seconds in the lower atmosphere for a GTO mission.

The chemicals of concern include the tropospheric criteria pollutants for which NAAQS apply (NO_x as NO_2, and CO) and tropospheric precursors to ozone (NO_x and reactive VOCs). Table 4.10-2 summarizes the total mass of the various chemicals of concern released into the lower atmosphere from vehicle exhaust and after-burning during a GTO mission.

Localized air quality impacts were assessed using the REEDM model. REEDM produces peak puff and 30-minute average concentration estimates. Many ambient air quality standards are expressed as 1-, 8-, and 24-hour averages, or an instantaneous ceiling. Launch emissions occur over periods of minutes,

Table 4.10-2. Summary of Flight Emissions Deposited in the Lower Atmosphere, Concept A[a] (in tons)

Launch Vehicle	Particulate	NO_x	CO	VOC
MLV-A	0.0	0.74	0.0	0.0
MLV-D	0.0	0.74	0.0	0.0
HLV-L	0.0	2.23	0.0	0.0
HLV-G	0.0	2.23	0.0	0.0

Note: (a) Assumes a geosynchronous transfer orbit mission.
CO = carbon monoxide
HLV = heavy lift variant
MLV = medium lift variant
NO_x = nitrogen oxides
VOC = volatile organic compound

and the launch plume rapidly clears the pad. An 8-hour average concentration was developed, assuming air quality impacts during 30 minutes of the 8-hour period. A maximum 8-hour average was developed by dividing the 30-minute average by 16. REEDM can also predict a peak puff concentration estimate as the puff moves over the receptor site. Tables for peak hourly and daily CO and NO_x predictions were produced. Rather than producing tables of each toxic hydrazine compound, the concentrations were summed for all hydrazine compounds. Separate tables of NH_3 concentrations were compiled when relevant, and tables for peak puff HCl concentrations were also compiled.

In practice, the REEDM results are factored into the local range safety risk management and launch decision models before a launch is allowed to proceed (see Section 3.7, Health and Safety).

The REEDM modeling exercises should be interpreted as screening tools; a systematic search for the worst-case meteorology beyond simple low wind speed conditions was not conducted. The worst-case modeling scenario depends on a number of factors including where the receptors of importance are located relative to the launch pad, the vertical profile of wind speed and direction, the atmospheric stability and the height of the mixed layer, and the stability/thickness of any capping inversion.

The predicted incremental concentrations for nominal (normal) launches for Concept A vehicles are presented in Table 4.10-3.

Table 4.10-3 indicates that since the launch would be a transient source, the 8-hour average CO concentration increment would only be a small fraction of the NAAQS and FAAQS.

The NAAQS for NO_x is an annual standard, and the annual average is not substantially perturbed by the transient releases from launches. For a consistent per-launch comparison, the Permissible Exposure Level (PEL) is shown, although this limit is not directly applicable to the EELV

Table 4.10-3. Summary of REEDM-Predicted Ambient Air Concentration Increments During Nominal Launches, Concept A

CO	Peak 8-hour average concentration increment (ppm)	NAAQS/FAAQS 8-hour average (ppm)
MLV-D	0.0	9
MLV-A	0.0	9
HLV-L	0.0	9
HLV-G	0.0	9
NO_x	Maximum 1-hour average concentration increment (ppm)	OSHA PEL[(a)] ceiling (ppm)
MLV-D	0.013	5
MLV-A	0.013	5
HLV-L	0.025	5
HLV-G	0.025	5

Note: (a) There is an annual NAAQS for NO_x; however, OSHA PELs are shown to provide a consistent per-launch comparison

CO = carbon monoxide
FAAQS = Florida Ambient Air Quality Standards
HLV = heavy lift variant
MLV = medium lift variant
NAAQS = National Ambient Air Quality Standards
NO_x = nitrogen oxides
OSHA = Occupational Safety and Health Administration
PEL = Permissible Exposure Level
ppm = parts per million
REEDM = Rocket Exhaust Effluent Dispersion Model

program. The PEL is a worker exposure limit; EELV program activities are not required to comply with this limit. The PEL is from the federal OSHA standards codified under Title 29 CFR 1910, Subpart Z. For conservative purposes, it has been assumed that all NO in NO_x is converted to NO_2 rapidly. In the absence of an applicable regulatory standard, the results indicate that the predicted NO_x maximum 30-minute average (NO + NO_2) concentration increment would be a small fraction of the OSHA PEL.

Launches are discrete events that cause short-term impacts on local air quality. Because launches are infrequent, and winds will rapidly disperse and dilute the launch emissions to background concentrations, long-term effects from pollutants are not expected.

Additional details and modeling results are presented in Appendix J. Regional impacts affecting maintenance of ambient air quality standards must be addressed in combination with other sections of the program.

Launch Failure Emissions. In addition to scheduled launches, on rare occasions, a launch could fail. Such a failure would result in deflagration, in which the fuel from all stages is explosively burned. Deflagrations result in a hot, buoyant ground cloud that is dispersed in the first 10,000 feet. Although the release of pollutants is an unscheduled event, it is important to consider the air quality impacts and any consequent risks that may arise. The air quality concentrations of criteria pollutants normally released during a successful launch might be larger for an aborted launch. An even more important concern is that there may be significant concentrations of toxic compounds that are normally released at much higher flight elevations, or that are released only because of uncontrolled combustion processes. The toxic compounds in the ground cloud can drift downwind and pose some degree of threat to at-risk animal and plant populations.

Emissions from launch failures have been estimated using the Aerospace fireball deflagration model (Brady et al., 1997) (Table 4.10-4). This model estimates the fate of the propellants and oxidants that are on board the vehicle. For the model runs, it was assumed that deflagration would occur on the launch pad. The possible fates of the propellants and oxidants are (1) combustion reaction with other propellants producing chemicals of concern and other reaction products; (2) thermal decomposition due to the high temperatures in the fireball; and (3) secondary non-combustion conversion to a chemical of concern or some other reaction product. The fractional masses of each propellant and oxidant for each fate were estimated utilizing the fireball model and then input into the REEDM model. The total emissions resulting from the deflagration fireball were estimated from the fate mass fractions and the total load of propellants and oxidants on the vehicle.

Concept A chemical of concern emissions from deflagration for each vehicle are summarized in Appendix J.

NH_3 was predicted by REEDM for the MLV-A and HLV-G abort scenarios. In the absence of an applicable regulatory standard, the OSHA PEL is shown for comparison, although it does not directly apply. The incremental concentrations are typical of rural ambient concentrations and would not pose any short-term health hazards.

For MLV-A and HLV-G vehicles, REEDM did not predict NO or NO_2 incremental concentrations during an abort. In the absence of an applicable regulatory standard, the results indicate that the predicted NO_x concentration increment would be a small fraction of the OSHA PEL.

Hydrazine compound concentrations have been estimated by REEDM for aborts of each launch vehicle. In the absence of an applicable regulatory standard, the OSHA PEL is shown for comparison. The maximum concentrations of hydrazine compounds are actually predicted for the smaller launch vehicle, possibly due to increased buoyancy making the final centerline height larger and the ground level concentrations smaller.

Regional Air Quality Impacts

Regional air quality impacts are best summarized by totaling the emissions in the ROI associated with the program. Criteria pollutants are of concern for long-term impacts over the entire air quality region (Brevard County).

Table 4.10-4. Summary of REEDM-Predicted Ambient Air Concentration Increments During Aborted Launches, Concept A

CO	Peak 8-hour average concentration increment (ppm)	NAAQS/FAAQS 8-hour average (ppm)
MLV-D	0.225	9
MLV-A	0.130	9
HLV-L	0.413	9
HLV-G	0.244	9
NO_x	Maximum 30-minute average concentration increment (ppm)	OSHA PEL[(a)] ceiling (ppm)
MLV-D	0.227	5
MLV-A	NA	5
HLV-L	0.139	5
HLV-G	NA	5
NH_3	Maximum 30-minute average concentration increment (ppm)	OSHA PEL[(a)] 8-hour average (ppm)
MLV-D	NA	50
MLV-A	0.004	50
HLV-L	NA	50
HLV-G	0.003	50
Hydrazine Compounds	Maximum 30-minute average concentration increment (ppm)	OSHA PEL[(a)] 8-hour average (ppm)
MLV-D	0.025	1
MLV-A	NA	1
HLV-L	0.015	1
HLV-G	NA	1

Note: (a) OSHA PELs are provided for hazard comparison purposes only. Although there is an annual NAAQS for NO_x, OSHA PELs are shown for a consistent per-launch comparison.

CO = carbon monoxide
FAAQS = Florida Ambient Air Quality Standards
HLV = heavy lift variant
MLV = medium lift variant
NA = not applicable
NAAQS = National Ambient Air Quality Standards
NH3 = ammonia
NOx = nitrogen oxides
OSHA = Occupational Safety and Health Administration
PEL = Permissible Exposure Level
ppm = parts per million
REEDM = Rocket Exhaust Effluent Dispersion Model

Annual emission rates depend on the proposed launch schedule (see Table 2.1-3). The emission summary for selected years from 2001 to 2020 is presented in Appendix J. The year of peak emissions into the lower atmosphere at Cape Canaveral AS is 2015 (Table 4.10-5).

Peak-year operation emissions of criteria pollutants would not jeopardize the attainment status for these pollutants, assuming that the attainment status criteria are the same in 2015 and everything else remains equal in Brevard County. Current baseline emissions in Brevard County are below the levels that would cause nonattainment, and the peak-year operation emissions

Table 4.10-5. Emission Comparison - Concept A, Cape Canaveral AS[a]

	Emissions (in tons)[b]				
	VOC	NO_x	CO	SO_2	PM_{10}
Launches	0.0	18.5	0.0	0.0	0.0
Preparation, Assembly, and Fueling	18.0	0.0	0.0	0.0	7.6
Mobile Sources	5.1	15.0	38.9	0.6	43.0
Point Sources	0.3	4.6	0.9	0.2	0.3
Total	23.4	38.0	39.8	0.8	50.9
Brevard County 1995 Total (for comparison)	24,983	26,122	134,743	27,524	35,090

Notes: (a) Includes emissions into the lower atmosphere (<3,000 feet) only.
(b) Emissions are based on launch rates shown in Table 2.1-3 for the peak emissions year at Cape Canaveral AS (2015)

CO = carbon monoxide
NO_x = nitrogen oxides
PM_{10} = particulate matter equal to or less than 10 microns in diameter
SO_2 = sulfur dioxide
VOC = volatile organic compound

would be only a small fraction of the county baseline. In addition, based on current emissions estimates, Concept A would result in a reduction of emissions from the baseline for all criteria pollutants.

4.10.1.1.2 **Concept A - Vandenberg AFB.** Localized air quality impacts can be addressed for Vandenberg AFB in a manner similar to that used for Cape Canaveral AS using methods described in Appendix J. Because of the attainment status and regulatory framework at Vandenberg AFB, regional air quality impacts must be assessed using additional thresholds and criteria, as described below.

Vandenberg AFB is situated in an area designated by the EPA as being in nonattainment of the ozone standard. The EELV program at this location would need to comply with air conformity requirements as defined in 40 CFR, 51 Subpart W, Section 176(c) of the CAA. The conformity rule defines the applicability criteria, including several source exemptions and de minimis emission thresholds, which determine if a federal action in a nonattainment area must conform or is exempt from conforming with the applicable SIP. If the total of indirect and direct emissions of a criteria pollutant in nonattainment exceeds the defined de minimis thresholds, a formal Air Conformity Determination is required. Requirements of an Air Conformity Determination include a public participation process and the demonstration of conformity with the SIP. General conformity prohibits the federal government from engaging in an activity that does not conform to the applicable SIP. Completion of an air conformity applicability analysis or an Air Conformity Determination does not exempt the federal action from any other requirements of the applicable SIP, the NEPA, or the CAA. Appendix K presents the required air conformity applicability analysis for the EELV program at Vandenberg AFB.

Changes associated with the EELV program would need to be documented in the ENVVEST reporting for Vandenberg AFB. Specifically, emissions from any stationary sources associated with EELV activities would need to be reported as part of the emissions from a source group. If emissions from any source group exceed applicable Title V permitting minimums, implementation of the ENVVEST program can be affected.

Under the current Rule 1301 source groups, the EELV stationary sources would likely fall under either the designation “Range Group” or “Commercial Space.” Actual emissions from each source group for 1994 are summarized in the table “Summary of Actual Emissions by SIC Major Group Code,” prepared by U.S. Air Force on April 24, 1997, and included in Appendix J. Based on this summary, NO_x emissions from the “Range Group” source group were 20.3 tons for 1994, compared to a Rule 370 threshold of 25 tons. Emissions of NO_x from this group can therefore increase by 4.7 tons before the ENVVEST program is affected. The NO_x emissions from the “Commercial Space” source group were 0.3 ton for 1994; emissions from this group can therefore increase by 24.7 tons before the ENVVEST program is affected.

The Concept A contractor plans to use existing boilers and heaters (NO_x sources) for this program. The existing boilers and heaters will be used for the EELV program instead of their current uses. The total estimated emissions of NO_x from these point sources is 4.5 tons per year, as shown in Table 4.10-10. These emissions will replace the baseline emissions (emissions associated with the current Atlas, Delta, and Titan programs). The total estimated baseline emissions of NO_x from point sources is 8.1 tons, as shown in Table 3.10-9. Therefore, implementing the Concept A EELV program is expected to decrease NO_x emissions by 3.6 tons per year. Because total emissions are expected to decrease, the EELV activities are not likely to negatively impact implementation of the ENVVEST program.

<u>Facility Construction</u>

Facility construction for Concept A operations at Vandenberg AFB would involve major renovation and selective new construction at SLC-3W. Major modifications would involve disturbing approximately 33 acres within the fence line at SLC-3W. Stripping, excavating, site clearing, backfilling, and compaction are expected to take place on about 16 acres per year. Ultimately, a total of 78,226 square feet has been assumed to require repaving. A combined total of 195,565 square feet of buildings and other structures would be constructed or renovated. Most of the construction would involve modifications to existing structures within the SLC-3W fenceline.

Emissions of pollutants were developed as described in Appendix J. Climatological parameters used in the calculation reflect wind speed and rainfall days appropriate to the Los Angeles, California, area (Table 4.10-6).

Table 4.10-6. Construction-Related Emissions - Concept A, Vandenberg AFB Average Annual Emissions Over Construction Period

Equipment	VOC	NO_x	CO	SO_2	PM_{10}
Grading Equipment (lbs/day)	3.3	28.2	19.3	13.4	2.3
Asphalt Paving (lbs/day)	0.5	3.3	4.9	4.9	0.2
Stationary Equipment (lbs/day)	6.8	14.8	150.1	1.7	12.6
Mobile Equipment (lbs/day)	15.6	87.6	77.7	1.8	12.4
Architectural Coatings (lbs/day)	9.5	0.0	0.0	0.0	0.0
Total Emissions (lbs/day)	35.7	133.9	252.0	21.8	27.5
Total Emissions (tpy)	4.1	15.4	29.0	2.5	3.2
Construction Commuter Automobiles (tpy)	1.7	1.7	19.6	0.1	8.0
Total Construction-Related Activities (tpy)	5.8	17.1	48.6	2.6	11.2
Santa Barbara County 1990 Total[(a)]	51,015	18,222	83,844	1,301	43,546
Santa Barbara County 1995 Total (tpy, for comparison)	44,664	13,994	102,509	1,290	29,374

Note: (a) The 1990 and 1995 inventory reporting structures differ according to the Santa Barbara County Air Pollution Control District.

CO = carbon monoxide
lbs = pounds
NO_x = nitrogen oxides
PM_{10} = particulate matter equal to or less than 10 microns in diameter
SO_2 = sulfur dioxide
tpy = tons per year
VOC = volatile organic compound

In addition to emissions that are directly construction-related, there would be emissions associated with commuter traffic (see Appendix J).

Local concentrations of criteria pollutants would increase during the construction phase as described in Section 4.10.1.1.1. Dust from construction activities should have minimal impacts on local communities on- and off-site. Impacts would be similar to those discussed for Cape Canaveral AS in Section 4.10.1.1.1.

The expected emissions of ozone precursors (VOC and NO_x) and PM_{10} from construction are small compared with the county baseline. However, since the SCCAB is in non-attainment for ozone and PM_{10} for state standards, these emissions would still be mitigated to the extent feasible.

Construction emissions of SO_2, NO_x, and CO would not jeopardize the attainment status for these pollutants. Baseline emissions in the SCCAB are below levels that would cause nonattainment, and the peak-year construction emissions are only a small fraction of the county baseline.

According to SBCAPCD Rule 202, permits are not required for engines used in construction activities. However, if the combined emissions from all construction equipment used to construct a stationary source that requires a permit have the potential to exceed 25 tons per year of SO_2, NO_x, PM_{10}, or VOC, emissions offsets must be obtained and the owner must demonstrate that no ambient air quality standard would be violated.

Measures to reduce emissions during the construction phase would be similar to those discussed for Cape Canaveral AS.

Operations

Pre- and Post-launch Processing. Pre- and post-launch processing for Concept A operations at Vandenberg AFB would result in minor amounts of air emissions from activities similar to those described in Section 4.10.1.1.1. Emissions of criteria pollutants could cause or contribute to the nonattainment of NAAQS or CAAQS for the region. Emissions of pollutants can also cause localized health effects.

Vehicle Preparation and Assembly. Procedures for vehicle preparation and assembly would be similar to those described in Section 4.10.1.1.1. Permitting for specific pieces of preparation and assembly equipment must be addressed under the California regional permitting requirements (SBCAPCD Regulation II). The use of toxic chemicals must be addressed under CCR 17-93000 et seq. (Toxic Air Contaminants); an Air Toxics “Hot Spots” questionnaire may need to be submitted. Changes would need to be documented in the ENVVEST reporting and could affect the status of Vandenberg AFB with regard to operating permit requirements.

Measures to reduce emissions would be taken during vehicle preparation and assembly similar to those discussed for Cape Canaveral AS.

Vehicle Fueling. Fueling of hydrogen for the CUS involves some venting of hydrogen during bulk fuel transfer, fuel system checkout, and post-launch fuel system purging. Emissions of combustion products from the hydrogen control flares have been estimated as described in Section 4.10.1.1.1.

Emission from RP-1 storage and fueling were estimated as described for Cape Canaveral AS in Section 4.10.1.1.1, and emissions would be minimal (less than 50 pounds per year). Existing RP-1 storage and handling equipment at SLC-3W has been permitted under Operating Permit 7397-03. This permit may need to be modified to allow for the changes in equipment and increased throughput (over the current 234,000-gallon-per-year limit). There are no vapor control requirements for the existing RP-1 equipment.

The final determination for control requirements for the new equipment would depend on the results of the SBCAPCD permitting process.

A combination of sealed transfer systems and portable scrubbers would be used to control emissions from hydrazine and N_2O_4 loading. The loading of MMH used in the SUS would be controlled using an existing portable bubble-cap scrubber, which uses water to trap hydrazine fuels. An existing portable scrubber similar to the oxidizer vapor scrubber system used for Titan IV operations would be used to control the loading of N_2O_4 used in the SUS.

Emissions of hydrazine are listed as HAP emissions. Emissions of N_2O_4 are minimal compared to other sources of nitrogen oxides (much less than 1 ton per year). The wet scrubbing systems have been permitted by SBCAPCD; these permits may need to be modified to reflect the change in operations.

After vehicle launch, the SLC must be cleaned and repaired. Surfaces are cleaned using a wire brush system, ablative coatings are applied, and painted surfaces are touched up or repainted. Particulate emissions from sandblasting were estimated based on typical abrasive use and a particulate emission factor, with an estimated 90-percent emissions reduction due to use of wire brushes instead of an abrasive blast system. VOC emissions from coatings were obtained from the chemical usage described in Section 4.6, Hazardous Materials and Hazardous Waste Management, and an estimated evaporation rate.

Emissions from the vehicle fueling operations could be reduced through the same measures described for Cape Canaveral AS. The final determination for control devices would depend on the results of the SBCAPCD permitting process.

Mobile Sources. Mobile sources of emissions would be the same as described in Section 4.10.1.1.1.

Vehicle Deliveries

Concept A vehicle components would be delivered by truck and aircraft. Emissions have been calculated as described in Section 4.10.1.1.1. Emission factors were taken from the EMFAC 7f and PART5 computer models; emissions from required escort cars for oversized loads were calculated similarly.

Because the ROI for Vandenberg AFB includes all of the SCCAB, transportation emissions have been calculated for all vehicular traffic in Santa Barbara, San Luis Obispo, and Ventura counties directly related to the EELV program.
Deliveries made by truck were assumed to involve round-trip traffic to and from the northern San Luis Obispo County line (50 percent) or the eastern Ventura County line (50 percent).

Aircraft emissions were estimated using the procedures described for Cape Canaveral AS in Section 4.10.1.1.1.

Vehicle Assembly and On-Site Transport. Assembly of the vehicle components and on-site transport of the vehicle would involve emissions from mobile sources (see Section 4.10.1.1.1). Emissions from these sources were estimated using VMT and the emission factors available in the EMFAC 7f and PART5 computer models. Other mobile sources emissions were calculated as described in Section 4.10.1.1.1.

Personal Automobile Use and Miscellaneous Supply Traffic. Emissions from automobile use and supply traffic were calculated based on both on- and off-site emissions. Emissions were calculated using VMT and the emission factors available in the EMFAC 7f and PART5 computer models. A surge in automobile traffic prior to launch has been accounted for in the calculations.

Emissions from mobile sources could be reduced by minimizing trip occurrences and trip lengths, and by improving emissions controls on mobile sources, as described in Section 4.10.1.1.1.

Point Sources. Point sources would include combustion sources, such as boilers and internal combustion engines (see Section 4.10.1.1.1). Also, some equipment currently at Vandenberg AFB would be used for the EELV program. Emissions from other point sources such as spray booths and solvent cleaning equipment have been included in the total emission calculations for vehicle preparation and assembly. Permitting for specific pieces of preparation and assembly equipment must be addressed under the SBCAPCD permitting requirements (Regulation II), and changes must be reflected in the ENVVEST reporting.

Emissions from boilers and other external combustion sources were estimated based on the estimated utility requirements for the program. Natural gas usage is provided in therms per day, and general EPA AP-42 emission factors were used to estimate emissions from combustion of natural gas.

Emissions from internal combustion sources were estimated based on the use of three emergency generators (two 1,000 kW and one 350 kW) operating an assumed 52 hours/year (one weekly one-hour test); and three small engines (welders, compressors, etc.) of 50 brake horsepower each, operating an assumed 500 hours/year. EPA AP-42 emission factors were used to calculate emissions estimates from combustion of these sources.

Emissions from point sources could be reduced through the use of propane instead of residual oil or solid fuel.

Impacts would be similar to those discussed in Section 4.10.1.1.1.

Regional impacts affecting maintenance of ambient air quality standards must be addressed in combination with other sections of the program. These impacts are addressed under Regional Air Quality Impacts and are summarized in Table 4.10-10.

Launch Activities

Launch Emissions. Vehicle launch emissions would occur as described in Section 4.10.1.1.1.

Concept A launch vehicles would use a booster that burns RP-1 and LO_2. The composition of the after-burning emissions is very similar to that of the Atlas IIA core booster. Launches from Vandenberg AFB are primarily LEO missions, and the flight trajectory for such a mission was used to estimate the amount of booster mass emitted into the lower atmosphere (0-3,000 feet) ROI. The launch vehicles would spend only 19 seconds in the lower atmosphere for an LEO mission.

The chemicals of concern include the tropospheric criteria pollutants for which NAAQS apply (NO_x, NO_2, and CO) and tropospheric precursors to ozone (NO_x and reactive VOCs). Table 4.10-7 summarizes the total mass of the various chemicals of concern released into the lower atmosphere from vehicle exhaust and after-burning during a LEO mission.

Table 4.10-7. Summary of Flight Emissions Deposited in the Lower Atmosphere, Concept A[(a)] (in tons)

Launch Vehicle	Particulate	NO_x	CO	VOC
MLV-A	0.0	0.48	0.0	0.0
MLV-D	0.0	0.48	0.0	0.0
HLV-L	0.0	1.44	0.0	0.0
HLV-G	0.0	1.44	0.0	0.0

Note: (a) Assumes a low-Earth orbit mission.
CO = carbon monoxide
HLV = heavy lift variant
MLV = medium lift variant
NO_x = nitrogen oxides
VOC = volatile organic compound

Localized air quality impacts have been assessed using the REEDM model (Table 4.10-8). The REEDM modeling for Vandenberg AFB should be interpreted as a screening tool; a systematic search for the worst-case meteorology was not conducted. In some, but not all cases, both a Vandenberg AFB and Cape Canaveral AS simulation were run for each launch

Table 4.10-8. Summary of REEDM-Predicted Ambient Air Concentration Increments for NO_x During Nominal Launches, Concept A

	Maximum 1-hour average concentration increment (ppm)	CAAQS 1-hour average NO_2 standard (ppm)
MLV-D	0.114	0.25
MLV-A	0.114	0.25
HLV-L	0.162	0.25
HLV-G	0.162	0.25

CAAQS = California Ambient Air Quality Standards
HLV = heavy lift variant
MLV = medium lift variant
NO_2 = nitrogen dioxide
NO_x = nitrogen oxides
ppm = parts per million
REEDM = Rocket Exhaust Effluent Dispersion Model

vehicle. The differences in the predictions are minor owing to similar meteorological inputs. Therefore, the modeling results presented in Section 4.10.1.1.1 also apply to Vandenberg AFB.

Additional details and modeling results are presented in Appendix J. Regional impacts affecting maintenance of ambient air quality standards must be addressed in combination with other sections of the program.

Launch Failure Emissions. Emissions from launch failures at Vandenberg AFB have been estimated using the Aerospace fireball deflagration model (Brady et al., 1997) (Table 4.10-9). The mass emission rates calculated from Concept A launch failures are the same at Vandenberg AFB as those shown for Cape Canaveral AS in Section 4.10.1.1.1.

Table 4.10-9. Summary of REEDM-Predicted Ambient Air Concentration Increments for NO_x During Aborted Launches, Concept A

	Peak 1-hour average concentration increment (ppm)	CAAQS 1-hour average NO_2 standard (ppm)
MLV-D	0.114	0.25
MLV-A	NA	0.25
HLV-L	0.057	0.25
HLV-G	NA	0.25

CAAQS = California Ambient Air Quality Standards
HLV = heavy lift variant
MLV = medium lift variant
NA = not applicable
NO_2 = nitrogen dioxide
NO_x = nitrogen oxides
ppm = parts per million
REEDM = Rocket Exhaust Effluent Dispersion Model

The CAAQS has an hourly NO_2 standard of 0.25 ppm. For conservative purposes, all NO in NO_x is assumed to convert to NO_2 rapidly. The REEDM-predicted NO_x (NO + NO_2) incremental concentrations resulting from the aborts of Concept A vehicles have been summarized in Table 4.10-9.

For the MLV-A and HVL-G vehicles, REEDM did not predict NO or NO_2 incremental concentrations during an abort. The results indicate that in the worst case, the predicted maximum hourly NO_x concentration increment is one-half of the hourly NO_2 standard.

Regional Air Quality Impacts

Regional impacts on the lower atmosphere are best summarized by totaling the emissions in the ROI associated with the program. Criteria pollutants are of concern for long-term impacts over the entire air quality region (SCCAB).

Annual emission rates depend on the proposed launch schedule (see Table 2.1-3). Many of the emission-generating activities occur once per vehicle launch. Launch emissions are summarized for the peak year (2007) in Table 4.10-10. A summary of launch emissions for other key years between 2001 and 2020 is presented in Appendix J.

Table 4.10-10. Emission Comparison - Concept A, Vandenberg AFB[a]

	Emissions (in tons)[b]				
	VOC	NO_x	CO	SO_2	PM_{10}
Launches	0.0	4.8	0.0	0.0	0.0
Preparation, Assembly, and Fueling	7.5	0.0	0.0	0.0	0.3
Mobile Sources	2.2	4.4	27.5	0.2	34.5
Point Sources	0.3	4.5	0.9	0.2	0.3
Total	10.0	13.7	28.4	0.5	35.1
Santa Barbara County 1990 Total[c]	51,015	18,222	83,844	1,301	43,546
Santa Barbara County 1995 Total (for comparison)	44,664	13,994	102,509	1,290	29,374

Notes: (a) Includes emissions into the lower atmosphere (<3,000 feet) only.
(b) Emissions are based on launch rates shown in Table 2.1-3 for the peak emissions year at Vandenberg AFB (2007).
(c) The 1990 and 1995 inventory reporting structures differ according to the Santa Barbara County Air Pollution Control District.
CO = carbon monoxide
NO_x = nitrogen oxides
PM_{10} = particulate matter equal to or less than 10 microns in diameter
SO_2 = sulfur dioxide
VOC = volatile organic compound

The expected emissions of ozone precursors (VOC and NO_x) and PM_{10} from peak-year operation are minimal compared with the county baseline. However, since the SCCAB is in nonattainment for ozone and PM_{10} for state standards, these emissions would still be mitigated to the extent feasible.

Peak-year operation emissions of SO_2, NO_x, and CO would not jeopardize the attainment status for these pollutants, assuming that attainment status criteria are the same in the peak year, and everything else remains equal in Santa Barbara County. Baseline emissions in the SCCAB are below the levels that would cause nonattainment, and the peak-year construction emissions are only a small fraction of the county baseline.

Based on current emissions estimates, Concept A would result in a reduction of emissions from the baseline for all criteria pollutants. The final system design would need to be compared with the permitting and regulatory requirements listed in Section 3.10 to determine the required action.

Based upon current estimates of stationary source emissions and the emissions estimates from the ENVVEST source categories, it does not appear that installation of new stationary sources to support the EELV program would trigger new requirements under SBCAPCD Rule 1301. Vandenberg AFB would need to consider EELV operations when determining whether ENVVEST emission reduction goals are being met.

4.10.1.2 **Concept B**

4.10.1.2.1 **Concept B - Cape Canaveral AS.** Air quality impacts from Concept B operations would result from the general sources described in Section 4.10.1.1.1, except that boilers for heating and propane for fuel would not be required. Vehicle components would be delivered by truck, aircraft, rail, and barge; emissions from these vehicles were calculated and compared to existing mobile source emissions. Fuels used in the Concept B vehicles include cryogenic liquids (LO_2 and LH_2), hydrazines (A-50 and N_2H_4), N_2O_4, and solid rocket propellant. Emissions from the handling and storage of these fuels were calculated and compared to existing emissions.

Facility Construction

Emissions generated by facility construction activities would be in the form of either gaseous or particulate pollutant emissions. Combustion product emissions would occur from construction equipment and worker vehicle travel to and from the site by construction workers, and particulate matter would occur from construction, as discussed for Concept A in Section 4.10.1.1.

Facility construction for Concept B at Cape Canaveral AS would involve renovation and new construction at SLC-37 (Pads 37A and 37B) and at other locations on Cape Canaveral AS. A total of approximately 96 acres (net of buildings) would be disturbed as part of site clearing, stripping, excavating, backfilling, and compaction operations. Building renovations and new construction would involve approximately 823,600 square feet, with over 85 percent within the launch facilities area and the remainder remote from the launch site. Square footage for all individual structures was estimated from scale site plan drawings considering facilities with similar purposes at other military properties. All calculations were made on the basis of average annual emissions over the construction period.

Construction emissions have been calculated using the methods described for Concept A in Section 4.10.1.1. Table 4.10-11 provides a summary of construction-related emissions.

Table 4.10-11. Construction-Related Emissions - Concept B, Cape Canaveral AS Average Annual Emissions Over Construction Period

	VOC	NO_x	CO	SO_2	PM_{10}
Grading Equipment (lbs/day)	8.1	51.7	11.2	3.4	9.0
Asphalt Paving (lbs/day)	0.9	0.0	0.0	0.0	0.0
Stationary Equipment (lbs/day)	63.9	52.1	11.3	3.5	3.0
Mobile Equipment (lbs/day)	60.8	612.0	616.2	34.6	45.6
Architectural Coatings (lbs/day)	50.2	0.0	0.0	0.0	0.0
Total Emissions (lbs/day)	183.9	715.8	638.6	41.5	57.7
Total Emissions (tpy)	21.2	82.3	73.4	4.8	6.6
Construction Commuter Automobiles (tpy)	1.7	2.6	12.2	0.1	6.1
Total Construction-Related Activities (tpy)	22.9	84.9	85.6	4.7	12.7
Brevard County 1995 Total (tpy, for comparison)	24,983	26,122	134,743	27,524	35,090

CO = carbon monoxide
lbs = pounds
NO_x = nitrogen oxides
PM_{10} = particulate matter equal to or less than 10 microns in diameter
SO_2 = sulfur dioxide
tpy = tons per year
VOC = volatile organic compound

In addition to emissions that are directly construction-related, there would be emissions associated with commuter traffic. VMT for employees, including commuting distances and non-work trips, were calculated (see Appendix J).

Measures could be taken to reduce fugitive dust emissions from ground-disturbing activities and combustive emissions from construction equipment; these measures would be similar to those described for Concept A in Section 4.10.1.1.1.

Local concentrations of criteria pollutants would increase during the construction phase, as described in Section 4.10.1.1.1. Impacts would be temporary, local, and minor.

Dust from construction activities should have minimal impacts on local communities, either on or off site.

Brevard County currently meets the FAAQS and NAAQS for ozone, SO_2, NO_x, CO, and PM_{10}. Because the area is in attainment for these pollutants, the FDEP has not been required to establish specific emission reduction measures. As discussed in Section 4.10.1.1.1, the PSD process does not provide a mechanism for dealing with non-stationary sources such as motor vehicles and aircraft.

Construction emissions of criteria pollutants would not jeopardize the attainment status for these pollutants. Current Brevard County baseline emissions are below the levels that would cause nonattainment, and the peak-year construction emissions would be only a small fraction of the baseline.

Operations

Pre- and Post-Launch Processing. Pre- and post-launch processing for Concept B operations at Cape Canaveral AS would result in minor amounts of air emissions as described in Section 4.10.1.1.1.

Emissions from pre-launch and post-launch processing would include criteria pollutants and toxic or irritant pollutants (including HAPs). Emissions of criteria pollutants could cause or contribute to the nonattainment of NAAQS or FAAQS for the region. Emissions of pollutants can also cause localized health effects.

Vehicle Preparation and Assembly. Manufacturing of Concept B vehicle components would occur off site; emissions have not been included in the scope of this EIS. The components would arrive complete, requiring only final on-site safety and quality checks prior to assembly.

Some chemical use would occur in the vehicle preparation and assembly stages. Emissions from chemical use and permitting requirements would be similar to those described in Section 4.10.1.1.1. A discussion of the Title V Operating Permit Application and associated requirements is provided in Section 4.10.1.1.1.

The EELV contractor has committed to implementing the program without the use of any Class I ODSs. The use of Class II ODSs (for refrigeration, etc.) would be minimized or eliminated.

Emissions of VOCs could be reduced as described in Section 4.10.1.1.1.

Vehicle Fueling. Fueling of hydrogen would involve some venting of hydrogen during bulk fuel transfer, fuel system checkout, and post-launch fuel system purging. Vented hydrogen would be controlled using a flare, which uses propane as auxiliary fuel. Emissions of combustion products from the hydrogen control flares have been estimated using EPA AP-42 standard factors for external combustion. Emission rates would be very small (significantly less than 1 ton/year of all pollutants).

A combination of sealed transfer systems, wet scrubbing, and oxidation would be used to control emissions from hydrazine, A-50, and N_2O_4 loading. The loading of hypergolic fuel used in the HUS would be controlled using packed-tower scrubber technology. Water/citric acid is contacted with the exhaust gas in a counter-current-packed tower that allows for intimate air-water contact. The hydrazine fuel is captured by the scrubber liquor. The loading of N_2O_4 would be controlled using similar scrubber equipment. The system uses a caustic (sodium hydroxide) solution to convert N_2O_4 into aqueous nitrates and nitrites. An alternative to sodium hydroxide would be potassium hydroxide, which would have the benefit of creating a fertilizer product instead of a liquid hazardous waste.

Emissions of hydrazine are listed as HAPs. Emissions of N_2O_4 are minimal compared to other sources of nitrogen oxides (much less than 1 ton per year).

After vehicle launch, the SLC must be cleaned and repaired. Surfaces are cleaned using an abrasive blaster, ablative coatings are applied, and painted surfaces are touched up or repainted. Particulate emissions from sandblasting were estimated based on estimated abrasive use and a particulate emission factor. VOC emissions from coatings were obtained from coating use estimates.

Further mitigation could be achieved using expanded capture and control systems. The final determination for control devices would depend on the results of the Florida permitting process.

Mobile Sources. Mobile emission sources are described in Section 4.10.1.1.1.

Vehicle Deliveries. Concept B vehicle components would be delivered by truck, aircraft, rail, and barge. Truck emissions have been calculated using pounds of emissions per vehicle mile traveled. Emission factors were taken from the MOBILE 5a and PART5 computer models; emissions from required escort cars for oversized loads were calculated similarly.

Transportation emissions have been calculated as described in Section 4.10.1.1.1.

Concept B aircraft deliveries were assumed to be made using a C-5 Galaxy aircraft. Emissions from the C-5 aircraft associated with landing and take-off were calculated using the factors available in the Calculation Methods for Criteria Air Pollutant Emission Inventories (Jagielski and O'Brien, 1994).

It was assumed that Concept B barge deliveries would be made in an unpowered barge maneuvered by two tugboats of 900 horsepower each. A 1-hour-approach and a 2-hour return for the tugboats was assumed for emission estimates.

Vehicle Assembly and On-Site Transport. Assembly of the vehicle components and on-site transport of the vehicle would involve emissions from mobile sources. Emissions were calculated as described in Section 4.10.1.1.1.

Personal Automobile Use and Miscellaneous Supply Traffic. Emissions from automobile use and supply traffic were calculated as described in Section 4.10.1.1.1. Emissions from mobile sources could be reduced through implementation of measures described in Section 4.10.1.1.1.

Point Sources. Calculation of point source emissions would be the same as discussed in Section 4.10.1.1.1. Permitting for specific pieces of preparation and assembly equipment must be addressed under the Florida permitting requirements (FAC 62-210 through 213).

Regional impacts affecting maintenance of ambient air quality standards must be addressed in combination with other sections of the program. These impacts are addressed under Regional Air Quality Impacts and are summarized in Table 4.10-15.

Launch Activities

Launch Emissions. Vehicle launch emissions would occur as described in Section 4.10.1.1.1.

Concept B launch vehicles would use a booster that burns LH_2 and LO_2. The composition of the after-burning emissions would be very clean, essentially resulting in only water, unburned fuel, and oxy-hydrogen radicals. The primary flight trajectory of launches from Cape Canaveral AS is GTO. This trajectory was used to estimate the amount of booster mass emitted into the lower atmosphere (0-3,000 feet). The launch vehicles would spend only 29 seconds in the lower atmosphere for a GTO mission.

The chemicals of concern include the tropospheric criteria pollutants for which NAAQS apply (NO_x, CO) and tropospheric precursors to ozone (NO_x and reactive VOCs). Table 4.10-12 summarizes the total mass of the various chemicals of concern released into the lower atmosphere from vehicle exhaust and after-burning during a GTO mission.

Table 4.10-12. Summary of Flight Emissions Deposited in the Lower Atmosphere, Concept B[a] (in tons)

Launch Vehicle	Particulate	NO_x	CO	HCl	VOC
DIV-S	0.0	0.56	0.0	0.0	0.0

DIV-M	0.0	0.56	0.0	0.0	0.0
DIV-M+	4.19	0.74	0.0	2.16	0.0
DIV-H	0.0	1.69	0.0	0.0	0.0

Note: (a) Assumes a geosynchronous transfer orbit mission.
CO = carbon monoxide
DIV-H = heavy launch vehicle
DIV-M = medium launch vehicle
DIV-M+ = medium launch vehicle with solid rocket motor strap-ons
DIV-S = small launch vehicle
HCl = hydrochloric acid
NO_x = nitrogen oxides
VOC = volatile organic compound

Localized air quality impacts were assessed using the REEDM model, similar to the assessments made for Concept A in Section 4.10.1.1.1. The model results are presented in Table 4.10-13. Table 4.10-13 indicates that the 8-hour average concentration increment for CO would be only a very small fraction of the NAAQS and FAAQS.

The NAAQS for NO_x is an annual standard, and the annual average is not substantially perturbed by the transient releases from launches. For comparison purposes, the OSHA PEL is shown, although this limit is not directly applicable. For conservative purposes, it has been assumed that all NO in NO_x is converted to NO_2 rapidly.

The predicted ambient concentrations of NO or NO_2 for nominal launches actually show the effects of the increased buoyancy due to the extreme heat release of the three boosters. Due to increased plume rise, the concentrations at the ground decrease significantly. The results indicate that the highest predicted NO_x concentration increment would be a very small fraction of the OSHA PEL.

Table 4.10-13. Summary of REEDM-Predicted Ambient Air Concentration Increments During Nominal Launches, Concept B

CO	Maximum 8-hour average concentration increment (ppm)	NAAQS/FAAQS 8-hour average (ppm)
DIV-S	0.0	9
DIV-M	0.0	9
DIV-M+	0.0	9
DIV-H	0.0	9
NO_x	Maximum 30-minute average concentration increment (ppm)	OSHA PEL[(a)] ceiling (ppm)
DIV-S	0.022	5
DIV-M	0.022	5
DIV-M+	0.026	5
DIV-H	0.012	5
HCl	Peak puff concentration increment (ppm)	OSHA PEL[(a)] ceiling (ppm)
DIV-S	0.0	5
DIV-M+	0.293	5

Note: (a) OSHA PELs are provided for hazard comparison purposes only. Although there is an annual NAAQS for NO_x, OSHA PELs are shown for a consistent per-launch comparison.

CO = carbon monoxide
DIV-H = heavy launch vehicle
DIV-M = medium launch vehicle
DIV-M+ = medium launch vehicle with solid rocket motor strap-ons
DIV-S = small launch vehicle
FAAQS = Florida Ambient Air Quality Standards
HCl = hydrochloric acid
NAAQS = National Ambient Air Quality Standards
NO_x = nitrogen oxides
OSHA = Occupational Safety and Health Administration
PEL = Permissible Exposure Level
ppm = parts per million
REEDM = Rocket Exhaust Effluent Dispersion Model

Launch Failure Emissions. As discussed in Section 4.10.1.1.1, a launch could fail on the pad. Emissions from launch failures have been estimated using the Aerospace fireball deflagration model (Brady et al., 1997) (Table 4.10-14). The Concept B emissions of chemicals of concern from deflagration for each vehicle are summarized in Appendix J.

NO or NO_2 incremental concentrations during an abort were predicted by REEDM for only the DIV-S vehicle configuration.

Ammonia was predicted by REEDM for all Concept B abort scenarios. The resulting maximum 30-minute average concentrations have been compared to the OSHA PEL, although they do not directly apply. Emissions would be a very small fraction of this PEL.

Hydrazine compound concentrations were estimated by REEDM for each launch vehicle for the abort scenario when the upper stage fuels could be

Table 4.10-14. Summary of REEDM-Predicted Ambient Air Concentration Increments During Aborted Launches, Concept B

CO	Maximum 8-hour average concentration increment (ppm)	NAAQS/FAAQS 8-hour average (ppm)
DIV-S	0.0009	9
DIV-M	NA	9
DIV-M+	0.0007	9
DIV-H	NA	9
NO_x	Maximum 30-minute average concentration increment (ppm)	OSHA PEL[(a)] ceiling (ppm)
DIV-S	0.143	5
DIV-M	NA	5
DIV-M+	NA	5
DIV-H	NA	5
NH_3	Maximum 8-hour average concentration increment (ppm)	OSHA PEL[(a)] 8-hour average (ppm)
DIV-S	0.004	50
DIV-M	0.002	50
DIV-M+	0.002	50
DIV-H	0.002	50
Hydrazine Compounds	Maximum 30-minute average concentration increment (ppm)	OSHA PEL[(a)] ceiling (ppm)
DIV-S	0.013	1
DIV-M	0.0	1
DIV-M+	0.0	1
DIV-H	0.0	1
HCl	Peak puff concentration increment (ppm)	OSHA PEL[(a)] ceiling (ppm)
DIV-M+	0.023	5

Note: (a) OSHA PELs are provided for hazard comparison purposes only. Although there is an annual NAAQS for NO_x, OSHA PELs are shown for a consistent per-launch comparison.

CO = carbon monoxide
DIV-H = heavy launch vehicle
DIV-M = medium launch vehicle
DIV-M+ = medium launch vehicle with solid rocket motor strap-ons
DIV-S = small launch vehicle
FAAQS = Florida Ambient Air Quality Standards
HCl = hydrochloric acid
NA = not applicable
NAAQS = National Ambient Air Quality Standards
NH_3 = ammonia
NOx = nitrogen oxides
OSHA = Occupational Safety and Health Administration
PEL = Permissible Exposure Level
REEDM = Rocket Exhaust Effluent Dispersion Model

combusted. As discussed previously, there is no NAAQS or FAAQS for hydrazine; the OSHA PEL is shown for comparison, although it does not directly apply. The maximum concentrations of hydrazine compounds resulting from the use of the DIV-S with its HUS are larger than any of the other Concept B configurations.

Chlorine in the form of HCl was predicted for the DIV-M+ vehicles (commercial only). There is no NAAQS or FAAQS for HCl. For comparison purposes, the PEL is shown, although this limit is not directly applicable. Peak puff concentrations are a small fraction of the OSHA PEL ceiling limit. The largest concentrations occur under nominal launch conditions and are so small that they do not appear to pose any short-term health hazards.

Additional details and modeling results are presented in Appendix J. Regional impacts affecting maintenance of ambient air quality standards must be addressed in combination with other sections of the program.

Regional Air Quality Impacts

Regional impacts on the lower atmosphere are best summarized by totaling the emissions into the ROI associated with the program. Criteria pollutants are of concern for long-term impacts over the entire air quality region (Brevard County). Emissions from the launch itself were modeled using REEDM to determine local impacts. Other EELV-related air emissions are generally of longer duration, lower mass emission rate, and are spread over Cape Canaveral AS and the air quality region. Short-term criteria pollutant concentrations are therefore not of concern for launch support activities.

Annual emission rates would depend on the proposed launch schedule (see Table 2.1-8). Many of the emission-generating activities occur once per vehicle launch. Peak-year emissions are summarized in Table 4.10.15. Emission summaries for key years between 2001 and 2020 are presented in Appendix J.

Table 4.10-15. Emission Comparison - Concept B, Cape Canaveral AS[(a)]

	Emissions (in tons)[(b)]				
	VOC	NO_x	CO	SO_2	PM_{10}
Launches	0.0	15.1	0.0	0.0	25.1
Preparation, Assembly, and Fueling	15.2	0.0	0.0	0.0	2.8
Mobile Sources	10.1	23.0	73.2	1.0	61.7
Point Sources	0.8	14.0	3.7	1.6	0.4
Total	26.1	52.1	76.9	2.6	90.0
Brevard County 1995 Total (for comparison)	24,983	26,122	134,743	27,524	35,090

Notes: (a) Includes emissions into the lower atmosphere (<3,000 feet) only.
(b) Emissions are based upon launch rates shown in Table 2.1-8 for the peak emission year at Cape Canaveral AS (2015).
AS = Air Station
CO = carbon monoxide
NO_x = nitrogen oxides
PM_{10} = particulate matter equal to or less than 10 microns in diameter
SO_2 = sulfur dioxide
VOC = volatile organic compound

Peak-year operation emissions of criteria pollutants would not jeopardize the attainment status for these pollutants. Baseline emissions in Brevard County are below the levels that would cause nonattainment, and the peak-year operation emissions are only a small fraction of the county baseline. In addition, based on current emissions estimates, a reduction of emissions from the baseline for all criteria pollutants would occur under Concept B.

4.10.1.2.2 **Concept B - Vandenberg AFB.** Localized air quality impacts have been addressed for Vandenberg AFB in a manner similar to that described in Section 4.10.1.1.2. Because of the attainment status and regulatory framework at Vandenberg AFB, regional air quality impacts must be assessed using additional thresholds and criteria. As described in Section 4.10.1.1.2, an air conformity applicability analysis is required to determine if the total of direct and indirect emissions of a criteria pollutant in a nonattainment area caused by the federal action equals or exceeds de minimis thresholds (see Appendix K).

Changes associated with the EELV program would need to be documented in the ENVVEST reporting for Vandenberg AFB, as discussed for Concept A in Section 4.10.1.1.1. The Concept B contractor plans to use new boilers and heaters (NO_x sources) for this program. These new boilers and heaters will be installed and used for the EELV program; boilers and heaters associated with the current Atlas, Delta, and Titan programs will either no longer be used, or their usage will be reduced. The total estimated emissions of NO_x from the new point sources is 4.2 tons per year, as shown in Table 4.10-20. These emissions will replace the baseline emissions (emissions associated with the current Atlas, Delta, and Titan programs). The total estimated baseline emissions of NO_x from point sources is 8.1 tons, as shown in Table 3.10-9. Therefore, implementing the Concept B EELV program is expected to decrease NO_x emissions by 3.9 tons per year. Because total emissions are expected to decrease, the EELV activities are not likely to negatively impact implementation of the ENVVEST program.

Facility Construction

Emissions generated by facility construction activities are described in Sections 4.10.1.1.1 and 4.10.1.1.2.

Facility construction for Concept B operations at Vandenberg AFB would involve extensive renovation and some new construction at SLC-6. Construction would involve disturbing 49.7 acres within the SLC-6 fenceline over a 32-month period. Stripping, excavating, site clearing, backfill, and compaction are expected to take place on about 19 acres per year. Ultimately, a total of 337,675 square feet has been projected as requiring repaving. A combined total of 844,188 square feet of buildings and other structures would be constructed or renovated. Nearly all of the facilities construction would involve modifications to existing structures within the SLC-6 fenceline. Additional renovation would include work planned for Buildings 520, 838, 398, and 330 (all facilities remote to SLC-6).

Emissions of pollutants were developed as described in Appendix J. Climatological parameters specific to the Los Angeles, California, area were used to reflect wind speed and rainfall days appropriate to the site.

In addition to emissions that are directly construction-related, there would be emissions associated with commuter traffic (see Section 4.10.1.1.1).

Measures to reduce emissions during the construction phase would be similar to those described for Cape Canaveral AS.

Local concentrations of criteria pollutants would increase during the construction phase, as described in Section 4.10.1.1.1 (Table 4.10-16).

Table 4.10-16. Construction-Related Emissions - Concept B, Vandenberg AFB Average Annual Emission Over Construction Period

Equipment	VOC	NO_x	CO	SO_2	PM_{10}
Grading Equipment (lbs/day)	2.5	21.6	20.7	2.6	1.7
Asphalt Paving (lbs/day)	0.4	4.0	2.5	0.5	0.3
Stationary Equipment (lbs/day)	57.0	1.1	748.6	0.3	0.1
Mobile Equipment (lbs/day)	17.2	55.6	32.5	2.9	4.9
Architectural Coatings (Non-Residential) (lbs/day)	38.0	0.0	0.0	0.0	0.0
Total Emissions (lbs/day)	115.1	82.3	807.2	6.3	7.0
Total Emissions (tpy)	13.2	9.5	92.8	0.7	0.8
Construction Commuter Automobiles (tpy)	1.3	1.2	15.6	0.1	5.4
Total activities (Construction and Commuter) (tpy)	14.5	10.7	108.4	0.8	6.2
Santa Barbara County 1990 Total[(a)]	51,015	18,222	83,844	1,301	43,546
Santa Barbara County 1995 Total (tpy, for comparison)	44,664	13,994	102,509	1,290	29,374

Note: (a) The 1990 and 1995 inventory reporting structures differ according to the Santa Barbara County Air Pollution Control District.

CO = carbon monoxide
lbs = pounds
NO_x = nitrogen oxides
PM_{10} = particulate matter equal to or less than 10 microns in diameter
SO_2 = sulfur dioxide
tpy = tons per year
VOC = volatile organic compound

Dust from construction activities should have minimal impacts to local communities either on or off site, similar to those discussed for Concept A in Section 4.10.1.1.1.

The expected emissions of ozone precursors (VOC and NO_x) and PM_{10} from construction would be minimal compared with the county baseline. However, since the SCCAB is in non-attainment for ozone and PM_{10}, these emissions would still be mitigated to the extent feasible.

Construction emissions of SO_2, NO_x, and CO would not jeopardize the attainment status for these pollutants. Baseline emissions in the SCCAB are below levels that would cause nonattainment, and the peak-year construction emissions are only a small fraction of the county baseline.

According to SBCAPCD Rule 202, permits are not required for engines used in construction activities. However, if the combined emissions from all construction equipment used to construct a stationary source that requires a permit have the potential to exceed 25 tons per year of SO_2, NO_x, PM_{10}, or VOC, emissions offsets must be obtained, and the owner must demonstrate that no ambient air quality standard would be violated.

<u>Operations</u>

Pre- and Post-Launch Processing. Pre- and post-launch processing for Concept B operations at Vandenberg AFB would result in minor amounts of air emissions from activities similar to those discussed for Cape Canaveral AS in Section 4.10.1.1.1. Emissions of criteria pollutants could cause or contribute to the nonattainment of NAAQS or CAAQS for the region. Emissions of pollutants can also cause localized health effects.

Vehicle Preparation and Assembly. Procedures for vehicle preparation and assembly would be similar to those described in Section 4.10.1.1.2. Measures to reduce emissions during vehicle preparation and assembly would be similar to those discussed in Section 4.10.1.1.1.

Vehicle Fueling. Fueling of hydrogen for the CUS would be the same as described in Section 4.10.1.2.1.

Emissions from hydrazine and N_2O_4 loading would be controlled by a combination of sealed transfer systems and portable scrubbers. The loading of MMH used in the CUS would be controlled using an existing portable bubble-cap scrubber, which uses water and citric acid to trap hydrazine fuels. An existing portable scrubber similar to the oxidizer vapor scrubber system used for Titan IVB operations would be used to control the loading of N_2O_4 used in the CUS.

Emissions of hydrazine are listed as HAPs emissions. Emissions of N_2O_4 are minimal compared to other sources of nitrogen oxides. The wet scrubbing systems have been permitted by SBCAPCD, but have since been exempted from permitting requirements. If permits are necessary, these permits would need to be modified to reflect the change in operation.

After vehicle launch, the SLC must be cleaned and repaired, as described in Section 4.10.1.2.1.

Mobile Sources. Mobile sources of emissions would be the same as those described in Section 4.10.1.1.1.

Vehicle Deliveries. Concept B vehicle components would be delivered by truck, aircraft, barge, or rail. Truck emissions were calculated using pounds of emissions per VMT based on EMFAC 7f and PART5 emission factors; emissions from required escort cars for oversized loads were calculated similarly.

Because the ROI for Vandenberg AFB includes all of the SCCAB, transportation emissions were calculated for all vehicular traffic that would take place in Santa Barbara, San Luis Obispo, and Ventura counties directly related to the EELV program.

It is assumed that deliveries made by truck would involve round-trip traffic to and from the northern San Luis Obispo County line (50 percent) or the eastern Ventura County line (50 percent).

Emissions from aircraft and barge operations were calculated as described in Section 4.10.1.2.1.

Vehicle Assembly and On-Site Transport. Assembly of the vehicle components and on-site transport of the vehicle would involve emissions from mobile sources which were estimated as described in Section 4.10.1.1.2.

Personal Automobile Use and Miscellaneous Supply Traffic. Emissions from automobile use and supply traffic were calculated based on both on- and off-site emissions. It was assumed that each vehicle would travel once per day to and from the center of its resident city to Cape Canaveral AS. Emissions were calculated using vehicle miles traveled and the emission factors in the EMFAC 7f and PART5 computer models. A surge in automobile traffic prior to launch has been accounted for in the calculations.

Point Sources. Point sources would be the same as those described in Section 4.10.1.1.1. Some equipment currently at Vandenberg AFB would be used for the EELV program. Emissions were calculated as described in Section 4.10.1.1.2. Permitting for specific pieces of preparation and assembly equipment must be addressed under the SBCAPCD permitting requirements (Regulation II), and changes must be noted in the ENVVEST reporting.

The duration and magnitude of emissions associated with vehicle preparation and assembly are described in Section 4.10.1.1.1.

Regional impacts affecting maintenance of ambient air quality standards must be addressed in combination with other sections of the program. These impacts are addressed under Regional Air Quality Impacts and are summarized in Table 4.10-20.

Launch Activities

Launch Emissions. Vehicle launch emissions would occur as described in Section 4.10.1.1.1.

The chemicals of concern include the tropospheric criteria pollutants for which NAAQS apply (NO_x, and CO) and tropospheric precursors to ozone (NO_x and reactive VOCs). Table 4.10-17 summarizes the total mass of the various chemicals of concern released into the lower atmosphere from vehicle exhaust and after-burning during a LEO mission from Vandenberg AFB.

Table 4-10-17. Summary of Flight Emissions Deposited in the Lower Atmosphere, Concept B[(a)] (in tons)

Launch Vehicle	Particulate	NO_x	CO	HCl	VOC
DIV-S	0.0	0.37	0.0	0.0	0.0
DIV-M	0.0	0.37	0.0	0.0	0.0
DIV-M+	2.71	0.48	0.0	1.40	0.0
DIV-H	0.0	1.10	0.0	0.0	0.0

Note: (a) Assumes a low-Earth orbit mission.
CO = carbon monoxide
DIV-H = heavy launch vehicle
DIV-M = medium launch vehicle
DIV-M+ = medium launch vehicle with solid rocket motor strap-ons
DIV-S = small launch vehicle
HCl = hydrochloric acid
NO_x = nitrogen oxides
VOC = volatile organic compound

Localized air quality impacts were assessed using the REEDM model as described in Section 4.10.1.1.1.

The CAAQS has an hourly NO_2 standard of 0.25 ppm. For conservative purposes, all NO in NO_x is assumed to convert to NO_2 rapidly. The REEDM-predicted NO_x (NO + NO_2) incremental concentrations resulting from the aborts of Concept B vehicles are summarized in Table 4.10-18.

Table 4.10-18. Summary of REEDM-Predicted Ambient Air Concentration Increments for NO_x During Nominal Launches, Concept B

	Peak Puff concentration increment (ppm)	CAAQS 1-hour average NO_2 standard (ppm)
DIV-S	0.102	5
DIV-M	0.109	5
DIV-M+	0.119	5
DIV-H	0.020	5

CAAQS = California Ambient Air Quality Standards
DIV-H = heavy launch vehicle
DIV-M = medium launch vehicle
DIV-M+ = medium launch vehicle with solid rocket motor strap-ons
DIV-S = small launch vehicle
NO_2 = nitrogen dioxide
NO_x = nitrogen oxides
ppm = parts per million
REEDM = Rocket Exhaust Effluent Dispersion Model

The predicted ambient concentrations of NO or NO_2 for nominal launches show the effects of the increased buoyancy due to the extreme heat release of the three boosters. Due to increased plume rise, the concentrations at the ground decrease significantly. The results indicate that in the worst case, the predicted NO_x concentration increment is a very small fraction of the OSHA PEL.

Launch Failure Emissions. Emissions from launch failures at Vandenberg AFB were estimated using the Aerospace fireball deflagration model (Brady et al., 1997) (Table 4.10-19). The mass emission rates calculated from Concept A launch failures are the same at Vandenberg AFB as those shown for Cape Canaveral AS in Section 4.10.1.2.1.

Table 4.10-19. Summary of REEDM-Predicted Ambient Air Concentration Increments for NO_x During Aborted Launches, Concept B

	Peak Puff concentration increment (ppm)	CAAQS 1-hour average NO_2 standard (ppm)
DIV-S	0.426	5
DIV-M	NA	5
DIV-M+	NA	5
DIV-H	NA	5

CAAQS = California Ambient Air Quality Standards
DIV-H = heavy launch vehicle
DIV-M = medium launch vehicle
DIV-M+ = medium launch vehicle with solid rocket motor strap-ons
DIV-S = small launch vehicle
NA = not applicable
NO_2 = nitrogen dioxide
NO_x = nitrogen oxides
ppm = parts per million
REEDM = Rocket Exhaust Effluent Dispersion Model

NO or NO_2 incremental concentrations during an abort were predicted by REEDM only for the DIV-S vehicle configuration.

Additional details and modeling results are presented in Appendix J. Regional impacts affecting maintenance of ambient air quality standards must be addressed in combination with other sections of the program.

Regional Air Quality Impacts

Cumulative impacts on the lower atmosphere are best summarized by totaling the emissions into the ROI associated with the program. Criteria pollutants are of concern for long-term impacts over the entire air quality region (SCCAB). Emissions from the launch itself were modeled using REEDM to determine local impacts. Other EELV-related air emissions would generally be of longer duration, lower mass emission rate, and are spread over Vandenberg AFB and the air quality region. Short-term criteria pollutant concentrations are therefore not of concern for launch support activities.

Annual emission rates depend on the proposed launch schedule (see Table 2.1-8). The complete emission summary for the years 2001 to 2020 is detailed in Appendix J. Peak emissions into the lower atmosphere at Vandenberg AFB would occur in 2007. The launch schedule and estimated emissions are presented in Table 4.10-20.

Table 4.10-20. Emission Comparison - Concept B, Vandenberg AFB[a]

	Emissions (in tons)[b]				
	VOC	NO_x	CO	SO_2	PM_{10}
Launches	0.0	5.4	0.0	0.0	5.4
Preparation, Assembly, and Fueling	6.6				1.2
Mobile Sources	6.7	10.8	83.9	0.5	78.0
Point Sources	0.5	4.2	1.1	0.4	0.1
Total	13.8	20.3	84.9	0.9	84.7
Santa Barbara County 1990 Total[c]	51,015	18,222	83,844	1,301	43,546
Santa Barbara County 1995 Total (for comparison)	44,664	13,994	102,509	1,290	29,374

Notes: (a) Includes emissions into the lower atmosphere (<3,000 feet) only.
(b) Emissions are based upon launch rates shown in Table 2.1-8 for the peak emissions year at Vandenberg AFB (2007).
(c) The 1990 and 1995 inventory reporting structures differ according to the Santa Barbara County Air Pollution Control District.
CO = carbon monoxide
NO_x = nitrogen oxides
PM_{10} = particulate matter equal to or less than 10 microns in diameter
SO_2 = sulfur dioxide
VOC = volatile organic compound

The expected emissions of ozone precursors (VOC and NO_x) and PM_{10} from peak-year operation are small compared with the county baseline. However, since the SCCAB is in nonattainment for ozone and PM_{10}, these emissions would still be mitigated to the extent feasible.

Peak-year operation emissions of SO_2, NO_x, and CO would not jeopardize the attainment status for these pollutants. Baseline emissions in the SCCAB are below the levels that would cause nonattainment, and the peak-year operation emissions are only a small fraction of the county baseline.

Based on current emissions estimates, Concept B would result in a reduction of emissions from the baseline for all criteria pollutants. The final system design would need to be compared with the permitting and regulatory requirements listed in Section 3.10 to determine required action.

Based on current stationary source emission estimates, and the current emissions estimates from ENVVEST source categories, it does not appear that installation of new stationary sources for Concept B would trigger new requirements under SBCAPCD Rule 1301. Vandenberg AFB will need to consider EELV operations when planning to meet ENVVEST emission reduction goals.

4.10.1.3 **Concept A/B**

Overall emission estimates were calculated as the sum of emissions from specific activities. Concept A/B emission estimates were calculated as the sum of emissions from the specific activities described for Concepts A and B in Sections 4.10.1.1 and 4.10.1.2, respectively.

4.10.1.3.1 **Concept A/B - Cape Canaveral AS.** Air quality impacts from Concept A/B would be similar to the combined effects described in Sections 4.10.1.1 and 4.10.1.2 for Concepts A and B, respectively.

Facility Construction

Under Concept A/B, the construction emissions described for Concept A in Section 4.10.1.1 and for Concept B in Section 4.10.1.2 would occur. Because the construction schedules would be staggered somewhat for the two concepts, and given that there is some flexibility in the construction schedules, it is difficult to predict the total average annual construction emissions for both concepts. Total construction emissions, roughly estimated as the sum of average annual emissions for Concepts A and B for VOCs, NO_x, CO, SO_2, and PM_{10} would be 36.0, 126.4, 134.5, 7.0, and 22.0 tons per year, respectively.

Operations

Emissions associated with Concept A/B operational activities would be the same for each launch vehicle as described for Concepts A and B in Section 4.10.1.1 and 4.10.1.2, respectively. Table 4.10-21 presents the emissions associated with Concept A/B operational activities, and reflects the sum of Concepts A and B emissions in the peak year.

Table 4.10-21. Emission Comparison - Concept A/B, Cape Canaveral AS[(a)]

	Emissions (in tons)[(b)]				
	VOC	NO_x	CO	SO_2	PM_{10}
Launches	0.0	21.4	0.0	0.0	16.8
Preparation, Assembly, and Fueling	19.1	0.0	0.0	0.0	5.9
Mobile Sources	12.0	29.8	88.2	1.2	78.2
Point Sources	1.0	14.3	3.4	1.3	0.6
Total	32.0	65.5	91.7	2.6	101.4
Brevard County 1995 Total (for comparison)	24,983	26,122	134,743	27,524	35,090

Notes: (a) Includes emissions into the lower atmosphere (<3,000 feet) only.
(b) Emissions are based upon launch rates shown in Table 2.1-11 for the peak emissions year at Cape Canaveral AS (2015).
CO = carbon monoxide
NO_x = nitrogen oxides
PM_{10} = particulate matter equal to or less than 10 microns in diameter
SO_2 = sulfur dioxide
VOC = volatile organic compound

Launch Activities

Launch emissions associated with Concept A/B for nominal and abort scenarios would be the same for each launch vehicle as described for Concepts A and B in Section 4.10.1.1 and 4.10.1.2, respectively (see Table 4.10-21).

Regional Air Quality Impacts

Regional impacts on the lower atmosphere include emissions associated with preparing and launching Concept A and Concept B vehicles. Criteria pollutants are of concern for long-term impacts over the entire air quality region (Brevard County).

Annual emission rates depend on the proposed launch schedule (see Table 2.1-11). The emission summary for key years between 2001 and 2020 is detailed in Appendix J. Peak emissions into the lower atmosphere at Cape Canaveral AS would occur during 2015 for Concept A/B (see Table 4.10-21).

Peak-year operation emissions of criteria pollutants would not jeopardize the attainment status for these pollutants. Baseline emissions in Brevard County are below the levels that would cause nonattainment and the peak-year operation emissions are only a small fraction of the county baseline. Also, based on current emissions estimates, Concept A/B would result in a reduction of emissions from the baseline for all criteria pollutants.

4.10.1.3.2 **Concept A/B - Vandenberg AFB.** Air quality impacts from Concept A/B would be similar to the combined effects described in Sections 4.10.1.1 and 4.10.1.2.

Changes associated with the EELV program would need to be documented in the ENVVEST reporting for Vandenberg AFB, as discussed for Concept A in Section 4.10.1.1.1. The Concept A contractor plans to use existing boilers and heaters (NO_x sources) for this program. The existing boilers and heaters will be used for the EELV program instead of their current uses. The Concept B contractor plans to use new boilers and heaters (NO_x sources) for this program. These new boilers and heaters will be installed and used for the EELV program. Boilers and heaters associated with the current Atlas, Delta, and Titan programs will either no longer be used or their usage will be reduced. The total estimated emissions of NO_x from the point sources associated with Concept A/B is 8.7 tons per year, as shown in Table 4.10-22. These emissions will replace the baseline emissions (emissions associated with the current Atlas, Delta, and Titan programs). The total estimated baseline emissions of NO_x from point sources is 8.1 tons, as shown in Table 3.10-9. Therefore, implementing the Concept A/B EELV program is expected to increase NO_x emissions by 0.6 tons per year. Based on the 1994 emissions summary shown in Appendix J, this increase would not be sufficient to cause any source group to exceed the Rule 370 threshold of 25 tons of NO_x. Therefore, the EELV activities are not likely to negatively impact implementation of the ENVVEST program.

Facility Construction

For Concept A/B, construction for the facilities for both contractors would proceed. The construction emissions described for Concept A in Section 4.10.1.1.1 and for Concept B in Section 4.10.1.2.1 would occur. As part of the Air Conformity Applicability Analysis (see Appendix K), estimates of annual construction emissions were performed based on the proposed construction schedule.

Operations

Emissions associated with Concept A/B operational activities would be the same for each launch vehicle as described for Concepts A and B in Sections 4.10.1.1 and 4.10.1.2, respectively. Table 4.10-22 presents the emissions associated with Concept A/B operational activities, and reflects the sum of Concepts A and B emissions in the peak year.

Table 4.10-22. Emission Comparison - Concept A/B, Vandenberg AFB[a]

	Emissions (in tons)[b]				
	VOC	NO_x	CO	SO_2	PM_{10}
Launches	0.0	7.9	0.0	0.0	10.8
Preparation, Assembly, and Fueling	9.9	0.0	0.0	0.0	1.1
Mobile Sources	6.8	11.7	86.1	0.6	87.1
Point Sources	0.8	8.7	2.0	0.6	0.4
Total	17.5	28.2	88.1	1.2	99.5
Santa Barbara County 1990 Total[c]	51,015	18,222	83,844	1,301	43,546
Santa Barbara County 1995 Total (for comparison)	44,664	13,994	102,509	1,290	29,374

Notes: (a) Includes emissions into the lower atmosphere (<3,000 feet) only.
(b) Emissions are based upon launch rates shown in Table 2.1-11 for the peak emissions year at Vandenberg AFB (2007).
(c) The 1990 and 1995 inventory reporting structures differ according to the Santa Barbara County Air Pollution Control District.
CO = carbon monoxide
NO_x = nitrogen oxides
PM_{10} = particulate matter equal to or less than 10 microns in diameter
SO_2 = sulfur dioxide
VOC = volatile organic compound

Launch Activities

Launch emissions associated with Concept A/B for nominal and abort scenarios would be the same for each launch vehicle as described for Concepts A and B in Sections 4.10.1.1 and 4.10.1.2, respectively (see Table 4.10-22).

As discussed in Section 4.10.1.1.2, an air conformity applicability analysis for EELV activities is provided in Appendix K.

Regional Air Quality Impacts

Regional impacts on the lower atmosphere include emissions associated with preparing and launching Concept A and Concept B vehicles. Criteria pollutants are of concern for long-term impacts over the entire air quality region (SCCAB).

Annual emission rates depend on the proposed launch schedule (see Table 2.1-11). Emission summaries for key years between 2001 and 2020 are detailed in Appendix J. Peak emissions into the lower atmosphere at Vandenberg AFB would occur during 2007. The launch schedule and estimated emissions are presented in Table 4.10-22.

The expected emissions of ozone precursors (VOC and NO_x) and PM_{10} from peak-year operations would be minimal compared with the county baseline.

However, since the SCCAB is in nonattainment for ozone and PM_{10} for state standards, these emissions would still be mitigated to the extent feasible.

Peak-year operation emissions of SO_2, NO_x, and CO would not be sufficient to jeopardize the attainment status for these pollutants. Baseline emissions in the SCCAB are below the levels that would cause nonattainment, and the peak-year operation emissions would be only a small fraction of the county baseline.

Based on current emissions estimates, Concept A/B would result in a reduction of emissions from the baseline for all criteria pollutants. The final system design would need to be compared with the permitting and regulatory requirements listed in Section 3.10 to determine required action.

4.10.2 **No-Action Alternative**

Emissions associated with the No-Action Alternative would be those associated with continued use of the Atlas, Delta, and Titan vehicles to meet the government portion of the NMM. Operations would continue as described in Section 3.10. The calculations in this section assume the use of Atlas IIA, Delta II, and Titan IVB vehicles.

Air quality impacts and health effects would be similar to those associated with the Proposed Action. In addition to the chemicals of concern associated with the Proposed Action, ODSs used as part of the degreasing operations for the No-Action Alternative have the potential to damage the stratospheric ozone layer. Damage to the stratospheric ozone layer can cause health hazards in the form of increased skin cancer rates.

Air quality impacts from No-Action Alternative operations would result from the general sources described in Section 4.10.1. Deliveries of vehicle components occur by truck and aircraft; emissions from both forms of delivery have been calculated and compared to existing mobile source emissions. Fuels used in the No-Action Alternative vehicles include kerosene fuel (RP-1), cryogenic gases (LO_2 and LH_2), hydrazines (MMH, A-50, and N_2H_4), N_2O_4, and solid rocket fuels. Emissions from the handling and storage of these fuels have been calculated and compared to existing emissions.

4.10.2.1 **Cape Canaveral AS.** Emissions from the No-Action Alternative would occur from the following sources: vehicle launch; vehicle preparation, assembly, and fueling; mobile sources such as support equipment, commercial transport vehicles (including trucks and aircraft), and personal vehicles; and point sources such as heating/power plants, generators, incinerators and storage tanks.

Estimates were divided into two categories: emissions that are directly launch-related and infrastructure emissions. Launch-related emissions were estimated on a pounds-per-launch basis; infrastructure emissions were estimated on a pounds-per-day basis and were assumed to take place regardless of the number of launches conducted per year.

Emissions were calculated using the methods and assumptions used to calculate the baseline emissions described in Section 3.10. In addition to the emissions from refrigeration units (ODSs), fire suppression and some degreasing operations would also produce emissions. Total ODS emissions associated with the Atlas, Delta, and Titan operations are difficult to estimate for the No-Action Alternative at Cape Canaveral AS because of ongoing efforts to reduce or eliminate the use of ODSs. Depending on the success of these efforts, ODS emissions may be zero.

Emissions from pre- and post-launch processing include criteria pollutants and toxic or irritant pollutants (including HAPs). Emissions of criteria pollutants could cause or contribute to the nonattainment of NAAQS or FAAQS for the region. Emissions of pollutants can also cause localized health effects.

Launch emissions and their associated impacts would be similar to those associated with baseline activities (see Section 3.10).

For comparison purposes, localized air quality impacts were assessed using the REEDM model, as described for Concepts A and B in Sections 4.10.1.1.1 and 4.10.1.2.1, respectively. Titan and Delta launches were modeled, and results for nominal scenarios are presented in Tables 4.10-23 and 4.10-24, respectively.

Table 4.10-23. Summary of REEDM-Predicted Ambient Air Concentration Increments During Nominal Launches (Titan IV and Delta II)

CO	Maximum 8-hour average concentration increment (ppm)	NAAQS 8-hour average (ppm)
Titan IVB-A	0.0089	9
Delta II-7925	0.0043	9
NO_x	Maximum 1-hour average concentration increment (ppm)	CAAQS NO_x 1-hour average (ppm)
Titan IVB-A	0.036	0.25
Delta II-7925	0.007	0.25
HCl	Peak puff concentration increment (ppm)	OSHA PEL[(a)] ceiling (ppm)
Titan IVB-A	3.32	5
Delta II-7925	1.821	5

Note: (a) OSHA PELs are provided for hazard comparison purposes only. Although there is an annual NAAQS for NO_x, OSHA PELs are shown for a consistent per-launch comparison.

CAAQS	=	California Ambient Air Quality Standards
CO	=	carbon monoxide
HCl	=	hydrochloric acid
NAAQS	=	National Ambient Air Quality Standards
NO_2	=	nitrogen dioxide
NO_x	=	nitrogen oxides
OSHA	=	Occupational Safety and Health Administration
PEL	=	Permissible Exposure Level
ppm	=	parts per million
REEDM	=	Rocket Exhaust Effluent Dispersion Model

Table 4.10-24. Summary of REEDM-Predicted Ambient Air Concentration Increments During Aborted Launches (Titan IV and Delta II)

CO	Maximum 8-hour average concentration increment (ppm)	NAAQS 8-hour average (ppm)
Titan IVB-A	0.535	9
Delta II-7925	0.129	9
NO_x	Maximum 1-hour average concentration increment (ppm)	CAAQS NO_x 1-hour average (ppm)
Titan IVB-A	2.090	0.25
Delta II-7925	0.085	0.25
NH_3	Maximum 8-hour average concentration increment (ppm)	OSHA PEL[a] 8-hour average (ppm)
Titan IVB-A	0.0985	50
Delta II-7925	0.0041	50
Hydrazine Compounds	Maximum 8-hour average concentration increment (ppm)	OSHA PEL[a] 8-hour average (ppm)
Titan IVB-A	0.0168	1
Delta II-7925	0.000687	1
HCl	Peak puff concentration increment (ppm)	OSHA PEL[a] ceiling (ppm)
Titan IVB-A	0.84	5
Delta II-7925	0.26	5

Note: (a) OSHA PELs are provided for hazard comparison purposes only. Although there is an annual NAAQS for NO_x, OSHA PELs are shown for a consistent per-launch comparison.

CAAQS =California Ambient Air Quality Standards
CO =carbon monoxide
HCl =hydrochloric acid
NAAQS =National Ambient Air Quality Standards
NH_3 =ammonia
NO_2 =nitrogen dioxide
NO_x =nitrogen oxides
OSHA =Occupational Safety and Health Administration
PEL =Permissible Exposure Level
ppm =parts per million
REEDM =Rocket Exhaust Effluent Dispersion Model

As with the Proposed Action, impacts from the No-Action Alternative on the lower atmosphere are best summarized by totaling the emissions into the ROI associated with the program. Annual emission rates would depend on the proposed launch schedule. Many of the emission-generating activities would occur once per vehicle launch. A No-Action Alternative launch schedule for 2001 through 2020 based on the government portion of the NMM was developed. The peak NO_x emissions would occur during 2015. Emissions are summarized for 2015 in Table 4.10-25.

It is important to note that the launch schedule developed for the No-Action Alternative does not include any commercial launches. For this reason, there are fewer launches per year shown for the No-Action Alternative than for the Proposed Action.

Emissions of several chemicals of concern into the lower atmosphere in the peak years for each of the launch concepts are presented in Table 4.10-26 for Cape Canaveral AS.

Table 4.10-25. No-Action Alternative Emission Comparison, Cape Canaveral AS[a]

	Emissions (in tons)[b][c]				
	VOC	NO_x	CO	SO_2	PM_{10}
Launches	0	7.5	0	0	59.2
Preparation, Assembly, and Fueling	8.9	0	0	0	3.6
Mobile Sources	22.6	53.9	183.8	2.5	112.8
Point Sources	1.0	22.9	6.2	17.7	1.0
Total	32.5	84.2	190.1	20.2	176.6
Brevard County 1995 Total (for comparison)	24,983	26,122	134,743	27,524	35,090

Notes: (a) Government launches only.
(b) Includes emissions into the lower atmosphere (<3,000 feet) only.
(c) Emissions are based upon launch rates shown in Appendix J for the peak emissions year at Cape Canaveral AS (2015).
CO = carbon monoxide
NO_x = nitrogen oxides
PM_{10} = particulate matter equal to or less than 10 microns in diameter
SO_2 = sulfur dioxide
VOC = volatile organic compound

Table 4.10-26. Lower Atmosphere Launch Emissions, Cape Canaveral AS (2015)

	Number of launches	Tons/Year		
		NO_x	PM_{10}	HCl
Concept A	23	18.5	0.0	0.0
Concept B	23	15.1	25.1	13.0
Concept A/B	26	21.4	16.8	8.6
No-Action Alternative[a]	11	7.5	59.2	29.9

Note: (a) Government launches only.
HCl = hydrochloric acid
NO_x = nitrogen oxides
PM_{10} = particulate matter equal to or less than 10 microns in diameter

The EELV program concepts are considerably cleaner in terms of the particulate and chlorine loading than those of the No-Action Alternative. The No-Action Alternative vehicles seem to produce less NO_x emissions than the EELV systems, but this is due to the large difference in the number of launches between the Proposed Action and No-Action Alternative. Although the No-Action Alternative includes fewer launches than the Proposed Action, it would produce more PM_{10} and HCl emissions.

Vandenberg AFB. Emissions from the No-Action Alternative would be similar to those described in Section 4.10.2.1. Although the No-Action Alternative includes fewer launches than the Proposed Action, it would produce more PM_{10} and HCl emissions.

Emissions were calculated using the methods and assumptions used to calculate the baseline emissions described in Sections 3.10 and 4.10.2.1.

Launch emissions and their associated impacts would be similar to those associated with baseline activities described in Section 3.10.

As with the Proposed Action, impacts from the No-Action Alternative on the lower atmosphere are best summarized by totaling the emissions into the ROI associated with the program (Table 4.10-27). The peak year is defined as the year with the highest predicted NO_x emissions, not the year with the most launches.

Table 4.10-27. No-Action Alternative Emission Comparison, Vandenberg AFB[a]

	Emissions (in tons)[b][c]				
	VOC	NO_x	CO	SO_2	PM_{10}
Launches	0.0	2.4	0.0	0.0	34.9
Preparation, Assembly, and Fueling	3.4	0.0	0.0	0.0	1.3
Mobile Sources	8.7	15.2	117.2	0.8	103.8
Point Sources	0.2	8.1	1.2	0.6	0.5
Total	12.3	25.7	118.4	1.4	140.5
Santa Barbara County 1990 Total[d]	51,015	18,222	83,844	1,301	43,546
Santa Barbara County 1995 Total (for comparison)	44,664	13,994	102,509	1,290	29,374

Notes: (a) Government launches only.
(b) Includes emissions into the lower atmosphere (<3,000 feet) only.
(c) Emissions are based upon launch rates shown in Appendix J for the peak emissions year at Vandenberg AFB (2008).
(d) The 1990 and 1995 inventory reporting structures differ according to the Santa Barbara County APCD.

CO = carbon monoxide
NO_x = nitrogen oxides
PM_{10} = particulate matter equal to or less than 10 microns in diameter
SO_2 = sulfur dioxide
VOC = volatile organic compound

Emissions of several chemicals of concern into the lower atmosphere in the peak years for each of the launch concepts are presented in Table 4.10-28 for Vandenberg AFB launches.

The Proposed Action is considerably cleaner in terms of particulates and chlorine loading than the No-Action Alternative. The No-Action Alternative does seem to produce less NO_x emissions than the Proposed Action, but this is due to the large difference in the number of launches between the alternatives. Although the No-Action Alternative includes fewer launches than the Proposed Action, it would produce more PM_{10} and HCl emissions.

Table 4.10-28. Lower Atmosphere Launch Emissions, Vandenberg AFB

	Peak Year	Number of launches	Tons/Year NO_x	Tons/Year PM_{10}	Tons/Year HCl
Concept A	2007	10	4.8	0.0	0.0
Concept B	2007	10	5.4	5.4	2.8
Concept A/B	2007	14	7.9	10.8	5.6
No-Action Alternative[a]	2008	4	2.4	34.9	17.6

Note: (a) Government launches only.
HCl = hydrochloric acid
NO_x = nitrogen oxides
PM_{10} = particulate matter equal to or less than 10 microns in diameter

4.11 AIR QUALITY (UPPER ATMOSPHERE)

Emissions into the upper atmosphere are not subject to any specific regulatory requirements. The upper atmosphere ROI consists of the upper troposphere, where weather systems can mix and remove pollutants after a few days to a few weeks, and the stratosphere, where the emissions are removed very slowly and can circle the earth. In the stratosphere, ODSs, including NO_x, Cl_x, and alumina particles, are the primary chemicals of concern.

4.11.1 Proposed Action

This section addresses potential impacts to the upper atmosphere associated with implementation of the EELV program. Because the upper atmosphere is common to both Cape Canaveral AS and Vandenberg AFB, the discussion focuses upon impacts related to implementation of Concept A, Concept B, and Concept A/B.

4.11.1.1 **Concept A.** Concept A launch vehicles would use a booster that burns RP-1 and LO_2. The composition of the after-burning emissions is very similar to that of the Atlas II core engine. There are four Concept A configurations that are distinguished by the type of upper stage and by the number of boosters strapped together (see Section 2.1.1). The boosters burn until they are well above the stratosphere, and no upper-stage emissions are emitted into the stratosphere.

Two flight trajectories (LEO and GTO) were used to estimate the amount of booster mass emitted into the lower atmosphere (0 to 3,000 feet) and the upper atmosphere (3,000 to 164,000 feet). The upper atmosphere ROI was divided into the three layers; the time of travel for each trajectory to pass through each layer is summarized in Table 4.11-1.

Table 4.11-1. Description of Flight Trajectories Used to Estimate the Fraction of Engine Burn Time in Atmospheric Layers

Layer Designation	Layer Top Elevation (feet)	Trajectory 1 (GTO) (seconds)	Trajectory 2 (LEO) (seconds)
Lower Atmosphere	3,000	29	19
Lower Troposphere	10,000	50	33
Upper Troposphere	49,000	95	72
Stratosphere	164,000	173	155

GTO = geosynchronous transfer orbit
LEO = low-Earth orbit

Table 4.11-2 summarizes the total mass of the various pollutants that would be released into the upper atmosphere from vehicle exhaust and after-burning during a GTO mission. In the stratosphere, the only pollutant emitted is CO from carbon in the burned RP-1 fuel. However, the influence of CO on the stratosphere is limited to radiative heating and minor chemical reactions.

Table 4.11-2. Summary of Flight Emissions into Atmospheric Layers, Concept A[(a)] (in tons)

Atmosphere Layer	Particulate	NO_x	CO	Cl_x
	MLV-A (CUS)			
Lower Troposphere	0.0	0.28	0.0	0.0
Upper Troposphere	0.0	0.50	1.00	0.0
Stratosphere	0.0	0.0	58.47	0.0
	MLV-D (SUS)			
Lower Troposphere	0.0	0.28	0.0	0.0
Upper Troposphere	0.0	0.50	1.00	0.0
Stratosphere	0.0	0.0	58.47	0.0
	HLV-L (SUS)			
Lower Troposphere	0.0	0.83	0.0	0.0
Upper Troposphere	0.0	1.50	3.01	0.0
Stratosphere	0.0	0.0	175.42	0.0
	HLV-G (CUS)			
Lower Troposphere	0.0	0.83	0.0	0.0
Upper Troposphere	0.0	1.50	3.01	0.0
Stratosphere	0.0	0.0	175.42	0.0

Note: (a) Assumes a geosynchronous transfer orbit mission.
Cl_x = chlorine compounds
CO = carbon monoxide
CUS = Cryogenic Upper Stage
HLV = heavy lift variant
MLV = medium lift variant
NO_x = nitrogen oxides
SUS = Storable Upper Stage

The emission rates were estimated for each year, and the year of peak NO_x emissions for the upper atmosphere was selected. The emission rates peaked for the year 2015 for Cape Canaveral AS and for 2014 for Vandenberg AFB. For estimation purposes, it was assumed that all Cape Canaveral AS launches would be GTO missions and that all Vandenberg AFB launches would be LEO missions. The peak annual launch emissions for the upper atmosphere and the stratosphere (Table 4.11-3) were calculated as the sum of using the emissions per vehicle flight (Table 4.11-2).

Table 4.11-3. Summary of Flight Emissions, Concept A (tons per year)[(a)]

Pollutant	(3,000 to 49,000 feet)	(49,000 to 164,000 feet)
Particulates	0	0
Cl_x	0	0
NO_x	22.9	0
CO	1,893	1,862

Note: (a) Emissions are based upon launch rates shown in Table 2.1-3 for peak emission years at each installation (2015 at Cape Canaveral AS, 2014 at Vandenberg AFB).
Cl_x = chlorine compounds
CO = carbon monoxide
NO_x = nitrogen oxides

Concept A launches would produce no emissions into the stratosphere of any effective ODSs, and would therefore not cause any degradation of the stratospheric ozone layer. Because of the lack of nitrogen in the fuels utilized for Concept A vehicles, and the rapid decrease in the efficiency of after-burning to produce NO, negligible amounts of NO_x are deposited into the stratosphere. The annual perturbation of the stratosphere CO budget due to Concept A vehicles is less than 1 part in 15,000. If all fuel is converted to water, the resulting annual perturbation is less than 1 part in 1,000. Such perturbations, by either chemical, would fail to substantially alter the stratospheric chemistry or its heat budget.

4.11.1.2 **Concept B.** Concept B launch vehicles would use a booster that burns LH_2 and LO_2. The composition of the after-burning emissions is very clean, essentially resulting in only water, unburned fuel, and oxy-hydrogen radicals. There are five Concept B configurations that are distinguished by the type of upper stage and by the number and type of boosters strapped together (see Section 2.1.2). The boosters would burn until they are well above the stratosphere and no upper-stage emissions are emitted into the stratosphere. The flight trajectories modeled were the same as those described in Section 4.11.1.1 for Concept A (see Table 4.11-1).

Concept B pollutants include NO_x, alumina particles, and Cl_x. CO is also tracked, but its role in the upper atmospheric chemistry is limited to radiative effects. Table 4.11-4 summarizes the total mass of the various pollutants released into the atmosphere from vehicle exhaust and after-burning during a GTO mission.

Table 4.11-4. Summary of Flight Emissions into Atmospheric Layers, Concept B[a] (in tons)

Atmosphere layer	Particulate	NO_x	CO	Cl_x
		DIV-S (HUS)		
Lower Troposphere	0.0	0.21	0.0	0.0
Upper Troposphere	0.0	0.38	0.0	0.0
Stratosphere	0.0	0.0	0.0	0.0
		DIV-M (CUS)		
Lower Troposphere	0.0	0.21	0.0	0.0
Upper Troposphere	0.0	0.38	0.0	0.0
Stratosphere	0.0	0.0	0.0	0.0
		DIV-M+ (CUS)		
Lower Troposphere	2.02	0.21	0.0	1.04
Upper Troposphere	8.34	0.47	0.33	4.30
Stratosphere	14.03	0.0	9.49	7.33
		DIV-H (CUS)		
Lower Troposphere	0.0	0.63	0.0	0.0
Upper Troposphere	0.0	1.14	0.0	0.0
Stratosphere	0.0	0.0	0.0	0.0

Note: (a) Assumes a low-Earth orbit mission.
Cl_x = chlorine compounds
CO = carbon monoxide
CUS = Cryogenic Upper Stage
DIV-H = heavy launch vehicle
DIV-M = medium launch vehicle
DIV-M+ = medium launch vehicle with solid rocket motor strap-ons
DIV-S = small launch vehicle
HUS = Hypergolic Upper Stage
NO_x = nitrogen oxides

In the troposphere, the only pollutant deposited from configurations with no strap-on solid rocket motors in any substantial amount is NO_x (see Table 4.11-4). Because of the lack of nitrogen in the fuels utilized for Concept B vehicles, and the rapid decrease in the efficiency of after-burning to produce NO, negligible amounts of NO_x are deposited into the stratosphere. The annual perturbation of the stratospheric CO budget due to Concept B vehicles is less than 1 part in 15,000. If all fuel is converted to water, the resulting annual perturbation to the stratospheric water budget is less than 1 part in 1,000. At such magnitudes, neither chemical would produce a significant perturbation. The stratospheric ODS emissions, consisting of chlorine and particles, come only from commercial configurations that use strap-on solid rocket motors.

The emission rates were estimated for each year, and the year of peak NO_x emissions for the upper atmosphere was selected. The emission rates peaked in the year 2015 for Cape Canaveral AS and in 2008 for Vandenberg AFB. For estimation purposes, it was assumed that all Cape Canaveral AS launches would be GTO missions and that all Vandenberg AFB launches would be LEO missions. The peak annual emissions for each upper atmospheric layer from all Concept B launches (Table 4.11-5) were estimated as the sum of the emissions per vehicle flight (see Table 4.11-4).

Table 4.11-5. Summary of Flight Emissions, Concept B (tons per year)[a]

Pollutant	(3,000 to 49,000 feet)	(49,000 to 164,000 feet)
Particulates	162.3	85.1
Cl_x	83.6	43.8
NO_x	22.7	0.0
CO	58.6	56.7

Note: (a) Emissions are based upon launch rates shown in Table 2.1-8 for peak emission years at each installation (2015 at Cape Canaveral AS, 2008 at Vandenberg AFB).
Cl_x = chlorine compounds
CO = carbon monoxide
NO_x = nitrogen oxides

Concept B government launch vehicles would not release ODSs into the stratosphere; however, the DIV-M+ (commercial only) launches would add ODSs. The projected emission rates are smaller than the baseline launch emissions described in Section 3.11. Even with commercial launches, Concept B would result in smaller deposition of ODSs in the stratosphere than the current launch vehicles, which would continue to be launched under the No-Action Alternative.

4.11.1.3 **Concept A/B.** Under Concept A/B, both Concept A and Concept B vehicles would be developed and launched. For analysis purposes, a nearly exact division of the Concept A and B launch rates has been assumed for each vehicle type (see Table 2.1-11). Concept A and B pollutant emissions are described in Sections 4.11.1.1 and 4.11.1.2, respectively. The flight trajectories used to estimate the amount of booster mass emitted into atmosphere are summarized in Table 4.11-1.

The emission rates were estimated for each year, and the year of peak NO_x emissions for the upper atmosphere was selected. The emission rates peaked in the year 2015 for Cape Canaveral AS and in 2007 for Vandenberg AFB.

The same assumption regarding use of LEO and GTO trajectories at each installation was utilized. The peak annual emissions for each upper atmospheric layer from all launches (Table 4.11-6) were estimated as the sum of the emissions per vehicle flight (see Tables 4.11-2 and 4.11-4).

Concept A/B launches would discharge emissions of alumina particulates and Cl_x into the stratosphere as a result of using solid rocket motors for Concept B commercial launches. However, as discussed in Section

Table 4.11-6. Summary of Flight Emissions, Concept A/B (tons per year)[(a)]

Pollutant	(3,000 to 49,000 feet)	(49,000 to 164,000 feet)
Particulates[(b)]	157.0	84.7
Cl_x	80.9	43.7
NO_x	32.3	0.0
CO	1359.4	1337.1

Notes: (a) Emissions are based upon launch rates shown in Table 2.1-11 for peak emission years at each installation (2015 at Cape Canaveral AS, 2007 at Vandenberg AFB).
(b) Concept B commercial launches only.
Cl_x = chlorine compounds
CO = carbon monoxide
NO_x = nitrogen oxides

4.11.1.2, Concept A/B launches would result in reductions of emissions of stratospheric perturbing substances compared to current launch systems.

4.11.2 **No-Action Alternative**

Emissions from the government component of launches based on the NMM were estimated assuming continuation of existing launch programs (Atlas IIA, Delta II, Titan IVB). The annual launch schedule, presented in Appendix J, was used to determine the peak years for emissions. Peak NO_x emissions would occur in 2015 for Cape Canaveral AS and in 2008 for Vandenberg AFB. No-Action Alternative emissions for the upper atmosphere and the stratosphere are provided in Table 4.11-7. Emissions of ODSs (alumina particulates and chlorine) from the No-Action Alternative launches would be greater than the estimated emissions for Concepts A and B, or for Concept A/B.

Table 4.11-7. Summary of the Annual Flight Emissions Resulting from the No-Action Alternative (in tons)

	Cape Canaveral AS (2015)		Vandenberg AFB (2008)	
Pollutant	Troposphere (3,000 to 49,000 feet)	Stratosphere (49,000 to 164,000 feet)	Troposphere (3,000 to 49,000 feet)	Stratosphere (49,000 to 164,000 feet)
Particulates	368.2	174.1	296.1	162.7
NO_x	10.9	0.6	5.2	0.6
CO	527.3	516.0	227.4	222.7
Cl_x	185.3	87.5	148.7	81.6

Cl_x = chlorine compounds
CO = carbon monoxide
NO_x = nitrogen oxides

4.12 **NOISE**

Potential impacts due to noise and sonic boom exposure are discussed in this section. The potential impacts on wildlife are described in Section 4.14, Biological Resources.

4.12.1 **Proposed Action**

The proposed EELV system has not yet been launched; consequently, actual vehicle noise measurements are not available. Launch and ascent noise were computed by the RNOISE model recently developed for launch vehicle analysis (Plotkin et al., 1997) (see Appendix F). Sonic booms were computed using the U.S. Air Force PCBoom3 model (Plotkin, 1996) (see Appendix F).

4.12.1.1 **Concept A**

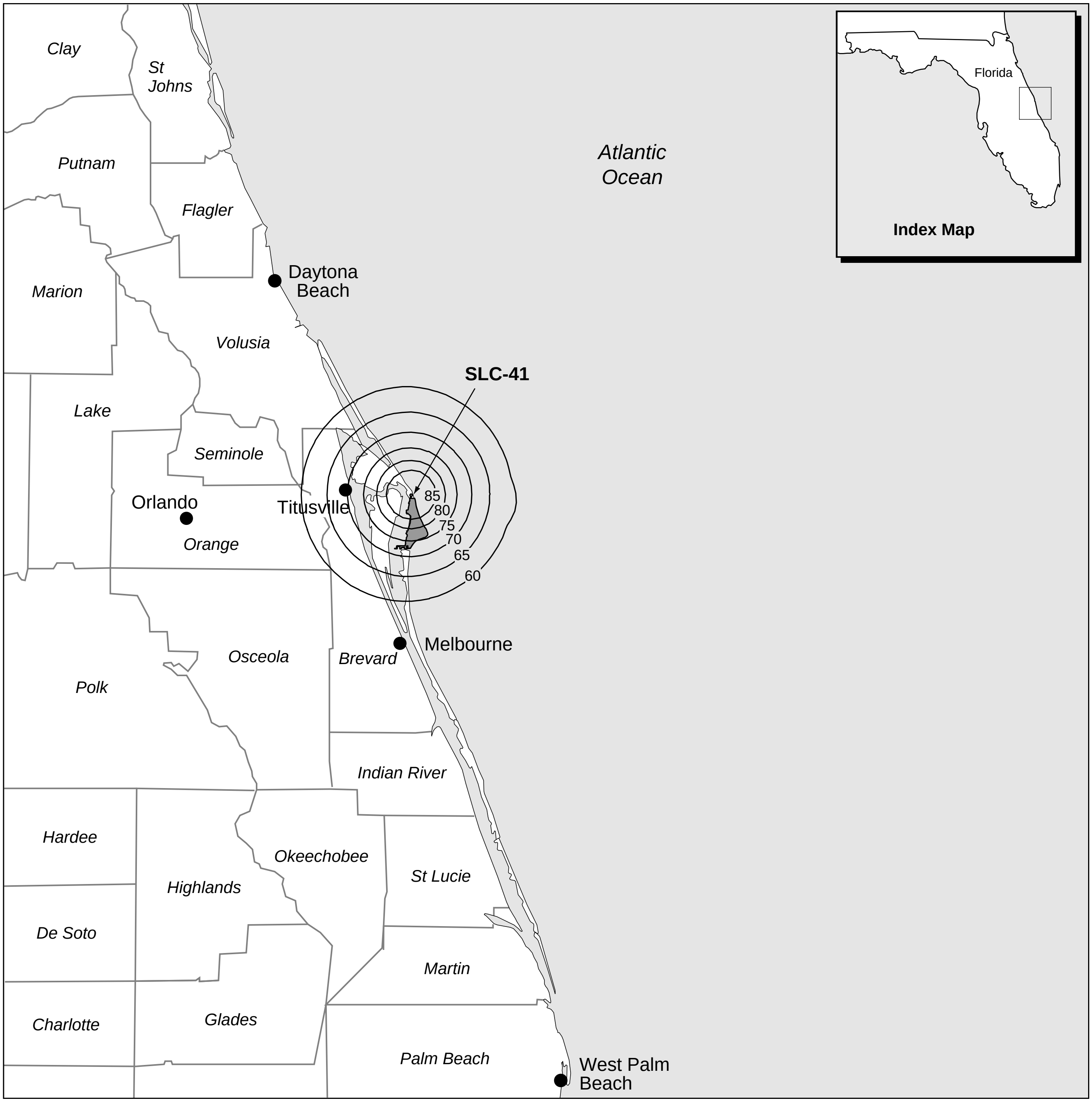
Noise analysis was performed for two vehicles (one three-engine heavy and one single-engine medium) at Cape Canaveral AS and Vandenberg AFB. The selected missions analyzed include: HLV-G (94-degree azimuth) and MLV-D (92-degree azimuth) at Cape Canaveral AS and HLV-L (181-degree azimuth), MLV-D (181-degree azimuth), MLV-A (158-degree azimuth), and MLV-A (186-degree azimuth) at Vandenberg AFB. Three medium vehicle launches were analyzed for Vandenberg AFB so as to assess the difference between various missions of the same vehicle type.

It was found that the noise and sonic boom footprints for the medium vehicles were similar among the missions analyzed, differing primarily according to the launch azimuth. The footprint from one mission can be approximated by that from another simply by rotating it to the corresponding azimuth. Launch direction is more important for sonic boom, with its crescent-shaped footprints, than for rocket noise, for which the highest level contours are approximately circular. In the following analysis, noise contours are shown for one heavy and one medium vehicle launch at each site. The effect of other launch azimuths is discussed.

The peak year launch rates for Concept A (see Table 2.1-3) are 23 per year from Cape Canaveral and 10 per year from Vandenberg. These are considerably less than one per day, the rate at which cumulative program noise metrics such as L_{dn} are meaningful. The following analysis of impacts, therefore, concentrates on single launch events.

4.12.1.1.1 **Concept A, Cape Canaveral AS**

In-Flight Rocket Noise. Figure 4.12-1 shows the in-flight maximum A-weighted noise level contours for the HLV-G. Figure 4.12-2 shows in-flight maximum A-weighted noise level contours for the MLV-D. Contours for other medium vehicles are similar to those shown in Figure 4.12-2. Sound levels for the medium vehicle are about 5 dB lower than for the heavy vehicle. Heavy vehicles represent approximately 2 percent of the projected Concept A launches. Conservative estimates of impact can be made by examining levels from the louder heavy vehicle.



EXPLANATION:

Cape Canaveral AS

—60— A-Weighted Noise Contours (5 dBA intervals)

0 8 16 32 Miles

Maximum A-Weighted Sound Pressure Level, HLV-G, Cape Canaveral AS

Figure 4.12-1

EELV/078

EXPLANATION:

Cape Canaveral AS

—60— A-Weighted Noise Contours (5 dBA intervals)

Maximum A-Weighted Sound Pressure Level, MLV-D, Cape Canaveral AS

0 8 16 32 Miles

Figure 4.12-2

EELV/078

The maximum A-weighted levels for the HLV-G in the nearest residential communities would be in the 75-dB range. This is somewhat louder than the noise of a passing automobile (65 to 70 dBA) and less than that of a passing heavy truck (80 to 85 dBA). Occasional sounds of this level will not cause adverse impact. SEL has been computed for this launch and is about 13 dB higher than the AWSPL. This corresponds to an effective duration of about 20 seconds. Launch noise is likely to be audible for a longer period, but the total time involved is not great enough to cause substantial impact.

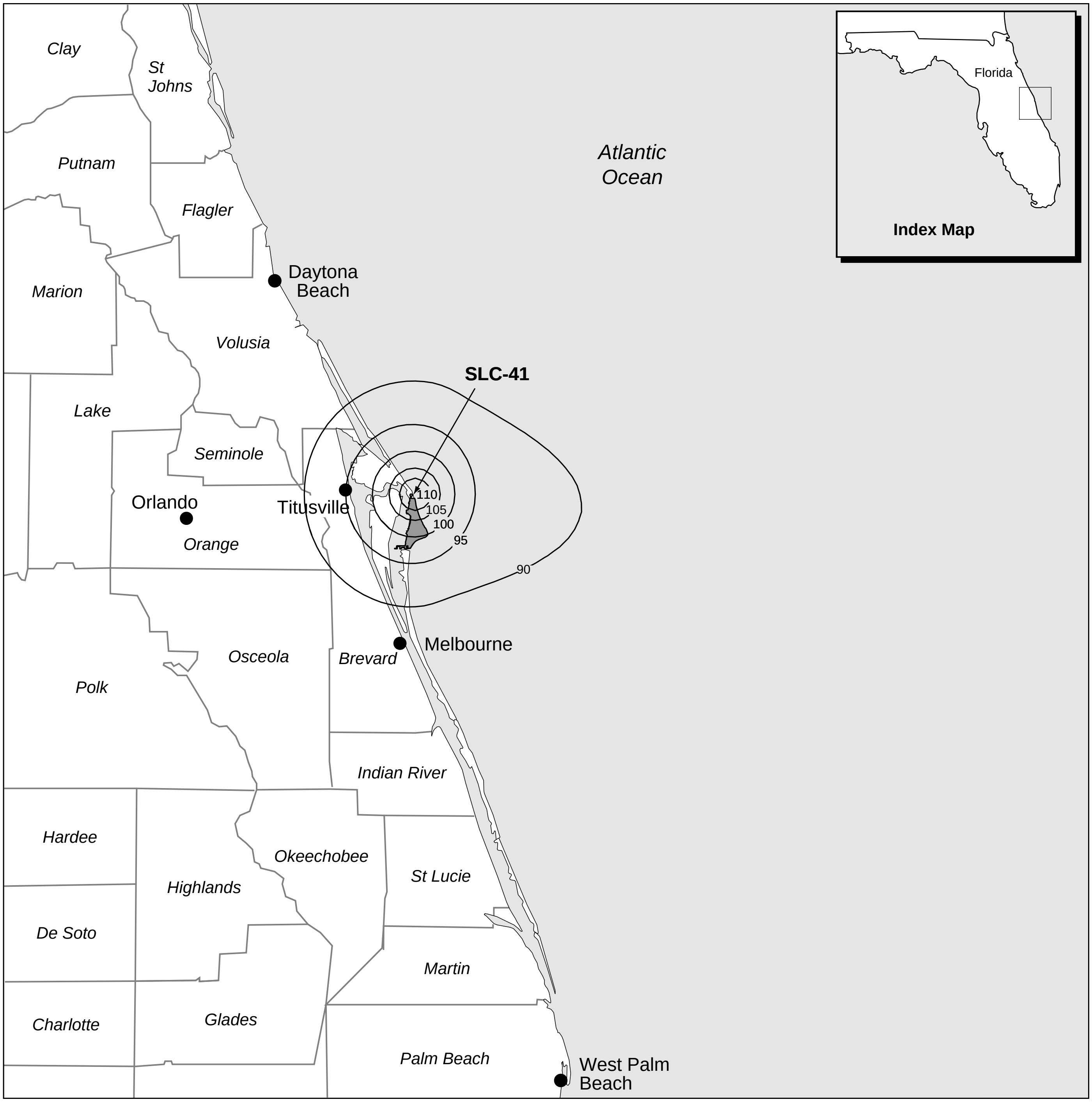
Figure 4.12-3 shows the OSPL for the HLV-G. The higher-level contours are approximately circular, so launch azimuth is not important. OSPL in excess of 110 dB, which could cause structural damage claims at a rate of one per 1,000 households, is limited to a radius of approximately 3.3 miles from the launch site. This area does not contain residential communities, and most of the land area affected is within Cape Canaveral AS and KSC. The OSPL at the nearest residential communities, 8 to 10 miles away, would be below 100 dB, where structural damage, if any, would occur at a negligible rate.

The majority of missions (98 percent) would utilize medium and small vehicles, for which noise is about 5 dB lower and correspondingly less intrusive.

Sonic Boom. Figure 4.12-4 shows the sonic boom footprint for the HLV-G, and Figure 4.12-5 shows the footprint for the MLV-D. These two footprints are drawn to scale, and the highest level contours in the focal zones (6 to 7 psf) are too small to be seen in the figures. The lowest contour value drawn, 0.5 psf, is larger for the heavy vehicle, and its maximum overpressure is slightly higher, but otherwise the footprints are fairly similar.

Both of these footprints are aligned with the launch azimuths (94 degrees and 92 degrees, respectively) and fall in the Atlantic Ocean, well offshore. Most Concept A launches would be at azimuths between 91 and 97 degrees, and would not be substantially different from those shown in Figures 4.12-4 and 4.12-5. Some launches would be at an azimuth of 64 degrees. The footprint would fall farther to the north but would still be entirely over the Atlantic Ocean.

Most of the boom footprints are below 1 psf, a level at which no adverse effects would be expected, even over land, from an occasional sonic boom. The maximum focus overpressures are in the 6- to 8-psf range. This is comparable to the focus boom overpressures routinely generated by military aircraft during supersonic training missions over both land and water (Plotkin et al., 1993), and similar to focus boom overpressures generated by other launch vehicles (Downing et al, 1996). Since the entire boom footprint is over water, the only potential impacts would be to wildlife (see Section 4.14, Biological Resources).



EXPLANATION:

Cape Canaveral AS

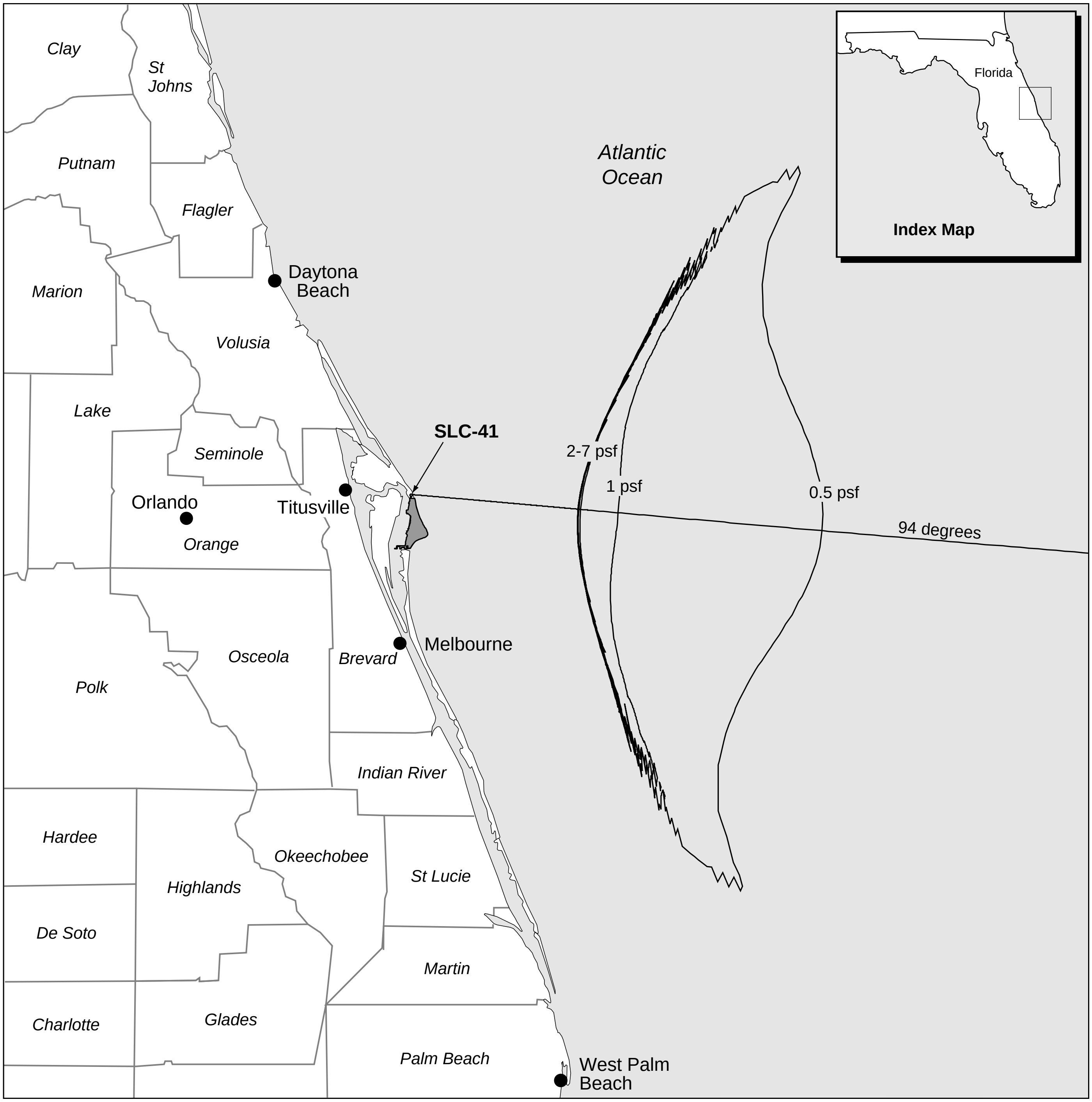
—90— Noise Contours (5 dB intervals)

Maximum Overall Sound Pressure Level, HLV-G, Cape Canaveral AS

0 8 16 32 Miles

Figure 4.12-3

EELV/078



EXPLANATION:

Cape Canaveral AS

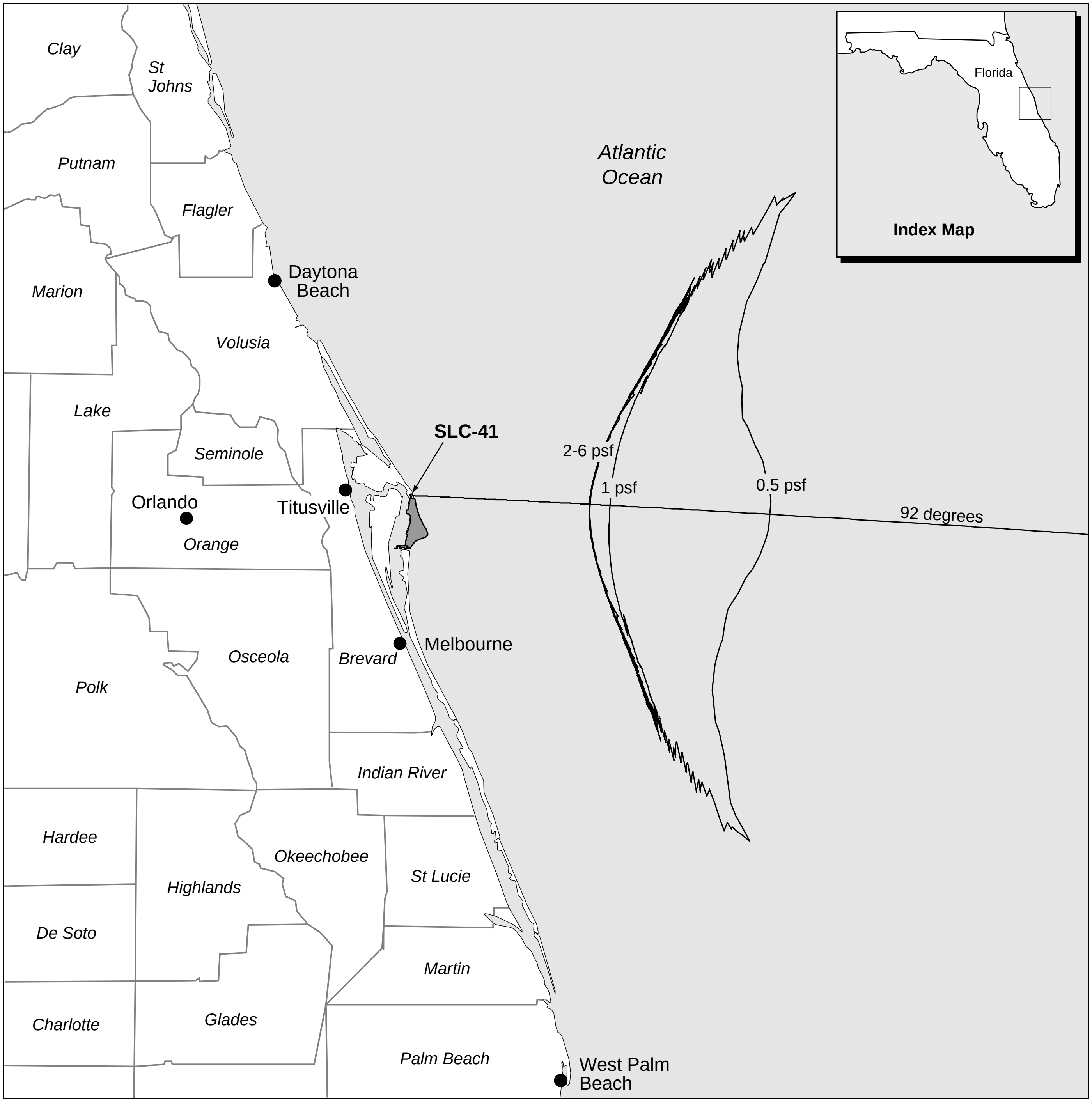
psf Pounds per square foot

Sonic Boom Footprint, HLV-G, Cape Canaveral AS

0 8 16 32 Miles

Figure 4.12-4

EELV/078



EXPLANATION:

Cape Canaveral AS

psf Pounds per square foot

0 8 16 32 Miles

Sonic Boom Footprint, MLV-D, Cape Canaveral AS

Figure 4.12-5

EELV/078

Cumulative program noise impacts would be quantified by L_{dn} which has been computed for the busiest years. Values are about 50 dB lower than the AWSPL values shown in Figures 4.12-4 and 4.12-5. This is well within acceptable criteria for any type of land use. However, L_{dn} is not meaningful for events as infrequent as EELV launches, so the primary impact assessment is the single-event analysis presented above.

4.12.1.1.2 **Concept A, Vandenberg AFB**

In-Flight Rocket Noise. Figures 4.12-6 and 4.12-7 show the in-flight maximum AWSPL for the HLV-L and MLV-D. These contours are very similar to the corresponding contours at Cape Canaveral AS, differing primarily in location and alignment with the launch trajectory. Contours for the MLV-D are approximately 5 dB lower than those for the heavy vehicle.

Considering the HLV-L (less than 1 percent of Vandenberg AFB launches would be heavy vehicles), maximum A-weighted levels in the nearest residential communities would be in the 80- to 85-dB range (see Figure 4.12-6). This is comparable to the noise of a passing heavy truck (80 to 85 dBA). Occasional sounds of this level will not cause adverse impacts. SEL has been computed for this launch, and is about 13 dB higher than the AWSPL. This corresponds to an effective duration of about 20 seconds. Launch noise is likely to be audible for a longer period, but the total time involved is not great enough to cause substantial impact.

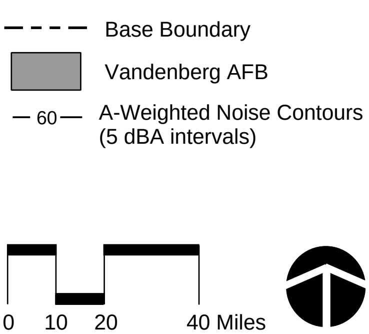
Figure 4.12-8 shows OSPL for the HLV-L. OSPL in excess of 110 dB, which could cause structural damage claims at a rate of one per 1,000 households, is limited to a radius of approximately 3.3 miles from the launch site. This area does not contain residential communities, and almost all of the land area affected is within Vandenberg AFB. The OSPL at the nearest residential community, Lompoc, about 8 miles away, would be below 100 dB, where structural damage, if any, would occur at a negligible rate.

The majority of missions (99 percent) would utilize medium and small vehicles, for which noise is about 5 dB lower and correspondingly less intrusive.

Sonic Boom. Figures 4.12-9 and 4.12-10 show the sonic boom footprints for the HLV-L and MLV-D, respectively. The boom footprints are offshore, in the Pacific Ocean. The footprints are similar to each other (HLV-L is slightly larger than MLV-D), differing primarily in position and orientation along the launch azimuth. The maximum overpressures, in the narrow focal zones, are in the 6- to 8-psf range. Impacts are expected to be minimal.

The two boom footprints shown intersect the Channel Islands, with this intersection being at or near the focal zone. Potential impacts to wildlife are discussed in Section 4.14, Biological Resources.

EXPLANATION



Maximum A-Weighted Sound Pressure Level, HLV-L, Vandenberg AFB

Figure 4.12-6

EELV/077

EXPLANATION

Base Boundary

Vandenberg AFB

— 60 — A-Weighted Noise Contours (5 dBA intervals)

0 10 20 40 Miles

Maximum A-Weighted Sound Pressure Level, MLV-D, Vandenberg AFB

Figure 4.12-7

EELV/077

EXPLANATION

Base Boundary

Vandenberg AFB

90 Noise Contours (5 dB intervals)

Maximum Overall Sound Pressure Level, HLV-L, Vandenberg AFB

0 10 20 40 Miles

Figure 4.12-8

EELV/077

EXPLANATION

– – – – Base Boundary

psf Pounds per square foot

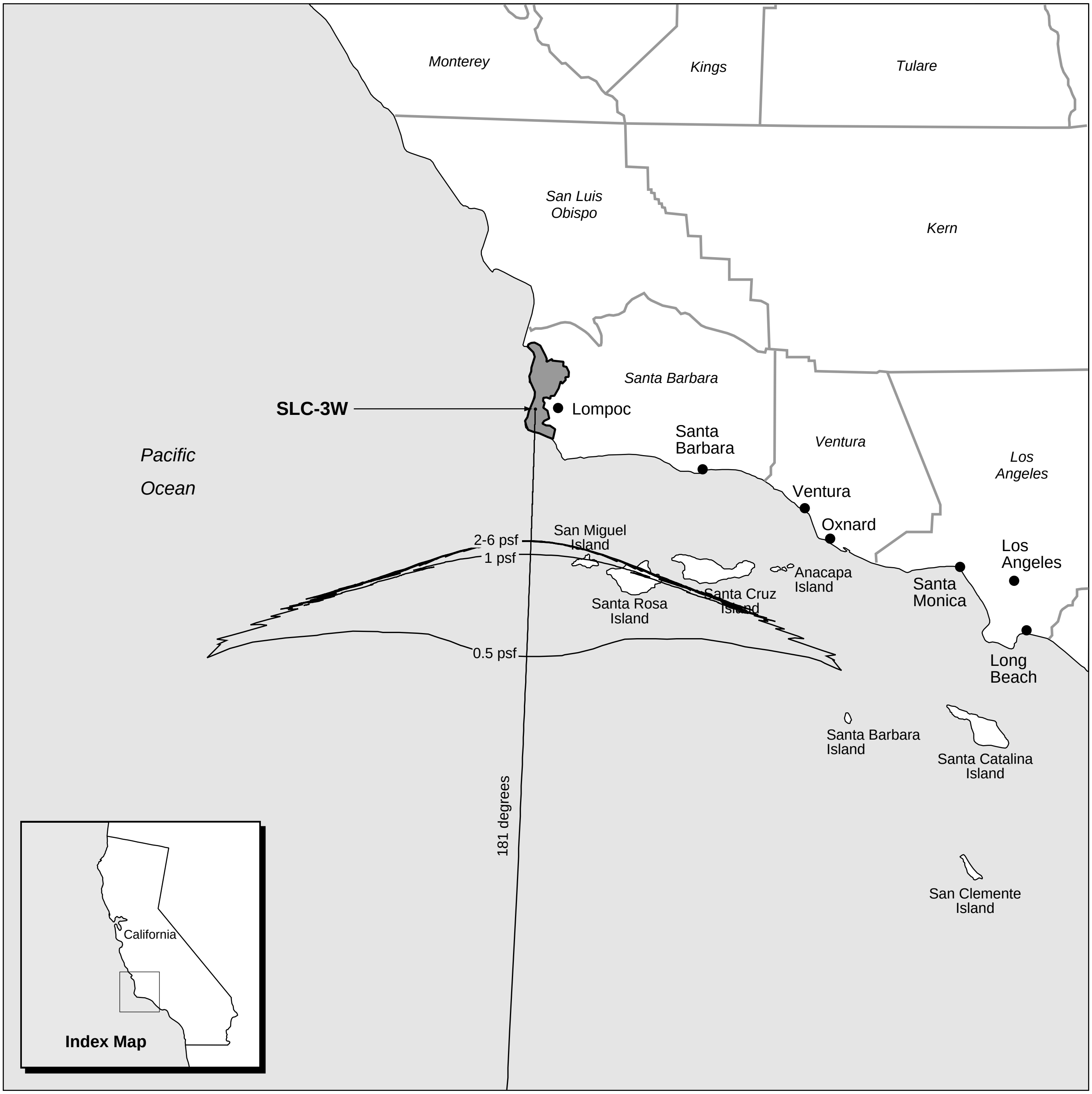
Vandenberg AFB

Sonic Boom Footprint, HLV-L, Vandenberg AFB

0 10 20 40 Miles

Figure 4.12-9

EELV/077



EXPLANATION

– – – –	Base Boundary
psf	Pounds per square foot
(shaded)	Vandenberg AFB

0 10 20 40 Miles

Sonic Boom Footprint, MLV-D, Vandenberg AFB

Figure 4.12-10

EELV/077

The two missions shown are at launch azimuth of 181 degrees. Most Concept A launches from Vandenberg AFB would be at azimuths from 174 to 187 degrees, and sonic boom footprints would occur in similar regions.

Cumulative program noise impacts would be quantified by L_{dn} which has been computed for the busiest years. Values are about 50 dB lower than the AWSPL values seen in Figures 4.12-6 and 4.12-7. As discussed in Section 4.12.1.1.1, this is well within acceptable criteria for any type of land use.

4.12.1.2 **Concept B**

Noise analysis was performed for two vehicles (one three-engine heavy and one single-engine medium) at Cape Canaveral AS and Vandenberg AFB, and one medium-plus vehicle at Cape Canaveral AS. The selected missions analyzed include: DIV-H (95-degree azimuth), DIV-M+ (95-degree-azimuth), DIV-S (65-degree azimuth) at Cape Canaveral AS and DIV-H (184-degree azimuth) and DIV-M (170-degree azimuth) at Vandenberg AFB.

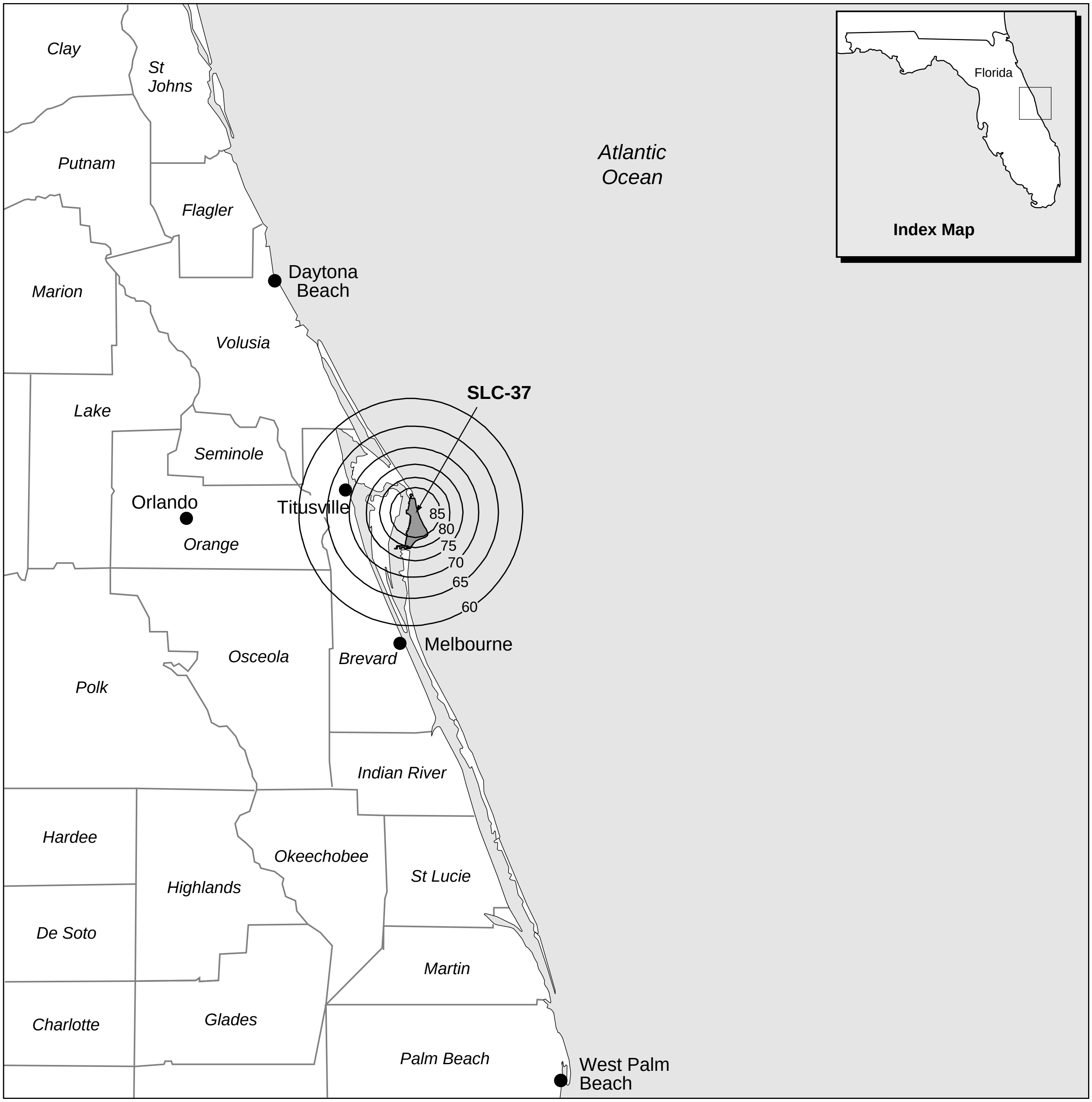
Noise and sonic boom footprints for the medium vehicles were similar among the missions analyzed, differing primarily according to launch azimuth and location. The results for the specific missions analyzed can be applied to other missions with the same vehicle sizes.

The peak-year launch rates for Concept B (see Table 2.1-8) are 23 per year from Cape Canaveral and 10 per year from Vandenberg. These are considerably less than one per day, the rate at which cumulative program noise metrics such as L_{dn}, are meaningful. The following analysis of impacts, therefore, concentrates on single launch events.

4.12.1.2.1 **Concept B, Cape Canaveral AS**

In-Flight Rocket Noise. Figures 4.12-11, 4.12-12, and 4.12-13 show the in-flight maximum A-weighted noise level contours for the three Cape Canaveral AS missions analyzed: heavy, medium-plus, and medium vehicles, respectively. There is slight distortion in the flight direction, but the contours (especially higher levels) are approximately circular. Sound levels for the medium and medium-plus vehicles are about 3 to 5 dB lower than for the heavy vehicle. Heavy vehicles represent approximately 2 percent of the projected Concept B Cape Canaveral AS launches. Conservative impact estimates can be made by examining levels from the louder heavy vehicles.

Referring to Figure 4.12-11, maximum A-weighted levels in the nearest residential communities would be in the 80-dB range. This is comparable to the noise of a passing heavy truck (80 to 85 dBA). Occasional sounds of this level will not cause adverse impact. SEL has been computed for this launch, and is about 18 dB higher than the AWSPL. This corresponds to an effective duration of about one minute. Launch noise is likely to be audible



EXPLANATION:

Cape Canaveral AS

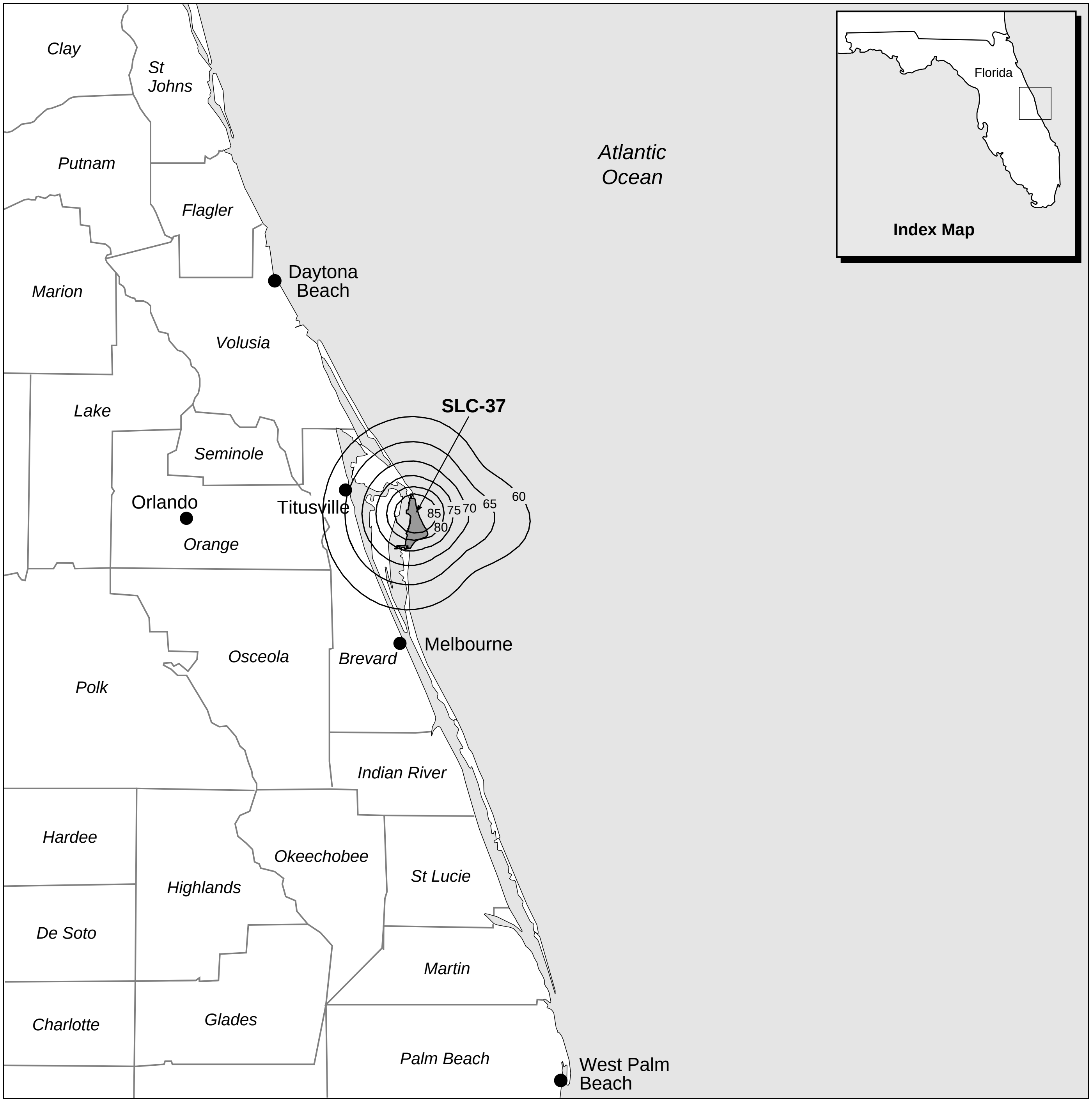
—60— A-Weighted Noise Contours (5 dBA intervals)

0 8 16 32 Miles

Maximum A-Weighted Sound Pressure Level, DIV-H, Cape Canaveral AS

Figure 4.12-11

EELV/078



EXPLANATION:

Cape Canaveral AS

—60— A-Weighted Noise Contours (5 dBA intervals)

0 8 16 32 Miles

Maximum A-Weighted Sound Pressure Level, DIV-M+, Cape Canaveral AS

Figure 4.12-12

EELV/078

EXPLANATION:

Cape Canaveral AS

—70— A-Weighted Noise Contours (5 dBA intervals)

0 8 16 32 Miles

Maximum A-Weighted Sound Pressure Level, DIV-S, Cape Canaveral AS

Figure 4.12-13

EELV/078

for a longer period, but the total time involved is not great enough to cause substantial impacts.

Figure 4.12-14 shows the OSPL contours for the DIV-H. OSPL in excess of 110 dB, which could cause structural damage claims at a rate of one per 1,000 households, is limited to a radius of approximately 4 miles from the launch site. This area does not contain residential communities, and most of the land area affected is within Cape Canaveral AS and KSC. The OSPL at the nearest residential communities, 8 to 10 miles away, would be in the 100- to 105-dB range, where structural damage claims would occur at a rate of about one per 10,000 households. Damage potential for the smaller vehicles, which would be used for 98 percent of Cape Canaveral AS launches, would be substantially less.

Sonic Boom. Figures 4.12-15, 4.12-16, and 4.12-17 show the sonic boom footprints for the heavy, medium-plus, and medium vehicles, respectively. The footprints have the characteristics described earlier. The maximum focus boom amplitude is 7.2 psf for the heavy vehicle. The carpet boom amplitude diminishes rapidly as the vehicle gains altitude. Sonic boom footprints for the other two missions (medium-plus and medium vehicles) are similar to that for the heavy vehicle mission, with comparable maximum overpressures and comparable or somewhat smaller areas.

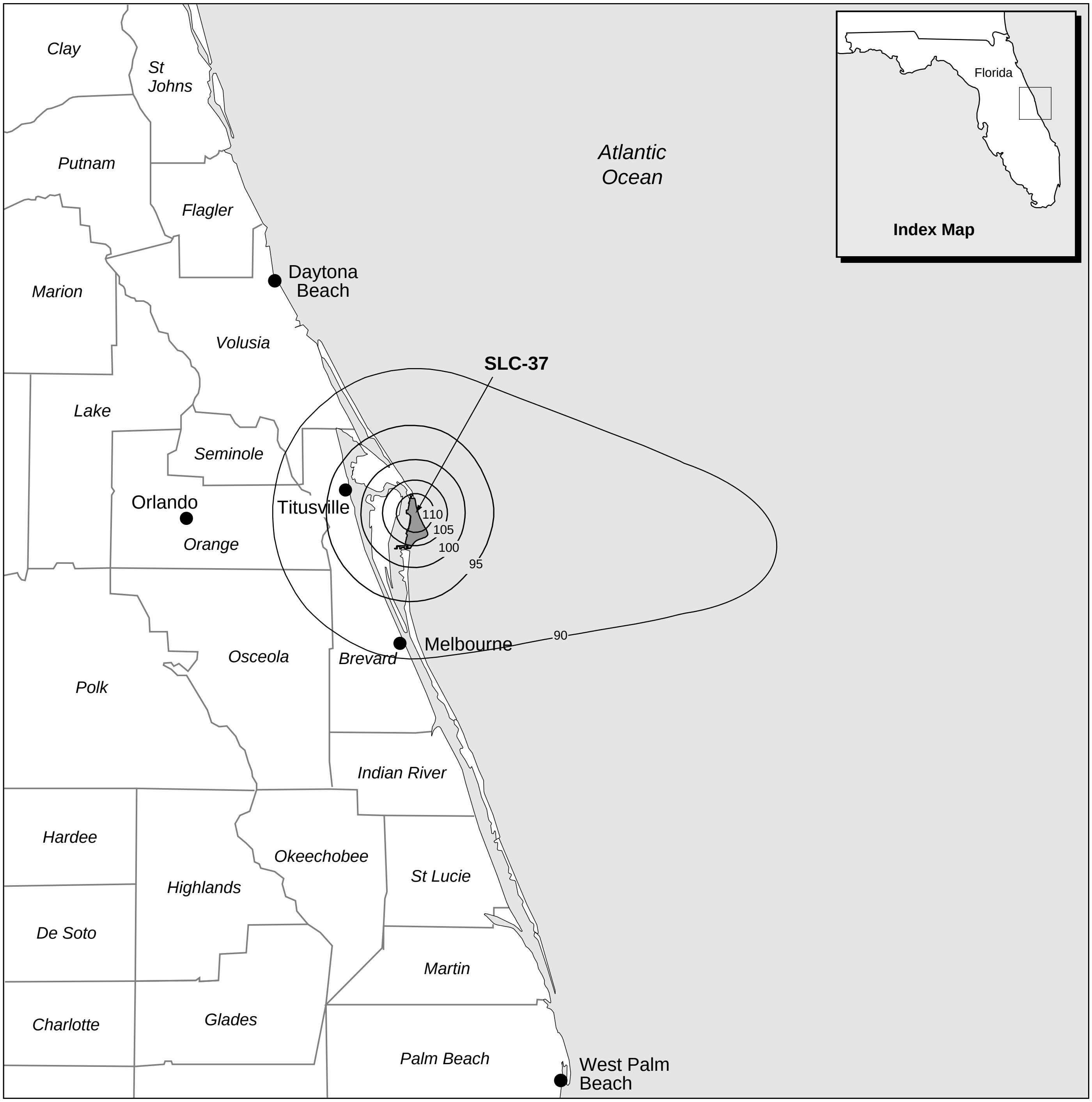
Most of the boom footprints are below 1 psf at which level no adverse effects would be expected, even over land, from an occasional sonic boom. The maximum overpressures, in the narrow focal zones, are in the 6- to 8-psf range. Since the entire boom footprint is over water, the only potential impact is to wildlife (see Section 4.14, Biological Resources).

Cumulative program noise impacts would be quantified by L_{dn} which has been computed for the busiest years. Values are about 50 dB lower than the AWSPL values seen in Figures 4.12-11 through 4.12-13. As discussed in Section 4.12.1.1.1, this is well within acceptable criteria for any type of land use.

4.12.1.2.2 **Concept B, Vandenberg AFB**

In-Flight Rocket Noise. Figures 4.12-18 and 4.12-19 show the in-flight maximum AWSPL for the DIV-H and DIV-M. These contours are very similar to the corresponding contours at Cape Canaveral AS, differing primarily in location and alignment with the launch trajectory. Contours for the DIV-M are approximately 5 dB lower than those for the heavy vehicle.

Considering the DIV-H (which would comprise 27 percent of Vandenberg AFB launches), maximum A-weighted levels in the nearest residential communities would be in the 80- to 85-dB range (see Figure 4.12-18). This is comparable to the noise of a passing heavy truck (80 to 85 dBA). Occasional sounds at



EXPLANATION:

Cape Canaveral AS

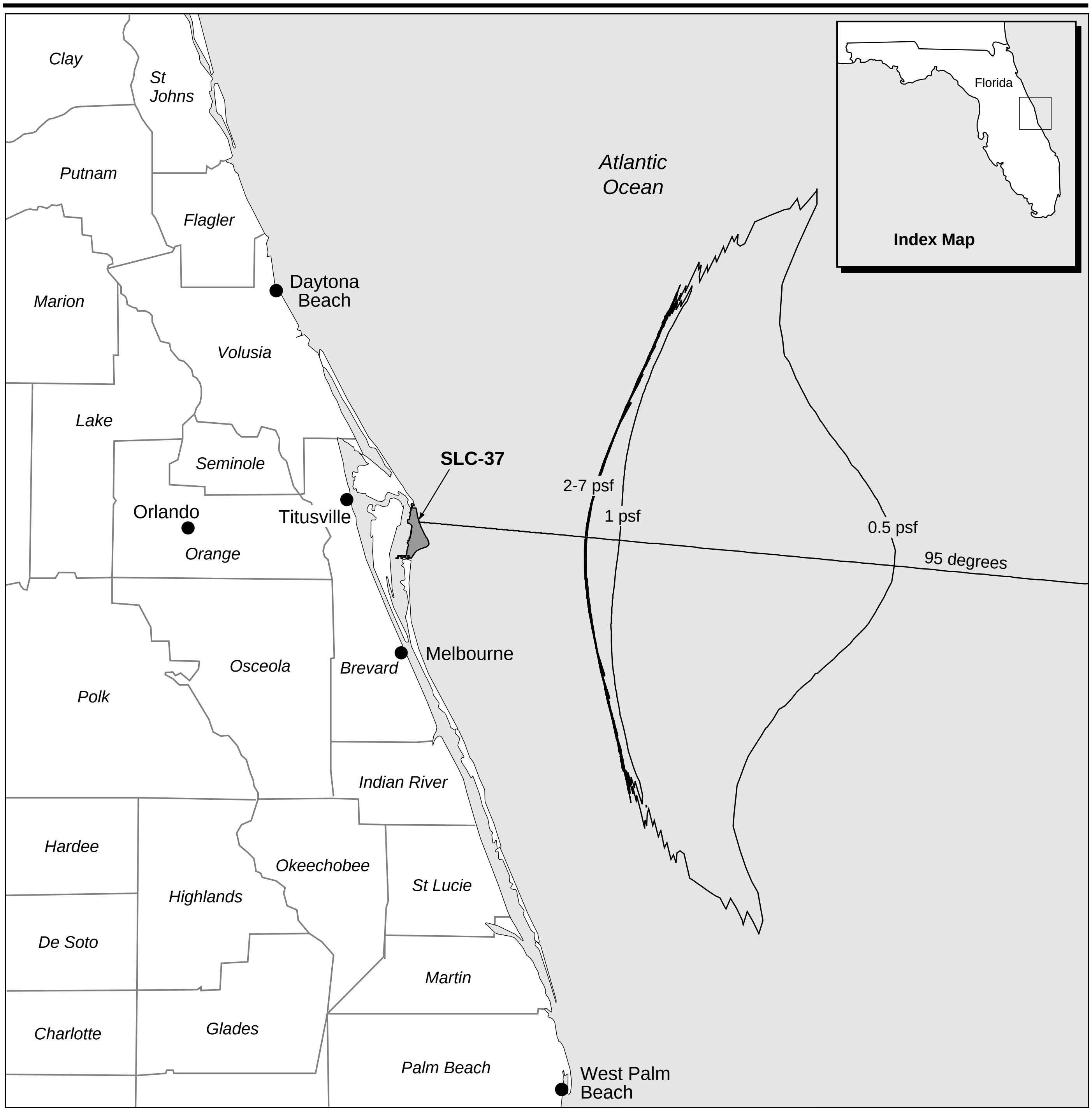
—90— Noise Contours (5 dB intervals)

0 8 16 32 Miles

Maximum Overall Sound Pressure Level, DIV-H, Cape Canaveral AS

Figure 4.12-14

EELV/078



EXPLANATION:

Cape Canaveral AS

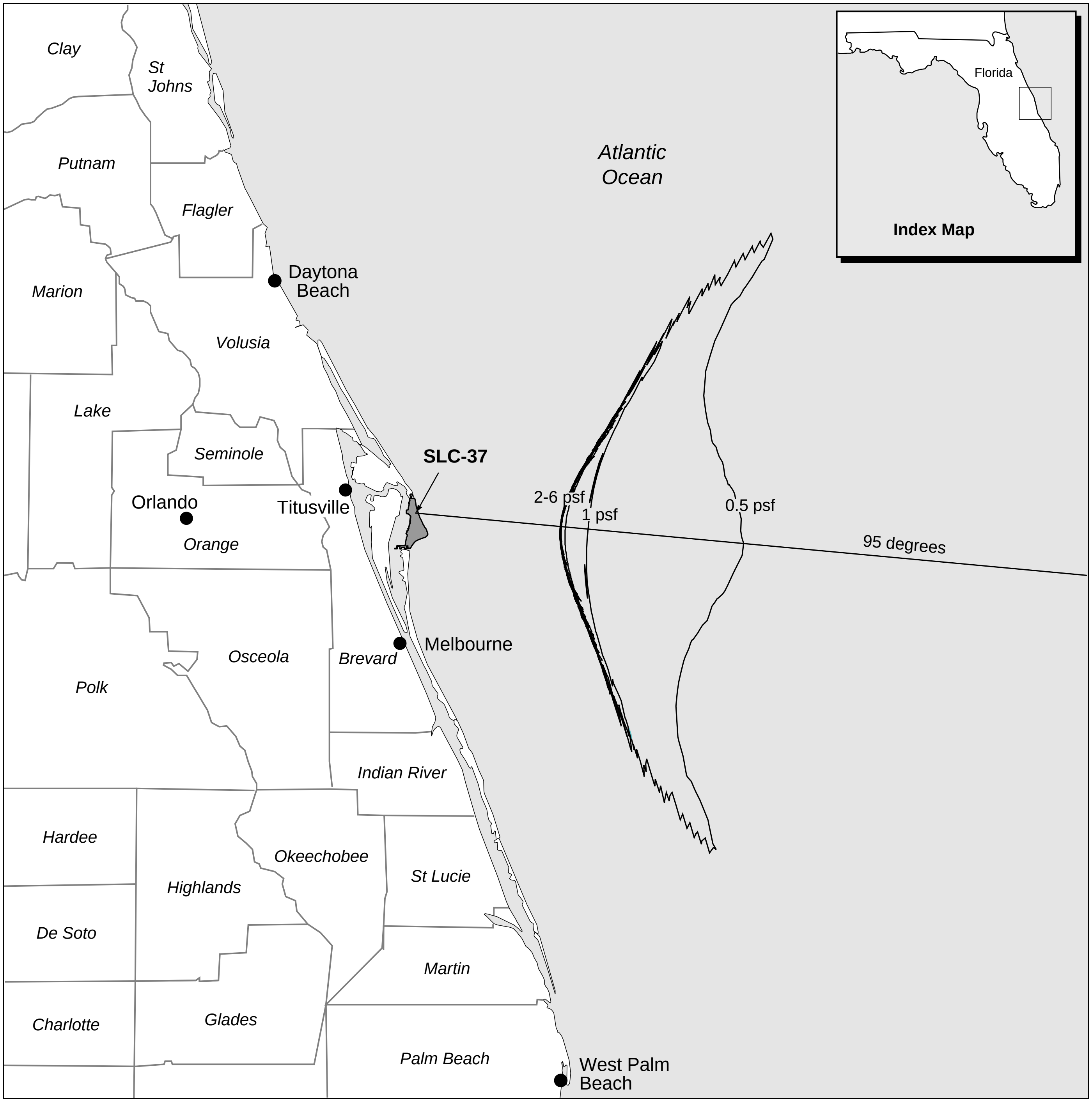
psf Pounds per square foot

0 8 16 32 Miles

Sonic Boom Footprint, DIV-H, Cape Canaveral AS

Figure 4.12-15

EELV/078



EXPLANATION:

Cape Canaveral AS

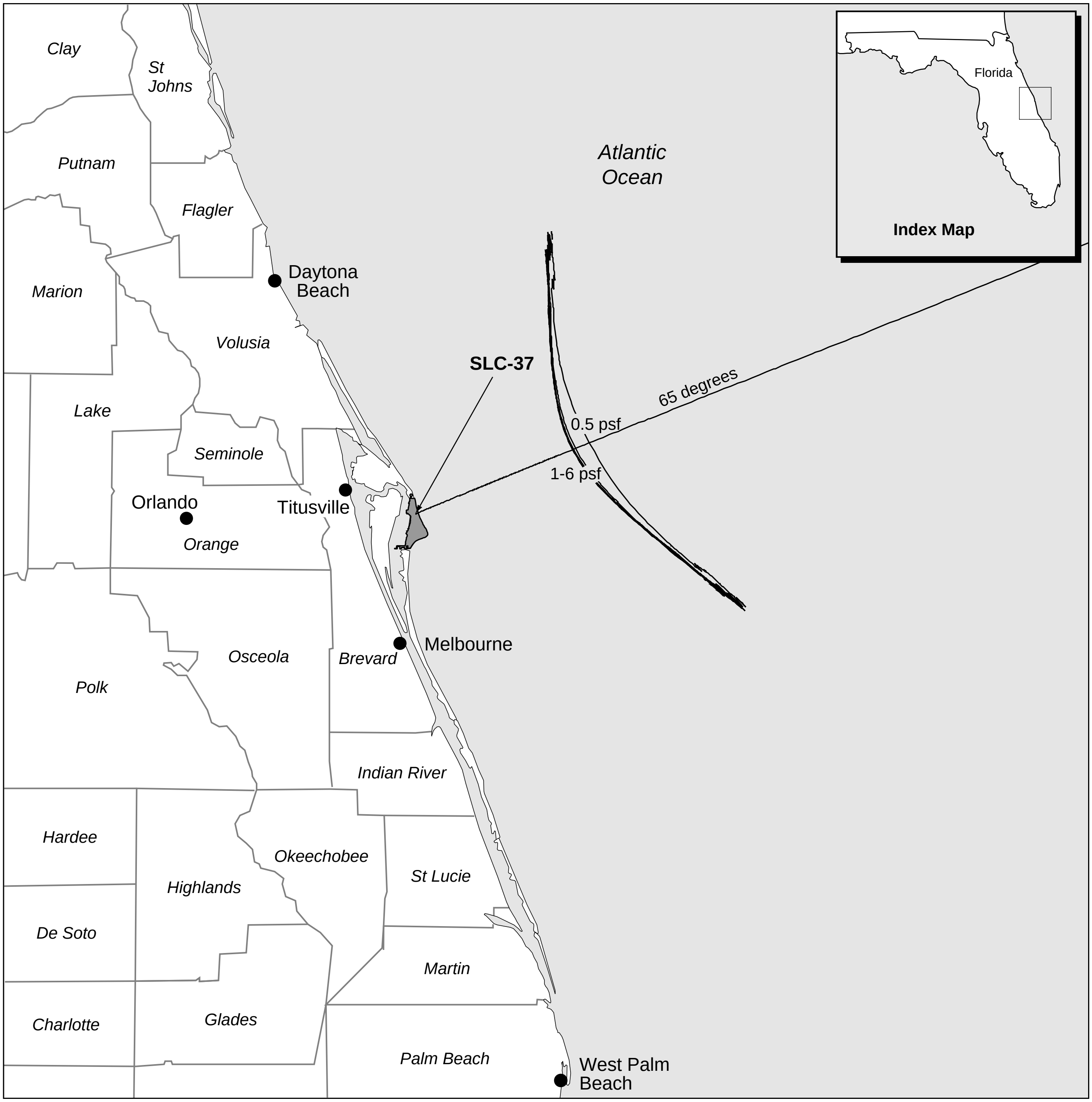
psf Pounds per square foot

0 8 16 32 Miles

Sonic Boom Footprint, DIV-M+, Cape Canaveral AS

Figure 4.12-16

EELV/078



EXPLANATION:

Cape Canaveral AS

psf Pounds per square foot

0 8 16 32 Miles

Sonic Boom Footprint, DIV-S, Cape Canaveral AS

Figure 4.12-17

EELV/078

EXPLANATION

- - - - Base Boundary

Vandenberg AFB

—60— A-Weighted Noise Contours (5 dBA intervals)

0 10 20 40 Miles

Maximum A-Weighted Sound Pressure Level, DIV-H, Vandenberg AFB

Figure 4.12-18

EELV/077

EXPLANATION

Base Boundary

Vandenberg AFB

60 A-Weighted Noise Contours (5 dBA intervals)

0 10 20 40 Miles

Maximum A-Weighted Sound Pressure Level, DIV-M, Vandenberg AFB

Figure 4.12-19

EELV/077

this level would not cause adverse impact. SEL has been computed for this launch, and is about 18 dB higher than the AWSPL. This corresponds to an effective duration of the sound of about a minute. Launch noise is likely to be audible for a longer period, but the total time involved is not great enough to cause substantial impacts.

Figure 4.12-20 shows OSPL for the DIV-H. OSPL in excess of 110 dB, which could cause structural damage claims at a rate of one per 1,000 households, is limited to a radius of approximately 4 miles from the launch site. This area does not contain residential communities, and almost all of the land area affected is within Vandenberg AFB. The OSPL at the nearest residential community, Lompoc, about 8 miles away, would be in the 100- to 105-dB range, where structural damage claims would occur at a rate of about one per 10,000 households. Damage potential for the smaller vehicles, which would be used for 73 percent of launches, would be substantially less.

Sonic Boom. Figures 4.12-21 and 4.12-22 show the sonic boom footprints for the DIV-H and DIV-M, respectively. The boom footprints are offshore, in the Pacific Ocean. These footprints are similar to each other, differing primarily in position and orientation along the launch azimuth. The maximum overpressures, in the narrow focal zones, are in the 6- to 8-psf range. Impacts are expected to be minimal

The two boom footprints shown intersect the Channel Islands, with this intersection being at or near the focal zone. Potential impacts to wildlife are discussed in Section 4.14, Biological Resources.

The two missions shown are at launch azimuths of 184 and 170 degrees. Concept B missions would have launch azimuths from 163 to 192 degrees. The booms would remain over the ocean, and differ in their relation to the Channel Islands.

Cumulative program noise impacts would be quantified by L_{dn} which has been computed for the years with the most launches. Values are about 45 dB lower than the AWSPL values seen in Figures 4.12-21 and 4.12-22. This is well within acceptable criteria for any type of land use. However, L_{dn} is not meaningful for events as infrequent as EELV launches, so the primary impact assessment is the single-event analysis presented above.

4.12.1.3 **Concept A/B**

Under Concept A/B, both Concept A and Concept B launch vehicle systems would be developed, and launches would be conducted as shown in Table 2.1-11. Noise and sonic boom from a given mission would be the same as for that mission for the corresponding Concept A or Concept B vehicle. Impacts would, therefore, be similar to the combined effects discussed in

EXPLANATION

Base Boundary

Vandenberg AFB

90 A-Weighted Noise Contours (5 dBA intervals)

0 10 20 40 Miles

EELV/077

Maximum Overall Sound Pressure Level, DIV-H, Vandenberg AFB

Figure 4.12-20

EXPLANATION

- - - - Base Boundary

psf Pounds per square foot

Vanderberg AFB

0 10 20 40 Miles

Sonic Boom Footprint, DIV-H, Vandenberg AFB

Figure 4.12-21

EELV/077

EXPLANATION

– – – –	Base Boundary
psf	Pounds per square foot
▇	Vandenberg AFB

0 10 20 40 Miles

Sonic Boom, Footprint, DIV-M, Vandenberg AFB

Figure 4.12-22

EELV/077

Sections 4.12.1.1 and 4.12.1.2. The total launch rate would be approximately the same, so cumulative noise impacts would also be the same as described in Sections 4.12.1.1 and 4.12.1.2.

4.12.2 No-Action Alternative

If the No-Action Alternative were selected, noise and sonic boom exposure would remain as it is under current operations (see Section 3.12). These levels are comparable to those that would result under the Proposed Action.

4.13 ORBITAL DEBRIS

4.13.1 Proposed Action

This section analyzes the potential impacts of the launch vehicle only. The environmental consequences of payloads that would utilize the EELV system to reach orbit would be addressed under separate NEPA documentation that would be prepared for each of the satellite programs, as required.

4.13.1.1 **Concept A.** Concept A would contribute to the overall space debris problem from the addition, although of limited duration, of intact upper stages to the orbital debris population through fragmentation if other debris were to collide with the intact upper stages. Because liquid propellants would be used, the typical solid rocket motor aluminum oxide dust emission impacts to the space environment would not occur.

The CUS used for HLV-G missions would remain in orbit after shutdown and separation from the payload. The CUS would be safed to vent residual propellants. Liquid hydrogen and oxygen would be vented through the engine valves without lighting the engine. Hydrazine would be vented through the settling thrusters. If propellants were not vented in a controlled manner, they would boil off, which would eventually cause relief valves to open. The resulting uncontrolled venting could cause the CUS to tumble. Tumbling motion could cause components to break off and become space debris.

The intact upper stages would remain in orbit. However, at the altitudes at which the upper stages of the MLV-D, HLV-L, and MLV-A missions would separate from their payloads, residence time in orbit would be short, and the debris population at altitudes below about 435 miles is not likely to exceed the critical density necessary for collisional growth in debris. At these altitudes, atmospheric drag will typically remove collision fragments before they collide with another object (National Research Council, 1995). However, the upper stage of the HLV-G missions would remain in orbit after shutdown and separation from the payload for an indeterminate time, due to their much higher altitude of release, leaving a total of 8 upper stages in orbit between 2001 and 2020 (see Table 2.1-3).

EELV launch vehicles would be designed to be litter-free: i.e., separation devices, shrouds, and other expendable hardware would separate at a low enough altitude and velocity to keep them from becoming orbital. In addition, stage-to-stage separation devices and other potential debris would be kept captive to the stage with lanyards or other provisions to minimize debris (Office of Science and Technology Policy, 1995). Where possible, the use of new materials on the EELV launch vehicles would reduce the natural degradation and fragmentation that occurs in the harsh environment of outer space (Office of Technology Assessment, 1990).

Two of the principal mitigation measures that would be employed to minimize creation of orbital debris are the expulsion of all propellants and pressurants, and the addition of electrical protection circuits to batteries to preclude electrical shorts and add protection from explosion (Office of Science and Technology Policy, 1995).

The impacts of this principal source of orbital debris from Concept A would be a small, incremental contribution to the existing orbital debris population impacts already occurring under the existing launch programs and discussed in more detail in Section 3.13.

Mitigation Measures. The use of operational practices to limit the orbital lifetime of spent upper stages has the potential to mitigate the growth of orbital debris. Wherever possible, mission designers would select orbital parameters that would minimize the creation of additional orbital debris. Other preventive measures could include designing and building the EELV launch vehicle upper stages so that they would resist environmental degradation from atomic oxygen and solar radiation (Office of Technology Assessment, 1990). Using paint less vulnerable to atomic oxygen, for example, would be one possibility (Johnson & McKnight, 1988).

4.13.1.2 **Concept B**

Under Concept B, the hypergolic upper stage, Delta cryogenic upper stage, and heavy Delta cryogenic upper stage would re-enter the atmosphere, remain intact and burn up as they re-enter the atmosphere. However, the optional third-stage rocket motor for the DIV-S would go into elliptical orbit. The Star 48B would have an explosive composition and weight of 4,431 pounds and would remain in an elliptical orbit of about 100 miles perigee by 19,323 nautical miles for some unknown period of time (McDonnell Douglas, 1997b).

The contribution to the overall space debris problem from Concept B launches would be similar to that described for Concept A. In addition, solid rocket motor emissions from the DIV-M+ and from the Star 48B for the DIV-S would eject aluminum oxide dust into the orbital environment. Larger chunks of unburned SRM propellant or slag may also be released (ignited propellant will not burn completely outside the pressurized confines of the rocket body).

However, as described in Section 3.13.3, solid rocket motor particles decay rapidly, and impacts are anticipated to be temporary and minor.

Although the intact upper stages would remain in orbit, at the altitudes at which the upper stages of the DIV-S, DIV-M, and DIV-H missions would separate from their payloads, residence time in orbit would be short, and the debris population at altitudes below about 435 miles is not likely to exceed the critical density necessary for collisional growth in debris. However, the Star 48B would remain in orbit after shutdown and separation from the payload for an indeterminate time, due to its much higher altitude of release (see Table 2.1-8).

The impacts of these two principal sources of orbital debris from Concept B would be a small, incremental contribution to the existing orbital debris population impacts already occurring under existing launch programs. As described for Concept A, EELV launch vehicles would be designed to minimize creation of orbital debris.

Mitigation Measures. Mitigation measures would be similar to those discussed in Section 4.13.1.1.

4.13.1.3 **Concept A/B**

With an estimated 532 launches under Concepts A and B, and 534 under Concept A/B between 2001 and 2020, for an average of just under 27 per year, and a projected peak annual launch rate of 30 missions in both 2006 and 2014, the contribution of Concept A/B to the orbital debris environment would be similar to that described for Concepts A and B.

4.13.2 **No-Action Alternative**

The No-Action Alternative, like any other launch vehicle program, including EELV, would contribute to the orbital debris population, as described for Concept A. It would also contribute to the problem of pollution in outer space that includes determination of paint and insulation, as well as radio-frequency interference and interference with scientific observations in all parts of the spectrum, as noted in Section 3.13. The continued use of older launch vehicles would not present the same opportunities for implementation of the mitigation measures identified below that use of the newer EELVs would allow.

4.14 BIOLOGICAL RESOURCES

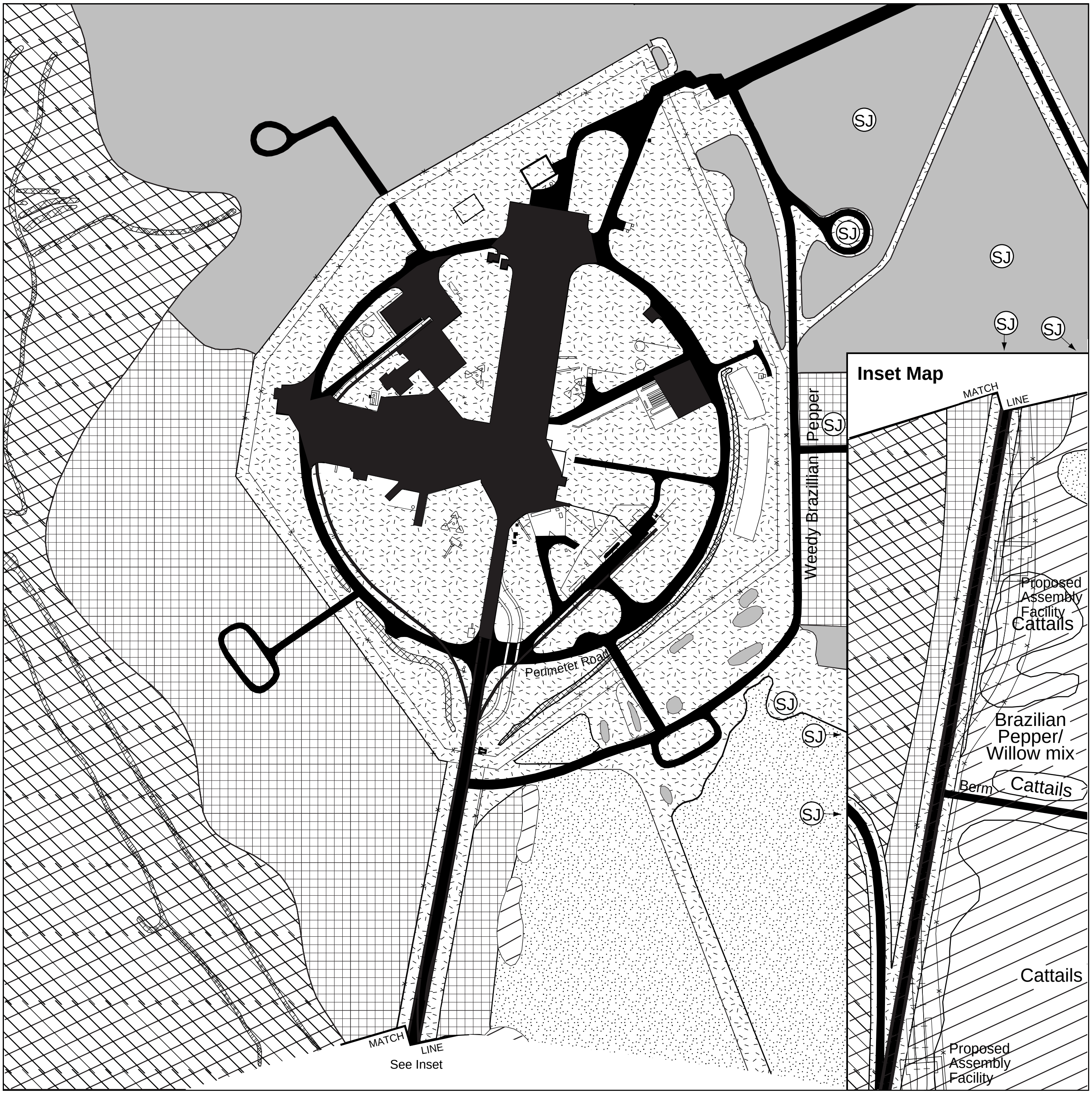
4.14.1 Proposed Action

EELV launch activities with the potential to affect biological resources include loud noises associated with launches including sonic booms, extreme heat/fire in the vicinity of the launch pad, visual impact from the rocket flight path, and vapor from water usage associated with launches; the dropping of the booster, payload fairings, and HLV side boosters containing kerosene fuel into the ocean; and use of exterior lighting at the SLCs.

4.14.1.1 Concept A

4.14.1.1.1 **Concept A, Cape Canaveral AS.** At Cape Canaveral AS, other potential impacts to biological resources from Concept A could occur from ground-disturbing activities at SLC-41, at the assembly facilities construction site, at road intersections that would be modified, and from launch activities at SLC-41 that would affect the biological resources in the extended vicinity. All other facilities would be used as is, or the modifications would be either internal to the building or on a concrete apron outside of the building. Biological resources impacts would not be expected from use of these facilities. Figure 4.14-1 shows the locations of vegetation and sensitive habitat associated with proposed construction at SLC-41.

Vegetation. The impact to vegetation from this concept would be minimal. The vegetation at SLC-41 is a mixture of mowed grasses and forbs. The area is currently affected by deposition of HCl and aluminum oxide associated with SRM launches which has resulted in changes to the vegetation community composition by elimination of species sensitive to this effect. Concept A would use only liquid fuels that would not result in acid deposition. The effect to the surrounding vegetation would be beneficial, allowing sensitive species to reestablish if conditions are otherwise appropriate. As discussed in Section 4.10.1.1.1, the RD-180 is a staged, closed-cycle combustion engine which operates at a high pressure and, therefore, should emit lower quantities of soot and unburned aromatic hydrocarbons than other motors burning RP-1 fuel. Therefore, vegetation in the area should not experience ash fallout as is observed with other launch vehicles using RP-1 fuel. Removal of 13 acres of road shoulder (mowed grass and Brazilian pepper or fill), wetland scrub (Brazilian pepper/willow mix), and wetland marsh vegetation (mostly cattail marsh) for the construction of the assembly facilities would cause minimal impact to the native vegetation in the area because the area has been previously disturbed and little native vegetation remains. Of the area to be disturbed, only 1.5 acres is in high-quality maritime hammock community that has not been extensively altered by non-native species. However, this is in four small areas and does not account for any notable contiguous habitat on Cape Canaveral AS. Wetland impacts will be discussed under Sensitive Habitats.



EXPLANATION

- Security Fence
- SJ Scrub Jay territories
- Developed
- Drainage ditch (open water)
- Barren
- Brazillian Pepper
- Maritime Hammock
- Mowed or open grassland
- Oak or Coastal Scrub (FL Scrub Jay habitat)
- Saltwater marsh
- Wetland
- New Proposed Facilities

0 150 300 Feet

Source: Aerial photograph, Smith Environmental Services, 1997; Earth Tech, 1997; site visit, 1997.

SLC-41 Vegetation and Sensitive Habitat Cape Canaveral AS, Florida

Figure 4.14-1

EEL/109

Launch effects on vegetation include burning of areas adjacent to the flame trenches and defoliation due to heat. Near-field deposition of debris from launch could also damage vegetation. Areas affected by the deluge vapor cloud could suffer damage from the hot water, but this should not result in any changes that would affect the composition of the vegetation community.

An anomaly on the launch pad could produce extreme heat and fire that could burn adjacent vegetation.

Wildlife. Wildlife would be temporarily displaced during the construction of the assembly facilities and other ground-disturbing activities, but the effect to the wildlife population would be negligible because the foraging and nesting habitat that would be impacted is of poor quality, and because adjacent similar habitat is nearby. The most important wildlife impact would occur during the launch activities.

The visual disturbance from pre-launch patrol aircraft overflight often creates more disturbance than the launch itself. The greatest effect of aircraft overflight on animals is from the visual effect of flying aircraft and the sound of its approach. Pre-launch patrol aircraft could temporarily disrupt nesting or feeding birds along the Banana River if flown below 550-feet above ground level (AGL). The 550-foot AGL zone has been shown to account for most wildlife reaction to visual stimuli (Bowles et al., 1991; Lamp, 1987). A report to Congress in 1992 by the U.S. Forest Service reviewed existing literature assessing wildlife impacts from aircraft overflight effects. The report concluded that, although aircraft overflights are initially startling, animals generally adapt by habituating behaviorally and physiologically to the challenge. The report concluded that overflights generally pose negligible risks to wildlife. Therefore, effects of patrol aircraft activities on wildlife are expected to be negligible.

Direct launch effects on the wildlife in the near-field area include incidental death from heat, loss of hearing to various degrees, and temporary disruption of life patterns such as feeding, roosting, and moving about. Because this launch pad is currently being used for rocket launches, resident species sensitive to these disturbances are not likely to be found in the nearby vicinity. Individuals that wander into the area during a launch could be lost, but the effects to the populations nearby from this loss would be negligible.

Wild animals exposed to sudden intense noise can panic and injure themselves or their young; however, this is usually the result of the noise in association with the appearance of something perceived by the animals as a pursuit threat, such as a low-flying aircraft. EELV launch noise is not expected to cause more than a temporary startle-response because the "pursuit" would not be present. Any loss or injury as a result of this startle response would be incidental and not a population-wide effect. Noise associated with EELV launches may startle many species within the area including the Indian River habitat, but actual losses are expected to be minimal.

Sonic booms created by the launch would occur over the open Atlantic Ocean. The effects of a sonic boom on whales or other open ocean species are not known. Because these sonic booms are infrequent, the marine species in the ocean's surface waters are present in low densities (although spring and fall migration will see periodic groups of migrating whales that follow the coastline), and the sonic boom footprint lies over 30 miles from Cape Canaveral AS, the sonic booms from EELV launches are not expected to negatively affect the survival of any marine species.

A residual amount of hydraulic fluid would remain in the stages when they fall into the ocean. If released, the fluid would be diluted by the vast amounts of sea water and is not expected to affect marine species. The chances that the stages would strike a marine mammal are unlikely due to the extent of the open ocean and the low density of marine mammals in open ocean areas.

An anomaly on the launch pad would also present potential impacts to biological resources due to the possibility of extreme heat and fire, and from percussive effects of the explosion. The explosion could injure or kill wildlife found adjacent to the launch pad or within debris impact areas. Potential fires started from the anomaly could result in a temporary loss of habitat and mortality of less mobile species. On SLC-41, fire would probably be limited to areas adjacent to the launch pad because of the amount of surrounding water. A mishap downrange would occur over the open ocean and would not likely jeopardize any wildlife, given the relatively low density of species within the surface waters of these open ocean areas.

Threatened and Endangered Species. Concept A may potentially affect species protected under the federal Endangered Species Act, the Migratory Bird Treaty Act, and the Bald and Golden Eagle Protection Act. Concept A would require compliance with the federal Endangered Species Act of 1973 (16 U.S.C. Sections 1531-1547, et al.) if a federal agency determines that there may be a potential impact to individuals, populations, or habitat of a species listed under the Endangered Species Act. Section 7 of this act requires the proponent federal agency to conduct endangered species consultation prior to irreversible and irretrievable commitment of resources for all federal actions that pose endangered species concerns. Formal consultation is a process between the USFWS and the proponent federal agency that concludes with the USFWS's issuance of an opinion stating whether or not the action is likely to jeopardize the continued existence of a listed species. Although formal consultation has not been initiated with the USFWS, informal consultation will occur through the agency's review of this EIS and the Air Force's request for mitigation planning. The USFWS will evaluate the need for formal consultation for the EELV program.

Two species state-listed as threatened (the golden polypody found in the 1.5 acres of maritime hammock, and the giant leather fern found in the Brazilian pepper/willow community) are expected to be directly affected by the construction activities associated with Concept A in the assembly facilities construction areas. These species are locally abundant and are not listed as rare on Cape Canaveral AS by the Florida Natural Areas Inventory (FNAI) (Smith Environmental Services, 1997). Therefore, the removal of a few individuals by the assembly facility construction would not threaten the range recovery or survival of these species. The area to be disturbed does not contain suitable scrub jay habitat. The American alligator is present at the assembly facility site but is abundant at Cape Canaveral AS and will move away from construction activities. No negative effect is expected to this species from construction activities. Most of the impacts to threatened and endangered species would occur from launch activities.

Four Titan IVB launches were monitored in 1990 from SLC-40 and 41 for effect on the scrub jay. No mortality was observed. All banded individuals were located four hours after the launches, and none showed signs of distress. Each responded to taped scrub jay calls played by investigators. Fire caused by one of the launches did disrupt the scrub jays in the area, who exhibited unusual intensity and duration of scolding behavior. The burned area was avoided by the birds for approximately one month (Larson et al., 1993). The Titan IVB launch vehicle is larger than the EELV; therefore, effects from EELV launches are anticipated to be less than from Titan launches. During construction of the EELV facilities, the USFWS will have 2 to 3 years to conduct prescribed burns in the area for scrub jay habitat improvement. Future prescribed burns for habitat management would need to be coordinated with Concept A launch schedules.

Effects to sensitive birds in the nearby estuaries (wood stork and bald eagle) or shorelines (least tern and piping plover) would be similar to those described for wildlife. The launches are not expected to jeopardize the continued existence of any listed species due to the intermittent nature of the disturbance and the ability of wildlife to habituate to disturbance or to return to normal behavior after a startle response.

Manatees are relatively unresponsive to human-generated noise to the point that they are often suspected of being deaf to oncoming boats (although their hearing is actually similar to that of pinnipeds) (Bullock et al., 1980). Since manatees spend most of their time below the surface, and since they do not startle readily, no effect of aircraft or launch vehicle overflights on manatees would be expected (Bowles et al., 1991).

Sea turtle adults and hatchlings are sensitive to artificial incandescent, metal halide, or high-pressure sodium lighting near their nesting beaches. The hatchlings use moonlight and starlight on the ocean water for directional guidance after emerging from the nest. If lighting inland is brighter than the reflective light, sea turtles may become confused and head the wrong way, never reaching the water. A new light management plan will need to be developed for SLC-41 that addresses the new lighting configuration to prevent negative sea turtle impacts. Any changes in this lighting would necessitate development of a new light plan and would require consultation with the USFWS under Section 7 of the Endangered Species Act. Cape Canaveral AS has lighting guidelines requiring low-pressure sodium lighting to minimize impacts to the sea turtle population.

Impacts of an anomaly would be as described for Wildlife, and could affect scrub jay habitat.

Sensitive Habitats. Wetlands would be impacted from clearing vegetation and constructing assembly facilities in a 29.5-acre project site. Up to 10.9 acres of these are jurisdictional wetlands that could be impacted. Of these jurisdictional wetlands, 10.5 acres are impounded, and 0.4 acre are isolated perimeter ditches, both for mosquito control (Smith Environmental Services, 1997). The impounded wetlands are Brazilian pepper/willow and cattail wetland communities that have low species richness and are not quality wetland habitats. The loss of these degraded wetland types would be mitigated as required in the appropriate permits.

Activities affecting federal jurisdictional wetlands would be subject to EO 11990 for the Protection of Wetlands and Section 404 of the CWA. Under the CWA, any action that would directly involve the placement of fill material in wetlands or other Waters of the United States is subject to the permit requirements of Section 404. According to U.S. EPA regulations issued under Section 404(b)(1), the permitting of fill activities will not be approved unless the following conditions are met: no practicable, less environmentally damaging alternative to the action exists; the activity does not cause or contribute to violations of state water quality standards or jeopardize endangered or threatened species; the activity does not contribute to significant degradation of waters of the United States; and all practicable and appropriate steps have been taken to minimize potential adverse impacts to the aquatic ecosystem (Title 40 CFR 230.10). Further, the guidelines establish a presumption, which the applicant has the opportunity to rebut, that for non-water-dependent projects, a practical alternative to the filling of wetlands exists.

The SJRWMD Environmental Resource Permit: Surface Water Management Systems (Chapter 40C-4, F.A.C.) is a joint application with the Section 404 Dredge and Fill Permit. Florida’s wetland program regulates dredge and fill activities in both fresh and salt waters under their jurisdiction. Jurisdictional waters include surface waters that are present all year and that are greater than 10 acres at a minimum average depth of 2 feet existing throughout the year, and permanent flowing streams and tributaries. Waters adjoining Florida’s coastline are also under the state’s jurisdiction.

The Banana River, which is adjacent to SLC-41, is manatee critical habitat. However, monitoring of manatee habitat conducted for the space shuttle program has revealed no lasting effect in these waters after a launch has taken place. Therefore, Concept A launches are not expected to adversely affect manatee habitat. The use of liquid propellants would not result in the production of an acid cloud such as that currently produced by Titan IVB launches, resulting in overall beneficial effects to manatee habitat.

Effects to rookeries in the waters surrounding the SLC from launch overflight would be as discussed for Wildlife.

Effects of noise and sonic booms from EELV launches on sensitive habitats would be as described for Wildlife.

An anomaly on the launch pad would frighten nearby sensitive species utilizing the Indian and Banana Rivers, such as birds in rookeries and neotropical landbirds. Manatees, sea turtles and other aquatic species are not expected to be adversely affected by an anomaly.

Mitigation Measures. To mitigate the threat to sea turtle nestling survival caused by artificial light sources, only low-pressure sodium lighting fixtures would be used for exterior lighting applications. A new light management plan will be required for SLC-41 construction and would be a part of the Section 7 consultation process prior to the approval of any new construction associated with the EELV program. This light management plan will be submitted to the FDEP for review and comment during the construction process.

Project planning and facility design have been conducted to minimize potential impacts to wetlands through avoidance of direct or indirect disturbance to quality salt marsh wetland communities. Other mitigation measures could include replacement of any wetlands lost at a ratio determined through consultation with the USFWS, the USACE, and the SJRWMD; protection or restoration wetland habitat away from the site for replacement; and monitoring (until habitat becomes well established) of any replacement wetlands in order to determine the effectiveness of replacement and to identify any necessary remedial measures. Avoidance of disturbance could include controlling runoff from demolition and construction sites into drainages through use of berms, silt curtains, straw bales, and other appropriate techniques. Equipment could be washed in areas where wash water could be contained and treated or evaporated. A FONPA will be prepared by the Air Force, as required by EO 11990, and must be signed by SAF/MIQ before activities that could affect wetlands are initiated.

Proposed mitigation measures for wetlands at SLC-41 (Smith Environmental Services, 1997) include a 1.5 to 1 restoration for wetlands lost through removal of the 1.4-mile dike, and a 7.4 to 1 enhancement of existing wetlands through reconnection of the 54-acre impoundment to the adjacent Banana River. This dike has already failed in one place, and the adjacent perimeter ditch has been filled with the dike spoil material. The dike footprint would increase by 6.7 acres of marsh. The work would be monitored to minimize effects to manatee, and would be coordinated with the FDEP and USFWS prior to construction. Work may be restricted to certain months of the year when manatee impacts would be less. A 3-year biological monitoring program would be conducted to determine if impoundment restoration goals are being achieved. The removal of the berm would allow the waters to ebb and flow with the tide and allow an exchange of nutrients and marine species. Cattail density would be expected to decrease with the decrease in water level stability, creating a diverse habitat capable of supporting a greater number of species.

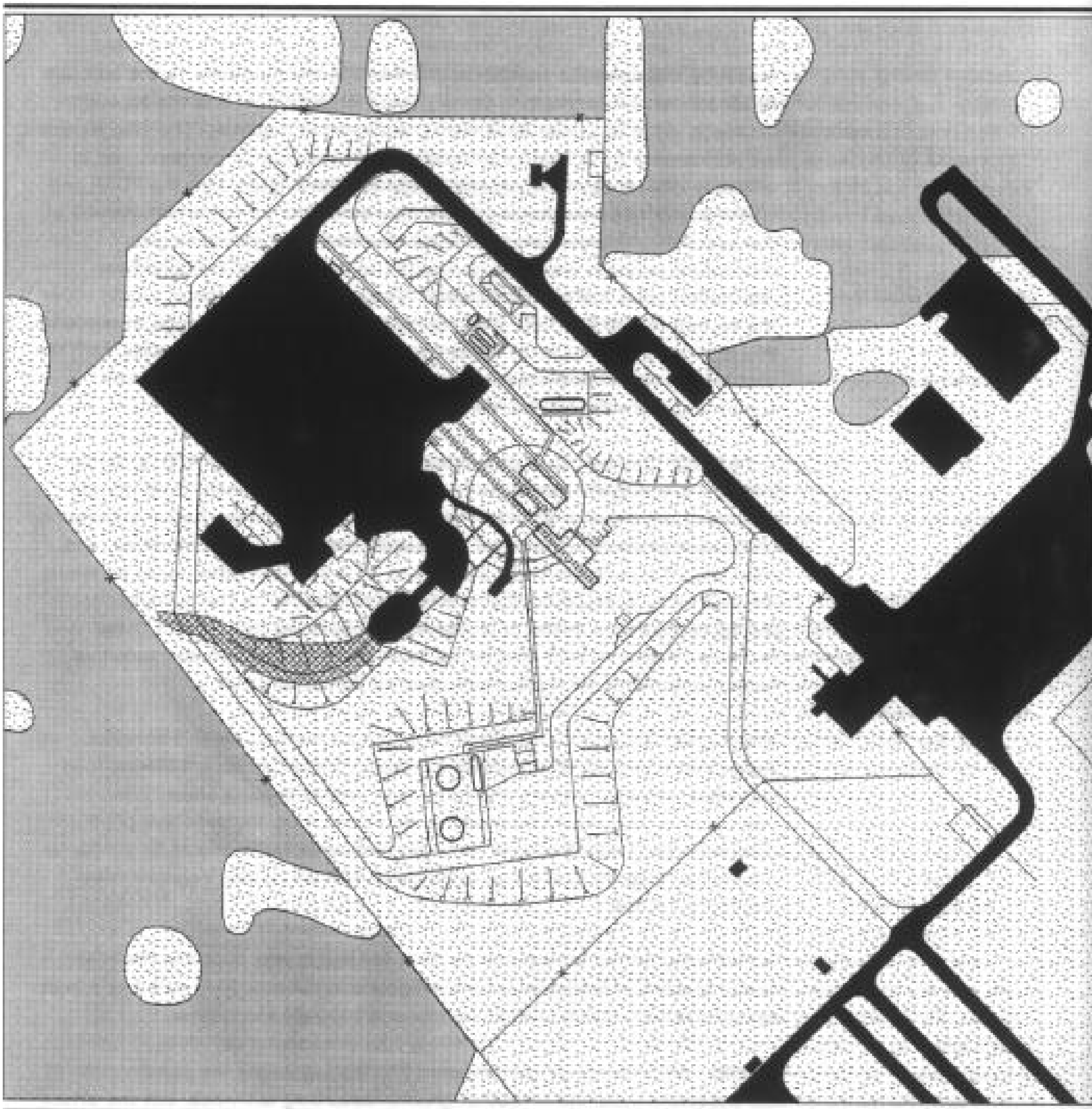
4.14.1.1.2 **Concept A, Vandenberg AFB.** At Vandenberg AFB, potential impacts to biological resources from Concept A could occur from ground-disturbing activities at SLC-3W, at the assembly facilities, power substation, USF construction sites, at road intersections that would be modified, and from the 14 launch activities per year at SLC-3W. All other facilities would be used as is, or the modifications would be internal to the building. Biological resources impacts would not be expected from use of these facilities. Figure 4.14-2 shows the locations of vegetation and sensitive habitat associated with proposed construction at SLC-3W.

Vegetation. Vegetation disturbance would be minimal for this concept. Areas that would be disturbed during facility construction are bladed road shoulders, mowed grasses and forbs, and weedy parking areas. The intersections that would be modified do not contain any sensitive plant communities. Launch effects on vegetation at SLC-3W would be similar to those described for SLC-41 at Cape Canaveral AS, under Vegetation in Section 4.14.1.1.1.

An anomaly on the launch pad could produce extreme heat and fire that would present potential impacts to vegetation. Vandenberg AFB has a high hazard risk for wildfire, which could result from an anomaly.

Wildlife. Wildlife would be temporarily displaced during the construction of the assembly buildings and other ground-disturbing activities, but the effect to the wildlife population would be negligible because sufficient suitable habitat is present nearby. The most important wildlife impact would occur during the launch activities. General sonic boom studies and specific studies conducted.

Launch noise at levels as low as 80 dBA caused a short-term (30-minute) abandonment of a pinniped haul-out area at Vandenberg AFB (Tetra Tech, 1997b). EELV launches would create noise levels lower than 80 dBA at



EXPLANATION

- Coastal Sage Scrub
- Developed
- New pavement proposed/ Proposed facilities
- Electrical line
- Grasslands
- Wetland (Willow Riparian)

0 60 120 240 Feet

Source: Bionetics Corporation, 1988; site visit, 1997.

SLC-3W Vegetation and Sensitive Habitat Vandenberg AFB, California

Figure 4.14.-2

Purisima Point, but would create launch noise of 85 dBA at Rocky Point. However, short-term haul-out area abandonment has not caused noticeable impacts on the pinniped populations at these locations. Therefore, EELV effects from launches from SLC-3W will be temporary and minor, and are not expected to negatively affect these populations. The two pinniped haul-out areas along Vandenberg AFB's coast (Purisima Point and Rocky Point) are shown on Figure 3.14-4.

The sonic boom footprint of the HLV could affect San Miguel and Santa Rosa Islands with up to 10 psf, as was experienced during a recent Titan IV launch. However, most of the launches would be with MLVs that could cross Santa Rosa Island with overpressures of up to 6 psf. The trajectories vary, however, so the sonic boom may occur over San Miguel Island, or may miss the Channel Islands completely. Titan IVB vehicles launched from SLC-4E created focused sonic booms over the northern Channel Islands but showed a lack of significant impact to biota of San Miguel Island (Versar, 1991). The Titan IVB launch effects would be similar to those of the HLV launches from SLC-3W, and would be greater than those of the EELV launches. None of the studies summarized in the Final Programmatic EA for the Marine Mammal Take Permit showed injury or pup abandonment during all noise levels and sonic boom overpressures observed from any launch site, although temporary abandonment of haul-out places were of a longer duration for those areas subject to higher noise levels (Tetra Tech, Inc., 1997b).

Launch noise effects on cetaceans appear to be somewhat attenuated by the air/water interface. The cetacean fauna in the area have been subjected to sonic booms from military aircraft for many years without apparent adverse effects (Tetra Tech, Inc., 1997b).

Launches from Vandenberg AFB require a take permit from the NMFS in order to address the harassment of marine mammals under the Marine Mammal Protection Act. Vandenberg AFB has prepared a 5-year draft programmatic take permit (June 1997) consolidating different launch programs that would allow incidental harassment of marine mammals to occur during their associated launches (Appendix H). The take permit final rule should be published by fall 1998. This programmatic permit is expected to meet the take permit requirements of EELV launches.

An anomaly on the launch pad could present potential impacts to wildlife from fire and from the percussive effect of the explosion and falling debris. The Santa Ynez River and Bear Creek present optimal riparian habitat for numerous species that could be killed by a fire. Habitat fires could drive mountain lions known to occur near SLC-3 to less optimal habitat, although they would return with habitat regrowth. Debris from a downrange anomaly could impact in the open ocean, the channel, or on the Channel Islands. Given the large amount of area beneath the flight path, it is unlikely that debris would fall in an area heavily populated by wildlife.

Threatened and Endangered Species. Impacts to threatened, endangered, or sensitive species from a launch are not expected to jeopardize the existence of any species. Impacts from EELV launches would be similar to or less than those of Titan IVB launches from SLC-4.

Southwestern willow flycatchers have been known to nest along the Santa Ynez River. To date, their reproductive success does not appear to be affected by launches, rather by parasitism natural changes in habitat (Holmgren and Collins, 1995).

Least terns at the Purisima site showed a lack of observable impact from a Titan IV launch from SLC-4 in May 1996 (Read, 1996a). Snowy plovers flushed at launch but returned to normal behavior soon after (Read, 1996a,b). EELV launches from SLC-3W would have less impact upon these birds because the launch site is farther from the coastline and most of the EELV launch vehicles are smaller than the Titan IVB. The least tern nesting colony near SLC-2 experienced noticeable impacts from Delta II launches from SLC-2 in 1997, when numerous launches occurred during the nesting season, although the take remained within the limits of the Biological Opinion (Johnston, 1998; Read, 1997). The EELV program would eliminate launches from SLC-2W and would, therefore, reduce the impacts to this nesting area. EELV launches from SLC-3W would directly overfly snowy plover habitat. Although a startle response from snowy plover would be likely, their reproductive success to date does not appear to be affected by launches, even in the SLC-2 area where Delta II launches occur within 0.5 mile of nesting snowy plovers.

Peregrine falcons nest within areas that could be subjected to high noise levels from launch activities. This exposure could cause lower nesting success of peregrines if launches were to occur during the nesting season, as supported by studies outlined in Appendix F.

Launch noises could disrupt the feeding and roosting activities of brown pelicans off the coast of Vandenberg AFB by causing a startle effect.

Potential impacts from launch noises to the unarmored threespine stickleback and the tidewater goby are expected to be minimal because noise is readily and well attenuated by water. Launch noises may potentially startle the red-legged frog, but the effect is expected to be temporary. Replacement of existing launch vehicles that use solid rocket motors with the EELV would result in a beneficial impact to these aquatic species because EELV launches would not result in acid deposition in aquatic habitats, as launches using solid rocket motors do.

The southern sea otter is found off the coast of Vandenberg AFB in a small breeding colony off Purisma Point near SLC-2. Larger populations are found primarily to the north of the base with an increase in sightings of sea otters along Vandenberg AFB's north shore. Concept A would eliminate launches from SLC-2W, which is situated on North Vandenberg AFB. Launches from

South Vandenberg AFB are less likely to adversely affect the sea otter, and could result in overall beneficial effects to the species.

Impacts of an anomaly would be as described for Wildlife. In addition, the endangered beach layia (plant) is 1.3 miles west and could be affected by a fire.

Sensitive Habitats. A willow wetland has been identified on SLC-3W. Construction plans of a road may affect the edge of the wetland (approximately 0.03 acre) closest to the fence. If this wetland is affected, consultation under Section 404 and a FONPA, as required by EO 11990 would be conducted, as described for Cape Canaveral AS. The Channel Islands are also a sensitive habitat and have been addressed under Wildlife. Vandenberg AFB is a significant shorebird migration/wintering area, and these birds are disturbed by launches from South Vandenberg AFB to as far north as SLC-2W. However, launches occur from SLC-2W, and the shore birds continue to use the area.

SLC-3W is close to known major overwintering monarch butterfly sites in Spring Canyon. It is 1.25 miles south of and downwind of the launch site, just south of SLC-4. Hazardous byproducts from launch are not expected from the liquid fuels used for this concept. A benefit to the butterflies would occur from eliminating launches using solid rocket motors that emit HCl at SLC-4. Therefore, no impacts to butterflies are anticipated.

White-tailed kite foraging habitat is over the grasslands and coastal sage scrub in the area. Although launches could be disruptive to foraging activities, the launches are expected to cause only a temporary startle effect and would not negatively affect the kite population.

Impacts to seabird nesting and roosting areas are discussed under the preceding Threatened and Endangered Species section.

Impacts from an anomaly would be as described under Vegetation and Wildlife. Burton Mesa Chaparral, a state-sensitive plant community 2 miles inland, supports sensitive bird species, including Bell's sage sparrow and Southern California rufous crowned sparrow. These species could be adversely affected by a wildfire at Vandenberg AFB. Burning of the butterfly trees would make them unsuitable for the overwintering monarchs. Burning of nesting habitat along Bear Creek may lower the reproductive success of the species that use this habitat.

Mitigation Measures. Studies conducted before, during, and after Titan IVB launches from SLC-4 in May and December 1996 have resulted in several recommended mitigations for future monitoring of sensitive species. Cumulative effects of multiple launches could cause a particularly sensitive species to abandon the area or have low breeding success. Monitoring could help identify these effects, if they occur.

All space launch effects on marine mammals would be monitored according to the monitoring measures that have been proposed by the take permit application, if adopted.

A Biological Opinion for Titan IVB launches from SLC-4 requires monitoring of sample populations of western snowy plovers, California least terns, peregrine falcons, and southwestern willow flycatchers before, during, and after launches during the breeding season and monitoring of sample populations of wintering western snowy plovers during the non-breeding season. No impacts to their continued use of habitat areas or nesting success of wintering and nesting snowy plovers has been observed, although they may flush at the sight and sound of a launch. However, impacts to snowy plover from SLC-3 launches have not been studied, and SLC-3 launches would result in more direct overflight of snowy plover habitat than launches from SLC-4. Therefore, monitoring of snowy plovers is warranted (Read, 1997). Pre-launch helicopter security patrols cause the most disruption to snowy plover behavior, so every effort must be made to ensure that these patrols do not unduly disturb this species (Read, 1996a). This would be accomplished through coordination with Environmental Management at Vandenberg AFB in order to apprise the security overflight personnel of the areas sensitive to direct overflight.

Least terns at the Purisima site also show a lack of observable impact from Titan IVB SLC-4 launches. However, monitoring of these least terns would be required because there are no data from launch effects on least terns from SLC-3 launches. If least terns re-establish a nesting site near the Santa Ynez River, terns at this location should be monitored for launch-related effects.

Pre- and post-launch monitoring of peregrine falcons could be conducted during the incubation and fledgling periods to note any breakage of already thin eggshells. Environmental Management would identify nest sites and nesting phases of concern during each year as identified through their ongoing sensitive species status monitoring program.

Possible wetland mitigations could be required for the 0.03 acre of the SLC-3 wetland affected by construction. This acreage and wetland impact is of the type and size that qualifies for Nationwide Permit 14.

Impacts of fire caused by an anomaly would be minimized through the fire response practices established through Vandenberg AFB Fire Regulation 92-1. Brush management in the areas around SLC-3 would keep the heat of the fire lower to help preserve root systems and facilitate recovery after a fire.

4.14.1.2 **Concept B**

Under Concept B, proposed activities that could potentially affect biological resources include ground disturbance during facility construction and modifications; loud noises, including sonic booms, extreme heat/fire in the vicinity of the launch pad, the overflight by prelaunch patrol aircraft and the rocket, and vapor from water usage associated with launches; the impact of the common core booster, payload fairings, and HLV side boosters into the ocean; use of security lighting; and maintenance of a clear zone at the SLCs.

4.14.1.2.1 **Concept B, Cape Canaveral AS.** At Cape Canaveral AS, potential impacts to biological resources from Concept B could occur from ground-disturbing activities during the construction of the two launch pads with lightning protection towers at SLC-37, at the HIF construction site, and along new utility corridors, from dredging activities at the roll on/roll off dock, and from launch activities at SLC-37. All other facilities would be used as is, or the modifications would be either internal to the building, on a concrete apron outside of the building, or would be built in an already developed area, and would not entail new ground disturbance. Therefore, biological resources impacts would not be expected from use or construction of these facilities. Additional potential impacts to biological resources from commercial activities include adverse effects of acid deposition resulting from use of solid rocket motors (commercial launches only). Figure 4.14-3 shows the locations of vegetation and sensitive habitat associated with proposed construction at SLC-37.

Vegetation. The impacts to vegetation would include clearing 60 to 70 percent of the scrub within the SLC-37 perimeter fence. Scrub also may be cleared along the road leading to SLC-37 in order to install a nitrogen gas line. However, this vegetation comprises mostly Brazilian pepper. Removal of this weedy, aggressive species would be beneficial to the ecosystem. Installation of the wastewater and electrical line would require the clearing of undisturbed scrub to create the utility corridor. Although clearing of scrub can provide an opportunity for invasion of weedy species, if weedy species are controlled, clearing dense scrub areas is beneficial to the plant community because it allows new growth to occur. Vegetation impacts associated with clearing scrub for construction of the HIF or utility lines would be compensated for under the habitat compensation plan for scrub jay habitat impacts (see Threatened and Endangered Species in this section).

Effects on vegetation from launches associated with some commercial launches could include burning of areas adjacent to the flame trenches and defoliation caused by heat. Near-field deposition of launch debris could also damage vegetation around the launch pad, including dune scrub and coastal

EXPLANATION

HIF Horizontal Integration Facility

S.J FL Scrub Jay territories

Swale

New proposed facilities

Developed

Open water

Coastal dune vegetation

Coastal strand vegetation

Mowed or open grassland

Oak or Coastal Scrub (FL Scrub Jay habitat)

Open sand (Beach mouse habitat)

Palmettos

Wetlands/ wet areas

Proposed mitigation area

0 200 400 800 Feet

Source: Aerial photograph interpretation following site visit, 1997; Earth Tech, 1997.

SLC-37 Vegetation and Sensitive Habitat Cape Canaveral AS, Florida

Figure 4.14-3

EEL/111

scrub vegetation. The effects to the vegetation communities in the region from EELV launches are expected to be minor because only a very small portion of available habitat would be affected.

The solid rocket propellant associated with some commercial launches produces an acid cloud that can damage vegetation when it settles to the ground. The effects of the acid cloud produced by Atlas IIAS, Delta II, and Titan IV launches are well documented and are summarized below. The effects of Concept B commercial launches would be similar to effects of these launches.

Atlas IIAS, Delta II, and Titan IV launches cause local environmental impacts in the areas surrounding the launch pad. Exhaust from the solid rocket boosters combines with deluge water to create an acidic cloud (American Institute of Aeronautics and Astronautics, 1993). Primary components of this cloud include water, carbon dioxide, aluminum oxide, and hydrochloric acid (National Aeronautics and Space Administration, 1985). The hydrochloric acid and aluminum oxide are the components that affect the biota. A ground cloud forms within the first 10-12 seconds of a launch, then cools, rises, and begins to move away from the launch site with prevailing winds.

Near-field deposition effects from 46 launches monitored between May 1995 and January 1998 at Cape Canaveral (22 Atlas II, 16 Delta II and 8 Titan IV) included scorched vegetation, ignition of ground fires, and partial to nearly complete defoliation of tree species within 70 meters (Titan IV and Delta II) to 100 meters (Atlas II) from the flame trench (National Aeronautics and Space Administration, 1995, 1996, 1997, 1998). Large particulate deposition was found beyond the scorched zone up to 200 meters from the pad (Titan IV). Small, brown-gray, powdery particulates, sand grains, and evidence of low-concentration acid deposition that left spots on leaves were typically found between 250 and 830 meters from the pad (Delta II), although one Titan IVB launch in October 1997 produced dry deposits and acid deposition up to 16 km from the pad. The exceptional distance traveled by the acid cloud for this Titan IVB launch was thought to have resulted from the interaction of the launch cloud with atmospheric moisture or localized showers.

Although space shuttle launches have been noted to decrease the pH in nearby surface waters due to the quantity of solid fuel burned during launch, the 46 launches monitored were not observed to produce sufficient acid deposition on nearby plants to indicate a pH drop in nearby surface waters (National Aeronautics and Space Administration, 1995, 1996, 1997, 1998). In support of this observation, the pH measured in nearby surface waters ranged from 7.58 to 8.21 in water quality samples collected in September 1995 and January 1996 (National Aeronautics and Space Administration, 1998). The surface waters and soils at Cape Canaveral AS comprise a well-buffered alkaline system. Because of the high alkalinity of the waters and soil in the area, the aluminum would not be made available by any decrease in pH as a result of an EELV launch. Therefore, aluminum toxicity effects resulting from acidification and release of aluminum into the nearby soil and water are not expected.

Impacts to vegetation from an anomaly would be damage from extreme heat and fire and from falling debris, as described for Concept A. Overgrown scrub would benefit from the clearing of the dense vegetation. No acid cloud is expected to be released during an anomaly.

Wildlife. Wildlife would be temporarily displaced during construction and other ground-disturbing activities, but the effect to the wildlife population would be negligible because sufficient suitable habitat is available nearby. The most important wildlife impact would occur during the launch activities.

The visual disturbance, direct launch effects, intense noise, and general wildlife effects from sonic booms would be as described in Section 4.14.1.1.1.

NASA conducted a thorough evaluation of the effects of rocket systems that impact in seawater. This study considered sounding rockets, which have a solid propellant. It was concluded that the release of missile-related hazardous materials into seawater would not be significant. The study determined that materials would be rapidly diluted and, except in the immediate vicinity of the debris, would not be found at concentrations identified as producing any adverse effects (U.S. Army Space and Strategic Defense Command, 1994; National Aeronautics and Space Administration, 1994). Any area affected by the release of the propellant as the rubber matrix dissolves would be relatively small due to the size of the rocket motor or propellant pieces relative to the quantity of water. Sensitive marine mammals are widely scattered, and the probability that one would encounter or ingest the slowly decaying propellant or a toxic chemical/seawater solution is remote (U.S. Department of the Navy, 1996).

In the 46 launches monitored during 1995-1998 that are expected to be similar to EELV launches, no fish or wildlife mortalities were attributed to the launches (National Aeronautics and Space Administration, 1995, 1996, 1997, 1998). Based on previous studies, temporary acidification of the soil or water is not expected, nor is creation of an aluminum toxicity in the biological systems as a result of a change in pH. Therefore, wildlife mortality from the launch or emissions is expected to be negligible.

The effects from an EELV anomaly on the launch pad or downrange would be as described for Concept A. Wildlife in any burn areas could be displaced, killed, or otherwise affected by such a fire.

Threatened and Endangered Species. Concept B may potentially affect species protected under the federal Endangered Species Act, the Migratory Bird Treaty Act, and the Bald and Golden Eagle Protection Act. Compliance with these acts would be required as described in Section 4.14.1.1.1.

SLC-37 is near a sea turtle nesting beach. Exterior lighting at the SLC will be low-pressure sodium fixtures in accordance with the 45 SW exterior lighting policy. A Light Management Plan would need to be prepared in accordance with the USFWS requirements for that complex.

The beach adjacent to SLC-37 is also habitat for the federally listed as threatened southeastern beach mouse. A lightning tower anchor would be placed with beach mouse habitat, and would cause direct mortality of any beach mice present in the 100-square-foot area proposed for disturbance. The flame duct points directly over 0.25 to 0.5 acre of this habitat and may impact this species during a launch by direct mortality of individuals from fire and heat, especially during night launches, when this species is active. A flame deflector shield would be used to minimize potential impacts on the beach mouse.

Gopher tortoises were found on SLC-37 and the HIF site. Their burrows are in areas planned for construction and would be impacted by the action. Those not directly impacted by construction may be impacted when the launches begin, although they are fire-adapted and have been known to come out of their burrows following a launch that has scorched the vegetation in the area. Other listed species that may reside within these burrows include the eastern Indigo snake, the Florida mouse, and the gopher frog. These species could also be affected by construction or launch effects.

Clearing the 15-acre HIF site and 0.25-acre scrub area for the switching station could impact numerous species, including the Florida scrub jay and those mentioned for SLC-37. The numbers of scrub jays are in a regional decline as a result of habitat loss and degradation due to fire suppression (Myers, 1990; Cox, 1987; and Cox, 1984). In a 1997 Florida scrub jay survey that determined the presence, density, and distribution of Florida scrub jays on the HIF site and in the SLC-37 area, only one pair was observed across the road from the HIF, although the HIF area is most likely part of the territory (Earth Tech, 1997). The areas along road shoulders that would be cleared to accommodate utility lines contain mostly Brazilian pepper, an introduced, aggressive, weedy species. Clearing this vegetation would provide openings in the scrub that would support scrub jay foraging.

Unless a scrub jay is directly in line with the flame trench, immediate mortality of scrub jays seldom occurs from current Titan IVB launches at SLCs 40 and 41. Some road mortality has been noted for scrub jays that occupy territories along the highway (Larson et al., 1993). In the 1997 scrub jay survey of SLC-37, four groups of birds were noted around the perimeter of the SLC (Earth Tech, 1997). Given the distribution of habitat and known scrub jay pairs within the area, it is expected that use of the SLC will not greatly impact Florida scrub jay territories. Project-related clearing of the SLC area inside the perimeter road will only serve to increase areas available for acorn caching. Fire and heat from launches would reduce cover in the area immediately surrounding the SLC, which would be favorable for the scrub jay. The direct impacts of the launch noise and flame could cause incidental mortality;

however, because scrub jay territories are maintained at SLCs 40 and 41 during launches without an observable adverse effect on the population, no adverse effect on scrub jays at SLC-37 would be expected. Prescribed burns required for current scrub jay habitat management in the SLC-37 area would need to be coordinated with Concept B launch schedules.

The effects from an anomaly would be as described for Concept A. The surrounding scrub jays would be temporarily displaced by a fire. Scrub jay nests could be destroyed if fires occur during the nesting season, but the scrub jays would experience a long-term benefit from the opening up of overgrown habitat as the result of fire and the regrowth of the burned habitat.

Other species that could be affected by an anomaly are the beach mouse and gopher tortoise commensal species, such as the eastern indigo snake, which would be affected by the blast or by the fire and smoke.

Sensitive Habitats. Wetlands would be impacted from construction of facilities within SLC-37 and the HIF (ENSR Corporation, 1997c). At the HIF site, 0.68 acre of jurisdictional wetlands could be filled during construction. This wetland is a swale surrounded by scrub and has been impacted by changes in the natural hydrology.

At SLC-37, man-made jurisdictional drainage ditches (other surface waters) surround the SLC and empty into the Banana River. New utility corridors to the SLC may cross the ditch, and their installation would constitute a “waters” impact (ENSR Corporation, 1998a). Within the SLC, 7 acres of vegetated drainage ditches connect to the ditch surrounding the SLC. Approximately 3 acres of these surface waters may be impacted as a result of proposed development. Impacts to these waters, as well as to the wetlands, would require the appropriate permits, as described in Section 4.14.1.1.1.

Contact with the acid cloud could be expected to irritate or annoy birds in the rookeries along the Banana River; however, solid rocket motor launches occur in the vicinity, and animals sensitive to these launches would most likely have moved elsewhere. Manatee critical habitat is not expected to be adversely affected by acid deposition because of the diluting effects of the water.
An anomaly could cause effects as described under Concept A. Although fire could benefit overgrown coastal scrub or wetlands by clearing duff and recycling nutrients, uncontrolled burns could adversely affect species using these habitats if fire occurs during sensitive seasons, such as Florida scrub jay nesting season. An anomaly could cause an acid cloud in the vicinity of the launch pad; however, effects would be less than those described for space shuttle launches.

Mitigation Measures. Mitigation for sea turtle nestling lighting impacts would be as described in Section 4.14.1.1.1.

Impacts to the southeastern beach mouse may be mitigated though a trapping effort to relocate the mice and through habitat restoration (clearing scrub) near the site. The final methods would be determined through consultation with the USFWS.

Any construction activities affecting Florida scrub jay habitat would be coordinated with USFWS. Specific mitigations may be developed during Endangered Species Act Section 7 consultation, and could include the following measures. To the extent possible, construction activities would occur between July 1 and February 29 to avoid the nesting season. If the nesting season cannot be avoided, surveys should be conducted one to two days prior to construction to identify any nests present in or around the construction site. If no nests are present in the construction area, or within 50 to 75 feet surrounding the area to be cleared, construction may proceed. Vegetation clearing would be limited to that absolutely necessary for the project (U.S. Air Force, 1993a). Scrub clearance would be followed by habitat compensation mitigation activities as outlined in the Scrub Jay Habitat Compensation Plan for Cape Canaveral AS, which requires restoration of 3 acres of scrub to compensate for the loss of each acre of scrub jay habitat. Areas that are extremely degraded may also be planted with live oak, myrtle oak, and Chapman’s oak seedlings. A 5-year monitoring program, including oak seedling replacement and weed control as required, would accompany any scrub jay habitat restoration activities (U.S. Air Force, 1993a). Removal of abandoned pavement and revegetation of these areas with scrub, and the clearing of densely vegetated areas previously containing scrub jay habitat, are some of the actions considered for compensation. Disturbed road shoulder areas should be replanted with native grasses, not with sod, to allow the scrub jays to utilize small patches of open sand for acorn caches.

Two areas have been selected as scrub mitigation sites. These areas total approximately 53 acres and are Scrub Compartment 9 and a triangular area between Beach Road, Patrol Road, and Samuel C. Phillips Parkway (ENSR Corporation, 1998a). The clearing of overgrown scrub jay habitat could also be considered as wetland restoration because it would benefit the swale wetlands in the area. Overgrown woody vegetation within swales would be cleared to compensate for wetlands impacted by the project at a ratio of 1 to 1. The selected mitigation site is adjacent, south of SLC-37. Use of mechanical clearing for brush removal, followed by a prescribed burn, is recommended. The proposed parcel contains 8 acres of degraded wetlands and will exceed mitigation requirements set by the USACE. Mitigations compensating for drainage ditch impacts will not be required.

Prior to construction, a biological survey would be conducted to identify existing gopher tortoises on the site. These tortoises would be trapped and removed from the area to a scrub jay enhancement site elsewhere on the base, prior to the clearing of any construction site. Necessary permits for handling tortoises would be obtained from the Florida Game and Freshwater Fish Commission. Additional mitigative actions, if necessary, would be identified by the USFWS through the Section 7 consultation process (U.S. Air Force, 1993). Gopher tortoise burrows create habitat for a number of sensitive species; relocation of the tortoises would facilitate creation of habitat for these species at other locations. Relocation of the species that use the tortoise burrows is not always feasible but could be conducted as appropriate.

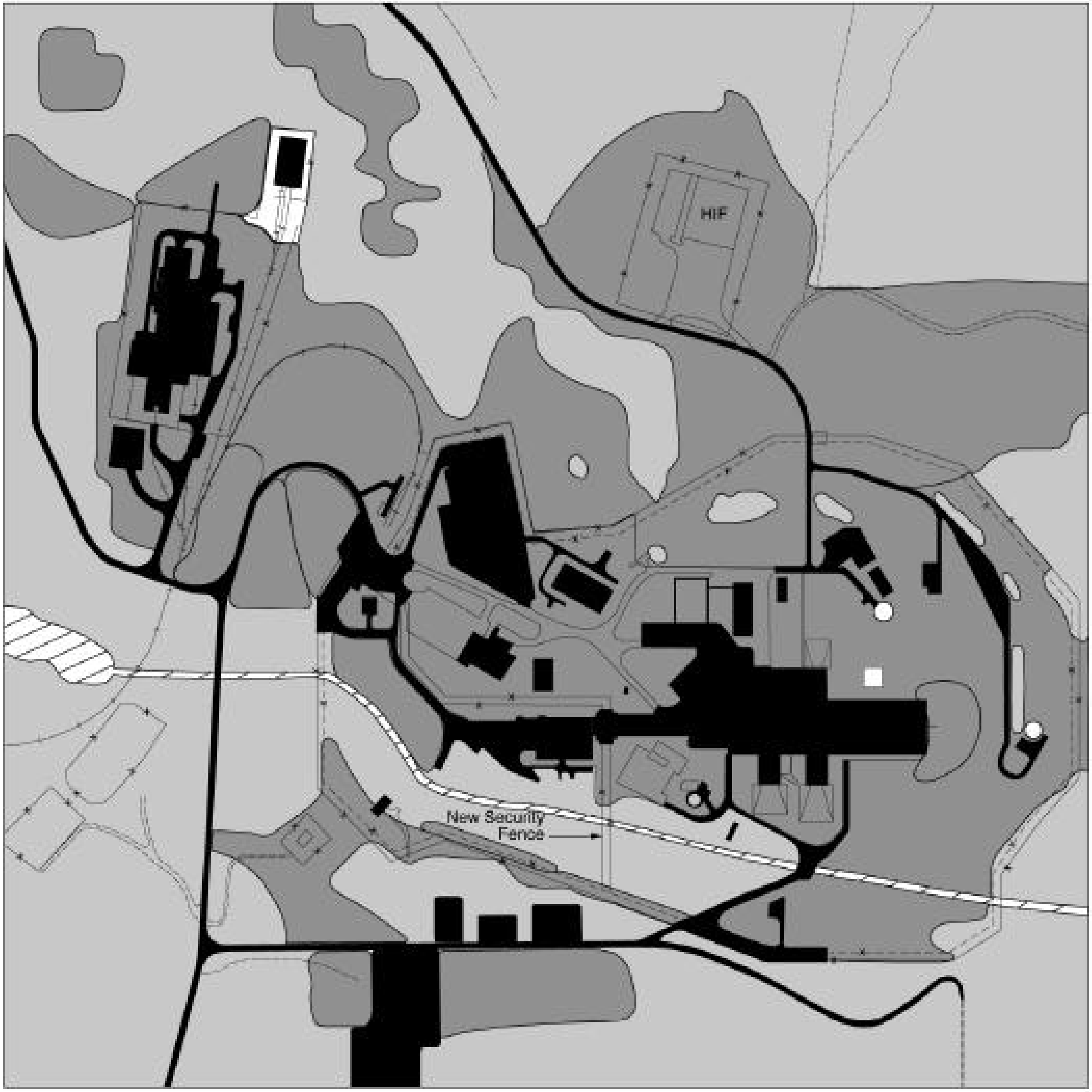
Mitigation parameters for wetland impacts would generally be as described in Section 4.14.1.1.2. Enhancement of degraded wetlands may be required as mitigation for wetlands impacts, at a ratio of 1 to 1. The site for wetlands mitigation would be the same as for the scrub jay habitat mitigation (ENSR Corporation, 1997c).

Monitoring of pre- and post-launch effects of acid cloud deposition on the nearby resident plant and animal species could provide information concerning long-term effects and potential protective measures.

4.14.1.2.2 **Concept B, Vandenberg AFB.** At Vandenberg AFB, potential impacts to biological resources from Concept B could occur from ground-disturbing activities at and adjacent to SLC-6, mainly from the construction of the HIF from dredging and off-loading activities at the boathouse dock, and from launch activities from SLC-6. All other facilities would be used as standing, or the modifications would be either internal to the building or on a concrete apron outside of the building. Biological resources impacts would not be expected from use of these other facilities. Figure 4.14-4 shows the locations of vegetation and sensitive habitat associated with proposed construction at SLC-6.

Some of the launches would utilize solid propellants whose combustion produces an acid cloud at launch.

Vegetation. Vegetation disturbance would be minimal for this concept. Areas planned for facility disturbance are either bladed road shoulders, mowed grasses and forbs, or weedy parking areas. Vegetation would be



EXPLANATION

- - -	Double Fence (If required)		Barren
—+—	Security Fence		Coastal Sage Scrub
HIF	Horizontal Integration Facility		Grassland
	Developed		Wetland
			New proposed facilities

0 145 290 580 Feet

Source: Bionetics Corporation, 1988; site visit, 1997.

SLC-6 Vegetation and Sensitive Habitat Vandenberg AFB, California

Figure 4.14-4

EEL/110

affected by the installation of a fence at SLC-6 and by direct effect of the launches (i.e., burning, defoliation, near-field deposition).

A fence would be constructed along the wetland drainage and may affect some native shrubs. Effects to vegetation from launches, acid cloud deposition, and launch anomalies would be the same as those summarized under Concept A for Vandenberg AFB (specific vegetation effects) and under Concept B for Cape Canaveral AS (acid cloud effects).

Wildlife. Wildlife would be temporarily displaced during construction and other ground-disturbing activities, but the effect to the wildlife population would be negligible because sufficient suitable habitat is available nearby. The primary effects to wildlife would occur during the launch activities.

The impacts to open-ocean species from direct ocean impacts, and to general wildlife species from pre-launch control aircraft overflights and direct effect of launches, would be similar to those described under Concept A for Vandenberg AFB. In addition, general sonic boom studies and specific studies have been conducted for the species on Vandenberg AFB and the Channel Islands.

Physiological and behavioral response to sonic booms and launch noise on birds and pinnipeds of California would be similar to those described in Section 4.14.1.1.2. SLC-6 is farther from the Point Sal and Purisima Point haul-out and nesting areas than SLC-3, although it is directly adjacent to the Rocky Point site. However, birds and pinnipeds continue to use these areas near SLC-2, even though launches are conducted there, so no long-term adverse effects on these species or their habitats are anticipated from EELV launches from SLC-6.

A literature search and the threshold of audibility over ambient noise was conducted for Harbor seals to calculate the anticipated startle response to EELV operations at the Vandenberg AFB Boat Dock (Acentech, 1998). The off-loading of rocket boosters, conducted up to four times per year for a 3-day period, is expected to cause a startle response within 280 feet of the dock. It has been determined that seals do not “hear in the air” nearly as well as humans do (SRS Technologies). Harbor seals that use the breakwater for a haul out location may avoid the dock area during operations, but are not expected to permanently abandon this area.

The permitting requirement for the harassment of marine mammals is described in Section 4.14.1.1.2.

The area by the boathouse designated for dredging was dredged in the mid-1980s. Clearing of this area could remove algae (seaweed) or surfgrass and cause siltation impacts to adjacent invertebrates. Although some individuals may be removed or buried, these invertebrate populations are not expected to be adversely affected by this siltation. Fish species present near Point Arguello would leave the area during dredging activities, as would any seals, sea lions, or sea otters that may be visiting the channel. Long-term effects to these species are not expected.

The deposition of dredged material could cause the greatest impact. Currently, the disposal sites under consideration for the 2,000 cubic yards of dredged material are on the beaches downcurrent of the harbor. Chemical components of the dredge material are similar to what has been identified in the sand along these beaches, with the exception of elevated hydrocarbon readings. The chemical analysis has identified the typically toxic component of the hydrocarbons present, the polynuclear aromatic hydrocarbons (PAHs), at well below levels of concern for toxicity of these constituents (ENSR Corporation, 1998b). The U.S. EPA requires dredged material to be tested for toxicity prior to disposal, so these levels will be monitored during the disposal process. Although the grain size of the dredge material is somewhat smaller than the sand grains on the beaches, natural drift and beach erosion will distribute the sand downcurrent without much disruption to any natural communities.

Solid propellant causes an acid cloud during launch. Replacement of existing launch vehicles that use solid rocket motors with the EELV would result in a beneficial impact to aquatic species because most of the EELV launches would not use solid rocket motors and would result in less potential acid deposition in aquatic habitats. The acidic emissions caused by solid rocket boosters have a potential to affect the shallow Cañada Honda Creek where the tidewater goby, the unarmored threespine stickleback, and the red-legged frog are found. Extensive monitoring of expendable launch vehicles on the East Coast has revealed that the acid cloud of vehicles similar to the EELV is typically confined to an area within one-half mile of the launch pad and does not affect the pH of nearby surface waters. A beneficial effect of terminating solid rocket motor launches under current programs would be cessation of acid deposition effects on sensitive least tern and snowy plover nesting areas near SLC-2.

An anomaly would cause effects as described for Concept A. Cañada Honda Creek and its associated wildlife is closer to SLC-6 than to SLC-3 and could be adversely affected as well.

Threatened and Endangered Species. Impacts to threatened and endangered species would be similar to those described in Section 4.14.1.1.2. Effects of SLC-3 launches on willow flycatchers along the Santa Ynez River would be minimal, as described in Section 4.14.1.1.2. Launches from SLC-6 would be expected to have less impact on this species than launches from SLC-3W because SLC-6 is located farther from the Santa Ynez River.

Least terns at the Purisima site showed a noticeable impact from Delta II launches from SLC-2 when numerous launches occurred during the nesting season, although the take stayed within Biological Opinion limits (Johnston, 1998; Read, 1997). Effects of EELV launches from SLC-6 would not be as great because the launch site is located much farther from the Purisima site than SLC-2. The EELV program would benefit the Purisima Point least tern population because launches from SLC-2 would be terminated.

General impacts to peregrine falcons from launch activities are described in Section 4.14.1.1.2. Because SLC-6 is much closer to the peregrine's nesting area than SLC-4, the potential for impacts from EELV launches from SLC-6 may be greater than for Titan IVB from SLC-4. Two recent Lockheed Martin Launch Vehicle (LMLV) launches from SLC-6 were monitored, and no substantial effects to peregrine falcons were noted, although these launches did not occur during the nesting season. Launching during the nesting season could adversely affect peregrine falcon nesting success because of this species' vulnerability to disturbance during this time.

The Boat Dock area was listed, in addition to the four natural points off Vandenberg AFB, as having higher proportions of roosting brown pelicans than other sites frequented by the pelicans, such as river mouths and beaches, due to the minimal human disturbance encountered at these sites. Under Concept B, the Boat Dock would be utilized up to four times per year for a 3-day period. During this time, the adult pelicans would most likely avoid the area. This disturbance is not expected to cause permanent abandonment of the area, however, nor is it expected to cause long-term crowding in the more favorable roosting sites, due to the infrequency and short duration of proposed EELV activities.

The negligible impacts on southern sea otter from South Vandenberg AFB launches are described in Section 4.14.1.1.2. Sea otters may be disturbed during off-loading of rocket boosters at the Boat Dock. However, this area would be used only up to four times per year for 3-day periods, and the harbor is visited only periodically by sea otters. The infrequent use of the area for EELV activities should not result in permanent abandonment of the area by the otters.

Potential general impacts from launch noises to the unarmored threespine stickleback and the tidewater goby are described in Section 4.14.1.1.2. The acidic emissions caused by solid rocket boosters could affect the shallow Cañada Honda Creek, but only if the wind is atypical (i.e., from the south). The tidewater goby, the unarmored threespine stickleback, and the red-legged frog inhabit the creek and could be adversely affected by acidification of the water. These impacts would be similar to those experienced under the current launch programs. Recent monitoring of an LMLV launch from SLC-6 did not show a substantial effect on the red-legged frog found in the evaporation ponds near the launch pad. Extensive monitoring of launches on the East Coast has revealed that the acid cloud of vehicles similar to the Concept B vehicle is typically confined to an area within 1/2 mile of the launch pad, and does not affect the pH in nearby surface waters.

Impacts from an anomaly would be as described under Wildlife. Sensitive species residing in the surrounding cliffs could be injured or killed from the explosion.

Sensitive Habitats. The Channel Islands are a sensitive habitat; potential impacts to them have been discussed under Wildlife. Shorebird nesting occurs along the coast of Vandenberg AFB and is disturbed by launches from South Vandenberg AFB to as far north as SLC-2W. However, launching occurs out of SLC-2W, and the shore birds continue to use the area; consequently, no long-term adverse impacts from EELV launches would be expected.

The dredging of the boathouse channel would have to be authorized by Section 10 of the Rivers and Harbors Act of 1899, Section 404 of the CWA, and Section 103 of the Marine, Protection, and Sanctuaries Act. These laws require permits authorizing activities in or affecting navigable Waters of the United States, the discharge of dredged or fill material into Waters of the United States, and the transportation of dredged material for the purpose of dumping it into ocean waters. This site was originally dredged in the mid-1980s and was authorized to be maintained at 12.4 feet below MSL through June 1989, although plans as stated on the permit include dredging as needed through 1998. Although it has not yet been determined whether the 20,000 cubic yards of spoils will ultimately be disposed on dry land as stipulated in the 1988 permit, in the ocean as was conducted in the mid-1980s, or on the beaches downcurrent of the harbor, the amount of dredging and dredged materials is approximately one-third of that originally dredged and is not expected to cause a serious impact. The spoil disposal site in the ocean was a deep canyon with a high degree of instability where land slumped off the canyon walls naturally and fell to the canyon bottom. It was thought that additional sand debris would not greatly impact the canyon’s ecology (U.S. Air Force, 1982b). Areas of biological importance, such as spawning grounds, are far from the canyon and are not thought to be affected by the disposal. In the latest permit (1988), the dredged sand was to be trucked to a borrow site located along the coastal bluffs at Point Pedernales. A favorable alternative being considered is the disposal of dredged sand on the beaches downcurrent of the harbor. As discussed under Wildlife, the effect to natural communities is expected to be short term and minimal due to natural drift and redistribution of sand.

Butterfly trees are present near SLC-6, and the visiting monarch butterflies could be affected by the acid cloud if a solid rocket motor launch occurs when the butterflies are congregating (November through February). Offshore or southerly wind directions during the launch could blow the acid cloud away from the butterfly trees; onshore or northerly winds could blow the cloud directly over the trees.

Impacts from an anomaly would be as described for Concept A, and could affect sensitive species and habitat along Cañada Honda Creek and in the cliffs surrounding SLC-6.

Mitigation Measures. Numerous special conditions were added to the original dredge permit for the boat dock and could be required for the new permit. These conditions included pre-, during, and post-surveys of flora and fauna to determine if the dredging caused changes in the rocky inter- and subtidal, and sandy regions; providing a qualified biologist on site to ensure that a minimal amount of physical impacts occur during the dredging to mammals and birds; notifying appropriate organizations of planned activities; and planting red abalone in rocky habitat adjacent to the boathouse area.

Studies conducted before, during, and after Titan IVB launches from SLC-4 in May and December 1996 resulted in several recommended mitigations for future monitoring of sensitive species. These are discussed in Section 4.14.1.1.2.

Monitoring of water quality in Cañada Honda Creek should be continued to assess effects to sensitive species and habitats if solid rocket motors are used and if the prevailing winds are from the south.

4.14.1.3 **Concept A/B**

4.14.1.3.1 **Concept A/B, Cape Canaveral AS.** Impacts from launch effects and anomalies would be as similar to the combined effects described for Concepts A and B because most of the launch effects are measured more by single events than by number of launches, providing the launches are spread apart to allow wildlife to resettle. Construction effects would also be the combined effects of both concepts and would be greater than for either concept individually.

Impacts to vegetation and wildlife from this concept's construction requirements would be similar to the combined effects described for Concepts A and B. No regionally sensitive vegetation community or wildlife would be affected in important amounts.

Impacts to threatened or endangered species would include effects described for both Concept A and B to the Florida scrub jay, the Florida beach mouse, the American alligator, and two state-listed plants. However, these effects are not considered significant for any single species. Concept A/B could disturb 0.68 acre associated with the SLC-37 HIF site and 8.2 acres at the assembly facility near SLC-41, resulting in disturbance of a total of 8.88 acres of wetlands under Concept A/B. Mitigations would be the same as those described in Sections 4.14.1.1 and 4.14.1.2 for Concepts A and B.

4.14.1.3.2 **Concept A/B, Vandenberg AFB.** Impacts from construction activities, launch operations, and anomalies would be a combination of the effects described for Concepts A and B. Concept A/B activities could disturb 0.03 acre of wetland associated with the SLC-3W site. Mitigations would be the same as described for Concepts A and B in Sections 4.14.1.1 and 4.14.1.2.

4.14.2 No-Action Alternative

4.14.2.1 Cape Canaveral AS

The solid rocket motors used in some existing launch vehicles produce an HCl/aluminum oxide cloud that affects the nearby vegetation as described for Concept B in Section 4.14.1.2.1. In addition, direct effects from launches on vegetation at these SLCs (e.g., burning of vegetation, defoliation from heat) and impacts to wildlife from launch noises, pre-launch control aircraft and rocket overflights, sonic booms, and impact of rocket debris in the open-ocean area from these launch programs would continue and would be similar to the impacts described for Concepts A and B.

4.14.2.2 Vandenberg AFB

The solid rocket motors used in some existing launch vehicles produce an HCl/aluminum oxide cloud that adversely affects the nearby ecosystem. The northern site would continue to operate launches in a location adjacent to sensitive species, including the endangered California least tern, the brown pelican, the threatened western snowy plover, and the southern sea otter, although this northern location avoids most impacts to the Channel Islands. An anomaly at this location could potentially affect the sensitive adjacent species from heat, fire, and the percussive effects of the explosion and falling debris. In addition, direct effects from launches on vegetation at these SLCs (e.g., burning of vegetation, defoliation from heat), and impacts to wildlife from launch noises, pre-launch control aircraft and rocket overflights, sonic booms, and impact of rocket debris in the open-ocean area from these launch programs would continue and would be similar to the impacts described for Concepts A and B.

4.15 CULTURAL RESOURCES

4.15.1 Proposed Action

4.15.1.1 Concept A

4.15.1.1.1 Concept A, Cape Canaveral AS

Prehistoric and Historic Archaeological Resources. Concept A at Cape Canaveral AS encompasses portions of land around SLC-41 that are under the jurisdiction of either Cape Canaveral AS or the KSC. Both installations have completed archaeological surveys and inventories that satisfy the requirements of Section 110 of the NHPA. Each installation has identified numerous prehistoric and historic sites and established archaeological sensitivity zones for those areas not intensively surveyed (New South Associates, 1996). Cape Canaveral AS cultural resources managers have consulted with the Florida SHPO, and the SHPO has concurred that ground-disturbing activities that take place outside of recorded site boundaries and the sensitivity zones require no additional study (see Appendix I). KSC cultural resources policy directs that additional studies be conducted when direct ground-disturbing activities have the potential to affect archaeologically unevaluated areas.

There are no National Register-listed or -eligible prehistoric or historic archaeological sites or archaeologically sensitive areas within the direct ground disturbance footprints for Concept A (i.e., areas of facility and utility line construction and roadway modification) within the ROI. Recent archaeological studies encompassing the ROI for the two proposed assembly facilities indicate that two previously identified mounds are non-aboriginal and that no other cultural remains are present (Archaeological Consultants, Inc., 1997). As a result, no effects on archaeological resources are expected to occur from construction activities associated with the EELV program under Concept A.

Because of the remote possibility that an on-pad or missile storage mishap could occur, an ROI around SLC-41 and the proposed assembly facility sites has been assumed. Within these areas, one prehistoric site (8BR914) that is potentially eligible for inclusion in the National Register (see Appendix I) and a portion of an archaeologically sensitive area were identified; both are located on land that is under the jurisdiction of the KSC.

Historic Buildings and Structures. None of the buildings and structures identified for EELV activities is under the jurisdiction of the KSC.

Facilities at Cape Canaveral AS requiring modification under Concept A include SLC-41 (encompassing numerous individual buildings and structures completed by 1965), Building 27220 (completed in 1996 and heavily modified in 1988), and Hangar J (Building 1721, constructed in 1956). All three facilities were recently assessed for their eligibility for inclusion in the National Register. However, because of their age, their lack of association with events or persons significant in history, their unremarkable architecture or design, their compromised integrity, and/or their unlikely ability to meet the exceptional criteria required under National Park Service Criteria Consideration G for properties less than 50 years in age, it is unlikely that any of the three facilities would meet the required National Register-listing criteria. In addition, the modifications of Hangar J and Building 27220 are minor and interior only. Of the numerous features within SLC-41, only a few (i.e., the MST, the Umbilical Tower, and the SEB) require substantial modification or removal.

Consultation with the Florida SHPO is in progress.

Native Populations/Traditional Resources. Two Native American tribes have expressed interest in the cultural resources environment in the ROI: the Seminole Indian Tribe and the Micosukee Indian Tribe. Although no traditional resources sites have been identified within the ROI, these groups were contacted during the EIS preparation process to ensure that their concerns regarding the EELV program would be considered. To date, no comments from either group have been received.

Mitigation Measures, Cape Canaveral AS

Prehistoric and Historic Archaeological Resources and Traditional Resources. Because no National Register-listed or -eligible prehistoric or historic archaeological resources or traditional resources have been identified within the direct ground disturbance ROI for Concept A, no mitigation measures have been identified. However, if during the course of program activities, cultural materials (particularly human remains) are unexpectedly discovered, work in the immediate vicinity of the cultural materials would cease and the Florida SHPO would be consulted through the Cape Canaveral AS Environmental Offices (see Appendix I). Subsequent actions would follow guidance provided in Title 36 CFR 800.11 and/or in NAGPRA.

Mitigation measures to offset potential effects on archaeological/traditional resources from an on-pad or missile storage mishap are not proposed because the probability of such an occurrence is low and the cost of the mitigation (e.g., data recovery) is high. In the unlikely event that a mishap occurs, post-event recommendations include survey, mapping, photography, and site record revisions to determine and record the extent of damage from impacts or fire.

Historic Buildings and Structures. Determination of the historical significance of SLC-41, Building 27220, and Hangar J is pending. Any required mitigation measures will be developed during consultation with the Florida SHPO (in progress).

4.15.1.1.2 **Concept A, Vandenberg AFB**

Prehistoric and Historic Archaeological Resources. Within the direct ground-disturbance footprints for Concept A (i.e., areas of facility and utility line construction and roadway intersection/building entrance modification), no National Register-listed or -eligible prehistoric or historic archaeological sites have been identified. However, in one proposed project location (the corner of Bear Creek and Coast roads), a National Register-eligible site does occur within close proximity to ground-disturbing activities.

The immediate project area at the corner of Bear Creek and Coast roads has been previously surveyed, and no sites have been recorded. This area is also very heavily disturbed from the installation of several communications and light poles and the recent replacement of large underground water pipes. Several archaeological sites are near this area, however, and one is eligible for inclusion in the National Register (Site SBA 534) (see Appendix I). Site SBA 534 is just south of the construction area where a power pole would be raised. Discussions with Vandenberg AFB cultural resources managers indicate that because of the proximity of this site to the ground-disturbing activities, archaeological and Native American monitoring would be required.

In addition, because of the remote possibility that an on-pad mishap could occur, an ROI around SLC-3W has been assumed. Within this area, 11 archaeological sites have been identified; a recent review of archaeological site records indicates that none of the sites is eligible for inclusion in the National Register.

As a result of the lack of National Register-eligible or -listed sites within the direct construction areas and the ROI, and the proposed mitigation monitoring at the intersection of Bear Creek and Coast roads, no adverse effects on archaeological resources are expected to occur from EELV program activities under Concept A. Except as already noted, consultation with Vandenberg AFB cultural resources managers indicates that no archaeological/Native American monitoring would be required at any of the ground-disturbing areas.

Historic Buildings and Structures. Facilities at Vandenberg AFB requiring modification under Concept A include SLC-3W, encompassing numerous individual buildings and structures completed between 1956 and 1959. SLC-3 (East and West) and all of its associated support facilities have been evaluated for inclusion in the National Register and determined to be eligible under the Cold War historic context as a “highly technical and scientific” facility. SLC-3W contributing features include the Launch and Service Building (Building 770), the MST, the Umbilical Tower, the retention basin, and the deluge channel. The Launch Operations Facility (Building 763) and the Launch Vehicle Support Facility (Building 766) are also contributing as “shared” facilities with SLC-3E.

The typical mitigation for potential adverse effects on historic buildings and structures (i.e., demolition, modification, damage from on-pad mishap) is recordation using standards developed by the HABS/HAER. HABS/HAER recordation of SLC-3 (East and West) was completed in 1993.

Native Populations/Traditional Resources. The only Native American tribe affiliated with the area encompassed by Vandenberg AFB is the Chumash Indian Tribe. No traditional resources sites have been identified within the Concept A ROI; however, the Santa Inez Band of Chumash Indians will be contacted as a part of the EIS process to ensure that any concerns regarding the EELV program are considered.

Paleontological Resources. There are no recorded fossils or National Natural Landmarks within the immediate vicinity of SLC-3 or any of the other proposed ground-disturbing areas within the Concept A cultural resources ROI; therefore, no effects are expected.

Consultation with the California SHPO and the Chumash Indian Tribe regarding the EELV program will be conducted by the Vandenberg AFB Office of Environmental Management.

Mitigation Measures, Vandenberg AFB

Prehistoric and Historic Archaeological Resources and Traditional Resources. Monitoring by a professional archaeologist and a Native American representative from the Santa Inez Band of Chumash Indians would be required during intersection modifications (road widening and the raising of power poles) proposed for the northeast and southeast corners of Bear Creek and Coast roads. No other cultural resources mitigation measures have been identified under Concept A at Vandenberg AFB. However, if during the course of any EELV program activities, cultural materials (particularly human remains) are unexpectedly discovered, work in the immediate vicinity of the cultural materials would cease and Vandenberg AFB cultural resources managers would be notified immediately.

4.15.1.2 Concept B

4.15.1.2.1 Concept B, Cape Canaveral AS

Prehistoric and Historic Archaeological Resources. Numerous prehistoric and historic sites and a large archaeological sensitivity zone (primarily along the Banana River) have been established for the portions of the APE that have not been intensively surveyed (New South Associates, 1996). Cape Canaveral cultural resources managers have consulted with the Florida SHPO who has concurred that ground-disturbing activities that take place outside of recorded site boundaries and the sensitivity zone require no additional study (see Appendix I).
There are no National Register-listed or -eligible prehistoric or historic archaeological sites or archaeologically sensitive areas within the direct ground disturbance footprints for Concept B (i.e., areas of facility and utility line construction and roadway intersection/facility entrance modification). As a result, no effects on archaeological resources are expected to occur from construction activities associated with the EELV program.

Because of the remote possibility that an on-pad mishap could occur, an ROI around SLC-37 has been assumed. Within this area, six archaeological sites have been identified; three of the sites (8BR82A, 8BR83, and 8BR221) are potentially eligible for inclusion in the National Register; the remaining sites are not eligible (see Appendix I).

Historic Buildings and Structures. Facilities at Cape Canaveral AS requiring modification under Concept B include SLC-37 (encompassing numerous individual buildings and structures completed by 1962); Hangar C (Building 1348, constructed in 1953); Buildings 38804 and 38835 within the CPF complex, and the Air Force Roll-on/Roll-off Dock (Structure 92050, constructed in 1956) (alternative to use of the Port of Canaveral dock). Under Concept B, launch activities may also require abandonment of Buildings 33001, 33003, 33007, 33009, 38320, 43401, 43403, and 43405, all of which are support structures associated with SLC-37.

SLC-37 and all associated support facilities have been evaluated for inclusion in the National Register and determined to be ineligible (Tri-Services Cultural

Resources Research Center, 1993). The Air Force Roll-on/Roll-off Dock has been recently assessed for possible inclusion in the National Register. However, because of their age, their lack of association with events or persons significant in history, their unremarkable architecture or design, and their unlikely ability to meet the exceptional criteria required under National Park Service Criteria Consideration G for properties less than 50 years in age, it is unlikely that these facilities would meet the required National Register-listing criteria. Buildings 38804 and 38835 have only recently been constructed and will be modified for EELV activities before final completion and acceptance by the Air Force.

Hangar C has also been recently assessed for possible inclusion in the National Register. Historical research indicates that there is some potential for this facility to possess historical significance based on its association with Werner von Braun and its function as a checkout and assembly facility for several early types of rockets (e.g., Matador, Snark, Bomarc). Proposed exterior modifications to this facility include rust removal around hangar doors, re-hanging of broken personnel doors, and construction of new entrance canopies over the east and west personnel entrances. Interior modifications include asbestos removal; lead-based paint abatement (probably by over-painting); installation of new lighting and power distribution, suspended ceiling, doors, and HVAC; removal of drywall partitions, refurbishment of stairwells, and painting.

The Air Force is consulting with the Florida SHPO regarding the eligibility of these facilities and any required mitigation measures.

Native Populations/Traditional Resources. Two Native American tribes have expressed interest in the cultural resources environment in the ROI: the Seminole Indian Tribe and the Micosukee Indian Tribe. Although no traditional resources sites have been identified within the ROI at Cape Canaveral AS, these groups were contacted during the EIS preparation process to ensure that any concerns regarding the EELV program would be considered. To date, no comments from either group have been received.

4.15.1.2.2 **Mitigation Measures, Cape Canaveral AS**

Prehistoric and Historic Archaeological Resources and Traditional Resources. Because no National Register-listed or -eligible prehistoric or historic archaeological resources or traditional resources have been identified within the direct ground disturbance ROI for Concept B, no mitigation measures have been identified. However, if during the course of program activities, cultural materials (particularly, human remains) are unexpectedly discovered, work in the immediate vicinity of the cultural materials would cease and the Florida SHPO would be consulted through the Cape Canaveral AS Environmental Office (see Appendix I). Subsequent actions would follow guidance provided in Title 36 CFR 800.11 and/or in NAGPRA.

Mitigation measures to offset potential effects on archaeological/traditional resources from an on-pad or missile storage mishap are not proposed because the probability of such an occurrence is low and the cost of the mitigation (e.g., data recovery) is high. In the unlikely event that a mishap occurs, post-mishap recommendations include post-event survey, mapping, photography, and site record revisions to determine and record the extent of damage from impacts or fire.

Historic Buildings and Structures. The historical significance of Hangar C, the MIS, and the Air Force Roll-on Roll-off Dock is pending. Any required mitigation measures will be developed during consultation with the Florida SHPO (in progress).

4.15.1.2.3 **Concept B, Vandenberg AFB**

Prehistoric and Historic Archaeological Resources. All of the direct ground disturbance areas under Concept B would take place at SLC-6, which is an archaeologically sensitive area. Numerous sites have been recorded within the fenceline of SLC-6, as well as adjacent to the complex, and 15 sites have been recorded within the cultural resources ROI for the EELV program; 6 of the 15 sites have been recommended as eligible for inclusion in the National Register.

Of the ground disturbance proposed for SLC-6, only construction of the HIF has the potential to directly affect an archaeological site (Site SBA 2032). Results of recent surface and subsurface studies of SBA 2032 (ENSR Corporation, 1997a) indicate that the site is heavily disturbed and deeply buried and not likely to be affected by HIF construction. However, recommendations developed in consultation with Vandenberg AFB cultural resources managers indicate that any earth disturbance in the southeastern quarter of the HIF project area should be monitored by an archaeologist and a representative from the Santa Inez Band of Chumash Indians. In addition, if the HIF construction area changes to include the North Access Road lower parking lot, Vandenberg AFB cultural resources managers are to be notified and a subsurface testing program undertaken to determine the presence or absence of SBA 2032-associated cultural materials.

As proposed, the remaining ground-disturbing activities associated with Concept B (e.g., installation of the security fence) do not threaten known archaeological sites. However, since the entire SLC 6 area is archaeologically sensitive, Vandenberg AFB cultural resources managers have requested that archaeological and Native American monitoring be conducted during all ground-disturbing activities in that area. Any ground disturbance in the vicinity of Building 398, which is immediately adjacent to SLC 6, and around other program areas, would also require monitoring (ENSR Corporation, 1997a).

Archaeological surveys of Vandenberg AFB include an underwater study of the South Vandenberg AFB Point Arguello boathouse harbor (U.S.

Department of the Interior, National Park Service, 1978). The study did not identify any underwater sites and indicated that no additional studies would be necessary. As such, dredging of the boathouse harbor would have no effect on underwater archaeological resources.

Historic Buildings and Structures. Facilities at Vandenberg AFB requiring modification under Concept B include SLC-6 (encompassing numerous individual buildings and structures completed by 1966) and Buildings 330, 375, 396, 520, 636, 1032, and 1670. None of these facilities is eligible or potentially eligible for inclusion in the National Register; therefore, no effects on historic buildings and structures are expected to occur.

Native Populations/Traditional Resources. The only Native American tribe affiliated with the area encompassed by Vandenberg AFB is the Chumash Indian Tribe. No specifically designated traditional resources sites have been identified within the Concept B ROI; however, some of the recorded archaeological sites may represent traditional resources sites or contain traditional resources elements as well. The Santa Inez Band of Chumash Indians will be contacted as a part of the EIS process to ensure that any concerns regarding the EELV program are considered.

Paleontological Resources. There are no recorded fossils or National Natural Landmarks within the SLC-6 ROI; therefore, no effects are expected to occur.

Consultation with the California SHPO and the Chumash Indian Tribe regarding the EELV program will be conducted by the Vandenberg AFB Office of Environmental Management.

4.15.1.2.4 **Mitigation Measures, Vandenberg AFB**

Prehistoric and Historic Archaeological Resources and Traditional Resources. Monitoring by a professional archaeologist and a Native American representative from the Santa Inez Band of Chumash Indians will be required during all ground-disturbing activities at SLC-6. No other cultural resources mitigation measures have been identified under Concept B at Vandenberg AFB. However, if during the course of any EELV program activities, cultural materials (particularly, human remains) are unexpectedly discovered, work in the immediate vicinity of the cultural materials would cease and Vandenberg AFB cultural resources managers would be notified immediately.

4.15.1.3 **Concept A/B**

4.15.1.3.1 **Concept A/B, Cape Canaveral AS**

Because Concept A/B encompasses the facilities described under both Concepts A and B, effects from EELV activities and any proposed mitigation measures would be similar to the combined effects described in Sections 4.15.1.1 and 4.15.1.2.

4.15.1.3.2 **Concept A/B, Vandenberg AFB**

Because Concept A/B encompasses the facilities described under both Concepts A and B, effects from EELV activities and any proposed mitigation measures would be similar to the combined effects described in Sections 4.15.1.1 and 4.15.1.2.

4.15.2 **No-Action Alternative**

4.15.2.1 **Cape Canaveral AS**

Under the No-Action Alternative at Cape Canaveral AS, SLCs 17, 36, 40, and 41 would continue to support Delta II, Atlas IIA, and Titan IVB launches. SLCs 17 and 36 have been evaluated for inclusion in the National Register and have been determined eligible (see Appendix I). SLC-41 was recently assessed, and a determination of eligibility is pending. SLC-40 has not yet been evaluated. However, because no new construction or facility modifications have been proposed under the No-Action Alternative, no effects on historic properties are expected.

4.15.2.2 **Vandenberg AFB**

Under the No-Action Alternative at Vandenberg AFB, SLCs 2W and 3E would continue to support Atlas IIA, Delta II, and Titan IVB launches. Both complexes have been evaluated for inclusion in the National Register and specific features determined to be eligible (see Appendix I); however, no new construction or facility modifications have been proposed under the No-Action Alternative. Therefore, no effects on historic properties are expected.

4.16 **ENVIRONMENTAL JUSTICE**

The analysis conducted for this EIS included a review of influencing factors (local community resources) and a discussion of resulting impacts associated with hazardous materials and hazardous waste management and the natural environment. Local community resources (e.g., employment and population, land use and aesthetics, transportation, utilities) have been identified as influencing factors only and therefore would not have disproportionately high and adverse human health and environmental effects on minority and low-income populations.

Based upon the analysis conducted for this EIS, it was determined that activities associated with the Proposed Action would not have adverse effects on low-income and minority populations for any of the resources analyzed in this EIS: hazardous materials and hazardous waste, health and safety, geology and soils, water resources, noise, biological resources, and cultural resources. Air quality impacts would be basin-wide, and orbital debris impacts would be at a global scale; thus, no disproportionately high and adverse air quality impacts to low-income and minority populations would be expected.

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Tables

Figures

5.0 CONSULTATION AND COORDINATION

The federal, state, and local/regional agencies, and private organizations that were contacted during the preparation of this Environmental Impact Statement are listed below.

Federal Agencies

Merritt Island National Wildlife Refuge
National Aeronautics and Space Administration
Natural Resources Conservation Service
U.S. Army Corps of Engineers
U.S. Department of Transportation/Federal Aviation Administration
U.S. Environmental Protection Agency
U.S. Fish and Wildlife Service

State Agencies

California Air Resources Board
Florida Department of Environmental Protection
Florida Department of Environmental Protection, Bureau of Air Regulations
Florida Department of Labor and Employment Security, Bureau of Labor Market Information
Florida Department of State, Division of Historical Resources

Local/Regional Agencies

Brevard County, Viera, Florida
Brevard County Growth and Management Department
Brevard County Housing and Human Services Administration
City of Cape Canaveral
City of Lompoc
County of Santa Barbara, Department of Planning
Port of Canaveral
St. John's River Water Management District
Santa Barbara Air Pollution Control District
Santa Barbara County Association of Governments
Santa Barbara County Department of Social Services
Santa Barbara County Human Services

Private Organizations

Aerospace Corporation
Brevard County Chamber of Commerce
C.I.T.A. Rescue Mission
Candelaria American Indian Council, Inc.
Catholic Charities
Catholic Social Services, Inc.
Private Organizations (Continued)

Central Brevard Sharing Center, Inc.
Coalition for the Hungry and Homeless of Brevard
Daily Bread, Inc.
Dynamac
EG&G, Kennedy Space Center
Foodbank of Santa Barbara County
Food Pantry of Lompoc Valley, Inc.
GRCI, Inc.
Good Samaritan Shelter
Guadalupe Community Center
Human Services Association
Johnson Controls World Services, Inc.
La Casa de La Raza
Lompoc Valley Community Kitchen
National Association for the Advancement of Colored People
Operation Lighthouse
Salvation Army
Stop-Gap of North Brevard, Inc.
Tetra Tech
United Way
University of California, Santa Barbara, Central Coast Information Center

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7.0 REFERENCES

Acentech, 1998. Facsimile of study results concerning threshold of audibility of harbor seals over ambient noise, Thousand Oaks, California, March.

American Institute of Aeronautics and Astronautics, 1993. Environmental Monitoring of Space Shuttle Launches at Kennedy Space Center: The First Ten Years. The Bionetics Corporation and NASA, Biomedical Operations and Research Office, Kennedy Space Center, Florida.

American National Standards Institute, 1988. Quantities and Procedures for Description and Measurement of Environmental Sound, Part 1, ANSI S12.9-1988.

Anderson, C. et al., 1997. Emission and Dispersion Modeling System (EDMS) Reference Manual and Software Program, prepared for U.S. Department of Transportation, Federal Aviation Administration, and U.S. Air Force, FAA-AEE-87-01, AL/EQ-TR-1997-0010, CSSI Inc., Washington, DC, April.

Andrews, D.G., J.R. Holton, C.B. Leovy, 1987. Middle Atmosphere Dynamics, Academic Press, Inc., Orlando, Florida.

Arbogast, et al., 1996. A Study of Air Emissions from Space Launch Operations: Phase II, Aerospace (ATR-9698264)-2, September.

Archaeological Consultants, Incorporated, 1997. Technical Memorandum: Archaeological Assessment Survey of the Evolved Expendable Launch Vehicle (EELV) Area, Contract AJT-097-0119. Memorandum from Steven Koski (Archaeological Consultants, Incorporated) to Perry Jennings (AJT & Associates), August 15.

Austin, O.L., Jr., W.B. Robertson, Jr., and G.E. Woolfenden, 1970. Mass Hatching Failure in Dry Tortugas Sooty Terns (*Sterna fuscata*), K.H. Voous, editor. Proceedings of the 15th International Ornithological Congress, the Hague, Netherlands.

Barton, D.F., and R.S. Levy, 1983. An Architectural and Engineering Survey and Evaluation of Facilities at Cape Canaveral Air Force Station, Brevard County, Florida, prepared for the National Park Service, Southeast Regional Office by Resources Analysts, Inc., Bloomington, Indiana.

Beiting, E.J., 1997. "Predicted Physical and Optical Characteristics of Solid Rocket Motor Exhaust in the Stratosphere," paper AIAA-97-0532, 35th Aerospace Science Meeting and Exhibit of the American Institute of Aeronautics and Astronautics, Reno, Nevada.

Bense, J.A., and J.C. Phillips, 1990. Selected Areas in Brevard County: A First Generation Model, Report of Investigation 32, Institute of West Florida Archaeology, University of West Florida, Pensacola.

Bionetics Corporation, 1988. Vegetation and Land Use Types, Vandenberg Air Force Base, 1986 source data, 1:9,600 scale.

Bionetics Corporation, 1993. Florida Scrub Jay Demography and Habitat Characteristics at Titan Launch Complexes 40 and 41 on Cape Canaveral Air Force Station, Florida, V.L. Larson, D.M. Oddy, D.R. Breininger, and M.J. Barkaszi eds., J.F. Kennedy Space Center, Florida, October.

Birnie, P.W., and A.E. Boyle, 1992. International Law and the Environment, Oxford University Press, Inc., New York.

Bojkov, R.K., and V.E. Fioletov, 1995. "Estimating the Global Ozone Characteristics During the Last 30 Years," *Journal of Geophysical Research*, 100:D8, 16548.

Bowles, A., B. Tabachnick, and S. Fidell, 1991. Review of the Effects of Aircraft Overflights on Wildlife, Volume II of III: Technical Report. National Park Service, Denver, Colorado.

Brady, B.B., A. McIlroy, and L.R. Martin, 1997. Launch Abort Chemistry Model, T9-97 (1410)-2, The Aerospace Corporation, April.

Brady, B.B, et al., 1994. Stratospheric Ozone Reactive Chemicals Generated by Space Launches Worldwide, prepared for Space and Missile Systems Center, Air Force Materiel Command, Los Angeles Air Force Base, California, November.

Briley, Wild and Associates, 1990. City of Cape Canaveral, Florida, Comprehensive Plan, As Revised by Adopted Amendment #1, January.

Bullock, T.H., D.P. Domning, and R.C. Best, 1980. "Evoked Brain Potentials Demonstrate Hearing in a Manatee (*Trichechus inunguis*)," *Journal of Mammalogy* 61(1): 130-133.

Burke, M.L., and P.F. Zittel, 1996. Laboratory Generation of Free Chlorine from HCl Under Stratospheric Afterburning Conditions, Aerospace Report No. TR-96(1306)-3, prepared for Space and Missile Systems Center, Air Force Materiel Command, Los Angeles Air Force Base, California, March.

California Department of Transportation and California Air Resources Board, 1994. EMFAC 7F1.1 Software Program (Emission Factor Model), Release 2.01, Division of New Technology, Materials, and Research; and Technical Support Division, Sacramento, California, July.

California Employment Development Department, 1995. For Your Benefit: California's Programs for the Unemployed, DE 2320, Revision 43 (June), Sacramento, California.

California Employment Development Department, 1997. Santa Barbara-Santa Maria-Lompoc MSA (Santa Barbara County) Current Labor Force and Industrial Employment, Sacramento, California.

Cantley, C.E., M.B. Reed, L. Raymor, and J.W. Joseph, 1994. Historic Properties Survey, Cape Canaveral Air Force Station, Brevard County, Florida, New South Associates Technical

Report 183, prepared for the U.S. Army Corps of Engineers and 45 Space Wing CEV by Ebasco Services, Inc., Huntsville, Alabama.

Chapman, S., 1996. "Space Junk," *Air Force Magazine*, Volume 79, No. 11, November.

Christopher, S.V., 1996a. Reptiles and Amphibians of Vandenberg Air Force Base: A Focus on Sensitive Aquatic Species, prepared for Vandenberg Air Force Base and U.S. Department of the Interior, April.

Christopher S.V., 1996b. Reptiles and Amphibians of Vandenberg Air Force Base, Santa Barbara County, California, 1995: A Focus on Sensitive Aquatic Species. Appendix C, Point Locality Maps of Reptiles and Amphibians at Vandenberg Air Force Base from Surveys in 1995, prepared for Vandenberg Air Force Base and U.S. Department of the Interior, December.

City of Lompoc, 1974. Land Use Plan, September.

City of Lompoc, 1996. Draft Proposed General Plan Revision, Environmental Review Copy.

Committee on Toxicology, National Research Council, 1996. "Permissible Exposure Levels for Selected Military Fuel Vapors."

Cooper, C.F., and J.R. Jehl, Jr., eds., 1979. Potential Impact of Space Shuttle Sonic Booms on the Biota of the California Channel Islands: Literature Review and Problem Analysis, prepared for U.S. Air Force Space and Missile System Organization by Center for Marine Studies, San Diego State University, and Hubbs/Sea World Research Institute, December.

Cooper, C.F., and J.R. Jehl, Jr., 1980. Potential Effects of Space Shuttle Sonic Booms on the Biota and Geology of the California Channel Islands: Synthesis of Research and Recommendations, Technical Report 80-2, prepared for U.S. Air Force Space and Missile Systems Organization through Center for Marine Studies, San Diego State University, and Hubbs/Sea World Research Institute, December.

Cotton, W.R., and R.A. Anthes, 1989. Storm and Cloud Dynamics, Academic Press, Inc., Harcourt Brace Jovanovich Publishers, San Diego, California.

Council on Environmental Quality, 1978. Regulations for Implementing the Procedural Provisions of the National Environmental Policy Act.

Cox, J.A., 1984. "Distribution, Habitat, and Social Organization of the Florida Scrub Jay, With a Discussion of the Evolution of Cooperative Breeding in New World Jays," Ph.D. Dissertation, Zoology Department, University of Florida, Gainesville.

Cox, J.A., 1987. Status and Distribution of the Florida Scrub Jay, Florida Ornithological Society Special Publication Number 3, Gainesville, Florida.

Damkowitch, J., 1997. Personal communication with J. Damkowitch, Transportation Planner, Santa Barbara County Association of Governments, Santa Barbara, California, June.

Defense Technical Information Center, 1979. Seismic Hazards Estimation Study for Vandenberg AFB, prepared for Air Force Geophysics Laboratory, November.

Defense Technical Information Center, 1988. Baseline Noise Measurements at Vandenberg AFB, CA, Final Report, prepared by USAF Occupational and Environmental Health Laboratory, Human Systems Division, Brooks Air Force Base, Texas, January.

Dibblee, T.W., Jr., 1950. "Geology of Southwestern Santa Barbara County, California," California Division of Mines and Geology Bulletin 150.

Do, T.T., 1994. Titan IV Launch Sound Levels at 2,700, 6,680, 11,200, 16,800, 19,000, and 43,129 Feet From the Pad, prepared for Space and Missile Systems Center, Los Angeles Air Force Base, California, January.

Do, T.T., 1996. Delta II Launch Sound Levels at Varying Distance from the Launch Pad, Delta II/Radarsat Launch from VAFB SLC-2W 4 November 1995, prepared for Space and Missile Systems Center, Los Angeles Air Force Base, California, May.

Downing, J.M. and K. Plotkin, 1996. "Validation of Launch Vehicle Sonic Boom Predictions," *Journal of the Acoustical Society of America*, Volume 100, Number 4, Part 2, p. 2566, October.

Dutsch, H. U. (1980). Ozon in der Atmosphere: Gefahrdet die stratospharishche Verschmutzung die Ozonschicht? Neujahrsblatt der Naturforschenden Gesellschaft in Zurich auf das Jahr 1980. Vierteljahresschr. 124, (5), I-48.

Earth Tech, Inc., 1997. Florida Scrub Jay Survey at Space Launch Complex 37, Cape Canaveral Air Station, Florida.

Ellis, D.H., Ellis, C.H., and Mindell, D.P., 1991. Raptor Responses to Low-Level Jet Aircraft and Sonic Booms, Environmental Pollution 74.

Endo Engineering, 1996. City of Lompoc Noise Element: Background Study, March.

ENSR Corporation, 1996. Environmental Assessment for Launch Rate Increase for Delta II Program at Vandenberg Air Force Base, August.

ENSR Corporation, 1997a. Cultural Resources Assessment Report, McDonnell Douglas Aerospace, Evolved Expendable Launch Vehicle Program, Vandenberg Air Force Base, California, July.

ENSR Corporation, 1997b. Wetland Assessment Report, McDonnell Douglas Aerospace, Evolved Expendable Launch Vehicle Program, Vandenberg Air Force Base, California, August.

ENSR Corporation, 1997c. Draft Wetland Assessment Report, McDonnell Douglas Aerospace, Evolved Expendable Launch Vehicle Program, Cape Canaveral Air Station, Florida, September.

ENSR Corporation, 1998a. Wetlands and Special Status Species Surveys and Mitigation Plans.

ENSR Corporation, 1998b. Letter on sediment sampling results in the Vandenberg AFB area, April 3.

Environmental Science Associates, 1996. Draft City of Lompoc General Plan Revision, Environmental Impact Report, June.

Environmental Solutions, Inc., 1988. Archaeological Resources Inventory and No Effects Determination for Proposed Phase III Geotechnical Testing, Proposed Space Launch Complex 7, Vandenberg Air Force Base, Santa Barbara County, California, prepared for U.S. Air Force, El Segundo, California.

Environmental Solutions, Inc., 1990. The Survey and Inventory of Historic Properties within the Titan IV/Centaur Launch Complex Study Area, Vandenberg Air Force Base, California, Volume 1, prepared for the U.S. Air Force Space Systems Division Headquarters, Department of Environmental Planning, El Segundo, California.

Epsmark, Y., 1972. "Behavior Reactions of Reindeer Exposed to Sonic Booms," Deer 2: 800-802 [Abstract].

Fernald, R.T., and B.R. Toland, 1991. The Florida Scrub Jay, Florida Game and Fresh Water Fish Commission, Tallahassee.

Florida Bureau of Labor Market Information, 1997. "State of Florida Labor Force Summary," 1990-96 Annual Averages, Department of Labor and Employment Security, Local Area Unemployment Statistics Program, Tallahassee, Florida.

Florida Natural Areas Inventory, 1996a. Species and Natural Communities of Concern on U.S. Air Force Lands, An Installation Specific Handbook for Cape Canaveral Air Station, The Nature Conservancy Pilot Project, May.

Florida Natural Areas Inventory 1996b. Biological Survey of Cape Canaveral Air Station, Final Report, The Nature Conservancy, June.

Florida Power & Light Company, 1992. Florida's Wood Stork, prepared by Environmental Affairs Office, Florida.

45 Space Wing, 1993a. Environmental Assessment and Finding of No Significant Impact, ROCC Back-Up Power Facility, Cape Canaveral Air Force Station, Florida, December.

45 Space Wing, 1993b. Toxic Materials Release Contingency Plan (Cape Aural Warning Plan), December.

45 Space Wing, 1994a. Abbreviated Environmental Assessment for Proposed Additional Parking at SLC-41, Cape Canaveral Air Station, Florida, September.

45 Space Wing, 1994b. Florida Power and Light Transmission Line Rebuild Project, May.

45 Space Wing, 1995a. Disaster Preparedness Operations Plan, OPlan 32-1, Volume II, December.

45 Space Wing, 1995b. FY 1995 Economic Impact Statement, September.

45 Space Wing, 1995c. General Plan, Cape Canaveral Air Station, Florida.

45 Space Wing, 1995d. Petroleum Products and Hazardous Waste Management Plan, OPlan 19-14, May.

45 Space Wing, 1995e. Titan Toxic Hazard Control Plan, July.

45 Space Wing, 1996a. Draft Environmental Assessment, Proposed Construction and Maintenance of Instrumentation Lines of Sight, April.

45 Space Wing, 1996b. Final Environmental Assessment for the Delta III Launch Vehicle Program, Cape Canaveral Air Station, Florida, April.

45 Space Wing, 1996c. Guide to Environmental Quality, Patrick Air Force Base and Cape Canaveral Air Station, March.

45 Space Wing, 1996d. Hazardous Materials Response Plan 32-3, Volume I, March.

45 Space Wing, 1996e. Planning Guidance Document, May.

Fugro West, Inc., 1996. Memorandum from M.K. Maki, May.

Gibson, R.O., 1991. The Chumash, Chelsea House Publishers, New York.

Gillespie, C., 1997. Personal communication with C. Gillespie regarding sensitive upland community impact mitigation requirements at Vandenberg Air Force Base.

Glassow, M.A., 1990. Archaeological Investigations on Vandenberg Air Force Base in Connection with the Development of Space Transportation System Facilities, Volume I, prepared for the U.S. Air Force Space Systems Division, Los Angeles, California, under USAF Order No. F04701-78-F-0027.

Glassow, M.A., and L.W. Spanne, 1976. Evaluation of Archaeological Sites on Vandenberg Air Force Base, Santa Barbara County, California (Final Report), prepared for the U.S. National Park Service, Office of Archaeology and Historic Preservation, Interagency Archaeological Service, San Francisco, January.

Goss-Custard, M., et al., 1996. "Measurements of Water Vapor Distributions by the Improved Stratospheric and Mesospheric Sounder: Retrieval and Validation," *Journal of Geophysical Research*, 101:6, 9907.

Hall, R.E., 1995. "Lost Jobs," Brookings Papers on Economic Activity, Volume 1, The Brookings Institute, Washington, DC.

Harrell, J., 1997. Personal communication with J. Harrell, Research Analyst, Florida Department of Labor and Employment Security, Bureau of Labor Market Information, Tallahassee, May.

Hawkins, W.E., R.M. Overstreet, and M.J. Provancha, 1984. Pathological Effects of Space Shuttle Exhaust Plumes on Gills of Some Estuarine Fish: A Light and Electron Microscopic Study of Acute Environmental Stress, Gulf Research Reports 7:297-3309.

Hervig, M.E., J.M. Russell III, L.L. Gordley, J.H. Park, S.R. Drayson, and T. Deshler, 1996. "Validation of Aerosol Measurements from the Halogen Occultation Experiment," *Journal of Geophysical Research,* 101:D6, 10,267.

Historic American Engineering Record, National Park Service, 1993. Historic American Engineering Record, Vandenberg Air Force Base, Space Launch Complex 3 (SLC-3), HAER No. CA-133-1, prepared by Versar, Inc.

Hoffman, D.J., J.M. Rosen, T.J. Pepin, and R.G. Pinnick, 1975. "Stratospheric Aerosol Measurements. I: Time Variation at Northern mid-Latitudes," *Journal of Atmospheric Science*, 32, 1446-1456.

Holland, R.F., 1986. Preliminary Descriptions of the Terrestrial Natural Communities of California, California Department of Fish and Game, Sacramento.

Holmgren, M.A., and P.W. Collins, 1995. Interim Report on the Distribution, Breeding Status, and Habitat Associations of Seven Federal Special-Status Bird Species and Brown-Headed Cowbirds at Vandenberg Air Force Base, Santa Barbara County, California, prepared for Vandenberg Air Force Base, December.

Huang, L., 1997. Personal communication with Lewis Huang, Deputy for Safety and Health, Safety Division, Space and Missile Systems Center, Los Angeles Air Force Base, regarding orbital debris regulations, June.

Hunter, C., 1996. Data provided regarding lifespan of the Brevard County Landfill, October.

Interagency Group (Space), 1989. Report on Orbital Debris, National Security Council, Washington, DC, February.

International Conference of Building Officials, 1991. Uniform Building Code.

Jackman, D.H., D.B. Considine, and E.L. Fleming, 1996. "The Space Shuttle's Impact on the Stratosphere: An Update." Paper from the *Impact of Rockets on the Stratosphere*, TRW, Space and Technology Division.

Jacobs Engineering Group, Inc., 1995. Site 6, Space Launch Complex 3-W, Preliminary Endangerment Assessment Report, prepared for 30 CES/CEVR Installation Restoration Program, Vandenberg Air Force Base, California, March.

Jagielski, K., and R. O'Brien, 1994. Calculation Methods for Criteria Air Pollutant Emission Inventories (AL/OE-TR-1994-0049), July.

Jennings, C.W., 1975. "Fault Map of California," California Geological Data Map Series, California Division of Mines and Geology, Map No. 1, Scale 1:750,000.

Johnson Controls, 1995. Basic Information Guide, Cape Canaveral, October.

Johnson Controls, 1996. Lists of regulated and unregulated underground and aboveground storage tanks at Cape Canaveral Air Station, Florida.

Johnson, Lt. Col., U.S. Air Force, 1997. Personal communication with Lt. Col. Johnson, Chief, Science and Technology Plans, HQ AFSPC Directorate of Plans and Programs, Peterson Air Force Base, regarding orbital debris regulations, June.

Johnson, N.L., 1987. "Preventing Collisions in Orbit," *Space*, Volume 3.

Johnson, N.L., 1989a. "Preliminary Analysis of the Fragmentation of the Spot 1 Ariane Third Stage" in *Orbital Debris from Upper-Stage Breakup*, Progress in Aeronautics and Astronautics, Volume 121, J.P. Loftus Jr., ed., American Institute of Aeronautics and Astronautics, Washington DC.

Johnson, N.L. 1989b. "Evolution of the Artificial Earth Satellite Environment" in *Orbital Debris from Upper-Stage Breakup*, Progress in Aeronautics and Astronautics, Volume 121, J.P. Loftus Jr., ed., American Institute of Aeronautics and Astronautics, Washington, DC.

Johnson, N.L., and D.S. McKnight, 1988. "Space Debris," *Space World*, July.

Johnston, J., 1998. Personal communication with J. Johnston (30 CES/CEVPP) regarding least tern take at Purisima Point.

Kephart, J.F., 1997. Personal communication with J.F. Kephart, Project Engineer, Western Range Directorate, Space Launch Operations, The Aerospace Corporation.

Kessler, D.J., P.M. Landry, B.G. Cour-Palais, and R.E. Taylor, 1980. "Collision Avoidance in Space," *IEEE Spectrum*, June.

Kessler, D.J., 1985. "Orbital Debris Issues," *Advanced Space Research*, Volume 5, Number 2.

Kessler, D.J., 1988. "Predicting Debris," *Aerospace America*, June.

Kessler, D.J., 1989. "Current Orbital Debris Environment" in *Orbital Debris from Upper-Stage Breakup*, Progress in Astronautics and Aeronautics, Volume 121, J.P. Loftus Jr., ed., American Institute of Aeronautics and Astronautics, Washington, DC.

Knott, W.M., 1983. STS-8 Environmental Effects: Quick Look Report, Biomedical Office, National Aeronautics and Space Association, John F. Kennedy Space Center, Florida.

Kubasek, N.K., and G.S. Silverman, 1994. Environmental Law, Prentice Hall, Englewood Cliffs, New Jersey.

Lahoz, W.A., et al., 1996. “Validation of Aerosol Measurements from the Improved Stratospheric and Mesospheric Sounder,” *Journal of Geophysical Research*, 101:D6, 9929.

Lambert, A., et al., 1996. “Validation of Measurements of Carbon Monoxide from the Improved Stratospheric and Mesospheric Sounder,” *Journal of Geophysical Research*, 101:D6, 9811.

Lamp, R.E., 1987. Monitoring the Effects of Military Operations at NAS Fallon on the Biota of Nevada. Job progress report for 1986-1987. Nevada Department of Wildlife.

Larson, V.L., et al., 1993. Florida Scrub Jay Demography and Habitat Characteristics at Titan Launch Complexes 40 and 41 on Cape Canaveral Air Force Station, Florida, National Aeronautics and Space Administration, Biomedical Operations and Research Office, John F. Kennedy Space Center, Florida.

Le Baron, J.F. 1884. “Prehistoric Remains in Florida,” in *Smithsonian Institution Annual Report for 1884*, Smithsonian Institution, Washington, DC.

Levy, R.S., D.F. Barton, and T. Riordan, 1984. An Archaeological Survey of Cape Canaveral Air Force Station, Brevard County, Florida. Prepared for the Southeast Regional Office, National Park Service by Resource Analysts, Inc., Bloomington, Indiana.

Loftus, J.P., 1989. “Preface” in *Orbital Debris from Upper-Stage Breakup*, Progress in Astronautics and Aeronautics, Volume 121, J.P. Loftus Jr., ed., American Institute of Aeronautics and Astronautics, Washington, DC.

Lohn, P.D., et al., 1994. The Impact of Deorbiting Space Debris on Stratospheric Ozone, Environmental Management Division, Space and Missile Systems Center, El Segundo, California, May.

Long, G.A., 1967. Indian and Historic Site Report: John F. Kennedy Space Center, NASA Site Report, prepared for the Kennedy Space Center Office of Public Affairs, manuscript on file, Division of Historical Resources, Department of State, Tallahassee, Florida.

Lopez-Valverde, M.A., et al., 1996. “Validation of Measurements of Carbon Monoxide from the Improved Stratospheric and Mesospheric Sounder,” *Journal of Geophysical Research*, 101:D6, 9929.

Manci, K.M., D.N. Gladwin, R. Villela, and M.G. Cavendish, 1988. Effects of Aircraft Noise and Sonic Booms on Domestic Animals and Wildlife: A Literature Synthesis, U.S. Fish and Wildlife Service National Ecology Research Center, Fort Collins, Colorado.

McCarthy, S., S. Enscore, and P. Nowlan, 1994. Historic American Engineering Record of Complex 19, Cape Canaveral Air Station, Cape Canaveral, Florida, prepared for the U.S. Department of the Air Force by the U.S. Army Construction Engineering Research Laboratories, Champaign, Illinois.

McInerny, S.A., 1992. Peacekeeper Launch Sound Levels at 1000, 2000, 3000, and 4000 Feet From the Pad. Prepared for Launch Plans and Projects Office, Space and Missile Systems Center, Los Angeles Air Force Base, California, December.

McInerny, S.A., 1993a. Delta Launch Sound Levels at 1500, 2000, 3000, and 4000 Feet From the Pad. Prepared for Huntington Beach Operations Branch, Goddard Space Flight Center, National Aeronautics and Space Administration, January.

McInerny, S.A., 1993b. Scout Launch Sound Levels at 1000, 2000, 3000, and 4000 Feet From the Pad. Prepared for Launch Plans and Projects Office, Space and Missile Systems Center, Los Angeles Air Force Base, California, March.

McPeters, R., M. Prather, and S. Doiron, 1991. Reply to comments on "The Space Shuttle's Impact on the Stratosphere," Journal of Geophysical Research, 96(D9): 17,379-17,381.

Meads, R., D.D. Spencer, and M.J. Molina, 1994. Stratospheric Chemistry of Aluminum Oxide Particles, MIT report to TRW Space and Technology Group, Massachusetts Institute of Technology, Cambridge, Massachusetts, June.

Mercadante, M., 1997. Personal communication with M. Mercadante, Johnson Controls, regarding presence of green sea turtles at Cape Canaveral Air Station.

Meshishnek, M.J., 1994. Overview of the Space Debris Environment. Aerospace Report No. TOR-94(4231)-1, Space and Missile Systems Center, Air Force Materiel Command, Los Angeles Air Force Base, Los Angeles, California, May.

Milligan, J.E., and G.B. Hubbard, 1983. "STS-5 Fish Kill, Kennedy Space Center, Florida," in *Space Shuttle Environmental Effects: The First Five Flights*, A. Potter, editor. National Aeronautics and Space Administration, L.B. Johnson Space Center, Houston, Texas.

Moller, A., 1978. "Review of Animal Experiments," *H. Sound and Vibration* 59:73-77 [Abstract].

Moore, C.B., 1922. Mound Investigations on the East Coast of Florida, in Additional Mounds of Duval and Clay Counties, Florida, Heye Foundation Indian Notes and Monographs, Museum of the American Indian, New York.

Myers, R.L., 1990. "Scrub and Alpine Habitat," *Ecosystems of Florida*, R.L. Myers and J.J. Ewell eds., University of Central Florida Press, Orlando.

National Aeronautics and Space Administration, 1985. Effects of Space Shuttle Launches STS-1 through STS-9 on Terrestrial Vegetation of John F. Kennedy Space Center, Florida, Technical Memorandum 83103.

National Aeronautics and Space Administration, 1988. Soil Erosion and Causative Factors at Vandenberg Air Force Base, California, March.

National Aeronautics and Space Administration, 1993. Supplemental Environmental Assessment, Modifications and Operations of Space Launch Complex-2W for the Delta II Launch Vehicle, Vandenberg Air Force Base, California, Goddard Space Flight Center, Greenbelt, Maryland, June.

National Aeronautics and Space Administration, 1994. Draft Supplemental Environmental Impact Statement for the Sounding Rocket Program.

National Aeronautics and Space Administration, 1995a. Environmental Assessment, Mars Global Surveyor Mission, September.

National Aeronautics and Space Administration, 1995b. Environmental Assessment, Near Earth Asteroid Rendezvous Mission, December.

National Aeronautics and Space Administration, 1995c. Final Environmental Impact Statement for the Cassini Mission, June.

National Aeronautics and Space Administration, 1995, 1996, 1997, 1998. Monitoring Reports on Delta, Atlas, and Titan Launches, conducted by NASA and Dynamac Corporation, Kennedy Space Center.

National Aeronautics and Space Administration, 1996. Final X-33 Programmatic Environmental Assessment: Vehicle and Technology Demonstration Concepts, Marshall Space Flight Center, Alabama, June.

National Aeronautics and Space Administration, 1998. Draft Cape Canaveral Air Station Water Quality Summary (excerpt).

National Park Service, 1980. Reconnaissance Survey: Man in Space, National Park Service, Denver Service Center, Denver, Colorado.

National Research Council, 1995. Orbital Debris: A Technical Assessment, National Academy Press, Washington, DC.

Nelson, D.M., E.A. Irlandi, L.R. Settle, M.E. Monaco, and L.C. Coston-Clements, 1991. Distribution and Abundance of Fishes and Invertebrates in Southeast Estuaries, ELMR Report Number 9, NOAA/NOS Strategic Environmental Assessments Division, Rockville, Maryland.

New South Associates, 1993. Historic Properties Survey, Cape Canaveral Air Force Station, Brevard County, Florida, prepared for the U.S. Army Corps of Engineers, Mobile District, December.

New South Associates, 1994. Identification of the Limits of a Burial Component at Site 8Br86, Cape Canaveral, Brevard County, Florida, Technical Report 222, August.

New South Associates, 1996. 45 Space Wing Cultural Resource Management Plan: Patrick Air Force Base and Cape Canaveral Air Station, Brevard County, Florida, Technical Report No. 386, May.

Nickerson, G.R., et al., 1993. Two-Dimensional Kinetics (TDK) Nozzle Performance Computer Program, Contract No. NASS-39048, George C. Marshall Space Flight Center, Alabama, March.

Office of Science and Technology Policy, 1995. Interagency Report on Orbital Debris, National Science and Technology Council, Washington, DC, November.

Office of Technology Assessment, 1990. Orbiting Debris: A Space Environmental Problem, Congress of the United States, Washington, DC.

Oyler, L.D., V.L. Holland, and D.J. Keil, 1995. Rare Plants of Vandenberg Air Force Base, prepared for Vandenberg Air Force Base under contract with The Nature Conservancy, December.

Pacetti, A.B., 1996. "Turning the Tide to Protect the Earth's Most Diverse Estuary, The Indian River Lagoon," *Florida Water*, Fall/Winter 1996, South Florida Water Management District, West Palm Beach, Florida and Southwest FLWMD, Brooksville.

Page, G.W., and P.E. Persons, 1995. The Snowy Plover at Vandenberg Air Force Base: Population Size, Reproductive Success, and Management, November.

PanAm World Services, Inc., 1986. Environmental Assessment, Proposed Air Force Berthing Wharf, Cape Canaveral Air Force Station, Florida, February.

PanAm World Services, Inc., 1989. Land Management Plan, Cape Canaveral Air Station, prepared for U.S. Air Force, Eastern Space and Missile Center, Patrick Air Force Base, Florida, June.

Payne, C.M., O.E. Swanson, and B.A. Schell, 1979. Investigations of the Hosgri Fault Offshore Southern California, Point Sal to Point Conception, U.S. Geological Survey open-file report 79-1199.

Pereksta, D., 1996. California Brown Pelican Roost Site and Coast Utilization Survey at Vandenberg Air Force Base, Santa Barbara County, California, prepared for U.S. Air Force, Vandenberg Air Force Base, May.

Pergament, H.S., et al., 1993. Standardized Plume Flowfield Model, SPF-III, Report No. PST-TR-11, U.S. Army Missile Command, Redstone Arsenal, Alabama, May.

Persons, P.E., 1995. Western Snowy Plover Populations Size and Reproductive Success in 1995 at Vandenberg Air Force Base, May.

Persons, P.E., and T.E. Applegate, 1996. Western Snowy Plover Population Size and Reproductive Success in 1996 at Vandenberg Air Force Base, California, Point Reyes Bird Observatory, November.

Peterson, R.T., 1980. A Field Guide to the Birds, A Completely New Guide to All the Birds of Eastern and Central North America, fourth edition, Houghton Mifflin Company, Boston.

Plotkin, K.J., 1993. "Sonic Boom Focal Zones from Tactical Aircraft Maneuvers, "Journal of Aircraft, Volume 30, Number 1, January-February.

Plotkin, K.J., 1996. PCBoom3 Sonic Boom Prediction Model: Version 1.0c, Wyle Research Report WR 95-22C, May.

Pooard, J.E., n.d. Effects of Launch Noise from the First Lockheed Launch Vehicle on Harbor Seals on South Vandenberg Air Force Base and San Miguel Island, Lockheed Environmental Systems and Technologies, Las Vegas, Nevada.

Pratt, P.F., 1996. "Aluminum," Chapter 1 in Diagnostic Criteria for Plants and Soils, ed. H.D. Chapman, University of California, Division of Agricultural Sciences.

R.S. Means Company, Inc., 1995. 1996 Means Square Foot Costs, 17th Annual Edition, Kingston, Massachusetts.

R.S. Means Company, Inc., 1997. R.S. Means Building Construction Cost Data Index, 55th Annual Edition, Kingston, Massachusetts.

Radian International, 1996. Cape Canaveral Air Station Air Emission Inventory Report, 1994, Cape Canaveral Air Station, Cape Canaveral, Florida, July.

Read, N., 1996a. Titan IV Launch from SLC-4, 12 May 1996, Monitoring of Threatened and Endangered Species on Vandenberg Air Force Base. Natural Resources Section, 30 CES/CEVPN, Civil Engineering Environmental Management.

Read, N., 1996b. Titan IV Launch from SLC-4, 20 December 1996, Monitoring of Threatened and Endangered Species on Vandenberg Air Force Base. Natural Resources Section, 30 CES/CEVPN, Civil Engineering Environmental Management.

Read, N., 1997. Facsimile from N. Read, 30 CES/CEVPN, regarding threatened and endangered species and sensitive habitats at Vandenberg AFB, August 21.

Reburn, W.J., et al., 1996. "Validation of Hydrogen Chloride Measurements made by the Halogen Occultation Experiment From the UARS Platform," *Journal of Geophysical Research*, 101:D6, 9873.

Reinis, 1976. "Acute Changes in Animal Inner Ears Due to Simulated Sonic Booms," *Journal of the Acoustical Society of America*, 60:133-138 [Abstract].

Reiter, E.R., 1975. "Stratospheric-Tropospheric Exchange Processes," *Review Geophysical Space Physics*, 13, 459.

Remedios, J.J., et al., 1996. "Measurements of Methane and Nitrous Oxide Distributions by the Improved Stratospheric and Mesospheric Sounder: Retrieval and Validation," *Journal of Geophysical Research*, 101:D6, 9843.

Reynolds, Smith and Hills, Inc., 1994. Finding of No Significant Impact and Environmental Assessment of the Proposed Spaceport Florida Authority Commercial Launch Program at Launch Complex-46 at the Cape Canaveral Air Station, Florida, prepared for Cape Canaveral Air Station and the Spaceport Florida Authority, October.

Roest, M., 1995. Final Report, Harbor Seals, Sea Otters, and Sea Lions at Vandenberg Air Force Base, California, prepared for Vandenberg Air Force Base under contract to The Nature Conservancy, December.

Ross, M., 1992. Potential Impact of Solid Rocket Motor Exhaust on Stratospheric Ozone, prepared for Space and Missile Systems Center, Air Force Materiel Command, Los Angeles Air Force Base, California, October.

Rouse, I., 1951. A Survey of Indian River Archaeology, Florida, Yale University Publication in Anthropology No. 44, Yale University, New Haven, Connecticut.

Russell, J.M. III, et al., 1996. “Validation of Hydrogen Chloride Measurements made by the Halogen Occultation Experiment From the UARS Platform,” *Journal of Geophysical Research*, D6:101, 10, 151.

Rydene, D.A., 1988. “Concentrations of Al, Cd, Pb, V, and Zn in Fishes Inhabiting Ponds Exposed to Space Shuttle Launch Exhaust.” Master’s Thesis, Florida Institute of Technology.

Sacramento Metropolitan Air Quality Management District, 1994. Air Quality Thresholds of Significance, Sacramento, California.

Santa Barbara Association of Governments, 1994. Congestion Management Program.

Santa Barbara County, 1982. Coastal Plan.

Santa Barbara County Air Pollution Control District, 1997. Facsimile with 1995 average ambient air concentrations for criteria pollutants at Vandenberg Air Force Base.

Santa Barbara County Air Pollution Control District, 1994. 1994 Clean Air Plan - Final, Santa Barbara County’s plan to attain the federal and state ozone standards, November.

Santa Barbara County Planning Department, 1996. Traffic Count.

Scheraga, J.D., 1986. “Curbing Pollution in Outer Space,” *Technology Review*, January.

Schmalzer, P.A., C.R. Hall, C.R. Hinkel, B.W. Duncan, W.M. Knott III, and B.R. Summerfield, 1993. Environmental Monitoring of Space Shuttle Launches at Kennedy Space Center: The First Ten Years, American Institute of Aeronautics and Astronautics, Washington DC.

Smith Environmental Services, 1997. Attachment A, Evolved Expendable Launch Vehicle Program, Cape Canaveral Air Station, Brevard County, Florida, Environmental Considerations and Mitigation Proposal: Joint Application for St. John’s River Water Management District Environmental Resource Permit - Surface Water Management Systems (Chapter 40C-4, F.A.C.) and Department of the Army Corps of Engineers Section 404 Dredge and Fill Permit, November.

Smith, M.S., 1982. Protecting the Earth and Outer Space Environment: Problems of On-Orbit Space Debris, American Institute of Aeronautics and Astronautics, Washington, DC.

South Coast Air Quality Management District, 1993. CEQA Air Quality Handbook, Diamond Bar, California, April.

Spradling, K., 1990. “Space Debris: The Legal Regime, Policy Consideration and Current Initiatives,” paper presented at the 28th Aerospace Sciences Meeting, January 8-11, Reno, Nevada. Published as AIAA-90-0088 by the American Institute of Aeronautics and Astronautics, Washington, DC.

SRS Technologies, 1998. Acoustic Measurements of the Titan IVA-18 Launch and Quantitative Analysis of Harbour Seal Behavior and Auditory Responses, Dr. Phillip Thorson, Mr. Jon Francine, and Mr. David Eidson, System Development Division, Manhattan Beach, California.

St. John’s River Water Management District, n.d. What You Should Know About the Indian River Lagoon, Melbourne, Florida.

Stewart, B.S., 1989. The Ecology and Population Biology of the Northern Elephant Seal, Mirounga angustirostris Gill 1866, on the Southern California Channel Islands, dissertation prepared in partial satisfaction of the requirements for the degree of Doctor of Philosophy in Biology, University of California, Los Angeles.

Stewart, B.S., 1996. Assessment of Potential Impacts of Launch Noise and Sonic Boom from Titan IV/NUS Space Launch Vehicles on Pinnipeds Near Vandenberg Air Force Base and on the Southern California Channel Islands, Hubbs-Sea World Research Institute Technical Report 96-262:1-143.

Stirling, G.M., 1935. Map of Merritt Island and Peninsula, Brevard County, Florida, showing mounds in the Canaveral Region. Map on file (Accession No. 31-13), Peabody Museum, Harvard University, Cambridge, Massachusetts.

Strategic Defense Initiative Organization, 1992. Environmental Assessment, Navy Lightweight Exoatmospheric Projectile (LEAP) Technology Demonstration, September.

Syage, J.A., 1994. Launch Safety, Toxicity, and Environmental Effects of the High Performance Oxidizer ClF_5. Prepared for Space and Missile Systems Center, Air Force Materiel Command, Los Angeles Air Force Base, California, March.

Tetra Tech, Inc., 1980. Case Study Report, Impact of Space Shuttle Activities on the Point Arguello Boathouse (Final Report), prepared for Headquarters Space Division, Directorate of Civil Engineering, Air Force Systems Command, Los Angeles Air Force Station, January.

Tetra Tech, Inc., 1981. Impact of Space Shuttle Activities on Air Quality at Vandenberg Air Force Base, Final Report, prepared for Headquarters Space Division, Los Angeles, California, August.

Tetra Tech, Inc., 1997a. Quarterly Report F97-1 for Vandenberg Air Force Base, Section 2.0: Air Quality Permit Listing.

Tetra Tech, 1997b. Final Environmental Assessment Issuance of a Letter of Authorization for the Incidental Take of Marine Mammals for Programmatic Operations at Vandenberg Air Force Base, California, July.

Tharpe, T., 1997. Personal communication with T. Tharpe, Planner, Brevard County Growth and Management Department, Titusville, Florida, June.

30 Space Wing, 1994. Capabilities Handbook, September.

30 Space Wing, 1997. Industrial Wastewater Compliance Review and Alternatives Evaluation, Vandenberg Air Force Base, California, January.

Transportation Research Board, 1994. Highway Capacity Manual, Special Report 209, Third Edition, National Research Council, Washington, DC.

Tri-Services Cultural Resources Research Center, U.S. Army Construction Engineering Research Laboratories, 1993. Determination of Eligibility of Launch Complexes and Related Facilities for Listing on the National Register of Historic Places at Cape Canaveral Air Force Station, Cape Canaveral, Florida, prepared for the U.S. Air Force, September.

Tri-Services Cultural Resources Research Center, U.S. Army Corps of Engineers Research Laboratories, 1996. Cold War Properties Evaluation, Phase 1, Inventory and Evaluation of Launch Complexes and Related Facilities at Vandenberg Air Force Base, California, Final Report, February.

TRW Space and Electronics Group, 1994a. The Impact of Tropospheric Rocket Exhaust on Stratospheric Ozone, prepared for Space and Missile Systems Center, El Segundo, California, May.

TRW Space and Electronics Group, 1994b. Feasibility Study for Advanced Microelectronics Technology of Sensor Applications and Ozone Depleters on Stratospheric Ozone and Deorbiting Space Debris, prepared for Space and Missile Systems Center, El Segundo, California, May.

Turner, S., et al., 1994. Historic American Engineering Record of Complex 13, 26, 36, Cape Canaveral Air Station, Cape Canaveral, Florida, prepared for the U.S. Air Force by the U.S. Army Construction Engineering Research Laboratories, Champaign, Illinois.

University of California, Santa Barbara (UCSB) Economic Forecast Project, 1997. The 1997 Santa Barbara County Economic Outlook, Volume 14, Santa Barbara, California, April.

University of Florida, 1996. Florida Population Studies: Population Projections by Age, Sex, and Race for Florida and Its Counties, 1995-2010, Volume 29, Number 3, Bulletin Number 155. Prepared by S.K. Smith, Director, Bureau of Economic and Business Research, and J. Nogle, assistant in research, Gainesville, July.

University of Florida, 1997. Florida Estimates of Population: April 1, 1996. Prepared by the Population Program, Bureau of Economic and Business Research, Warrington College of Business Administration, Gainesville, February.

U.S. Air Force, 1978. Final Environmental Impact Statement for the Space Shuttle Program, Vandenberg Air Force Base, California, January.

U.S. Air Force, 1981a. Draft Environmental Assessment for Increased Shuttle Launch Pad Security Measures, Vandenberg Air Force Base, California, January.

U.S. Air Force, 1981b. Operations Plan 234-81 (SPCC). Headquarters 4392 Space Aerospace Support Group, U.S. Air Force, Vandenberg AFB, California, July.

U.S. Air Force, 1982a. Coastal Consistency Determination, Space Shuttle Program, Vandenberg Air Force Base, California, September.

U.S. Air Force, 1982b. Environmental Analysis for the Proposed Disposal of Material Dredged from the External Tank Landing Facility, Vandenberg Air Force Base, California, Headquarters Space Division, Los Angeles, California.

U.S. Air Force, 1984. Environmental Assessment, Space Shuttle North Access Road at SLC-6, Vandenberg Air Force Base, California, November.

U.S. Air Force, 1985. Environmental Assessment for Construction and Operation of Space Shuttle Power Plant and Natural Gas Pipeline, Vandenberg Air Force Base, California, January.

U.S. Air Force, 1987a. Biological Assessment for the Complementary Expendable Launch Vehicle (CELV) at Cape Canaveral Air Force Station, Florida, January.

U.S. Air Force, 1987b. Environmental Assessment for Titan II Space Launch Vehicle Modification and Launch Operation, Vandenberg Air Force Base, August.

U.S. Air Force, 1988a. Archaeological Resources Inventory and No Effects Determination for Proposed Phase III Geotechnical Testing, Proposed Space Launch Complex 7, Vandenberg Air Force Base, Santa Barbara County, California, October.

U.S. Air Force, 1988b. Biological Assessment for the Titan II and Titan IV Space Launch Vehicle Modifications and Launch Operations Programs, Vandenberg Air Force Base, California, June.

U.S. Air Force, 1988c. Draft Environmental Assessment, Modifications to and Operations at the Hypergolic Maintenance and Checkout Facility, Vandenberg Air Force Base, California, September.

U.S. Air Force, 1988d. Draft Environmental Impact Statement for the Mineral Resource Management Plan, Potential Exploration, Development, and Production of Oil and Gas Resources, Vandenberg Air Force Base, California, June.

U.S. Air Force, 1988e. Environmental Assessment for Titan IV Space Launch Vehicle Modification and Operation, Vandenberg Air Force Base, February.

U.S. Air Force, 1988f. Supplement to Environmental Assessment for Construction and Operation of STS Power Plant and Natural Gas Pipeline, Vandenberg Air Force Base, California, May.

U.S. Air Force, 1989a. Draft Environmental Impact Statement Construction and Operation of Space Launch Complex 7, Vandenberg Air Force Base, California, Volume I, July.

U.S. Air Force, 1989b. Environmental Assessment for the American Rocket Company (AMROC) Commercial Expendable Launch Vehicle, Initial Evaluation Launch Phase, Vandenberg Air Force Base, California, July.

U.S. Air Force, 1989c. Supplemental Environmental Assessment, Titan IV Space Launch Vehicle Modifications and Launch Operations Program, Power Upgrade Project, Vandenberg Air Force Base, California, March.

U.S. Air Force, 1989d. Vandenberg Air Force Base Comprehensive Plan, Santa Barbara County, California, August.

U.S. Air Force, 1990a. Biological Assessment, Titan IV/Centaur Launch Complex, Vandenberg Air Force Base, California, March.

U.S. Air Force, 1990b. Environmental Assessment for the Titan IV/Solid Rocket Motor Upgrade Program, Cape Canaveral AFS, Florida and Vandenberg AFB, California, February.

U.S. Air Force, 1991a. Draft Programmatic Environmental Assessment, Medium Launch Vehicle III Program, June.

U.S. Air Force, 1991b. Environmental Assessment, Air Force Small Launch Vehicle, Vandenberg Air Force Base, Edwards Air Force Base, and San Nicolas Island, California, May.

U.S. Air Force, 1991c. Environmental Assessment, Centaur Cryogenic Tanking Facility and Centaur Processing Building, Cape Canaveral Air Force Station, Florida, October.

U.S. Air Force, 1991d. Environmental Assessment, Commercial Atlas IIAS, Cape Canaveral Air Force Station, Florida, August.

U.S. Air Force, 1991e. Environmental Assessment, Delta Centralized Facility, Cape Canaveral Air Force Station, Florida, June.

U.S. Air Force, 1991f. Final Environmental Assessment, Vandenberg Air Force Base, Atlas II Program, August.

U.S. Air Force, 1992a. Environmental Assessment for Disposal of Buildings at Vandenberg Air Force Base, California, July.

U.S. Air Force 1992b. Environmental Assessment for the Taurus Standard Small Launch Vehicle Program, Vandenberg Air Force Base, California, April.

U.S. Air Force 1992c. Final Environmental Assessment of Patrick Air Force Base Wastewater Tie-In with City of Cocoa Beach, Florida, August.

U.S. Air Force, 1993a. Draft Environmental Impact Report for the Vandenberg AFB Landfill Permit Renewal Project, July.

U.S. Air Force, 1993b. Environmental Assessment, NAVSTAR Global Positioning System, Block II/IIA, Cape Canaveral Air Force Station, Florida, September.

U.S. Air Force, 1993c. Supplemental Environmental Assessment, Taurus Standard Small Launch Vehicle Program, Vandenberg Air Force Base, California, May.

U.S. Air Force, 1993d. Biological Assessment of Potential Effects to Federally Protected Species from Proposed Construction of ROCC Back-Up Power Facility, Cape Canaveral Air Force Station, Florida, Johnson Controls World Services Inc., Engineering and Environmental Planning, File No 9-3.

U.S. Air Force, 1993e. Biological Assessment of Potential Impact from Proposed Construction of Percolation Ponds, Tel IV, Kennedy Space Center, Florida, Johnson Controls World Services Inc., Engineering and Environmental Planning, File No. 8-5.

U.S. Air Force, 1994a. Clean Air Act General Conformity Analysis, Titan and Atlas IIAS Fiber Optic Transmission System, Vandenberg Air Force Base, California, June.

U.S. Air Force, 1994b. Draft Environmental Assessment, NAVSTAR Global Positioning System, Block IIR, and Medium Launch Vehicle II, Cape Canaveral Air Force Station, Florida, March.

U.S. Air Force, 1994c. Environmental Assessment for the California Spaceport, Vandenberg Air Force Base, California, December.

U.S. Air Force, 1994d. Environmental Assessment, Milstar I and II Satellite Vehicle, Cape Canaveral Air Force Station, Florida, January.

U.S. Air Force, 1994e. Final Environmental Assessment, Long-Term Staging of Titan IV Solid Rocket Motor Upgrades, May.

U.S. Air Force, 1994f. Final Environmental Assessment, NAVSTAR Global Positioning System, Block IIR, and Medium Launch Vehicle II, Cape Canaveral Air Force Station, Florida, November.

U.S. Air Force, 1994g. Environmental Assessment, Titan and Atlas IIAS Fiber Optic Transmission System, Vandenberg Air Force Base, July.

U.S. Air Force, 1995a. Eastern and Western Range 127-1, Range Safety Requirements, March.

U.S. Air Force, 1995b. Eastern and Western Range 127-1, Range Safety Requirements, Range User Handbook, August.

U.S. Air Force, 1995c. Environmental Assessment for Defense Satellite Communications System III with Integrated Apogee Boost System, Cape Canaveral Air Station, Florida, July.

U.S. Air Force, 1995d. Final Environmental Baseline Study Resource Appendices, Eglin Air Force Base, Florida, May.

U.S. Air Force, 1995e. Installation Restoration Program, 45 Space Wing Facilities at Cape Canaveral Air Station, Florida, Environmental Condition of Property Report, September.

U.S. Air Force, 1995f. Air Force Instruction 91-202, Safety: The U.S. Air Force Mishap Prevention Program, October.

U.S. Air Force, 1996a. Draft Environmental Assessment for Space and Missile Tracking System Flight Demonstration System, Cape Canaveral Air Station, Florida, July.

U.S. Air Force, 1996b. 30th Space Wing Plan 32-7080, Pollution Prevention Management Plan, May.

U.S. Air Force 1996c. Site Investigation Report and Phase I RCRA Facility Investigation for 45 Space Wing Facilities at Cape Canaveral Air Station, Florida, Volume 21, Trident Wharf Area (79100), June.

U.S. Air Force, 1996d. Preliminary Draft, Integrated Natural Resources Management Plan for Cape Canaveral Air Station, Florida, 45 Space Wing.

U.S. Air Force, 1997. Summary of Actual Emissions by SIC Major Group Code, 1994 Inventory Actual Emissions (TPY). Prepared by AFCEE, April 24.

U.S. Air Force Space Command, 1995a. Management Action Plan, Vandenberg Air Force Base, California, December.

U.S. Air Force Space Command, 1995b. Restoration Management Action Plan, Cape Canaveral Air Station, Florida, November.

U.S. Air Force Space Command, 1995c. Supplemental Preliminary Assessment, Final Report, Volume I, Installation Restoration Program, Vandenberg AFB, October.

U.S. Army Corps of Engineers, 1988. Historic Properties Investigation of a Proposed Security Fence for Fuel Storage Area #1, Cape Canaveral Air Station, Brevard County, Florida, prepared for the Eastern Space and Missile Center, Patrick Air Force Base by the Mobile District, U.S. Army Corps of Engineers.

U.S. Army Corps of Engineers, 1989. Historic Properties Investigations of Several Proposed Projects: Launch Complex 17 Security Fence Upgrade, TGSF Storage Facilities, Launch Complex 01 Line of Sight, Cape Canaveral Air Force Station, Brevard County, Florida, prepared for the Eastern Space and Missile Center, Patrick Air Force Base by the Mobile District, U.S. Army Corps of Engineers.

U.S. Army Corps of Engineers, 1990a. Draft Navigation Study for Canaveral Harbor, Florida, Feasibility Report and Environmental Impact Statement - 81240, June.

U.S. Army Corps of Engineers, 1990b. Historic Properties Investigation of the Centaur Processing Facility, Interim Spin Test Facility, Missile Assembly Building Parking, prepared for the Eastern Space and Missile Center, Patrick Air Force Base by the Mobile District, U.S. Army Corps of Engineers.

U.S. Army Corps of Engineers, 1991. Historic Properties Investigation of the Chemical Testing Laboratory, Wastewater Treatment Facility, Command Control Building Addition Fence, prepared for the Eastern Space and Missile Center, Patrick Air Force Base by the Mobile District, U.S. Army Corps of Engineers.

U.S. Army Corps of Engineers, 1992. Archaeological Sensitivity Map, Cape Canaveral Air Force Station, Brevard County, Florida. Prepared for the Eastern Space and Missile Center, Patrick Air Force Base by the Mobile District, U.S. Army Corps of Engineers.

U.S. Army Space and Strategic Defense Command, 1994. Draft Environmental Impact Statement, Theater Missile Defense Extended Test Range, Volume I, January.

U.S. Bureau of Economic Analysis, 1996a. Regional Economic Information System, Department of Commerce, Economics and Statistics Administration, Regional Economic Measurement Division, Washington, DC, June.

U.S. Bureau of Economic Analysis, 1996b. U.S. Gross Domestic Product, Federal Defense Implicit Price Deflator Index, received from the National Income and Wealth Division, Department of Commerce, Economics and Statistics Administration, Washington, DC.

U.S. Bureau of Economic Analysis, 1996c. U.S. Gross Domestic Product, Personal Consumption Expenditures Implicit Price Deflator Index, received from the National Income and Wealth Division, Department of Commerce, Economics and Statistics Administration, Washington, DC.

U.S. Bureau of Economic Analysis, 1997a. Regional Multipliers: A User Handbook for the Regional Input-Output Modeling System (RIMS II), Third Edition, Department of Commerce, U.S. Government Printing Office, Washington, DC, March.

U.S. Bureau of Economic Analysis, 1997b. RIMS II Multipliers for Brevard County, Florida, and Santa Barbara County, California, Department of Commerce, Regional Economic Analysis Division, Washington, DC, June.

U.S. Bureau of Economic Analysis, 1997c. Survey of Current Business, Table 7.1, page D-17, Volume 77, Number 2 (February), Department of Commerce, Economics and Statistics Administration, Washington DC.

U.S. Bureau of Labor Statistics, 1995. "Worker Displacement: A Decade of Change," *Monthly Labor Review*, pp. 45-57, Volume 118, Number 4 (April), Department of Labor, Washington, DC.

U.S. Bureau of Labor Statistics, 1997. "Current Labor Statistics," Monthly Labor Review, Table 7, p. 55, Volume 120, Number 2 (February), Department of Labor, Washington, DC.

U.S. Bureau of the Census, 1991. 1990 Census of Population and Housing, Department of Commerce, Washington DC.

U.S. Council of Economic Advisors, 1997. Annual Report, together with the Economic Report of the President, Appendix B, Tables B-3 and B-57, U.S. Government Printing Office, Washington, DC, February.

U.S. Department of Agriculture, Soil Conservation Service, 1974. Soil Survey of Brevard County, Florida, November.

U.S. Department of Defense, 1995. Atlas/Data Abstract for the United States and Selected Areas, Fiscal Year 1994, Washington Headquarters Service, Directorate of Information, Operations and Reports, DIOR/L03-94, Washington, DC.

U.S. Department of the Interior, National Park Service, 1978. An Inter-Tidal and Underwater Archaeological Survey of the Point Arguello Boathouse Area, Vandenberg Air Force Base, California.

U.S. Department of the Interior, U.S. Fish and Wildlife Service, n.d. National Wetlands Inventory Wetlands Maps, Cape Canaveral Air Station, Florida.

U.S. Department of the Interior, U.S. Fish and Wildlife Service, 1995. Mapping Effort for United States Air Force, Vandenberg Air Force Base, National Wetlands Inventory, July.

U.S. Department of the Navy, 1996. Overseas Environmental Assessment, Alt Air, Short Range Ballistic Target Test Demonstration, Point Mugu, California.

U.S. Department of Transportation, Office of Commercial Space Transportation, 1992. Draft Programmatic Environmental Impact Statement for Commercial Reentry Vehicles, January.

U.S. Environmental Protection Agency, 1971. Air Quality Criteria for Oxides, AP-84, Research Triangle Park, North Carolina.

U.S. Environmental Protection Agency, 1994a. User's Guide to Mobile 5 (Mobile Source Factor Model) and Software Program, Office of Air and Radiation, EPA-AA-AQAB-94-1, Ann Arbor, Michigan, May.

U.S. Environmental Protection Agency, 1994b. Draft User's Guide to PART5: A Program for Calculating Particle Emissions from Motor Vehicles, Office of Mobile Sources, EPA-AA-AQAB-94-2, Ann Arbor, Michigan, July.

U.S. Environmental Protection Agency, 1995. Compilation of Air Pollutant Emission Factors, Volume I: Stationary Point and Area Sources, 5ed (AP-42), Office of Air Quality Planning and Standards, Ann Arbor, Michigan, January.

U.S. Environmental Protection Agency, 1995. Emissions by Tier 2 Category for Counties in Florida.

U.S. Federal Reserve Bank of San Francisco, 1997. "Job Creation and Destruction," FRBSF Economic Letter, Number 97-13 (May 2), San Francisco, California.

U.S. Office of Management of Budget, 1987. Standard Industrial Classification Manual 1987, Executive Office of the President, Washington, DC.

Vandenberg Air Force Base, 1996a. Title V Operating Permit Application, June.

Vandenberg Air Force Base, 1996b. Water Quality ENVVEST Initiative.

Versar, Inc., 1991. Preliminary Final Environmental Assessment, Vandenberg Air Force Base, Atlas II Program, June.

Wadzinski, M., 1997. Personal communication with Mike Wadzinski regarding health and safety, July.

Warneck, P., 1988. "Chemistry of the Natural Atmosphere," Academic Press, Inc., Harcourt Brace Jovanovich Publishers, San Diego, California.

The White House, 1996. National Space Policy, National Science and Technology Council, September.

Wiley, G.R., 1954. "Burial Patterns in the Burns and Fuller Mounds, Cape Canaveral, Florida," *Florida Anthropologist*, Volume 7.

Wofsy, S.C., and J.A. Logan, 1982. "Recent Developments in Stratospheric Photochemistry," Causes and Effects of Stratospheric Ozone Reduction: An Update, National Research Council, National Academy Press, Washington, DC.

Wolfe, M.G., V.A. Chobotov, and F.E. Bonds, 1983. "Man-Made Space Debris: Implications for the Future," *Space Technology*, Volume 3, Number 1.

World Meteorological Organization, 1989. Scientific Assessment of Stratospheric Ozone: 1989, Volume 1, Global Ozone Research and Monitoring Project - Report No. 20.

World Meteorological Organization, 1995. Scientific Assessment of Ozone Depletion: 1994, World Meteorological Organization, Global Ozone Research and Monitoring Project - Report Number 37, Geneva, Switzerland.

Zittel, P.F., 1995. Computer Model Calculations of NO_x Production in Rocket Motors and Plumes. Aerospace Report No. TOR-96(1306)-1, Aerospace Corporation, El Segundo, California.

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APPENDIX A

GLOSSARY OF TERMS AND ACRONYMS/ABBREVIATIONS

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 (ANSI S1.4-1971) and accounts for the response of the human ear.

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

Advisory Council on Historic Preservation. A 19-member body appointed, in part, by the President of the United States to advise the President and Congress and to coordinate the actions of federal agencies on matters relating to historic preservation, to comment on the effects of such actions on historic and archaeological cultural resources, and to perform other duties as required by law (Public Law 89-655; 16 U.S. Code 470).

Aerozine-50. A toxic, colorless liquid propellant that is spontaneously hypergolic in combination with nitric acid and concentrated hydrogen peroxide.

Aesthetics. Referring to the perception of beauty.

Aggregate. Materials such as sand, gravel, or crushed stone used for mixing with a cementing material to form concrete or alone as railroad ballast or graded fill.

Air basin. A region within which the air quality is determined by the meteorology and emissions within it with minimal influence on and impact by contiguous regions.

Albedo. The fraction of incident light or electromagnetic radiation that is reflected by a surface or body (such as the moon or a cloud).

Ammonium perchlorate (NH_4ClO_4). All of the perchlorates produce hydrogen chloride and other chlorine compounds when combined and combusted with other fuels. The exhaust gases are highly corrosive and toxic.

Anomaly. Any deviation from the characteristics of a normal launch.

Apogee. The point in the orbit that is farthest from the Earth.

Aquifer. The water-bearing portion of subsurface earth material that yields or is capable of yielding useful quantities of water to wells.

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

Area of Concern. A location where contamination is likely or suspected, but where further investigation is needed to confirm its presence and whether it is below action levels.

Area of Potential Effect. The geographic area within which direct and indirect impacts generated by the Proposed Action and alternatives could reasonably be expected to occur and thus cause a change in the historic, architectural, archaeological, or cultural qualities possessed by the property.

Asbestos. A carcinogenic substance formerly used widely as an insulation material by the construction industry; often found in older buildings.

Asbestos-containing material (ACM). Any material containing more than 1 percent asbestos.

Attainment area. A region that meets the National Ambient Air Quality Standards for a criteria pollutant under the Clean Air Act (CAA).

Attitude. The position of an aircraft or spacecraft determined by the relationship between its axes and a reference datum (such as the horizon or a particular star).

Average annual daily traffic (AADT). For a one-year period, the total volume passing a point or segment of a highway facility in both directions, divided by the number of days in the year.

Average daily traffic (ADT). The typical 24-hour volume of traffic passing a given point or segment of a roadway in both directions.

Avionics. The science and technology of electronics applied to aeronautics and astronautics.

Azimuth. The compass direction along which the launch vehicle's ground track lies in its early flight.

Biophysical. Pertaining to the physical and biological environment, including the environmental conditions crafted by man.

Biota. The plant and animal life of a region.

Candidate species. A species of plant or animal for which there is sufficient information to indicate biological vulnerability and threat, and for which proposing to list as "threatened" or "endangered" is or may be appropriate.

Capacity. The maximum rate of flow at which vehicles can be reasonably expected to traverse a point or uniform segment of a lane or roadway during a specified time period under prevailing roadway, traffic, and control conditions.

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 air quality standard. See Criteria pollutants.

Census tract. Small, relatively permanent statistical subdivisions of a county that are delineated for all metropolitan areas and other densely populated counties.

Class I, II, and III Areas. Area classifications, defined by the Clean Air Act, for which there are established limits to the annual amount of air pollution increase. Class I areas include international parks and certain national parks and wilderness areas; allowable increases in air pollution are very limited. Air pollution increases in Class II areas are less limited, and are least limited in Class III areas. Areas not designated as Class I start out as Class II and may be reclassified up or down by the state, subject to federal requirements.

Clean Air Act (CAA). (42 U.S. Code 7401 et seq.) Establishes (1) national air quality criteria and control techniques (Section 7408); (2) National ambient air quality standards (Section 7409); (3) state implementation plan requirements (Section 4710); (4) federal performance standards for stationary sources (Section 4711); (5) national emission standards for hazardous air pollutants (Section 7412); (6) applicability of CAA to federal facilities (Section 7418), i.e., federal agency must comply with federal, state, and local requirements respecting control and abatement of air pollution, including permit and other procedural requirements, to the same extent as any person; (7) federal new motor vehicle emission standards (Section 7521); (8) regulations for fuel (Section 7545); (9) aircraft emission standards (Section 7571).

Clean Water Act. (33 U.S. Code 1251 et seq.) Restores and maintains the chemical, physical, and biological integrity of the nation's waters.

Coastal sage scrub. A plant community of low, soft-woody, perennial subshrubs (growing to about 1 meter in height) dominated by California sage brush and California brittlebush. Plant growth is most active during the winter and early spring months.

Commodity Connection Building. All fuel and gas lines are routed into this building to provide on-pad fueling of the vehicle.

Community of Comparison (COC). A regional political jurisdiction identified to allow comparison of smaller political units in order to determine the potential for environmental justice impacts (i.e., disproportionately high and adverse impacts to low-income and/or minority populations).

Comprehensive Plan. A public document, usually consisting of maps, text, and supporting materials, adopted and approved by a local government legislative body, which describes future land uses, goals, and policies.

Contaminants. Undesirable substances rendering something unfit for use.

Council on Environmental Quality (CEQ). Established by the National Environmental Policy Act (NEPA), the CEQ consists of three members appointed by the President. A CEQ regulation (Title 40 Code of Federal Regulations [CFR] 1500-1508, as of July 1, 1986) describes the process for implementing NEPA, including preparation of environmental assessments and environmental impacts statements, and the timing and extent of public participation.

Criteria pollutants. The Clean Air Act required the U.S. Environmental Protection Agency (EPA) to set air quality standards for common and widespread pollutants after preparing “criteria documents” summarizing scientific knowledge on their health effects. Today there are standards in effect for six “criteria pollutants”: sulfur dioxide (SO_2), carbon monoxide (CO), particulate matter equal to or less than 10 microns in diameter (PM_{10}), nitrogen dioxide (NO_2), ozone (O_3), and lead (Pb).

Cultural resources. Prehistoric and historic districts, sites, buildings, objects, or any other physical evidence of human activity considered important to a culture, subculture, or a community for scientific, traditional, religious, or any other reason.

Cumulative impact. The impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time.

Day-Night Average Sound Level (DNL). The 24-hour average-energy sound level expressed in decibels, with a 10-decibel penalty added to sound levels between 10:00 p.m. and 7:00 a.m. to account for increased annoyance due to noise during night hours.

Decibel (dB). A unit of measurement of a logarithmic scale which describes the magnitude of a particular quantity of sound pressure or power with respect to a standard reference value.

Deflagration. A launch failure in which the fuel from all stages is explosively burned, resulting in a hot, buoyant ground cloud that is dispersed in the first 10,000 feet.

Dobsen Unit. A unit of measurement used for atmospheric ozone, presented in milliatmosphere centimeters.

Effluent. Waste material discharged into the environment.

Endangered species. A species that is threatened with extinction throughout all or a significant portion of its range.

Endangered Species Act. (16 U.S. Code 1531 et seq.) Provides for listing and protection of animal and plant species identified as in danger, or likely to be in danger, or extinction throughout all or a significant part of their range. Section 7 places strict requirements on federal agencies to protect listed species.

Environmental Impact Analysis Process. The process of conducting environmental studies as outlined in Air Force Instruction 32-7061.

Environmental Justice. An identification of potential disproportionately high and adverse impacts on low-income and/or minority populations that may result from proposed federal actions (required by Executive Order 12898).

Erosion. Wearing away of soil and rock by weathering and the actions of surface water, wind, and underground water.

Evolved Expendable Launch Vehicle (EELV) systems. For the purposes of this document, EELV systems consist of one or more families of vehicles that could replace Atlas IIA, Delta II, and Titan IVB launch vehicles.

Executive Order 12898. Issued by the President on February 11, 1994, this Executive Order requires federal agencies to develop implementation strategies, identify low-income and minority populations that may be disproportionately impacted by proposed federal actions, and solicit the participation of low-income and minority populations.

Explosive safety quantity-distance. The quantity of explosive material and distance separation relationships providing defined types of protection. These relationships are based on levels of risk considered acceptable for the stipulated exposures. Separation distances are not absolute safe distances but are relatively protective or safe distances.

Fault. Fracture in Earth’s crust accompanied by a displacement of one side of the fracture with respect to the other and in direction parallel to the fracture.

Fault zone. An area where rupture and subsequent motion has produced rock that is badly crushed. This area may be many feet thick, providing a conduit for the relatively easy passage of fluids.

Floodplain. The lowland and relatively flat areas adjoining inland and coastal waters including flood-prone areas of offshore islands. Includes, at a minimum, that area subject to a 1 percent or greater chance of flooding in any given year (100-year floodplain).
Forbs. Low-growing, non-woody plants other than grass.

Fragmentation. Process by which an orbiting space object disassociates and produces debris.

Frequency. The time rate (number of times per second) that the wave of sound repeats itself, or that a vibrating object repeats itself, now expressed in Hertz (Hz), formerly in cycles per second (cps).

Friable. Easily crumbled or reduced to powder.

Fungicide. Any substance that kills or inhibits the growth of fungi.

Geostationary Earth orbit. Geostationary Earth orbit is a type of geosynchronous Earth orbit in which the object orbits above the Earth’s equator at an angular rotation speed equal to the rotation of the Earth, thus appearing to remain stationary with respect to a point on the equator.

Geosynchronous Earth orbit. Geosynchronous Earth orbit occurs at an altitude of 22,238 miles and has an orbital period of approximately 24 hours.

Groundwater. Water within the earth that supplies wells and springs.

Groundwater basin. Subsurface structure having the character of a basin with respect to collection, retention, and outflow of water.

Groundwater recharge. Absorption and addition of water to the zone of saturation.

Hazardous materials/hazardous wastes. Those substances defined as hazardous by the Comprehensive Environmental Response, Compensation and Liability Act, as amended, and the Solid Waste Disposal Act, as amended by the Resource Conservation and Recovery Act, as amended. Generally, this includes substances that, because of their quantity, concentration, or physical, chemical, or infectious characteristics, may present substantial danger or public health or welfare or the environment when released into the environment.

Herbicide. A pesticide, either organic or inorganic, used to destroy unwanted vegetation, especially various types of weeds, grasses, and woody plants.

Historic properties. Under the National Historic Preservation Act, these are properties of national, state, or local significance in American history, architecture, archaeology, engineering, or culture, and worthy of preservation.

Hydrazine (N_2H_4). A toxic, colorless liquid propellant that is spontaneously hypergolic in combination with nitric acid and concentrated hydrogen peroxide. Vapors may form explosive mixtures with air.

Hydrocarbons (HC). Any of a vast family of compounds containing hydrogen and carbon. Used loosely to include many organic compounds in various combinations; most fossil fuels are composed predominantly of hydrocarbons. When hydrocarbons mix with nitrogen oxides in the presence of sunlight, ozone is formed; hydrocarbons in the atmosphere contribute to the formation of ozone.

Hydroxyl-terminated polybutadiene. A polymer binder used in composite propellants.

Hypergolic. Igniting upon contact of components without external aid; of, relating to, or using hypergolic fuel.

Impacts (effects). An assessment of the meaning of changes in all attributes being studied for a given resource; an aggregation of all the adverse effects, usually measured using a qualitative and nominally subjective technique. In this EIS, as well as in the CEQ regulations, the word impact is used synonymously with the word effect.

Inclination. Angle between the orbital plane of a space object and the plane of the Earth's equator.

Indirect impacts. Indirect effects, which are caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable. Indirect effects may include growth-inducing effects and other effects related to induced changes in the pattern of land use, population density or growth rate, and related effects on air and water and other natural systems, including ecosystems.

Infrastructure. The basic installation and facilities on which the continuance and growth of a community or state (e.g., roads, schools, power plants, transportation, communication systems) are based.

Installation Restoration Program (IRP). The Air Force program designed to identify, characterize, and remediate environmental contamination on Air Force installations. Although widely accepted at the time, procedures followed prior to the mid-1970s for managing and disposing of many wastes often resulted in contamination of the environment. The program has established a process to evaluate past disposal sites, control the migration of contaminants, and control potential hazards to human health and the environment. Section 211 of Superfund Amendments and Reauthorization Act (SARA), codified as the Defense Environmental Restoration Program (DERP), of which the Air Force IRP is a subset, ensures that DoD has the authority to conduct its own environmental restoration programs. DoD coordinates IRP activities with the U.S. EPA and appropriate state agencies.

Jurisdictional wetlands. Those wetlands that meet the hydrophytic vegetation, hydric soils, and wetland hydrology criteria under normal circumstances (or meet the special circumstances as described in the U.S. Army Corps of Engineers, 1987, wetland delineation manual where one or more of these criteria may be absent and are a subset of "Waters of the United States").

L_{eq}. The equivalent steady-state sound level, which, in a stated period of time, would contain the same acoustical energy as time-varying sound level during the same period.

L_{max}. The highest A-weighted sound level observed during a single event of any duration.

Lead (Pb). A heavy metal used in many industries which can accumulate in the body and cause a variety of negative effects. One of the six pollutants for which there is a national ambient air quality standard.

Lead-based paint. Paint on surfaces with lead in excess of 1.0 milligram per square centimeter as measured by X-ray fluorescence detector or 0.5 percent lead by weight.

Level of service (LOS). In transportation analysis, a qualitative measure describing operational conditions within a traffic stream and how they are perceived by motorists and/or passengers.

Liquid ammonia (NH_3). A liquid propellant that is toxic before combustion or mixing with oxygen, but the exhaust gases produced are non-toxic.

Liquid hydrogen (LH_2). A liquid propellant that has a boiling point of -253.33°C (-424°F), and that requires large, bulky tanks and special materials designed to withstand extremely low temperatures. Mixtures of LH_2 and solid oxygen are explosive. It is the lightest and coldest of all known fuels.

Liquid oxygen (LO_2). A liquid oxidizer that can detonate in combination with organic materials on impact and will accelerate combustion of other materials. Although it will not combust spontaneously with organic materials at ambient temperatures, ignitions or explosions will occur when confined mixtures of oxygen and organic materials undergo sudden pressurization.

Loudness. The qualitative judgment of intensity of a sound by a human being.

Low Earth orbit (LEO). Low-earth orbit occurs at altitudes less than 1,243 miles with an orbital period of 127 minutes or less. Most space activity, particularly commercial, has occurred within this orbital regime.

Low-income. Low-income populations, as used in this EIS, refer to those people with an income below the poverty level ($12,764 for a family of four in 1989, as reported in the 1990 Census of Population and Housing).

Medium Earth orbit. Medium Earth orbit occurs between low and geosynchronous Earth orbits and is a semi-synchronous orbit with a period of approximately 12 hours.

Mineral. Naturally occurring inorganic element or compound.

Mineral resources. Mineral deposits that may eventually become available, known deposits not recoverable at present or yet undiscovered.

Minority. Minority populations, as reported in the 1990 Census of Population and Housing, includes Black; American Indian; Eskimo, or Aleut; Asian or Pacific Islander; Hispanic; or other.

Mitigation. A method or action to reduce or eliminate program impacts.

Monomethyl hydrazine (MMH). A toxic, colorless liquid that is capable of spontaneous ignition when in contact with nitric acid and concentrated hydrogen peroxide. It is a strong reducing agent that tends to react violently with oxidizing agents and is hypergolic with several rocket oxidizers.

National Ambient Air Quality Standards (NAAQS). Section 109 of the Clean Air Act requires the U.S. EPA to set nationwide standards, the NAAQS, for widespread air pollutants. Currently, six pollutants are regulated by primary and secondary NAAQS: carbon monoxide (CO), lead (Pb), nitrogen dioxide (NO_2), ozone, particulate matter equal to or less than 10 microns in diameter (PM_{10}), and sulfur dioxide (SO_2).

National Environmental Policy Act. Public Law 91-190, passed by Congress in 1969. The Act established a national policy designed to encourage consideration of the influences of human activities (e.g., population growth, high-density urbanization, industrial development) on the natural environment. NEPA also established the Council on Environmental Quality (CEQ). NEPA procedures require that environmental information be made available to the public before decisions are made. Information contained in NEPA documents must focus on the relevant issues in order to facilitate the decision-making process.

National Historic Preservation Act (NHPA). (16 U.S.C. 470) Provides for an expanded national Register of Historic Places (NRHP) to register districts, sites, buildings, structures, and objects significant to American history, architecture, archaeology, and culture. Section 106 requires that the President's Advisory Council on Historic Preservation be afforded an opportunity to comment on any undertaking that adversely affects properties listed in the NRHP.

National Priority List (NPL). A list of sites (federal and state) where releases of hazardous materials may have occurred and may cause an unreasonable risk to the health and safety of individuals, property, or the environment.

National Register of Historic Places (National Register). A register of districts, sites, buildings, structures, and objects important in American history, architecture, archaeology, and culture, maintained by the Secretary of the Interior under authority of Section 2 (b) of the Historic Sites Act of 1935 and Section 101 (a)(1) of the National Historic Preservation Act of 1966, as amended.

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.

Native vegetation. Plant life that occurs naturally in an area without agricultural or cultivational efforts. It does not include species that have been introduced from other geographical areas and have become naturalized.

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

Nitrogen oxides (NO_x). Gases formed primarily by fuel combustion, which contribute to the formation of acid rain. Hydrocarbons and nitrogen oxides combine in the presence of sunlight to form ozone, a major constituent of smog.

Nitrogen tetroxide (N_2O_4). A liquid oxidizer that can cause spontaneous ignition with many common materials such as paper, leather, or wood. It also forms strong acids in combination with water, and contact can cause severe chemical burns. It is a yellow-brown liquid which is easily frozen or vaporized.

Nodal period. Elapsed time between either of the points at which the orbit of an object crosses the plane of the equator.

Noise attenuation. The reduction of a noise level from a source by such means as distance, ground effects, or shielding.

Noise contour. A line connecting points of equal noise exposure on a map. Noise exposure is often expressed using the day-night average sound level.

Nonattainment area. An area that has been designated by the U.S. EPA or the appropriate state air quality agency as exceeding one or more national or state ambient air quality standards.

Orbital debris (space debris). Space objects in Earth orbit that are not functional. Spent rocket bodies, mission-related objects, fragments from breakups and deterioration, non-functional spacecraft, and aluminum particles from solid rocket exhaust are all considered debris.

Ozone (O_3) (ground level). A major ingredient of smog. Ozone is produced from reactions of hydrocarbons and nitrogen oxides in the presence of sunlight and heat. One of the six criteria pollutants for which there is a national ambient air quality standard.

Paleontology. The study of life in past geologic time, based on fossil plants and animals.

Particulate matter equal to or less than 10 microns in diameter (PM_{10}). Solid particles consisting of dust, soot, and various types of chemical species that have been emitted into the atmosphere and can remain suspended for several days or weeks. Particulate matter equal to or less than 10 microns in diameter can be hazardous to human health because it is small enough to penetrate the lung's natural defenses and may contain toxic or other chemicals that present a health concern. One of the six criteria pollutants for which there is a national ambient air quality standard.

PCB-contaminated equipment. Equipment which contains a concentration of polychlorinated biphenyls (PCBs) from 50 to 499 parts per million (ppm). Disposal and removal are regulated by the U.S. EPA.

PCB equipment. Equipment that contains a concentration of PCBs of 500 ppm or greater. Disposal and removal are regulated by the U.S. EPA.

PCB items. Fluids containing 5 to 49 ppm of PCBs. Regulated in California under Title 22, Chapter 30 of the California Code of Regulations and Chapter 6.5 of the California Health and Safety Code.

Perigee. The point in the orbit that is closest to the Earth.

Permeability. The capacity of a porous rock or sediment to transmit a fluid.

Pesticide. Any substance, organic or inorganic, used to destroy or inhibit the action of plant or animal pests; the term thus includes insecticides, herbicides, fungicides, rodenticides, miticides, fumigants, and repellants. All pesticides are toxic to humans to a greater or lesser degree. Pesticides vary in biodegradability.

Physiography. The science of the surface of the earth and the interrelations of air, water, and land.

Pleistocene. An earlier epoch of the Quaternary period during the "Ice Age" beginning approximately 3 million years ago and ending 10,000 years ago. Also refers to the rocks and sediments deposited during that time.

Plume. An elongated mass of contaminated fluid moving with the flow of the fluid.

Polychlorinated biphenyls (PCBs). Any of a family of industrial compounds produced by chlorination of biphenyl. these compounds are noted chiefly as an environmental pollutant that accumulates in organisms and concentrates in the food chain with resultant pathogenic (disease-causing) and teratogenic (deformity-causing) effects. They also decompose very slowly.

Potable water. Suitable for drinking.

Prehistoric. The period of time prior to European contact, established in 1769 in the western United States.

Prevention of Significant Deterioration (PSD). In the 1977 Amendments to the Clean Air Act, Congress mandated that areas with air cleaner than required by national ambient air quality standards must be protected from significant deterioration. The Act's PSD program consists of two elements: requirements for best available control technology on major new or modified sources, and compliance with an air quality increment system.

Primary roads. A consolidated system of connected main roads important to regional, statewide, and interstate travel; they consist of rural arterial routes and their extensions into and through urban areas of 5,000 or more population.

Prime farmland. Environmentally significant agricultural lands protected from irreversible conversion to other uses by the Farmland Protection Policy Act.

Protohistoric. Referring to the study of the time period between European contact and established written history.

Radon. A naturally occurring, colorless and odorless radioactive gas that is produced by radioactive decay of naturally occurring uranium.

Rawinsonde. A meteorological balloon tracked by a radio direction-finding instrument or radar, used for measuring wind speed in the upper atmosphere.

Recent. The time period from approximately 10,000 years ago to the present and the rocks and sediments deposited during that time.

Region of Influence (ROI). The geographical region that would be expected to be affected in some way by proposed action and alternative.

Riparian. Of or on the bank of a natural course of water.

Sediment. Material deposited by wind or water.

Scoping. A process initiated early during preparation of an environmental impact statement to identify the scope of issues to be addressed, including the significant issues related to the proposed action. During scoping, input is solicited from affected agencies as well as the interested public.

Scrubber. An apparatus for removing impurities from a gas.

Seismicity. Relative frequency and distribution of earthquakes.

Sensitive habitat. An area inhabited by rare, threatened, or endangered species; an ecosystem supporting a wide variety of plants, birds, and wildlife.

Site. As it relates to cultural resources, any location where humans have altered the terrain or discarded artifacts.

Solid rocket motor. A rocket motor that uses a solid propellant rather than liquids.

Sound exposure level. The A-weighted sound level integrated over the entire duration of a noise event and referenced to a duration of 1 second.

State Historic Preservation Officer (SHPO). The official within each state, authorized by the state at the request of the Secretary of the Interior, to act as liaison for purposes of implementing the National Historic Preservation Act.

Stratosphere. The part of the atmosphere between the troposphere and the mesosphere, occupying the altitudes from approximately 49,000 feet to 167,000 feet (9 to 31 miles).

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; it can also irritate the upper respiratory tract and cause lung damage. The major source of SO_2 in the United States is coal-burning electric utilities. One of the six criteria pollutants for which there is a national ambient air quality standard.

Therm. A measurement of units of heat.

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

Total suspended particulates (TSP). The particulate matter in the ambient air. The previous national standard for particulates was based on TSP levels; it was replaced in 1987 by an ambient standard based on levels of particulate matter equal to or less than 10 microns.

Trajectory. The flight path that a spacecraft will take during a mission.

Trichloroethylene (TCE). A colorless, nonflammable, photoreactive liquid, with a chloroform-like odor, which is slightly soluble in water, and toxic when inhaled. TCE is used for metal degreasing, cleaning, and drying electronic parts; extraction processes; and other chemical processes (Chemical Formula CHCl:CCl2.

Unsymmetrical Dimethylhydrazine (UDMH). A derivative of hydrazine, having many of the same characteristics as hydrazine. It forms a more stable liquid than hydrazine at higher temperatures.

U.S. Environmental Protection Agency (EPA). The independent federal agency, established in 1970, that regulates federal environmental matters and oversees the implementation of federal environmental laws.

Wetlands. Areas that are inundated or saturated with surface or groundwater at a frequency and duration sufficient to support a prevalence of vegetation typically adapted for life in saturated soil. This classification includes swamps, marshes, bogs, and similar areas.

Volume. The number of vehicles passing a point on a lane, roadway, or other trafficway during some time interval.

Zoning. The division of a municipality (or county) into districts for the purpose of regulating land use, types of buildings, required yards, necessary off-street parking, and other prerequisites to development. Zones are generally shown on a map, and the text of the zoning ordinance specifies requirements for each zoning category.

ACRONYMS AND ABBREVIATIONS

A-50	Aerozine-50
AADT	average annual daily traffic
ACM	asbestos-containing material
ACO	Aeronautical Control Officer
A.D.	Anno Domini
ADT	average daily traffic
AFB	Air Force Base
AFI	Air Force Instruction
AFM	Air Force Manual
AFPD	Air Force Policy Directive
AF/SG	Air Force Surgeon General
AFSPC	Air Force Space Command
AGL	above ground level
AIRFA	American Indian Religious Freedom Act
Al	aluminum
Al_2Cl_3	aluminum chloride
Al_2O_3	aluminum oxide
AOC	area of concern
APCD	Air Pollution Control District
APCO	Air Pollution Control Officer
APS	Aboveground Petroleum Storage
ARPA	Archaeological Resources Protection Act
AS	Air Station
AST	aboveground storage tank
AWSPL	A-weighted sound pressure level
BAB	Booster Assembly Building
BACT	Best Available Control Technology
B.C.	Before Christ
BEBR	Bureau of Economic and Business Research
BMP	Best Management Practices
C	Celsius
CAA	Clean Air Act
CAAA	Clean Air Act Amendments
CAAQS	California Ambient Air Quality Standards
CAP	Collection Accumulation Point
CARB	California Air Resources Board
CBC	common booster core
CCR	California Code of Regulations
CCTF	Centaur Cryogenic Tanking Facility
CCTV	closed circuit television
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CERL	Construction Engineering Research Laboratories
CFR	Code of Federal Regulations
cfs	cubic feet per second
Cl	chlorine (atom)
Cl_2	chlorine (molecule)
ClO	hypochlorite
Cl_x	chlorine compounds
cm	centimeter
CMS	Corrective Measures Study
CNEL	Community Noise Equivalent Level
CO	carbon monoxide
CO_2	carbon dioxide

COC	Community of Comparison
COMSTAC	Commercial Space Transportation Advisory Council
COT	Committee on Toxicology
CPB	Centaur Processing Building
CPF	Centaur Processing Facility
CPSC	Consumer Product Safety Commission
CSB	common support building
CSLA	Commercial Space Launch Activities
CUS	Cryogenic Upper Stage
CWA	Clean Water Act
CZMA	Coastal Zone Management Act
CZMP	Coastal Zone Management Program
°	degree
DAIP	Danger Area Information Plan
dB	decibel
dBA	A-weighted decibel
DCG	Disaster Control Group
DCUS	Delta Cryogenic Upper Stage
DEIS	draft environmental impact statement
DERP	Defense Environmental Restoration Program
DHUS	Delta II hypergolic upper stage
DIV	Delta IV
DIV-H	heavy launch vehicle
DIV-M	medium launch vehicle
DIV-M+	medium launch vehicle with solid rocket motor strap-ons
DIV-S	small launch vehicle
DNL	day-night average noise level
DoD	Department of Defense
DOT	Department of Transportation
DRMO	Defense Reutilization and Marketing Office
DTSC	Department of Toxic Substances Control
EELV	Evolved Expendable Launch Vehicle
EHC	Emission Hazard Corridor
EHS	Environmental Health Services
EIAP	Environmental Impact Analysis Process
EIS	environmental impact statement
EMD	Engineering and Manufacturing Development
ENVVEST	Environmental Investment
EO	Executive Order
EOD	Explosive Ordnance Disposal
EPA	Environmental Protection Agency
EPT	elevated platform transport
ER	Eastern Range
ESMC	Eastern Space and Missile Center
ESQD	Explosive Safety Quantity-Distance
EWR	Eastern and Western Range
F	Fahrenheit
FAA	Federal Aviation Administration
FAAQS	Florida Ambient Air Quality Standards
FAC	Florida Administrative Code
FCMA	Florida Coastal Management Act
FDCA	Florida Department of Community Affairs
FDEP	Florida Department of Environmental Protection
FEIS	final environmental impact statement
FNAI	Florida Natural Areas Inventory
FONPA	Finding of No Practicable Alternatives
FSA	Flight Safety Analyst

ft	feet
FTS	flight termination system
FUT	fixed umbilical tower
FVIS	fuel vapor incineration system
gal	gallons
GEM	Graphite Epoxy Motor
GHe	gaseous helium
GN_2	gaseous nitrogen
GOP	Ground Operations Plan
gpd	gallons per day
gpm	gallons per minute
GSE	ground support equipment
GTO	Geosynchronous Transfer Orbit
H_2	hydrogen
HABS/HAER	Historic American Buildings Survey/Historic American Engineering Record
HAP	hazardous air pollutant
HazMart	hazardous materials pharmacy distribution system
HCl	hydrochloric acid
HDCUS	Heavy Delta Cryogenic Upper Stage
He	helium
HIF	Horizontal Integration Facility
HLV	heavy launch vehicle (Concept B)
HLV	heavy lift variant (Concept A)
HMTA	Hazardous Materials Transportation Act
HNO_3	nitric acid
HQ AFSPC/SG	Headquarters Air Force Space Command/Surgeon General
HSWA	Hazardous and Solid Wastes Amendments
HTPB	hydroxyl-terminated polybutadiene
HUS	Hypergolic Upper Stage
HVAC	heating, ventilation, and air conditioning
HWMP	Hazardous Waste Management Plan
Hz	hertz
ICBM	Intercontinental Ballistic Missile
IIP	Instantaneous Impact Point
in	inch
IPF	Integrated Processing Facility
IPS	Ignition Pulse Suppression
IRA	Interim Remedial Action
IRP	Installation Restoration Program
ITL	Integrate Transfer Launch
IWTP	industrial wastewater treatment plant
JP	jet propulsion
JPC	Joint Propellants Contractor
km	kilometer
KSC	Kennedy Space Center
kW	kilowatt
kWH	kilowatt hours
LBS	Launch Base Support
LCCV	Low-Cost Concept Validation
LDCG	Launch Disaster Control Group
L_{dn}	day-night average noise level
LEO	low Earth orbit
L_{eq}	equivalent noise level
LH_2	liquid hydrogen
LMLV	Lockheed Martin Launch Vehicle
LMU	launch mount unit
LN_2	liquid nitrogen

LO_2	liquid oxygen
LOCC	Launch Operations Control Center
LOS	level of service
LO_x	liquid oxygen
LST	Launch Support Team
m	meter
M	magnitude
MACT	Maximum Available Control Technology
MAIS	Major Automated Information System
MARSS	Meteorological and Range Safety Support
MAS	mobile assembly shelter
mb	millibars
MBTU	million British thermal units
MCL	maximum contaminant level
MDAP	Major Defense Acquisition Programs
MFCO	Mission Flight Control Officer
MGD	million gallons per day
mg/l	milligrams per liter
$\mu g/m^3$	micrograms per cubic meter
mi	mile
MIS	Missile Inert Storage
MLV	medium launch vehicle (Concept B)
MLV	medium lift variant (Concept A)
mm	millimeter
MMH	monomethyl hydrazine
MMS	Minerals Managaement Service
MOA	Memorandum of Agreement
MOL	Manned Orbital Laboratory
mph	miles per hour
MSL	mean sea level
MSPSP	Missile System Prelaunch Safety Package
MST	Mobile Service Tower
MW	megawatt
MWH	megawatt-hour
N_2H_4	hydrazine
N_2O	nitrous oxide
N_2O_3	nitrogen anhydride
N_2O_4	nitrogen tetroxide
N_2O_5	nitric anhydride
NAAQS	National Ambient Air Quality Standards
NAGPRA	Native American Graves Protection and Repatriation Act
NASA	National Aeronautics and Space Administration
NAS/NRC/COT	National Academy of Science, National Research Council Committee on Toxicology
NCS	nutation control system
NEPA	National Environmental Policy Act
NESHAP	National Emissions Standards for Hazardous Air Pollutants
NFRAP	no further response action planned
NH_4ClO_4	ammonium perchlorate
NHPA	National Historic Preservation Act
NIOSH	National Institute for Occupational Safety and Health
NMFS	National Marine Fisheries Service
NMM	National Executable Mission Model
NO	nitric oxide
NO_2	nitrogen dioxide
NO_3	nitrogen trioxide

NO_x	nitrogen oxides
NOAA	National Oceanic and Atmospheric Administration
NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NSPS	New Source Performance Standards
NSR	New Source Review
O	atomic oxygen
OBDG	Ocean Breeze Dry Gulch
ODS	Ozone-Depleting Substance
OFW	Outstanding Florida Water
OPlan	Operations Plan
OSHA	Occupational Safety and Health Administration
OSP	Operations Safety Plan
OSPL	overall sound pressure level
OVSS	oxidizer vapor scrubber system
PAH	polynuclear aromatic hydrocarbon
Pb	lead
PCB	polychlorinated biphenyl
PEA	Preliminary Endangerment Assessment
PEL	Permissible Exposure Level
PG-2	triethyl boron/triethyl aluminum
pH	hydrogen ion concentration
PHC	Potential Hazard Corridor
PHV	peak-hour volume
P.L.	Public Law
PM	particulate matter
$PM_{2.5}$	particulate matter equal to or less than 2.5 microns in diameter
PM_{10}	particulate matter equal to or less than 10 microns in diameter
POL	petroleum, oil, and lubricants
PPA	Pollution Prevention Act
ppbv	parts per billion volume
PPF	Payload Processing Facility
ppm	parts per million
PPMP	Pollution Prevention Management Action Plan
PPPG	Pollution Prevention Program Guide
PSC	polar stratospheric cloud
PSD	prevention of significant deterioration
psf	pounds per square foot
RA	Remedial Action
RCRA	Resource Conservation and Recovery Act
RCS	reaction control system
RDC	Range Operations Commander
REEDM	Rocket Exhaust Effluent Diffusion Model
REL	Recommended Exposure Limit
RF	radio frequency
RFI	RCRA Facility Investigation
RI/FS	Remedial Investigation/Feasibility Study
RIMSII	Regional Input-Output Modeling System
RIS	Rocket Inert Storage
RLCC	Remote Launch Control Center
ROCC	Range Operations Control Center
ROD	Record of Decision
ROI	region of influence
RP-1	kerosene fuel (rocket propellant-1)
RWD	Report of Waste Discharge
RWQCB	Regional Water Quality Control Board

SAP	satellite accumulation point
SARA	Superfund Amendments and Reauthorization Act
SBCAPCD	Santa Barbara County Air Pollution Control District
SCCAB	South Central Coast Air Basin
SEB	Support Equipment Building
SEL	sound exposure level
SHPO	State Historic Preservation Officer
SI	Site Investigation
SIC	Standard Industrial Classification
SIP	State Implementation Plan
SJRWMD	St. John's River Water Management District
SLC	Space Launch Complex
SLMP	Space Launch Modernization Plan
SMAQMD	Sacramento Metropolitan Air Quality Management District
SMC	Space and Missile Systems Center
SO_2	sulfur dioxide
SPCC	Spill Prevention, Control, and Countermeasure
SPD	System Performance Document
SPF-3	Standardized Plume Flowfield Model
SPS	stratospheric-perturbing substances
SPTC	Southern Pacific Transportation Company
SR	State Route
SRM	solid rocket motor
SRMU	solid rocket motor upgrade
SSPP	System Safety Program Plan
STEL	short-term exposure limit
SUS	Storable Upper Stage
SW	Space Wing
SWMP	Solid Waste Management Plan
SWMU	solid waste management unit
TCE	trichloroethylene
TDK	Two-Dimensional Kinetics
TDRSS	Tracking and Data Relay Satellite System
TDS	total dissolved solids
THA	Toxic Hazards Assessment
THC	toxic hazard corridor
THZ	Toxic Hazard Zones
TNT	trinitrotoluene
TRCP	Toxic Release Contingency Plan
TSCA	Toxic Substances Control Act
TSDF	treatment, storage, or disposal facility
TSP	total suspended particulate
TWA	time-weighted average
UCSB	University of California at Santa Barbara
UDMH	unsymmetrical dimethylhydrazine
U.N.	United Nations
U.S.	U.S. Highway
USACE	U.S. Army Corps of Engineers
U.S.C.	U.S. Code
USCG	United States Coast Guard
USF	Upper Stage Processing Facility
USFWS	U.S. Fish and Wildlife Service
UST	underground storage tank
UV	ultraviolet
V/C	volume-to-capacity
VMT	vehicle miles traveled
VOC	volatile organic compound

VPF	Vehicle Processing Facility
WDR	Waste Discharge Requirement
WR	Western Range
WWTP	wastewater treatment plant

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APPENDIX B

NOTICE OF INTENT

The following Notice of Intent was circulated and published by the Air Force in the February 19, 1997, Federal Register in order to provide public notice of the Air Force's intent to prepare an Environmental Impact Statement for the Evolved Expendable Launch Vehicle (EELV) program. This Notice of Intent has been retyped for clarity and legibility.

NOTICE OF INTENT
TO PREPARE AN ENVIRONMENTAL IMPACT STATEMENT
EVOLVED EXPENDABLE LAUNCH VEHICLE PROGRAM

The Department of the Air Force through Space and Missile Systems Center (SMC/MV) is considering development and deployment of an Evolved Expendable Launch Vehicle (EELV) to meet the U.S. government's requirements for unmanned space launches. The EELV Program Office at Los Angeles Air Force Base (AFB), California, is managing program activities and intends to study the environmental issues associated with the EELV program. To this end, the Air Force Center for Environmental Excellence (AFCEE) will prepare an environmental impact statement (EIS) for use in the decision-making process.

The EELV would be an unmanned, expendable space launch vehicle evolved from existing systems capable of launching Department of Defense (DoD), National Aeronautics and Space Administration (NASA), other government, and civil satellites, including payloads up to 45,000 pounds. It is intended to meet the requirements of the National Mission Model, both medium and heavy lift, at a lower cost than the present expendable systems. EELV would be DoD's sole source of expendable medium and heavy spacelift transportation to orbit through 2020. EELV would replace current Titan II, Titan IV, Atlas II, and Delta II launch vehicles.

EELV launch activities would occur at Cape Canaveral Air Station (AS), Florida, and Vandenberg AFB, California, from existing space launch complexes that would be modified to meet program requirements.

The EELV program decision to be made is whether EELV should proceed into the engineering and manufacturing development phase on through production and launch operations. The EIS will examine continuing use of existing launch systems and facilities as alternatives to the continued development of EELV and its associated facilities.

Scoping will be conducted to identify environmental concerns and issues that need to be addressed in the EIS. Two public scoping meetings will be held as part of the process (one each in Cape Canaveral, Florida, and Lompoc, California) to determine the environmental issues and concerns that should be addressed. The schedule for the scoping meetings is as follows:

DATE	LOCATION	TIME
11 March 1997	Radisson Resort at the Port 8701 Astronaut Blvd Cape Canaveral, Florida	7:00 - 10:00 p.m.
13 March 1997	Lompoc City Council Chambers 100 Civic Center Plaza Lompoc, California	7:00 - 10:00 p.m.

Public input and comments are solicited concerning the environmental aspects of the proposed program. To ensure that the Air Force will have sufficient time to fully consider public input on issues, written comments should be mailed to ensure receipt no later than April 11, 1997.

Comments concerning the proposed project or the EIS should be addressed to:

Jonathan D. Farthing
Chief, Environmental Analysis Division
HQ AFCEE/ECA
3207 North Road
Brooks Air Force Base, Texas 78235-5363
(210) 536-3668

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APPENDIX C

FINAL ENVIRONMENTAL IMPACT STATEMENT MAILING LIST

This list of recipients includes interested federal, state, and local agencies and individuals who have expressed an interest in receiving the document, and public outreach agencies identified during the environmental justice analysis. This list also includes the governors of Florida and California, as well as United States senators and representatives and state legislators.

ELECTED OFFICIALS

Federal Officials - State of Florida

U.S. Senate

The Honorable Robert Graham
The Honorable Connie Mack

U.S. House of Representatives

The Honorable David Weldon

Federal Officials - State of California

U.S. Senate

The Honorable Barbara Boxer
The Honorable Dianne Feinstein

U.S. House of Representatives

The Honorable Walter Capps

State of Florida Officials

Governor

The Honorable Lawton Chiles

Senate

The Honorable Charlie Bronson
The Honorable Patsy Ann Kurth

State of Florida Officials (Continued)

Assembly

The Honorable Randy Ball
The Honorable Howard Futch
The Honorable Harry C. Goode, Jr.
The Honorable Bill Posey

State of California Officials

Governor

The Honorable Pete Wilson

Senate

The Honorable Jack O'Connell

Assembly

The Honorable Tom Bordonaro
The Honorable Brooks Firestone

Local Officials - Florida

The Honorable Bill Allan
Commissioner, City of Cocoa Beach

The Honorable Larry Bartley
Mayor of Titusville

The Honorable John Blubaugh
Council Member, City of Cocoa

The Honorable John Buckley
Mayor of Melbourne

The Honorable Mark Cook
Brevard County Commissioner, District 4

The Honorable Nancy Higgs
Brevard County Commissioner, District 3

The Honorable Michael Hill
Mayor of Cocoa

The Honorable Anthony Johnson
Commissioner, City of Cocoa Beach

Local Officials - Florida (Continued)

The Honorable James Kelley
Mayor of Melbourne Beach

The Honorable Joseph Morgan
Mayor of Cocoa Beach

The Honorable Randy O'Brien
Brevard County Commissioner, District 2

The Honorable John Porter
Mayor of Cape Canaveral

The Honorable Rocky Randels
Mayor Pro-Tem, City of Cape Canaveral

Charles Rowland, Executive Director
Canaveral Port Authority

The Honorable Truman Scarborough, Jr.
Brevard County Commissioner, District 1

The Honorable Helen Voltz
Brevard County Commissioner, District 5

The Honorable Chuck Wells
Mayor of West Melbourne

Local Officials - California

The Honorable Roger Bunch
Mayor of Santa Maria

The Honorable Joyce Howerton
Mayor of Lompoc

The Honorable Mary Leach
Lompoc Councilwoman

The Honorable Renaldo Pili
Mayor of Guadalupe

The Honorable Mike Siminski
Lompoc Councilman

The Honorable Timothy Staffel
Santa Barbara County Supervisor

Local Officials - California (Continued)

The Honorable George Stillman
Lompoc Councilman

The Honorable Bill Wallace
3rd District

GOVERNMENT AGENCIES

Federal Agencies

Advisory Council on Historic Preservation

Federal Aviation Administration, Office of Commercial Space Transportation

Federal Emergency Management Agency

Department of the Interior
Bureau of Indian Affairs

Department of the Interior
Office of Environmental Policy and Compliance

Environmental Protection Agency

Department of Defense

AFCEE/CCR-A

AFCEE/CCR-S

MAJ Steven H. Boyd
AFOTEC/OL-BC

Regional Offices of Federal Agencies - State of Florida

Department of Commerce
National Marine Fisheries Service
Southeast Regional Office

Department of the Interior
Fish and Wildlife Service, Regional Office
Jacksonville, Florida

Regional Offices of Federal Agencies - State of Florida (Continued)

Department of the Interior
Fish and Wildlife Service
Merritt Island National Wildlife Refuge
Titusville, Florida

Department of the Interior
National Parks
Cape Canaveral National Seashore
Titusville, Florida

Environmental Protection Agency, Region IV
Atlanta, Georgia

Kennedy Space Center

Regional Offices of Federal Agencies - State of California

Department of Commerce
National Marine Fisheries Service
Southwest Regional Office

Department of the Interior
San Francisco, California

Department of the Interior
Fish and Wildlife Service
Ventura, California

Environmental Protection Agency, Region IX
San Francisco, California

State of Florida Agencies

Department of Community Affairs

Department of Natural Resources

Department of State, Division of Historic Resources

East Central Florida Regional Planning Council

Florida Department of Environmental Protection

Florida State Clearinghouse

Game and Fresh Water Commission

State of California Agencies

Cal EPA/DTSC

Cal EPA/DTSC Legislative Analysis

California Air Resources Board

California Department of Fish and Game
Paso Robles, California

California Department of Fish and Game
Sacramento, CA

California Regional Water Quality Control Board

California Resources Agency

Clean Water Action

Environmental Health Services

Federal Programs

Office of Historic Preservation

State Clearinghouse

State Coastal Conservancy

Local Agencies - Cape Canaveral AS

Brevard County Emergency Management

Brevard County Natural Resources

St. John's River Water Management District

Local Agencies - Vandenberg AFB

Economic Development Association

Environmental Health Services

Hazardous Materials Environmental Safety (CAER)

Lompoc Public Works

Local Agencies - Vandenberg AFB (Continued)

Public Safety Department
City of Solvang

San Luis Obispo County Board of Supervisors

Santa Barbara County Air Pollution District

Santa Barbara County Environmental Health Department

Santa Barbara County Fire Department

Santa Barbara Water Agency

Santa Ynez River and Water

Southern California Association of Governments

Water Resources

Libraries - Florida

Cape Canaveral Library

Central Brevard Library

Cocoa Beach Library

Melbourne Library

Merritt Island Library

North Brevard Library

Palm Bay Library

Libraries - California

Lompoc Public Library

San Luis Obispo City/County Library

Santa Maria Public Library

California Polytechnic State University
Robert F. Kennedy Library

Libraries - California (Continued)

University of California, Santa Barbara
Davidson Library, Reference Services

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Other Organizations/Individuals

Rusty Anchors

Bixby Ranch Co.
John Bauchke

The Boeing Company
Clare Elser

EDAW, Inc.
Jim Zielinski

Federation of American Scientists
Steven Aftergood

J.B. Kump

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Tom Giordano
Edward Rodriguez

Lockheed Martin, Cape Canaveral AS
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Dennie Bernier

Marine Resources Council
Gerald Rosebery, Ph.D.

Micosukee Indian Tribe

Parsons Engineering Science, Inc.
Craig McColloch

John Pitcher

Ed Rutkowski

Santa Ynez Band of Chumash Indians

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Seminole Indian Tribe

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Spaceport Systems International
Dominick Barry
Lori Anne Redhair

Tetra Tech
Scott Gard

Walter & Bornholdt Law Offices
Kenneth C. Bornholdt

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Appendix D

Representative Federal Permits, Licenses, and Entitlements

Table D-1. Representative Federal Permits, Licenses, and Entitlements
Page 1 of 2

Permit, License, or Entitlement	Typical Activity, Facility, or Category of Persons Required to Obtain the Permit, License, or Entitlement	Authority	Regulatory Agency
Federal			
Clean Air Act (CAA) Title V Permit	Any major source (source that emits more than 100 tons/year of criteria pollutant in a nonattainment area for that pollutant or is otherwise defined in Title I of CAA as a major source); affected sources as defined in Title IV of CAA; sources subject to Section 111 regarding New Source Performance Standards; sources of air toxics regulated under Section 112 of CAA; sources required to have new source or modification permits under Parts C or D of Title I of CAA; and any other source such as Hazardous Waste pollutants designated by U.S. Environmental Protection Agency (U.S. EPA) regulations.	Title V of CAA, as amended by the 1990 CAA Amendments	U.S. EPA; Florida Department of Environmental Protection (FDEP)
National Pollutant Discharge Elimination System (NPDES) Wastewater permit	Discharge of pollutant from any point source into waters of the United States.	Section 402 of Clean Water Act, 33 U.S.C. Section 1342	U.S. EPA, FDEP, Central Coast Regional Water Quality Control Board (CCRWQCB)
NPDES Storm Water Discharge permit	Discharge of storm water during construction projects disturbing 5 acres or more.		U.S. EPA, St. John's River Water Management District (SJRWMD), CCRWQCB
Section 404 (Dredge and Fill) permit	Any project activities resulting in the discharge of dredged or fill material into bodies of water, including wetlands, within the United States.	Section 404 of Clean Water Act, 33 U.S.C. Section 1344; Chapter 62-312, Florida Administrative Code (FAC).	U.S. Army Corps of Engineers, in consultation with U.S. EPA; SJRWMD; CCRWQCB

Table D-1. Representative Federal Permits, Licenses, and Entitlements
Page 2 of 2

Permit, License, or Entitlement	Typical Activity, Facility, or Category of Persons Required to Obtain the Permit, License, or Entitlement	Authority	Regulatory Agency
Hazardous waste treatment, storage, or disposal (TSD) facility permit	Owners or operators of a new or existing hazardous waste TSD facility.	Resource Conservation and Recovery Act (RCRA) as amended, 42 U.S.C. Section 6901; Title 40 Code of Federal Regulations (CFR) 270; Chapter 403.704, 403.721, 403.8055, Florida Statutes (FS); Chapter 62-730.180, FAC.	U.S. EPA; FDEP; California EPA, Department of Toxic Substances Control
U.S. EPA identification number	Generators or transporters (off-site transport) of hazardous waste.	40 CFR 262.10 (generators); Title 40 CFR Part 263, Subpart B (transporters)	U.S. EPA; FDEP
Archaeological Resources Protection permit	Excavation and/or removal of archaeological resources from public lands or Indian lands and carrying out of activities associated with such excavation and/or removal.	Archaeological Resource Protection Act of 1979, 16 U.S.C. Section 470cc	U.S. Department of the Interior, National Park Service
Endangered Species Act Section 10 permit	Taking endangered or threatened wildlife species; engaging in certain commercial trade of endangered or threatened plants or removing such plants on property subject to federal jurisdiction.	Section 10 of Endangered Species Act, 16 U.S.C. Section 1539; Title 50 CFR 17 Subparts C, D, F, and G.	U.S. Department of the Interior, Fish and Wildlife Service
Marine Mammal Protection Act	Any project activities resulting in the incidental, but not intentional, taking of marine mammals by United States citizens who engage in specified activities (other than commercial fishing).	16 U.S.C. 1361 et. seq.	National Marine Fisheries Service

APPENDIX E

SYSTEM PERFORMANCE DOCUMENT

1.1 SCOPE

1.2 Purpose

This document identifies the Evolved Expendable Launch Vehicle (EELV) system performance requirements and goals derived from the EELV Operational Requirements Document (ORD).

1.3 Overview of EELV Program

The primary requirement of the EELV program is to execute the Government portion (DoD and NASA) of the National Mission Model at lower recurring costs than those of current expendable systems. The program shall also maintain or improve reliability, capability, and operability.

1.4 Document Overview

This document, including its unclassified and classified Annexes, establishes performance and verification requirements for the development and deployment of the EELV system. It is intended to be the foundation for the Contractor prepared System/Segment/Subsystem Specifications.

1.4.1 Quantitative Requirements

In sections denoted by an asterisk (*) and in subsections thereof, quantitative requirements designated as threshold values are non tradable and must be met or exceeded by the EELV system. Quantitative values stated as objectives or goals are tradable. If both a threshold and an objective/goal value are provided, the trade space is between these values.

Threshold values for all other requirements should be met unless doing so would have a significant adverse impact on program costs.

If only an objective/goal value is provided, the system must provide some capability with respect to the subject requirement, the magnitude of that capability being determined by trades considering performance and cost.

1.4.2 Qualitative Requirements

Where requirements are qualitatively stated, the system must provide some capability/features with respect to the subject requirement, the specifics of the capability/features being determined by trades considering performance and cost.

1.5 Precedence

In the event of conflicts between the documents referenced herein and the contents of the SPD, the requirements of this document shall be considered the superseding requirements. The contracting officer shall be notified of any instances of conflicting requirements.

1.6 APPLICABLE DOCUMENTS

1.7 Compliance Documents

None

1.8 Reference Documents

EELV Payload Database Document.
Air Force Space Command Operational Requirements Document (Rev 1) for the EELV System (22 Oct 96)

2. REQUIREMENTS

2.1 System Definition

2.1.1 System Description

The EELV system will be used to deploy Government payloads. The EELV system consists of the Launch Vehicle (LV) Segment and the Ground Segment. The EELV system includes all equipment, facilities, and launch base infrastructure necessary to launch a payload, place it in the required delivery orbit, provide specified environments, provide EELV system maintenance, and perform any necessary recovery/refurbishment operations. The major EELV system elements and external interfaces shall be defined and illustrated in the Contractor prepared system specification.

2.1.2 IOC Events

The following events need to be completed before an IOC can be declared:

- All the training for operations and maintenance for a system completed
- Critical spares in place
- Technical manuals complete and in place
- Site activation complete
- Production and acceptance test activities for the vehicle and system are in place

2.1.3 Medium Vehicle IOC.

Medium IOC shall be accomplished when EELV demonstrates a launch rate of 3 launches in a 12 month period on the east coast and 2 launches in a 12 month period on the west coast, not including the test launch. Based on the current schedule both IOCs should occur by 2003.

2.1.4 Heavy Vehicle IOC.

Heavy IOC shall be accomplished when EELV demonstrates the capability to process and launch a heavy vehicle. This should occur with the test flight in 2003. HLV IOC at VAFB isn't required until system FOC.

2.1.5 Full Operational Capability (FOC)

For the EELV system to reach FOC all IOCs shall have been completed and all logistics, operation and maintenance processes be in place and functioning. This includes the close-out of all corrective actions generated during the heavy test flight This shall occur by 2004.

2.1.6 System Segments

2.1.6.1 Launch Vehicle Segment
The LV segment consists of the means for transporting the payload from the launch site to the delivery orbit, through completion of the contamination and collision avoidance maneuver (CCAM) and stage disposal. It includes, but is not limited to, production, assembly, propulsion, guidance and control, electrical power, tracking and telemetry, communication, ordnance, flight termination, payload separation, structural elements, payload fairing, software, and appropriate vehicle/ground and vehicle/payload interfaces that are necessary to meet mission requirements. The payload and its unique Airborne Support Equipment (ASE), though transported by the EELV, are not considered as part of the EELV system.

2.1.6.2 Ground Segment
The ground segment consists of all existing, modified or new construction, facilities, and the equipment, software, and utilities necessary to support the planning (mission, flight, and launch operations), storage, integration, check-out, processing, launch, telemetry, tracking and control through CCAM, and recovery/refurbishment (if any) for the EELV system.

2.1.7 Government Furnished Equipment (GFE
GFE shall be defined in the Contractor prepared system specification.

2.1.8 System Functions
The EELV system shall perform the major functions identified below.

2.1.8.1 Manufacturing
This function includes the manufacturing of all launch vehicle components, subsystems, and subassemblies.

2.1.8.2 Transportation
This function includes activities and procedures necessary to transport launch vehicle elements/subsystems/subassemblies from the manufacturing source to the launch site.

2.1.8.3 Receipt and Checkout
This function includes initial receipt, unloading, and checkout of launch vehicle elements/subsystems/subassemblies.

2.1.8.4 Launch Vehicle Storage
This function includes the capability to store launch vehicle elements/subsystems/subassemblies prior to use in the system.

2.1.8.5 Vehicle Element Processing
This includes the activities that are required for the assembly and test of the vehicle elements, such as the core, strap-on booster, and upper stage, from the various subsystems and subassemblies, such as tanks, structure, propulsion systems, and avionics. Element testing includes the activities required to verify the functionality of EELV elements in the assembled condition.

2.1.8.6 Integration
Integration includes all the activities required to mate vehicle elements and payload to each other and includes the necessary tests to verify satisfactory mechanical and electrical interfaces among all elements and the launch facility.

2.1.8.7 Functional Testing
This function includes the activities required to verify the functionality of an EELV in the integrated condition. This function also includes the final checkout required prior to launch of the integrated fueled vehicle and payload.

2.1.8.8 Launch and Flight Operations
This function includes all activities necessary for launching an EELV, including flight planning, support for the ascent flight (including range safety related functions), payload delivery, and deorbit/maneuvering of vehicle components for disposal or recovery.

2.1.8.9 Recovery
This function includes the activities required for recovery and return of reusable components, if any, of the EELV after mission completion.

2.1.8.10 Refurbishment
This function includes activities required to refurbish ground equipment and facilities for reuse.

2.1.8.11 Subassembly Refurbishment Overhaul

This function includes rebuilding and repairing EELV subassemblies for reuse after failures during prelaunch processing, or after recovery of reusable components, if any.

2.1.8.12 Logistics Support

This function includes all activities necessary to provide a supportable design, integrate support requirements with readiness objectives, and maintain operational capability at minimum cost.

2.2 System Requirements

The spacelift system shall improve upon current systems. The following subsections delineate the EELV requirements.

2.2.1 Performance

EELV shall have the ability to accurately deliver the government portion of the NMM missions to required orbit(s). The mission masses and required orbits are defined in Table 1. The complete NMM includes all DoD, intelligence, and civil expendable launch missions projected for EELV and serves as the consolidated national forecast of spacelift requirements for the future based on documented customer (payload) needs. .

2.2.1.1 Performance: Mass to Orbit*

The threshold requirement is to deliver the required mass to the desired orbit of the national mission model reference missions (Table 1) at a cost effectiveness better than current launch systems. Support Missions A, B, C, D and E are to be used only for performance trades and cost estimating, and are not threshold performance requirements. For missions A, B, C, D and E, the actual threshold EELV requirements are defined in the SPD classified Annex. The EELV shall have the capability to inject into geosynchronous transfer orbits on either the first ascending or descending leg. Following payload separation, the LV shall perform a collision and contamination avoidance maneuver (CCAM).

DoD PORTION	PAYLOAD	ORBIT	CURRENT VEHICLE CLASS	LAUNCH WT(LBS)	APOGEE (NM)	PERIGEE (NM)	INCLINATION (DEGREES)	NOTES
AFSPC	ADV MILSATCOM	GTO	ATLAS IIAS	8500	19300	100	27	17
	DMSP	POLAR	TITAN II	3300	458	458	98.7	1
	DSCS	GTO	ATLAS II	6300	19279	127	25.5	18
	DSP	GEO	TITAN IV-IUS	5402	19323	19323	3	
	GPS IIF	SEMI SYNC	DELTA II 7925	4725	10998	100	44	2
	SBIRSLEO	LEO	DELTA II 7920	8157	378	378	54.7	3
	SBIRSGEO	GTO	ATLAS IIAS	8450	19324	90	27	
OTHER DoD	TSX	POLAR	DELTA II 7925	6000	500	500	90	14
	NPOESS	POLAR	DELTA II 7925	6840	450	450	98.2	
SUPPORT	MISSION A	GTO	ATLAS IIAS	8500	19324	90	27	4,13
	MISSION B	LEO	ATLAS IIAS	17000	100	100	63.4	5, 6,7,13
	MISSION C	GEO	TITAN IV-CENT	13500	19323	19323	0	8,13
	MISSION D	POLAR	TITAN IV-NUS	41000	100	100	90	10,13,15
	MISSION E	POLAR	ATLAS IIAS	16100	100	100	90	9,10,13
NASA								
	DISCOVERY	PLNTRY	DELTA II 7920	2000	N/A	N/A	28.5	12
	EOS AM	SUN-SYNC	DELTA II 7920	11220	380	380	98.2	16
	EOS PM	SUN-SYNC	DELTA II 7920	7000-8000	380	380	98.2	
	EOS CHEM	SUN-SYNC	DELTA II 7920	7900	380	380	98.2	

*** Launch weight includes the weight of the separated space vehicle, the space vehicle to launch vehicle adapter (if supplied by the space vehicle), and all other unique hardware required on the launch vehicle to support the space vehicle's mission.**
1 - Direct injection orbit .
2 - SPD to allow delivery to transfer orbit (4725 lbs to 44 degrees) with spin stabilization or to final orbit (2675 lbs at 10,998 nmi circular orbit at 55 degree inclination) at EELV ktr's option; EELV provides spin table, unless the direct insertion option is used; GPS provides SV destruct system.
3 - SBIRSLEO spacecraft will be launched 3 at a time. Launch weight is combined weight of all 3 s/c with adapter. Data reflects parking orbit. Transfer to final orbit (864 NM at 54.7 degree inclination) will be done using SV propellant
4 - 8500 lbs to Mission A is greater than Atlas IIAS capability of 8150 lbs.
5 - Launch Site may be either ER or WR.
6 - 17000 lbs to Mission B is equivalent to Atlas IIAS capability from the WR.
7 - The capability to achieve higher orbits by coasting, restarting, and executing a short duration burn with the final stage is also required.
8 - 13500 lbs to Mission C is design goal for Titan IV - SRMU - Centaur
9 - 16100 lbs to Mission E is equivalent to Atlas IIAS capability from WR.
10 - The capability to achieve higher orbits by coasting, restarting, and executing a short duration burn with the final stage is desirable but needs to be weighed against the added complexity and risk.
12. - Launch Energy C3=17 km^2/sec^2
13. - Equivalent missions (Reference SPD Classified Annex)
14 - For the first TSX-8 mission in (FY 01) the payload launch weight (TBD) will be made compatible with the MLV lift capability to the delivery orbit (TBD) when launched from ER.
15 - Mission D is a reference mission for a HLV capability from WR. There are currently no Mission Ds manifested in the NMM. The HLV 173'' standard interface payload attach fitting is not required to accomidate this mission.
16 - Throw weight is current EOS-AM1 configuration. Delta II 7920 is baseline vehicle for space vehicle design for future EOS AM space vehicles.
17 - AdvMilsatCom includes two space vehicle systems (Advanced EHF and Advanced SHF K/a). Mission model data is the same but orbital parameter accuracy varies (see Table 2).
18 - DSCS orbital parameters are applicable to the first ascending node.

Table 1: Government Reference Missions

2.2.1.1.1 Payload Mass Growth

Growth potential is a goal for EELV. It is the degree to which the system approach or hardware design enables an increment in performance capabilities of the spacelift system without necessitating unplanned redesigns (of hardware or operations) or a decrease in performance margin. EELV shall have a preplanned Payload Mass Growth capability of at least 5% (threshold) for the MLV, with an objective of 15%. For the HLV there is no threshold value: the objective is to be able to accommodate a 5% Payload Mass Growth.

2.2.1.1.2 Performance Margin

Performance margin is the difference between the lift capability indicated by a 3σ-assurance performance estimation technique and the usable (advertised) lift capability (NMM Payload Mass plus Payload Mass Growth capability) of an EELV vehicle. Performance margin provides for a robust operable system. Performance margin will not be considered to be usable lifting capacity or flight performance reserve, nor will it be considered Payload Mass Growth. EELV shall have a threshold performance margin of 2%. As an objective, EELV shall have a performance margin of 5%.

2.2.1.1.3 Flight Performance Reserve

EELV performance shall provide a 3σ (99.865%) assurance of the vehicle fully meeting mass to orbit requirements (including payload mass growth and performance margin capabilities) while considering possible uncertainties in EELV and environmental parameters such as propellant loading, Isp, and atmospheric density.

2.2.1.1.4 Dry Weight Growth Margins

Appropriate launch vehicle dry weight growth margins shall be maintained for all hardware commensurate with the maturity of the hardware and the phase of design.

2.2.1.2 Performance: Accuracy*

2.2.1.2.1 Orbital Parameter Accuracy

The accuracy at the final orbit injection point for each payload mission is defined by the following six variables: apogee, perigee, inclination, argument of perigee, LAN and RAAN, these values are defined in the national mission model and reflect the payload customer's requirements. The EELV shall have orbital parameter accuracy’s within these 3 sigma values (threshold) or better (objective).

Table 2: Orbital Parameter Accuracy's

	Apogee (nmi)	Perigee (nmi)	Inc (deg)	ArgPer (deg)	LAN (deg)	RAAN (deg)
ADVMIL (EHF) *	±100	±2.0	±0.1	±0.3	N/A	±0.75
ADVMIL (SHF) *	±70	±1.5	±0.1	±0.4	±0.5	N/A
DMSP	±9	±7	±0.1	Variable	Variable	Variable
DSCS	±70	±1.5	±0.1	±0.4	±0.5	N/A
DSP ***	N/A	N/A	N/A	N/A	N/A	N/A
GPSIIF/Transfer	±210	±4	±0.4	TBD	N/A	±0.2
GPSIIF/Direct to Orbit	+210	0.0 + .02 ****	+ 1	TBD	+ 2	Variable
SBIRS LEO	TBD	TBD	TBD	TBD	TBD	TBD
SBIRSGEO	TBD	TBD	TBD	TBD	TBD	TBD
TSX	TBD	TBD	TBD	TBD	TBD	TBD
NPOESS	TBD	TBD	TBD	TBD	TBD	TBD
DISCOVERY	TBD	TBD	TBD	TBD	TBD	TBD
EOS AM	TBD	TBD	TBD	TBD	TBD	TBD
EOS PM	TBD	TBD	TBD	TBD	TBD	TBD
EOS CHEM	TBD	TBD	TBD	TBD	TBD	TBD
Mission A	**	**	**	**	**	**
Mission B	**	**	**	**	**	**
Mission C	**	**	**	**	**	**
Mission D	**	**	**	**	**	**
Mission E	**	**	**	**	**	**

* For AdvMilSatCom these values are for insertion into GTO
** See requirements in SPD Classified Annex
*** DSP orbital requirements do not specify accuracy; however, Inclination (2.5-3.0 degrees) is optimized
***** For GPSIIF Direct to Orbit this value is Eccentricity

2.2.1.2.2 Attitude and Rate Accuracies

During park orbit or transfer orbit coasts, the EELV shall be capable of providing passive thermal control by orienting the roll axis of the upper stage/payload to passive thermal control attitude and holding attitude to within ± 5 degrees (3 sigma). Also during park orbit or transfer orbit coasts, the EELV shall be capable of providing a commanded roll rate in either direction of between 0.5 and 1.5 degrees per second (MLV configurations) and between 0.5 and 1.0 degrees (HLV configuration) as negotiated by the SV/LV ICD.

Prior to separation, the EELV shall be capable of pointing the upper stage/payload to any desired attitude and either minimizing all rotation rates (3-axis stabilized missions) or providing a spin about the longitudinal axis (spin-stabilized missions). For 3-axis stabilized missions, attitude errors shall be no greater than 1.4 degrees (3 sigma) about each axis and rotation rates shall be less than 0.2 degree/sec (3 sigma) in pitch and yaw and .25 degree/sec (3 sigma) in roll. For spin-stabilized missions, the MLV EELV shall have the capability to provide payload spin rates of 5 + 0.5 (3 sigma) rpm with spin axis orientation accurate to within 1.75 degrees (3 sigma) assuming a maximum 0.5" SV CG offset. For GPS missions, the EELV shall have the capability to provide payload spin rates of 55 + 11 / - 5 (3 sigma) rpm, with spin axis orientation accurate to within 3 degrees (3 sigma) assuming a maximum 0.05" Payload CG (to include adapter) offset.

2.2.2 Mission Reliability

Mission reliability, measured from launch commit, is the probability of successfully placing the payload into its delivery orbit with the required delivery accuracy and then executing a collision avoidance maneuver. Mission reliability takes into account both vehicle design and process reliability's. Vehicle design reliability accounts for potential mission failure modes that have their genesis in the design of system hardware, component integration architecture, and software (including those pertaining to staging events and CCAMs). Process reliability includes consideration of failure modes introduced by manufacturing, infrastructure, assembly, ground processing, and system integrating activities (including payload mating activities performed by EELV). For all MLV missions, EELV shall have a mission reliability of 0.975 (threshold) or better (objective),at 50% confidence level. For an HLV flights to GEO and LEO Polar, EELV shall have a mission reliability of 0.97 (threshold), with an objective of better than 0.975, at 50% confidence level.

2.2.2.1 Vehicle Design Reliability*

For all missions, EELV vehicles shall have a vehicle design reliability of 0.98 (threshold) or better (objective), at 50% confidence level.

2.2.2.2 Limit Load Conditions

The LV shall be designed to withstand limit loads, which include quasi-static and static-elastic aerodynamic loads, plus the extreme expected dynamic loads (value at 99% probability with 90% confidence) contributed by flight dynamic pressures and buffet. The LV shall also be designed to withstand limit loads from other conditions such as, but not limited to, transients due to liftoff, gust, maximum acceleration, ignitions and shut-downs, separations, thermal conditions, and any other significant events, including handling, storage and transportation. Pressure vessels and pressurized structures shall be designed to withstand instantaneous worst case combinations of internal pressure and other loads.

2.2.2.3 Stiffness and Deflections

Adequate stiffness shall be provided to all structural subsystems and attachment structures so that no contact occurs between system elements except at attachment points. This provision shall pertain during ground transportation and handling, launch, flight, and during separation events.

2.2.2.4 Pogo Stability

The EELV shall be designed to maintain pogo stability regardless of payload configuration.

2.2.2.5 Human Performance/Human Engineering

Human performance considerations and human engineering approaches shall be incorporated in the design of all EELV processes and new equipment, and in the modification of existing equipment for EELV. Emphasis shall be placed on designs which minimize the potential for human errors which would result in schedule delays, mission aborts, or flight failures. Human engineering design approaches shall also focus on facilitating rapid processing timelines and system maintainability.

2.2.3 Standardization

The EELV system shall standardize vehicle and ground hardware and their associated operations processes. Standard payload interfaces shall be developed in collaboration with EELV users. EELV shall use standardized hardware/software and processes, as well as streamlined spacelift operations with flexibility to support a broad variety of missions. The following paragraphs describe the elements of standardization.

2.2.3.1 Launch Pads*

Launch pads that are required to support the NMM shall be able to launch all configurations of EELV to be launched from that site (threshold). Additionally, EELV shall have a HLV capability at VAFB to support reference Mission D. Prior to HLV IOC it is not a requirement for launch pads and supporting infrastructure to be configured for the HLV.

2.2.3.2 Infrastructure

The infrastructure shall provide standard equipment and processes to support the launch of the EELV. As a threshold, equipment and processes will be standardized for each launch vehicle configuration. As an objective, equipment and processes will be standardized for all vehicles.

2.2.3.3 Operations Procedures

Operational launch procedures shall be standardized in order to establish a team capable of launching any configuration of EELV. As a threshold, the operational launch procedures shall be standard for each vehicle configuration at each launch site, and as an objective, standard for all vehicle configurations at all launch sites.

2.2.3.4 Launch Vehicles

The system shall incorporate commonality between medium and heavy lift variants to the maximum extent practical. Launch vehicle elements for each vehicle class shall be useable independent of the particular mission being flown. Performance analyses and performance margins for the EELV design shall consider unit-to-unit variability of launch vehicle elements (e.g. engines, motors).

2.2.3.5 Payload Interfaces*

The EELV as a threshold shall have a single standard interface for each vehicle class in the EELV family. Unique payload mounting or multiple-manifested-satellite-dispensing requirements will be satisfied with a payload-provided adapter to the standard interface or dispenser, and these items shall be considered a part of the payload mass. As an objective, there would be only one payload interface for all vehicles in the EELV family. Specific standard interface requirements are contained in SPD Annex C.

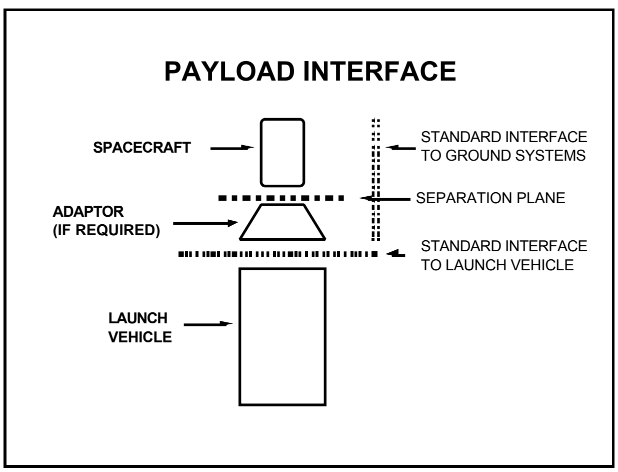

Table 3: Payload Interface

2.2.3.5.1 Payload Separation Requirements

The EELV shall provide a separation enable signal to the payload-provided separation system, and shall provide a positive separation verification to the ground. The EELV shall also have the capability to provide a separation activation signal to the separation system. Following separation, the launch vehicle shall provide capability to avoid payload contamination and avoid collision of the payload with any launch vehicle components or debris. See SPD Annex C for specific requirements.

2.2.3.6 Payload Accomodation
EELV shall provide standard payload accommodations, environments and services. All government payloads requiring EELV support shall conform to these standard accommodations, environments and services. EELV shall be able to provide sufficient, reliable, predictable and repeatable services (fuel, power, etc.), environments (noise, vibration, shock, cleanliness, etc.), and the physical envelope (access, volume, diameter, length) for the payload. Unique payload needs shall be satisfied by payload-provided Airborne Support Equipment (ASE) and the ASE shall be considered a part of payload mass. Specific standard interface requirements are contained in SPD Annex C.

2.2.4 Cost
Using current systems as a cost baseline, the total Life Cycle Cost (less the $2B for development) and the annual fixed cost for launching the Government portion of the NMM shall be reduced by 25% (threshold) from those of current launch systems. An objective is a 50% reduction in these costs.

2.2.5 Timeliness (Schedule Dependability)
The EELV shall consistently launch on time based on need and schedule. EELV shall be robust enough to be minimally affected by outside influences such as weather conditions, daylight restrictions and electromagnetic radiation, or by component/equipment failures during launch processing. Given the system is not in a stand down mode, the EELV shall provide at least an 0.80 probability of launching (within a designated launch window) no more than 10 calendar days after the accountable launch date confirmed 90 days prior. An objective is at least a 0.90 probability of launching no more than 10 calendar days after the accountable launch date.

2.2.6 Launch Rate Capabilities
EELV shall have launch rate capabilities and improved responsiveness to support scheduled and unscheduled launch needs and to recover from schedule delays caused by downing events or unscheduled launches. EELV should improve over current processing timelines for: (1) assembly and checkout of launch vehicles; (2) mechanical and electrical mating of spacecraft with the launch vehicle; (3) checkout and maintenance of the launch pad and launch processing facilities; (4) checkout of the integrated vehicle and verification of payload interfaces; (5) fueling and final checkout of the launch vehicle at the launch pad; and (6) verification of range interfaces. The total capacity of the launch system is comprised of the Basic Launch Rate (threshold) plus capabilities for satisfying Resiliency and Crisis Response (objectives) as shown in Table 4. The launch rates must be achievable taking into account maintenance of the system and its infrastructure, weather delays, launch range conflicts with other spacelift systems, and other typical launch delays.

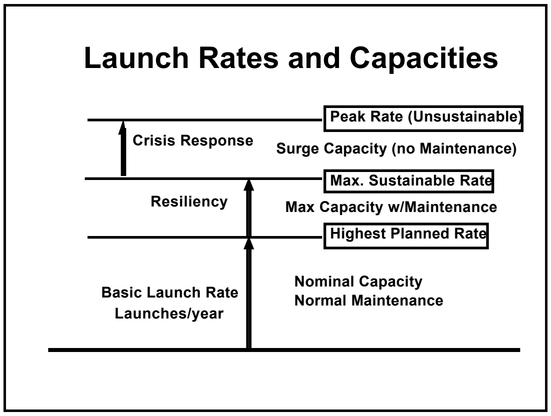

Table 4: Launch Rate Relationships

2.2.6.1 Basic Launch Rate

The Launch Rate (the highest planned rate) is the EELV portion of the National Mission Model and it varies for each coast. As a threshold, the EELV system must have the capacity to provide 12 launches at CCAS, which may include one heavy mission, and 6 launches at VAFB, which may include one heavy mission. As an objective, the system should include the capacity to meet the Resiliency and Crisis Response objectives for a total of 26 possible launches: 17 launches at CCAS which may include two heavy mission, and 9 launches at VAFB which may include up to two heavy missions.

2.2.6.2 Resiliency

Resiliency is measured as the maximum sustainable (two shift operations; three shifts during launch countdown) launch rate with scheduled maintenance. It facilitates the timely, efficient, and dependable execution of the national space launch mission. EELV must be resilient enough to recover on a timely basis from a downing event or other delays which could cause the system to not meet the government portion of the NMM EELV resiliency capability available at FOC shall, as an objective, provide for 5 additional launches (2 medium and 1 heavy, East Coast;1 medium and 1 heavy, West Coast) above the Basic Launch Rate.

2.2.6.3 Crisis Response

A crisis could require an increase in launch rates above the maximum sustainable (resilience) rate to provide on-orbit support to the warfighter. Crisis response will allow the insertion of payloads into the schedule with minimal delay of previously scheduled payloads. The increased launch rate required for crisis response and subsequent schedule recovery is for a short duration and not sustainable. EELV crisis response capability available at FOC shall, as an objective, enable the call up and launch of 3 crisis-response medium payloads (2 East and 1 West) within a 2 month period every 12 months from each site and be back on schedule within 6 months (assuming the current schedule is at the maximum sustainable launch rate). Schedule time allocated for scheduled facility maintenance can be postponed to accommodate a crisis response or to facilitate subsequent schedule recovery.

2.2.6.4 Responsiveness (Unscheduled Launch)

EELV shall support an unscheduled DoD launch within the required call-up time. For medium vehicles the threshold call up response time for an unscheduled launch is 45 days with an objective of 30 days; for the heavy vehicle the threshold is 90 days and an objective of 60 days. This time interval includes processing the vehicle, mating the launch vehicle with the payload, and conducting launch operations. An unscheduled launch must still meet the timeliness requirement.

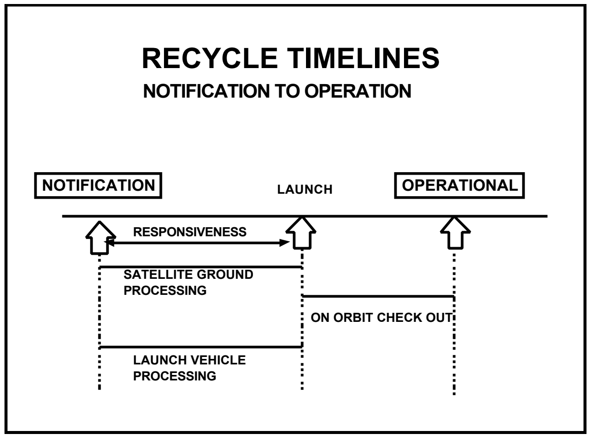

Table 5: Responsiveness Timelines

2.2.7 Design Flexibility

Design Flexibility, an objective of EELV, is the degree to which the system approach or hardware design enables an increment or decrement in spacelift system performance capabilities without having to redesign hardware or operations. Additionally, the EELV shall be flexible enough to accommodate payloads that may require unique payload-provided payload adapters or ASE, on-pad services or somewhat longer processing timelines without impacting other scheduled launches.

2.2.8 Launch and Flight Operations Requirements

2.2.8.1 Mission Ready Hold

Once the launch system is at the 24 hours until launch point in its countdown, it shall be able to hold at that point for 10 days and still be able to launch within 24 hours.

2.2.8.2 Launch Recycle

At any time up to its last recycle time (approximately T-9 seconds) before launch, EELV shall be capable of repeatedly recycling within 5 minutes (threshold) to the standard last hold point (as close to T=0 as practical) in the launch countdown for immediate re-entry into the launch procedure. An objective is to accomplish this recycle as close to instantly as possible.

2.2.8.3 Launch-Ready Hold

The EELV shall be capable of maintaining a launch-ready (fueled vehicle) hold status necessary to support any given payload launch window requirement, and be capable of re-entering the launch sequence with minimal delay. The system shall be capable of holding at the standard last hold point for at least 2 hours (threshold) with an objective of 4 hours following a launch recycle.

2.2.8.4 Next Day Readiness

EELV shall be capable of launching within the prescribed launch window on the next calendar day following a fueled vehicle hold and launch scrub occurring at or before its last recycle point. As a threshold the EELV system shall be able to perform the next day readiness for 2 successive days with an objective of 10 successive days.

2.2.8.5 Launch Abort Capability

Anytime prior to launch commit, the EELV system shall be capable of performing a safe abort in a manner that protects and provides for the intact recovery of the payload and launch system.

2.2.8.6 Recovery and Disposal Requirements
The system shall provide for safe disposal (including trajectory and debris dispersions) or recovery of all the spacelift system vehicle components and all non-deployed payload equipment.
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2.2.8.6.1 Low Earth Orbit Or Suborbital Trajectories
Based on existing mandates, disposal or recovery from low earth orbit or suborbital trajectories shall be in accordance with international agreements.

2.2.8.6.2 Orbital Debris
EELV shall comply with National, DoD and USSPACECOM orbital debris minimization policies to minimize residual orbital debris after launch. The LV stages which are orbital shall be safely deorbited whenever practical. If not deorbited, then the following shall be met:

a. Stages and other components left in orbit or allowed to decay naturally must initially be placed in a disposal orbit such that the probability of their collision with other objects is substantially reduced. Specifically, the collision probability shall be at least a factor of 100 lower than if the LV stage/component remained in the payload's delivery/mission orbit.

b. Stages and/or components shall be designed to minimize their break-up characteristics due to explosions, hypervelocity collisions, and the effects of space environment. Where practical, EELV shall incorporate space debris minimization features. Pressurized components shall be vented and otherwise designed to minimize the likelihood of explosion.

2.2.9 System Diagnostics
The EELV System (including all vehicles) shall have an integrated health monitoring system. The purpose of this system is to measure and report how well the EELV System performs relative to intended design parameters within all mission phases. This capability will allow the user to monitor, evaluate, fault isolate, and record the EELV system performance.

2.2.9.1 Pre-Flight Diagnostics
The system shall include built in tests, integrated vehicle system health monitoring, and fault detection/isolation capabilities as required to meet the EELV system requirements. This capability shall be designed to meet the system operability and reliability requirements.

2.2.9.2 In-Flight Diagnostics
Use of in-flight vehicle system health monitoring, fault detection, fault isolation and anomaly resolution for vehicle system components should be used where appropriate to achieve the mission reliability requirements.

2.2.10 System Data

2.2.10.1 Pre-Flight Data
Ground segment equipment shall provide information to support the launch decision.

2.2.10.2 In-Flight Data

The launch vehicle shall telemeter key data from launch through the completion of CCAM and disposal operations (compatible with range equipment). Key data is defined as all data necessary to 1) support range safety requirements, 2) verify system/subsystem performance, 3) verify payload environments, and 4) enable rapid post-flight diagnosis of anomolies/failures. Accordingly, the objective is to obtain telemetry in as near real time as possible with minimum data loss due to transmission-interrupting phenomonology or the unavailability of transmission links.Using these data the EELV system shall provide a quick-look data report within 2 hours (threshold) with an objective of 30 minutes of completion of CCAM and/or disposal operations following data receipt at an EELV facility. A complete post-flight analysis and report shall be provided within 7 working days (threshold) with an objective of 3 working days of completion of CCAM and/or disposal operations. .

2.2.11 Computer Resources

EELV computer resources include all computer software, firmware, and the associated computational equipment that comprise the launch vehicle segment, ground segment, and any software/firmware/hardware support environments/equipment.

2.2.11.1 Hardware and Software

To reduce the cost of software development and software maintenance, computer hardware and software for the EELV system shall be appropriately selected from among the following options: (1) Commercial off-the-shelf (COTS), (2) Military off-the-shelf (MOTS), (3) reusable software components, and (4) EELV-developed software (including any modified versions of COTS and/or reusable software components). Proprietary software used within the EELV system shall either be COTS or have right to use granted to the Government consistent with the Federal Acquisition Regulation and other guidance.

2.2.11.2 Programming Languages

Programming language(s) shall be selected that provide a cost-effective solution over the entire EELV system life cycle. Programming language requirements shall be provided and addressed in the Contractor prepared system specification.

2.2.11.3 Software Supportability

Software supportability considerations shall be incorporated into the EELV design. The Contractor prepared system specification shall address characteristics of the EELV software needed for ease of maintenance, as well as characteristics of the software support environment(s) necessary for efficient post-deployment support.

2.2.11.4 Computer Resource Reserves

Reserves for processor, primary memory, peripheral data storage (secondary memory), and data transmission media capacity/throughput shall be provided and shall be addressed in the Contractor prepared system specification.

2.2.11.5 Other Software Considerations

To the extent practical, the software used in the EELV system shall provide the following capabilities within each functional processing element: (1) measurement of computer resource utilization information, (2) logging of system events to support anomaly resolution (including software anomalies) and system performance verification, and (3) restart/reinitialization of software to recover from anomalies.

2.2.12 Range Interfaces

The system shall interface and be compatible with current spacelift ranges and their existing infrastructure, if they are used, including facilities and equipment for integration, check-out, processing, Telemetry Tracking and Commanding (TT&C) and launch operations. The system shall interface and be compatible with future range upgrades under the Range Standardization and Automation (RSA) program. Once certified, the Global Positioning System (GPS) will be the EELV range safety metric tracking system. Until the GPS system is certified as the tracking source at both ranges, EELV shall be capable of carrying and operating GPS and C-Band simultaneously. EELV shall have sufficient signal strength and be compatible with current ground, airborne, and space based telemetry relay systems if they are used.

2.3 Integrated Logistics Support (ILS)

An ILS program shall be established to ensure a disciplined, unified and iterative approach to the management and technical activities necessary to: (a) integrate support considerations into system equipment design, (b) develop and acquire support requirements that are related consistently to readiness objectives (launch rate, timeliness, responsiveness), to design, and to each other, (c) and provide the support during the operational phase at minimum cost. The ILS program shall determine the most effective support concepts through a Logistics Support Analysis (LSA) program including the use of standard Air Force logistics systems as one alternative.

2.3.1 Training & Training Support

Type I training, shall be provided by the Contractor to train personnel (Air Force or equivalent Contractor) to satisfy operations and maintenance requirements. The overall objective is to certify a government infrastructure that is proficient in standard launch base procedures, all tasks performed by government personnel as necessary to operate and maintain the system. All necessary equipment (e.g. simulators, PC based training equipment) ,course materials and logistics support for training equipment shall be provided as necessary to enable implementation of an organic Air Force training capability.

2.3.2 Standard Procedures and Technical Data

The EELV shall utilize standard procedures and digitized technical data in Joint Continuous Acquisition and Life Cycle Support (JCALS) format for maintenance, engineering data/drawings, trouble shooting, supply, processing, flight planning, launch operations, and post processing of the system encompassing the needs of the missions in the NMM, SPD Annex A. Technical Manuals delivered for use by Air Force personnel must be managed using the standard Air Force Technical Order Management System. All technical data shall be organized similar to Air Force Technical Orders and have a disciplined change process in place. Air Force Technical Orders- shall be validated and maintained for major integrated system test and countdown operations performed by government personnel. A technical publications library shall be maintained on-site for use by contractor and government personnel. This library shall contain all publications necessary to operate the EELV system in a safe and efficient manner.

2.3.3 Packaging, Handling, Storage, and Transportation

Transportation of EELV system components shall be via existing or currently being developed air, sea or ground transportation vehicles. Modification of transportation vehicles or new transportation vehicles shall be specified only when justified economically. The packaging methods shall ensure system, equipment, and support items are properly preserved, packaged, handled, and transported for short and long storage or environmental considerations.

2.3.4 Supportability

The EELV system shall be supportable via a logistics system configured to enable flexible and efficient conduct of launch operations commensurate with the Government missions in the National Mission Model. The EELV logistics system shall also be capable of supporting changes in planned mission operations, and facilitating recovery from delay situations caused by equipment failure during launch processing. Supply support shall incorporate a sparing approach optimized to reduce standing stock levels and to encourage flexible and responsive sparing. Contractor data systems for supply and support maintenance data collection shall be interoperable with those of the Air Force logistics systems.

2.3.5 Maintainability and Maintenance Planning

The EELV system shall be sufficiently maintainable to allow meeting launch rate and schedule dependability requirements. Emphasis shall be placed on rapid fault detection and isolation (Objective: 99% of the time to 3 or less LRU's'; 95% to 2 or less LRU's and, 90% to 1 LRU), ease of access for maintenance, and ease of removal of faulty components for repair or replacement. Schedules for maintenance of system equipment and facilities shall be sufficiently short and flexible to have minimal, if any, impacts on system readiness. The EELV Contractor may use the Air Force Core Automated Maintenance System (CAMS) or a designated follow-on which is available at no cost. Air Force personnel shall be provided electronic access to Contractor maintenance management information systems if CAMS is not used. As a minimum, the maintenance planning database shall include failure data, launch vehicle processing schedules, and all other data that impact the ability of the system to meet launch schedules and windows in a timely manner.

2.3.6 Support Equipment

The EELV system shall utilize existing support equipment to the greatest extent possible, including possible modifications to existing equipment. To the extent that it complies with spacelift system requirements, maximum use of non-developmental items is required. Equipment owned, operated and/or maintained by the government must be supported using the standard Air Force logistics infrastructure.

2.4 Safety, Security, Environmental and Transition Requirements

2.4.1 Safety Requirements

2.4.1.1 General

Wing safety, contractor safety, and maintenance controllers will help ensure EELV contractor compliance with Range Safety requirements and support mishap investigations (in accordance with AFI 91-204, Safety Investigations and Reports) as necessary. HQ AFSPC will provide the ranges with policy and safety compliance as necessary.

2.4.1.2 System Safety

The EELV program shall include a system safety program in accordance with the tailored EWR 127-1. System safety program objectives are to minimize loss of personnel and resources due to mishaps and preserve the combat capability of the Air Force by ensuring system safety is applied throughout a system life cycle. Hazard analyses shall be performed on the overall system design to identify critical components, and safety critical issues will be addressed and documented during system design and deployment. The identification and analyses of system safety requirements are an integral part of an effective man-machine design for aerospace systems. Programs shall comply with the system safety requirements of the tailored EWR 127-1 including range approval of all hazardous procedures. Users must obtain wing issued Missile System Safety Approvals, Flight Termination System Approvals, Facility System Safety Approvals, and Ground Operation Approvals. Refer to the tailored EWR 127-1 for detailed compliance requirements.

2.4.1.3 Range Safety

The objective of the Range Safety program is to ensure that the general public, launch area personnel, foreign land masses, and launch area resources are provided an acceptable level of safety and that all aspects of prelaunch and launch operations adhere to public laws and national needs. The mutual goal of the Ranges and the EELV program shall be to launch vehicles and payloads safely and effectively with commitment to public safety. EWR 127-1 shall be tailored for the EELV program. The EELV system shall comply with the tailored EWR 127-1 or obtain appropriate deviations or waivers. EWR 127-1 specifies that new programs and major program modifications require phased safety reviews at critical milestones such as at concept, preliminary, and critical design reviews, and 120 days prior to shipment to either range.

2.4.1.3.1 Flight Safety

The EELV system shall provide sufficient vehicle, trajectory and performance data to permit the development of flight safety criteria, selection and scheduling of tracking and telemetry antenna assets, accurate collision avoidance runs, radio frequency interface analysis, link margin analyses and other range safety analyses. Users must obtain preliminary and final Flight Plan Approvals and provide all necessary flight support data, as specified in the tailored EWR 127-1, prior to approvals. The flight safety objectives are to conduct missions from the safest approach, methodology or position acceptable and to minimize risk to the greatest extent possible. EELV shall be capable of providing real time tracking and telemetry data during launch that provides safety personnel with the ability to determine vehicle performance, detect a violation of flight criteria, and terminate the flight throughout all launch phases. The data shall include performance, guidance, and Flight Termination System (FTS) data as required by EWR 127-1, paragraph 2.5.5.

2.4.1.3.2 Flight Termination System

All launch vehicles shall have a flight termination system that has an overall system reliability threshold of 0.999 (at a 95% confidence level). This reliability requirement shall be satisfied by using the design (including block redundancy) and testing guidelines in the range regulation.

2.4.2 System Security

EELV shall provide secure and survivable systems as necessary to support mission requirements. Program protection will be applied throughout the system's lifecycle to maintain technical superiority, system integrity and availability. Safeguarding the integrity of the system acquisition, deployment and operation is necessary to maintain the high level of effectiveness of EELV operations. Physical security countermeasures shall protect against compromise or loss of information and resources due to unauthorized access to facilities, equipment, payloads, data, and shall protect operations against espionage, sabotage, damage, tampering, and theft. Data and communication links carrying classified information, up to and including Top Secret/Sensitive Compartmentalized Information, shall be protected according to NSA and Air Force COMSEC requirements from disclosure, intrusion, and other forms of information warfare. Data and communication links carrying sensitive unclassified and critical information shall be protected according to its sensitivity or criticality level from disclosure, intrusion, and other forms of information warfare.

2.4.3 Environments

2.4.3.1 Natural Environments

The spacelift system in general must be tolerant of the environment during pre-launch and launch operations. It is not intended; however, that the system be processed/launched during periods outside normal indigenous environmental conditions. Ground operations (pre-launch) must take into account the typical weather conditions that exist at either coast (e.g. thunderstorms and lightning). Ground operations shall also be tolerant of earthquakes which are prevalent at the western launch site. Launch operations must likewise consider lightning and winds (ground and aloft).

2.4.3.2 Induced Environments

The launch vehicle shall incorporate robust tolerances to withstand environmental and structural extremes associated with: transport from production facilities to storage or the launch base, processing, launch, and flight in atmospheric and exoatmospheric regimes. These environmental and structural extremes include handling loads, wind loading while on-stand, flight loads, temperature, humidity, acoustics, vibrations and in-flight RF environments.

2.4.3.3 Ground Environments

2.4.3.3.1 Transportability

System hardware shall be designed to withstand normal handling and transportation environments without any detrimental effects to the systems.

2.4.3.3.2 Transportation Environmental Monitoring

Critical hardware items shall be monitored and data recorded during shipping to provide complete time histories of the most severe environments, as well as summaries thereof.

2.4.3.3.3 Thermal and Humidity

The EELV shall have the capability to control the thermal and humidity environments inside the fairing throughout all phases of launch processing. See SPD Annex C for specific requirements. The Payload Database Document may be used for reference information regarding current payloads.

2.4.3.3.4 Processing Contamination Control

The airborne particle concentrations shall not exceed Class 100K in locations occupied by the payload during payload integration. See SPD Annex C for specific other specific requirements.

2.4.3.3.5 Electromagnetic Compatibility (EMC)

The LV shall not emit electromagnetic interference (EMI) that harms or interferes with the payload or any ground equipment, nor shall the LV be susceptible to EMI. See SPD Annex C for specific requirements.

2.4.3.3.6 EMI Safety Margin (EMISM)

The payload and LV integrated system shall be designed to provide EMC with a safety margin for DC (no-fire threshold) and positive safety margin for RF for ordnance circuits and EMISM for all non-ordnance circuits. Payload and LV designs shall incorporate the necessary provisions to assure intra-system EMISM of the payload and LV individual segments and inter-system EMC of each segment with its associated AGE and EAGE. See SPD Annex C for specific requirements. The Payload Database Document may be used for reference information regarding current payloads.

2.4.3.3.7 Range Radiated Emissions

The flight configured LV/payload shall be compatible with the launch site RF requirements. The LV and payload shall each be responsible for the individual system compatibility with the worst case theoretical value.

2.4.3.3.8 Lightning Protection

Lightning protection shall be provided for the LV, payload, and all hardware, structures, and personnel. Electrical circuits shall be designed to minimize damage due to lightning strikes.

2.4.3.3.9 Grounding and Shielding

EELV system components shall be grounded as necessary to protect against inadvertent electrical charges or static charge buildup. Electrically sensitive portions of the system shall be shielded from non-essential electrical environments.

2.4.3.4 Environmental Constraints

The EELV system shall operate within applicable laws and regulations without waivers and minimize the use and generation of hazardous materials at all sites to include launch and manufacturing sites (contractor and subcontractor).

2.4.3.4.1 Hazardous Materials Management

The EELV system shall not use materials designated as Class I Ozone-Depleting Substances (ODSs) in manufacturing, maintenance, launch processing or system disposal. The design shall identify, justify, minimize and/or eliminate requirements for the usage of Class II ODSs, and EPCRA Section 313 chemicals.

2.4.4 Transition Operations

The EELV system shall be capable of being deployed and operated with the absolute minimum disruption to current launch base operations and facilities.

2.5 Payload-Related Requirements

The EELV goal is to move rapidly toward standard payload interfaces and services to reduce system complexity and enhance responsive spacelift capability. However, spacelift systems should be flexible enough to accommodate payloads that may require unique payload adapters or ASE, and longer payload processing timelines without adversely impacting the overall responsiveness of the spacelift system. Payload programs will be responsible for delivering a flight-ready payload to the launch base. The payload will comply with EELV standard interfaces and streamlined processing. Payload processing (except as noted above) will minimize constraints placed on spacelift mission operations. The payload provider will be responsible for ensuring payload compatibility with the spacelift system.

2.5.1 Payload Interfaces and Accomodations

2.5.1.1 Coordinate System

The standard interface coordinate system is defined in SPD Annex C (Standard Interface Specification).

2.5.1.2 Payload Accommodation

The EELV shall accommodate the Government payloads in the NMM and shall provide standard interfaces and services (such as mechanical interfaces, power, environmental conditioning, etc.). The Payload Database Document may be used for reference information regarding current payloads. Current or new payloads having unique interface/services needs (such as special power conditioning) shall provide appropriate payload adapters/ASE/services. The weight of the adapters/ASE shall be considered payload weight. EELV shall facilitate direct communication between the payload and its ground station. EELV will not provide any communication hardware unique to the payload.

2.5.1.3 Payload Access

Access shall be provided for safe-and-arm initiation, ordnance installation, propellant fill and drain, and access to umbilical and electrical connectors. The Payload Database Document may be used for reference information regarding current payloads.

2.5.1.4 Payload Fairing Envelope

The envelope shall be sufficient to provide a minimum of one inch clearance (threshold) between the payload and the fairing under worst case dynamic conditions. The Payload Database Document may be used for reference information regarding current payloads. See SPD Classified Annex for specific payload information. See SPD Annex C for specific requirements.

2.5.1.5 Payload Mass Properties

The LV shall be capable of accommodating the mass properties of the Government payloads in the National Mission Model plus any planned Payload Mass Growth capability. The Payload Database Document may be used for reference information regarding current payloads.

2.5.1.6 Payload Encapsulation

If adopted, all payload encapsulation shall be performed off-pad for maximum efficiency in processing and launch operations. During the transition to EELV systems, encapsulation may be conducted on the launch pad.

2.5.1.7 Payload Volume Growth

EELV shall have a planned Payload Volume Growth of at least a 5% (threshold) at constant diameter, with an objective of 10% at constant diameter.

2.5.2 Payload Flight Environments

2.5.2.1 Acceleration Loads

The maximum thrust-axis and lateral-axes accelerations of the LV shall not exceed those acceptable by the Government payloads in the National Mission Model. See SPD Annex C for specific requirements.

2.5.2.2 Acoustic Environment

The free-field maximum expected sound pressure levels (value at 95% probability with 50% confidence) in decibels for the empty fairing shall not exceed the values acceptable by the Government payloads in the NMM. Provisions shall be made for application of sound attenuation measures for individual payload programs which may seek to reduce exposure to acoustic noise. See SPD Annex C for specific requirements.

2.5.2.3 Shock

The maximum expected shock spectrum at the payload interface (assuming the separation system is provided by the payload) in g's (value at 95% probability with 50% confidence) for a resonant amplification factor (Q) of 10 shall not exceed in any direction the values acceptable by the Government payloads in the NMM. See SPD Annex C for specific requirements.

2.5.2.4 Flight Contamination Control

After lift-off, the contamination level for all surfaces inside the fairing shall be no greater than those acceptable by the payload. The Payload Database Document may be used for reference information regarding current payloads.

2.5.2.5 Ascent Heat Flux

The heat flux to the payload from all LV sources (which may include, but are not limited to, heat flux from the inner fairing and stage plume) shall be compatible with the payload during all phases of ascent. The Payload Database Document may be used for reference information regarding current payloads.

2.5.2.6 Thermal

The EELV shall have the capability to control the thermal environments within the payload fairing during appropriate phases of flight. See SPD Annex C for specific requirements. The Payload Database Document may be used for reference information regarding current payloads.

2.5.2.7 Free Molecular Heating

The maximum free molecular heating shall be compatible with the payload during all phases of flight. See SPD Annex C, paragraph 3.4.4 for specific requirements. The Payload Database Document may be used for reference information regarding current payloads.

2.5.2.8 Pressure Decay Rate

The pressure decay rate shall be compatible with the payload during all phases of the flight. The Payload Database Document may be used for reference information regarding current payloads.

2.5.3 Payload Substitution

To maximize operational flexibility and reduce costs, prior to payload mate the EELV shall allow payload substitution with another payload already pre-integrated (integration planning and analysis completed) and prepared (payload processing completed) for launch on the same size LV. The EELV system shall facilitate rapid payload substitution so that schedule launch date delays are minimized or avoided. Payload substitution should not drive additional launch processing other than activities normally required for payload mating.

2.5.4 Contamination & Collision Aviodance

Debris from all LV sources, including but not limited to Reaction Control System operation and LV staging events, shall not impinge on any surface of the payload with sufficient kinetic energy to penetrate, nick, scratch, indent, fracture, or otherwise harm the payload. The CCAM shall be designed to preclude recontact with the payload and to minimize payload exposure to LV contaminants.

3. QUALITY ASSURANCE PROVISIONS

3.1 Inspections and Quality Control

The Contractor shall apply parts, materials, and process controls during production of all items to ensure that a reliable system will be flown. Complete records indicating relevant test and inspection data and nonconformance reports, if any, shall be maintained for the EELV system items and shall be made available for review during the service life of the system.

3.2 Verification Approach

3.2.1 Analysis

Analysis may be used for determination of qualitative and quantitative properties and performance of an item by study calculations and modeling. Similarity analysis may be used in lieu of tests when it can be shown that an item is similar or identical in design to another item that has been certified previously to equivalent or more stringent criteria.

3.2.2 Demonstration

Demonstration may be used for determination of qualitative and quantitative properties and performance of an item and is accomplished by example. Verification of an item by this method would be by using it for its designed purpose and may require no special test for final proof of performance.

3.2.3 Test

Test may be used for the determination of qualitative and quantitative properties and performance of an item by technical means, which requires the use of external resources such as volt meters, recorders, and any test equipment necessary for measuring performance. Newly designed items shall be qualified for the EELV system. Items that incorporate significant changes in design, manufacturing processing, environmental levels, or performance requirements shall be requalified for the EELV system.

3.3 Requirements Verification

The mechanism for maintaining traceability of the requirements verification will be a Requirements Verification Matrix as shown in example Table 4. An equivalent verification matrix accounting for all requirements shall be incorporated into the Contractor prepared system specification.

Verification Method: I=Inspection, A=Analysis, D=Demonstration, T=Test, N/A=Not Applicable Verification Phase: E=Engineering, Q=Qualification, A=Acceptance, S=Storage, L=Service Life, P=Prelaunch

Verification Number	SPD Paragraph Reference	Responsible Contractor	Verification Method	Verification Phase	Verification Result	Comment
	3.2.1.1 Lift Capability					
	3.2.1.2.1 Transition					

	3.2.1.2.2 Launch Rates					
	...					

Table 6: Example Requirements Verification Matrix

4. PREPARATION FOR DELIVERY

EELV items shall be packaged, labeled and delivered commensurate with regulatory requirements and the requirements of the selected transportation mode(s) and involved facilities or bases. The EELV system and components shall be delivered to the launch operator certified flight worthy. As an objective, the hardware shall be delivered to the launch operator with no pending actions or waivers.

5. ACRONYMS AND ABBREVIATIONS

AFOSH	Air Force Occupational Safety and Health
AFSPC	Air Force Space Command
AGE	Aerospace Ground Equipment
ASE	Airborne Support Equipment
CCAM	Collision, Contamination Avoidance Maneuver
CCAS	Cape Canaveral Air Force Station
COMSEC	Communications Security
COTS	Commercial Off-The-Shelf
DC	Direct Current
DoD	Department of Defense
EAGE	Electrical Aerospace Ground Equipment
EELV	Evolved Expendable Launch Vehicle
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
EMISM	EMI Safety Margin
EPA	Environmental Protection Agency
EWR	Eastern and Western Range Regulation
FOC	Full Operational Capability
GEO	Geosynchronous Earth Orbit
GFE	Government Furnished Equipment
GPS	Global Positioning System
GTO	Geosynchronous Transfer Orbit
HLV	Heavy Lift Variant
HQ	Headquarters
ILS	Integrated Logistics Support
IOC	Initial Operational Capability
LAN	Longitude of Ascending Node
LEO	Low Earth Orbit
LRU	Line Replaceable Unit
LSA	Logistics Support Analysis
LV	Launch Vehicle
MLV	Medium Lift Variant
MOTS	Military Off-The-Shelf
N/A	Not Applicable
NMI	Nautical Miles
NMM	National Mission Model
NSA	National Security Agency
ODS	Ozone Depleting Substance
ORD	Operational Requirements Document
OSHA	Occupational Safety and Health Administration
RAAN	Right Ascension of Ascending Node
RF	Radio Frequency
RPM	Revolutions Per Minute
RSA	Range Standardization and Automation
SER	Safety Equivalency Report
SPD	System Performance Document
T	Launch Countdown Time
TBD	To Be Determined
TT&C	Tracking, Telemetry & Commanding

VAFB	Vandenberg Air Force Base

SPD ANNEX A

EELV Government Mission Model

TABLE 7A - EELV Government Mission Model

The EELV Government MM reflects DOD and NASA spacelift requirements as baselined in the AFSPC Executable National Mission Model (06 Dec 96) and the NASA Long Range Planning-Compatibility with DOD/EELV Program (K. Poniatowski - 8 Feb 95). Additionally, references reflect the Requirements-based Mission Model (9 Apr 97) and feedback from interviews with AFSPC satellite program Command Leads and SMC program offices.

Included in this mission model are the requirements for Delta, Titan II, Atlas I/II, and Titan IV class vehicles.

Excluded from the Mission Model are requirements for small launch vehicles, Medium Light and Medium Light II launch vehicles.

Shaded missions and years are beyond those years covered in the AFSPC NMM and are notional.

	FY01	FY02	FY03	FY04	FY05	FY06	FY07	FY08
Medium	TSX	GPS IIF GPS IIF DMSP(V) DSCS III SBIRS GEO MISSION B (V)	GPS IIF GPS IIF GPS IIF DMSP(V) DSCS III SBIRS GEO	GPS IIF GPS IIF MISSION A MISSION A MISSION B (V) SBIRS GEO SBIRS LEO	GPS IIF GPS IIF TSX(V) ADV MILSATCOM SBIRS GEO MISSION B (V) SBIRS LEO SBIRS LEO SBIRS LEO	DMSP(V) GPS IIF GPS IIF GPS IIF SBIRS GEO MISSION A MISSION B (V) ADV MILSATCOM SBIRS LEO SBIRS LEO SBIRS LEO	GPS IIF GPS IIF GPS IIF NPOESS (V) NPOESS (V) DMSP(V) ADV MILSATCOM ADV MILSATCOM ADV MILSATCOM MISSION A SBIRSLEO	GPS IIF GPS IIF GPS IIF NPOESS (V) DMSP(V) ADV MILSATCOM ADV MILSATCOM ADV MILSATCOM MISSION B (
Heavy			DSP			MISSION C		MISSION C
East Coast	1	4	6	6	7	10	8	
Med	1	4	5	6	7	9	9	
Heavy	0	0	1	0	0	1	0	
West Coast	0	2	1	1	2	2	3	
Med	0	2	1	1	2	2	3	
Heavy	0	0	0	0	0	0	0	
Total	1	6	7	7	9	12	11	

TABLE 7A (Cont.)

	FY11	FY12	FY13	FY14	FY15	FY16	FY17	FY1
Medium	GPS IIF GPS IIF GPS IIF GPS IIF DISCOVERY MISSION A MISSION B (V) MISSION B (V) MISSION E (V) MISSION E (V) SBIRS LEO SBIRS LEO SBIRS LEO	GPS IIF GPS IIF GPS IIF NPOESS (V) EOS-PM3(V) MISSION B (V) MISSION E (V) SBIRS GEO ADV MILSATCOM SBIRS LEO SBIRS LEO	GPS IIF GPS IIF GPS III GPS III TSX(V) DISCOVERY MISSION A MISSION E (V) MISSION E (V) ADV MILSATCOM ADV MILSATCOM SBIRS GEO	GPS III GPS III GPS III NPOESS (V) EOS-CHM(V) MISSION A ADV MILSATCOM ADV MILSATCOM SBIRS GEO MISSION B (V) MISSION E (V) SBIRS LEO SBIRS LEO	GPS III GPS III DISCOVERY ADV MILSATCOM ADV MILSATCOM SBIRS GEO MISSION E (V) MISSION E (V) MISSION E (V) SBIRS LEO SBIRS LEO SBIRS LEO	GPS III GPS III GPS III NPOESS (V) ADV MILSATCOM ADV MILSATCOM MISSION B (V) MISSION E (V) MISSION A SBIRS LEO SBIRS LEO	GPS III GPS III TSX(V) DISCOVERY ADV MILSATCOM ADV MILSATCOM MISSION A MISSION B (V) MISSION E (V) MISSION E (V) SBIRS GEO	GPS III GPS III GPS III NPOESS ADV MILSAT MISSION MISSION MISSION MISSION SBIRS G SBIRS L SBIRS L
Heavy		MISSION C		MISSION C		MISSION C		MISSION
East Coast	9	8	9	10	9	9	7	
Med	9	7	9	9	9	8	7	
Heavy	0	1	0	1	0	1	0	
West Coast	4	4	3	4	3	3	4	
Med	4	4	3	4	3	3	4	
Heavy	0	0	0	0	0	0	0	
Total	13	12	12	14	12	12	11	

Missions in italics are the system test flights and shouldn't be included in determining recurring costs.

Total Missions					
East Coast	146	West Coast	58		
Med	137	Med	58		
Heavy	9	Heavy	0	Total	204

TABLE 7B- EELV GOVERNMENT MISSION MODEL PAYLOAD LAUNCH VEHICLE REQUIREMENTS

The EELV Government MM PL Requirements are based upon mission information in the AFSPC National Executable Mission Model (06 Dec 96)). For Payloads for which mission data was unavailable, the maximum capacity of the currently assigned launch vehicle was assumed.

DoD	PAYLOAD	ORBIT	CURRENT	LAUNCH	APOGEE	PERIGEE	INCLINATION	NOTES

PORTION			VEHICLE CLASS	WT(LBS)	(NM)	(NM)	(DEGREES)	
AFSPC	ADV MILSATCOM	GTO	ATLAS IIAS	8500	19300	100	27	17
	DMSP	POLAR	TITAN II	3300	458	458	98.7	1
	DSCS	GTO	ATLAS II	6300	19279	127	25.5	18
	DSP	GEO	TITAN IV-IUS	5402	19323	19323	3	
	GPS IIF	SEMI SYNC	DELTA II 7925	4725	10998	100	44	2
	SBIRSLEO	LEO	DELTA II 7920	8157	378	378	54.7	3
	SBIRSGEO	GTO	ATLAS IIAS	8450	19324	90	27	
OTHER DoD	TSX	POLAR	DELTA II 7925	6000	500	500	90	14
	NPOESS	POLAR	DELTA II 7925	6840	450	450	98.2	
SUPPORT	MISSION A	GTO	ATLAS IIAS	8500	19324	90	27	4,13
	MISSION B	LEO	ATLAS IIAS	17000	100	100	63.4	5, 6,7,13
	MISSION C	GEO	TITAN IV-CENT	13500	19323	19323	0	8,13
	MISSION D	POLAR	TITAN IV-NUS	41000	100	100	90	10,13,15
	MISSION E	POLAR	ATLAS IIAS	16100	100	100	90	9,10,13
NASA								
	DISCOVERY	PLNTRY	DELTA II 7920	2000	N/A	N/A	28.5	12
	EOS AM	SUN-SYNC	DELTA II 7920	11220	380	380	98.2	16
	EOS PM	SUN-SYNC	DELTA II 7920	7000-8000	380	380	98.2	
	EOS CHEM	SUN-SYNC	DELTA II 7920	7900	380	380	98.2	

*** Launch weight includes the weight of the separated space vehicle, the space vehicle to launch vehicle adapter (if supplied by the space vehicle), and all other unique hardware required on the launch vehicle to support the space vehicle's mission.**
1 - Direct injection orbit .
2 - SPD to allow delivery to transfer orbit (4725 lbs to 44 degrees) with spin stabilization or to final orbit (2675 lbs at 10,998 nmi circular orbit at 55 degree inclination) at EELV ktr's option; EELV provides spin table, unless the direct insertion option is used; GPS provides SV destruct system.
3 - SBIRSLEO spacecraft will be launched 3 at a time. Launch weight is combined weight of all 3 s/c with adapter. Data reflects parking orbit. Transfer to final orbit (864 NM at 54.7 degree inclination) will be done using SV propellant
4 - 8500 lbs to Mission A is greater than Atlas IIAS capability of 8150 lbs.
5 - Launch Site may be either ER or WR.
6 - 17000 lbs to Mission B is equivalent to Atlas IIAS capability from the WR.
7 - The capability to achieve higher orbits by coasting, restarting, and executing a short duration burn with the final stage is also required.
8 - 13500 lbs to Mission C is design goal for Titan IV - SRMU - Centaur
9 - 16100 lbs to Mission E is equivalent to Atlas IIAS capability from WR.
10 - The capability to achieve higher orbits by coasting, restarting, and executing a short duration burn with the final stage is desirable but needs to be weighed against the added complexity and risk.
12. - Launch Energy C3=17 km^2/sec^2
13. - Equivalent missions (Reference SPD Classified Annex)
14 - For the first TSX-8 mission in (FY 01) the payload launch weight (TBD) will be made compatible with the MLV lift capability to the delivery orbit (TBD) when launched from ER.
15 - Mission D is a reference mission for a HLV capability from WR. There are currently no Mission Ds manifested in the NMM. The HLV 173'' standard interface payload attach fitting is not required to accomidate this mission.
16 - Throw weight is current EOS-AM1 configuration. Delta II 7920 is baseline vehicle for space vehicle design for future EOS AM space vehicles.
17 - AdvMilsatCom includes two space vehicle systems (Advanced EHF and Advanced SHF K/a). Mission model data is the same but orbital parameter accuracy varies (see Table 2).
18 - DSCS orbital parameters are applicable to the first ascending node.

APPENDIX F

NOISE METHODS OF ANALYSIS

Noise is generally described as unwanted sound. Unwanted sound can be based on objective effects (hearing loss, damage to structures, etc.) or subjective judgments (community annoyance). Noise analysis thus requires a combination of physical measurement of sound, physical and physiological effects, plus psycho- and socioacoustic effects.

Section 1.0 of this appendix describes how sound is predicted and measured. Section 2.0 describes the effect of noise on people, structures, and wildlife. Section 3.0 provides a summary description of the specific methods used to predict noise from EELV activities.

1.0 NOISE DESCRIPTORS AND PREDICTION

EELV launch vehicles would generate two types of sound. One is engine noise, which is continuous sound. The other is sonic booms, which are transient, impulsive sounds. These are quantified in different ways.

Section 1.1 describes the quantities used to describe sound. Section 1.2 describes rocket noise and how it is modeled. Section 1.3 describes the modeling and presentation of sonic booms.

1.1 NOISE DESCRIPTORS

Measurement and perception of sound involves two basic physical characteristics: amplitude and frequency. Amplitude is a measure of the strength of the sound and is directly measured in terms of the pressure of a sound wave. Because sound pressure varies in time, various types of pressure averages are usually used. Frequency, commonly perceived as pitch, is the number of times per second the sound causes air molecules to oscillate. Frequency is measured in units of cycles per second, or Hertz (Hz).

Amplitude. The loudest sounds the human ear can comfortably hear have acoustic energy one trillion times the acoustic energy of sounds the ear can barely detect. Because of this vast range, attempts to represent sound amplitude by pressure are generally unwieldy. Sound is therefore usually represented on a logarithmic scale with a unit called the decibel (dB). Sound on the decibel scale is referred to as a sound level. The threshold of human hearing is approximately 0 dB, and the threshold of discomfort or pain is around 120 dB.

The difference in dB between two sounds represents the ratio of those two sounds. Because human senses tend to be proportional (i.e., detect whether one sound is twice as big as another) rather than absolute (i.e., detect whether one sound is a given number of pressure units bigger than another), the decibel scale correlates well with human response.

Frequency. The normal human ear can hear frequencies from about 20 Hz to about 15,000 or 20,000 Hz. It is most sensitive to sounds in the 1,000 to 4,000 Hz range. When measuring community response to noise, it is common to adjust the frequency content of the measured sound to correspond to the frequency sensitivity of the human ear. This adjustment is called A-weighting

(American National Standards Institute, 1988). Sound levels that have been so adjusted are referred to as A-weighted sound levels. The amplitude of A-weighted sound levels is measured in dB. It is common for some noise analysts to denote the unit of A-weighted sounds by dBA or dB(A). As long as the use of A-weighting is understood, there is no difference between dB, dBA or dB(A). It is only important that the use of A-weighting be made clear. It is common to use the term A-weighted sound pressure level (AWSPL) to refer to A-weighted sounds.

For analysis of damage to structures by sound, it is common not to apply any frequency weighting. Such overall sound levels are measured in dB and are often referred to as overall sound pressure levels (OASPL or OSPL).

C-weighting (American National Standards Institute, 1988) is sometimes applied to sound. This is a frequency weighting that is flat over the range of human hearing (about 20 Hz to 20,000 Hz) and rolls off above and below that range. C-weighted sound levels are often used for analysis of high-amplitude impulsive noise, where adverse impact is influenced by rattle of buildings.

Time Averaging. Sound pressure of a continuous sound varies greatly with time, so it is customary to deal with sound levels that represent averages over time. Levels presented as instantaneous (i.e., as might be read from the dial of a sound level meter), are based on averages of sound energy over either 1/8 second (fast) or one second (slow). The formal definitions of fast and slow levels are somewhat complex, with details that are important to the makers and users of instrumentation. They may, however, be thought of as levels corresponding to the root-mean-square sound pressure measured over the 1/8-second or 1-second periods.

The most common uses of the fast or slow sound level in environmental analysis are in the discussion of the maximum sound level that occurs from the action, and in discussions of typical sound levels. Figure F-1 is a chart of sound levels from typical sounds.

Assessment of cumulative noise impact requires average levels over periods longer than just the fast or slow times. The sound exposure level (SEL) sums the total sound energy over a noise event. Mathematically, the mean square sound pressure is computed over the duration of the event, then multiplied by the duration in seconds, and the resultant product is turned into a sound level. SEL is sometimes described as the level which, occurring for one second, would have the same sound energy as the actual event.

Note that SEL is a composite metric that combines both the amplitude of a sound and its duration. It is a better measure of noise impact than the maximum sound level alone, since it accounts for duration. Long sounds are more intrusive than short sounds of equal level, and it has been well established that SEL provides a good measure of this effect.

SEL can be computed for A- or C-weighted levels, and the results denoted ASEL or CSEL. It can also be computed for unweighted (overall) sound levels, with a corresponding designation.

For longer periods of time, total sound is represented by the equivalent continuous sound pressure level (L_{eq}). L_{eq} is the average sound level over some time period (often an hour or a day, but any explicit time span can be specified), with the averaging being done on the same energy basis as used

Figure F-1. A-Weighted Sound Levels of Common Sounds for SEL. SEL and L_{eq} are closely related, differing according to (a) whether they are applied over a specific time period or over an event, and (b) whether the duration of the event is included or divided out.

Just as SEL has proven to be a good measure of the noise impact of a single event, L_{eq} has been established to be a good measure of the impact of a series of events during a given time period. Also, while L_{eq} is defined as an average, it is effectively a sum over that time period and is thus a measure of the cumulative impact of noise.

Noise tends to be more intrusive at night than during the day. This effect is accounted for by applying a 10-dB penalty to events that occur after 10 p.m. and before 7 a.m. If L_{eq} is computed over a 24-hour period with this nighttime penalty applied, the result is the day-night average sound level (L_{dn} or DNL). L_{dn} is the community noise metric recommended by the U.S. Environmental Protection Agency (U.S. Environmental Protection Agency, 1972) and has been adopted by most federal agencies (Federal Interagency Committee on Noise, 1992). It has been well established that L_{dn} correlates well with community response to noise (Schultz, 1978; Finegold et al., 1994).

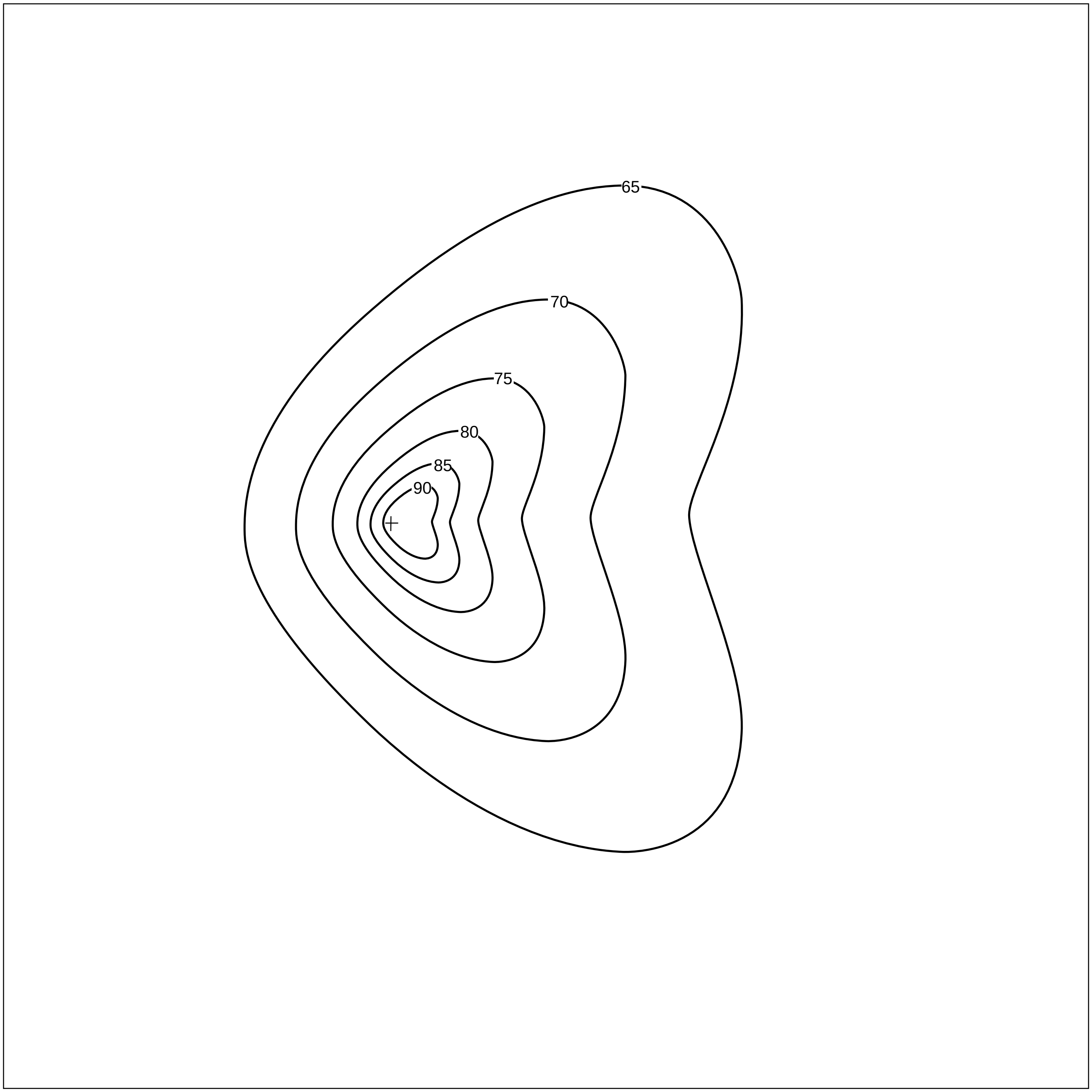
The state of California quantifies noise by Community Noise Equivalent Level (CNEL). This metric is similar to L_{dn} except that a penalty of 5 dB is applied to sounds that occur in the evening, after 7:00 p.m. and before 10:00 p.m.

It was noted earlier that, for impulsive sounds, C-weighting is more appropriate than A-weighting. The day-night average sound level can be computed for C-weighted noise, and is denoted L_{Cdn} or CDNL. This procedure has been standardized, and impact interpretive criteria similar to those for L_{dn} have been developed (CHABA, 1981).

1.2 ROCKET NOISE

Rocket noise is generated primarily by the mixing of the high-speed rocket exhaust flow with the atmosphere. Noise is also generated by fuel and oxidizer burning in the combustion chamber, shock waves and turbulence within the exhaust flow, and sometimes, burning of excess fuel in the exhaust flow. The result is a high-amplitude continuous sound, directed generally behind the vehicle. Figure F-2 shows the typical pattern of noise behind a rocket engine. In this illustration, the exhaust flow is horizontal, directed toward the east (right). This corresponds to a horizontally mounted rocket (common in ground testing of engines) or a rocket on a launch pad where a deflector has turned the exhaust sideways. Noise is shown as contours of various decibel values. All points inside a given contour experience noise equal to or higher than that contour value. The pattern is fairly uniform in the forward direction (toward the left in this figure), has high-amplitude lobes at around 45 degrees from the flow direction (the angle of the lobes varies), and has a minimum directly in line with the exhaust.

When a rocket is launched, after a short time, it is above the ground, and the exhaust is clear of the ground and any deflectors. When the rocket is climbing vertically, the noise contours on the ground are circular. As the rocket continues to climb, it will pitch over in its launch azimuth. The contours will be distorted in this direction, sometimes becoming stretched and sometimes broadened, depending on details of the particular vehicle and launch. Figure F-3 shows typical noise contours for a launch toward the east. The trajectory is indicated, and the launch point is at the center of the innermost contours.



EXPLANATION

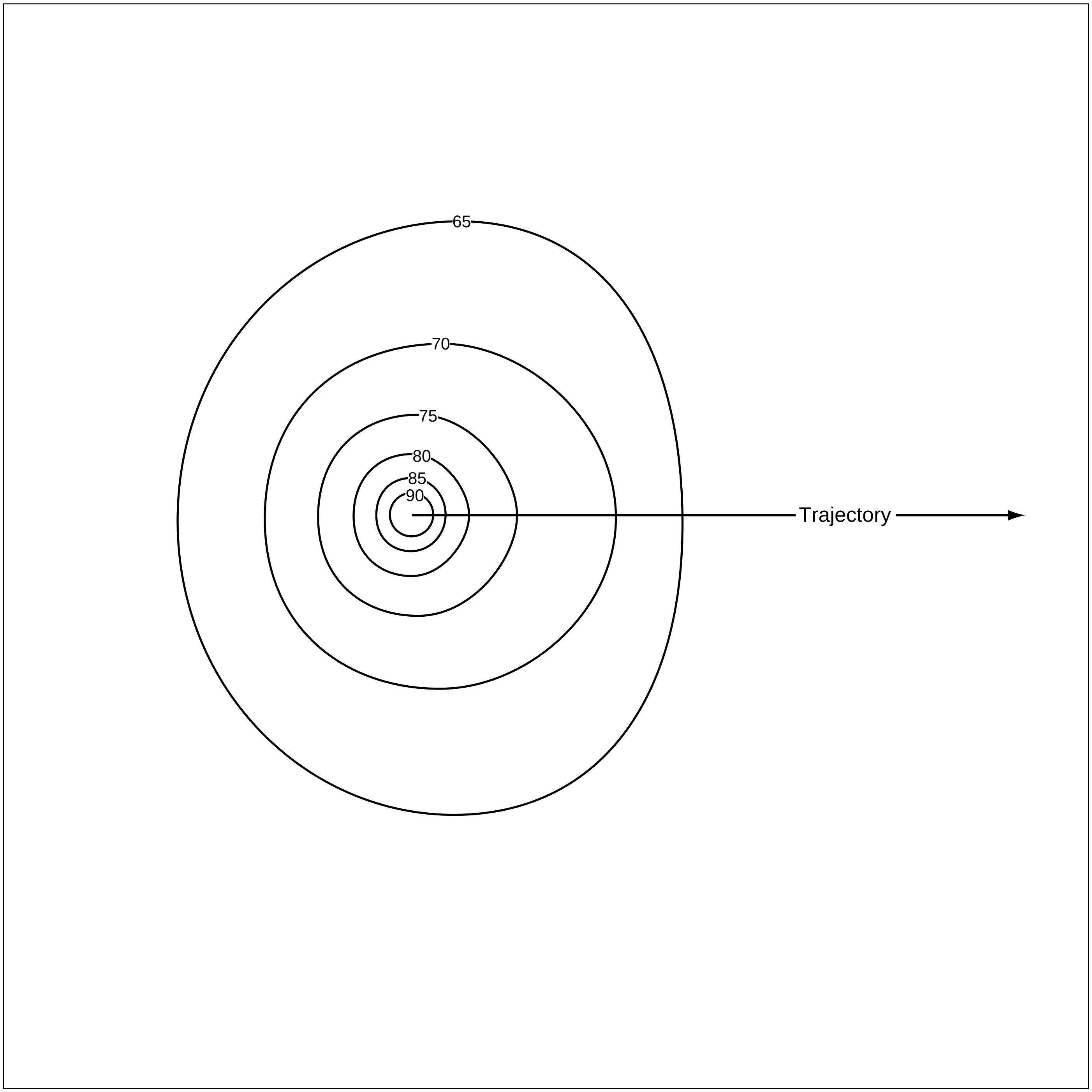
—80— Noise Contour (decibels)

Not to Scale

EELV/097

Nominal Noise Contours for Horizontal Firing Rocket Engine

Figure F-2



EXPLANATION

—80— Noise Contour (decibels)

Not to Scale

EELV/094

Nominal Noise Contours for Ascent of a Launch Vehicle

Figure F-3

In Figure F-2, as long as the rocket is on the ground the noise is constant, and the contours show what would be measured at any time while the engine is firing. For a launch, as in Figure F-3, noise is not constant. It is loudest shortly after launch, then diminishes as the rocket climbs. The noise is still considered to be continuous because it varies over periods of seconds or minutes. Contours of AWSPL or OSPL are drawn to represent the maximum levels that occur at each point during the entire launch. These levels may only occur for a few seconds and do not occur at the same time at each point, but are the most important (i.e., worst case) quantity for assessing launch noise impact.

In this assessment, contours (similar to Figure F-3) are presented for launch noise. Because contours are approximately circular, it is often adequate to summarize noise by giving the sound levels at a few distances from the launch site.

1.3 SONIC BOOMS

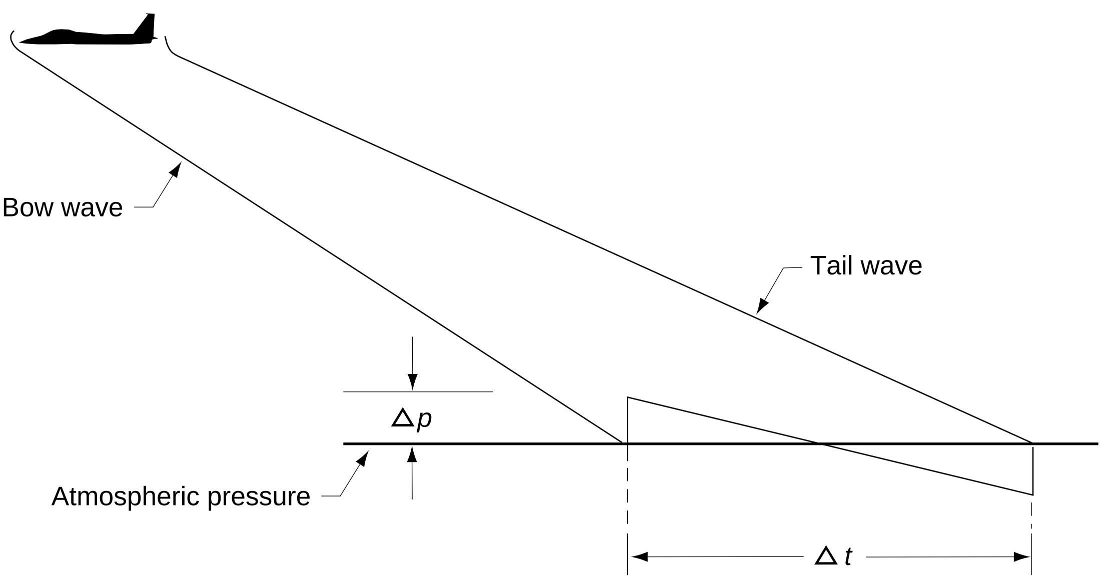
When launch vehicles reach supersonic speed, they generate sonic booms. Sonic booms are the shock waves resulting from the displacement of air in supersonic flight. They differ from other sounds in that they are impulsive and brief.

Figure F-4 is a sketch of sonic boom for the simple case of an aircraft in steady-level flight. The aircraft is flying to the left. The sonic boom consists of two shock waves: one generally associated with the front of the aircraft, and one with the rear. They are connected by a linear expansion. The pressure-time signature at the ground resembles the letter “N” and is referred to as an N-wave. It is described by the peak overpressure of each shock, and the time between the shocks. Usually the time between shocks does not affect impact, so sonic booms are most commonly described by their peak overpressures.

In Figure F-4, the sonic boom is generated continuously as the aircraft flies, and this illustration is from the perspective of moving with the aircraft. At a location on the ground, however, the boom exists briefly as the N-wave passes over that point. It is common to refer to the footprint of a steady-flight sonic boom as a “carpet”, consisting of a “carpet” of area on the ground that is swept out as the aircraft flies along its path. N-wave booms are often referred to as “carpet booms”.

Figure F-5 shows an aircraft sonic boom from a different perspective. The aircraft is flying to the right, and the cone to the left is a three-dimensional version of the shocks in Figure F-4. It is the boom as it exists at a given time. It is generated over a period of time, with the boom at the ground having been created at an earlier time. The sonic boom energy generated at a given time propagates forward of the aircraft, along a cone similar to the one projected to the right in Figure F-5. It reaches the ground in a forward-facing crescent, as indicated in the figure.

Sonic booms from launch vehicles differ from those sketched in Figures F-4 and F-5 in two ways. First, launch vehicles begin their flight vertically, then slowly pitch over toward the horizontal. Second, launch vehicles accelerate, so speed is continuously changing as they ascend. The cone angles shown in Figures F-4 and F-5 change with speed. Shock waves are generated only after the vehicle exceeds Mach 1, and reach the ground as sonic booms only after the vehicle has pitched over and reached a particular Mach number. Figure F-6 shows nominal sonic boom noise contours (not to scale) from a launch vehicle. The contour values represent pressure in pounds per square foot (psf), the unit most commonly used. The launch site is noted on the figure, and the launch

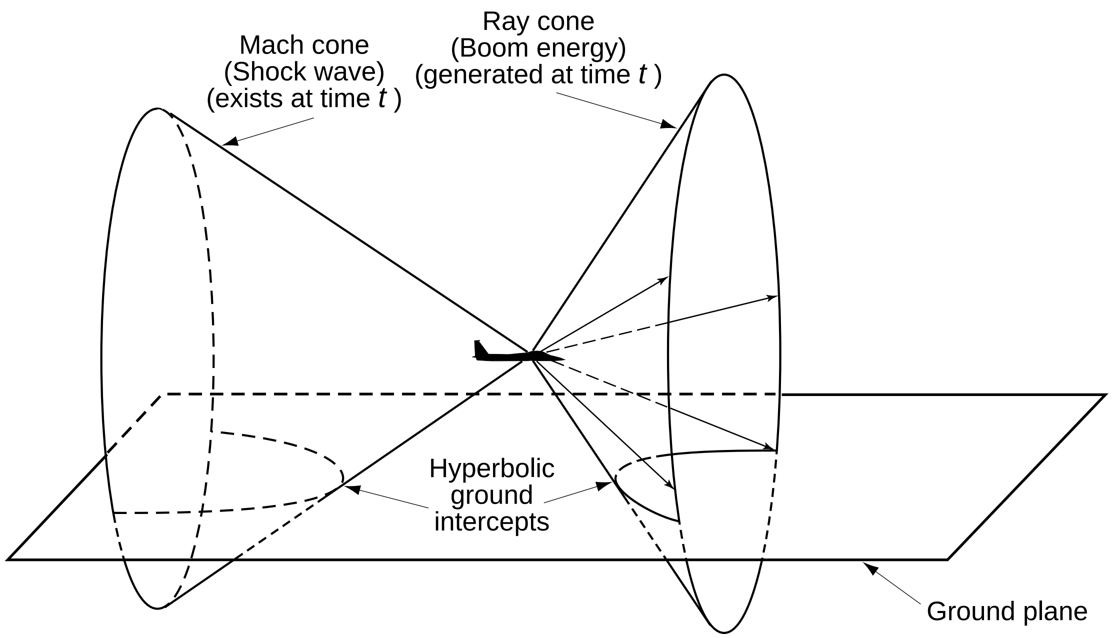


Sonic Boom From an Aircraft in Level Flight

Figure F-4

Not to Scale

EELV/099

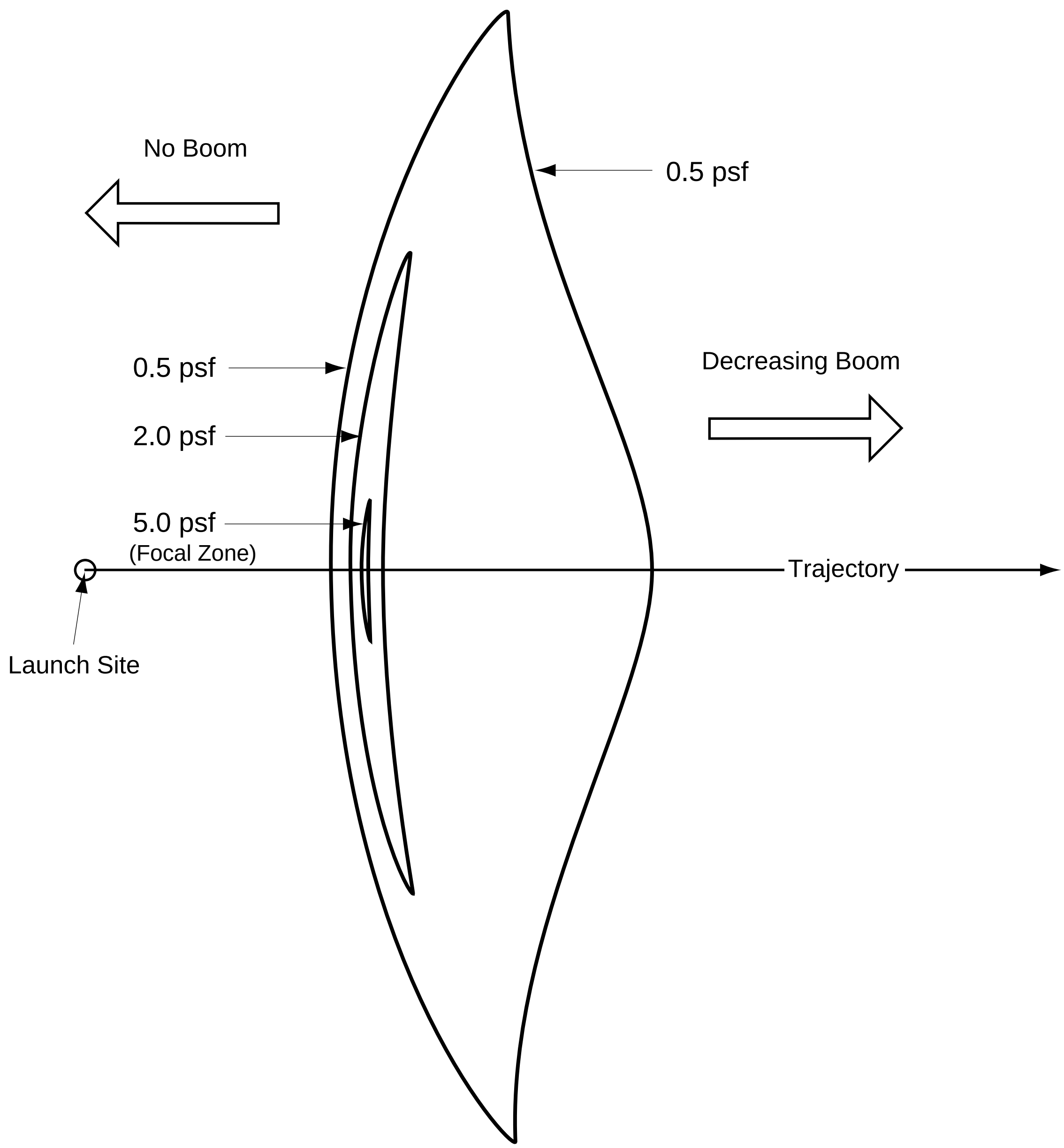


Sonic Boom in Level Flight, Showing Shock Wave and Propogation of Boom Energy

Figure F-5

Not to Scale

EELV/098



EXPLANATION

psf Pounds per square foot

Not to Scale

EELV/095

Nominal Sonic Boom Contours for Ascent of a Launch Vehicle

Figure F-6

direction is to the right. As with the noise contours shown in Figures F-2 and F-3, regions within each contour experience overpressures equal to or greater than that denoted for the contour. Also, the contours denote the peak pressure that occurs at each point over the course of the launch and does not represent noise at any one time. The sonic boom event at each position is brief, as noted in the preceding paragraph.

Because sonic boom is not generated until the vehicle becomes supersonic some time after launch, the launch site itself does not experience a sonic boom. The crescent shape of the contours reflects this “after launch” nature of sonic boom: the entire boom footprint is downtrack, and portions of the footprint to the side of the trajectory (up and down in the figure) are farther downtrack. This pattern is similar to the forward-facing crescent seen in the right half of Figure F-5. There is no boom to the left of the contours shown, and the boom diminishes rapidly farther downtrack, to the right of the contours.

The left edge of the contours shown in Figure F-6 is a special region. Because the vehicle is accelerating, sonic boom energy tends to be more concentrated than if it were in steady flight. The left edge is where the boom first reaches the ground, and the concentration is highest there. There is a narrow “focus boom” or “superboom” region, usually less than 100 yards where the sonic boom amplitude is highest. The boom signature is also distorted into what is referred to as a “U-wave”.

Figure F-7 shows time histories (pressure versus time) for N-wave carpet booms and U-wave focus booms. Each consists of a pair of shock waves connected by a linear expansion (N-wave) or a U-shaped curve (U-wave). Each type of boom is well described by its peak overpressure in pounds per square foot (psf), and its duration in milliseconds (msec). Duration tends to have a minor effect on impact, so the peak pressure is all that is normally required.

The 0.5-psf contour shown in Figure F-6, although not to scale, has a shape similar to an actual low-overpressure sonic boom contour. The two higher contours, 2.0 and 5.0 psf, are considerably distorted from typical actual contours. The crescent shape is correct, and their width across the trajectory (i.e., vertical height on this figure) relative to the 0.5-psf contour is approximately correct. Their width and position in the direction along the trajectory is greatly exaggerated. It is typical that the left edge of these higher contours would be very close to the left edge of the 0.5-psf contour, and would not appear as a distinct line when plotted to any reasonable scale. The right edge of these contours would also be much closer to the left than shown and would often not appear as distinct lines. The focus boom region is within the 0.5-psf contour.

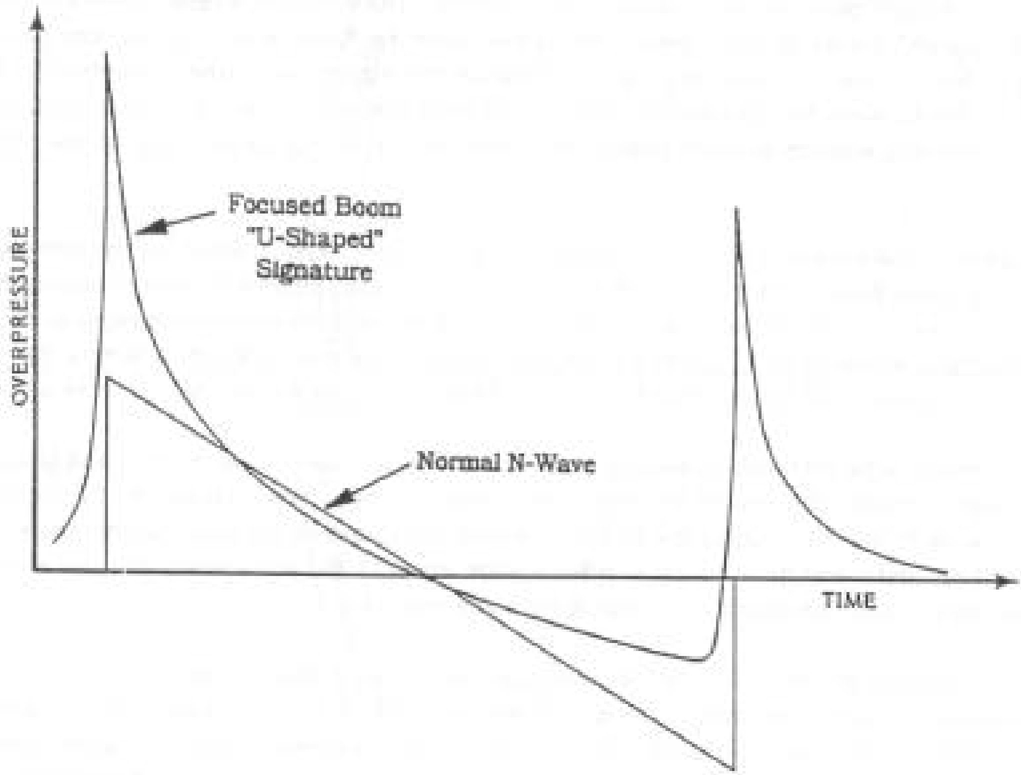
For assessment of impact via L_{Cdn} as discussed in Section 1.1, the peak pressure is related in a simple way to CSEL, from which L_{Cdn} can be constructed. The peak pressure P (psf) is converted to the peak level (L_{pk}) dB by the relation:

$$L_{pk} = 127.6 + 20 \log_{10} P$$

CSEL is then given by Plotkin (1993):

$$\text{CSEL} = L_{pk} - 26 \qquad \text{(N-wave)}$$

$$\text{CSEL} = L_{pk} - 29 \qquad \text{(U-wave)}$$



Focused U-Wave and Unfocused N-Wave Boom Signatures

Figure F-7

Most sonic boom literature describes booms in terms of overpressure psf. This assessment adheres to that convention. The above relations give simple conversions to decibels should those units be of interest.

2.0 NOISE EFFECTS

2.1 ANNOYANCE

Studies of community annoyance from numerous types of environmental noise show that L_{dn} is the best measure of impact. Schultz (1978) showed a consistent relationship between L_{dn} and annoyance. This relationship, referred to as the "Schultz curve", has been reaffirmed and updated over the years (Fidell et al., 1991; Finegold et al., 1994). Figure F-8 shows the current version of the Schultz curve.

A limitation of the Schultz curve is that it is based on long-term exposure to noise. EELV launches will be relatively infrequent. Therefore, analysis in the current study examines individual noise levels rather than L_{dn} compared to the Schultz curve.

Some time ago, L_{dn} of 55 dB or less was identified as a threshold below which adverse impacts to noise are not expected (U.S. Environmental Protection Agency, 1972). It can be seen from Figure F-8 that this is a region where a small percentage of people is highly annoyed. L_{dn} of 65 dB is widely accepted as a level above which some adverse impact should be expected (Federal Interagency Committee on Noise, 1992), and it is seen from Figure F-8 that about 15 percent of people are highly annoyed at that level.

2.2 SPEECH INTERFERENCE

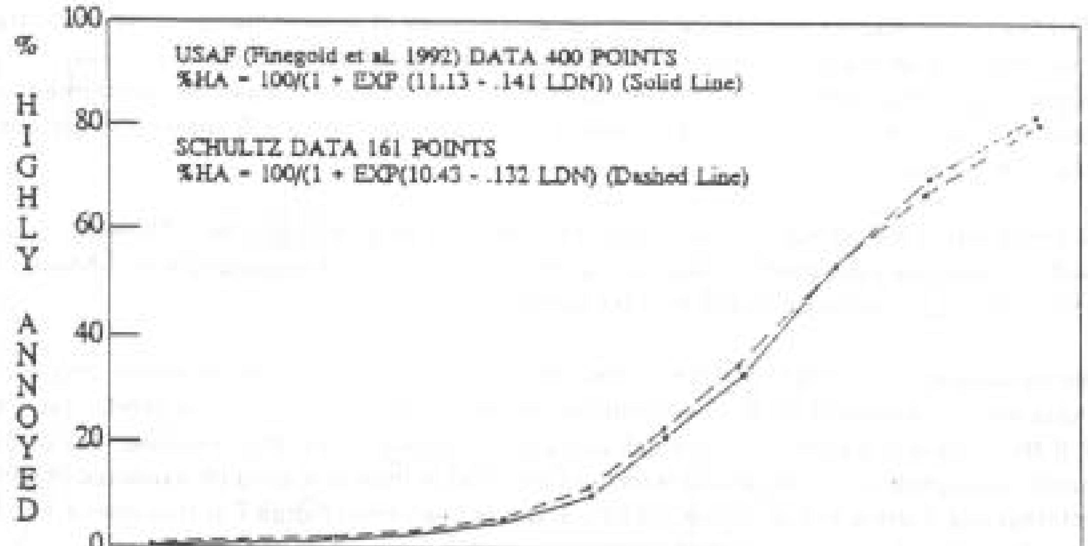
Conversational speech is in the 60- to 65-dB range, and interference with this can occur when noise enters or exceeds this range. Speech interference is one of the primary causes of annoyance. The Schultz curve incorporates the aggregate effect of speech interference on noise impact.

Because EELV launches would be infrequent, and noise would last for only a few minutes, speech interference is not expected to be a major issue.

2.3 SLEEP INTERFERENCE

Sleep interference is commonly believed to represent a significant noise impact. The 10-dB nighttime penalty in L_{dn} is based primarily on sleep interference. Recent studies, however, show that sleep interference is much less than had been previously believed (Pearsons et al., 1989; Ollerhead, 1992).

Traditional studies of sleep disturbance indicate that interference can occur at levels as low as 45 dB. Data indicates that at indoor SEL of 70 dB, about 20 percent of people will awaken (Federal Interagency Committee on Noise, 1992). Assuming a nominal outdoor-to-indoor noise reduction of 20 dB, these correspond to outdoor sound exposure levels of 65 dB and 90 dB, respectively. Note that the awakening threshold is comparable to the threshold of outdoor speech interference.



Day - Night Average Sound Level in dB		40	45	50	55	60	65	70	75	80	85	90
Calculated %HA Points	USAF	0.41	0.831	1.66	3.31	6.48	12.29	22.1	36.47	53.74	70.16	82.64
	SCHULTZ	0.576	1.11	2.12	4.03	7.52	13.59	23.32	37.05	53.25	68.78	81

Community Response to Noise

Figure F-8

2.4 TASK INTERFERENCE

Due to startle effects, some task interference may occur from sonic booms. High levels of rocket noise may cause some task interference close to the launch sites. It is difficult to estimate degrees of task interference, since this is highly dependent on specific tasks. Startle from sonic booms is often stated as a concern, but there are no credible reported incidents of harm from sonic boom startle. Task interference from rocket noise is expected to occur at higher noise levels than speech interference.

2.5 HEARING LOSS

Federal Occupational Safety and Health Administration (OSHA) guidelines (Title 29 CFR 1910.95) specify maximum noise levels to which workers may be exposed on a regular basis without hearing protection. Pertinent limits are a maximum of 115 dBA for up to 15 minutes per day, and unweighted impulsive noise of up to 140 dB. Exceeding these levels on a daily basis over a working career is likely to lead to hearing impairment. These levels are conservative for evaluating potential adverse effects from occasional noise events.

2.6 HEALTH

Nonauditory effects of long-term noise exposure, where noise may act as a risk factor, have never been found at levels below federal guidelines established to protect against hearing loss. Most studies attempting to clarify such health effects found that noise exposure levels established for hearing protection will also protect against nonauditory health effects (von Gierke, 1990). There are some studies in the literature that claim adverse effects at lower levels, but these results have generally not been reproducible.

2.7 STRUCTURES

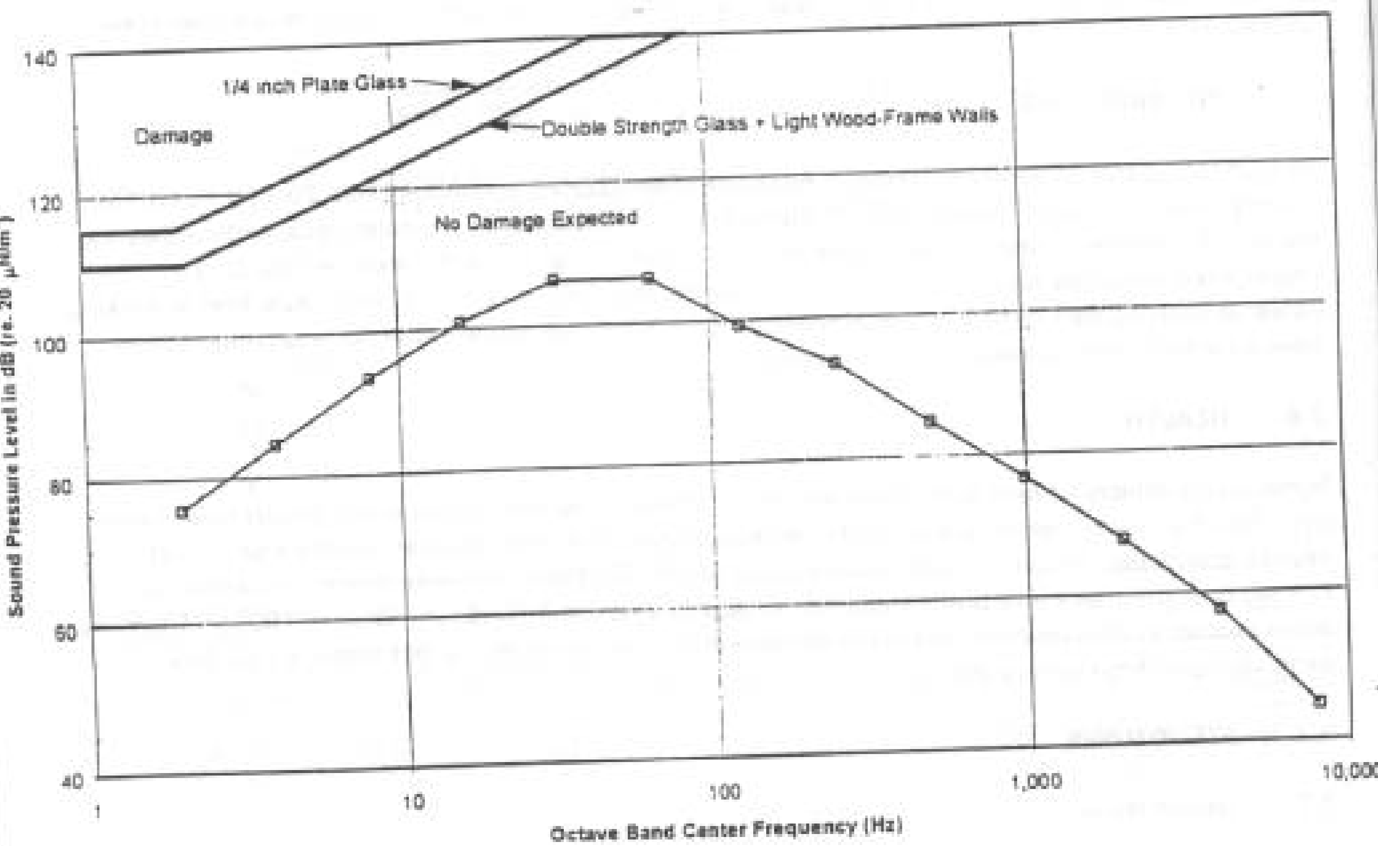
2.7.1 Launch Noise

Damage to buildings and structures from noise is generally caused by low-frequency sounds. The probability of structural damage claims has been found to be proportional to the intensity of the low-frequency sound. Damage claim experience (Guest and Sloane, 1972) suggests that one claim in 10,000 households is expected at a level of 103 dB, one in 1,000 households at 111 dB, and one in 100 households at 119 dB.

Figure F-9 shows criteria for damage to residential structures (Sutherland, 1968) and compares them to launch noise spectra that could occur a few kilometers from the launch pad. These data show that noise-induced damage to off-base property would be minimal.

2.7.2 Sonic Boom

Sonic booms are commonly associated with structural damage. Most damage claims are for brittle objects, such as glass and plaster. Table F-1 summarizes the threshold of damage that might be expected at various overpressures. There is a large degree of variability in damage experience, and much damage depends on the pre-existing condition of a structure. Breakage data for glass, for



Criteria for Noise Damage to Residential Structures and Typical Off-Base Launch Noise Spectrum

Figure F-9

Table F-1. Possible Damage to Structures From Sonic Booms

Sonic Boom Overpressure Nominal (psf)	Type of Damage	Item Affected
0.5-2	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 chimneys.
2-4	Glass, plaster, roofs, ceilings	Failures show that would have been difficult to forecast in terms of their existing localized condition. Nominally in good condition.
4-10	Glass	Regular 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)	Interior walls known to move at 10 psf.
Greater than 10	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 gable-end and wall-plate cracks; domestic chimneys dislodged if not in good condition.
	Walls	Interior walls can move even if carrying fittings such as hand basins or taps; secondary damage due to water leakage.
	Bric-a-brac	Some nominally secure items can fall; e.g., large pictures, especially if fixed to party walls.

Source: Haber and Nakaki, 1989

example, spans a range of two to three orders of magnitude at a given overpressure. While glass can suffer damage at low overpressures, as shown in Table F-1, laboratory tests of glass (White, 1972) have shown that properly installed window glass will not break at overpressures below 10 psf, even when subjected to repeated booms.

Most of the area exposed to sonic booms will be below 2 psf, where there is a small probability of damage. Boom amplitude will exceed this in limited areas associated with focusing, with maximum overpressures in the 6- to 8-psf range. Because of the limited area involved in a focal zone, adverse impact will depend on the relation of the focal zones to sensitive receptors.

2.8 WILDLIFE

The response to sonic booms or other sudden disturbances is similar among many species (Moller, 1978). Sudden and unfamiliar sounds usually act as an alarm and trigger a “fight or flight” startle reaction. This sudden panic response may cause wildlife to injure themselves or their young; however, this is usually the result of the noise in association with the appearance of something perceived by the animals as a pursuit threat, such as a low-flying aircraft. Launch noise is not expected to cause more than a temporary startle-response because the “pursuit” would not be present. Any loss or injury as a result of this startle response would be incidental and not a population-wide effect. Animals control their movements to minimize risk. Loss rates have varied greatly in the few documented cases of injury or loss: mammals and raptors appear to have little susceptibility to those losses; the most significant losses have been observed among waterfowl. Panic responses typically habituate quickly and completely with fewer than five exposures (Bowles, 1997).

During a Titan II launch from SLC-4 at Vandenberg AFB, all snowy plovers flushed and settled in a somewhat different flock configuration. One-half mile south of the Santa Ynez River, no discernible response occurred during launch. The snowy plovers stood from roost sites and walked one meter from original roosting position. The reaction exhibited resembled the response to a perceived predator threat, including a return to normal behavior when the perceived threat had passed (Read, 1996a,b).

The startling effect of a sonic boom can be stressful to an animal. This reaction to stress causes physiological changes in the neural and endocrine systems including increased blood pressure and higher levels of available glucose and corticosteroids in the bloodstream. Continued disturbances and prolonged exposure to severe stress may deplete nutrients available to the animal.

Both physiological and behavioral responses to sonic booms have been examined among California pinnipeds (Manci et al., 1988). The physiological study demonstrated recognizable short-lived changes in hearing sensitivity due to minimum sonic boom overpressures. Longer temporary hearing losses are likely to occur for exposures greater than those tested (Manci et al., 1988).

Behaviorally, harbor seals, California sea lions, northern fur seals, and Guadalupe fur seals at the Channel Islands will react to sonic booms of any intensity, and many will move rapidly into the water depending on the season and amplitude of the boom. However, any observed response is usually short in duration. Elephant seals will startle in response to sonic booms of low intensity, but they resume normal behavior within a few minutes of the disturbance (Manci et al., 1988).

A launch effect of 127.4 dB (108.1 dBA) caused 20 of 23 of the Purisima Point harbor seals to flee into the water, and only 3 returned after 2.5 hours. At Rocky Point, 20 of 74 harbor seals fled into the water during a 103.9-dB (80-dBA) launch event, returning after 30 minutes. Another launch (98.7 to 101.8 dBA) caused almost all Rocky Point harbor seals ashore to flee into the water, after which 75 percent returned within 90 minutes (Tetra Tech, Inc., 1997).

Harbor seals, California sea lions, northern fur seals, and Guadalupe fur seals at the Channel Islands will startle in response to sonic booms of any intensity, and many will move rapidly into the water depending on the season and amplitude of the boom. However, any observed response is usually short-lived. Elephant seals will startle in response to sonic booms of low intensity, but they resume normal behavior within a few minutes of the disturbance (Manci et al., 1988).

Manatees are relatively unresponsive to human-generated noise to the point that they are often suspected of being deaf to oncoming boats (although their hearing is actually similar to that of pinnipeds) (Bullock et al., 1980). Since manatees spend most of their time below the surface, and since they do not startle readily, no effect of aircraft or launch vehicle overflights on manatees would be expected (Bowles et al., 1991).

The effect of launch noises on cetaceans appears to be somewhat attenuated by the air/water interface. The cetacean fauna in the area have been subjected to sonic booms from military aircraft for many years without apparent adverse effects (Tetra Tech, Inc., 1997).

Raptor response to sonic boom while nesting was investigated through the use of simulated booms in natural conditions. Response to sonic boom was fairly minimal (Ellis et al., 1991). The sonic booms generated for response testing were equivalent to impulse noises generated by supersonic jets in the medium- to high-altitude range (2,000-3,000 m). There was a total of seven raptor species tested including 84 individuals in various life stages. Of the individuals observed during sonic booms, 65 responses were insignificant. Adult response to the sonic boom usually resulted in flushing from the nest, although incubating or brooding adults never left the nesting area. Reactions among species did have some variation. The reproductive rates for the tested sites were at or above normal for both years of testing. Heart rate response to sonic booms were measured using captive peregrine falcons. Heart rates after sonic booms were at or below a heart rate level of a falcon returning from flight (Ellis et al., 1991). In a different study on adult peregrine falcons, the startle response was found to cause egg breakage of already thin eggshells (residual dichlorodiphenyltrichloroethane (DDT) effects) or cause young close to fledgling age to fledge prematurely, thus placing them at a particularly high risk of mortality (Read, 1996a). Peregrine falcons at the early nesting phase are not adversely impacted by Titan IV launches because the chicks are expected to crouch safely down in their nests rather than move toward the edge of the ledge (Read, 1996a).

A huge sooty tern nesting failure that occurred in the southern Florida Dry Tortugas colony in 1969 may have been a result of sonic booms that occurred on a daily basis (Austin et al., 1970). Birds had been observed to react to sonic booms in previous seasons with a panic flight, circling over the island momentarily and then usually settling down on their eggs again. Upon review, the nesting failure was attributed to be most likely due to the interruption of the incubation period and from nest abandonment.

3.0 NOISE MODELING

3.1 LAUNCH NOISE

On-pad and in-flight rocket noise was computed using the RNOISE model (Plotkin et al., 1997). Rocket noise prediction via this model consists of the following elements:

1. The total sound power output, spectral content and directivity is based on the in-flight noise model of Sutherland (1993). Noise emission is a function of thrust, nozzle exit gas velocity, nozzle exit diameter, and exhaust gas properties.

   Propagation from the vehicle to the ground accounts for Doppler shift, absorption of sound by the atmosphere (American National Standards Institute, 1978), inverse square law spreading, and attenuation of sound by the ground (Chien and Soroka, 1980). A semi-hard ground surface (1,000 mks rayls) was assumed.

2. One-third spectral levels were computed at the ground, for every flight trajectory point, on a grid of 3,721 points. ASEL and maximum A-weighted and overall sound levels were then derived from the results at each grid point.

The computed noise levels were then depicted as contours of equal level.

3.2 SONIC BOOM

Sonic boom was computed using the U.S. Air Force's PCBoom3 software (Plotkin, 1996). This is a full ray tracing model. Details of sonic boom theory are presented by Plotkin (1989) and Maglieri and Plotkin (1991). The specific approach to EELV sonic boom modeling included the following elements:

1. Trajectories provided by the vehicle manufacturers were converted into PCBoom3 TRJ format using PCBoom3's TRAJ2TRJ utility. This utility generated required higher derivatives, as well as converting file formats.

2. Vehicle F-functions were calculated using the method of Carlson (1978). Area distributions were obtained from vehicle drawings. The shape factors computed were used to obtain nominal N-wave F-functions.

3. The F-function associated with the plume was obtained using a combination of the Universal Plume Model (Jarvinen and Hill, 1970) and Tiegerman's (1975) hypersonic boom theory.

4. Ray tracing and signature evolution were computed by integration of the eiconal and Thomas's (1972) wave parameter method.

5. Focal zones were detected from the ray geometry, and focus signatures computed by applying Gill and Seebass's (1975) numerical solution.

The resultant sonic boom calculations were depicted as contours of constant overpressure (psf).

REFERENCES

American National Standards Institute, 1988. Quantities and Procedures for Description and Measurement of Environmental Sound, Part 1, ANSI S12.9-1988.

Austin, D.L., Jr., W.B. Robertson, Jr., and G.E. Woolfenden, 1970. Mass Hatching Failure in Dry Tortugas Sooty Terns (*Sterna fuscata*), K.H. Voous, editor. Proceedings of the 15th International Ornithological Congress, the Hague, Netherlands.

Bowles, A.E., 1997. Effects of Recreational Noise on Wildlife: An Update. Hubbs-Sea World Research Institute, San Diego, California.

Bowles, A., B. Tabachnick, and S. Fidell, 1991. Review of the Effects of Aircraft Overflights on Wildlife, Volume II of III: Technical Report. National Parks Service, Denver, Colorado.

Bullock, T.H., D.P. Donming, and R.C. Best, 1980. "Evoked Brain Potentials Demonstrate Hearing in a Manatee (*Trichechus inunguis*)," *Journal of Mammalogy* 61(1): 130-133.

Carlson, H.W., 1978. Simplified Sonic Boom Prediction, NASA TP 1122.

CHABA, 1981. Assessment of Community Noise Response to High-Energy Impulsive Sounds, Report of Working Group 84, Committee on Hearing, Bioacoustics and Biomechanics, Assembly of Behavioral and Social Sciences, National Research Council, National Academy of Sciences, Washington, DC.

Chien and Soroka, 1980. "A Note on the Calculation of Sound Propagation Along an Impedance Boundary," J. Sound Vib. 69, pp. 340-343.

Ellis, D.H., C.H. Ellis, and D.P. Mindell, 1991. Raptor Responses to Low-Level Jet Aircraft and Sonic Booms, Environmental Pollution 74.

Federal Interagency Committee on Noise, 1992. Federal Agency Review of Selected Airport Noise Analysis Issues, Federal Interagency Committee on Noise", August.

Fidell, S., D.S. Barger, and T.J. Schultz, 1991. "Updating a Dosage-Effect Relationship for the Prevalence of Annoyance Due to General Transportation Noise", Journal of the Acoustical Society of America, 89, pp. 221-223, January.

Finegold, L.S., C.S. Harris, and H.E. von Gierke, 1994. "Community Annoyance and Sleep Disturbance: Updated Criteria for Assessing the Impacts of General Transportation Noise on People", Noise Control Engineering Journal, Volume 42, Number 1, January-February 1994, pp. 25-30.

Gill, P.M., and A.R. Seebass, 1975. "Nonlinear Acoustic Behavior at a Caustic: An Approximate Solution", AIAA Progress in Aeronautics and Astronautics, H.J.T. Nagamatsu, Ed., MIT Press.

Guest, S. and R.M. Sloane, Jr., 1972. "Structural Damage Claims Resulting from Acoustic Environments Developed During Static Firing of Rocket Engines," presented at NASA Space Shuttle Technology Conference, San Antonio, Texas, April. Published as NASA Technical Memo NASA TM X-2570, July.

Haber, J. and D. Nakaki, 1989. Sonic Boom Damage to Conventional Structures, HSD-TR-89-001, April.

Jarvinen, P.O. and J.A.F. Hill, 1970. Universal Model for Underexpanded Rocket Plumes in Hypersonic Flow, Proceedings of the 12th JANNAF Liquid Meeting.

Maglieri D.J. and K.J. Plotkin, 1991. "Sonic Boom," Chapter 10, Aeroacoustics of Flight Vehicles, edited by H.H. Hubbard, NASA RP 1258 Vol. 1, pp. 519-561.

Manci, K.M., D.N. Gladwin, R. Villela, and M.G. Cavendish, 1988. Effects of Aircraft Noise and Sonic Booms on Domestic Animals and Wildlife: A Literature Synthesis, U.S. Fish and Wildlife Service National Ecology Research Center, Fort Collins, Colorado.

Moller, A., 1978. "Review of Animal Experiments," *H. Sound and Vibration* 59: 73-77 [Abstract].

Ollerhead, J.B., et al., 1992. Report of a Field Study of Aircraft Noise and Sleep Disturbance. The Department of Transport, Department of Safety Environment and Engineering. Civil Aviation Authority, London, December.

Pearsons, K.S., D.S. Barber, and B.G. Tabachick, 1989. Analysis of the Predictability of Noise-Induced Sleep Disturbance, HSD-TR-89-029, October.

Plotkin, K.J., 1989. "Review of Sonic Boom Theory," AIAA 89-1105.

Plotkin, K.J., 1993. "Sonic Boom Focal Zones from Tactical Aircraft Maneuvers," Journal of Aircraft, Volume 30, Number 1, January-February 1993.

Plotkin, K.J., 1996. PCBoom3 Sonic Boom Prediction Model: Version 1.0c, Wyle Research Report WR 95-22C, May.

Plotkin, K.J., L.C. Sutherland, and M. Moudou, 1997. Prediction of Rocket Noise Footprints During Boost Phase, AIAA 97-1660, May.

Read, N., 1996a. Titan IV Launch from SLC-4, 12 May 1996, Monitoring of Threatened and Endangered Species on Vandenberg Air Force Base. Natural Resources Section, 30 CES/CEVPN, Civil Engineering Environmental Management.

Read, N., 1996b. Titan IV Launch from SLC-4, 20 December 1996, Monitoring of Threatened and Endangered Species on Vandenberg Air Force Base. Natural Resources Section, 30 CES/CEVPN, Civil Engineering Environmental Management.

Schultz, T.J., 1978. "Synthesis of Social Surveys on Noise Annoyance", Journal of the Acoustical Society of America, 64, pp. 377-405, August.

Sutherland, L.C., 1968. Sonic and Vibration Environments for Ground Facilities - A Design Manual. Wyle Laboratories Research Report WR68-2, March.

Sutherland, L.C., 1993. Progress and Problems in Rocket Noise Prediction for Ground Facilities, AIAA 93-4383.

Tetra Tech, Inc., 1997. Final Environmental Assessment: Issuance of a Letter of Authorization for the Incidental Take of Marine Mammals for Programmatic Operations of Vandenberg AFB, California, July.

Thomas, C.L., 1972. Extrapolation of Sonic Boom Pressure Signatures by the Waveform Parameter Method. NASA TN D-6832, June.

Tiegerman, B., 1975. "Sonic Booms of Drag-Dominated Hypersonic Vehicles," Ph.D. Thesis, Cornell University, August.

U.S. Environmental Protection Agency, 1972. Information on Levels of Environmental Noise Requisite to Protect the Public Health and Welfare With an Adequate Margin of Safety, U.S. Environmental Protection Agency Report 550/9-74-004, March 1972.

von Gierke, H.R., 1990. The Noise-Induced Hearing Loss Problem, National Institute of Health Consensus Development Conference on Noise and Hearing Loss, Washington, DC, 22-24 January.

White, R., 1972. Effects of Repetitive Sonic Booms on Glass Breakage, FAA Report FAA-RD-72-43, April.

APPENDIX G

BIOLOGICAL RESOURCES

Table G-1. Plant and Animal Species Potentially Occurring in the Vicinity of Cape Canaveral AS
Page 1 of 6

Common Name	Scientific Name
Plants	
Water Plaintain Family	**Alismataceae**
Arrowheads	*Sagittaria* spp.
Sumac or Cashew Family	**Anacardiaceae**
Brazilian pepper	*Schinus terebinthifolius*
Poison ivy	*Toxicodendron radicans*
Custard Apple Family	**Annonaceae**
Pond apple	*Annona glabra*
Palm Family	**Arecaceae**
Palmetto	*Sabal* spp.
Cabbage palmetto	*Sabal palmetto*
Saw Palmetto	*Serenoa repens*
Milkweed Family	**Asclepiadaceae**
Curtiss' milkweed	*Asclepias curtissii*
Sunflower Family	**Asteraceae**
Groundsel tree	*Baccharis halmifolia*
Sea oxeye daisy	*Borrichia frutescens, B. arborescens*
Beach elder	*Iva imbricata*
Camphorweed	*Pluchea purpurascens*
Cactus Family	**Cactaceae**
Prickly pear	*Opuntia* spp.
Honeysuckle Family	**Capriofoliaceae**
Twinberry	*Locinera involucrata*
Rock Rose Family	**Cistaceae**
Nodding pinweed	*Lechea cernua*
Combretum Family	**Combretaceae**
Buttonwood	*Conocarpus erecta*
Morning Glory Family	**Convolvulaceae**
Railroad vine	*Ipomoea pes-caprae*
Cypress Family	**Cupressaceae**
Red cedar	*Juniperus virginiana*
Sedge Family	**Cyperaceae**
Sedges	*Carex* spp.
Crowberry Family	**Empetraceae**
Rosemary	*Ceratiola ericoides*
Spurge Family	**Euphorbiaceae**
Beach croton	*Croton* spp.
Oak Family	**Fagaceae**
Chapman's oak	*Quercus chapmanii*
Sand live oak	*Quercus geminata*

Table G-1. Plant and Animal Species Potentially Occurring in the Vicinity of Cape Canaveral AS
Page 2 of 6

Common Name	Scientific Name
Plants (Continued)	
Myrtle oak	*Quercus myrtifolia*
Live oak	*Quercus virginiana*
Gentian Family	**Gentianaceae**
Sabatia	*Sabatia* spp.
Laurel Family	**Lauraceae**
Red bay	*Persea borbonia*
Lily Family	**Liliaceae**
Catbrier	*Smilax* spp.
Mulberry Family	**Moraceae**
Strangler fig	*Ficus aurea*
Red mulberry	*Morus rubra*
Wax Myrtle Family	**Myricaceae**
Wax myrtle	*Myrica cerifera*
Myrsine Family	**Myrsinaceae**
Myrsine	*Myrsine quianensis*
Adder's Tongue Family	**Ophioglassaceae**
Hand fern	*Ophioglossum palmatum*
Pine Family	**Pinaceae**
Sand pine	*Pinus clausa*
Grass Family	**Poaceae**
Saltgrass	*Distichlis spicata*
Muhly grass	*Muhlenbergia* spp.
Cuban shoal grass	*Halodule wrightii*
Beach cordgrass	*Spartina* spp.
Sea oats	*Uniola paniculata*
Buckwheat Family	**Polygonaceae**
Sea grapes	*Coccoloba uvifera*
Buckthorn Family	**Rhamnaceae**
Buckthorn	*Rhamnus caroliniana*
Tough buckthorn	*Rhamnus* spp.
Rose Family	**Rosaceae**
Carolina Laurelcherry	*Prunus caroliniana*
Rue Family	**Rutaceae**
Hercules' club	*Zanthoxylem clava-herculis*
Willow Family	**Salicaceae**
Willows	*Salix* spp.
Soapberry Family	**Sapindaceae**
Varnish leaf	*Dodoneae viscosa*
Sapodilla Family	**Sapotaceae**
Satin leaf	*Chrysophyllum oliviforme*

Table G-1. Plant and Animal Species Potentially Occurring in the Vicinity of Cape Canaveral AS
Page 3 of 6

Common Name	Scientific Name
Plants (Continued)	
Bald Cypress Family	**Taxodiaceae**
Cypress tree	*Taxodium* spp.
Cattail Family	**Typhaceae**
Cattail	*Typha* spp.
Elm Family	**Ulmaceae**
Hackberry	*Celtis* spp.
American elm	*Ulmas americana*
Vervain Family	**Verbinaceae**
Black mangrove	*Avicennia germinans*
Mangrove	*Avicennia, Laguculari, Rhizophora* spp.
Coastal vervain	*Glandulareia maritima*
White mangrove	*Laguculari racemosa*
Grape Family	**Vitaceae**
Virginia creeper	*Parthenocissus quinquefolia*
Muscadine grape	*Vitis rotundifolia*
Animals	
Mammals	
Feral pig (swine)	*Sus* spp.
Sei whale	*Baeaenoptera borealis*
Finback whale	*Balaenoptera physalus*
Armadillo	*Dasypus novemcinctus*
Northern right whale	*Eubalaena glacialis*
Domestic cat	*Felis domesticus*
Bobcat	*Lynx rufus*
Humpback whale	*Megaptera novaeangliae*
Long-tailed weasel	*Mustela frenata*
White-tailed deer	*Odocoileus virginianus*
Round-tailed muskrat	*Ondatra zibethicus*
Southeastern beach mouse	*Peromyscus polionotus niveiventris*
Sperm whale	*Physeter catodon*
Florida mouse	*Podomys floridanus*
Raccoon	*Procyon lotor*
Rats	*Rattus* spp.
Spotted dolphin	*Stenelle dubia*
Manatee	*Trichechus manatus*
Bottlenose dolphin	*Tursiops truncatus*

Table G-1. Plant and Animal Species Potentially Occurring in the Vicinity of Cape Canaveral AS

Common Name	Scientific Name
Birds	
Sharp-shinned hawk	*Accipiter striatus*
Spotted sandpiper	*Actitis macularia*
Roseate spoonbill	*Ajaia ajaja*
Florida scrub jay	*Aphelocoma coerulescens coerulescens*
Great blue heron	*Ardea herodias*
Ruddy turnstone	*Arenaria interpres*
Red-tailed hawk	*Buteo jamaicensis*
Northern cardinal	*Cardinalis cardinalis*
Turkey vulture	*Cathartes aura*
Willet	*Catotrophorus semipalmatus*
Piping plover	*Charadrius melodus*
Common ground dove	*Columbina passerina*
Fish crow	*Corvus ossifragus*
Blue jay	*Cyanocitta cristata*
Black-throated blue warbler	*Dendroica caerulescens*
Blackpoll warbler	*Dendroica striata*
Gray catbird	*Dumetella carolinenses*
Little blue heron	*Egretta caerulea*
Peregrine falcon	*Falco perigrinus*
Southeastern American kestrel	*Falco sparverius paulus*
Bald eagle	*Haliaetus leucocephalus*
Black-necked stilt	*Himantopus mexicanus*
Barn swallow	*Hirundo rustica*
Red-bellied woodpecker	*Melanerpes carolinus*
Northern mockingbird	*Mimus polyglottus*
Black-and-white warbler	*Mniotilta varia*
Wood stork	*Mycteria americana*
Osprey	*Pandion haliaetus*
Downy woodpecker	*Pecoides pubescens*
Brown pelican	*Pelicanus occidentalis*
Rufous-sided towhee	*Pipilo erythrophthalmus*
Common grackel	*Quiscalus mexicanus*
Ovenbird	*Seirus aurocapillus*
American redstart	*Setophaga ruticilla*
Least tern	*Sterna antillarum*
Caspian tern	*Sterna caspia*
House wren	*Troglodytes aedon*
Eastern kingbird	*Tyrannus tyrannus*
Blue-winged warbler	*Vermivora pinus*
Yellow-throated vireo	*Vireo flavifrons*
Red-eyed vireo	*Vireo olivaceus*
Mourning dove	*Zenaida macroura*

Table G-1. Plant and Animal Species Potentially Occurring in the Vicinity of Cape Canaveral AS

Common Name	Scientific Name
Amphibians and Reptiles	
American alligator	*Alligator mississippiensis*
Green anole	*Anolis carolinensis*
Florida softshell	*Apalone* spp.
Atlantic loggerhead sea turtle	*Caretta caretta*
Green sea turtle	*Chelonia mydas*
Six-lined racerunner	*Cnemidophorus sexlineatus*
Racer	*Coluber constrictor*
Leatherback sea turtle	*Dermochelys coriacea*
Southern ringneck snake	*Diadophis punctatus*
Eastern indigo snake	*Drymarchon corais couperi*
Hawksbill sea turtle	*Eretmochelys imbricata imbricata*
Broadhead skink	*Eumeces laticeps*
Eastern narrow-mouthed toad	*Gastroophryne carolinensis*
Gopher tortoise	*Gopherus polyphemus*
Green treefrog	*Hyla cinerea*
Squirrel frog	*Hyla squirella*
Atlantic (Kemp's) Ridley sea turtle	*Lepidochelys kempi*
Eastern coachwhip	*Masticophis flagellum*
Mangrove salt marsh snake	*Nerodia clarkii compressicauda*
Gopher frog	*Rana capito*
Southern leopard frog	*Rana utricularia*
Spade-foot toad	*Scaphiopus holbrookii holbrookii*
Florida box turtle	*Terrapene carolina*
Fish	
Bay anchovy	*Anchoa mitchilli*
Sheepshead	*Archosargus probatorephalus*
Spotted seatrout	*Cynoscion nebulosus*
Sheepshead minnow	*Cyprinodon variegatus*
Killfish	*Cyprinodontidae*
Ladyfish	*Elops sauras*
Topminnow	*Fundulus lineolatus, or F. chrysotus*
Pinfish	*Lagodon rhomboides*
Spot	*Leiostomus xanthurus*
Garfish	*Lepisosteus* spp.
Bluegill	*Lepomis macrochirus*
Gray snapper	*Lutjanus griseus*
Atlantic silversides	*Menidia menidia*
Largemouth bass	*Micropterus salmoides*
Striped mallet	*Mugil cephalus*

Table G-1. Plant and Animal Species Potentially Occurring in the Vicinity of Cape Canaveral AS
Page 6 of 6

Common Name	Scientific Name
Fish (Continued)	
Sailfin molly	*Poecilia latipinna*
Black drum	*Sciaenops ocellata*

Sources: Florida Natural Areas Inventory, 1996b; National Aeronautics and Space Administration, 1995c, 1996; Nelson et al., 1991.

Table G-2. Plant and Animal Species Potentially Occurring in the Vicinity of Vandenberg AFB
Page 1 of 7

Common name	Scientific name
Plants	
Fig-Marigold Family	**Aizoaceae**
Hottentot fig	*Carpobrotus eludis*
Sumac or Cashew Family	**Anacardiaceae**
Poison oak	*Toxicodendron diversilobilum*
Sunflower Family	**Asteraceae**
California sagebrush	*Artemisia californica*
Coyote brush	*Baccharis pilularis*
La Graciosa thistle	*Cirsium loncholepis*
Surf thistle	*Cirsium rhothophylum*
Mock heather	*Ericameria ericoides*
Goldenbush	*Isocoma menziesii*
Deer Fern Family	**Blechnaceae**
Beach layia	*Layia carnosa*
Borage Family	**Boraginaceae**
Large-flowered fiddleneck	*Amsinckia* spp.
Mustard Family	**Brassicaceae**
Black mustard	*Brassica nigra*
Beach spectaclepod	*Dithyrea maritima*
Gambel's watercress	*Rorippa gambelli*
Honeysuckle Family	**Caprifoliaceae**
Twinberry	*Lonicera involucrata*
Pink Family	**Caryophyllaceae**
Marsh sandwort	*Arenaria paludicola*
Goosefoot Family	**Chenopodiaceae**
California goosefoot	*Chenopodium californicum*
Cypress Family	**Cupressaceae**
Monterey cypress	*Cupressus macrocarpa*
Sedge Family	**Cyperaceae**
Bullrushes	*Scirpus* spp.
Tule	*Scirpus validus*
Heath Family	**Ericacae**
Purisma manzanita	*Arctostaphylos purissima*
Sand mesa manzanita	*Arctostaphylos rudis*
Shagbark manzanita	*Arctostaphylos* spp.
Salal	*Gaultheria shallon*
Huckleberry	*Vaccinium ovatum*
Legume Family	**Fabaceae**
Locoweed	*Astragalus* spp.
Deerweed	*Lotus scoparius*
Lupine	*Lupinus* spp.

Table G-2. Plant and Animal Species Potentially Occurring in the Vicinity of Vandenberg AFB

Common name	Scientific name
Plants (Continued)	
Tomcat clover	*Trifolium wildenovii*
Vetch	*Vicia* spp.
Oak Family	**Fagaceae**
Santa Cruz Island oak	*Quercus parvula*
Geranium Family	**Geraniaceae**
Filaree	*Erodium brachycarpum*
Waterleaf Family	**Hydrophyllaceae**
Lompoc yerba santa	*Eriodictyon capitatum*
Iris Family	**Iridaceae**
Blue-eyed grass	*Sisrinchium bellum*
Arrow Grass Family	**Juncaginaceae**
Crisp Monardella	*Monardella crispa*
San Luis Obispo monardella	*Monardella frutescens*
Myrtle Family	**Myrtaceae**
Eucalyptus	*Eucalyptus*
Blue eucalyptus	*Eucalyptus globulus*
Grass Family	**Poaceae**
Wild oats	*Avena fatua*
Brome	*Bromus* spp.
Veldt grass	*Ehrharta calycina*
Fescue	*Festuca arundinacea*
Giant wild rye	*Leymus condensatus*
Needle-grass	*Nassella carnua*
Buttercup Family	**Ranunculaceae**
Blochman's delphinium	*Delphinium parryi*
Dune delphinium	*Delphinium* spp.
Buckthorn Family	**Rhamnaceae**
Coast ceanothus	*Ceanothus* spp.
Santa Barbara ceanothus	*Ceanothus* spp.
Rose Family	**Rosaceae**
Chamise	*Adenostoma fasciculatum*
Kellogg's horkelia	*Horkelia* spp.
Blackberry	*Robus ursinas*
Willow Family	**Salicaceae**
Arroyo willow	*Salix lasiolepis*
Figwort Family	**Scrophulariaceae**
Owl's clover	*Castilleja attenuata, C. exserta, C. densiflora*
Seaside's bird's beak	*Cordylanthus rigidus* spp. *littoralis*
Lompoc bush monkeyflower	*Mimulus aurantiacus*
Black flowered figfort	*Scrophularia atrata*
Cattail Family	**Typhaceae**
Cattails	*Typha* spp.

Table G-2. Plant and Animal Species Potentially Occurring in the Vicinity of Vandenberg AFB
Page 3 of 7

Common name	Scientific name
Plants (Continued)	
Nettle Family	**Urticaceae**
Stinging nettle	*Uritica dioica*
Creek nettle	*Uritica holoserica*
Animals	
Mammals	
Guadalupe fur seal	*Arctocephalus townsendi*
Sei whale	*Baeaenoptera borealis*
Right whale	*Balaena glacialis*
Blue whale	*Balaenoptera musculus*
Finback whale	*Balaenoptera physalus*
Northern fur seal	*Callorhinus ursinus*
Coyote	*Canis latrans*
California ground squirrel	*Citellus variegatus*
Virginia opossum	*Didelphis virginiana*
Heerman's kangaroo rat	*Dipodomys heermanni*
Sea otter	*Enhydra lutris*
Southern sea otter	*Enhydra lutris nereis*
Grey whale	*Eschrichtius gibbosus*
Stellar sea lion	*Eumetopias jubatus*
Mountain lion	*Felis concolor*
Jackrabbit	*Lepus californicus*
Bobcat	*Lynx rufus*
Humpback whale	*Megaptera novaeangliae*
Striped skunk	*Mephitis mephitis*
Elephant seals	*Mirounga agustirostris*
Northern elephant seal	*Mirounga angustirostris*
Long-tailed weasel	*Mustela frenata*
Dusky-footed woodrat	*Neotoma fuscipes*
Desert woodrat	*Neotoma lepida*
Mule deer	*Odocoileus hemionus*
California pocket mouse	*Perognathus californicus*
California mouse	*Peromyscus eremicus*
Harbor seal	*Phoca vitulina*
Sperm whale	*Physeter catadon*
Raccoon	*Procyon lotor*
Ornate shrew	*Soex ornatus*
Trowbridge shrew	*Sorex trowbridgei*
Feral pig	*Sus scrofa*
Desert cottontail	*Sylvilagus auduboni*
Brush rabbit	*Sylvilagus bachmani*

Table G-2. Plant and Animal Species Potentially Occurring in the Vicinity of Vandenberg AFB
Page 4 of 7

Common name	Scientific name
Mammals (Continued)	
Badger	*Taxidea taxis*
Botta's pocket gopher	*Thommomys bottae*
California sea lion	*Zalophus californianus*
Birds	
Cooper's hawk	*Accipiter cooperii*
Southern California Rufous crowned sparrow	*Aimophila ruficeps*
Scrub jay	*Alphelocoma coerulescens*
Grasshopper sparrow	*Ammodramus savannarum*
Bell's sage sparrow	*Amphispiza belli*
Black-chinned hummingbird	*Archilochus alexandri*
Short-eared owl	*Asio flammeus*
Long-eared owl	*Asio otis*
Brant	*Branta bernicla*
Great-horned owl	*Bubo virginianus*
Red-tailed hawk	*Buteo jamaicensis*
Red-shouldered hawk	*Buteo lineatus*
Ferruginous hawk	*Buteo regalis*
California quail	*Callipepla gambelii*
Costa's hummingbird	*Calypte costae*
Pine siskin	*Carduelis pinus*
House finches	*Carpodacus mexicanus*
Swainson's thrush	*Catharus guttatus*
Hermit thrush	*Catharus guttatus*
Pigeon guillemot	*Cepphus columba*
Wrentit	*Chamaea fasciata*
Western snowy plover	*Charadrius alexandrinus nivosus*
Northern harrier	*Circus cyaneus*
Anna's hummingbird	*Clypte anna*
Western yellow-billed cuckoo	*Coccyzus americanus occidentalis*
Western wood peewee	*Contopus sordidulus*
Yellow-rumped warbler	*Dendroica coronata*
White-tailed kite	*Elanus leucurus*
Southwestern willow flycatcher	*Empidonax traillii extimus*
California horned lark	*Eremophila alpestris*
Merlin	*Falco columbarius*
Prairie falcon	*Falco mexicanus*
American peregrine falcon	*Falco peregrinus anatum*
American kestrel	*Falco sparverius*
Arctic loon	*Gavia arctica*
Loon	*Gavia immer*

Table G-2. Plant and Animal Species Potentially Occurring in the Vicinity of Vandenberg AFB
Page 5 of 7

Common name	Scientific name
Birds (Continued)	
Roadrunner	*Geococyx californianus*
Common yellowthroat	*Geothlypis trichas*
Southern bald eagle	*Haliaeetus leucocephalus*
Oriole	*Icterus* spp.
Loggerhead shrike	*Lanius ludovicianus*
Western gull	*Larus occidentalis*
Bonaparte’s gull	*Larus philadelphia*
Gulls	*Larus* spp.
California black rail	*Laterallus jamaicensus coturniculus*
Song Sparrow	*Melospiza melodia*
Brown-headed cowbird	*Molothrus ater*
Long-billed curlew	*Numenius americanus*
Ashy storm-petrel	*Oceanodroma homochroa*
Leach’s storm-petrel	*Oceanodroma luecorhoa*
Savannah sparrow	*Passerculus sandwichensis*
Belding’s savannah sparrow	*Passerculus sandwichensis beldingi*
California brown pelican	*Pelacanus occidentalis californicus*
Brown Pelican	*Pelecanus occidentalis*
Double-crested	*Phalacrocorax auritus*
Pelagic cormorant	*Phalacrocorax pelagicus*
Brandt’s cormorant	*Phalacrocorax penicillatus*
Red-necked phalarope	*Phalaropas lobatus*
Red phalarope	*Phalaropus fulicaria*
Black headed grosbeak	*Pheucticus melanocephalus*
Nutall’s woodpecker	*Picoides nuttallii*
Downy woodpecker	*Picoides pubescens*
Hairy woodpecker	*Picoides villosus*
California towhee	*Pipilo crissalis*
Spotted towhee	*Pipilo erythrophthalmus*
Cassin’s auklet	*Ptychoramphus aleuticus*
Ruby-crowned kinglet	*Regalus calendula*
Kinglet	*Regulus* spp.
Black phoebe	*Sayornis nigricans*
Burrowing owl	*Speotyto cunicularia*
California least	*Sterna antillarum browni*
Elegant tern	*Sterna elegans*
Western meadowlarks	*Sturnella neglecta*
European starling	*Sturnus vulgaris*
Tree swallow	*Tachycineta bicolor*
Bewick’s wren	*Thryomanes bewickii*
California thrasher	*Toxostoma redivivum*
American robin	*Turdus migratorius*

Table G-2. Plant and Animal Species Potentially Occurring in the Vicinity of Vandenberg AFB

Common name	Scientific name
Birds (Continued)	
Barn owl	*Tyto alba*
Common murre	*Uria aalge*
Least Bell's vireo	*Vireo bellii pusillus*
Warbling vireo	*Vireo gilvus*
Hutton's Vireo	*Vireo huttoni*
Wilson's warbler	*Wislonia pusilla*
White-crowned sparrow	*Zonotrichea leucophrys*
Amphibians and Reptiles	
California tiger salamander	*Ambystoma californiense*
Blackbelly slender salamander	*Batrachoseps nigriventris*
Western toad	*Bufo boreas*
Loggerhead sea turtle	*Caretta caretta*
Green sea turtle	*Chelonia mydas*
Southwestern pond turtle	*Clemmys marmorata*
Leatherback sea turtle	*Dermochelys coriacea*
Ensatina	*Ensatina eschscholtzii*
Western skink	*Eumeces skiltonianus*
Southern alligator lizard	*Gerrhonotus multicarinatus*
Pacific treefrog	*Hyla regilla*
Common kingsnake	*Lampropeltis getula*
Pacific Ridley sea turtle	*Lepidochelys olivacea*
Gopher snake	*Pituophis melanoleucus*
Pacific chorus frog	*Psuedacris regilla*
California red-legged frog	*Rana aurora draytonii*
Bullfrog	*Rana catesbeina*
Western fence lizard	*Sceloporus occidentalis*
Two-striped garter snake	*Thamnophis hamondii*
Common garter snake	*Thamnophis sirtalis*
Southern Pacific rattlesnake	*Crotalus viridis helleri*
Fish	
Topsmelt	*Atherinops affinis*
Pacific herring	*Clupea harengus*
Tidewater goby	*Eucyclogobius newberryi*
Mosquito fish	*Gambusia affinis*
Threespine stickleback	*Gasterosteus aculeatus microcephalus*
Unarmored threespine stickleback	*Gasterostreus aculeatus williamsonii*
Arroyo chub	*Gila orcutti*
Walleye surfperch	*Hyperprosopon argenteum*
Bluegill sunfish	*Lepomis macrochirus*

Table G-2. Plant and Animal Species Potentially Occurring in the Vicinity of Vandenberg AFB
Page 7 of 7

Common name	Scientific name
Fish (Continued)	
Bass	*Micropteras* spp.
Fathead minnow	*Pimephales promelas*
Starry flounder	*Platicthys stellatus*
Pile surfperch	R. *vacca*
Steelhead trout	*Oncorhynchus mykiss irideus*
Invertebrates	
Abalone	
Polychaete (marine) worms	*Auxiothella rubrocincta, Lumbrineris zonata*
Burrowing shrimp	*Callianasa californiensis*
Snail	*Gastropoda* spp.
Marine snail	*Mitrella carinata*
Seastar	*Patiria miniata*
Stonefly	*Plecoptera* spp.
Clam	*Tellina modesta*
Caddisfly	*Trichoptera* spp.

Sources: Christopher, 1996a, 1996b; Holmgren and Collins, 1995; U.S. Air Force, 1978, 1989a, 1994c; Versar, 1991.

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APPENDIX H

SUMMARY OF REQUEST FOR LETTER OF AUTHORIZATION FOR THE INCIDENTAL TAKE OF MARINE MAMMALS FOR PROGRAMMATIC OPERATIONS AT VANDENBERG AIR FORCE BASE, CALIFORNIA

Introduction

Vandenberg Air Force Base (AFB) submitted a request on July 11, 1997, to the National Marine Fisheries Service (NMFS) for a 5-year Letter of Authorization for the Incidental Take of Marine Mammals for Programmatic Operations on base. The purpose of the request is to eliminate the need to obtain 1-year permits for each programmatic operation and to receive instead a 5-year incidental take permit under Section 101(a)(5)(A) of the Marine Mammal Protection Act for all programmatic operations on Vandenberg AFB. The Air Force will be coordinating with the NMFS to determine whether the proposed EELV activities would be included under the conditions of such a permit. In support of this request, an Environmental Assessment was prepared by Vandenberg AFB to address potential noise impacts from actions proposed under the permit. The environmental assessment includes: coastal habitat of Vandenberg AFB, adjacent coastal waters, the northern Channel Islands, and the marine mammals that utilize these areas.

Included Activities

The application document addresses noise-related impacts from the following operations on Vandenberg AFB:

- Activities addressed under previous harassment permit applications, including:
    - The launch of Lockheed Martin Launch Vehicles from Space Launch Complex 6 (SLC-6)
    - The launch of McDonnell Douglas Aerospace Delta II rockets from SLC-2W
    - The launches of Titan II and Titan IV rockets from SLC-4
    - The launch of Taurus rockets from Launch Support Complex 576-E
- Flight test operations, which maintain a 1,000-foot bubble (standoff distance) around pinniped colonies
- The helicopter operations of the 76th Rescue Flight (Helicopter Flight) (for pad security, range safety/security, and aerial photography), which maintain a 1,000-foot bubble (standoff distance) around pinniped colonies
- Launch programs, including those listed above, the upper-limit activity level of which comprises approximately 10 ballistic and 20 space launches per year (a maximum of 100 space launches throughout the course of the permit), for a maximum of 30 launches per year.

Affected Marine Mammal Species

Marine mammals that could be affected by the programmatic activities on Vandenberg AFB include 6 species of pinnipeds (i.e., seals and sea lions) and 29 species of cetaceans (i.e., whales and dolphins).

The seals and sea lions in the area use the coastal habitat on Vandenberg AFB, the Channel Islands, and the surrounding waters for resting or hauling out and breeding. Pinniped species common to the area include California sea lions (*Zalophus californianus californianus*), Pacific harbor seals (*Phoca vitulina*), northern elephant seals (*Mirounga angustirostris*) and northern fur seals (*Callorhinus ursinus*). All four species are known to breed in rookeries on the Channel Islands, in highest density at San Miguel Island. Guadalupe fur seals (*Arctocephalus townsendi*) and Stellar sea lions (*Eumetopias jubatas*) are found in the Santa Barbara Channel and at haul-out sites but are not known to breed in the area. Pinnipeds are most prevalent around the Channel Islands during the molting and breeding seasons.

Haul-out sites on base include Purisima Point and Rocky Point, used primarily by harbor seals, and Point Sal, which is used essentially by California sea lions, although northern elephant seals, California sea lions, and harbor seals can be seen along any area of the Vandenberg AFB coastline.

Cetaceans including toothed whales, dolphins, and baleen whales use the waters off the coast of California and near the Channel Islands as migration routes. Cetaceans are most often found to use waters at depths between 600 and 6,000 feet over the continental slope. Dolphins, killer whales (*Orcinus orca*), and some species of porpoise are common off the coast of Vandenberg AFB and the Channel Islands year-round.

Noise Impacts

Noise is generally defined as undesirable sound that affects and may interfere with wildlife and human normal activity and that diminishes the quality of the environment. Airborne noise measurements are often expressed as broadband A-weighted sound levels, expressed in dBA. The A-weighting scale approximates the hearing sensitivity of humans at low sound levels. The C-weighted scale is useful for sonic boom analysis because it emphasizes the lower frequencies. However, harbor seals are known to respond to a higher range of frequencies than humans.

Flight test operations will not reach supersonic speeds and thus will not create sonic booms, although many high-performance jets are extremely noisy, especially when using the afterburners. Launches, however, will include sonic boom. Generally, four types of noise are associated with the operation of launch vehicles. They are:

- Combustion noise from the launch vehicle chambers
- Jet noise from the interaction of the exhaust jet and the atmosphere
- Combustion noise from the post-burning of combustion products
- Sonic booms.

The period of maximum noise production during a launch will be less than 1 minute. Brief periods of engine noise from overflights, launches, and helicopters during pre-launch surveillance will also occur. Although of short duration, this noise may be sufficient to create a startle response in animals.

Generally, there has been little research on noise impacts on pinnipeds. Impacts may include auditory interference by masking average hearing capabilities, behavioral disruption, causing pinnipeds to stop their immediate behavior, and possible long-term effects that include temporary and permanent threshold shift in hearing.

Sonic boom from a launch can potentially impact pinniped and cetacean populations. Sonic booms are impulse noises with sharp initial peaks of sound pressure. The Titan IV rocket has the greatest potential to impact marine mammals. Cetaceans may also exhibit a startle response to launch noise. There is some indication that refraction from water may attenuate noise levels.

Habitat Impacts

The habitat of these animals is not expected to be impacted. No loss of critical or preferred habitat is expected due to ongoing operations at Vandenberg AFB. Any impacts to the population sizes of marine mammals due to habitat loss is not expected.

Mitigation and Monitoring

Mitigation measures for both flight tests and helicopter flight operations will be both spatial and temporal. A continual 1,000-foot standoff distance will be maintained around rookeries on base at Point Sal, Purisima Point, and Rocky Point. The only exceptions to this standoff distance would be emergency response or real-time security incidents. When feasible, launch windows will be scheduled outside of the pupping season and at night.

Monitoring to record any impacts due to launches will be performed at one of the on-base rookeries closest to the launch site. It will begin 72 hours prior to launch and will continue 48 hours after the launch. If a sonic boom could impact areas on the northern Channel Islands, those areas will be monitored. Monitoring results will be submitted in report form to the NMFS. If the monitoring shows mortalities or decreased reproductive levels during pupping season, the Air Force and NMFS will develop mitigation measures at that time.

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APPENDIX I

DESCRIPTION OF HISTORIC PROPERTIES[(a)] POTENTIALLY AFFECTED BY EELV ACTIVITIES

1.0 CONCEPT A

1.1 Cape Canaveral Air Station/Kennedy Space Center, Florida

1.1.1 Archaeological Sites

8BR914 - Multi-component site associated with the St. John's II period (AD 800-1565). Associated artifacts include aboriginal ceramics, animal bone, and shell food remains.

1.1.2 Buildings And Structures

The eligibility of Space Launch Complex (SLC)-41, the Launch Operations Control Center (Building 27220), Hangar J (Building 1721), and the Missile Inert Storage (MIS) Building (Building 75251) is pending.

1.2 Vandenberg Air Force Base, California

1.2.1 Archaeological Sites

SBA 534 - Site SBA 534 is located in close proximity to the proposed modifications of the intersection of Bear Creek and Coast roads. Associated artifacts include a dense scattering of lithic debris and several hammerstone fragments.

1.2.2 Buildings And Structures

SLC-3W. SLC-3W is eligible for the National Register of Historic Places (National Register) under the Cold War historic context as a highly technical and scientific facility. Contributing features include the Mobile Service Tower (MST), the umbilical mast, the retention basin and deluge channel, and Building 770. The launch operations facility and the launch vehicle support facility are also contributing as shared elements with SLC-3E.[1]

[(a)] National Register-listed-eligible, and potentially eligible sites, buildings, and structures

2.0 CONCEPT B

2.1 Cape Canaveral Air Station, Florida

2.1.1 Archaeological Sites

SLC-37 Sites. Six sites are located near SLC-37. Three of the sites have been determined to be potentially eligible for inclusion in the National Register (described below); the remaining three sites (8BR219, 8BR237, and 8BR1636) have been determined to be ineligible (New South Associates, 1996).

8BR82A - Possible habitat or homestead site associated with the Malabar I, II, and Protohistoric Periods (BC 300-1700) and Cape Canaveral's 19th and 20th century growth. Associated artifacts include aboriginal ceramics, historic bottle and glass fragments, wire nails, and metal fragments.

8BR83 - Burial mound associated with the Malabar I and II Periods (BC 300-AD1400). The mound is approximately 75 feet in diameter and 6 feet in height. Associated artifacts include four burials, one of which contains historic glass fragments.

8BR221 - Possible habitat or homestead site associated with the Malabar II period (AD 700-1400). Associated artifacts include aboriginal and historic ceramics, shell and glass fragments, and a subsurface midden.

2.1.2 Buildings And Structures

The eligibility of Hangar C and the Air Force Roll-on/Roll-off Dock is pending.

2.2 Vandenberg Air Force Base, California

2.2.1 Archaeological Sites

SLC-6 Sites - Fifteen sites are located near SLC-6. Six of the sites have been determined to be eligible or potentially eligible for inclusion in the National Register (described below); five have been determined not to be eligible (SBA 1106, 1148, 2217, 2218, and 2219); the remaining four are unevaluated (SBA 1105, 1113, 1678, and 2215).

SBA 1107 - A small historical dump containing a large, whole abalone shell, stove parts, and broken dishes.

SBA 1108 - A lithic and shell process site.

SBA 1109 - A short-term occupation site with a moderate density of shell and chert debitage.

SBA 1110 - A moderate density scatter of shell and chert debitage.

SBA 1686 - A large site containing over 6,000 lithic fragments, including manos, hammerstones, large chert cores, projectile points, and knife fragments.

SBA 2032 - A short-term habitation site or seasonal residential base. Artifacts include manos, anvil stones, chert knives, and projectile point fragments.

3.0 CONCEPT A/B

3.1 Cape Canaveral Air Station, Florida

3.1.1 Archaeological Sites

As described under Concepts A and B combined.

3.1.2 Buildings And Structures

As described under Concepts A and B combined.

3.2 Vandenberg Air Force Base, California

3.2.1 Archaeological Sites

As described under Concepts A and B combined.

3.2.2 Buildings And Structures

As described under Concepts A and B combined.

4.0 NO-ACTION ALTERNATIVE

4.1 Cape Canaveral Air Station, Florida

4.1.1 Archaeological Sites

None.

4.1.2 Buildings And Structures

Selection of the No-Action Alternative at Cape Canaveral AS requires the continued use of facilities that currently support medium and heavy launch vehicle programs (SLCs 17, 36, 40, and 41). Of these facilities, two, SLCs 17 and 36, have been determined to be eligible for inclusion in the National Register.

SLC-17. Constructed in 1957, SLC-17 is the oldest continuously active launch complex at Cape Canaveral AS. More satellites have been launched from this complex than from any other location in the United States, including the Thor weapons system, America's first operational intercontinental ballistic missile (ICBM). Historic American Buildings Survey/Historic American Engineering Record (HABS/HAER) recordation of SLC-17 is in progress.

SLC-36. SLC-36 was built as an Atlas/Centaur launch facility for NASA to launch weather and communications satellites. HABS/HAER recordation has been completed.

4.2 Vandenberg AFB, California

4.2.1 Archaeological Sites

None.

4.2.2 Buildings And Structures

Selection of the No-Action Alternative at Vandenberg AFB requires the continued use of two facilities that currently support medium and heavy launch vehicle programs. Elements of all three of these facilities have been determined to be eligible for inclusion in the National Register under the Cold War historic context.

SLC-2W. SLC-2W directly supported operational missions of exceptionally important Cold War programs. Contributing elements of SLC-2W include the blockhouse, the MST, two trailer shelters, the tank farm, the fixed umbilical tower, the flame bucket/flame trench, the cableway, and several propellant transfer units.

SLC-3E. Along with SLC-3W, SLC-3E qualifies as a highly technical and scientific facility that directly supported exceptionally significant operational missions of the Cold War era. Contributing elements of SLC-3E include the launch and service facility, the MST and umbilical mast, the retention basin, and the deluge channel. SLC-3E shares two other National Register-eligible buildings with SLC-3W: the launch operations facility and the launch vehicle support facility.

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APPENDIX J

AIR QUALITY METHODS OF ANALYSIS

1.0 LAUNCH SUPPORT EMISSIONS

Air quality analysis methods for launch support operations involve estimation of emissions and an assessment of emissions impact. To allow comparison of the different options (baseline, Concept A, Concept B, Concept A/B, No-Action Alternative), similar calculation methods have been used for each option to the extent feasible.

The baseline year for the air quality analysis is 1995, which is the most recent year for which detailed emissions information was available at the time of the analysis. Emissions were totaled for sources associated with the Evolved Expendable Launch Vehicle (EELV) program. Unrelated activities that occur at Cape Canaveral Air Station (AS), Florida and Vandenberg Air Force Base (AFB), California were not included in the comparisons.

The individual launch schedules (Concept A or Concept B going forward, Concept A/B going forward, and the No-Action Alternative) have different numbers of launches predicted for each year. For example, in 2007, the one-contractor option includes 29 launches, the two-contractor option includes 30 launches, and the No-Action Alternative includes 13 launches. Since the annual emission rate is dependent upon the number of launches, a direct comparison of the annual emissions from the different options can be misleading because it is not an "apples to apples" comparison. For example, the No-Action Alternative launch schedule does not include any commercial launches.

Throughout the calculations, emission calculations for volatile organic compounds (VOCs) and particulates are handled as consistently as possible. For Vandenberg AFB, several information sources identify "ROC" for reactive organic compounds, instead of "VOC" for volatile organic compounds. For all practical purposes, these two terms can be considered equivalent. The federal government generally uses the term VOC, which is defined in part in Title 40 Code of Federal Regulations (CFR) 60.2 as "any organic compound which participates in atmospheric photochemical reactions." The term VOC has been chosen for use in this environmental impact statement (EIS). When using emission factors that list emissions as "total hydrocarbons" and "total non-methane hydrocarbons", "total non-methane hydrocarbons" has been utilized in this EIS as a VOC equivalent. Methane does not participate in atmospheric photochemical reactions and therefore does not fall under the definition of VOC. While there are other hydrocarbons which similarly do not fall under the VOC definition, the use of "total non-methane hydrocarbons" as a VOC equivalent is considered conservative and appropriate.

Particulate emissions are quantified as consistently as possible as particulate matter equal to or less than 10 microns in diameter (PM_{10}). In circumstances where the breakdown of particulate sizes is not known, all particulates are conservatively estimated to be PM_{10}.

Overall emission estimates were calculated as the sum of the emissions from specific activities. The methods used to estimate emissions from specific activities are described below. There are several instances where calculations were based on simplifying assumptions and engineering estimates. Many of these assumptions are listed on the spreadsheet calculations used for the EELV program, which are included in the project files. Concept A/B emissions were calculated as the sum of the emissions that would occur from each contractor's activities.

1.1 Chemical Use (Processing)

Baseline

Both contractors supplied information on hazardous materials usage for the Atlas, Delta, and Titan vehicles. This information was used as a basis for emissions estimates. Based on the description of the chemicals and their usage, a percent VOC and a percent evaporation of that VOC were estimated.

Concept A

Concept A chemical use emissions were calculated similarly to baseline emissions.

Concept B

Concept B chemical use emissions were calculated similarly to baseline emissions.

No-Action Alternative

The No-Action Alternative chemical use emissions were calculated similarly to baseline emissions.

1.2 Hydrogen Control Flare

Because hydrogen is neither a criteria pollutant nor a hazardous air pollutant (HAP), it is not considered a contaminant of concern. Hydrogen emissions from the hydrogen control flare have not been quantified. Similarly, the only product of hydrogen combustion is water, which is not a contaminant of concern. Significant emissions from the hydrogen control flare are, therefore, only emissions from combustion of the pilot fuel. The pilot fuel is propane at Cape Canaveral AS and natural gas at Vandenberg AFB. Emissions were estimated using Compilation of Air Pollutant Emission Factors, Volume I: Stationary Point and Area Sources, 5th edition, Environmental Protection Agency (EPA) Office of Air Quality Planning and Standards, January 1995 (AP-42). Emission factors for external combustion of propane were used from Table 1.5-2, for commercial boilers. Emission factors for external combustion of natural gas were used from Tables 1.4-1 through 1.4-3, for commercial boilers. An additional quantity of nitrogen oxides (NO_x) has also been accounted for. This NO_x is generated from the reaction of atmospheric nitrogen with oxygen in the hot exhaust flame.

1.3 RP-1 (Kerosene Fuel) Fuel Handling and Storage

Emissions of RP-1 occur through working and breathing losses. Working losses include those associated with fueling of the vehicle. Emissions were estimated using AP-42 emission factors for fixed roof storage tanks (Section 7.1.3). These are the same procedures as are used in the EPA computer model TANKS.

Baseline

Tank data from the July 1996 Emission Inventory Report for Cape Canaveral AS and the 1995 Santa Barbara County Air Pollution Control District (SBCAPCD) Air Emissions Questionnaire for Vandenberg AFB were utilized. Throughputs of RP-1 were estimated based on the 1995 launch rate and the RP-10 propellant loading for each applicable vehicle.

Concept A

Tank data were obtained from construction details provided by the contractor. Throughputs of RP-1 were estimated based on the peak launch schedule and the RP-1 propellant loading for each applicable vehicle.

Concept B

Concept B launch vehicles would not utilize RP-1; therefore, no emissions from RP-1 storage and loading were included.

No-Action Alternative

Tank data were obtained from the July 1996 Emission Inventory Report for Cape Canaveral AS and the 1995 SBCAPCD Air Emissions Questionnaire for Vandenberg AFB. Throughputs of RP-1 were estimated based on the estimated peak launch rate and the RP-1 propellant loading for each applicable vehicle.

1.4 Hydrazine and Nitrogen Tetroxide (N_2O_4) Handling and Storage

Hydrazine and N_2O_4 emissions from loading activities were estimated based on an estimated loss percentage during fueling and an estimated control efficiency for the wet scrubber/oxidizer vapor control systems.

1.5 Post-Launch Cleaning and Repair

After launch, portable abrasive blasters would be used to refurbish the launch complex. Information available for abrasive blasting is limited. Available information includes a summary of the 1993 abrasive usage for Vandenberg AFB and an emission factor of 0.04 pounds particulate emissions per pound of abrasive used, a factor listed in the South Coast Air Quality Management District Permit Processing Handbook and Permit to Operate 8928 for abrasive blasting equipment at Vandenberg AFB. An overall emission factor of pounds of particulate per launch was generated from these data. For Concept A at Vandenberg AFB, a 90-percent reduction in emissions was assumed based on the use of wire brushes instead of abrasive blasters.

1.6 Truck and Automobile Operation

Total emissions for vehicular traffic were estimated using available trip and mileage estimates and emission factors from transportation emission models. For Cape Canaveral AS, the models MOBILE5 and PART5 were used to determine emission factors. For Vandenberg AFB, the models EMFAC 7f and PART5 were used. Traffic estimates were developed based on trips per day, estimated mileage, and estimated vehicle mix, as described in the transportation sections of the EIS (3.4 and 4.4). Delivery traffic was estimated based on available data from Arbogast, Kephart, Tomei, and Wildhagen, A Study of Air Emissions from Space Launch Operations: Phase II, Aerospace ATR-96(8264)-2, September 1996. Telephone conversations with Jim Kephart of Aerospace, as well as data on the baseline launch vehicles, were also used. In addition, a general estimate of emissions from specialty equipment (e.g., cranes) was included.

Similarly, emissions from traffic associated with construction activities were estimated using available trip and mileage estimates and emission factors from transportation emission models. No construction traffic was included in the baseline or No-Action Alternative.

1.7 Aircraft Operation

Aircraft would be used to deliver some launch vehicle components. Emission factors for C-141 and C-5A aircraft were calculated (in pounds) according to landing and takeoff cycle. General flight occurs outside the region of influence (above 3,000 feet). The Emission and Dispersion Modeling System (EDMS, Version 3.0) was used to generate default values for the C-141. Emissions for the C-5A (and particulate emissions for the C-141) were calculated using the techniques and factors set forth in Calculation Methods for Criteria Air Pollutant Emission Inventories, Jagielski and O'Brien, July 1994. These calculations include approach and taxi time.

1.8 Boilers and other External Combustion Sources

Products of combustion would be emitted by boilers and other external combustion devices. Emissions were estimated based on the best available information.

Baseline

Emissions at Cape Canaveral AS from external combustion devices facility-wide are summarized in the July 1996 Radian International Air Emissions Inventory report. It is not clear how many of these sources are directly involved with the Atlas, Delta, and Titan programs (i.e., would be shut down when the programs are phased out). The calculations assume that 25 percent of emissions from boilers are associated with the Atlas, Delta, and Titan programs.

Emissions at Vandenberg AFB from external combustion devices facility-wide are summarized in the 1995 SBCAPCD Air Emissions Questionnaire. It is not clear how many of these sources are directly involved with the Atlas, Delta, and Titan programs. The calculations assume that 50 percent of emissions from boilers are associated with the Atlas, Delta, and Titan programs.

Concept A

Although specific boiler and external combustion data are not readily available, the contractor provided fuel use estimates to support utility requirements. Emissions were calculated based on this fuel use, assuming that it would occur year-round. The fuel is assumed to be combusted in one or more external combustion sources operating similarly to commercial boilers. Emissions were estimated using Compilation of Air Pollutant Emission Factors, Volume I: Stationary Point and Area Sources, 5th Edition, EPA Office of Air Quality Planning and Standards, January 1995 (AP-42). Emission factors for external combustion of propane (for Cape Canaveral AS) were taken from Table 1.5-2, for commercial boilers. Emission factors for external combustion of natural gas (for Vandenberg AFB) were taken from Tables 1.4-1 through 1.4-3, for commercial boilers.

Concept B

Estimates for emissions from specific combustion sources were provided by the contractor in the following documents: Air Emissions Information for the Delta IV - Evolved Expendable Launch Vehicle Program, Cape Canaveral Air Station, Florida, August 1997, prepared by Cape Canaveral Air Station, The Boeing Company, and Raytheon Engineers and Constructors, and Air Emissions Information for the Delta IV - Evolved Expendable Launch Vehicle Program, Vandenberg Air Force Base, California, August 1997, prepared by Vandenberg Air Force Base, The Boeing Company, and Raytheon Engineers and Constructors.

The estimates presented in these documents were reviewed and adjusted, as necessary, to maintain consistency with the estimates prepared for the other concepts. In general, the estimates presented in these documents use EPA AP-42 emission factors and estimates of equipment size and operating hours.

No-Action Alternative

For the No-Action Alternative, external fuel combustion and resultant emissions were assumed to be similar to those calculated for the baseline emissions.

1.9 Generators and other Internal Combustion Sources

Products of combustion would be emitted by small generators and other internal combustion devices. Emissions were estimated based on the best available information.

Baseline

Emissions from internal combustion devices facility-wide are summarized in the July 1996 Radian International Air Emissions Inventory report for Cape Canaveral AS. It is not clear how many of these sources are directly involved with the Atlas, Delta and Titan programs. The calculations assume that 5 percent of emissions from internal combustion engines would be associated with the Atlas, Delta, and Titan programs.

Emissions at Vandenberg AFB from internal combustion devices facility-wide are summarized in the 1995 SBCAPCD Air Emissions Questionnaire. It is not clear how many of these sources are directly involved with the Atlas, Delta, and Titan programs. The calculations assume that 50 percent of emissions from internal combustion engines would be associated with the Atlas, Delta, and Titan programs.

Concept A

Available data indicate that there would be a small number of internal combustion engines directly associated with Concept A activities. Emissions were estimated using AP-42 emission factors (Table 3.3-2) for emissions from diesel industrial engines. One emergency generator operating one hour per week and three small engines operating 500 hours per year were assumed.

Concept B

Estimates were taken from the same documents cited for external combustion sources (see Section 1.8 of this appendix), and were reviewed and adjusted as necessary. Operation at Cape Canaveral AS was modified based on subsequent information from the contractor. One of the two 1,000 kW generators will operate at 30 percent fuel usage for 72 hours per launch.

No-Action Alternative

For the No-Action Alternative, internal fuel combustion and resultant emissions were assumed to be similar to those calculated for the baseline emissions.

1.10 Construction Activities

No construction activities were included in the baseline or No-Action Alternative.

All calculations were made based on average emissions per year over the construction period. Source data included estimated square footage of facility construction, as well as contractor-provided estimates of construction equipment usage. Square footage for all individual structures was estimated from site plans and from facilities with similar purposes at other military installations.

The surface area associated with paving modifications includes the sum of a factor for new pavement related to new building construction, plus all renovated pavement due to road and utility improvements. Sources for construction factors include The R.S. Means Building Construction Cost Data index (55th Annual Edition, 1997) and actual ratios from other government facilities including Pease, Norton and Homestead AFBs. Emissions of ROCs, NO_x, and PM_{10} have been projected based on SMAQMD Emission Estimation procedures (Sacramento Metropolitan Air Quality Management District, Air Quality Thresholds of Significance, Sacramento California, 1994). These emissions factors have been established for each of the following categories of construction activity: grading equipment, asphalt paving, stationary equipment, mobile equipment, and architectural coatings.

Emissions of VOCs, NO_x, and PM_{10} were projected based on standard estimation techniques. These emission factors were established for all three pollutant groups (where applicable) in each of the following five categories of construction activity:

- Grading Equipment
- Asphalt Paving
- Stationary Equipment

- Mobile Equipment
- Architectural Coatings.

Emissions of CO and SO_2 were estimated based on the ratio of emissions for similar activities. Unmitigated or fugitive PM_{10} emissions from site preparation were calculated based on emission factors from AP-42, Sections 13.2, Fugitive Dust Sources, 13.2.3, Heavy Construction Operations, and 13.2.4, Aggregate Handling & Storage Piles. Development of these projections took into consideration all site-specific meteorological input parameters from Kennedy Space Center records and other sources.

In addition to direct construction-related emissions, there would be emissions associated with commuter traffic. Employees for construction-related activities travel by automobile, both on-site and off-site. Emissions from construction employees' automobile use were calculated using vehicle miles traveled and the emission factors available in the MOBILE 5a and PART5 computer models.

2.0 REGIONAL AIR QUALITY IMPACTS

Regional impacts were assessed by totaling the expected emissions from all sources for the baseline or peak launch year. In general, emissions are grouped into two categories: infrastructure emissions, which occur whether or not a launch is taking place and launch surge emissions, which take place once the vehicle is launched. For example, commuter traffic contributes to infrastructure emissions, while vehicle delivery contributes to launch emissions. Tables J-1 through J-19 present infrastructure and launch surge emissions, as well as emission totals for several launch years.

Emission factors for mobile source emissions vary depending upon the year being analyzed. The models used (MOBILE5, PART5, and EMFAC 7f) take into account improvements in the average vehicle emissions as newer, cleaner cars are purchased and older, dirtier cars are discarded. Emissions for mobile sources were, therefore, recalculated for each year analyzed.

In some instances, the maximum pollutant emission rate was predicted for different years for different pollutants. In these instances, the "peak" emissions year was taken as the year with the highest predicted NO_x emissions.

For documentation as part of the ENVVEST reporting for Vandenberg AFB, emissions from stationary sources associated with EELV activities need to be reported as part of a source group. Actual emissions from each source group for 1994 are summarized in Table J-20.

3.0 ANNUAL LAUNCH EMISSIONS

Annual launch emissions between the years 2001 and 2020 were estimated using the per launch emission estimates presented in Sections 4.10 and 4.11 of the EIS and the launch schedules presented in Tables J-21 through J-26. The annual emissions were estimated for the lower atmosphere (0-3,000 feet), the troposphere (3,000-49,000 feet), and the stratosphere (49,200-

Table J-1. Concept A Emissions, Cape Canaveral AS (tons)

	VOC	NO_X	CO	SO_2	PM_{10}
2001 (13 launches)[(a)]					
Launches	0.00	9.62	0.00	0.00	0.00

Preparation, Assembly, and Fueling	9.75	0.00	0.00	0.00	4.29
Mobile Sources	4.61	8.32	33.35	0.41	28.63
Point Sources	0.33	4.57	0.91	0.25	0.32
Total	14.69	22.51	34.26	0.66	33.24
2006 (22 launches)					
Launches	0.00	17.77	0.00	0.00	0.00
Preparation, Assembly, and Fueling	17.24	0.00	0.00	0.00	7.29
Mobile Sources	5.36	10.70	39.99	0.55	42.16
Point Sources	0.33	4.57	0.91	0.25	0.32
Total	22.93	33.04	40.90	0.80	49.74
2007 (19 launches)					
Launches	0.00	14.06	0.00	0.00	0.00
Preparation, Assembly, and Fueling	14.25	0.00	0.00	0.00	6.27
Mobile Sources	5.23	10.14	39.10	0.53	38.22
Point Sources	0.33	4.57	0.91	0.25	0.32
Total	19.81	28.77	40.01	0.78	44.81
2013 (22 launches)					
Launches	0.00	17.77	0.00	0.00	0.00
Preparation, Assembly, and Fueling	17.24	0.00	0.00	0.00	7.26
Mobile Sources	5.10	10.26	38.65	0.55	42.10
Point Sources	0.33	4.57	0.91	0.25	0.32
Total	22.67	32.60	39.56	0.80	49.68
2014 (20 launches)					
Launches	0.00	14.80	0.00	0.00	0.00
Preparation, Assembly, and Fueling	15.00	0.00	0.00	0.00	6.60
Mobile Sources	4.99	10.01	38.17	0.54	39.06
Point Sources	0.33	4.57	0.91	0.25	0.32
Total	20.32	29.38	39.08	0.79	45.98
2015 (23 launches)					
Launches	0.00	18.51	0.00	0.00	0.00
Preparation, Assembly, and Fueling	17.99	0.00	0.00	0.00	7.59
Mobile Sources	5.09	14.95	38.91	0.56	43.00
Point Sources	0.33	4.57	0.91	0.25	0.32
Total	23.41	38.03	39.82	0.81	50.91

Note: (a) Number of launches by vehicle type is provided in Table 2.1-3.
CO = carbon monoxide
NO_X = nitrogen oxides
PM_{10} = particulate matter equal to or less than 10 microns in diameter
SO_2 = sulfur dioxide
VOC = volatile organic compound

Table J-2. Concept A - Infrastructure Emissions, Cape Canaveral AS (tons per calendar year)

	VOC	NO_x	CO	SO_2	PM_{10}
Launches	NA	NA	NA	NA	NA
Preparation, Assembly, and Fueling	NA	NA	NA	NA	NA
Mobile Sources	(a)	(a)	(a)	(a)	(a)
Point Sources	0.33	4.57	0.91	0.25	0.31

Note: (a) Value depends on the year.
CO = carbon monoxide
NA = not applicable
NO_x = nitrogen oxides
PM_{10} = particulate matter equal to or less than 10 microns in diameter
SO_2 = sulfur dioxide
VOC = volatile organic compound

Table J-3. Concept A - Launch Surge Emissions, Cape Canaveral AS (tons per launch)

	VOC	NO_x	CO	SO_2	PM_{10}
MLV-D					
Launches	0.00	0.74	0.00	0.00	0.00
Preparation, Assembly, and Fueling	0.75	0.00	0.00	0.00	0.33
Mobile Sources	(a)	(a)	(a)	(a)	(a)
Point Sources	NA	NA	NA	NA	NA
Total	0.75	0.74	0.00	0.00	0.33
MLV-A					
Launches	0.00	0.74	0.00	0.00	0.00
Preparation, Assembly, and Fueling	0.75	0.00	0.00	0.00	0.33
Mobile Sources	(a)	(a)	(a)	(a)	(a)
Point Sources	NA	NA	NA	NA	NA
Total	0.75	0.74	0.00	0.00	0.33
HLV-L					
Launches	0.00	2.23	0.00	0.00	0.00
Preparation, Assembly, and Fueling	1.49	0.00	0.00	0.00	0.33
Mobile Sources	(a)	(a)	(a)	(a)	(a)
Point Sources	NA	NA	NA	NA	NA
Total	1.49	2.23	0.00	0.00	0.33
HLV-G					
Launches	0.00	2.23	0.00	0.00	0.00
Preparation, Assembly, and Fueling	1.49	0.00	0.00	0.00	0.33
Mobile Sources	(a)	(a)	(a)	(a)	(a)
Point Sources	NA	NA	NA	NA	NA
Total	1.49	2.23	0.00	0.00	0.33

Note: (a) Value depends on the year.
CO = carbon monoxide
HLV = heavy lift variant
MLV = medium lift variant
NA = not applicable
NO_X = nitrogen oxides
PM_{10} = particulate matter equal to or less than 10 microns in diameter
SO_2 = sulfur dioxide
VOC = volatile organic compound

Table J-4. Concept A Emissions, Vandenberg AFB (tons)

	VOC	NO_x	CO	SO_2	PM_{10}
2001 (4 launches)[(a)]					
Launches	0.00	1.92	0.00	0.00	0.00
Preparation, Assembly, and Fueling	3.00	0.00	0.00	0.00	0.13
Mobile Sources	3.29	4.00	37.99	0.15	22.37
Point Sources	0.33	4.52	0.91	0.25	0.33
Total	6.62	10.44	38.90	0.40	22.83
2002 (6 launches)					
Launches	0.00	2.88	0.00	0.00	0.00
Preparation, Assembly, and Fueling	4.50	0.00	0.00	0.00	0.20
Mobile Sources	3.39	4.56	39.33	0.18	27.45
Point Sources	0.33	4.52	0.91	0.25	0.33
Total	8.22	11.96	40.24	0.43	27.97
2006 (8 launches)					
Launches	0.00	3.84	0.00	0.00	0.00
Preparation, Assembly, and Fueling	6.00	0.00	0.00	0.00	0.26
Mobile Sources	2.35	4.27	28.98	0.19	31.37
Point Sources	0.33	4.52	0.91	0.25	0.33
Total	8.68	12.63	29.89	0.44	31.96
2007 (10 launches)					
Launches	0	4.8	0	0	0
Preparation, Assembly, and Fueling	7.5	0	0	0	0.3
Mobile Sources	2.2	4.4	27.5	0.2	34.5
Point Sources	0.3	4.5	0.9	0.2	0.3
Total	10.0	13.7	28.4	0.5	35.1
2014 (10 launches)					
Launches	0.00	4.80	0.00	0.00	0.00
Preparation, Assembly, and Fueling	7.50	0.00	0.00	0.00	0.33
Mobile Sources	1.27	3.74	19.26	0.21	34.52
Point Sources	0.33	4.52	0.91	0.25	0.33
Total	9.10	13.06	20.17	0.46	35.18

Note: (a) Number of launches by vehicle type is provided in Table 2.1-3.

CO = carbon monoxide

NO_X = nitrogen oxides

PM_{10} = particulate matter equal to or less than 10 microns in diameter

SO_2 = sulfur dioxide

VOC = volatile organic compound

Table J-5. Concept A - Infrastructure Emissions, Vandenberg AFB (tons per calendar year)

	VOC	NO_x	CO	SO_2	PM_{10}
Launches	NA	NA	NA	NA	NA
Preparation, Assembly, and Fueling	NA	NA	NA	NA	NA
Mobile Sources	(a)	(a)	(a)	(a)	(a)
Point Sources	0.33	4.52	0.91	0.25	0.33

Note: (a) Value depends on the year.
CO = carbon monoxide
NA = not applicable
NO_X = nitrogen oxides
PM_{10} = particulate matter equal to or less than 10 microns in diameter
SO_2 = sulfur dioxide
VOC = volatile organic compound

Table J-6. Concept A - Launch Surge Emissions, Vandenberg AFB (tons per launch)

	VOC	NO_x	CO	SO_2	PM_{10}
MLV-D					
Launches	0.00	0.48	0.00	0.00	0.00
Preparation, Assembly, and Fueling	0.75	0.00	0.00	0.00	0.03
Mobile Sources	0.12	0.35	0.85	0.01	0.03
Point Sources	NA	NA	NA	NA	NA
Total	0.87	0.83	0.85	0.01	0.06
MLV-A					
Project Launches	0.00	0.48	0.00	0.00	0.00
Preparation, Assembly, and Fueling	0.75	0.00	0.00	0.00	0.03
Mobile Sources	0.10	0.20	0.70	0.00	0.01
Point Sources	NA	NA	NA	NA	NA
Total	0.85	0.68	0.70	0.00	0.04
HLV-L					
Project Launches	0.00	1.44	0.00	0.00	0.00
Preparation, Assembly, and Fueling	1.49	0.00	0.00	0.00	0.03
Mobile Sources	0.13	0.24	0.78	0.01	0.01
Point Sources	NA	NA	NA	NA	NA
Total	1.62	1.68	0.78	0.01	0.04
HLV-G					
Project Launches	0.00	1.44	0.00	0.00	0.00
Preparation, Assembly, and Fueling	1.49	0.00	0.00	0.00	0.03
Mobile Sources	0.12	0.35	0.85	0.01	0.03
Point Sources	NA	NA	NA	NA	NA
Total	1.61	1.79	0.85	0.01	0.06

CO = carbon monoxide
HLV = heavy lift variant
MLV = medium lift variant
NA = not applicable
NO_X = nitrogen oxides
PM_{10} = particulate matter equal to or less than 10 microns in diameter
SO_2 = sulfur dioxide
VOC = volatile organic compound

Table J-7. Concept B Emissions, Cape Canaveral AS (tons)

	VOC	NO_x	CO	SO_2	PM_{10}
2001 (13 launches)[(a)]					
Launches	0.00	8.72	0.00	0.00	33.52
Preparation, Assembly, and Fueling	8.58	0.00	0.00	0.00	1.56
Mobile Sources	8.87	15.05	62.21	0.74	43.65
Point Sources	0.64	9.71	2.53	1.09	0.26
Total	18.09	33.48	64.74	1.83	78.99
2006 (22 launches)					
Launches	0.00	14.53	0.00	0.00	25.14
Preparation, Assembly, and Fueling	14.52	0.00	0.00	0.00	2.64
Mobile Sources	10.73	19.10	75.97	1.00	61.06
Point Sources	0.74	13.55	3.55	1.57	0.38
Total	25.99	47.18	79.52	2.57	89.22
2007 (19 launches)					
Launches	0.00	11.72	0.00	0.00	25.14
Preparation, Assembly, and Fueling	12.54	0.00	0.00	0.00	2.28
Mobile Sources	10.46	18.56	74.75	0.98	57.96
Point Sources	0.71	12.27	3.21	1.41	0.34
Total	23.71	42.55	77.96	2.39	85.72
2013 (22 launches)					
Launches	0.00	14.53	0.00	0.00	25.14
Preparation, Assembly, and Fueling	14.52	0.00	0.00	0.00	2.64
Mobile Sources	10.18	18.50	73.07	1.00	61.00
Point Sources	0.74	11.89	3.14	1.40	0.37
Total	25.44	44.92	76.21	2.40	89.15
2014 (20 launches)					
Launches	0.00	12.28	0.00	0.00	25.14
Preparation, Assembly, and Fueling	13.20	0.00	0.00	0.00	2.40
Mobile Sources	9.98	18.18	72.48	0.98	58.62
Point Sources	0.72	12.69	3.32	1.47	0.36
Total	23.90	43.15	75.80	2.45	86.52
2015 (23 launches)					
Launches	0.00	15.09	0.00	0.00	25.14
Preparation, Assembly, and Fueling	15.18	0.00	0.00	0.00	2.76
Mobile Sources	10.14	23.03	73.23	1.00	61.71
Point Sources	0.75	13.97	3.66	1.63	0.40
Total	26.07	52.09	76.89	2.63	90.01

Note: (a) Number of launches by vehicle type is provided in Table 2.1-8.

CO = carbon monoxide

NO_X = nitrogen oxides

PM_{10} = particulate matter equal to or less than 10 microns in diameter

SO_2 = sulfur dioxide

VOC = volatile organic compound

Table J-8. Concept B - Infrastructure Emissions, Cape Canaveral AS (tons per calendar year)

	VOC	NO_x	CO	SO_2	PM_{10}
Launches	NA	NA	NA	NA	NA
Preparation, Assembly, and Fueling	NA	NA	NA	NA	NA
Mobile Sources	(a)	(a)	(a)	(a)	(a)
Point Sources	0.50	4.17	1.06	0.39	0.09

Note: (a) Value depends on the year.
CO = carbon monoxide
NA = not applicable
NO_X = nitrogen oxides
PM_{10} = particulate matter equal to or less than 10 microns in diameter
SO_2 = sulfur dioxide
VOC = volatile organic compound

Table J-9. Concept B - Launch Surge Emissions, Cape Canaveral AS (tons per launch)

	VOC	NO_x	CO	SO_2	PM_{10}
DIV-S					
Launches	0.00	0.56	0.00	0.00	0.00
Preparation, Assembly, and Fueling	0.66	0.00	0.00	0.00	0.12
Mobile Sources	(a)	(a)	(a)	(a)	(a)
Point Sources	0.01	0.43	0.11	0.05	0.01
Total	0.66	0.56	0.00	0.00	0.12
DIV-M					
Launches	0.00	0.56	0.00	0.00	0.00
Preparation, Assembly, and Fueling	0.66	0.00	0.00	0.00	0.12
Mobile Sources	(a)	(a)	(a)	(a)	(a)
Point Sources	0.01	0.43	0.11	0.05	0.01
Total	0.66	0.56	0.00	0.00	0.12
DIV-H					
Launches	0.00	1.69	0.00	0.00	0.00
Preparation, Assembly, and Fueling	0.66	0.00	0.00	0.00	0.12
Mobile Sources	(a)	(a)	(a)	(a)	(a)
Point Sources	0.01	0.43	0.11	0.05	0.01
Total	0.81	2.06	0.92	0.02	0.14
DIV-M+					
Launches	0.00	0.74	0.00	0.00	4.19
Preparation, Assembly, and Fueling	0.66	0.00	0.00	0.00	0.12
Mobile Sources	(a)	(a)	(a)	(a)	(a)
Point Sources	0.01	0.43	0.11	0.05	0.01
Total	0.66	0.74	0.00	0.00	4.31

Note: (a) Value depends on the year.
CO = carbon monoxide
DIV-H = heavy launch vehicle
DIV-M = medium launch vehicle
DIV-M+ = medium launch vehicle with solid rocket motor strap-ons
DIV-S = small launch vehicle
NO_X = nitrogen oxides
PM_{10} = particulate matter equal to or less than 10 microns in diameter
SO_2 = sulfur dioxide
VOC = volatile organic compound

Table J-10. Concept B Emissions, Vandenberg AFB (tons)

	VOC	NO_x	CO	SO_2	PM_{10}
2001 (4 launches)[(a)]					
Launches	0.00	3.16	0.00	0.00	5.42
Preparation, Assembly, and Fueling	2.64	0.00	0.00	0.00	0.48
Mobile Sources	10.50	11.76	121.08	0.44	60.75
Point Sources	0.50	4.17	1.06	0.39	0.09
Total	13.64	19.09	122.14	0.83	66.74
2002 (6 launches)					
Launches	0.00	2.22	0.00	0.00	0.00
Preparation, Assembly, and Fueling	3.96	0.00	0.00	0.00	0.72
Mobile Sources	10.27	11.88	119.45	0.47	62.52
Point Sources	0.50	4.17	1.06	0.39	0.09
Total	14.73	18.27	120.51	0.86	63.33
2006 (8 launches)					
Launches	0.00	4.64	0.00	0.00	5.42
Preparation, Assembly, and Fueling	5.28	0.00	0.00	0.00	0.96
Mobile Sources	7.35	11.08	89.99	0.48	75.38
Point Sources	0.50	4.17	1.06	0.39	0.09
Total	13.13	19.89	91.05	0.87	81.85
2007 (10 launches)					
Launches	0.00	5.38	0.00	0.00	5.42
Preparation, Assembly, and Fueling	6.60	0.00	0.00	0.00	1.20
Mobile Sources	6.66	10.76	83.88	0.54	78.02
Point Sources	0.50	4.17	1.06	0.39	0.09
Total	13.76	20.31	84.94	0.93	84.73
2014 (10 launches)					
Launches	0.00	5.38	0.00	0.00	5.42
Preparation, Assembly, and Fueling	6.60	0.00	0.00	0.00	1.20
Mobile Sources	3.88	8.74	57.70	0.54	78.07
Point Sources	0.50	4.17	1.06	0.39	0.09
Total	10.98	18.29	58.76	0.93	84.78

Note: (a) Number of launches by vehicle type is provided in Table 2.1-8.

CO = carbon monoxide

NO_X = nitrogen oxides

PM_{10} = particulate matter equal to or less than 10 microns in diameter

SO_2 = sulfur dioxide

VOC = volatile organic compound

Table J-11. Concept B - Infrastructure Emissions, Vandenberg AFB (tons per calendar year)

	VOC	NO_x	CO	SO_2	PM_{10}
Launches	NA	NA	NA	NA	NA
Preparation, Assembly, and Fueling	NA	NA	NA	NA	NA
Mobile Sources	(a)	(a)	(a)	(a)	(a)
Point Sources	0.50	4.17	1.06	0.39	0.09

Note: (a) Value depends on the year.
CO = carbon monoxide
NA = not applicable
NO_X = nitrogen oxides
PM_{10} = particulate matter equal to or less than 10 microns in diameter
SO_2 = sulfur dioxide
VOC = volatile organic compound

Table J-12. Concept B - Launch Surge Emissions, Vandenberg AFB (tons per launch)

	VOC	NO_x	CO	SO_2	PM_{10}
DIV-S					
Launches	0.00	0.37	0.00	0.00	0.00
Preparation, Assembly, and Fueling	0.66	0.00	0.00	0.00	0.12
Mobile Sources	0.10	0.19	0.73	0.01	0.01
Point Sources	NA	NA	NA	NA	NA
Total	0.76	0.56	0.73	0.01	0.13
DIV-M					
Launches	0.00	0.37	0.00	0.00	0.00
Preparation, Assembly, and Fueling	0.66	0.00	0.00	0.00	0.12
Mobile Sources	0.10	0.19	0.73	0.01	0.01
Point Sources	NA	NA	NA	NA	NA
Total	0.76	0.56	0.73	0.01	0.13
DIV-H					
Launches	0.00	1.10	0.00	0.00	0.00
Preparation, Assembly, and Fueling	0.66	0.00	0.00	0.00	0.12
Mobile Sources	0.15	0.37	0.92	0.02	0.02
Point Sources	NA	NA	NA	NA	NA
Total	0.81	1.47	0.92	0.02	0.14
DIV-M+					
Launches	0.00	0.48	0.00	0.00	2.71
Preparation, Assembly, and Fueling	0.66	0.00	0.00	0.00	0.12
Mobile Sources	0.10	0.21	0.75	0.01	0.01
Point Sources	NA	NA	NA	NA	NA
Total	0.76	0.69	0.75	0.01	2.84

CO = carbon monoxide
DIV-H = heavy launch vehicle
DIV-M = medium launch vehicle
DIV-M+ = medium launch vehicle with solid rocket motor strap-ons
DIV-S = small launch vehicle
NA = not applicable
NO_X = nitrogen oxides
PM_{10} = particulate matter equal to or less than 10 microns in diameter
SO_2 = sulfur dioxide
VOC = volatile organic compound

Table J-13. Concept A/B Emissions, Cape Canaveral AS (tons)

	VOC	NO_x	CO	SO_2	PM_{10}
2001 launches, Concept A (7), Concept B (7)[(a)]					
Launches	0.00	9.46	0.00	0.00	8.38
Preparation, Assembly, and Fueling	9.87	0.00	0.00	0.00	3.15
Mobile Sources	11.84	20.08	84.26	0.99	57.71
Point Sources	0.91	11.73	2.76	1.01	0.50
Total	22.62	41.27	87.02	2.00	69.74
2006 launches, Concept A (10), Concept B (10)					
Launches	0.00	16.16	0.00	0.00	12.57
Preparation, Assembly, and Fueling	14.84	0.00	0.00	0.00	4.50
Mobile Sources	12.46	22.52	90.28	1.18	72.53
Point Sources	0.94	13.00	3.10	1.18	0.54
Total	28.24	51.68	93.38	2.36	90.14
2007 launches, Concept A (8), Concept B (8)					
Launches	0.00	11.89	0.00	0.00	8.38
Preparation, Assembly, and Fueling	11.28	0.00	0.00	0.00	3.60
Mobile Sources	12.18	21.86	88.82	1.16	67.95
Point Sources	0.92	12.15	2.87	1.07	0.51
Total	24.38	45.90	91.69	2.23	80.44
2013 launches, Concept A (10), Concept B (10)					
Launches	0.00	17.11	0.00	0.00	8.38
Preparation, Assembly, and Fueling	14.84	0.00	0.00	0.00	4.50
Mobile Sources	11.84	21.87	86.96	1.18	73.41
Point Sources	0.94	13.00	3.10	1.18	0.54
Total	27.62	51.98	90.06	2.36	86.83
2014 launches, Concept A (9), Concept B (9)					
Launches	0.00	13.37	0.00	0.00	12.57
Preparation, Assembly, and Fueling	12.69	0.00	0.00	0.00	4.05
Mobile Sources	11.63	21.51	86.33	1.16	69.59
Point Sources	0.93	12.58	2.99	1.12	0.53
Total	25.25	47.46	89.32	2.28	86.74
2015 launches, Concept A (13), Concept B (13)					
Launches	0.00	21.37	0.00	0.00	16.76
Preparation, Assembly, and Fueling	19.07	0.00	0.00	0.00	5.85
Mobile Sources	11.96	29.82	88.25	1.21	78.24
Point Sources	0.97	14.28	3.44	1.34	0.58
Total	32.00	65.47	91.69	2.55	101.43

Note: (a) Number of launches by vehicle type is provided in Table 2.1-11.
CO = carbon monoxide
NO_X = nitrogen oxides
PM_{10} = particulate matter equal to or less than 10 microns in diameter
SO_2 = sulfur dioxide
VOC = volatile organic compound

Table J-14. Concept A/B Emissions, Vandenberg AFB (tons)

	VOC	NO_x	CO	SO_2	PM_{10}
2001 launches, Concept A (2), Concept B (2)[a]					
Launches	0.00	2.43	0.00	0.00	0.00
Preparation, Assembly, and Fueling	2.82	0.00	0.00	0.00	0.31
Mobile Sources	12.33	13.64	143.16	0.51	68.84
Point Sources	0.83	8.69	1.97	0.64	0.42
Total	15.98	24.76	145.13	1.15	69.56
2002 launches, Concept A (3), Concept B (3)					
Launches	0.00	2.77	0.00	0.00	5.42
Preparation, Assembly, and Fueling	4.23	0.00	0.00	0.00	0.46
Mobile Sources	11.18	13.13	130.56	0.52	70.29
Point Sources	0.83	8.69	1.97	0.64	0.42
Total	16.24	24.59	132.53	1.16	76.59
2006 launches, Concept A (5), Concept B (5)					
Launches	0.00	4.47	0.00	0.00	5.42
Preparation, Assembly, and Fueling	7.05	0.00	0.00	0.00	0.77
Mobile Sources	7.35	11.29	91.25	0.50	76.27
Point Sources	0.83	8.69	1.97	0.64	0.42
Total	15.23	24.45	93.22	1.14	82.87
2007 launches, Concept A (7), Concept B (7)					
Launches	0.00	7.85	0.00	0.00	10.84
Preparation, Assembly, and Fueling	9.87	0.00	0.00	0.00	1.07
Mobile Sources	6.82	11.69	86.13	0.58	87.12
Point Sources	0.83	8.69	1.97	0.64	0.42
Total	17.52	28.23	88.10	1.22	99.45
2014 launches, Concept A (6), Concept B (6)					
Launches	0.00	5.54	0.00	0.00	10.84
Preparation, Assembly, and Fueling	8.46	0.00	0.00	0.00	0.92
Mobile Sources	3.82	8.99	58.73	0.56	79.84
Point Sources	0.83	8.69	1.97	0.64	0.42
Total	13.11	23.22	60.70	1.20	92.01

Note: (a) Number of launches by vehicle type is provided in Table 2.1-11.

CO = carbon monoxide

NO_X = nitrogen oxides

PM_{10} = particulate matter equal to or less than 10 microns in diameter

SO_2 = sulfur dioxide

VOC = volatile organic compound

Table J-15. Baseline Emissions, 1995 (tons)

	VOC	NO_x	CO	SO_2	PM_{10}
Cape Canaveral AS					
Launches	0.00	13.30	0.00	0.00	144.10
Preparation, Assembly, and Fueling	14.93	0.00	0.00	0.00	4.95
Mobile Sources	37.62	63.60	311.26	2.93	128.58
Point Sources	1.01	22.85	6.22	17.70	1.00
Total	**53.56**	**99.75**	**317.48**	**20.63**	**278.63**
Vandenberg AFB					
Launches	0.00	1.70	0.00	0.00	30.80
Preparation, Assembly, and Fueling	2.25	0.00	0.00	0.00	0.66
Mobile Sources	33.79	30.00	354.49	2.00	101.50
Point Sources	0.21	8.12	1.18	0.57	0.48
Total	**36.25**	**39.82**	**355.67**	**2.57**	**133.44**

AFB = Air Force Base
AS = Air Station
CO = carbon monoxide
NO_X = nitrogen oxides
PM_{10} = particulate matter equal to or less than 10 microns in diameter
SO_2 = sulfur dioxide
VOC = volatile organic compound

Table J-16. No-Action Alternative Emissions (tons)

	VOC	NO_x	CO	SO_2	PM_{10}
Cape Canaveral AS (2015)					
Launches	0.00	7.50	0.00	0.00	59.24
Preparation, Assembly, and Fueling	8.86	0.00	0.00	0.00	3.63
Mobile Sources	22.61	53.87	183.84	2.50	112.80
Point Sources	1.01	22.85	6.22	17.70	1.00
Total	**32.48**	**84.21**	**190.06**	**20.20**	**176.67**
Vandenberg AFB (2008)					
Launches	0.00	2.40	0.00	0.00	34.90
Preparation, Assembly, and Fueling	3.42	0.00	0.00	0.00	1.32
Mobile Sources	8.70	15.15	117.18	0.85	103.83
Point Sources	0.21	8.12	1.18	0.57	0.48
Total	**12.33**	**25.67**	**118.36**	**1.42**	**140.53**

AFB = Air Force Base
AS = Air Station
CO = carbon monoxide
NO_X = nitrogen oxides
PM_{10} = particulate matter equal to or less than 10 microns in diameter
SO_2 = sulfur dioxide
VOC = volatile organic compound

Table J-17. Mobile Source Emissions, No-Action Alternative

Table J-18. No-Action Alternative Launch Emissions (tons)

	Number of Launches	PM	NO_x	Cl_x
Cape Canaveral AS (GTO)				
Atlas II Core	7	0.00	0.56	0.00
Delta II 7925	3	5.35	0.45	2.76
Titan IV SRMU	1	43.18	2.20	21.59
Total	**11**	**59.24**	**7.50**	**29.86**
Vandenberg AFB (LEO)				
Atlas II Core	1	0.00	0.37	0.00
Delta II 7925	2	3.47	0.29	1.79
Titan IV SRMU	1	27.99	1.43	14.00
Total	**4**	**34.93**	**2.37**	**17.57**

Note: Launch schedule from peak emissions year 2008 for Vandenberg AFB and 2015 for Cape Canaveral AS.

AFB = Air Force Base
AS = Air Station
Clx = chlorine compounds
GTO = Geosynchronous Transfer Orbit
LEO = Low Earth orbit
NOx = nitrogen oxides
PM = particulate matter
SRMU = solid rocket motor upgrade

Table J-19. Baseline and No-Action Alternative Emissions - Preparation, Assembly, and Fueling

Vehicle	Baseline Emissions (1995)					No-Action Alternative Emissions			
	tons per launch				tons per year	tons per launch			
	Number of Launches	Hazardous Materials (VOC)	Fueling Emission (VOC)	Abrasives (PM_{10})	Fueling Emission (VOC)	Number of Launches[a]	Hazardous Materials (VOC)	Abrasives (PM_{10})	Fueling Emission (VOC)
Cape Canaveral AS									
Atlas II	10	0.84	0.01	0.33		7	0.84	0.33	0.01
Delta II	2	0.31	0.01	0.33		3	0.31	0.33	0.01
Titan IV	3	1.92	0.0	0.33		1	1.92	0.33	0.00
Annual Total (in tons per year)	**15**	**14.78**	**0.12**	**4.95**	**0.03**	**11**	**8.73**	**3.63**	**0.11**
Vandenberg AFB									
Atlas II67	0	0.84	0.01	0.33		1	0.84	0.33	0.01
Delta II	1	0.31	0.01	0.33		2	0.31	0.33	0.01
Titan IV	1	1.92	0.0	0.33		1	1.92	0.33	0.00
Annual Total (in tons per year)	**2**	**2.23**	**0.01**	**0.66**	**0.01**	**4**	**3.38**	**1.32**	**0.03**

Note: (a) Launch schedule from peak emissions year 2008 for Vandenberg AFB and 2015 for Cape Canaveral AS.
AFB = Air Force Base
AS = Air Station
PM_{10} = particulate matter equal to or less than 10 microns in diameter
VOC = volatile organic compound

Table J-20. Summary of Actual Emissions by Standard Industrial Classification Major Group Code, 1994 Inventory Actual Emissions (tons per year)

Source Group	SIC	Activity	NO_x	SO_x	CO	ROC	PM_{10}	Pb	HAP
Command and Control #1	47	Commercial Space	0.3080	0.0007	0.0770	0.0075	0.0302	0.0001	0.0199
Command and Control #2	96	NASA	1.7031	0.1379	3.1920	0.7321	0.5707	0.0662	0.1573
Command and Control #3	97	National Security, Navy	0.0365	0.0004	0.0049	0.0012	0.0005	0.0000	0.0000
Group #1 Remediation	16	Remediation	1.3874	0.0593	0.2554	0.0535	0.0215	0.0000	0.0000
Group #2 Flight Line	45	Flight Line	0.8992	0.0545	0.1916	0.2117	0.0704	0.0000	0.0058
	48	Western Range	10.6292	0.8241	3.3196	0.8894	0.5065	0.0001	0.1199
	87	Satellite Launching	9.1149	0.4052	1.7500	8.4543	3.6739	0.0003	4.7194
	89	Weather Monitoring	0.5361	0.0538	0.1141	0.0329	0.0168	0.0000	0.0030
Group #3 Range Group		Group Total	20.2802	1.2831	5.1837	9.3766	4.1972	0.0004	4.8423
	49	Utilities Services	0.0370	0.0034	0.0075	0.0021	0.0009	0.0000	2.9994
	55	Gasoline Stations	0.0000	0.0000	0.0000	3.8200	0.0000	0.0000	0.1410
	58	Food Services	0.3875	0.0023	0.0859	0.0266	0.0464	0.0000	0.0002
	65	Shopping Centers	0.1238	0.0007	0.0260	0.0090	0.0149	0.0000	0.0001
	70	Lodging	6.2972	0.0354	1.4250	0.4188	0.6958	0.0000	0.0050
	75	Motor Vehicle Services	0.0000	0.0000	0.0000	0.6267	0.0000	0.0000	0.1653
	79	Recreation Services	0.5043	0.0046	0.1048	0.8902	0.0589	0.0000	0.0258
	92	Public Safety	0.3791	0.0346	0.0813	0.0239	0.0107	0.0000	0.0017
Group #4 Amenities Group		Group Total	7.7289	0.0810	1.7305	5.8173	0.8276	0.0000	3.3385
	80	Health Services	3.6489	0.1762	0.7401	0.2037	0.1688	0.0000	0.0529
	83	Social Services	0.2653	0.0179	0.0565	0.0178	0.0175	0.0000	0.0009
Group #5 Hospital Services		Group Total	3.9142	0.1941	0.7966	0.2215	0.1863	0.0000	0.0538
Group #6 AF Primary Mission	97	National Security, Air Force	15.8113	0.4353	13.6307	4.7569	1.5962	0.0000	0.9656
	99	EOD	0.0127	0.0009	0.0478	0.0006	0.0007	0.0000	0.0000
		Group Total	15.8240	0.4362	13.6785	4.7575	1.5969	0.0000	0.9656
		Grand Total	52.0815	2.2472	25.1102	21.1789	7.5013	0.0667	9.3832

CO = carbon monoxide
HAP = hazardous air pollutant
NO_x = nitrogen oxides
Pb = lead
PM_{10} = particulate matter equal to or less than 10 microns in diameter
ROC = reactive organic compound
SIC = Standard Industrial Classification
SO_x = sulfur oxides

Table J-21. Cape Canaveral AS Lower Atmosphere Annual Launch Emissions (tons per year)

	PM				NO_x				CO				Cl_x				VOC				SO_2			
Year	A	B	A/B	NA	A	B	A/B	NA	A	B	A/B	NA	A	B	A/B	NA	A	B	A/B	NA	A	B	A/B	NA
2001	0	25.11	6.28	5.35	9.65	8.4	9.41	0.45	0	0	0	0	0	12.93	3.23	2.76	0	0	0	0	0	0	0	0
2002	0	18.83	10.46	10.71	11.88	9.82	12.03	2.03	0	0	0	0	0	9.7	5.39	5.51	0	0	0	0	0	0	0	0
2003	0	18.83	12.55	59.24	12.63	12.08	13.99	4.67	0	0	0	0	0	9.7	6.47	29.86	0	0	0	0	0	0	0	0
2004	0	18.83	6.28	10.71	13.37	10.95	10.72	3.16	0	0	0	0	0	9.7	3.23	5.51	0	0	0	0	0	0	0	0
2005	0	18.83	12.55	10.71	15.6	12.65	14.73	4.85	0	0	0	0	0	9.7	6.47	5.51	0	0	0	0	0	0	0	0
2006	0	18.83	10.46	59.24	15.6	14.34	13.9	6.93	0	0	0	0	0	9.7	5.39	29.86	0	0	0	0	0	0	0	0
2007	0	18.83	6.28	16.06	14.11	11.52	11.85	3.61	0	0	0	0	0	9.7	3.23	8.27	0	0	0	0	0	0	0	0
2008	0	18.83	12.55	59.24	14.11	13.21	15.09	5.8	0	0	0	0	0	9.7	6.47	29.86	0	0	0	0	0	0	0	0
2009	0	18.83	12.55	16.06	11.88	9.82	9.68	1.91	0	0	0	0	0	9.7	6.47	8.27	0	0	0	0	0	0	0	0
2010	0	18.83	12.55	16.06	13.37	10.95	14.55	3.04	0	0	0	0	0	9.7	6.47	8.27	0	0	0	0	0	0	0	0
2011	0	18.83	6.28	69.95	14.85	13.77	14.64	6.14	0	0	0	0	0	9.7	3.23	35.38	0	0	0	0	0	0	0	0
2012	0	18.83	6.28	16.06	14.85	12.08	14.46	4.17	0	0	0	0	0	9.7	3.23	8.27	0	0	0	0	0	0	0	0
2013	0	18.83	6.28	69.95	15.6	14.34	17.08	6.7	0	0	0	0	0	9.7	3.23	35.38	0	0	0	0	0	0	0	0
2014	0	18.83	10.46	16.06	14.85	12.08	13.33	4.17	0	0	0	0	0	9.7	5.39	8.27	0	0	0	0	0	0	0	0
2015	0	18.83	12.65	59.24	16.34	14.9	21.26	7.5	0	0	0	0	0	9.7	6.47	29.86	0	0	0	0	0	0	0	0
2016	0	18.83	12.55	16.06	14.85	12.08	14.73	4.17	0	0	0	0	0	9.7	6.47	8.27	0	0	0	0	0	0	0	0
2017	0	18.83	6.28	16.06	13.37	10.95	11.85	3.04	0	0	0	0	0	9.7	3.23	8.27	0	0	0	0	0	0	0	0
2018	0	18.83	6.28	59.24	14.11	13.21	13.33	5.8	0	0	0	0	0	9.7	3.23	29.86	0	0	0	0	0	0	0	0
2019	0	18.83	12.55	16.06	14.85	12.08	16.04	4.17	0	0	0	0	0	9.7	6.47	8.27	0	0	0	0	0	0	0	0
2020	0	18.83	12.55	59.24	14.11	13.21	16.21	5.8	0	0	0	0	0	9.7	6.47	29.86	0	0	0	0	0	0	0	0

A = Concept A
A/B = Concept A/B
B = Concept B
Cl_x = chlorine compounds
CO = carbon monoxide
NA = No-Action Alternative
NO_x = nitrogen oxides
PM = particulate matter
SO_2 = sulfur dioxide
VOC = volatile organic compound

Table J-22. Cape Canaveral AS Upper Atmosphere Annual Launch Emissions (tons per year)

	PM				NO_x				CO				Cl_x			
Year	A	B	A/B	NA	A	B	A/B	NA	A	B	A/B	NA	A	B	A/B	NA
2001	0	167.62	41.91	26.63	10.13	9.6	10.07	0.64	773.2	58.87	431.05	24.3	0	86.35	21.59	13.72
2002	0	125.72	69.84	53.27	12.46	10.9	12.94	2.46	951.63	44.15	500.34	138.96	0	64.76	35.98	27.44
2003	0	125.72	83.81	368.18	13.24	13.27	15.07	7.93	1011.11	44.15	564.72	301.37	0	64.76	43.18	185.3
2004	0	125.72	41.91	53.27	14.02	12.08	11.44	3.65	1070.58	44.15	490.53	229.32	0	64.76	21.59	27.44
2005	0	125.72	83.81	53.27	16.36	13.86	15.85	5.42	1249.01	44.15	624.2	364.85	0	64.76	43.18	27.44
2006	0	125.72	69.84	368.18	16.36	15.63	14.91	10.3	1249.01	44.15	559.82	482.09	0	64.76	35.98	185.3
2007	0	125.72	41.91	79.9	14.8	12.67	12.63	4.29	1130.06	44.15	490.53	253.62	0	64.76	21.59	41.16
2008	0	125.72	83.81	368.18	14.8	14.45	16.22	9.11	1130.06	44.15	743.16	391.73	0	64.76	43.18	185.3
2009	0	125.72	83.81	79.9	12.46	10.9	10.55	2.51	951.63	44.15	445.77	118.08	0	64.76	43.18	41.16
2010	0	125.72	83.81	79.9	14.02	12.08	15.66	3.69	1070.58	44.15	564.72	208.44	0	64.76	43.18	41.16
2011	0	125.72	41.91	421.45	15.58	15.04	15.56	9.8	1189.54	44.15	668.96	395.15	0	64.76	21.59	212.74
2012	0	125.72	41.91	79.9	15.58	13.27	15.37	4.88	1189.54	44.15	609.49	298.79	0	64.76	21.59	41.16
2013	0	125.72	41.91	421.45	16.36	15.63	18.11	10.39	1249.01	44.15	728.44	440.33	0	64.76	21.59	212.74
2014	0	125.72	69.84	79.9	15.58	13.27	14.32	4.88	1189.54	44.15	559.82	298.79	0	64.76	35.98	41.16
2015	0	125.72	83.81	368.18	17.14	16.22	22.7	10.89	1308.49	44.15	921.59	527.27	0	64.76	43.18	185.3
2016	0	125.72	83.81	79.9	15.58	13.27	15.85	4.88	1189.54	44.15	624.2	298.79	0	64.76	43.18	41.16
2017	0	125.72	41.91	79.9	14.02	12.08	12.63	3.69	1070.58	44.15	490.53	208.44	0	64.76	21.59	41.16
2018	0	125.72	41.91	368.18	14.8	14.45	14.18	9.11	1130.06	44.15	609.49	391.73	0	64.76	21.59	185.3
2019	0	125.72	83.81	79.9	15.58	13.27	17.22	4.88	1189.54	44.15	683.68	298.79	0	64.76	43.18	41.16
2020	0	125.72	83.81	368.18	14.8	14.45	17.4	9.11	1130.06	44.15	743.16	391.73	0	64.76	43.18	185.3

A = Concept A
A/B = Concept A/B
B = Concept B
Cl_x = chlorine compounds
CO = carbon monoxide
NA = No-Action Alternative
NO_x = nitrogen oxides
PM = particulate matter
SO_2 = sulfur dioxide
VOC = volatile organic compound

Table J-23. Cape Canaveral AS Stratospheric Annual Launch Emissions (tons per year)

	PM				NO_x				CO				Cl_x			
Year	A	B	A/B	NA	A	B	A/B	NA	A	B	A/B	NA	A	B	A/B	NA
2001	0	85.37	21.34	9.1	0	0	0	0	760.16	56.91	423.55	23.58	0	43.98	10.99	4.69
2002	0	64.03	35.57	18.2	0	0	0	0	935.59	42.69	491.51	136	0	32.98	18.32	9.38
2003	0	64.03	42.69	174.12	0	0	0	0.62	994.06	42.69	554.72	293.94	0	32.98	21.99	87.47
2004	0	64.03	21.34	18.2	0	0	0	0	1052.53	42.69	482.02	224.84	0	32.98	10.99	9.38
2005	0	64.03	42.69	18.2	0	0	0	0	1227.96	42.69	613.2	358.09	0	32.98	21.99	9.38
2006	0	64.03	35.57	174.12	0	0	0	0.62	1227.96	42.69	549.98	471.61	0	32.98	18.32	87.47
2007	0	64.03	21.34	27.3	0	0	0	0	1111.01	42.69	482.02	248.42	0	32.98	10.99	14.06
2008	0	64.03	42.69	174.12	0	0	0	0.62	1111.01	42.69	730.15	382.78	0	32.98	21.99	87.47
2009	0	64.03	42.69	27.3	0	0	0	0	935.59	42.69	437.78	115.17	0	32.98	21.99	14.06
2010	0	64.03	42.69	27.3	0	0	0	0	1052.53	42.69	554.72	204	0	32.98	21.99	14.06
2011	0	64.03	21.34	192.32	0	0	0	0.62	1169.48	42.69	657.44	385.53	0	32.98	10.99	96.85
2012	0	64.03	21.34	27.3	0	0	0	0	1169.48	42.69	598.97	292.84	0	32.98	10.99	14.06
2013	0	64.03	21.34	192.32	0	0	0	0.62	1227.96	42.69	715.92	429.94	0	32.98	10.99	96.85
2014	0	64.03	35.57	27.3	0	0	0	0	1169.48	42.69	549.98	292.84	0	32.98	18.32	14.06
2015	0	64.03	42.69	174.12	0	0	0	0.62	1286.43	42.69	905.57	516.03	0	32.98	21.99	87.47
2016	0	64.03	42.69	27.3	0	0	0	0	1169.48	42.69	613.2	292.84	0	32.98	21.99	14.06
2017	0	64.03	21.34	27.3	0	0	0	0	1052.53	42.69	482.02	204	0	32.98	10.99	14.06
2018	0	64.03	21.34	174.12	0	0	0	0.62	1111.01	42.69	598.97	382.78	0	32.98	10.99	87.47
2019	0	64.03	42.69	27.3	0	0	0	0	1169.48	42.69	671.67	292.84	0	32.98	21.99	14.06
2020	0	64.03	42.69	174.12	0	0	0	0.62	1111.01	42.69	730.15	382.78	0	32.98	21.99	87.47

A = Concept A
A/B = Concept A/B
B = Concept B
Cl_x = chlorine compounds
CO = carbon monoxide
NA = No-Action Alternative
NO_x = nitrogen oxides
PM = particulate matter
SO_2 = sulfur dioxide
VOC = volatile organic compound

Table J-24. Vandenberg AFB Lower Atmosphere Annual Launch Emissions (tons per year)

	PM				NO_x				CO				Cl_x				VOC				SO_2			
Year	A	B	A/B	NA	A	B	A/B	NA	A	B	A/B	NA	A	B	A/B	NA	A	B	A/B	NA	A	B	A/B	NA
2001	0	4.07	0	0	1.93	3.1	2.43	0	0	0	0	0	0	2.1	0	0	0	0	0	0	0	0	0	0
2002	0	0	4.07	3.47	2.89	2.19	2.71	0.66	0	0	0	0	0	0	2.1	1.79	0	0	0	0	0	0	0	0
2003	0	0	4.07	3.47	2.89	5.12	2.71	0.66	0	0	0	0	0	0	2.1	1.79	0	0	0	0	0	0	0	0
2004	0	8.14	4.07	0	3.37	2.91	3.56	1.1	0	0	0	0	0	4.19	2.1	0	0	0	0	0	0	0	0	0
2005	0	4.07	4.07	3.47	3.37	4.2	3.56	1.02	0	0	0	0	0	2.1	2.1	1.79	0	0	0	0	0	0	0	0
2006	0	4.07	4.07	3.47	3.85	4.56	4.41	1.39	0	0	0	0	0	2.1	2.1	1.79	0	0	0	0	0	0	0	0
2007	0	4.07	8.14	10.41	4.81	5.29	7.74	1.97	0	0	0	0	0	2.1	4.19	5.36	0	0	0	0	0	0	0	0
2008	0	4.07	0	34.93	4.81	5.29	5.81	2.37	0	0	0	0	0	2.1	0	17.57	0	0	0	0	0	0	0	0
2009	0	4.07	4.07	3.47	3.85	4.56	5.14	1.39	0	0	0	0	0	2.1	2.1	1.79	0	0	0	0	0	0	0	0
2010	0	4.07	4.07	6.94	3.85	4.56	5.14	1.31	0	0	0	0	0	2.1	2.1	3.58	0	0	0	0	0	0	0	0
2011	0	4.07	4.07	0	3.85	3.1	4.41	1.46	0	0	0	0	0	2.1	2.1	0	0	0	0	0	0	0	0	0
2012	0	4.07	2.71	6.94	3.85	4.56	4.24	1.31	0	0	0	0	0	2.1	1.4	3.58	0	0	0	0	0	0	0	0
2013	0	4.07	2.71	3.47	3.37	3.83	4.24	1.02	0	0	0	0	0	2.1	1.4	1.79	0	0	0	0	0	0	0	0
2014	0	4.07	8.14	6.94	4.81	4.56	5.43	2.05	0	0	0	0	0	2.1	4.19	3.58	0	0	0	0	0	0	0	0
2015	0	4.07	2.71	0	2.41	3.1	0.96	0.37	0	0	0	0	0	2.1	1.4	0	0	0	0	0	0	0	0	0
2016	0	4.07	4.07	3.47	3.37	3.83	3.56	1.02	0	0	0	0	0	2.1	2.1	1.79	0	0	0	0	0	0	0	0
2017	0	4.07	4.07	3.47	3.85	3.83	4.41	1.39	0	0	0	0	0	2.1	2.1	1.79	0	0	0	0	0	0	0	0
2018	0	4.07	2.71	3.47	4.33	3.83	5.93	1.75	0	0	0	0	0	2.1	1.4	1.79	0	0	0	0	0	0	0	0
2019	0	4.07	0	0	2.41	3.1	0.85	0.37	0	0	0	0	0	2.1	0	0	0	0	0	0	0	0	0	0
2020	0	4.07	2.71	3.47	3.85	3.83	4.24	1.39	0	0	0	0	0	2.1	1.4	1.79	0	0	0	0	0	0	0	0

A = Concept A
A/B = Concept A/B
B = Concept B
Cl_x = chlorine compounds
CO = carbon monoxide
NA = No-Action Alternative
NO_x = nitrogen oxides
PM = particulate matter
SO_2 = sulfur dioxide
VOC = volatile organic compound

Table J-25. Vandenberg AFB Upper Atmosphere Annual Launch Emissions (tons per year)

Year	PM				NO_x				CO				Cl_x			
	A	B	A/B	NA	A	B	A/B	NA	A	B	A/B	NA	A	B	A/B	NA
2001	0	36.58	0	0	2.31	3.87	2.91	0	233.69	14.41	116.85	0	0	18.84	0	0
2002	0	0	36.58	22.22	3.47	2.64	3.41	0.92	350.54	0	189.67	68.18	0	0	18.84	11.45
2003	0	0	36.58	22.22	3.47	6.15	3.41	0.92	350.54	0	189.67	68.18	0	0	18.84	11.45
2004	0	73.16	36.58	0	4.05	3.79	4.43	1.32	408.96	28.81	248.1	133.13	0	37.69	18.84	0
2005	0	36.58	36.58	22.22	4.05	5.19	4.43	1.36	408.96	14.41	248.1	112.56	0	18.84	18.84	11.45
2006	0	36.58	36.58	22.22	4.63	5.63	5.44	1.8	467.38	14.41	306.52	156.94	0	18.84	18.84	11.45
2007	0	36.58	73.16	66.67	5.78	6.51	9.59	2.75	584.23	14.41	437.77	204.55	0	18.84	37.69	34.34
2008	0	36.58	0	296.1	5.78	6.51	6.98	5.16	584.23	14.41	350.54	227.36	0	18.84	0	148.72
2009	0	36.58	36.58	22.22	4.63	5.63	6.32	1.8	467.38	14.41	306.52	156.94	0	18.84	18.84	11.45
2010	0	36.58	36.58	44.45	4.63	5.63	6.32	1.83	467.38	14.41	306.52	136.37	0	18.84	18.84	22.9
2011	0	36.58	36.58	0	4.63	3.87	5.44	1.76	467.38	14.41	306.52	177.51	0	18.84	18.84	0
2012	0	36.58	24.39	44.45	4.63	5.63	5.19	1.83	467.38	14.41	243.3	136.37	0	18.84	12.56	22.9
2013	0	36.58	24.39	22.22	4.05	4.75	5.19	1.36	408.96	14.41	243.3	112.56	0	18.84	12.56	11.45
2014	0	36.58	73.16	44.45	5.78	5.63	6.82	2.71	584.23	14.41	379.35	225.12	0	18.84	37.69	22.9
2015	0	36.58	24.39	0	2.89	3.87	1.26	0.44	292.11	14.41	68.03	44.38	0	18.84	12.56	0
2016	0	36.58	36.58	22.22	4.05	4.75	4.43	1.36	408.96	14.41	248.1	112.56	0	18.84	18.84	11.45
2017	0	36.58	36.58	22.22	4.63	4.75	5.44	1.8	467.38	14.41	306.52	156.94	0	18.84	18.84	11.45
2018	0	36.58	24.39	22.22	5.2	4.75	7.22	2.23	525.81	14.41	360.14	201.32	0	18.84	12.56	11.45
2019	0	36.58	0	0	2.89	3.87	1.02	0.44	292.11	14.41	58.42	44.38	0	18.84	0	0
2020	0	36.58	24.39	22.22	4.63	4.75	5.19	1.8	467.38	14.41	243.3	156.94	0	18.84	12.56	11.45

A = Concept A
A/B = Concept A/B
B = Concept B
Cl_x = chlorine compounds
CO = carbon monoxide
NA = No-Action Alternative
NO_x = nitrogen oxides
PM = particulate matter

Table J-26. Vandenberg AFB Stratospheric Annual Launch Emissions (tons per year)

	PM				NO_x				CO				Cl_x			
Year	A	B	A/B	NA	A	B	A/B	NA	A	B	A/B	NA	A	B	A/B	NA
2001	0	21.04	0	0	0	0	0	0	230.58	14.03	115.29	0	0	10.84	0	0
2002	0	0	21.04	8.97	0	0	0	0	345.86	0	186.96	67.04	0	0	10.84	4.62
2003	0	0	21.04	8.97	0	0	0	0	345.86	0	186.96	67.04	0	0	10.84	4.62
2004	0	42.08	21.04	0	0	0	0	0	403.51	28.05	244.6	131.36	0	21.68	10.84	0
2005	0	21.04	21.04	8.97	0	0	0	0	403.51	14.03	244.6	110.82	0	10.84	10.84	4.62
2006	0	21.04	21.04	8.97	0	0	0	0	461.15	14.03	302.25	154.61	0	10.84	10.84	4.62
2007	0	21.04	42.08	26.91	0	0	0	0	576.44	14.03	431.56	201.11	0	10.84	21.68	13.86
2008	0	21.04	0	162.68	0	0	0	0.61	576.44	14.03	345.86	222.73	0	10.84	0	81.61
2009	0	21.04	21.04	8.97	0	0	0	0	461.15	14.03	302.25	154.61	0	10.84	10.84	4.62
2010	0	21.04	21.04	17.94	0	0	0	0	461.15	14.03	302.25	134.07	0	10.84	10.84	9.24
2011	0	21.04	21.04	0	0	0	0	0	461.15	14.03	302.25	175.15	0	10.84	10.84	0
2012	0	21.04	14.03	17.94	0	0	0	0	461.15	14.03	239.93	134.07	0	10.84	7.23	9.24
2013	0	21.04	14.03	8.97	0	0	0	0	403.51	14.03	239.93	110.82	0	10.84	7.23	4.62
2014	0	21.04	42.08	17.94	0	0	0	0	576.44	14.03	373.92	221.64	0	10.84	21.68	9.24
2015	0	21.04	14.03	0	0	0	0	0	288.22	14.03	66.99	43.79	0	10.84	7.23	0
2016	0	21.04	21.04	8.97	0	0	0	0	403.51	14.03	244.6	110.82	0	10.84	10.84	4.62
2017	0	21.04	21.04	8.97	0	0	0	0	461.15	14.03	302.25	154.61	0	10.84	10.84	4.62
2018	0	21.04	14.03	8.97	0	0	0	0	518.79	14.03	355.21	198.39	0	10.84	7.23	4.62
2019	0	21.04	0	0	0	0	0	0	288.22	14.03	57.64	43.79	0	10.84	0	0
2020	0	21.04	14.03	8.97	0	0	0	0	461.15	14.03	239.93	154.61	0	10.84	7.23	4.62

A = Concept A
A/B = Concept A/B
B = Concept B
Cl_x = chlorine compounds
CO = carbon monoxide
NA = No-Action Alternative
NO_x = nitrogen oxides
PM = particulate matter

164,000 feet). Emissions of criteria and toxic pollutants were estimated in the lower atmosphere, while ozone-depleting substance emissions were estimated for the upper atmosphere. The annual launch schedules for the No-Action Alternative reflect only government launches, so commercial launches of Atlas IIAs with strap-on solid rocket motors were not analyzed. The annual number of No-Action Alternative launches is generally half that of Concept A, Concept B, and Concept A/B (no commercial launches are included for the No-Action Alternative), so direct comparisons between the various launch schedules should not be made.

3.1 Cape Canaveral AS Annual Emissions

The annual launch emissions released into the lower atmosphere, upper atmosphere, and stratosphere for the No-Action Alternative and the three EELV concepts are summarized in Tables J-21, J-22 and J-23, respectively. Smaller NO_x emissions are associated with the No-Action Alternative, due, in part, to fewer launches (no commercial launches were analyzed for the No-Action Alternative). The influence of the Titan IVB emissions of particles and Cl_x is evident in the table. The large inter-annual variations in the No-Action Alternative emissions are present in all species except carbon monoxide (CO).

The advantage of Concept A over the other concepts is clearly noted for alumina particulates and Cl_x, where the No-Action Alternative shows a peak in emissions of such pollutants several times greater than in the EELV vehicles, despite the fewer launches scheduled.

3.2 Vandenberg AFB Annual Emissions

The annual launch emissions released into the lower atmosphere for the No-Action Alternative and the three Proposed Action concepts are summarized in Table J-24. As mentioned previously, the NO_x emissions of the EELV concepts are several times that of the No-Action Alternative. The inter-year variability in NO_x emissions is significant, changing by nearly 100 percent from one year to the next. The year 2008 seems to be an outlier with respect to the No-Action Alternative emissions of PM and chlorine compounds (Cl_x). The table indicates that for many years there is not a substantial difference between EELV emissions over those of the No-Action Alternative for Cl_x and alumina particulates. There seems to be a surprising lack of association between No-Action Alternative NO_x emissions and those produced by EELV systems.

The annual launch emissions released into the stratosphere for the No-Action Alternative and the three EELV concepts are summarized in Table J-26. In the stratosphere, the largest sources of particulate matter (PM) and Cl_x occur for the No-Action Alternative during 2008. The peak years of the EELV program include several heavy vehicle launches, but their emissions are considerably less than those resulting from a Titan IV launch.

4.0 MODELING OF AIR QUALITY IMPACTS

The modeling of launch emissions impacts on the ambient air quality concentrations in the lower troposphere was conducted using the Rocket Exhaust Effluent Diffusion Model (REEDM) air quality dispersion model, which predicts short term (less than 1 hour) incremental increases in concentrations of criteria and toxic pollutants. The chemicals of concern include the criteria pollutants NO_x (nitric oxide [NO] and/or nitrogen dioxide [NO_2]) and CO, as well as the toxic or irritant pollutants ammonia (NH_3), hydrochloric acid (HCl), and the hydrazine compounds unsymmetrical dimethylhydrazine (UDMH), monomethyl hydrazine (MMH), and hydrazine (N_2H_4). Concentrations are predicted as a layer average concentration over the first 3,000 meters. The reported concentration time-averaging is for 30 minutes. Since launches are intermittent, hourly concentrations were treated as half of the 30-minute average, the 8-hour CO is 1/16th, and a peak daily average was estimated as 1/48th of the peak 30-minute concentration.

The meteorological inputs for REEDM are based on a vertical sampling of the atmosphere taken by a balloon launched at 1500 Eastern Standard Time (EST) on November 1, 1995 (profile 184) from Vandenberg AFB. The winds, which are relatively light, range in speed from 1-2 miles per second over the lowest 3,000 meters. Wind direction is from the northwest; however, since the same profile is used for both sites, only the downwind distance to the maximum concentration was examined. Critical fenceline distances for pads at both sites is on the order of 5 kilometers or less. The REEDM model was exercised with receptor arcs at 1-kilometer intervals from 1 to 30 kilometers.

The REEDM modeling should be interpreted as a screening tool since a systematic search for the worst-case meteorology was not conducted at either launch site. The use of a single meteorological profile is a simplification, because the surface meteorology at the two sites is different, as indicated in Section 3.10 of the EIS.

In some, but not all cases, both a Vandenberg AFB and Cape Canaveral AS simulation were run for each launch vehicle. The differences in the predictions are minor owing to similar meteorological inputs. There are two launch modes: a normal flight which produces only NO_x and in some cases CO, and an abort/deflagration mode in which the launch vehicle is destroyed. This latter mode produces the greatest emissions of pollutants, particularly in the case where upper stages utilizing solid or hypergolic propellants are used.

4.1 Ambient Concentrations, Concept A

For aborted launches, the total emissions resulting from the deflagration fireball were estimated from the fate mass fractions and the total load of propellants and oxidants (Table J-27).

As described earlier, REEDM produces peak puff and 30-minute average concentration estimates, which are converted to hourly and daily concentrations. Tables for peak hourly and daily CO and NO_x predictions were produced. Rather than producing tables for each toxic hydrazine compound, the concentrations were summed for all hydrazine compounds. Separate tables for NH_3 and HCl peak 30-minute concentrations have been compiled where relevant.

The CO-predicted incremental concentrations for Concept A vehicles is presented in Table J-28. This table indicates that since the launch is a transient source, the 8-hour average concentration increment is a small fraction of the National Ambient Air Quality Standards (NAAQS) of 9 parts per million (ppm).

Table J-27. Summary of Emissions Resulting from Launch Failure, Concept A (in tons)

	MLV-A	MLV-D	HLV-L	HLV-G
CO	16.94	16.94	50.82	50.82
NO_x	6.07	0.0	6.07	0.0
HCl	0.0	0.0	0.0	0.0
N_2O_4	0.0	0.0	0.0	0.0
Hydrazine [a]	0.72	0.0	0.72	0.0
VOC[b]	12.25	12.25	36.75	36.75

Notes: (a) Includes monomethyl hydrazine (MMH), anhydrous hydrazine (N_2H_4), and unsymmetrical dimethylhydrazine (UDMH).

(b) The estimate of VOCs is based on the residual RP-1 that is vaporized.

CO = carbon monoxide
HCl = hydrochloric acid
HLV = heavy lift variant
MLV = medium lift variant
N_2O_4 = nitrogen tetroxide
NO_x = nitrogen oxides
RP-1 = rocket propellant-1 (kerosene fuel)
VOC = volatile organic compound

Table J-28. Summary of REEDM-Predicted Ambient Air Concentration Increments for CO During Aborted Launches, Concept A

	Distance to maximum concentration (km)	30-minute average concentration increment (ppm)	8-hour average concentration increment (ppm)	Daily average concentration increment (ppm)
MLV-D	4	3.61	0.225	0.075
MLV-A	4	2.08	0.130	0.043
HLV-L	5	6.61	0.413	0.137
HLV-G	5	3.91	0.244	0.081

CO = carbon monoxide
HLV = heavy lift variant
km = kilometers
MLV = medium lift variant
ppm = parts per million
REEDM = Rocket Exhaust Effluent Diffusion Model

The NAAQS for NO_x is an annual standard and is not affected by the transient launch releases. The California Ambient Air Quality Standards (CAAQS) has an hourly NO_2 standard of 0.25 ppm. For conservative purposes, it was assumed that all NO in NO_x is converted to NO_2 rapidly. The REEDM-predicted NO_x (NO + NO_2) incremental concentrations resulting from the abort of Concept A vehicles are summarized in Table J-29.

For the MLV-A and HLV-G, REEDM did not predict NO or NO_2 incremental concentrations during an abort. The results indicate that the maximum predicted NO_x concentration increment is half of the hourly NO_2 standard.

Table J-29. Summary of REEDM-Predicted Ambient Air Concentration Increments for NO_x During Aborted Launches, Concept A

	Distance to maximum concentration (km)	30-minute average concentration increment (ppm)	1-hour average concentration increment (ppm)	Daily average concentration increment (ppm)
MLV-D	4	0.227	0.114	0.0047
MLV-A	NA	NA	NA	NA
HLV-L	6	0.139	0.057	0.0029
HLV-G	NA	NA	NA	NA

HLV = heavy lift variant
km = kilometers
MLV = medium lift variant
NA = not applicable
NO_x = nitrogen oxides
ppm = parts per million
REEDM = Rocket Exhaust Effluent Diffusion Model

Chlorine in the form of HCl would not be employed for any of the Concept A launch vehicles. NH_3 was predicted by REEDM for the MLV-A and HLV-G abort scenarios. Table J-30 provides the resulting peak and 30-minute average concentrations.

Table J-30. Summary of REEDM-Predicted Ambient Air Concentration Increments for NH_3 During Aborted Launches, Concept A

	Distance to maximum concentration (km)	30-minute average concentration increment (ppm)	Peak puff concentration increment (ppm)
MLV-D	NA	NA	NA
MLV-A	4-5	0.004	0.013
HLV-L	NA	NA	NA
HLV-G	5-6	0.003	0.006

HLV = heavy lift variant
km = kilometers
MLV = medium lift variant
NA = not applicable
NH_3 = ammonia
ppm = parts per million
REEDM = Rocket Exhaust Effluent Diffusion Model

The incremental concentrations are typical of rural ambient concentrations and would not pose any short-term health hazards.

Hydrazine compound concentrations were estimated by REEDM for each launch vehicle and are summarized in Table J-31.

The maximum concentrations of hydrazine compounds were predicted for the smaller launch vehicle, possibly because of the increased buoyancy of this vehicle, making the final centerline height larger and the ground-level concentrations smaller.

Table J-31. Summary of REEDM-Predicted Ambient Air Concentration Increments for Hydrazine Compounds During Aborted Launches, Concept A

	Distance to maximum concentration (km)	30-minute average concentration increment (ppm)	Peak puff concentration increment (ppm)
MLV-D	4	0.025	0.079
MLV-A	4	0.0	0.001
HLV-L	5-6	0.015	0.038
HLV-G	NA	0.0	0.0

HLV = heavy lift variant
km = kilometers
MLV = medium lift variant
NA = not applicable
ppm = parts per million
REEDM = Rocket Exhaust Effluent Diffusion Model

4.2 Ambient Concentrations, Concept B

Emissions from aborted launches were estimated as described in Section 4.1 of this appendix (Table J-32).

Table J-32. Summary of Emissions Resulting from Launch Failure, Concept B (in tons)

	DIV-S	DIV-M	DIV-M+	DIV-H
CO	0.0	0.0	0.0	0.0
NO_x	0.23	0.0	0.66	0.0
HCl	0.0	0.0	8.80	0.0
Hydrazine [(a)]	0.186	0.005	0.005	0.01
PM	0.0	0.0	17.09	0.0
VOC	0.0	0.0	0.0	0.0

Note: (a) Includes monomethyl hydrazine (MMH) anhydrous hydrazine (N_2H_4), and unsymmetrical dimethylhydrazine (UDMH).
CO = carbon monoxide
DIV-H = heavy launch vehicle
DIV-M = medium launch vehicle
DIV-M+ = medium launch vehicle with solid rocket motor strap-ons
DIV-S= small launch vehicle
HCl = hydrochloric acid
NO_x = nitrogen oxides
PM = particulate matter
VOC = volatile organic compound

As described earlier, REEDM produces peak puff and 30-minute average concentration estimates, which are converted to hourly and daily concentrations. Tables for peak hourly and daily CO and NO_x predictions were produced. Rather than producing tables for each toxic hydrazine compound, the concentrations were summed for all hydrazine compounds. Separate tables for NH_3 and HCl peak 30-minute concentrations have been compiled where relevant.

The CO-predicted incremental concentrations for Concept B vehicles is presented in Table J-33.

Table J-33. Summary of REEDM-Predicted Ambient Air Concentration Increments for CO During Aborted Launches, Concept B

	Distance to maximum concentration (km)	30-minute average concentration increment (ppm)	8-hour average concentration increment (ppm)
DIV-S	5	0.011	0.0009
DIV-M	NA	NA	NA
DIV-M+	4	0.011	0.0007
DIV-H	NA	NA	NA

CO = carbon monoxide
DIV-H = heavy launch vehicle
DIV-M = medium launch vehicle
DIV-M+ = medium launch vehicle with solid rocket motor strap-ons
DIV-S = small launch vehicle
km = kilometers
NA = not applicable
ppm = parts per million
REEDM = Rocket Exhaust Effluent Diffusion Model

As Table J-33 indicates, given that the launch is a transient source, the 8-hour average concentration increment is a minuscule fraction of the NAAQS of 9 ppm. The concentrations are so small that a daily average concentration increment was not estimated.

The NAAQS for NO_x is an annual standard and is not affected by the transient launch releases. The CAAQS has an hourly NO_2 standard of 0.25 ppm. For conservative purposes, it was assumed that all NO in NO_x is converted to NO_2 rapidly. Table J-34 summarizes the REEDM-predicted NO_x (NO + NO_2) incremental concentrations resulting from the abort of Concept B vehicles.

Table J-34. Summary of REEDM-Predicted Ambient Air Concentration Increments for NO_x During Aborted Launches, Concept B

	Distance to maximum concentration (km)	30-minute average concentration increment (ppm)	1-hour average concentration increment (ppm)	Daily average concentration increment (ppm)
DIV-S	5	0.143	0.071	0.003
DIV-M	NA	NA	NA	NA
DIV-M+	NA	NA	NA	NA
DIV-H	NA	NA	NA	NA

DIV-H = heavy launch vehicle
DIV-M = medium launch vehicle
DIV-M+ = medium launch vehicle with solid rocket motor strap-ons
DIV-S = small launch vehicle
km = kilometers
NA = not applicable
NO_x = nitrogen oxides
ppm = parts per million
REEDM = Rocket Exhaust Effluent Diffusion Model

NO or NO_2 incremental concentrations during an abort were predicted by REEDM only for the DIV-S vehicle configuration. Results indicate that the maximum NO_x concentration increment is about one-fifth of the hourly NO_2 standard.

Chlorine in the form of HCl was predicted for the DIV-M+ (commercial only) configurations. Table J-35 summarizes the REEDM concentration increment predictions.

Table J-35. Summary of REEDM-Predicted Ambient Air Concentration Increments for HCl During Aborted Launches, Concept B

	Distance to maximum concentration (km)	30-minute average concentration increment (ppm)	Peak puff concentration increment (ppm)
DIV-M+	4	0.007	0.023

DIV-M+ = medium launch vehicle with solid rocket motor strap-ons
HCl = hydrochloric acid
km = kilometers
ppm = parts per million
REEDM = Rocket Exhaust Effluent Diffusion Model

Peak puff concentrations are a small fraction of the Occupational Safety and Health Administration (OSHA) Permissible Exposure Level (PEL) ceiling limit of 5 ppm.

NH_3 was predicted by REEDM for all Concept B abort scenarios. Table J-36 presents the resulting peak and 30-minute average concentrations.

Table J-36. Summary of REEDM-Predicted Ambient Air Concentration Increments for NH_3 During Aborted Launches, Concept B

	Distance to maximum concentration (km)	30-minute average concentration increment (ppm)	Peak puff concentration increment (ppm)
DIV-S	4-5	0.058	0.173
DIV-M	4	0.002	0.005
DIV-M+	4	0.002	0.005
DIV-H	5	0.002	0.005

DIV-H = heavy launch vehicle
DIV-M = medium launch vehicle
DIV-M+ = medium launch vehicle with solid rocket motor strap-ons
DIV-S = small launch vehicle
HCl = hydrochloric acid
km = kilometers
NH_3 = ammonia
ppm = parts per million
REEDM = Rocket Exhaust Effluent Diffusion Model

For the DIV-S abort scenario, REEDM predicted larger concentrations than for all other vehicles. The incremental concentrations for all other launch configurations are typical of rural ambient concentrations and would not pose any short-term health hazards.

Table J-37 summarizes hydrazine compound concentrations estimated by REEDM for each Concept B launch vehicle. The maximum concentrations of hydrazine compounds resulting from the use of the DIV-S with its hypergolic upper stage are larger than for any other Concept B vehicle.

Table J-37. Summary of REEDM-Predicted Ambient Air Concentration Increments for Hydrazine Compounds During Aborted Launches, Concept B

	Distance to maximum concentration (km)	30-minute average concentration increment (ppm)	Peak puff concentration increment (ppm)
DIV-S	4-5	0.013	0.039

DIV-M	NA	0.0	0.0
DIV-M+	NA	0.0	0.0
DIV-H	NA	0.0	0.0

DIV-H = heavy launch vehicle
DIV-M = medium launch vehicle
DIV-M+ = medium launch vehicle with solid rocket motor strap-ons
DIV-S = small launch vehicle
HCl = hydrochloric acid
km = kilometers
ppm = parts per million
REEDM = Rocket Exhaust Effluent Diffusion Model

4.3 Estimation of Emissions Resulting from Launch Failure

The REEDM model utilizes information from a fireball chemical model (Brady et al., 1997) to estimate the fate of the propellants and oxidants from a vehicle that is deliberately destroyed. The chemicals suffer several different fates, including:

- Accelerated combustion reaction
- Thermal decomposition
- Vaporization
- Atmospheric combustion
- Chemical conversion.

Each fate produces a different mass budget of pollutant products, many of which are chemicals of concern. By analyzing REEDM input and output, a mass budget was developed to account for the fuel mass that is converted into emitted chemicals of concern. The mass budget provides a more efficient method of analyzing launch failures for different vehicles and documenting the results.

APPENDIX K

CLEAN AIR ACT CONFORMITY APPLICABILITY ANALYSIS
VANDENBERG AIR FORCE BASE, CALIFORNIA

Purpose

The U.S. Air Force is required to perform a formal air conformity applicability analysis to determine whether the Evolved Expendable Launch Vehicle (EELV) program at Vandenberg Air Force Base (AFB), California complies with the Environmental Protection Agency (EPA) Final Conformity Rule, 40 Code of Federal Regulations (CFR) 93, Subpart B (for federal agencies) and 40 CFR 51, Subpart W (for state requirements) of the amended Clean Air Act (CAA).

Background

The U.S. EPA has issued regulations clarifying the applicability of and procedures for ensuring that federal activities comply with the amended CAA. The EPA Final Conformity Rule implements Section 176(c) of the CAA, as amended in 42 U.S. Code (USC) 7506(c). This rule was published in the Federal Register on November 30, 1993, and took effect on January 31, 1994.

The EPA Final Conformity Rule requires all federal agencies to ensure that any federal action resulting in nonattainment criteria pollutant emissions conforms with an approved or promulgated state implementation plan (SIP) or federal implementation plan (FIP). Conformity means compliance with a SIP/FIP's purpose of attaining or maintaining the National Ambient Air Quality Standards (NAAQS). Specifically, this means ensuring that the federal action will not: (1) cause a new violation of the NAAQS; (2) contribute to any increase in the frequency or severity of violations of existing NAAQS; or (3) delay the timely attainment of any NAAQS interim milestones, or other attainment milestones. NAAQS are established for six criteria pollutants: ozone (O_3), carbon monoxide (CO), particulate matter equal to or less than 10 microns in diameter (PM_{10}), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), and lead (Pb). The current standards apply to federal actions in NAAQS nonattainment or maintenance areas only.

Status

The proposed EELV program would be implemented at Vandenberg AFB in Santa Barbara County, California. Air quality management in Santa Barbara County is under the jurisdiction of the Santa Barbara County Air Pollution Control District (SBCAPCD), the California Air Resources Board (CARB), and the U.S. EPA, Region 9. All sections of SBCAPCD's Rule 702 were adopted verbatim from the federal General Conformity regulation (58 Federal Regulation [FR] 63214, November 30, 1993), except for provision 51.860, preambled below.

51.860 Mitigation of Air Quality Impact.

(A) Any measures that are intended to mitigate air quality impact must be identified (including the identification and quantification of all emission reductions claimed) and the process for implementation (including any necessary funding of such measures and tracking of such emission reductions) and enforcement of such measures must be described, including an implementation schedule counting explicit timelines for implementation.

(B) Prior to determining that a Federal action is in conformity, the Federal agency making the conformity determination must obtain written commitments from the appropriate persons or agencies to implement any mitigation measures which are identified as conditions for making conformity determinations. Such written commitments shall describe such mitigation measures and the nature of the commitment, in a manner consistent with paragraph (A).

(C) Persons or agencies voluntarily committing to mitigation measures to facilitate positive conformity determinations must comply with the obligations of such commitments.

(D) In instances where the Federal agency is licensing, permitting or otherwise approving the action of another governmental or private entity, approval by the Federal agency must be conditioned on the other entity meeting the mitigation measures set forth in the conformity determination, as provided in paragraph (A).

(E) When necessary because of changed circumstances, mitigation measures may be modified so long as the new mitigation measures continue to support the conformity determination in accordance with 51.858 and 51.859 and this section. Any proposed change in the mitigation measures is subject to the reporting requirements of section 51.856 and the public participation requirements of section 51.857.

(F) After a State revises its SIP to adopt its general conformity rules and EPA approves that SIP revision, any agreements, including mitigation measures, necessary for a conformity determination will be both State and Federally enforceable. Enforceability through the applicable SIP will apply to all persons who agree to mitigate direct and indirect emissions associated with a Federal Action for a conformity determination. Adopted 10/20/94.

Other than the above listed, Santa Barbara County is following federal implementation guidelines. The area of Santa Barbara County containing Vandenberg AFB complies with state and federal standards for SO_2, NO_2, CO, and lead. The entire Santa Barbara County is classified as in serious nonattainment for ozone. The classification of nonattainment for PM_{10} is by state standards only. The SBCAPCD did not meet its emission goals for moderate nonattainment for ozone. As a result, the district was reclassified to ozone **serious** nonattainment in December 1997.

The EPA Final Conformity Rule requires that total direct and indirect emissions of nonattainment criteria pollutants, including ozone precursors (volatile organic compounds [VOCs] and nitrogen oxides [$NO_{x]}$), be considered in determining conformity. The rule does not apply to actions where the total direct and indirect emission of nonattainment criteria pollutants do not exceed threshold levels for criteria pollutants established in 40 CFR 93.135(b). Ongoing activities are exempt from the rule as long as there is no increase in emissions above the de minimis levels specified in the rule. Table K-1 presents the de minimis threshold level of nonattainment areas. This analysis compares air emissions totals to both de minimis thresholds to take into consideration the ozone reclassification status of Santa Barbara County from moderate to serious nonattainment.

Table K-1. De Minimis Threshold in Nonattainment Areas (tons per year)

Pollutant	Degree of Nonattainment Level	De Minimis[(a)(b)]
Ozone (VOCs and NO_x)	Moderate	100
	Serious	**50**
	Severe	25
	Extreme	10
VOCs	Marginal	50
NO_x	Marginal	100
Carbon Monoxide	All	100
Particulate Matter	Moderate	100
	Serious	70
SO_2 or NO_2	All	100
Lead	All	25

Notes: (a) The de minimis threshold level for ozone in Santa Barbara County was reclassified to 50 tons per year.
(b) Number in bold reflects de minimis threshold used in this analysis.
NO_2 = nitrogen dioxide
NO_x = nitrogen oxides
SO_2 = sulfur dioxide
VOC = volatile organic compound

Source: Santa Barbara County Air Pollution Control District - Regulation VII, Rule 702

In addition to meeting de minimis requirements, a federal action must not be considered a regionally significant action. A federal action is considered regionally significant when the total emissions from the action equal or exceed 10 percent of the air quality control area's emission inventory for any criteria pollutant. If a federal action meets de minimis requirements and is not considered a regionally significant action, then it is exempt from further conformity analyses pursuant to 40 CFR 93.153(c).

Summary of Air Pollutant Emissions and Regulatory Standards

This section provides a summary of the Santa Barbara County non-compliance pollutant standards as defined in the 1994 Air Quality Management Plan for Santa Barbara County.

As discussed in the air quality section of the environmental impact statement (EIS) for the EELV program, Santa Barbara County is currently in violation of the state PM_{10} standard and the state and federal ozone standards. Exceedances of the annual state standard for PM_{10} have occurred only at the downtown Santa Maria monitoring station, while the 24-hour PM_{10} state standard (50 micrograms per cubic meter [$\mu g/m^3$] for California and 150 $\mu g/m^3$ for the federal standard) violations are dispersed throughout the county. Since Vandenberg AFB is located in Santa Barbara County, which does not exceed federal PM_{10} standards and is unclassified by federal standards, a PM_{10} analysis is not included as part of this Air Conformity Applicability Analysis.

Both the federal CAA and the California State CAA set up a method for classifying areas according to severity of ozone. These classifications determine regulatory requirements and target dates for ozone standard attainment. Five classifications have been mandated for ozone: marginal, moderate, serious, severe, and extreme. The current federal ozone standard is 0.12 parts per million. An area is designated as being in nonattainment if it violates the standard more than three times in 3 years at a single monitoring station. As mentioned in the EIS, the EPA has approved a new ozone standard. The new standard and implementation measures have not yet been approved in the Santa Barbara County Air Quality Management Plan or SIP.

For federal actions, an air conformity applicability analysis and (if needed) a conformity determination are required when the total of direct and indirect emissions of a criteria pollutant in a nonattainment or maintenance area caused by the federal action equals or exceeds the de minimis thresholds. The nonattainment pollutants included in this analysis are the ozone precursors (measured by VOCs and NO_x).

Emission Modeling

A total of direct and indirect emissions (increases and decreases) from the EELV program concepts was estimated using methods similar to those presented in the EIS. The following conformity-related emission sources were considered in the emission estimates: launch emissions, operational direct and indirect emissions, construction-related emissions, and mobile source (direct and indirect) emissions from operations. The emission estimates for this project were calculated for the following years: construction years 1998, 1999, 2000, 2001, 2002; EELV operation years 2001 and 2002; Air Quality Management Plan Conformity Growth year 2006; and peak launch years 2007 and 2014. The baseline year, consistent with the EIS for the air conformity applicability analysis, is 1995, which is the most recent year for which detailed emissions information was available at the time of the analysis. Emissions were totaled for sources associated with the EELV program; unrelated activities that occur at Vandenberg AFB were not included in the comparison.

Further review of the definition of “indirect emissions” in the General Conformity Rule has resulted in modifications to the sources addressed in the “Direct and Indirect Emissions” portion of the protocol. Indirect emissions are defined in 40 CFR 93.152 as emissions of a criteria pollutant which: (1) are caused by a federal action, but may occur later in time and/or may be farther removed in distance from the action itself but are still reasonably foreseeable, and (2) the federal agency can practicably control and will maintain control over due to a continuing program responsibility.

The air quality modeling analysis required under the conformity rule must be based on the applicable air quality model, data bases, and other requirements specified in the “Guideline on Air Quality Models (Revised)” (1986), including supplements (EPA Publication No. 450/2-78-027R) and the Air Force Conformity Guide Handbook. Models used in this applicability analysis to determine air emissions resulting from the EELV program at Vandenberg AFB include the EMFAC 7(f), the state of California-approved model for motor vehicles, emission factors of aircraft associated with EELV component deliveries from Emissions and Dispersion Modeling System (EDMS, Version 3.0), and Calculation Methods for Criteria Air Pollutant Emission Inventories (Jagielski and O’Brien, 1994). Emissions of VOCs and NO_x generated by facility construction activities were projected based on Sacramento Metropolitan Air Quality Management District (SMAQMD) factors (Sacramento Metropolitan Air Quality Management District, Air Quality Thresholds of Significance, Sacramento, California, 1994). These emission factors have been established for each of the following categories of construction activity:

- Grading Equipment: Emissions in the grading phase are primarily associated with the exhaust from large earth-moving equipment.

- Asphalt Paving: VOC emissions in the asphalt paving phase are released through the evaporation of solvents contained in paving materials.

- Stationary Equipment: Emissions from stationary equipment occur when machinery such as generators, air compressors, welding machines, and other similar equipment are used at the construction site.

- Mobile Equipment: Mobile equipment includes fork lifts, dump trucks, excavators, etc.

- Architectural Coatings: VOCs are released through the evaporation of solvents that are contained in paints, varnishes, primers, and other surface coatings.

- Commuter Automobiles: Commuter traffic emissions are generated from commuter trips to and from the work site by construction employees. The average vehicle ridership number (1.5 persons per vehicle) from the California Environmental Quality Act (CEQA) Handbook was applied.

Tables and Emission Data

Emission calculations for VOCs were performed as consistently as possible. Several information sources identify “ROC,” for reactive organic compounds, instead of “VOC,” for volatile organic compounds. For all practical purposes, these two terms can be considered equivalent. The federal government generally uses the term VOC, which is defined, in part, in 40 CFR 60.2, as “any organic compound which participates in atmospheric photochemical reactions.” The term VOC has been chosen for use in this document. When using emission factors that list emissions as “total hydrocarbons” and “total non-methane hydrocarbons,” the document uses “total non-methane hydrocarbons” as a VOC equivalent. Methane does not participate in atmospheric photochemical reactions and therefore does not fall under the definition of VOC. While there are other hydrocarbons that similarly do not fall under the definition of VOC, the use of “total non-methane hydrocarbons” as a VOC equivalent is considered conservative and appropriate.

The emissions of ozone precursors (VOCs and NO_x) and other criteria pollutants that would result from construction and implementation of the EELV program are shown in Tables K-2 through K-5.

Table K-2. Comparison of EELV Annual Emission Inventory at Vandenberg AFB, Concept A (tons/year)

Pollutants	Emission Sources	1998	1999	2000	2001	2002	2006	2007	2014
VOCs	Construction-Related								
	Grading Equipment		-	1.1	0.0		-	-	-
	Asphalt Paving	-	-	0.0	0.2		-	-	-
	Stationary Equipment	-	-	1.2	1.2	0.0	-	-	-
	Mobile Equipment	-	-	2.4	2.9	0.1	-	-	-
	Architectural Coatings								
	(Non-Residential)	-	-	0.4	2.2	0.7	-	-	-
	Commuter Automobiles	-	-	2.6	2.0	0.5	-	-	-
	Total Construction Emissions	-	-	7.7	8.5	1.3	-	-	-
	Operation-Related								
	Program Launches				-	-	-	-	-
	Preparation and Assembly				3.0	4.5	6.0	7.5	7.5
	Mobile Sources				3.3	3.4	2.4	2.2	1.3
	Point Sources				0.3	0.3	0.3	0.3	0.3
	Total Project Emissions	-	-	-	6.6	8.2	8.7	10.0	9.1
	Emission Decreases from No-Action								
	Alternative	-	-	-	(2.4)	(3.5)	(4.7)	(5.3)	(5.3)
	Total Annual Emissions	**-**	**-**	**7.7**	**12.7**	**6.0**	**4.0**	**4.7**	**3.7**
NO_x	Construction-Related								
	Grading Equipment	-	-	9.6	0.1		-	-	-
	Asphalt Paving	-	-		1.1		-	-	-
	Stationary Equipment	-	-	2.1	3.0	0.0	-	-	-
	Mobile Equipment	-	-	13.1	16.9	0.3	-	-	-
	Architectural Coatings								
	(Non-Residential)	-	-				-	-	-
	Commuter Automobiles	-	-	2.6	2.1	0.5	-	-	-
	Total Construction Emissions	-	-	27.4	23.2	0.8	-	-	-
	Operation-Related								
	Program Launches				1.9	2.9	3.8	4.8	4.8
	Preparation and Assembly								
	Mobile Sources				4.0	4.6	4.3	4.4	3.7
	Point Sources				4.5	4.5	4.5	4.5	4.5
	Total Project Emissions	-	-	-	10.4	12.0	12.6	13.7	13.1
	Emission Decreases from No-Action								
	Alternative	-	-	-	(10.1)	(11.4)	(12.6)	(13.7)	(13.6)
	Total Annual Emissions	**-**	**-**	**27.4**	**23.5**	**1.4**	**(0.0)**	**(0.0)**	**(0.6)**

NO_x = nitrogen oxides

VOC = volatile organic compound

Table K-3. Comparison of EELV Annual Emission Inventory at Vandenberg AFB, Concept B (tons/year)

Pollutants	Emission Sources	1998	1999	2000	2001	2002	2006	2007	2014
VOCs	Construction-Related								
	Grading Equipment	-	0.7	0.2			-	-	-
	Asphalt Paving	-	0.0	0.1			-	-	-
	Stationary Equipment	0.2	2.1	17.2	0.5		-	-	-
	Mobile Equipment	0.2	0.8	5.0	0.1		-	-	-
	Architectural Coatings								
	(Non-Residential)	0.3	1.4	8.8	2.9		-	-	-
	Commuter Automobiles	0.2	1.4	3.7	1.2		-	-	-
	Total Construction Emissions	0.9	6.4	35.0	4.7		-	-	-
	Operation-Related								
	Program Launches				-	-	-	-	-
	Preparation and Assembly				2.6	4.0	5.3	6.6	6.6
	Mobile Sources				10.5	10.3	7.4	6.7	3.9
	Point Sources				0.5	0.5	0.5	0.5	0.5
	Total Project Emissions	-	-	-	13.6	14.7	13.1	13.8	11.0
	Emission Decreases from								
	No-Action Alternative	-	-	-	(2.4)	(3.5)	(4.7)	(5.3)	(5.3)
	Total Annual Emissions	**0.9**	**6.4**	**35.0**	**15.9**	**11.2**	**8.5**	**8.5**	**5.6**
NO_x	Construction-Related								
	Grading Equipment	-	5.9	1.6		-	-	-	-
	Asphalt Paving	-		1.3	0.1	-	-	-	-
	Stationary Equipment	0.2	0.1	0.3	0.0	-	-	-	-
	Mobile Equipment	2.1	5.8	12.4	1.0	-	-	-	-
	Architectural Coatings								
	(Non-Residential)	-	-	-	-	-	-	-	-
	Commuter Automobiles	0.2	1.2	3.4	0.2	-	-	-	-
	Total Construction Emissions	2.5	13.0	19.0	1.3	-	-	-	-
	Operation-Related								
	Program Launches				3.2	2.2	4.6	5.4	5.4
	Preparation and Assembly								
	Mobile Sources				11.8	11.9	11.1	10.8	8.7
	Point Sources				4.2	4.2	4.2	4.2	4.2
	Total Project Emissions	-	-	-	19.2	18.3	19.9	20.4	18.3
	Emission Decreases from								
	No-Action Alternative	-	-	-	(10.1)	(11.4)	(12.6)	(13.7)	(13.6)
	Total Annual Emissions	**2.5**	**13.0**	**19.0**	**10.4**	**6.9**	**7.3**	**6.7**	**4.7**

NO_x = nitrogen oxides

VOC = volatile organic compound

Table K-4. Comparison of EELV Annual Emission Inventory at Vandenberg AFB, Concept A/B (tons/year)

Pollutants	Emission Sources	1998	1999	2000	2001	2002	2006	2007	2014
VOCs	Construction-Related								
	Grading Equipment	-	0.7	1.3	0.0	-	-	-	-
	Asphalt Paving	-	0.0	0.1	0.2	-	-	-	-
	Stationary Equipment	0.2	2.1	18.3	1.6	0.0	-	-	-
	Mobile Equipment	0.2	0.8	7.4	3.1	0.1	-	-	-
	Architectural Coatings (Non-Residential)	0.3	1.4	9.2	5.1	0.7	-	-	-
	Commuter Automobiles	0.2	1.4	6.3	3.2	0.5	-	-	-
	Total Construction Emissions	0.9	6.4	42.6	13.2	1.3	-	-	-
	Operation-Related								
	Program Launches				-	-	-	-	-
	Preparation and Assembly				1.3	2.0	3.3	9.9	4.6
	Mobile Sources				12.3	11.2	7.4	6.8	3.8
	Point Sources				0.8	0.8	0.8	0.8	0.8
	Total Project Emissions	-	-	-	14.4	14.0	11.5	17.5	9.3
	Emission Decreases from No-Action Alternative	-	-	-	(2.4)	(3.5)	(4.7)	(5.3)	(5.3)
	Total Annual Emissions	**0.9**	**6.4**	**42.6**	**25.2**	**11.8**	**6.8**	**12.3**	**4.0**
NO_x	Construction-Related								
	Grading Equipment	-	5.9	11.2	0.1	-	-	-	-
	Asphalt Paving	-	-	1.3	1.2	-	-	-	-
	Stationary Equipment	0.2	0.1	2.4	3.0	0.0	-	-	-
	Mobile Equipment	2.1	5.8	25.5	17.8	0.3	-	-	-
	Architectural Coatings (Non-Residential)	-	-	-	-	-	-	-	-
	Commuter Automobiles	0.2	1.2	6.1	2.3	0.5	-	-	-
	Total Construction Emissions	2.5	13.0	46.4	24.4	0.8	-	-	-
	Operation-Related								
	Program Launches				2.4	2.8	4.5	7.9	5.5
	Preparation and Assembly								
	Mobile Sources				13.6	13.1	11.3	11.7	9.0
	Point Sources				8.7	8.7	8.7	8.7	8.7
	Total Project Emissions	-	-	-	24.7	24.6	24.5	28.2	23.2
	Emission Decreases from No-Action Alternative	-	-	-	(10.1)	(11.4)	(12.6)	(13.7)	(13.6)
	Total Annual Emissions	**2.5**	**13.0**	**46.4**	**39.1**	**14.0**	**11.8**	**14.5**	**9.5**

NO_x = nitrogen oxides

VOC = volatile organic compound

Table K-5. Comparison of Pollutant Emissions to Emissions Inventory

	Emissions (tons/year)				
Proposed Action	Year	VOC	% of Inventory	NO_x	% of Inventory
Santa Barbara County Emissions Inventory[a]		51,015		18,222	
Concept A Emissions	1998	0.0	0.00	0.0	0.00
	1999	0.0	0.00	0.0	0.00
	2000	7.7	0.02	27.4	0.15
	2001	12.7	0.02	23.5	0.13
	2002	6.0	0.01	1.4	0.01
	2006	4.0	0.01	0.0	0.00
	2007	4.7	0.01	0.0	0.00
	2014	3.7	0.01	0.0	0.00
Concept B Emissions	1998	0.9	0.00	2.5	0.01
	1999	6.4	0.01	13.0	0.07
	2000	35.0	0.07	19.0	0.10
	2001	15.9	0.03	10.4	0.06
	2002	11.2	0.02	6.9	0.04
	2006	8.5	0.02	7.3	0.04
	2007	8.5	0.02	6.7	0.04
	2014	5.6	0.01	4.7	0.03
Concept A/B Emissions	1998	0.9	0.00	2.5	0.01
	1999	6.4	0.01	13.0	0.07
	2000	42.6	0.08	46.4	0.25
	2001	25.2	0.05	39.1	0.21
	2002	11.8	0.02	14.0	0.08
	2006	6.8	0.01	11.8	0.06
	2007	12.3	0.02	14.5	0.08
	2014	4.0	0.01	9.5	0.05

Note: (a) Emissions inventory for Santa Barbara County obtained from 1994 Santa Barbara County Clean Air Plan.

NO_x = nitrogen oxides

VOC = volatile organic compound

Analysis

The total of direct and indirect emissions resulting from EELV activities is illustrated in Table K-6. The VOC and NOx emissions were estimated based on the information provided by each of the two contractors. Emissions fall below the de minimis thresholds for conformity. A formal air conformity determination will not be required for the EELV program, as required by the CAA, 40 CFR Part 93. All ongoing activities are exempt from the rule as long as there is no increase in emissions above the de minimis levels specified in the rule. Resultant direct and indirect emissions occurring during EELV program operations are illustrated in Tables K-2, K-3, and K-4. A decrease in emissions is expected by full employment in 2007. This decrease in emissions is a result of the replacement of Atlas IIA, Delta II, and Titan IVB launch programs with the EELV program. Normal operations for the EELV program would not exceed any de minimis thresholds. During the peak launch operation years of 2007 and 2014, it is anticipated that a slight increase in emissions would occur due to temporary launch technical crews associated with the launch activities. These temporary technical crews would consist of 14 to 18 persons per launch, who would remain in the county for up to 14 days per launch. During the peak launch years, increases in direct and indirect emissions from temporary technical crews are not anticipated to cross the de minimis threshold for nonattainment pollutants. Total emissions from each concept of the EELV program are less than 10 percent of the Santa Barbara County emission inventory. Therefore, the EELV program is not regionally significant.

Table K-6. Comparison of EELV Annual Emission Inventory with De Minimis Threshold, Vandenberg AFB

Pollutant		Emissions (tons/year)							
		1998	1999	2000	2001	2002	2006	2007	2014
VOCs									
Serious Ozone Nonattainment Threshold	50								
Concept A		0.0	0.0	7.7	12.7	6.0	4.0	4.7	3.7
Concept B		0.9	6.4	35.0	15.9	11.2	8.5	8.5	5.6
Concept A/B		0.9	6.4	42.6	25.2	11.8	6.8	12.3	4.0
NO_x									
Serious Ozone Nonattainment Threshold	50								
Concept A		0.0	0.0	27.4	23.5	1.4	0.0	0.0	0.0
Concept B		2.5	13.0	19.0	10.4	6.9	7.3	6.7	4.7
Concept A/B		2.5	13.0	46.4	37.1	14.0	11.8	14.5	9.5

NO_x = nitrogen oxides
VOC = volatile organic compound

References

California Air Resources Board, 1997. Proposed Amendments to the Area Designations for State Ambient Air Quality Standards, and Proposed Maps of the Area Designations for the State and National Ambient Air Quality Standards, California Environmental Protection Agency, November.

California Department of Transportation and California Air Resources Board, 1994. EMFAC 7F1.1 Software Program (Emission Factor Model, Release 2.01), Division of New Technology, Materials, & Research, and Technical Support Division, Sacramento, California, July.

Jagielski and O'Brien, 1994. Calculation Methods for Criteria Air Pollutant Emission Inventories, (AL/OE-TR-1994-0049), July.

Sacramento Metropolitan Air Quality Management District, 1994. Air Quality Thresholds of Significance, Sacramento, California.

Santa Barbara County, 1994. Clean Air Plan, Santa Barbara County's Plan to Attain the Federal and State Ozone Standard, November.

South Coast Air Quality Management District, 1993. CEQA Air Quality Handbook, April.

U.S. Air Force, 1994a. Clean Air Act Conformity Guide, October.

U.S. Air Force, 1994b. Space and Missile Systems Center, Clean Air Act General Conformity Analysis, Titan and Atlas IIAS Fiber Optic Transmission System, Vandenberg Air Force Base, California, June.

U.S. Air Force, 1996. Air Conformity Applicability Model (Final), Version 2.0 LT, User's Guide, March.

U.S. Air Force, 1997. Clean Air Act General Conformity Determination, Proposed Multiple Uses of March Air Force Base, Riverside County, California, May.

U.S. Environmental Protection Agency, 1994. Draft User's Guide to PART5: A Program for Calculating Particle Emissions from Motor Vehicles. Office of Mobile Sources, EPA-AA-AQAB-94-2, Ann Arbor, Michigan, July.

U.S. Environmental Protection Agency, 1995. Compilation of Air Pollutant Emission Factors, Volume I: Stationary Point and Area Sources, 5th Edition (AP-42), Office of Air Quality Planning and Standards, Ann Arbor, Michigan, January.