Environmental Impact Analysis Process

ENVIRONMENTAL ASSESSMENT

AIR FORCE SMALL LAUNCH VEHICLE
VANDENBERG AIR FORCE BASE, EDWARDS AIR FORCE BASE, AND SAN NICOLAS ISLAND, CA
MAY 1991

DEPARTMENT OF THE AIR FORCE

Report Documentation Page

Report Date	Report Type	Dates Covered (from... to)
00051991	N/A	-

Title and Subtitle Environmental Impact Analysis Process Environmental Assessment Air Force Small Launch Vehicle	**Contract Number** **Grant Number** **Program Element Number**
Author(s)	**Project Number** **Task Number** **Work Unit Number**
Performing Organization Name(s) and Address(es) Engineering Science 199 S. Los Robles Ave. P.O.Box 7056 Pasadena, CA 91109	**Performing Organization Report Number**
Sponsoring/Monitoring Agency Name(s) and Address(es) sponsoring agency and address	**Sponsor/Monitor's Acronym(s)** **Sponsor/Monitor's Report Number(s)**
Distribution/Availability Statement Approved for public release, distribution unlimited	
Supplementary Notes	
Abstract	
Subject Terms	
Report Classification unclassified	**Classification of this page** unclassified
Classification of Abstract unclassified	**Limitation of Abstract** UU
Number of Pages 374	

ENVIRONMENTAL ASSESSMENT
for the
AIR FORCE SMALL LAUNCH VEHICLE PROGRAM

VANDENBERG AIR FORCE BASE
EDWARDS AIR FORCE BASE, AND
SAN NICOLAS ISLAND, CALIFORNIA

Prepared for

HEADQUARTERS SPACE SYSTEMS DIVISION/ DEV
LOS ANGELES AFB, CALIFORNIA
and
AIR FORCE OCCUPATIONAL AND ENVIRONMENTAL
HEALTH LABORATORY/EQE
BROOKS AFB, TEXAS

Contract No. F33615-89-D-4003
Order No. 003

May 1991

Prepared by
ENGINEERING-SCIENCE
DESIGN ■ RESEARCH ■ PLANNING
199 S. LOS ROBLES AVE. P.O.BOX 7056 PASADENA, CALIFORNIA 91109

Printed on
Recycled Paper
PS244

SUMMARY

This Environmental Assessment (EA) has been prepared as part of the United States Air Force (USAF) Environmental Impact Analysis Process (EIAP) for evaluation of proposed major projects, in compliance with the National Environmental Policy Act (NEPA) and the regulations of the President's Council on Environmental Quality (CEQ). The EA presents an environmental impact analysis of the proposed action and its alternatives. Section 1 of this EA contains the proposed action, its purpose and need, and alternatives. Section 2 is a description of the natural and man-made environment which may potentially be affected by the proposed action. Section 3 is an analysis of the potential environmental impacts which may result from implementation of the proposed action. Section 4 presents mitigation measures to prevent or minimize potentially significant impacts. Section 5 is a regulatory review of the proposed action, including identification of environmental permits and approvals which may be required. Section 6 summarizes the environmental impacts for each alternative.

Proposed Action and Alternatives

The proposed action is the construction and operation of an Air Force Small Launch Vehicle (AFSLV) and associated structures in support of the Department of Defense (DOD) space program. The AFSLV program will provide inexpensive launch services for small research and development (R&D) satellite payloads. The Air Force plans to acquire launch services for small payloads through a contractor. An initial launch capability of early fiscal year 1993 is planned. A maximum of 5 launches per year, or a total of 40 launches over a period of eight years, is planned through the year 2000. The proposed action would provide DOD, and possibly other users, with access to space via polar launch from the West Coast.

The specific site and launch system configuration for the AFSLV program have not been selected at this time. This document evaluates the potential sites and launch systems that may be selected for AFSLV, and therefore, is "programmatic" in nature, covering the broad action with an evaluation that is generic in nature and based on environmental analyses of past launch projects. This EA has been prepared in support of the Air Force source selection process for the AFLSV program, and allows the evaluation of environmental effects from each concept to be considered as part of the decisionmaking process. Once a specific site and launch system are selected by the Air Force, a site specific environmental analysis will be prepared.

Nine potential sites in California for the proposed AFSLV program are evaluated in this EA: seven sites on Vandenberg Air Force Base (VAFB), one site on Edwards Air Force Base (EAFB), and one site on San Nicolas Island. Sites being considered include both active launch sites currently used for other programs and undeveloped sites. The active launch sites are Launch Facility 6 (LF 06), Test Pad 1, Advanced Ballistic Re-Entry System (ABRES) A-3 on North VAFB; Space Launch Complex (SLC)-4W (west) and SLC-5 on South VAFB; an air platform facility for an air-launched space program at EAFB; and U.S. Navy facilities, including Pad 192, on San Nicolas Island. Undeveloped sites are Cypress Ridge and Boathouse Flats, both on South VAFB.

Three launch systems are evaluated in this EA: conventional launch pad, launch from an air platform, and launch from a transportable truck-trailer system. The conventional launch system is considered from each active launch site where similar launch activities have occurred: LF 06, Test Pad 1, ABRES A-3, SLC-4W, SLC-5 and Pad 192. The air-launched system is considered at existing facilities on EAFB. The truck-trailer system is considered at LF 06, Test Pad 1, SLC-5, Cypress Ridge and Boathouse Flats.

The selected AFSLV facility would include a fenced area of a size to be determined. At active launch sites, this size would be influenced by the extent of available facilities which could be reconstructed or modified for the AFSLV program. Depending on requirements unique to each particular launch system, facilities would be expected to include a launch area, a launch control structure, one or more operations support structure, and vehicle and payload processing areas. It is possible that some processing activities would take place at an off-site location, although processing facilities are available at each of the three bases. Existing access roads, utilities and parking areas would be used, where available, at active sites. Since these facilities are not available at undeveloped sites, use of these sites would require more construction activities. Utility corridors or tie-ins and access roads would be required at the undeveloped sites. The construction period will depend on the extent of available facilities that can be modified at active sites. At undeveloped sites, construction would require more time.

Alternatives to the proposed action are evaluated. These alternatives include: placement of AFSLV payloads as secondary payloads with other launch programs, participation with Navy/NASA launch vehicle acquisition, or initiating a new military development program. It was determined that only few opportunities as secondary payloads are available, and this would result in risk to mission schedules. The uncertainty of Navy and NASA programs would not allow the Air Force to meet mission objectives. An Air Force development program for a small launch vehicle would require funds in excess of the budgeted amount and not meet mission schedule requirements. Also, it would not foster the promotion of a commercial space launch industry. The No Action alternative was also evaluated and determined not to be a viable solution for meeting DOD mission requirements for assured access to space. Therefore, each of these alternatives were eliminated from further consideration. It has been determined that acquisition of launch services and use of available launch sites and facilities at VAFB, EAFB or San Nicolas Island would present the most reasonable course of action for meeting mission requirements, technical needs, costs, and engineering design considerations.

Environmental Setting

The three potential locations for the AFSLV program are VAFB in Santa Barbara County, EAFB in Kern County, and San Nicolas Island off the coast of Southern California in Ventura County. Characteristics of existing environments at these locations vary according to topography and the amount of previous development at each individual site.

Each available active facility varies in terms of existing structures that could be adapted to launch an AFSLV. LF 06 is an active Minuteman III launch silo facility, located at the northernmost area of North VAFB. Test Pad 1, also on North VAFB, is an active AFSC facility that consists of a concrete platform. The ABRES A-3 site is an active aboveground launch mount facility on North VAFB, used to launch a commercial Single Module Launch Vehicle (SMLV). On South VAFB, SLC-4W and SLC-5 are active Titan II and NASA Scout launch pads with associated facilities and structures. Cypress Ridge and Boathouse Flats are two undeveloped sites that were evaluated for the proposed construction of the Titan IV/Centaur facility known as SLC-7. Both sites are vacant, with the exception of an access road (Shuttle External Tank Tow Route) and electrical service at the Boathouse Flats site. Existing ground support facilities for the Air Launched Vehicle (ALV) at EAFB are available as a potential site for an air-launched AFSLV. Facilities consist of a vehicle assembly building, office trailers and primary runways on Rogers Dry Lake. Pad 192 on San Nicolas Island is an aboveground launch mount currently used for the U.S. Navy Vandal launch program. San Nicolas Island is part of the U.S. Navy Pacific Missile Test Center (PMTC) Naval Air Station (NAS).

- **Air Quality**

Air quality at each of the three general locations is generally good, with the exception of periods when ambient air quality standards are exceeded for ozone and particulates at VAFB and EAFB. Areas around EAFB may also exceed the ambient standards for nitrogen oxides. Air quality at San Nicolas Island is expected to meet all ambient air quality standards.

- **Water Quality**

Surface water is found in the immediate vicinities of SLC-4W and SLC-5. Unnamed drainages are located near some of the North VAFB facilities. Most sites on VAFB are underlain by non-water bearing formations, or are isolated from groundwater resources. On EAFB, three groundwater basins provide a source of domestic water. Pad 192 on San Nicolas Island overlies an area of groundwater recharge, which occurs by percolation.

Surface and ground water quality on VAFB has exhibited high mineral, metal and total dissolved solids concentrations. On EAFB, water quality has shown elevated levels of organic contaminants. Data collected on San Nicolas Island indicate that water is of marginal quality for consumption.

- **Geology**

Sites on North VAFB are located at the base of the Santa Ynez Mountains within one mile of the Pacific Ocean. On VAFB, sites are underlain by bedrock of the Monterey Formation. Topography is varied, ranging from sea level to elevated marine terraces, and includes sand dunes at some sites. At EAFB, soils are not unique, whereas San Nicolas Island soils are derived from stabilized sand dunes. Potentially significant paleontological resources are found at VAFB, EAFB and San Nicolas Island. All sites are located within the range of several active and potentially active earthquake faults.

- **Biota**

VAFB is located within a boundary region between coastal southern and central California provinces. A number of plant and animal species reach their northern, southern, or western limits in this region, making the base an area of ecological value. Although much of California has been modified or disturbed in the past, VAFB is relatively undisturbed and offers habitats that include central coastal scrub, Burton Mesa (maritime) chaparral, stabilized sand dunes, riparian scrub, and small wetlands. While many special status plants occur on VAFB, the Federal Category 2 candidate plant, San Luis Obispo monardella, occurs at several of the sites. Several species of protected marine mammals use the beaches and rocky coastal areas of VAFB for haul out areas. The base also provides habitat for a number of wide-ranging reptile, amphibian, mammal, and bird species, including regionally rare, candidate and protected species.

EAFB is characterized by Joshua tree woodland, creosote bush scrub, Mojave saltbush scrub, shadscale scrub, and alkali sink scrub plant communities in which three Federal candidate plants may occur. Small reptiles, mammals and birds are common on EAFB. In addition to other regionally rare or protected species, the federal- and State-listed threatened desert tortoise and Mojave ground squirrel occur on EAFB.

San Nicolas Island, one of the eight Channel Islands, is the location of marine mammal and sea bird rookeries. Except during a two-month period in the fall, the entire southern shore is restricted to human access. The federally-threatened sea otter also uses the extensive kelp beds along the island’s south shore. Other species on the island include the State-listed rare island fox and the federally-listed threatened island night lizard. Four species of federally-listed sea turtles and seven endangered cetaceans either occur, or are expected to occur, offshore.

- **Visual Resources**

The visual environment of VAFB is characterized by rolling hills, valleys, ocean cliffs, and wide-open terrain. Some sites on VAFB are visible from marine vessels, from the public railroad which runs the length of the base, and from public beaches. EAFB offers less visual resources, and is generally not visible from any public vantage points. San Nicolas Island is visible to marine traffic. All three locations include active and industrial type uses.

- **Socioeconomics and Public Services**

The socioeconomic area of influence in Santa Barbara, Kern and Los Angeles Counties is growing, and communities are affected by VAFB, EAFB, and the oil and gas industry.

With the exception of San Nicolas Island, temporary and permanent housing are available in the surrounding communities. With the exception of limited water supplies on San Nicolas Island, public services and utilities are available.

- **Transportation**

Transportation routes are available to each base. Primary access to VAFB is via Highway 101. The Southern Pacific, Santa Maria Valley, and Ventura County Railroads also provide service in the vicinity of VAFB. Access to EAFB is via Highways 14, 395, 18, and State Routes 58 and 138. The Atchison, Topeka and Santa Fe rail line provides freight service to the EAFB area. All materials must be barged to San Nicolas Island. A commercial commuter air service transports personnel to and from the island.

- **Cultural Resources**

Prehistoric and historic cultural material is abundant on VAFB, EAFB and San Nicolas Island. Over 712 known archaeological sites have been documented on VAFB. Approximately 1,130 cultural resource sites are known on EAFB, and more than 500 sites have been found on San Nicolas Island.

Impacts and Mitigation Measures

Although potential impacts to the natural and man-made environments could result from implementation of the proposed action at each location, most potential direct and indirect impacts may be avoided through careful project design or operational procedures, adherence to regulatory and permit requirements, and specific mitigation efforts.

In the event that an active site is selected for the AFSLV and new construction is not required, impacts are expected to be minimal. With the application of mitigation measures, such impacts could be reduced to a level of insignificance. In the event that an active site is selected and modifications include any earthmoving activities, it is possible that impacts could occur. With the exception of impacts associated with launch operations from San Nicolas Island, it is also possible that such impacts could be mitigated to a level of insignificance. The use of the undeveloped sites at Cypress Ridge or Boathouse Flats would involve new construction, and therefore, would result in greater impacts than use of active facilities.

- **Air Quality**

Impacts to air quality could result from construction activities involving earthmoving. The generation of fugitive dust during construction can be effectively reduced by applying water to exposed surfaces. Construction activities will also result in the emission of exhaust products from construction machinery, vehicles or equipment use. Launch preparation, including payload processing activities, will result in the emission of volatile organic solvents and other chemicals. Propellant loading operations will also result in potential emissions of propellant and combustion products. The launch ground cloud is expected to be contain hydrochloric acid and aluminum oxide, which may be initially harmful to populations in the immediate vicinity of the launch site. Pre-launch meteorological monitoring is an effective means of avoiding launch during times that would result in a persistent ground cloud to remain in the area. Launching during favorable meteorological conditions should result in short-term minimal impacts to air quality and the civilian population surrounding VAFB. The air-launched system will result in aircraft emissions of carbon monoxide, nitrogen oxides, and hydrocarbons. Potential accidents on the launch pad and during takeoff would also result in the generation of air pollutants and toxic constituents. Emissions of greenhouse gases from the proposed AFSLV program are not expected to contribute significantly to global warming.

- **Water Quality**

Impacts to hydrologic resources could occur at VAFB from the inadvertent discharge of wastewater. The proposed action would also place an increased demand on groundwater basins that are currently experiencing overdraft conditions. In the event that construction is required, soil compaction and loss of pervious areas will contribute to this overdraft. The potential for contamination of surface water by hydrochloric acid and aluminum oxide is also possible at all sites except EAFB. This effect is potentially minimized by pre-launch meteorological monitoring. At EAFB the lack of surface water resources, and air platform launch would preclude such contamination. The potential for generation of contaminated stormwater runoff is possible for all sites with the exception of EAFB. The potential for contamination from accidental spills is possible at each site.

- **Geology**

Impacts to geologic resources include changes in topography and physiography from site modification for all VAFB sites, and erosion of stratigraphic units from construction at Pad 192 on San Nicolas Island. Erosion of sand dunes could occur at Test Pad 1, ABRES A-3 and at Pad 192. Landslide hazards are possible at LF 06 and Cypress Ridge. Slope failure from wavecutting of sea cliffs is a potential impact at Boathouse Flats. Strong to intense ground motion, and possible surface rupture along unmapped faults, could occur as a result of potential future large earthquakes at many of the AFSLV sites. Construction at VAFB and on San Nicolas Island could result in the loss of potentially significant paleontological resources. Mitigation of these potential impacts could be accomplished using careful design considerations, including preventive construction practices, to avoid or minimize these effects. The use of a paleontologic monitor at sensitive sites is also an effective mitigation.

- **Biota**

In the event that construction occurs, vegetation would be lost, with the greatest losses expected at undeveloped sites. During siting of facilities, consideration should be given to avoiding ecologically sensitive areas, and any areas containing unique or special status plants. This is particularly important at LF 06, sand dunes at Test Pad 1, ABRES A-3, Pad 192, and at the two undeveloped sites. Because of the proximity of ABRES A-3, SLC-4W and SLC-5 to surface water, the potential for inadvertent contamination of freshwater resources at these sites as a result of wastewater discharge or spills, should be given consideration.

The launch of the AFSLV may have potential effects on marine mammals and birds along the coast at both VAFB and San Nicolas Island. Such effects would be related to the sudden impulse noise from a launch. Noise levels expected from the AFSLV are not expected to result in long term effects, such as permanent hearing loss. The projected launch direction from San Nicolas Island would fly over breeding areas for marine mammals and seabirds. Effects on breeding activities may occur if launches take place during critical courtship and mating periods.

- **Visual Resources**

The AFSLV program may result in loss of visual resources from public views if placement of new structures result in alteration of terrain and obstruction of views. This is a potential impact at LF 06, ABRES A-3, Cypress Ridge, Boathouse Flats, and Pad 192.

- **Socioeconomics and Public Services**

Although difficult to quantify, construction activities at either of the undeveloped sites may result in potential impacts on community services, depending on the number of construction personnel required. Additional temporary and permanent housing would be required on San Nicolas Island. Impacts to the available water supply on San Nicolas Island would also occur. Economic impacts to commercial fishermen, using the waters around San Nicolas Island, may also occur during periods of evacuation.

- **Transportation**

The proposed action may result in temporary disruption of local traffic patterns during transport of launch vehicle components to the sites. This impact would be short-term and localized, and therefore, not significant. Transport of components to San Nicolas Island by barge is not expected to result in any significant impacts to marine traffic.

- **Waste Management**

Waste management is not expected to result in any significant impacts, although transport of waste would vary according to the site. Two sites on VAFB (Test Pad 1 and ABRES A-3) have evidence of past hazardous waste contamination and are currently being investigated under the VAFB Installation Restoration Program.

- **Noise**

Impacts to the noise environment is not expected as a result of the AFSLV program. With the exception of EAFB, a focused sonic boom over the Channel Islands and/or the mainland is possible, as a result of launch from any site.

- **Cultural Resources**

Impacts to cultural resources, as a result of construction, could occur at Test Pad 1, ABRES A-3, SLC-4W, SLC-5 and Cypress Ridge. Such impacts are not expected to be significant if pre-construction surveys, construction monitoring and mitigation are implemented. Impact to archaeological sites on San Nicolas Island could result from launch operations that would lead to the acceleration of natural erosion processes.

Conclusions

Potential environmental consequences of the proposed AFSLV program have been evaluated in this EA. Specific environmental impacts associated with the AFSLV program cannot be evaluated until detailed project and site information is known. The Air Force will prepare a site-specific EA or Environmental Impact Statement (EIS) when detailed information on the selected launch system and site becomes available.

The environmental sensitivities of sites considered for the AFSLV have been evaluated to provide information on the potential for significant environmental impacts. The potential for significant impacts has been projected for each AFSLV site:

- Sites with the highest environmental sensitivity, and the highest potential for causing significant environmental impacts, are San Nicolas Island and Cypress Ridge. This is because of the potential effects on protected marine mammal species that breed on San Nicolas Island, and the presence of important biological and cultural resources at Cypress Ridge.

- Because of modifications required at Boathouse Flats, Test Pad 1 and ABRES A-3 these sites have moderate environmental sensitivity and moderate potential for causing significant environmental impacts. While Boathouse Flats is an undeveloped site in close proximity to marine mammal haul-out areas, the use of a transportable launch system at this site would not require construction of any new access roads. All three sites have important biological and cultural resources present.

- Because active launch facilities would be used with minimal modification required, LF 06, SLC-4W, SLC-5, and EAFB have the lowest environmental sensitivity and a low potential for causing significant environmental impacts. Site-specific studies will be required to determine potential impacts to any biological and cultural resources at any of these sites, especially if any disturbances outside of the perimeter fence occur. In the event of new construction, and depending on the scale of construction, at these four sites, the sensitivity and potential for causing significant environmental impacts might increase to a moderate level.

TABLE OF CONTENTS

TABLE OF CONTENTS (Cont'd)

TABLE OF CONTENTS (Cont'd)

LIST OF TABLES

LIST OF TABLES (Cont'd)

LIST OF FIGURES

LIST OF FIGURES (Cont'd)

SECTION 1

DESCRIPTION OF PROPOSED ACTION AND ALTERNATIVES

In support of the U. S. Department of Defense (DOD) space program, the U. S. Air Force (USAF), Space Systems Division (SSD), proposes implementation of the Air Force Small Launch Vehicle (AFSLV) Program, which will provide inexpensive launch services for small research and development (R & D) satellite payloads. Possible sites for AFSLV launch facilities include: Launch Facility 6 (LF 06), Test Pad 1, and the Advanced Ballistics Reentry System (ABRES) A-3 Facility on North Vandenberg Air Force Base (VAFB); Space Launch Complex (SLC)-4W (West), SLC-5, Cypress Ridge, and Boathouse Flats on South VAFB; an air-launch platform on Edwards Air Force Base (EAFB); and Pad 192 on San Nicolas Island (off the coast of Southern California). The locations of VAFB, EAFB and San Nicolas Island are shown in Figure 1.1 (Regional Location Map).

The Air Force plans to acquire AFSLV launch services for small payloads through a contractor. This endeavor would include modified commercial procedures and development of a capability to meet Air Force mission requirements. An Initial Launch Capability (ILC) of early Fiscal Year (FY) 1993 is planned for the AFSLV. The contractor selected will be required to perform first-time integration, production, and launch of an AFSLV to initially support one funded Space Test Program (STP) Space Test Experiment Platform (STEP) payload per year in the 1993 to 2000 time frame. Additional launches (maximum 5 per year) in support of similar weight class payloads are also possible.

The anticipated cost of this action would be lower than alternative solutions to meet mission requirements and promote the commercial development of space in accordance with the Commercial Space Launch Act of 1984 (Public Law 98-575).

1.1 PURPOSE AND NEED

This action would provide DOD with access to space for small satellite payloads, via polar launch and orbiting from the West Coast, and would represent a continuation of the USAF space launch program at VAFB. It is the policy of the Air Force to continue as the provider of launch support for the DOD. The Air Force has identified a requirement

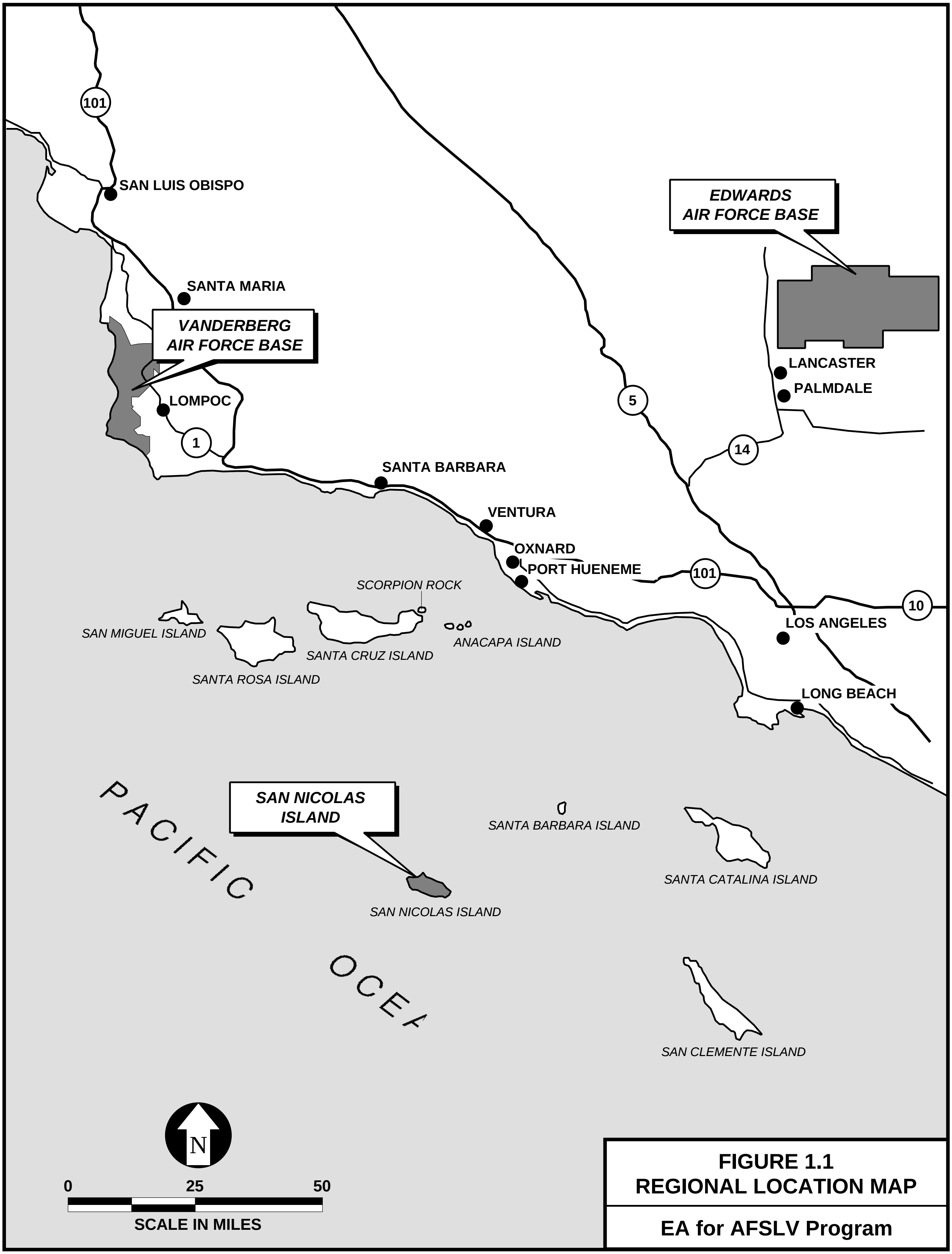

FIGURE 1.1
REGIONAL LOCATION MAP

EA for AFSLV Program

to provide a total of eight R & D launches, and a total of 32 additional potential R & D launches of small payloads through the year 2000. Air Force missions will require the launch of small R & D payloads and support of other Air Force programs. It is also the intent of the Air Force to provide launch opportunities for other potential DOD, National Aeronautics and Space Administration (NASA) and Foreign Military Sales (FMS) users as well as for commercial efforts.

1.2 BACKGROUND

Historically, small payloads have had few launch alternatives, primarily the Scout program. There are five Scout launches remaining: three for NASA, one for the U. S. Navy, and one for the Air Force. Limited opportunities exist as secondary payloads on the Space Shuttle or larger expendable launch vehicles, but these have been eliminated because of the unacceptable risks associated with placing smaller satellite payloads into suboptimum orbits with larger payloads. Due to the lack of affordable small launch services, most potential users do not have program approval. It is planned that the existing Air Launched Vehicle (ALV) program will be used to satisfy small payload launch requirements for the near term (until 1992). During this interim, an open competition will take place for these launch services, and the Air Force will select a contractor and a launch system to provide long-term AFSLV launch services.

Thus, the Air Force is in the process of evaluating proposals from contractors interested in providing AFSLV launch services. As there are no constraints on the design of the vehicle, there may be many possible concepts proposed for launch of small payloads. Similarly, no constraints have been imposed on siting. Some offerers are considering locations where similar launch and support facilities are currently located. Proposed sites are those that are being considered by offerers. Representative sites are those that have been identified by the Air Force as available for siting and development of the AFSLV at VAFB. Proposed facilities and sites have been studied by competing contractors who have submitted proposals for consideration by the Air Force. The selected contractor will be required to develop a program that will adhere to all applicable environmental criteria and safety standards, and implement all mitigation measures.

1.3 SCOPE OF THE ENVIRONMENTAL REVIEW

This document is part of the Environmental Impact Analysis Process (EIAP) for the AFSLV Program. The EIAP is set forth in Air Force Regulation (AFR) 19-2, which implements the National Environmental Policy Act (NEPA, 42 USC 4331 et seq.), the President's Council on Environmental Quality (CEQ) Regulations, and DOD Directive 6050.1, 30 July 1979. An AF Form 813, Request for Environmental Impact Analysis, has been prepared by the Air Force for this action, and it has been determined that an Environmental Assessment (EA) is required.

Because the specific site, configuration of the launch system, and support facilities have not been selected, this EA has been prepared for most likely actions or reasonable alternatives that could be selected for the AFSLV. The range of reasonable alternatives was identified by the concepts proposed by potential AFSLV contractors. Other concepts or alternatives exist and may not be considered reasonable because they were not proposed. Only one proposed concept will ultimately be selected and deployed. This document will identify, describe and evaluate the potential environmental impacts or issues associated with the launch facility, vehicle type and system of operation for each of the proposed concepts and sites being considered.

This EA will be used in support of source selection to ensure that environmental considerations are included in the decision process as required by CEQ Regulations Part 1505. The analyses in this document will cover all proposed AFSLV systems that are most likely to be selected, and the launch-related operations that would occur at the proposed site. This report does not evaluate shipment of vehicle components between the manufacturer and the launch location, any activities related to manufacture of components, nor other off-site actions. It is not known at this time whether all launch vehicle preparation or processing will be conducted on-base or at a remote location.

The method of environmental analysis in this EA follows the definitions set forth in CEQ Regulations Part 1502.4 for preparation of an Environmental Impact Statement (EIS) for broad Federal actions. This analysis will provide information relevant to, and timed to coincide with, agency planning and decisionmaking (CEQ Regulations Part 1502.4 (b)). This EA evaluates the proposed actions in a generic way to address elements with relevant similarities, such as common impacts (CEQ Regulations Part 1502.4 (c)(2)). This generic evaluation also protects the proprietary nature of each AFSLV proposal. Once the specific launch configuration is selected, a site-specific environmental analysis will be conducted by the Air Force, tiering from this EA, in accordance with CEQ Regulations Parts 1502.20 and 1508.28.

1.4 PROPOSED ACTION

The Air Force proposes awarding of a contract for the AFSLV program to launch small payloads (e.g., less than 500 pounds) into polar orbit. Because of overflight restrictions, polar launches must be made from the West Coast location. At VAFB, it is assumed that all southerly launch azimuths from 150 to 201 degrees, within destruct limit lines at the Western Test Range (WTR), would be available for the AFSLV (Summers, 1990). The WTR is a military test range controlled by the Western Space and Missile Center (WSMC) at VAFB.

Sites at VAFB, EAFB and San Nicolas Island are currently under consideration for the AFSLV. The program would involve either modifying an existing launch facility at VAFB, constructing a new launch facility at VAFB, use of existing facilities at EAFB, or using/modifying existing facilities on San Nicolas Island. The maximum AFSLV launch rate is 5 per year, and the anticipated average launch rate is 2 to 3 per year, with an ILC of FY1993. Program duration is nine years, with final launch in the year 2000. Additionally, the contractor is likely to enter the commercial market and use the same facilities for commercial launch operations. Any additional commercial launches are not included in the maximum 5 launches per year. The specific number of payloads to be launched into orbit is not known at this time, and will be evaluated in a site-specific environmental analysis.

1.4.1 Launch Systems

The AFSLV program could be accomplished using several possible launch systems. Possible configurations are: conventional launch (i.e., launch pad), truck-transporter launch, air launch, rail garrison launch, and sea launch .

Conventional launch of the AFSLV could be undertaken by use of either a new or existing land-based launch pad facility. This includes either a subterranean launch silo or an aboveground launch pad or mount.

The AFSLV could be launched from a mobile platform that would be trucked to a site. Ground operations would consist of component arrival, assembly, and testing inside a series of truck trailers . These trailers would be configured to provide a mobile launch stand where vehicle stages could be stacked. Payload processing could also occur inside the trailers, followed by mating, testing and launch.

Launch from an airborne platform, via a large-lift aircraft, is another alternative. The AFSLV could be launched from an air platform attached to a large-lift aircraft that takes off from EAFB, and is flown in a northwest-trending route to cross the California coast approximately 81 miles north of San Luis Obispo. The launch vehicle would then be positioned for a southward launch, approximately 100 miles out into the WTR over the Pacific Ocean. In April 1990, the first air-launched booster was launched from a B-52B aircraft, which began its flight from EAFB. The Defense Advanced Research Projects Agency (DARPA) has contracted for air-launch services for five polar launches, with an option for one additional launch.

The rail garrison launch concept would consist of a locomotive and rail cars for test support, missile launch, launch control, and maintenance. Existing ground processing buildings would be used while launch vehicle components would be transported along existing or new railroad track. Launch would occur from a rail car. This concept was not proposed for the AFSLV program and will not be evaluated in this EA.

Sea launch would consist of launch from a barge platform placed in a coastal or offshore location. The launch vehicle would be processed in ground facilities on-shore and transported to the ocean location. This concept was not proposed for AFSLV and will not be evaluated in this EA.

1.4.2 Project Location on VAFB

VAFB occupies 98,400 acres along the south-central coast of California and is located approximately 140 miles west-northwest of Los Angeles (see Figure 1.1). State Highway 246 bisects VAFB into North VAFB and South VAFB. With its unique coastal location and existing infrastructure, VAFB is a base of operations for testing of high inclination and polar orbital missions, including Minuteman and Peacekeeper (MX) Intercontinental Ballistic Missiles (ICBM), and space launch activities for the Titan II, Titan IV, Scout, Atlas E, Atlas II and Delta II space vehicles.

The Air Force has identified seven representative sites on VAFB that would be available for the AFSLV. These sites are shown in Figure 1.2. Launches from the three sites on North VAFB would require a launch “dogleg” maneuver to avoid overflight of populated areas on base. Recurring high winds are prevalent on North VAFB. On South VAFB, potential AFSLV launch sites are limited to two existing launch facilities and two new locations where the quantity-distance (QD) separation does not encroach upon the

Legend

Electrical Sub-Stations

Railroad

Beach Access Areas

Controlled Air Space Boundaries

N

FIGURE 1.2
REPRESENTATIVE SITES FOR AFSLV AT VAFB

EA for AFSLV Program

public railroad. This QD constraint and the mountainous terrain at South VAFB limit possible new launch sites to Cypress Ridge and Boathouse Flats. The seven representative sites on VAFB are described in the following paragraphs.

1.4.2.1 Launch Facility 6 on North VAFB

LF 06 is located off Point Sal Road at the end of Occulto Road on the northernmost part of North VAFB south of Point Sal. LF 06 is located approximately 900 ft from the coast, on a marine terrace in a remote, relatively flat grassland. This facility was built in 1961 for the Minuteman I ICBM. It is currently an active Air Force Systems Command (AFSC) facility last used for launch of the Minuteman III. LF 06 includes a launch silo and underground facilities enclosed by a perimeter fence. Parking is available for 20-25 cars. Water, power and communications are available at the site.

1.4.2.2 Test Pad 1 on North VAFB

Test Pad 1 is located at the end of Rhea Road on North VAFB, approximately 3,500 ft north of San Antonio Creek. The facility is located in stabilized sand dunes on San Antonio Terrace, approximately 9,000 ft from the coast. It was built in 1982 for the first "cold launch" of the Peacekeeper from VAFB in 1983, and it is currently an active AFSC facility. Test Pad 1 has an aboveground launch mount on a concrete pad enclosed by a perimeter fence. Parking is available adjacent to the site. Water, power and communications are available at the site.

1.4.2.3 ABRES A-3 on North VAFB

The ABRES A-3 facility is located at the end of 13th Street on North VAFB, approximately 2,200 ft south of San Antonio Creek and 8,200 ft from the coast. ABRES A-3, on Burton Mesa, is located on stabilized sand dunes in a combination grassland/coastal sage scrub plant community. The area is characterized by a steep-walled, deep canyon that supports riparian type vegetation. The facility was first constructed in 1959 for ICBM and Atlas D use. Thirty-two launches were conducted from this site between 1958 and 1972. It was previously used for the Atlas and Ballistic Missile Reentry Systems (BMRS) programs. It is currently an active commercial facility used for launch of American Rocket Company’s (AMROC) Single Module Launch

Vehicle (SMLV). The ABRES A-3 launch pad facility (Bldg 1788) and Launch Operations Building (Bldg 1793) have been modified by AMROC (USAF, 1989b).

1.4.2.4 SLC-4W on South VAFB

SLC-4W is located on South VAFB at the end of Agena Road, approximately 300 ft from the coast. The facility is situated on an elevated terrace in a central dune/coastal scrub plant community with some riparian vegetation in Spring Canyon south of the complex. SLC-4W is an active AFSC facility which is being used for mission-specific Titan II launches through the year 1995. It was built in 1962 for the Atlas-Agena launches, which began in 1963. Modifications to accommodate the Titan II vehicle were completed in 1988. Use of this above-ground launch pad would require modification or reconstruction to accommodate the AFSLV. Water, power and communications utilities are available at this site.

1.4.2.5 SLC-5 on South VAFB

SLC-5 is an active NASA Scout launch facility, located on South VAFB, at the intersection of Delphy and Avery Roads, approximately 3,000 ft from the coast. The facility is located on hilly terrain north of Honda Canyon in a stabilized dune (coastal stage scrub) plant community. Built in 1961, the Scout launch system has been in operation for approximately 29 years and has launched over 100 boosters. There are plans for four additional launches through FY 1992. The launch area is configured for the solid rocket Scout booster, which is launched when the aboveground shelter is moved back from the launch platform before launch. A blockhouse, containing the launch control center, is located west of the launch area. It can accommodate a maximum of 50 personnel during launch. Water, communications and power utilities including a diesel generator and battery back-up power, are available at SLC-5. It is probable that this facility may also be used for the NASA Small Expendable Launch Vehicle (SELV) program.

1.4.2.6 Cypress Ridge on South VAFB

Cypress Ridge is a vacant site on South VAFB south of SLC-6 and east of Coast Road, approximately 2,100 ft from the coast. The site was proposed for a new launch facility, SLC-7, which was not built. With the exception of the boathouse and offshore oil platforms, there are no overflight hazards associated with launch from this extreme southern location. The site was evaluated as an alternative for the proposed Titan IV/Centaur Launch Complex (USAF, 1989c and 1990f). The site is located on an elevated marine terrace that is used for cattle grazing. Utilities or communication services are not available, and the site is difficult to access (i.e., new roads would be required).

1.4.2.7 Boathouse Flats on South VAFB

Boathouse Flats is an undeveloped site, south of Cypress Ridge, that is located on a marine terrace that overlooks the coast. The site is currently used for grazing. It is near a coastal marine mammal haul-out location and known archaeological resources. Launch from this site would have the same overflight considerations as Cypress Ridge. The site is relatively level, with elevations ranging from 50 to 150 feet. There is road access to this site from the External Tank Tow Route that was constructed for the Space Shuttle Project. This site was evaluated as an alternative location for the Titan IV/Centaur Launch Complex in USAF (1989c and 1990f). Electrical service is available at this site, but there are no communication lines, water or sewer systems.

1.4.3 Project Location on Edwards Air Force Base

EAFB is located in the Mojave Desert, approximately 50 miles north of Los Angeles (see Figure 1.1). Existing ground support facilities currently used for the Air-Launched Vehicle (ALV) Program at EAFB could be made available for the AFSLV program. These structures are located at the NASA Dryden Flight Research Facility, and include office trailers, a vehicle assembly building, and primary runways on Rogers Dry Lake. Electrical service, an ordnance grounding system, and fire and potable water are available at ground support facilities. Five potential launches remain for the current air-launch program. It is expected that an L1011 aircraft would carry the platform from which the AFSLV would be launched.

1.4.4 Project Location on San Nicolas Island

San Nicolas Island is one of the eight California Channel Islands, located approximately 127 miles due west of Oceanside, California in Ventura County. It is considered one of the central Channel Islands, and is located south of the Northern Channel Islands, which are comprised of San Miguel, Santa Rosa, Santa Cruz and Anacapa Islands. San Nicolas Island is under the jurisdiction of the U.S. Navy Pacific Missile Test Center (PMTC) based at Naval Air Station (NAS), Point Mugu. Facilities on the island are used by the Navy for launch observation, and testing of small and medium range missiles, such as drones and probes. Facilities on the island include two launch pads, an airfield, a barge landing area, blockhouses, ordnance assembly buildings, a magazine area for storage, access roads, and housing for approximately 250 personnel stationed on the island. Water must be barged onto the island. Electricity and communication utilities are available on the island. Pad 192, located on the northwest-facing plateau of the island, is being considered as a launch site for the AFSLV.

1.4.5 Propellants

Propellants for space launch vehicles typically include fuels, oxidizers, binders, wetting agents, plasticizers and other constituents. The AFSLV could use solid propellants for propulsion or liquid propellants for reaction control systems (RCS). Solid propellants typically used in the solid rocket motors are composed of various chemicals that include aluminum, acrylonitrite, and ammonium perchlorate. Typical solid propellants are:

- Polybutadiene acrylonitrile (PBAN) composite propellant designated TP-H1101 and TP-H1043, MIL Hazard Class 1.3.

- Hydroxyl-terminated polybutadiene (HTPB) fuel binder, with aluminium and ammonium perchlorate fuel and oxidizer components, MIL Hazard Class 1.3.

Liquid propellants include small amounts of hydrazines (N_2H_4 and monomethyl hydrazine, MMH). Typical propellants for the RCS include strontium perchlorate, $Sr(Cl0_4)_2$, and cold gas (i.e., inert nitrogen, N_2).

1.4.6 Evaluation of the Proposed Action

This EA evaluates nine sites for the AFSLV: LF 06, Test Pad 1, ABRES A-3, SLC-4W and SLC-5, Cypress Ridge, Boathouse Flats, EAFB, and San Nicolas Island. These nine sites fall into two general categories as shown on Table 1.1.

A site that is currently an active launch facility would require a minimum to moderate amount of modification and/or construction to adapt it for the AFSLV. Sites that are currently undeveloped would require more extensive construction and earthmoving to provide launch facilities, utilities and road access. At the two undeveloped sites, Cypress Ridge and Boathouse Flats, new construction would include installation of a concrete pad.

Table 1.1

Classification of Representative Sites for the AFSLV

LOCATION	ACTIVE LAUNCH FACILITIES	UNDEVELOPED SITES
North VAFB	LF 06 Test Pad 1 ABRES A-3	
South VAFB	SLC-4W SLC-5	Cypress Ridge Boathouse Flats
Edwards AFB	Air platform	
San Nicolas Island	Pad 192	

This EA evaluates three launch systems: launch pad, truck/trailer and air launch. In order to utilize existing facilities at each of the nine potential sites available for the AFSLV, only certain launch systems are considered at each site. The potential launch systems available at each of the nine sites are shown on Table 1.2.

This document evaluates environmental effects of the proposed AFSLV Program for each environmental area and site. The first part of this evaluation is a description of the affected environment at each launch site. As appropriate, the environmental baseline may be described in terms of a regional overview (i.e., Santa Barbara County), a local perspective (i.e., City of Lompoc), and a site-specific description (i.e., the actual AFSLV site). The environmental impact analysis evaluates the effects of the various launch systems at the representative sites, using a typical launch booster configuration in order to identify potential effects and relative degree of impact. Cumulative environmental effects are also evaluated. The environmental impact analysis also identifies mitigation measures to prevent or minimize significant environmental effects.

1.5 ALTERNATIVES TO THE PROPOSED ACTION

The Air Force has considered and eliminated four program alternatives to the proposed action: use of other Air Force programs to launch small payloads, cooperative efforts to

Table 1.2

Potential Launch Systems at Representative AFSLV Sites

		LAUNCH SYSTEM		
LOCATION	LAUNCH SITE	Launch Pad	Truck/ Trailer	Air Launch
North VAFB	LF 06	■	■	
	Test Pad 1	■	■	
	ABRES A-3	■		
	SLC-4W	■		
South VAFB	SLC-5	■	■	
	Cypress Ridge		■	
	Boathouse Flats		■	
Edwards AFB	Air Platform			■
San Nicolas Island	Pad 192	■		

launch payloads with other agencies, Air Force development of a launch vehicle, and the no action alternative. Each alternative is described below.

1.5.1 Secondary Payloads Alternative

As one alternative, the Air Force would be required to depend on opportunities for launching the small payloads as secondary payloads of other programs. These programs include the Space Shuttle, Titan II, Titan IV, Atlas E, Atlas II, and Delta II. This alternative would place additional requirements on the schedules and planning of these other programs, and may result in the inability to carry out AFSLV missions as planned. This alternative would cause an increase in integration efforts that are already complex.

Although this alternative is relatively inexpensive and utilizes existing launch vehicles, there are few opportunities for secondary payloads, and the payload would be subject to last minute "bumping" from the launch. Use of existing launches would place small payloads in suboptimum orbits and add risk to the performance of operational satellites, a risk the satellite users are unwilling to accept. There are not enough small satellites going to the same orbits within a reasonable period of time to support the alternative of combining larger and smaller payloads.

Under this alternative, all sites under consideration would remain in their present condition. It is possible that this alternative would result in some additional environmental impacts at the locations of the other programs used in place of an AFSLV program.

1.5.2 NASA/Navy Participation Alternative

A second alternative would be Air Force participation with NASA and/or the Navy in the launching of small payloads. While both NASA and the Navy are preparing to acquire small launch vehicles, it is uncertain whether the Navy will acquire launch services. This alternative would place additional requirements and planning on NASA and/or the Navy, and may not meet AFSLV mission objectives. In addition, the NASA schedule is roughly one year behind the Air Force effort, so launch capabilities would be delayed. Although this alternative would be cost-effective and reduce Air Force manpower requirements, it would abrogate the Air Force responsibility as the DOD executive launch agent and limit Air Force control of launch efforts. The Navy acquisition approach and schedule are uncertain at this time, and it is expected that the Air Force could acquire the AFSLV capabilities at a lower cost within the required time frames. Under this alternative, all sites under consideration would remain in their present condition. It is possible that this alternative could result in some additional environmental impacts at the NASA and/or Navy locations.

1.5.3 New Military SLV Development Alternative

The third alternative considered was the development of a new military small launch vehicle (SLV), with the traditional design, production and launch to be conducted entirely by the Air Force. In this way, the Air Force could optimize program development for STP requirements, and have centralized control of design, development and production. It is expected that this alternative would require at least 3 years lead time. Because the Air Force mission model requires launch capability as early as 1993, it was determined that this alternative could not meet the required schedule. This separate development program would involve high costs and these funds are not budgeted. It was determined that an AFSLV program that could utilize existing/modified facilities and capabilities would be more cost effective. In addition, a new military program for small launches would not foster the promotion of commercial space launch capabilities.

1.5.4 No Action Alternative

If the AFSLV program is not implemented as planned, the Air Force would not be able to satisfy mission objectives of providing launch opportunities for DOD users, or would have to find other options to satisfy mission requirements. The Air Force would be forced to depend on other options for launching small payloads from the West Coast. The ability to launch small payloads into polar orbit for R & D purposes would not be available. Larger boosters would have to be used at higher costs. Under the no action alternative, existing launch facilities and vacant sites under consideration would remain in their present condition.

SECTION 2

AFFECTED ENVIRONMENT

2.1 NATURAL ENVIRONMENT

2.1.1 Meteorology

This section describes the climate of each region. A background discussion on global warming is provided in Appendix A.

- **Vandenberg Air Force Base**

Vandenberg Air Force Base (VAFB) is located in the South Central Coast Air Basin. The climate in the basin is categorized as Mediterranean, or dry and subtropical. The weather is warm and dry from May to November, and is wet and cool from December to April. Total annual precipitation varies widely from less than 10 inches to more than 40 inches. The annual average precipitation is between 10 and 15 inches. Precipitation is mainly in the form of rain along the coast and lowland areas. Thundershowers produce occasional rainfall during the summer. The temperature along the coast is mild, and the range is fairly narrow because of the influence of the Pacific Ocean. The prevailing wind direction is northwesterly to westerly throughout the year. In the winter, flow reverses to a southeasterly direction. Sea breezes flow onshore during the day, and weaker land breezes flow offshore at night. During fall and winter months, the area is subject to warm, dry, and gusty Santa Ana winds. Because of the meeting of cool surface air and warm, dry subsiding air from aloft, the Southern California coast experiences early morning inversions about 87 percent of the time. Pollutants are trapped in the inversion layer until enough heat lifts the layer, or strong surface winds disperse the pollutants.

The Pacific Ocean is a moderating influence on the temperature and moisture content of the air at VAFB, resulting in a narrow range of values for these two meteorological parameters. The average annual temperature is 55°F. The mean annual relative humidity recorded at the VAFB airfield is 77 percent. Low relative humidity (less than 10 percent) is occasionally experienced during the occurrence of a Santa Ana wind condition. This temporary condition is caused by a high-pressure cell stalled over the Colorado Plateau.

This phenomenon causes air to flow in an offshore direction, resulting in heating by compression as the air descends from the upper desert to sea level.

The average annual precipitation for the VAFB region is 12.7 inches. The wettest month is usually February, when most of the extratropical storms from the southwest move inland. The mean monthly precipitation for February is 2.6 inches. July is usually the driest month, with a 0.01-inch mean monthly precipitation.

The widely-varying terrain at VAFB results in a great variation in local wind speed and direction. In general, winds are stronger on the higher ridge lines, along the beaches, and on Sudden Ranch. The average maximum diurnal wind speed at South VAFB (about 17.3 mph at 3 p.m.) is greater than that at North VAFB (about 5.8 to 8.0 mph at 4 p.m.). The mean annual surface wind speed is 7.0 mph from a predominantly northwesterly direction. Mean maximum gusts of wind up to 47.2 mph have been experienced during January, February, and March. Wind rose diagrams developed from data gathered at North VAFB are presented in Figures 2.1.1-1, 2.1.1-2, 2.1.1-3, and 2.1.1-4. A wind rose diagram for South VAFB, developed from data collected at the Point Arguello Prevention of Significant Deterioration (PSD) air monitoring station, is presented in Figure 2.1.1-5.

At Cypress Ridge and Boathouse Flats, winds tend to flow in a more westerly direction. After sunset, stable downslope winds would be expected to drain through the area at a relatively-low velocity, and in a general offshore direction. During Santa Ana conditions, high velocity, easterly winds could be expected through these areas. Along the western coast from SLC-6 to SLC-4W, and from Purisima Point to LF 06 on North VAFB, the wind is expected to be along a northerly inclination. Nighttime winds would also drain through this area in an offshore direction at a relatively low velocity. Santa Ana winds would blow along a northeasterly direction through these areas.

Reduced visibility in the VAFB region is due largely to coastal fog, which occurs primarily during July, August, and September. Ground fog is usually confined to late evening and morning hours, but may persist in the nearshore area throughout the day. Visibilities of 0.25 mile or less occur approximately 5 percent of the time during early morning hours.

Figure 2.1.1-1 January 1986 Wind Rose (Watt Road Station, VAFB)

Figure 2.1.1-2 April 1986 Wind Rose (Watt Road Station, VAFB)

Figure 2.1.1-3 July 1986 Wind Rose (Watt Road Station, VAFB)

Figure 2.1.1-4 September 1986 Wind Rose (Watt Road Station, VAFB)

Figure 2.1.1-5 Point Arguello Wind Direction and Wind Frequencies

Clouds are common in the VAFB area, averaging about 48 percent cloud cover annually. The total cloud cover is greater at North VAFB than at South VAFB. The average annual ceiling height is approximately 1,000 feet, depending on the base height of the inversion layer.

- **Edwards Air Force Base**

Edwards Air Force Base (EAFB) is located in the Southeast Desert Air Basin. Meteorology in the area is characterized by large seasonal temperature differences, reflecting the absence of marine influences and low levels of precipitation. Summertime temperatures are extremely high. Precipitation throughout the region is normally between four to five inches per year. Relative humidity is very low, averaging 30 to 50 percent in the early morning, and 10 to 20 percent during the late afternoon. During all seasons, the predominant winds are from the south and west.

Edwards Air Force Base is bound on the west by the Tehachapi Mountains, and on the south by the San Gabriel Mountains. These two mountain ranges block the flow of moist marine air to the Mojave Desert, resulting in a climate that is characterized by low rainfall with hot dry summers and mild winters.

Summertime temperatures reach mean maximums of 98°F in July. The lowest mean maximum of 56°F occurs in January. Maximum temperatures above 100°F occur about 35 days a year, while an average number of 67 days have a minimum temperature below 32°F. The relative humidity is lowest in the summer, with a minimum of 27 percent in July and a maximum of 56 percent in January.

Annual total precipitation averages 4.9 inches. Eighty percent of the year's precipitation occurs between November and March, when frontal storms move through the region. The remaining 20 percent falls from April to October. Most of the precipitation falls as rain, however, from November to April, snow will occur at an average of 2.3 days per year. Thunderstorms are rare, occurring about 5.3 days per year during June through September. Winds are usually out of the west, with a monthly mean maximum of 12 knots occurring in June, and a monthly mean minimum of 6 knots occurring in November, December, and January. On an annual basis, winds are calm 18 percent of the time, as shown in the annual wind rose diagram for EAFB (Figure 2.1.1-6).

From September to February, especially at night, calm conditions average between 19 to 29 percent of the time. This

Figure 2.1.1-6 Annual Wind Rose for Edwards Air Force Base phenomenon is due to the rapid cooling at night in the surface layer, which inhibits the transfer of momentum to the surface. Severe winds have been recorded at 64 knots.

The rapid nighttime cooling, especially during September through February, causes frequent surface-based inversions. Coupled with calm winds, the potential for air pollution exists.

- **San Nicolas Island**

The climate on San Nicolas Island is typical of coastal locations in the Southwestern United States, and is categorized as subtropical. It is generally favorable, with a pronounced dry season from May to November, and minimal precipitation the rest of the year. Temperatures are mild and winds are northwesterly.

The Pacific Ocean surrounds San Nicolas Island and is a moderating influence on the meteorological conditions of the island. Temperatures are mild, ranging from 57.2^{o}F during the coldest month to 64.4^{o}F during the hottest month. The dry season extends from May to September. Total annual precipitation is about 0.10 inch. Heaviest rainfall occurs during the month of January. Early morning fog is a usual occurrence throughout the year and the fog gradually lifts as the day progresses. Winds are usually from the north and northwest, with relatively high speeds ranging from 23 to 35 miles per hour (20 to 30 knots). A wind rose diagram for San Nicolas Island based on data gathered from 1945 to 1960 is presented in Figure 2.1.1-7.

2.1.2 Air Quality

2.1.2.1 Description of Local Air Quality

- **Vandenberg Air Force Base**

Air quality at VAFB and nearby communities is monitored at stations on VAFB and in the City of Lompoc, as shown in Figure 2.1.2-1. The VAFB monitor is located on Watt Road in the northwestern portion of VAFB. The air monitor in the City of Lompoc is located on "H" Street. Another air monitor, located on Jalama Road, monitors for sulfur dioxide. In mid-1988, the VAFB monitor was shut down for relocating elsewhere on VAFB. Previously, VAFB had another air monitoring station near SLC-6.

Figure 2.1.1-7 Wind Rose Pattern for San Nicolas Island

Figure 2.1.2-1 Air Monitoring Stations Operated by VAFB

Four pollutants are monitored at these stations: ozone (O_3), carbon monoxide (CO), nitrogen dioxide (NO_2), and sulfur dioxide (SO_2). These are four of the five criteria pollutants which are monitored for compliance with national and state ambient air quality standards. The fifth criteria pollutant is respirable particulate matter less than 10 microns in diameter (PM_{10}), which is not measured at any of the nearby monitors. A summary of air quality data for the year 1988 measured at the three stations is presented on Table 2.1.2-1. The data is compared to the federal National Ambient Air Quality Standards (NAAQS) and the California Ambient Air Quality Standards (CAAQS).

Table 2.1.2-1

1988 Summary of Air Quality at VAFB and Vicinity

POLLUTANT	Highest Measured Concentration VAFB Watt Rd.	Lompoc H St.	Lompoc Jalama Rd	NAAQS	CAAQS
Ozone (O_3)					
1-hour average, ppm	0.08	0.10	ND	0.12	0.09
Carbon monoxide (CO)					
1-hour average, ppm				35.0	20.0
8-hour average, ppm	1.00	6.00	ND	9.0	9.0
Nitrogen dioxide (NO_2)					
1-hour average, ppm	0.03	0.06	ND	NS	0.25
Sulfur dioxide (SO_2)					
1-hour average, ppm	0.01	0.02	0.03	NS	0.25
3-hour average, ppm	ND	ND	ND	0.5	NS
24-hour average, ppm	ND	ND	ND	NS	0.05
PM_{10}					
24-hour average, $\mu g/m^3$	ND	ND	ND	150	50
AGM, $\mu g/m^3$	ND	ND	ND	50	30

Source: California Air Resources Board, 1988 Quarterly Summaries

ND - No data
NS - No standard
AGM - Annual geometric mean

As shown on Table 2.1.2-1, air quality in the area is generally good, meeting almost all of the California and federal ambient standards. However, concentrations of ozone exceed the California standard. For this reason, the area has been designated as a non-attainment area for ozone. It has been indicated previously that the strong Santa Ana winds have been responsible for ozone precursor migration from the South Coast Air Basin.

Measurements of PM_{10} at Santa Maria, north of VAFB, indicate that the highest and second-highest measured 24-hour average concentrations in 1988 were 60 and 56 $\mu g/m^3$ (CARB, 1988). These data indicate that the state standard is often exceeded. PM_{10} measurements have not been conducted at any of the monitoring stations on VAFB or in the vicinity.

■ Edwards Air Force Base

Air pollutant monitoring stations are not present at Edwards Air Force Base. Measurements taken at the nearest air monitoring stations in Lancaster, Barstow, and Mojave are shown on Table 2.1.2-2, providing an indication of the general air quality of the area. The table indicates that both state and federal standards for ozone are exceeded. It also shows that the state standard for PM_{10} and the federal standard for nitrogen dioxide are exceeded. The Southeast Desert Air Basin has been designated a non-attainment area for both ozone and PM_{10}.

Table 2.1.2-2

1988 Summary of Air Quality in the Vicinity of EAFB

POLLUTANT	Highest Measured Concentration Lancaster	Barstow	Mojave	NAAQS	CAAQS
Ozone (O_3)					
1-hour average, ppm	0.18	0.15	ND	0.12	0.09
Carbon monoxide (CO)					
1-hour average, ppm	11.0	13.0	ND	35.0	20.0
8-hour average, ppm	ND	ND	ND	9.0	9.0
Nitrogen dioxide (NO_2)					
1-hour average, ppm	0.90	0.90	ND	NS	0.25
Sulfur dioxide (SO_2)					
1-hour average, ppm	ND	ND	ND	NS	0.25
3-hour average, ppm	ND	ND	ND	0.5	NS
24-hour average, ppm	ND	ND	ND	NS	0.05
PM_{10}					
24-hour average, $\mu g/m^3$	ND	63	148	150	50
AGM, $\mu g/m^3$	ND	ND	ND	50	30

Source: California Air Resources Board, 1988 Quarterly Summaries
ND - No data
NS - No standard
AGM - Annual geometric mean

■ San Nicolas Island

Air quality at San Nicolas Island is not monitored by any federal or state agency. The nearest air pollutant monitoring stations are located at Anacapa Island (directly north) and at Long Beach (directly east) on the mainland. Measurements at the Anacapa monitoring station are presented in Table 2.1.2-3 as a comparative reference. Data at Long Beach would not be representative of San Nicolas Island because of intense urban and industrial development at Long Beach compared to the military activities at San Nicolas Island.

In general, air quality at Anacapa is good, meeting all federal, and state ambient air quality standards, except the California standard for ozone. Activities at Anacapa that could potentially impact local air quality are extremely limited in comparison to those at San Nicolas Island. It could be inferred that air quality at San Nicolas Island is not as good as at Anacapa. However, it is anticipated that because of the predominantly strong winds at San Nicolas Island, pollutants generated by various military activities on San Nicolas Island would be easily dispersed without adversely affecting air quality on San Nicolas Island. Pollutant migration to the mainland from activities on San Nicolas Island is unlikely due to the island's distance from the mainland (127 miles) and the predominant northerly winds.

Table 2.1.2-3

1988 Summary of Air Quality at Anacapa Island

POLLUTANT	Highest Measured Concentration	NAAQS	CAAQS
Ozone (O_3)			
1-hour average, ppm	0.10	0.12	0.09
Carbon monoxide (CO)			
1-hour average, ppm	ND	35.0	20.0
8-hour average, ppm	ND	9.0	9.0
Nitrogen dioxide (NO_2)			
1-hour average, ppm	0.10	NS	0.25
Sulfur dioxide (SO_2)			
1-hour average, ppm	0.10	NS	0.25
3-hour average, ppm	ND	0.5	NS
24-hour average, ppm	ND	NS	0.05

PM_{10}			
24-hour average, $\mu g/m^3$	ND	150	50
AGM, $\mu g/m^3$	ND	50	30

Source: California Air Resources Board, 1988 Quarterly Summaries
ND - No data
NS - No standard
AGM - Annual geometric mean

2.1.3 Hydrology

2.1.3.1 Surface Water

- **Vandenberg Air Force Base**

The North VAFB water basin consists of three principal drainage systems leading to the ocean: Shuman Canyon Creek, San Antonio Creek, and Cañada Tortuga Creek. Surface water creeks and lakes are shown in Figure 2.1.3-1. Based on measurement at the Casmalia gaging station, located at the western end of the watershed, surface runoff in San Antonio Creek, the principal creek on North VAFB, averages about 3,600 acre feet per year (ESA, 1982). Groundwater reaches the surface at Barka Slough, and contributes to a perennial flow from Barka Slough to the ocean. Above Barka Slough, San Antonio Creek exists as an ephemeral stream. Below Barka Slough, the creek has entrenched into the San Antonio Terrace along its course to the Pacific Ocean. Due to wave and tidal action, the outlets of the North VAFB creeks to the Pacific Ocean are blocked by drifting sand along the beach.

Steam flow is limited by rainfall, with flooding occurring from November to May, and very little or no discharge occurring in most streams during the drier months. Five small surface impoundments are located on North VAFB. These lakes include Mod III Lake, Punchbowl Lake, and Upper, Middle and Lower Pine Canyon Lakes. The small lakes cover a total of 27.3 acres, with a combined volume of 200 acre-feet.

The Santa Ynez River forms the geomorphic boundary between North and South VAFB. The river stretches seventy miles from its headwaters in the Santa Ynez Mountains to a one-mile long lagoon at its terminus near the Pacific Ocean. The average flow rate is 51.5 cubic feet per second (cfs), measured near the terminus. The major drainage for South VAFB is Cañada Honda Creek, as shown on Figure 2.1.3-1. In addition, several small ephemeral and intermittent creeks have cut drainage basins leading into the Pacific Ocean on coastal terraces of South VAFB. There are no permanent lakes, impoundments, rivers, or flood plains on South VAFB. Jalama Creek is near and outside the southern boundary of the base.

Figure 2.1.3-1 Surface Water at VAFB

Launch Facility 6

The former Minuteman missile silo site is located on Point Sal Road, approximately 3 miles north of the Shuman Canyon Creek watershed. Shuman Canyon Creek enters the ocean on the northern border of VAFB, approximately 4 miles north of San Antonio Creek. It is 9 miles long, and drains an area of about 21 square miles. As is the case with many of the streams of the vicinity, flow rates in Shuman Canyon Creek probably range from zero during the dry months to several cfs during flood periods (USAF, 1980). Unnamed, deeply cut channels drain surface water around the LF 06 pad. The steep slopes in the basin near the LF 06 site indicate that local flooding from high intensity rainfall is likely. Flooding near the site is usually of short duration and occurs as a result of high intensity rainfall.

The LF 06 launch pad is slightly sloped to divert water into concrete drainage culverts encircling the pad. Runoff from the pad is diverted to the north, where it discharges into an unnamed stream that flows into the ocean.

Test Pad 1

San Antonio Creek flows into the Pacific Ocean 0.75 mile south of Test Pad 1. The launch site is located on San Antonio Terrace, which is generally level. Surface water runoff drainage patterns have not developed because roughly 60 percent of the terrace is covered by highly permeable dune sand, which enables most surface water to percolate. The only water body in the close proximity to Test Pad 1 is Mod III Lake on the southeast mesa, as shown on Figure 2.1.3-1. Stormwater runoff from the pad flows north into a concrete lined drainage culvert that leads to a rock lined infiltration basin. Runoff from the paved parking area flows north into an unnamed drainage gully, cut through the dune terrace.

ABRES A-3

San Antonio Creek flows into the Pacific Ocean just north of the ABRES A-3 site. The proposed launch site is located on an uplifted terrace above the San Antonio Creek Basin. The terrace is covered by highly permeable dune sand which enables most of the surface water to percolate. The only water body in the vicinity is Mod III Lake on the northwest end of the ABRES A-3 mesa, as shown in Figure 2.1.3-1. The launch site contains a flame deflector and runoff channel, which diverts debris and stormwater runoff to an unnamed drainage ditch south of the site.

SLC-4W

Surface runoff from SLC-4W is drained entirely by Spring Canyon Creek, which lies 0.1 mile south and downslope, as shown on Figure 2.1.3-1. Spring Canyon Creek discharges range from zero to 0.51 cfs, only in direct response to rainfall (USAF, 1988a). Water in the streambed is ponded at the Coast Road embankment and percolates into the groundwater system, which is in hydraulic continuity with the Pacific Ocean.

SLC-5

The SLC-5 site is located on all uplifted marine terrace on the north ridge of Cañada Honda Creek, as shown on Figure 2.1.3-1. Surface water drains from the launch site into Cañada Honda Creek. The Cañada Honda Creek watershed encompasses the largest area on South VAFB. Ponded surface water, blocked by drifting sand, is perennial at the creek's ocean discharge point. The creek exists in a well defined canyon, which extends approximately 7 miles from headwaters to the ocean.

Cypress Ridge

Cypress Ridge does not contain any natural channeling due to surface water flow. Therefore, surface water runoff from this site occurs by sheet wash flowing into adjacent drainage systems or onto a lower terrace. Most of this location is part of the Oil Well Canyon watershed, with the creek bed located outside the eastern boundary of the proposed site. During 25-year and 100-year storm events, runoff flows for the entire Cypress Ridge area are estimated at 370 and 570 cfs, respectively (USAF, 1989c).

Boathouse Flats

The Boathouse Flats site is situated on a flat uplifted marine terrace. The terrace is covered with lowlying grasses and compacted soil from cattle grazing. Drainage of surface water from the terrace is by sheeting action and percolation. Natural drainage contours on the terrace have been altered during construction of the Space Shuttle External Tank Tow Route (USAF, 1989c). During storm events, rapid sheet flow runoff occurs, often cutting into the terrace surface. Boathouse Flats receives drainage from Oil

Well Canyon situated just north of the site. For 25-year and 100-year storm events, flows estimated at 1,310 and 1,920 cfs, respectively, occur at the Boathouse Flats site (USAF, 1989c).

- **Edwards Air Force Base**

EAFB is located in the western portion of Southern California's Mojave Desert. The area is known as the Antelope Valley, and is bordered on the south by the San Gabriel Mountains and on the northwest by the Tehachapi Mountains. EAFB is located in a portion of the valley composed of layers of sand and alluvial material filling a basin around Rosamond and Rogers Dry Lakes. Stormwater runoff from the mountains washes down to the dry lake beds during major storm events. Surface water flows are in direct response to rainfall, and sometimes occur as flashfloods. The dry lakes are composed of smooth impermeable clay soil, which allows for slow percolation of water. Rainfall around the NASA Dryden Flight Research Facility generally percolates into the ground, or is lost to evaporation before reaching Rogers Dry Lake.

- **San Nicolas Island**

San Nicolas Island is a landmass in which topography is carved by surface water runoff to the ocean. The island contains no permanent water bodies or surface water flows. The basic hydrology can be divided into two distinct drainage systems that are separated by the southern escarpment. Stream courses along the southern portion of the island drain surface water through very steep, V-shaped canyons forming straight courses to the ocean with only minor or no tributaries. The surface water drainage patterns of the northern portion of San Nicolas Island includes the upland area, which extends down to the sand dunes on the flat terrace surfaces.

Tule Creek is the only stream that is not dry throughout the year. The presence of natural springs indicates areas of perched groundwater in the creek basin. Headwaters for Tule Creek form at the highest point of the island, and extend in a defined gully to a sand dune area on the northeast side of San Nicolas Island. The creek loses its expression as it flows through the dunes. Drought years have depleted both surface water in Tule Creek and springs associated with the creek basin. Several drainage basins on San Nicolas Island have been modified with containment structures, increasing the retention time of surface water and allowing for groundwater recharge. Surface water flows on San Nicolas Island are not used as potable water.

Drainage patterns around Pad 192 form streams on either side of the facility. Surface water runoff from the pad is channelled by contoured gutters to a storm drain on the northwest side of the concrete pad. Storm runoff water is discharged through the storm drain to stream on the west side of the pad.

2.1.3.2 Groundwater

- **Vandenberg Air Force Base**

The San Antonio Valley Basin and the Shuman Canyon Creek Basin are the only known groundwater basins on North VAFB. The expanse of groundwater basins is shown in Figure 2.1.3-2. The San Antonio Valley Basin contains an estimated 8.5 million acre-feet of groundwater in permanent storage above sea level (ESA, 1982). The major consumptive user of groundwater in the San Antonio Valley is VAFB. Agricultural irrigation is also a major consumptive use. The VAFB water supply system contains four production wells in the San Antonio Valley. They produced 4,063.06 acre-feet of groundwater in 1990 (VAFB, 1991). Recharge in the San Antonio Valley Basin results from percolation of surface runoff in creek channels and rainfall. The groundwater basin is underlain by impermeable consolidated rocks present beneath the entire San Antonio Valley. The San Antonio Basin is independent and not hydraulically connected to other groundwater basins.   An upwarp exists that channels groundwater upward to the land surface, where it discharges into a marshy area of San Antonio Creek at the Barka Slough.

In the Shuman Canyon Creek Basin, groundwater is found in zones of perched water associated with terrace deposits, and in the alluvial fill comprising the bed of Shuman Canyon Creek.

The Lompoc Valley groundwater system is comprised of three distinct, but hydraulically connected basins. These basins are the Lompoc Terrace, Lompoc Plain and Lompoc Upland, which are shown on Figure 2.1.3-2. The South VAFB water supply system is derived from the Lompoc Terrace Groundwater Basin, which is independent and isolated from the North VAFB system. The Lompoc Terrace groundwater basin is bordered by the Pacific Ocean to the west and young Santa Ynez Valley alluvium to the east, and by faults on the north and south. This basin covers an area of 4,800 acres with a total storage capacity of 60,000 acre-feet (USAF, 1988a). VAFB maintains a production well field in the Lompoc Terrace. It produced 231.76 acre-feet in 1990 for the water demands on South VAFB (VAFB, 1991). Primary domestic users of water from the Lompoc Plain

Figure 2.1.3-2 Groundwater Basins in the VAFB Vicinity

Groundwater Basin are VAFB, the Federal Correctional Institution, and the City of Lompoc. The current collective use of these groundwater basins results in an overdraft of the basins. More groundwater is being pumped per year than is recharged into the basin. The Santa Ynez Production Well Field produced 519.68 acre-feet of water for VAFB in 1990 (VAFB, 1991).

South VAFB is characterized by small watershed drainages along the coast that contain localized groundwater in alluvial deposits. Launch sites discussed in this section are primarily located on uplifted marine terraces underlain by Orcutt Sand. Varying percentages of silt and clay prevent it from yielding large amounts of water. The underlying formation provides containment for percolated rainwater.

Launch Facility 6

The LF 06 site is underlain primarily by the non-water bearing Monterey Formation. Groundwater associated with the LF 06 site exists as water percolated into the soil from precipitation or surface water flows. This is not considered a recharge zone for local aquifers.

Test Pad 1

The Test Pad 1 launch site is underlain by the non-water bearing Monterey Formation. Perched water is known to occur in the unconsolidated deposits, which develop springs that occur at outcrops along the San Antonio Valley. Groundwater occurs in alluvial deposits in the San Antonio Creek basin, where the water table is 10 to 30 feet below the surface. Any groundwater flow from the launch site moves west into the Pacific Ocean. The San Antonio Valley is confined by impermeable consolidated rocks on all sides. Barka Slough is located southeast of Test Pad 1 in the San Antonio Creek bed.

ABRES A-3

The ABRES A-3 launch site is underlain by the non-water bearing Monterey Formation. Perched water is known to occur in the unconsolidated deposits, which develop springs occurring at outcrops throughout the San Antonio Valley. Groundwater occurs in alluvial deposits in the San Antonio Creek basin, where the water table is 10 to 30 feet below the surface. Groundwater flow underlying the launch site moves west into the Pacific Ocean. The San Antonio Valley is confined by impermeable consolidated rocks on all sides. Barka Slough is located northeast of ABRES A-3 in the San Antonio Creek bed.

SLC-4W

Small quantities of groundwater underlying the SLC-4W site are found in the Orcutt Sand and Quaternary (Holocene) alluvium, at about 4 to 20 feet below the surface. The underlying Sisquoc and Monterey Formations are not water-bearing, except for fracture lines or local sand beds (USAF,1988a).

The Lompoc Terrace groundwater system is isolated from the SLC- 4W facility by clay layers underlying the site. Perched aquifers are contained within the Spring Canyon Creek alluvium. Predominant groundwater flow is toward the ocean.

SLC - 5

The SLC-5 site is isolated from the Lompoc Terrace groundwater basin. Small quantities of groundwater underlying the SLC-5 site are found in the Orcutt Sand and the Quaternary (Holocene) alluvium. The underlying Sisquoc and Monterey Formations are not water-bearing, except for fracture lines or local sand beds (USAF,1988a). Groundwater underlying the site is contained within the Cañada Honda Creek alluvium. Any groundwater flow would be toward the ocean.

Cypress Ridge

A very small amount of groundwater is found in the Cypress Ridge area. Five water wells have yielded from one to 30 gallons per minute in this vicinity (USAF, 1989c). Depth to water ranges from 70 to 130 feet. Water is contained primarily in fracture zones in the underlying Monterey Formation.

Boathouse Flats

The underlying Sisquoc and Monterey Formations are not water-bearing, except for fracture lines or local sand beds (USAF, 1988a). This area is undeveloped except for the construction of the Space Shuttle External Tank Tow Route (USAF, 1989c).

Construction related activities associated with the Tow Route have compacted soil and reduced area-wide surface water infiltration rates.

- **Edwards Air Force Base**

EAFB is underlain by three groundwater basins, shown in Figure 2.1.3-3: the North Muroc Basin, Lancaster Basin, and Gloster Basin. The Lancaster Basin, which underlies the NASA Dryden Flight Research Facility, is the largest, covering an area of about 800 square miles. It is the primary groundwater basin source for water in the area. The Lancaster Basin is comprised of two primary aquifers, referred to as the principal aquifer and the deep aquifer. These two aquifers are separated by a lacustrine clay layer of low permeability.

EAFB's water demands are supplied primarily by groundwater. Currently, nine wells, located throughout the North Base and South Base, supply the entire base with domestic water. Depth to these wells ranges from 360 feet to 700 feet. Approximately 4,450 acre-feet per year are pumped from the domestic groundwater system (ES, 1989). Groundwater pumping in the Lancaster Basin has exceeded recharge since prior to 1930, causing a decline in total basin storage. The base is supplementing its water supply by developing an interconnection to State Water Project water sources from the Antelope Valley East Kern Water Agency. Completion of this connection is scheduled for mid-1991.

Overdraft of groundwater basins underlying EAFB has caused subsidence of the land surface over a broad area of the Antelope Valley, both in and around EAFB. Large fissures or cracks in the ground surface, measuring up to 4 feet wide, 12 feet deep, and 0.5 mile long, have resulted from this subsidence at EAFB. These fissures have forced closure of one runway.

- **San Nicolas Island**

San Nicolas Island is the only Channel Island composed entirely of sedimentary materials. The island is made up of consolidated marine sediments, which offer little storage capacity for recoverable amounts of potable groundwater. Surface water percolation, along with percolation of precipitation, are the only sources of groundwater recharge. Groundwater occurs primarily on the western end of the island in perched aquifers within the upper few feet of the weathered surface.

All movement of groundwater is by percolation and in response to gravity. Groundwater, percolated from the uplands, is believed to move northwesterly towards designated potential water-bearing areas (USGS, 1958). The island's southern beaches

Figure 2.1.3-3 Groundwater Basin Map, EAFB and terraces are absent of fresh-water springs and seeps. Water percolated into the marine terraces, located on the southern portion of the island, acquire salts by solution and by mixing with brackish groundwater.

The primary source of domestic water used on the island is from a reverse osmosis desalination unit, and from shallow wells located on the northwest side of the island. The output of the wells, which account for about 3,000 to 5,000 gallons per day, is dependent on rainfall. Wells are overdrafted to the point of exhaustion during drought years. Depleted wells become polluted with brackish non-potable water when overpumped. The reverse osmosis unit produces about 12,000 gallons of potable water per day for San Nicolas Island.

Domestic wells serving San Nicolas Island are not located in the vicinity of Pad 192. Water that percolates into the ground around the launch pad moves northwesterly toward potential water-bearing areas.

2.1.4 Water Quality

2.1.4.1 Surface Water

Title 22 of the California Code of Regulations (CCR) provides drinking water standards as established by the California Department of Health Services. Table 2.1.4-1 shows these standards as maximum contaminant levels (MCL) for constituents found in surface water and groundwater.

- **Vandenberg Air Force Base**

Water quality data for creeks and lakes on VAFB are shown on Tables 2.1.4-2 and 2.1.4-3. Five small lakes are present in the central portion of VAFB, between San Antonio Creek and the Santa Ynez River, with a combined surface area of 27.3 acres and a total volume slightly over 200 acre-feet.

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 (USAF, 1989b). Flow rates for all the named and unnamed drainages at VAFB have not been measured, but are known to be highly variable depending on storm intensities. Surface water is not used as a potable water supply at VAFB.

Drinking water standards are provided in Table 2.1.4-1 for comparison. These standards do not apply to surface waters on VAFB, because surface water is not associated with the drinking water supply. Ambient water quality sampling is performed by the Air Force.

Table 2.1.4-1

Maximum Contaminant Levels for Drinking Water Established by the California Department of Health Services

	Maximum Contaminant Level
Inorganic Constituents	
Arsenic	.05
Cadmium	.010
Chromium	.05
Copper	1.00
Iron	.30
Lead	.05
Maganese	.05
Nickel	NS
Magnesium	NS
Selenium	.01
Sodium	NS
Zinc	5
Aluminum	1
Sulfates	250
Nitrates	45
Nitrates (as nitrogen)	10
Alkalinity	400
TDS	500
Specific Conductance (μmho/cm)	1,600
Oil and Grease	NS
pH (pH units)	5.0 - 9.0
Organic Constituents	
Benzene	.001 mg/L
Ethylbenzene	.680
Trichloroethylene	.005
1,1 Dichloroethane	.005
Toluene	100.0
Xylene	1,750

Source: CCR, Title 22, Chapter 15, Article 5, Port 64435 and 64444.5 July 1990.

NS - No established standard
Note: All units in mg/L unless otherwise noted

Launch Facility 6

Shuman Canyon Creek is the primary drainage for the watershed that contains the Casmalia Landfill. The landfill is a Class I landfill facility, located approximately 7 miles east of the ocean. Water quality is a concern for Shuman Canyon Creek, and it is monitored quarterly by the Air Force as it flows through the base. The most recent sampling data (Table 2.1.4-2) detected trace levels of arsenic and manganese in the creek, although the levels were below the MCLs established by the California Department of Health Services. Organic constituents have not been detected in the creek. Due to the agricultural runoff and other non-point source runoff into Shuman Canyon Creek, the creek is non-potable.

Water quality measurements taken at Shuman Canyon Creek are shown on Table 2.1.4-2. This is the closest creek to LF 06 in which sampling information is available. Shuman Canyon Creek does not receive drainage from LF 06.

Table 2.1.4-2

Surface Water Quality on North VAFB

	Mod III Lake	Shuman Canyon Creek	San Antonio (Midpoint)	San Antonio (Entry)	San Antonio (Exit)
Sulfates (mg/L)	640	900	215	108	170
Specific Conductance (μmho/cm)	3,563	3,788	2,050	931	1,206
TDS (mg/L)	2,747	2,996	1,301	555	762
Alkalinity (mg/L)	260	440	380	120	290
Oil & Grease (mg/L)	2.7	.5	3.5	2.2	.5
Copper (μg/L)	48	<20	<20	26	24
Cadmium (μg/L)	<10.0	<10	<10	<10	<10
Arsenic (μg/L)	<10.0	13	<10	<10	<10
Chromium (μg/L)	<50	<50	<50	<50	<50
Iron (μg/L)	7,710	802	130	617	371
Lead (μg/L)	<20	<20	<20	<20	<20
Manganese (μg/L)	1,466	77	58	1,267	215
Nickel (μg/L)	95	<50	<50	<50	<50
Selenium (μg/L)	<10.0	<10	<10	<10	<10
Sodium (mg/L)	555.0	499	32.4	141.8	141.0
Zinc (μg/L)	73	<50	<50	<50	<50
Aluminum (μg/L)	792	<100	<100	<100	107
Magnesium (mg/L)	163.1	173.6	3.5	21.3	33.0
pH	9.3	8.0	7.74	7.3	8.03
Nitrates (as nitrogen)	<0.1	<0.1	1.68	1.02	.0.89

Source: Environmental Sampling Data, samples collected by lSTRAD Hospital/SGB at VAFB in 1989.
NS = No established standard

Test Pad 1 and ABRES A-3

San Antonio Creek has been monitored extensively because it is a source of recharge to the San Antonio Groundwater Basin. This creek is located approximately 3,500 feet south of Test Pad 1, and 2,200 feet north of the ABRES A-3 facilities. Sampling locations along the creek are at creek entry to the base, midpoint, and near the ocean discharge. The most recent sampling data for San Antonio Creek is shown on Table 2.1.4-2. Sampling results indicate that the creek is high in mineral constituents, with total dissolved solids (TDS) ranging from 555 to 1,301 mg/L.

SLC-4W

Due to the considerable disturbances in the Spring Canyon Creek drainage basin related to SLC-4 construction, maintenance and operations, surface water quality in the drainage system for the SLC-4W area is considered moderate to poor. Titan IV launches from SLC-4E have used 170,000 gallons of deluge water per launch. All but approximately 50,000 gallons is vaporized during each launch. The remaining 50,000 gallons will be taken to the proposed SLC-6 wastewater treatment facility for testing, treatment (if necessary), and reuse. At present, the launch water, which is non-hazardous, is taken to the evaporation ponds located at the SLC-6 wastewater treatment facillity. Past studies have classified the quality of groundwater underlying SLC-4 as poor. Water quality upstream of SLC-4 has notably low pH values of 6.0 to 6.7, and high concentrations of sodium, aluminum, and iron. Concentrations of iron, copper, zinc, calcium, magnesium, and chloride levels above MCLs have been recorded at sampling stations downstream of SLC-4 from 1983 to 1986 (USAF, 1988d). The RWQCB no longer allows discharge of this wastewater into Spring Canyon Creek, although past discharges occurred prior to the policy change in 1988.

SLC-5

Cañada Honda Creek has good surface water quality compared to the other creeks on VAFB, with a pH of 7.8, a TDS level of 1,564 mg/L, and an alkalinity of 375 mg/L (USAF, 1988a). Honda Creek is relatively undisturbed and has partially grazed watersheds (USAF, 1989b). Water used for pad washdown and fire suppression is stored on site. All water used for launch activities is contained on site and does not enter Cañada Honda Creek. Water is trucked to the base treatment facility for treatment and disposal.

- **Cypress Ridge**

Cypress Ridge is presently undeveloped. Water quality data on the unnamed creek north of Cypress Ridge indicate relatively poor water quality with a TDS level of 1,308 mg/L as shown on Table 2.1.4-3.

Boathouse Flats

Boathouse Flats is presently undeveloped. Water quality data for Oil Well Canyon indicate relatively poor water quality with a TDS level of 1,228 mg/L as shown on Table 2.1.4-3.

- **Edwards Air Force Base**

Surface water on EAFB is a result of heavy precipitation and flooding. Every 5 years to 7 years, Rogers and Rosamond Dry Lakes occasionally flood and hold water for a short period of time, usually between the months of October and February (ES, 1989). The alkaline, non-potable water evaporates or percolates within a matter of days. The Piute wastewater impoundment and evaporation ponds, located at the extreme southwest corner of EAFB, contain secondary treated effluent year round. Significant percolation does not occur at these ponds due to their clay subsoil. The remainder of the surface water bodies on EAFB consist of stormwater retainment basins and sewage evaporation ponds. These basins and ponds are scattered throughout the base and are of marginal importance. Surface water at EAFB is short-lived due to rapid evaporation, and rapid percolation in alluvial areas.

- **San Nicolas Island**

Surface water at San Nicolas Island is a result of precipitation runoff. The Tule Creek contains natural springs that often surface during wet weather conditions. The sewage treatment plant discharges to percolation-evaporation ponds. The facility is capable of handling up to 40,000 gallons per day. Quality of surface water is a concern because it recharges the groundwater domestic water supply.

Table 2.1.4-3 Surface Water Quality on South VAFB

2.1.4.2 Groundwater

- **Vandenberg Air Force Base**

Table 2.1.4-4 shows concentrations of various constituents contained in the VAFB groundwater basins. Groundwater monitoring is conducted for basins which are utilized for drinking water. The San Antonio Valley Groundwater Basin currently exceeds drinking water standards for TDS, manganese and iron, as shown in Table 2.1.4-4. The Santa Ynez Groundwater Basin, a component of the Lompoc Terrace, also exceeds drinking water standards for TDS and iron. The Lompoc Terrace groundwater contains constituents that exceed MCLs for TDS.

Launch Facility 6

Groundwater underlying the LF 06 site does not serve any production use. The launch silo is scrubbed manually with wire brushes after launch activities and all wastewater generated from this operation is containerized for off-site treatment and disposal. The low amount of runoff water from the site is not expected to enter the groundwater.

Test Pad 1

The Test Pad 1 site is currently being investigated under the Air Force Installation Restoration Program (IRP). The program has identified sites where hazardous waste remediation action is needed. The site is located above the San Antonio Creek groundwater basin which is used as a drinking water supply on base. An IRP monitoring well located near Test Pad 1 has produced water with high levels of lead and chromium, exceeding MCLs as shown on Table 2.1.4-5.

ABRES A-3

The ABRES A-3 site is currently being investigated under the Air Force IRP. Two IRP monitoring wells are located near the site, and sampling results are shown in Table 2.1.4-5. Quality of groundwater underlying this site exhibits sulfates, specific conductance, TDS, and chromium concentrations exceeding MCLs for these constituents.

Table 2.1.4-4 Groundwater Water Quality on VAFB

Table 2.1.4-5

Quality of Water in IRP Groundwater Monitoring Wells

CONSTITUENT	Test Pad 1 SITE 31 31-MW-1	ABRES A-3 SITE 13 13-MW-11	ABRES A-3 LAKE SITE 14 14-MW-1	SLC-4W SITE 9 9-MW-1	SLC-4W SITE 9 9-MW-2
Sulfates (mg/L)	18	28	436	83	44
Specific Conductance (μmho/cm)	282	1720	3166	1310	165
TDS (mg/L)	338	1700	2566	920	1200
Copper (mg/L)	ND	ND	ND	ND	ND
Cadmium (mg/L)	0.0009	0.0006	0.0009	0.0006	ND
Chromium (mg/L)	1.2	0.59	ND	0.06	0.14
Lead (mg/L)	0.073	0.002	0.002	0.005	ND
Nickel (mg/L)	ND	0.17	ND	- - -	- - -
Zinc (mg/L)	0.32	ND	ND	- - -	- - -
pH	6.1	6.5	7.2	6.4	6.5

Source: Analytical Results for Groundwater Samples -- VAFB IRP, Phase II, Stage I, 1988.

ND = Not detected
- - - = Analysis not performed

SLC-4W

Past studies have classified the groundwater underlying SLC-4W as poor. A study performed in 1987 compared water quality data from the late 1950's and early 1960's with recent data, and concluded that, except for increases in dissolved iron and silica concentration, no significant difference in water quality was apparent (Stearns Catalytic, 1987). This site is also being studied under the Air Force IRP. As shown on Table 2.1.4-5, wells at SLC-4W exhibit high concentrations of TDS and chromium.

SLC-5

The SLC-5 facility, situated on a terrace above Cañada Honda Creek, is underlain by small perched aquifers which are recharged by runoff that percolates into the terrace. These small perched aquifers are not used for any production purposes.

All launch process and washdown water used for launch activities is containerized for off-site treatment and disposal; therefore, wastewater would not be expected to enter the groundwater underlying SLC-5 and Cañada Honda Creek.

Cypress Ridge

Cypress Ridge is currently undeveloped. Water quality data on the groundwater and from springs adjacent to this site indicate relatively poor water quality, with a TDS level of 1,150 mg/L, hardness of 617 mg/L, and chloride level of 343 mg/L (USAF, 1989c). Due to the high chloride concentrations, water yielded from these wells is not recommended for either drinking or irrigation (USAF, 1989c).

Boathouse Flats

Boathouse Flats is currently undeveloped. Water quality data on the groundwater and from springs adjacent to Cypress Ridge indicate relatively poor water quality, with a TDS level of 1,150 mg/L, hardness of 617 mg/L, and chloride level of 343 mg/L (USAF, 1989c). Due to the high chloride concentrations, water yielded from nearby wells is not recommended for either drinking or irrigation (USAF, 1989c).

■ Edwards Air Force Base

EAFB operations include extensive aircraft testing and service operations. These operations are associated with extensive use of halogenated organic solvents, gasoline and jet fuel. Groundwater contamination, due to past spills and leaks of jet fuel from fuel pipelines, and due to discharges of chlorinated solvents in the aircraft service and operations areas, have been documented (ES, 1989). The Air Force's current practice is to contain and clean up fuel spills with absorbent materials immediately following spill event (Phillips, 1990d). Several sites throughout the base have been designated by the Air Force to be included in the IRP and are in the process of remedial investigation of groundwater contamination. The NASA Dryden Facility is currently investigating two sites under the IRP. The Service-Station / Auto Garage Area has been subject to a leaky underground tank. A remediation program has been initiated for the site. The other site is in the Stormwater Ramp - Flight Line Area. Industrial runoff is the primary course for contamination at this site. Remediation of this site is expected to begin in 1992 (Ambrose, 1990). Both sites are downgradient from the ALV staging area. All fuel used for the ALV Program is trucked in from Edwards.

- **San Nicolas Island**

In general, groundwater from sources nearest the surface water recharge area are of the best quality. Chemical analyses of samples obtained from wells near Tule Creek are marginal quality for human consumption, containing varying levels of sodium chloride in solution. Groundwater is mixed with water from the reverse osmosis unit to make up the portable water supply. The current dilution rate of reverse osmosis water and well water is 3 to 1.

2.1.5 Geology and Soils

2.1.5.1 Topography and Physiography

- **Vandenberg Air Force Base**

VAFB is located along the Pacific Coast, north of Point Conception. It is situated in the middle of the 400-square mile Santa Maria physiographic district. This wedge-shaped district is defined by the northwest trending San Rafael Mountains, the west-trending Santa Ynez Mountains, and the coastline along the Pacific Ocean. The southern part of VAFB is comprised of a series of generally west trending mountains and valleys within the Transverse Ranges Geomorphic Province. The northern part of VAFB is comprised of northwest trending mountains of the Coastal Ranges Geomorphic Province as shown on Figure 2.1.5-1.

Topography within the district is varied, ranging from sea level at the coastline to over 1,300 feet in the Casmalia Hills. On the south side of VAFB, the steep-crested to well-rounded ridges of Santa Ynez Mountains reach elevation of 2,200 feet above sea level. They are represented by a series of nearly parallel ridges, separated by narrow V-shaped canyons or valleys that have deeply incised into these mountains. Within VAFB, elevations range from 0 to about 2,000 feet.

Mesas and terraces represent remnants of ancient erosional platforms at VAFB. These erosional platforms were cut by waves during a time prior to uplift of the land surface that resulted from faulting and tectonism. Evidence of at least five different levels of wave-cut terraces are present at VAFB (Fugro, 1978). Burton Mesa, where the main facilities on VAFB are located, and Lompoc and San Antonio Terraces, are the prominent erosional platforms at VAFB as shown on Figure 2.1.5-1. They were formed during the middle to

Figure 2.1.5-1 Physiographic Features of VAFB and Vicinity late Pleistocene, the period of most recent tectonic activity. The current coastline is dominated by beaches, sand dunes, terraces, sea cliffs, and sea stacks.

Numerous large and small rivers and creeks provide surface drainage at VAFB. San Antonio Creek and its tributaries form the primary drainage system in the northern half of VAFB. The Santa Ynez River and its tributaries form the primary drainage system in the southern half of VAFB.

A significant area of VAFB is covered by Quaternary and Holocene age sand dunes as shown on Figure 2.1.5-2. Most of the dunes are stabilized by vegetation, forming a highly-irregular ground surface, with 30 to 50 feet of relief. But these dunes are still active along their western margin near the beach.

- **Edwards Air Force Base**

EAFB occupies 301,000 acres of land located in the northeastern section of the Antelope Valley, in the western part of the Mojave Desert Geomorphic Province. Gently rolling hills, alluvial plains and fans, and playas or dry lake beds characterize the area as shown on Figure 2.1.5-3. Elevations range from about 2,270 feet above sea level at Rogers Dry Lake to over 3,420 feet above sea level at Red Buttes. The valley is bounded on the south by the San Gabriel Mountains, and on the west by the Tehachapi Mountains.

- **San Nicolas Island**

San Nicolas Island is located approximately 63 miles southwest of Malibu. It is the outer most of the Channel Island Group, and the western most island lying within the Peninsular Ranges Geomorphic Province. This province is characterized by a series of northwest trending faults separating mountains ranges from valleys and basins. San Nicolas Island is located on the Santa Rosa Cortes Ridge.

San Nicolas Island is approximately 9 miles long, has an average width of 3 miles, and covers an area of about 23 square miles. Most of the island is covered by a series of wave cut marine terraces separated by steep slopes. Wind and water erosion has carved deep gullies through the hillsides. The shore line is formed by cliffs averaging less than 100 feet in height, overlooking sand covered beaches on the east, north, and southwest sides of the island. Maximum elevation is about 900 feet.

Figure 2.1.5-2 Generalized Locations of Sand Dunes on VAFB

Figure 2.1.5-3 Physiographic Features of EAFB and Vicinity

2.1.5.2 Stratigraphy

- **Vandenberg Air Force Base**

VAFB lies within two separate structural provinces, the western Santa Ynez Mountains on the south and the Santa Maria Basin on the north. The Franciscan assemblage, a severely sheared melange of sedimentary and volcanic rocks, forms the basement complex of both provinces. Variations between younger sedimentary rocks exist between the two provinces, resulting from time differences in the development of the two sedimentary basins now represented by the structural provinces present. These geologic formations are shown on Figures 2.1.5-4a and 2.1.5-4b, a generalized geologic map of western Santa Barbara County. Figures 2.1.5-5 and -6 display the geologic units, their ages, thickness, and descriptions for the two provinces.

Formations of the Santa Ynez Mountains were deposited in the Santa Barbara embayment, a depositional basin receiving sediments from Cretaceous to Pliocene time. The Lower Cretaceous age Espada Formation is a thick, monotonous series of marine shales that unconformably overlies the Honda Shale, which may be a shale member of the Franciscan. The Jamala Formation is another marine shale unit which overlies the Espada.

Unconformably above the Jamala is a very thick series of marine sandstones and shales known as the Eocene-Oligocene Series. This series includes the Sierra Blanca, Anita, Matilija, Cozy Dell, Sacate, and Gaviota Formations. The Lower Miocene age Vaqueros and Rincon Formations are marine sandstone and claystone units, respectively, which unconformably overlie the Eocene-Oligocene Series. The Tranquillon Volcanics, a local flow and ash unit, is unconformably above the Rincon, and conformably below the Monterey Formation. The Monterey contains a large amount of organic material, largely remains of microscopic plant and animal life. It is well known as a source of oil and gas resources. The Sisquoc Formation is a diatomite and clay shale unit overlying the Monterey. Upper Pleistocene marine and non-marine terrace deposits, and Recent stream-laid alluvium overlie these sedimentary formations.

In contrast to the Santa Ynez Mountains, the Santa Maria Basin did not develop until Miocene time. The Espada Formation in the Santa Maria Basin is generally known as the

"Knoxville" Formation. The Eocene-Oligocene Series is not present in the Santa Maria Basin. As a result, the Lower Miocene age Lospe Formation, a terrestrial sandstone and

Figure 2.1.5-4a Generalized Geologic Map of North VAFB

Figure 2.1.5-4b Generalized Geologic Map of South VAFB

Figure 2.1.5-5 Stratigraphic Column for Western Santa Ynez Mountains

Figure 2.1.5-6 Stratigraphic Column for Southern Santa Maria Basin tuff unit overlies the Lower Cretaceous Espada. The Lospe may correspond to the Vaqueros-Rincon Formations of the Santa Ynez Mountains. The Monterey and Sisquoc Formations occur above the Lospe. Foxen Claystone and Careaga Sandstone are marine formations, unique to the Santa Maria Basin, which overlie the Sisquoc. Above the Careaga is the Paso Robles Formation, a series of terrestrial gravels, sands and clays. Discordantly above the Paso Robles is the Orcutt Formation, a unit of terrestrial sand and gravel that ranges from less than a foot to over 150 feet in thickness. As in the Santa Ynez Mountains, terrace deposits and alluvium overlie the older formations. Recent dune sands also cover an extensive area of northern VAFB as shown on Figure 2.1.5-2.

- **Edwards Air Force Base**

EAFB is underlain by a unconsolidated Quaternary age sediments, and Tertiary age sedimentary and volcanic rocks. The underlying basement complex is comprised of Pre-Tertiary age granitic and metamorphic rocks (ES, 1989). Quaternary age playa deposits of former Lake Thompson have subsided and cracked as a result of groundwater overdraft. At EAFB, the largest crack is four feet wide, twelve feet deep, and one-half mile long, and it has required closure of one runway. Figure 2.1.5-7 shows the relationship between these geologic units.

- **San Nicolas Island**

San Nicolas Island is comprised of a series of Middle and Late Eocene age marine sedimentary rocks, represented by interbedded sandstone, shale, mudstone and siltstone, with minor amounts of conglomerate. It is locally referred to as the "San Nicolas" Formation (Norris, 1951). Vedder and Norris (1963) have divided these rocks into 35 mappable units that reach a total thickness of almost 3,500 feet.

Miocene age andesitic rocks intrude the older sedimentary rocks of the "San Nicolas" Formation. These Miocene and Eocene rocks are folded into a broad, complexly faulted anticline (Vedder and Norris, 1963). Pleistocene age marine and nonmarine terrace deposits, equivalent to the San Pedro Formation, and Holocene age sand dunes overlie the older sedimentary and intrusive rocks.

Recent terrestrial gravel deposited on wave cut terraces can be found along the coast, often referred to as Dune sand. The low coastal plain is covered with 75 feet of

Figure 2.1.5-7 Geologic Units of EAFB

cobble-gravel, silt and sand. Sediments of recent age are alluvium, consisting of unconsolidated clays, silts, sands and gravels, reaching a thickness of 150 ft.

Pad 192 is underlain by Quaternary age eolian sands. These wind blown sands were deposited on an erosional terrace that had been cut into a thick bedded sandstone sequence (Unit 7 of Vedder and Norris, 1963).

2.1.5.3 Paleontologic Resources

- **Vandenberg Air Force Base**

Rocks of the western Santa Ynez and Santa Maria districts contain varied and abundant fossils, primarily marine invertebrates. Microscopic invertebrates, including diatoms and foraminifera, are present in nearly all of the marine units, but are particularly characteristic of the Monterey Formation. Crustaceans (barnacles and ostracodes) are found in the Foxen, Careaga, Paso Robles, and Orcutt Formations, and within marine terrace deposits. Echinoids (sand dollars) are common in the Careaga and Vaqueros Formations, and are also present in the Foxen Formation. Molluscs (limpets, snails, clams and oysters) are locally abundant in many of the units, including the Sisquoc, Foxen, Careaga, Vaqueros, Paso Robles, and Orcutt Formations, and in the Eocene-Oligocene series of the Santa Ynez Mountains.

Vertebrate fossil material is less common than invertebrate fossils on VAFB. In the Santa Maria district, Woodring and Bramlette (1950) have recorded a fragment of a turtle carapace, marine mammal bones, and questionable mastodon material in the Careaga Formation, rodent molars in the Paso Robles Formation, and marine mammal bones in the Sisquoc Formation. Chitinous remains of fish scales are abundant throughout the Monterey Formation (Dibblee, 1950). Monterey rocks can also yield whale bones, fish fragments, insects, crabs, algae imprints, and coprolite material (Parsons, 1981; 1982). On the southern part of the base, Loel and Corey (1932) found abundant marine mammal bones, and common shark and skate teeth in the Vaqueros Formation. Drs. Robert Gray and George Jefferson (1990) have recovered vertebrate material from the continental portions of the terrace deposits on both the north and south halves of the base. In the vicinity of Jalama Beach on the southern part of the base, mammoth bone and tooth material have been found (Los Angeles County Museum of Natural History locality 4938). In the Point Sal and Corralillos Canyon vicinity, vertebrate material recovered includes mammoth, mastodon, camel, bison, horse, giant ground sloth, and tapir (UC Berkeley localities 65099 and 71018).

Continental terrace deposits distributed throughout VAFB have the highest potential for vertebrate paleontological resources (Gray, 1990). Table 2.1.5-1 summarizes the paleontological resource potential for these deposits, and other geologic units yielding significant fossils at VAFB.

Table 2.1.5-1

Paleontological Potential of Rock Units on VAFB

Geologic Age	Formation	Rock Description	Vertebrate Fossil Material	Potential For Vertebrate Fossils
Holocene	Alluvium/ Colluvium	Unconsolidated, uncemented gravel, sand, silt, and rock.	Archaeological remains fossils considered	Low; vertebrate in rock units older than Holocene.
Upper Pleistocene	Terrace Deposits	Qt_1 (marine); semi-consolidated, clean to clayey, well sorted sands on beveled rock surface of wave-cut platform (marine terrace deposits - 120,000 to 85,000 years).	Some bone material of marine origin	Low; most deposits contain invertebrate marine fossils.
		Qt_2 (continental); semi-consolidated, silty to clayey sands, clayey silts, 45,000 years); non-marine.	Mastodon, mammoth, camel, horse, ground sloth	Moderate to high.
Middle Pleistocene	Orcutt Sand	Semi-consolidated sands and clayey sands, inclined terrace deposits; non-marine.	None; questionable bone chips	Low; ancient dune sand.
Upper Micone	Monterey Formation	Consolidated; diatomaceous mudstone, porcelaneous shales, chert lenses, siltstone; marine.	Numerous fish fossils; whale, porpoise	Moderate; marine mammal bones; considerable fish material, whole fish fossils located along bedding planes widespread in Southern California.

Source: Modified from Gray, 1985 and from USAF, 1989c.

The potential for significant paleontologic resources on VAFB is variable. The marine terrace deposits which underlie Launch Facility 6, SLC-4W, Cypress Ridge and Boathouse Flats, have a low to moderate paleontologic sensitivity. Excavation in this geologic unit may uncover invertebrate fossils and infrequent bone material. Test Pad 1, ABRES A-3, and SLC-5 are underlain by recent alluvial deposits, which are unlikely to yield fossil material.

- **Edwards Air Force Base**

Potentially significant paleontological resources may occur on EAFB. The San Bernardino County Museum has documented about 540 fossil localities. Material recovered includes teeth and bones from camels, mammoths, mastodons, horses, rabbits and other rodents, and other large herbivores. This vertebrate fossil material has been recovered from Quaternary older alluvium, both latest Pleistocene age (10,000 years before present) and middle Pleistocene age (500,000 years before present), and from the middle Miocene age (18 million years before present) Tropico Formation. Potentially significant fossils are especially common in sediments around former Pleistocene lakes. The existing ALV facilities at EAFB, which are being considered for the AFSLV program, are located adjacent to Rogers Dry Lake. This site may overlie fossiliferous deposits.

- **San Nicolas Island**

The Quaternary sedimentary rocks on San Nicolas Island contain vertebrate and invertebrate fossil material. The Los Angeles Natural History Museum has documented four vertebrate fossil localities on the island. Quaternary deposits containing the fossil material are unnamed eolianite units, which are dune sands cemented by calcite. Vertebrate fossil specimens in the Los Angeles County Natural History Museum collections include remains of sharks, bony fishes, aquatic birds including shearwaters, puffins and auks, and aquatic carnivores such as walruses, sea lions and seals. Any of these fossils could be found as disarticulated or associated skeletons, but they usually occur as isolated bones, especially for the fish and birds. Large mammals are most likely to be found as articulated bones.

Currently, research is being conducted on an extinct, new species of late Pleistocene (about 10,000 to 400,000 years ago) puffin that was recently recovered from San Nicolas Island (Thomas et al., in press). Living representatives of this group of birds are unusual. They are the only wing-propelled diving birds of the northern hemisphere that parallel the penguins in the south.

Invertebrate fossil material has also been recovered on the island, from both the terrace deposits and the Quaternary sand deposits (Kennedy, 1990). This material consists primarily of molluscs, including marine and land snails, bivalves, chitons, barnacles, and sea lilies.

Pad 192 is located upon Quaternary, wind-transported, sand deposits. These deposits, which have yielded land snails, are of low to moderate paleontologic sensitivity. Any excavation as a result of the proposed project will probably uncover fossils.

2.1.5.4 Mineral Resources

- **Vandenberg Air Force Base**

Mineral resources of economic potential identified at VAFB include oil and gas, sand and gravel, diatomite, and limestone (USAF, 1980). Of these mineral resources, potential oil and gas reserves currently have the most significant commercial value. Known economic occurrences of the other mineral resources (sand and gravel, diatomite, and limestone) are more than five miles from the project area.

Extensive oil and gas production is present in the surrounding area, both onshore and offshore. The closest offshore oil field is Point Arguello-Point Pedernales, located about five miles southwest of VAFB. It produces low gravity oil from fractured Monterey Shale (USAF, 1989c).

Numerous oil and gas exploration wells have been drilled on VAFB in the past, but with limited success. Only one field discovery was made on San Antonio Terrace in the 1950s at Jesus Maria Field (USAF, 1980). Since 1979, four operators have drilled wells on VAFB: Unocal, Conoco, Nomeco, and Grace. Unocal and Conoco each currently operate one well on VAFB. Nomeco had three wells (abandoned), and Grace drilled and abandoned one well (USAF, 1987a). Potential oil and gas production and reserves are analyzed in detail and discussed in USAF (1987a).

- **Edwards Air Force Base**

Significant commercial deposits of mineral resources are not known at EAFB. Since lands at EAFB have been withdrawn from mineral entry, the probability of future discoveries of commercial mineral resources is extremely low.

- **San Nicolas Island**

Significant commercial deposits of mineral resources are not known on San Nicolas Island. Subsurface structures suitable for trapping accumulations of oil and gas are present underlying San Nicolas Island, but Eocene and Late Cretaceous rocks present beneath San Nicolas Island are not likely to generate commercial quantities of oil and gas (Vedder and Norris, 1963).

2.1.5.5 Soils

- **Vandenberg Air Force Base**

Soil develops from the weathering of underlying geologic materials, including rock formations, sand dunes, alluvium, and terrace deposits. Soil deposits are present on most slopes at VAFB except where bedrock is exposed. Soil thickness is variable at VAFB, ranging from zero to several feet. Generally, soil layers are less than three feet thick. Soil types for the north and central parts of VAFB are discussed in USAF (1987a) and Fugro (1978), and shown in Figure 2.1.5.-8. Soil types for South VAFB are discussed in USAF (1989c) and shown in Figure 2.1.5-9.

- **Edwards Air Force Base**

Soils at EAFB are youthful and poorly developed. They are derived from underlying geologic material, and vary based on local depositional environments and underlying rock type. Quaternary alluvial deposits, and Tertiary age volcanic and sedimentary rock units are the primary source materials for soils at EAFB. In general, soils are comprised of sand, and silty or clayey sand, ranging in thickness from 1 to 5 feet. They are represented by sandy loam and loamy sand. Detailed descriptions of soil types present at EAFB, and their characteristics and engineering properties are provided by the U.S. Department of Agriculture (1988, 1989). Most soil types present at EAFB are suitable for building site development (U.S. Department of Agriculture, 1988; 1989). Three soil types found at EAFB (105 Popson fine sandy loam, 107 Voyager fine sandy loam, and 140 Voyager fine sandy loam) are also suitable for irrigated cropland.

- **San Nicolas Island**

Soils on San Nicolas Island are derived from the underlying "San Nicolas" Formation, terrace deposits and sand dunes. Pad 192 overlies soil classified as Nicolas sandy loam. It is up to 63 inches deep, and is derived from stabilized sand dunes. Soil types and their engineering properties are described in detail by the U.S. Department of Agriculture (n.d.).

Figure 2.1.5-8 Local Soil Types for North and Central VAFB

Figure 2.1.5-9 Local Soils Map for South VAFB

2.1.5.6 Geologic Hazards

Numerous geologic hazards are present at VAFB, EAFB and San Nicolas Island including: landslides, seismicity, surface rupture, liquefaction, flooding, and tsunamis.

- **Landslides**

A landslide is a mass downslope movement of earth materials under the influence of gravity, and includes a variety of forms: rockfalls, debris slides, mudflows, block slides, soil slides, slumps and creep. These mass movements are triggered or accelerated by earthquake-induced ground motion, increased water content, excessive surface loading, or alteration of existing slopes by man (improper grading) or nature (stream or wave undercutting). Adverse geologic conditions, such as daylighted bedding planes, low-strength soils or bedrock materials, and high groundwater content, could also contribute to landslides.

Two principal areas are prone to landslides on VAFB: the Casmalia Hills and the Santa Ynez Mountains as shown on Figure 2.1.5-10. In the Casmalia Hills on the northern end of VAFB, slopes comprised of the Lospe, Point Sal and Monterey Formations, are all prone to landslides.

Landslides are common in the Santa Ynez Mountains which cover the southern part of VAFB. Slides are common on steep slopes surrounding Tranquillon Mountain. Formations affected by slides include the Honda, Espada, Matilija, Cozy Dell, Sacate, Gaviota, Vaqueros, Rincon, Tranquillon, and Monterey.

Landslides are not considered a hazard at EAFB.

Although the high sea cliffs surrounding the shoreline of San Nicolas Island are generally protected by beach sands, they are periodically subject to undercutting by wave action during periods of extreme high tide. When undercut, landsliding will occur. Several large landslides are present along the steep slope on the north side of the island, and a few small landslides have been identified along steep slopes on other parts of the island.

Figure 2.1.5-10 Two Principal Areas Prone to Landslides

- **Faulting and Seismicity**

Several major faults are present within 100 miles of VAFB, EAFB and San Nicolas Island. Numerous smaller faults are located within a few miles of VAFB, EAFB and San Nicolas Island, with some crossing through the bases. Many of these faults are considered active or potentially active, and capable of generating large, damaging earthquakes. These faults are shown in Figures 2.1.5-4a, 2.1.5-4b and 2.1.5-11.

Historical records indicate that the faults described below are considered active and capable of generating earthquakes that could affect VAFB, EAFB and San Nicolas Island, causing severe damage to facilities. Large historic earthquakes recorded in the VAFB, EAFB and San Nicolas Island areas are listed on Table 2.1.5-2.

An earthquake is classified by the amount of energy released, which is quantified using the Richter scale. This is a logarithmic scale where each whole number increase in Richter magnitude, M, represents a tenfold increase in the wave amplitude generated by an earthquake, which is a representation of an earthquake's size . Also, for each full point increase in Richter magnitude, the corresponding amount of energy released increases 31.6 times. Thus, a M 6.3 earthquake is 10 times larger than a M 5.3 earthquake and releases 31.6 times more energy. In contrast, a M 7.3 event is 100 times larger than a M 5.3, and releases almost 1,000 times more energy. Earthquakes of M 6.0 to 6.9 are classified as "moderate", M 7.0 to 7.9 as "major", and M 8.0 and larger as "great".

Earthquake-induced ground motion intensity is described by the Modified Mercalli scale as shown on Tables 2.1.5-3 and 2.1.5-4. It is based largely on damage to man-made structures built prior to revisions in building codes that resulted from damage assessment following the 1933 Long Beach earthquake. Earthquake-induced ground motion intensity is dependent upon earthquake magnitude, distance between the site and the epicenter, and the nature of the earth materials underlying the site.

San Andreas Fault Zone

The San Andreas Fault Zone is about 54 miles from VAFB, about 20 miles from EAFB, and over 110 miles from San Nicolas Island. The San Andreas Fault System, comprised of the San Andreas Fault Zone and other major parallel fault zones, is considered the boundary between two major crustal plates that are moving in opposite directions. The

Figure 2.1.5-11 Major Quaternary (Active and Potentially Active) Faults and Large Historic Earthquakes in the Region

Table 2.1.5-2

Large Historic Earthquakes Recorded in the Vandenberg and Edwards Air Force Base Regions

DATE	MAGNITUDE	FAULT
February 9, 1971	6.4	San Fernando-Sunland Fault
April 9, 1968	6.5	San Jacinto Fault Zone
July 21, 1952	7.7	White Wolf Fault
April 10, 1947	6.2	Manix Fault (?) in Mojave Desert
October 21, 1942	6.6	San Jacinto Fault Zone
July 1, 1941	6.0	Undetermined Fault in Santa Barbara Channel
March 10, 1933	6.3	Newport Inglewood Fault Zone
November 4, 1927	7.5	Undetermined Fault offshore Point Arguello
June 29, 1925	6.3	Undetermined Fault in Santa Barbara Channel
July 23, 1923	6.3	Claremont Fault (San Jacinto Fault Zone)
April 21, 1918	6.8	Claremont Fault (San Jacinto Fault Zone)
October 23, 1916	6.0	Tejon Pass area (San Andreas Fault Zone suspected)
December 25, 1899	6.6	Claremont Fault (San Jacinto Fault Zone)
April 4, 1893	6.0	San Fernando-Santa Susana Fault
January 9, 1857	8.3 +	San Andreas Fault Zone
December 8, 1812	7.0	Newport-Inglewood Fault Zone
December 21, 1812	7.1	Undetermined Fault in Santa Barbara Channel
July 28, 1769	6.7	San Fernando-Santa Susana Fault (suspected)

Pacific Plate is moving in a northwesterly direction relative to the North American Plate (Crowell 1968; Atwater, 1970; Allen, 1975). This motion has been responsible for numerous historic earthquakes along the entire length of the fault, including several major and two great earthquakes. The San Andreas Fault Zone is generally characterized by right-lateral strike-slip movement, with cumulative offset on the combined San Andreas/ San Gabriel Fault Zones totaling 185 miles since the late Miocene (Crowell, 1962, 1975). Two of California's three great historic earthquakes, the 1906 San Francisco and the 1857 Fort Tejon earthquakes, occurred on the San Andreas Fault. The 1857 Fort Tejon earthquake is the largest earthquake to affect southern California since exploration of the region by the Spanish in 1769 (Ziony and Yerkes, 1985). It is estimated that this earthquake was larger than the M 8.3 San Francisco earthquake of 1906.

Physical evidence of historic earthquakes that have occurred along the San Andreas Fault since 260 A.D. is preserved in the sediments at Pallett Creek, about 16 miles southeast of Palmdale. Twelve significantly large earthquakes, including the 1857 event,

Table 2.1.5-3

Modified Mercalli Intensity Scale of 1931

The Modified Mercalli scale measures the intensity of an earthquake's effects in a given locality. Values on the Modified Mercalli intensity scale range from I to XII. The most commonly used adaptation covers the range of intensity from the conditions of "I-not felt except by very few, favorably situated," to " XII-damage total, lines of sight disturbed, objects thrown into the air." While an earthquake has only one magnitude, it can have many intensities, which decrease with distance from the epicenter.

I	Not felt except by a very few under especially favorable circumstances.
II	Felt only by a few persons at rest, especially on upper floors of buildings. Delicately suspended objects may swing.
III	Felt quite noticeably indoors, especially on upper floors of buildings, but many people do not recognize it as an earthquake. Standing motor cars may rock slightly. Vibration like passing of truck. Duration estimated.
IV	During the day felt indoors by many, outdoors by few. At night some awakened. Dishes, windows, doors disturbed; walls make cracking sound. Sensation like heavy truck striking building. Standing motor cars rocked noticeably.
V	Felt by nearly everyone, many awakened. Some dishes, windows, etc., broken; a few instances of cracked plaster; unstable objects overturned. Disturbances of trees, poles and other tall objects sometimes noticed. Pendulum clocks may stop.
VI	Felt by all, many frightened and run outdoors. Some heavy furniture moved; a few instances of fallen plaster or damaged chimneys. Damage slight.
VII	Everybody runs outdoors. Damage negligible in building of good design and construction; slight to moderate in well-built ordinary structures; considerable in poorly built or badly designed structures; some chimneys broken. Noticed by persons driving motor cars VIII Damage slight in specially designed structures; considerable in ordinary substantial buildings, with partial collapse; great in poorly built structures. Panel walls thrown out of frame structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned. Sand and mud ejected in small amounts. Changes in well water. Persons driving motor cars disturbed.
IX	Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb; great in substantial buildings, with partial collapse. Buildings shifted off foundations. Ground cracked conspicuously. Underground pipes broken.
X	Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations; ground badly cracked. Rails bent. Landslides considerable from river banks and steep slopes. Shifted sand and mud. Water splashed (slopped) over banks.
XI	Few, if any, (masonry) structures remain standing. Bridges destroyed. Broad fissures in ground. Underground pipelines completely out of service. Earth slumps and land slips in soft ground. Rails bent greatly.
XII	Damage total. Practically all works of construction are damaged greatly or destroyed. Waves seen on ground surface. Lines of sight and level are distorted. Objects are thrown upward into the air.

Source: CDMG, 1979.

Table 2.1.5-4

Comparison Of Earthquake Magnitude And Intensity

Richter Magnitude	Expected Modified Mercalli Maximum Intensity (at epicenter)	Effects and Consequences
2	I-II	Usually detected only by instruments
3	III	Felt indoors
4	IV-V	Felt by most people; slight damage
5	VI-VII	Felt by all; many frightened and run outdoors; damage minor to moderate
6	VII-VIII	Everybody runs outdoors; damage moderate to major
7	IX-X	Major damage
8	X-XII	Total and major damages

Source: CDMG, 1979.

are recorded in the sediments at this site. At least 5 of the earthquakes were similar in magnitude to the 1857 event (Ziony and Yerkes, 1985). Based on the occurrence of these twelve earthquakes, the average recurrence interval for a major (M 7.0-7.9) or great (M 8.0+) earthquake in the area is 145 years (Ziony and Yerkes, 1985).

There is a high probability that Southern California will experience another great earthquake, similar in magnitude to the 1857 event, during the remainder of this century or early in the next century, generating strong ground motion at VAFB and intense ground motion at EAFB (Davis et al., 1982). Ground motion at San Nicolas Island would be moderate.

San Jacinto Fault Zone

The San Jacinto Fault Zone, about 50 miles from the EAFB and over 135 miles from San Nicolas Island, is a northwest trending series of right-lateral faults extending from the eastern San Gabriel Mountains, where it branches from the San Andreas Fault Zone, south through the Borrego Valley on the southwest side of the Salton Sea. The zone extends to the southeast for over 170 miles before crossing the Mexican border.

Seismicity along the San Jacinto Fault Zone is moderately high (Hileman and Hanks, 1975). The San Jacinto Fault Zone is currently considered the primary active branch of the San Andreas Fault System in this area (Iacopi, 1973). It may be the most active fault in southern California, producing numerous small to moderately large historic earthquakes (Allen, 1965).

The high level of seismic activity exhibited by the San Jacinto Fault Zone indicates continuous release of stress along this zone. As a result of these factors, the probability of a major (M 7.0 to 7.9) or great (M 8.0+) earthquake occurring on the San Jacinto Fault Zone is very low. Small to moderate earthquakes will continue to result from movement along this zone, but compared to the seismic risk from other faults in the region, the San Jacinto Fault Zone is not considered a primary seismic hazard to EAFB. However, a large earthquake along this zone could generate strong ground motion at EAFB. Ground motion at VAFB and San Nicolas Island would not be significant.

Faults of the Transverse Ranges

The Santa Ynez-Pacifico Fault Zone, the Lompoc-Solvang (Santa Ynez River)-Honda Fault Zone, and the Lions Head-Los Alamos-Baseline Fault Zones in the VAFB area, as well as their potential offshore extensions, are three of the primary fault zones within the western part of the east-west trending structural zone known as the Transverse Ranges. The Malibu Coast-Santa Monica-Hollywood-Raymond Hill Fault System forms the southern boundary of the Transverse Ranges. It is generally believed that the Transverse Ranges, and the faults within this zone, are associated with the "bend" in the San Andreas Fault at the intersection of these two dominant structural trends (Iacopi, 1973; Wesson et al., 1974). The Transverse Ranges Province includes the Santa Barbara Channel and the numerous offshore faults within the channel. Based on the 1927 Point Arguello (M 7.5) and 1952 Kern County (M 7.7) earthquakes, Ziony and Yerkes (1985), and Wesson et al. (1974) suggest the possibility of a M 7.7 earthquake within the Transverse Ranges.

The Santa Ynez-Pacifico Fault Zone is comprised of several individual faults projected through the southern most portion of VAFB. The fault zone runs through the central part of the Santa Ynez Mountains, transecting the Transverse Ranges Province for over 100 miles (Jennings, 1975). West of Jalama and Point Conception, the fault zone appears to extend offshore for 10 additional miles, giving the Santa Ynez-Pacifico Fault Zone a total length of 110 miles or more. Vertical movement along these reverse or thrust faults has created part of the Santa Ynez Mountains and nearby hills. Numerous branches of these and other unnamed faults are present within the South VAFB area.

The Lompoc-Solvang (Santa Ynez River)-Honda Fault Zone is also comprised of several individual faults, and is projected through the south-central part of VAFB. The fault zone runs through the northern part of the Santa Ynez Mountains, branching north from the Santa Ynez Fault Zone east of Solvang, transecting the Transverse Ranges Province for over 40 miles to the coast and beyond.

The Lions Head-Los Alamos-Baseline Fault Zone is also comprised of several individual faults, and is projected through the northern part of VAFB. The fault zone runs through the San Rafael and Solomon Hills, after branching north from the Santa Ynez Fault Zone east of Solvang. From this point it crosses about 50 miles to the coast and beyond, possibly connecting to the Hosgri Fault Zone.

Faults within the Santa Ynez-Pacifico and Lions Head-Los Alamos-Baseline Fault Zones have been active during the Quaternary and Holocene (Jennings, 1975). The occurrence of small earthquakes (M 4.0 to M 4.9) along the Lompoc-Solvang-Honda Fault Zone segment of the system indicates that this fault zone is also active. Detailed mapping of fault zones within this system is limited. As a result, determining recurrence intervals and recency of movement is difficult. The most notable recent earthquake along the Santa Ynez Fault was the M 5.5 earthquake of 1926. The most notable recent earthquake along the Los Alamos Fault was the M 5.8 earthquake of 1915. The 1927 (M 7.5) Point Arguello earthquake may have originated on an offshore extension of one of these fault zones or along the Hosgri Fault Zone.

The Malibu Coast-Santa Monica-Hollywood-Raymond Hill Fault System, known as the Frontal Fault System, is comprised of several individual faults located within 48 miles of San Nicolas Island. The Frontal Fault System runs along the south flank of the Santa Monica Mountains, transecting the Los Angeles metropolitan area for 31 miles (Hill, 1979). West of Pacific Palisades, the Malibu Coast Fault parallels the coastline for 30 additional miles. Offshore branches of this fault system, including the Santa Cruz Island Fault, extend to the west for approximately 100 miles, giving the Frontal Fault System a total length of 160 miles or more. Vertical movement along these north dipping reverse or thrust faults has created the Santa Monica Mountains and nearby hills. Weber et al. (1980) also suggest at least 15 miles of left-lateral movement along this fault system.

Faults within the Frontal Fault System have been active during Quaternary, and probably during the Holocene (Hill et al., 1979; Weber et al., 1980). Intense urban development has modified original topography, destroying many natural features associated with Quaternary activity. As a result, determining recurrence intervals and recency of movement is difficult. The most notable recent earthquake along this system was the M 5.9 Point Mugu earthquake of February 21, 1973.

This fault system is considered potentially active (Jennings, 1975), and capable of generating damaging earthquakes. Major earthquakes along this system could generate strong ground motions at San Nicolas Island.

These fault systems within the Transverse Ranges are considered active (Jennings, 1975; Wesson et al., 1974) and capable of generating damaging earthquakes. Moderate or major earthquakes along these systems could generate strong or intense ground motions in the area, and possibly result in surface ruptures of unmapped faults along the northern and southern boundaries, as well as the central part of VAFB. During the 1971 (M 6.4) San Fernando earthquake, numerous separate, previously unmapped faults ruptured over a discontinuous length covering about 10 miles. Areas overlying bedrock on the upthrown (south) side of this fault system could experience the largest ground accelerations, possibly reaching or exceeding 1.0 g locally, similar to those measured at the Pacoima Dam site during the 1971 San Fernando earthquake. Ground motion at EAFB would not be significant. Major earthquakes along this system could generate strong ground motions at San Nicolas Island.

Sur-Nacimiento and Rinconada Fault System

The Sur-Nacimiento and Rinconada Fault System is represented by a series of parallel and sub-parallel faults and fault zones. It is located approximately 40 miles from VAFB. This fault system parallels the nearby San Andreas Fault System, running from Monterey Bay to the Big Pine Fault Zone over a distance of approximately 200 miles. This fault system may be related to either, or both, the San Andreas Fault System or the Hosgri Fault Zone.

Numerous small (M 4.0 to M 4.9), and a few moderate earthquakes have occurred along this fault system during the recent past. The most significant of these was the M 6.0 earthquake of 1952. A moderate earthquake along the southern end of this fault system could generate moderate to strong ground motion at VAFB. Ground motion at EAFB, and San Nicolas Island would not be significant.

Hosgri Fault Zone

The Hosgri Fault Zone is a series of offshore faults running along the California coast from Monterey Bay to Point Sal, and possibly beyond. It is located less than 10 miles offshore from VAFB, and its length covers a distance of at least 120 miles. This fault zone generally parallels both the San Andreas, and Sur-Nacimiento and Rinconada Fault Systems, and may be related to either, or both fault systems. The Hosgri Fault Zone is characterized by primarily dip-slip motion.

This fault zone is considered active and capable of generating large and damaging earthquakes. The 1927 M 7.5 Point Arguello earthquake is the most significant recent earthquake that may have occurred along this fault. A major earthquake along this fault in the vicinity of VAFB would generate intense ground motion at VAFB, and possibly a tsunami similar to the one observed in 1927. Ground motion at EAFB would not be significant. Ground motion at San Nicolas Island could be moderate.

Garlock Fault Zone

The Garlock Fault Zone is located approximately 20 miles from EAFB. It is a major fault zone comprised of numerous east-northeast trending oblique-slip faults. Primary motion is left-lateral strike-slip, with a significant vertical component. As much as 40 miles of left-lateral offset has occurred along the Garlock Fault Zone (Iacopi, 1973).

This fault zone represents the northern boundary of the Mojave Desert, extending for a distance of 150 miles from the San Andreas Fault Zone to the Death Valley Fault Zone. It is believed that the Big Pine Fault Zone was the western extension of the Garlock Fault Zone, prior to being displaced six miles to the north by the San Andreas Fault Zone (Iacopi, 1973). The Big Pine extends west from the San Andreas Fault Zone for at least 50 miles.

Although the Garlock Fault Zone was once very active (Iacopi, 1973), only numerous small earthquakes (M 4.0 to M 4.9) have occurred along this fault zone during the 20th century. Surface ruptured has been noted for earthquakes in 1952 and possibly 1971 (Jennings, 1975).

Lamar et al. (1973) have assigned a recurrence intervals of 2 to 10 years for a M 6.0 earthquake, and 30 to 90 years for a M 7.0 earthquake on the Garlock Fault Zone. An earthquake of M 6.0 to 7.0 would generate moderate to intense ground motion at EAFB. Ground motion at VAFB and San Nicolas Island would not be significant.

Faults of the Mojave Desert

Numerous active and potentially active faults are present in the Mojave Desert, many within a few miles of EAFB, and a few actually crossing EAFB. Motion on these faults can be either strike-slip, dip-slip, or oblique-slip. Mapped lengths of known faults range from a few miles to over 90 miles.

Numerous small earthquakes (M 3.0 to M 5.0) have occurred along various faults in the Mojave Desert in the historic past, including two under Rogers Dry Lake. The most significant recent earthquake along one of the faults in the Mojave Desert was the M 6.2 Manix earthquake of 1947. A moderate earthquake along one of the faults in the immediate vicinity of EAFB could generate moderate to intense ground motion, and possibly surface rupture at EAFB. Ground motion at VAFB and San Nicolas Island would not be significant.

Newport-Inglewood Structural Zone

The Newport-Inglewood Structural Zone, located about 84 miles from San Nicolas Island, manifests itself as a line of positive topographic features or hills, underlain by producing oil fields. It is believed that these uplifts are related to a deep-seated "master" fault (Barrows, 1974) that is commonly referred to as the Newport-Inglewood Fault. The zone runs in a northwesterly direction from Newport Beach, apparently terminating against the Santa Monica Fault (Yeats, 1973; Barrows, 1974). Some authors, including Barrows (1974), believe this fault is the northwest extension of the South Coast Offshore Fault, and possibly the Rose Canyon Fault in the San Diego area. If these faults are all part of one continuous structural zone, the zone would extend over a distance of 125 miles. Woodford et al. (1954) have suggested as much as 5,000 feet of right-lateral offset along this fault.

The Newport-Inglewood Structural Zone exhibits continuous seismic activity. The 1933 Long Beach earthquake (M 6.3) is the most notable recent earthquake to occur along the Newport-Inglewood Structural Zone. Property damage was estimated at $50 million and 120 lives were lost. A major earthquake on December 8, 1812, estimated at M 7.0, is the largest known historic earthquake that may have occurred along this fault zone.

The impact of a large or major future earthquake along the Newport-Inglewood Structural Zone has been studied extensively (Barrow, 1974; Evernden and Thomson, 1985; Toppozada, 1988, 1989). A large or major earthquake along this fault zone would produce moderate to strong ground motion at San Nicolas Island. Ground motion at VAFB and EAFB would not be significant.

Faults of the Channel Islands

Numerous northwest-southeast and east-west trending faults are present within the Channel Island area. Many of these faults are classified as active or potentially active (Clarke et al., 1985; Jennings, 1975). These faults dissect the offshore area, dividing it into a series of alternating ridges and deep basins. San Nicolas Island is located on a ridge running northwesterly and including Santa Rosa and San Miguel Islands.

Numerous historic earthquakes of M 4.0 to M 5.0 have been recorded in the Channel Island area. The most notable of these are the M 5.0 earthquake of November 18, 1947 and the M 5.1 earthquake of October 24, 1969. The 1947 event was located along the northeast coast of San Nicolas Island, while the 1969 event occurred about 14 miles east of the island. Strong to intense ground motion at San Nicolas Island will result from moderate to major earthquakes on nearby faults within the channel system. Ground motion at VAFB and EAFB would not be significant.

Faults of San Nicolas Island

San Nicolas Island is a complexly faulted anticline that plunges gently to the southeast. Two sets of intersecting faults, trending approximately N 30º W and N 80º E, offset geologic units by as much as 800 feet. Most of the faults are high angle normal faults without any evidence of strike slip motion, dipping from 70 to 80 degrees (Vedder and Norris, 1963). These faults are found throughout San Nicolas Island, and may be hidden under terrace and dune deposits. Vedder and Norris (1963), have postulated the presence of buried faults of unknown displacement underlying the Pad 192 site. These faults are not known to cut Holocene age sediments, but faults have been identified cutting Pleistocene age sediments at one locality (Vedder and Norris, 1963). Therefore, they are classified as potentially active (Hart, 1988). Although unlikely, earthquakes along these faults could produce strong to intense ground motion, and possibly cause surface rupture at San Nicolas Island. Ground motion at VAFB and EAFB would not be significant.

- **Flooding**

Flooding at VAFB is associated with two different hazards: excessive stream runoff and tsunamis. Streams in the area can flood during heavy precipitation. Damage has resulted from at least two past Santa Ynez River floods (USAF, 1980). Stream flood hazards are confined to primary drainages running through VAFB. Tsunamis are discussed below.

At EAFB, stream flow results from infrequent precipitation in the mountains surrounding the Antelope Valley. Water generally percolates into the ground or evaporates before reaching the playas. However, flash floods may result from severe thunderstorms, characterized by either sheet wash (runoff) or overflowing streams and arroyos.

- **Liquefaction**

Strong ground motion generated by an earthquake causes various types of ground failure, including liquefaction. During an extended period of ground shaking or dynamic loading, porewater pressure increases and the ground is altered from a solid to a liquid state. Liquefaction poses a hazard to engineered structures. Loss of strength in cohesionless sand and silt can result in differential settlement of the ground surface, loss of load bearing capacity (the ability to support the weight of a structure), lateral spreading, or landsliding on a very gentle slope.

Severity of ground shaking is dependent on depth to groundwater. Shaking intensity decreases approximately one intensity unit with an increase in depth to groundwater from 0 to 30 feet (Evernden and Thomson, 1985). Liquefaction is most likely to occur when sediments are water saturated less than 50 feet below the surface. Ground shaking must be of relatively long duration to cause liquefaction. Unconsolidated silt, sand, and silty sand are most susceptible to liquefaction.

Liquefaction has occurred during several historic southern California earthquakes, including the 1971 San Fernando, 1952 Kern County, and 1933 Long Beach earthquakes. During the Long Beach earthquake, severe damage was caused by local ground failures in Compton and the southern portion of Long Beach. Liquefaction resulting from the 1971 San Fernando earthquake may have contributed to the ground failure damaging the San Fernando Juvenile Hall facility (Smith and Fallgren, 1975). The potential for liquefaction in the VAFB area has been identified (USAF, 1987a). Areas within VAFB delineated as susceptible to liquefaction include, but are not limited to, alluvial deposits adjacent to the Santa Ynez River and San Antonio Creek as shown on Figure 2.1.5-12.

Liquefaction at EAFB is a potential hazard. Groundwater is found at depths ranging from 7 to 20 feet below the surface. Water saturated sands and silty sands at these depths could liquefy during extended period of ground shaking, such as would be experienced during a major earthquake on the San Andreas or Garlock Fault Zones.

Liquefaction hazards have not been identified at San Nicolas Island.

- **Tsunamis**

A tsunami is an ocean wave generated by the rapid displacement of a large volume of seawater as a result of either submarine vertical faulting or large-scale submarine landslides. These ocean waves or seismic sea waves may travel thousands of miles, reach heights over 40 feet, and cause extensive damage to unprotected coastal areas. During historic times, coastal California has experienced numerous tsunamis of both local and distant origin. Tsunamis from the 1960 Chilean and 1964 Alaskan earthquakes affected the coast line at VAFB. Locally, the 1927 Point Arguello earthquake generated a tsunami with a runup of about 6 feet at Surf. The 1812 Santa Barbara Channel earthquake also generated a tsunami, reportedly reaching a height of 50 feet along the Santa Barbara coast (Iacopi, 1973). McCulloch (1985) estimates that the actual runup from this tsunami was about 13 feet at Gaviota. Flood hazards associated with tsunamis are confined to the coastal areas of VAFB and San Nicolas Island. For VAFB, these areas are shown in Figure 2.1.5-13.

2.1.6 Biota

The regional and local biological environment of the proposed AFSLV sites at VAFB, EAFB and San Nicolas Island is described in the following sections. The terrestrial, freshwater and marine biota, and special status (i.e., threatened, endangered or otherwise protected) species is described for each site. Biological resources on the Channel Islands are also provided as a baseline for the San Nicolas Island site and because of the potential impact of launch-induced sonic booms from VAFB which may extend over some of these islands.

Figure 2.1.5-12 Areas of Potential Liquefaction at VAFB

Figure 2.1.5-13 Areas of Potential Tsunami Inundation at VAFB

2.1.6.1 Terrestrial Biota

- **Vandenberg Air Force Base**

VAFB is unique in the value of its environmental resources with 166 miles of streams, 5,000 acres of wetlands, 35 miles of undeveloped coastline and 9,000 acres of dune habitat. The diverse biological resources found at VAFB represent the ecotonal region where the northern and southern biotic provinces meet. This results in an overlap of species populations that are in their southern or northern distributional limits (USAF, 1989e). Natural vegetative communities on VAFB include: southern foredunes, southern coastal bluff scrub, central dune scrub, central coastal scrub, Venturan coastal sage scrub, chaparral (including central maritime chaparral), coast live oak woodland and savanna, grassland, tanbark oak forest, southern Bishop pine forest, and diverse wetland communities such as coastal salt marsh, freshwater marsh, riparian forests, scrub, and vernal pools (USAF, 1989c). Five of these plant communities are considered sensitive as shown in Figure 2.1.6-1. The areal extent of all plant communities on VAFB is shown on Table 2.1.6-1. These communities have been previously described in USAF (1988a) and Versar (1987).

Table 2.1.6-1

Vegetation Communities on VAFB

Community Name	Approximate Acres	Percent of Total
Southern foredunes	760	0.8
Coastal scrub[a]	30,600	31.1
Central dune scrub	7,700	7.9
Venturan coastal sage scrub	3,860	3.9
Chaparral	13,100	13.3
Coast live oak woodland	4,350	4.4
Grassland	18,650	18.9
Tanbark oak forest	60	0.1
Southern Bishop pine forest	450	0.5
Wetlands/riparian woodland	5,400	5.5
Nonvegetation area	10,700	10.8
Ruderal/exotic species	2,770	2.8
Total Acres	**98,400**	**100.0**

Source: USAF, 1989c

[a]Coastal scrub includes southern coastal bluff scrub, central coastal scrub, and grassland coastal scrub.

Figure 2.1.6-1 Sensitive Plant Communities at VAFB

Although many native plant communities on VAFB, EAFB and San Nicolas Island are considered high priority by the California Department of Fish and Game Natural Diversity Data Base (NDDB), much of the native vegetation at these locations has been modified or otherwise disturbed by humans. Some previously native communities are now dominated by introduced invasive species, or have been altered by communication and utility lines. The introduced annual grassland community is important for cattle grazing (USAF, 1989c). VAFB occupies one of six remaining coastal dune systems in California. Others are found at Crescent City, Humboldt, Fort Bragg, Point Reyes and Fort Ord. Although all coastal habitats are becoming rare, dunes and coastal marshes are particularly affected by development. VAFB has the only major southern California dune system with areas which still resemble their original condition, and where the natural climatological and soil factors still directly influence the biology of the area. Because of this, and because coastal dune systems are relatively sensitive to disturbance, the coastal dunes, their associated wetlands, vegetation and dependent fauna, have high biological and scientific importance (USAF, 1983b). Extensive central foredunes and coastal dune scrub are found along the coast of North VAFB south of the Santa Ynez River on South VAFB as shown in Figure 2.1.6-1.

Launch Facility 6

LF 06, an active Minuteman ICBM facility, is located in the extreme northern portion of North VAFB in a grasslands plant community. The existing facility includes a launch silo, underground facilities and a parking area, which are enclosed within a perimeter fence. The site is a flat windblown vegetated area on the top of a sheer bluff, approximately 50 feet above sea level. Vegetation surrounding the existing facility shows little effect from past activity. Vegetation is composed of grasses and small herbs, such as sand verbena (*Abronia maritima*), carex (*Carex pansa*), heliotrope (*Heliotropium curassavicum v. oculatum*), phacelia (*Phacelia ramosissima v. austrolitoralis)* sea rocket (*Cakile maritima*), and sea dahlia (*Coreopsis gigantea)*. The force of constant winds is indicated by the sea dahlia's stunted growth. An invasive succulent, *Mesembryanthemum crystallinum*, a member of the ice-plant family (*Aizoaceae*) and a native of Southeast Africa, has naturalized itself near the edge of well-drained bluffs at LF 06, where it is clonal and strong. Larger plants nearby are stunted due to wind shear. This particular plant appears to be a superior competitor to surrounding herbaceous plants, and may later prove a threat to native plant species.

Faunal activity is shown by existence of burrow holes for pocket gophers and ground squirrels. Sightings of ring-billed, western and Heerman's gulls, cormorants, brown pelicans, and red-tailed hawks were also made at this site during an August 1990 visit. Other species expected in this grassland community include: mouse, rabbit, sparrow, swallow, thrashers, golden eagle, turkey vulture , mule deer and possibly badger.

If this site is selected for the AFSLV, and areas outside the existing perimeter fence will be disturbed, a site survey to determine the current status of biological resources at the site would be required.

ABRES A-3

The ABRES A-3 facility is an active, commercial AMROC booster launch complex located in Burton Mesa, as shown in Figure 2.1.6-2. Burton Mesa contains several distinct vegetation types. Extensive portions are covered with annual grassland/coastal sage scrub growing on formerly cleared, flat terrain that has been disturbed by grazing activities. Riparian vegetation and coastal sage scrub occur in a large canyon, on the southern border of Burton Mesa (USAF, 1989b).

The species composition of a representative area of the coastal sage scrub/annual grassland formation typical of the northern part of Burton Mesa includes: mock heather *(Haplopappus ericoides*), coyote bush *(Baccharis pilularis* subsp. *consangiunea*), coastal sagebrush *(Artemisia californica*), and the weedy sawtooth goldenbush *(Haplopappus squarrosus*), which are dominant shrubs. Perennial associates include: the prostrate (low-lying), scruffy-leaved croton *(Croton californicum)*, cudweed-aster *(Coreothrogyne filaginifolia*), poison oak *(Toxicodendron diversilobum*), deerweed *(Lotus scoparius*), goldenrod *(Solidago spathulata*), and a cinquefoil *(Horkelia cuneata*). The latter two species occur in patches.

Scattered individuals of chamise *(Adenostema fasciculatum)*, typical of chaparral, also occur. Between the shrubs is a herbaceous matrix of native and introduced annual grasses, and native and introduced annual herbs (USAF, 1989b). A site visit conducted in August 1990 confirmed the presence of most of the above-listed plant species.

The prostrate form of the shrubs, especially of the manzanitas and the ceanothus, may be due as much to the constant sea breeze and nutrient-poor soils as to genetic factors (USAF, 1980).

Figure 2.1.6-2 Vegetation in the ABRES A-3 Site Area

The composition of sand dune species in the northwestern portion of Burton Mesa is similar to that of similar sites on the San Antonio Terrace. Conspicuous plants here are mock heather, dune lupine, dune mint and prickly-phlox. El Segundo dunes spineflower *(Chorizanthe californica* var. *suksdorfii*) occurs sporadically in the dunes (USAF, 1980).

A steep-walled deep canyon, apparently unnamed, runs diagonally from southeast to northwest approximately through the middle of the siting area. It widens until it terminates at the coastal sand dunes, near where, at one time, it probably joined San Antonio Creek just above its mouth. The canyon bottom supports a tangle of riparian vegetation typical of other canyons on VAFB. Dominant trees are willows *(Salix spp.)*, with a number of mesophytic herbs and subshrubs forming an understory. This area is an important habitat for wildlife, as evidenced by reports of deer, skunk and small mammal scat. The rather steep-walled sides of the canyon support dense coastal sage scrub/chapparal vegetation, with patches of sea dahlia *(Coreopsis gigantea)*, a semisucculent native coastal plant.

Due to its quality of wildlife habitat and its ability to support a variety of food sources, the Burton Mesa area, encompassing the ABRES A-3 launch site, is an important and valuable area of concern. Over forty species of birds commonly occur in the Burton Mesa area. Red-tailed hawk and cliff swallow were observed during the August 1990 site visit. Mammal species, including the mule deer *(Odocoileus hemionus)*, desert cottontail *(Sylvilagus audubonii)*, brush rabbit *(Sylvilagus bachmani)*, bobcat *(Lynx rufus)*, striped skunk *(Mephitis mephitis)*, and feral pig *(Sus scrofa)*, inhabit the area. Species common to chaparral and the grassland areas include the California ground squirrel *(Spermophilus beecheyi)* and black tailed jackrabbit *(Lepus californicus)*. The coyote *(Canis latrans)* has been seen in the project area on numerous occasions, and are found in all habitat types (USAF, 1989b).

Test Pad 1

Test Pad 1 is located within the San Antonio Terrace area of North VAFB. This area has previously been described in USAF (1980 and 1988c). San Antonio Terrace is located within, and adjacent to, the largest expanse of stabilized sand dunes on VAFB. The distribution of stabilized sand dune vegetation is shown on Figure 2.1.6-3.

From the coast, running inland, exists a continuum of diverse habitats, beginning with beach sand and active, unvegetated dunes, and a narrow zone of dunes being stabilized by

Figure 2.1.6-3 Vegetation in the Vicinity of Test Pad 1 widespread, commonly prostrate and viney, strand plants. Behind the immediate coast and stabilized dunes is a broader zone of dunes covered with what has been described as the "stabilized dune phase" of coastal sage scrub. Test Pad 1 is situated in this stabilized dune phase, where the vegetation is composed of both shrubby and herbaceous elements. The most conspicuous plant here is dune lupine (*Lupinus chamissonis*), a silvery silky-leaved large shrub. Mock heather, seacliff buckwheat (*Eriogonum parvifolium*), cudweed-aster (*Coreothrogy filaginifolia* var. *latifolia* and *robusta*), the federal candidate *Monardella crispa*, and a live-forever (*Dudleya caespitosa* or *farinosa*) are common associates. Between the 20 to 50 ft. tall dunes are low areas (swales) with groundwater seasonally reaching the surface. Conspicuous here are: willows, poison oak, cinquefoil (*Horkelia cureata* subsp. *cuneata*), wild blackberry (*Rubus ursinus*), Hottentot fig (*Carpobrotus edulis*), rosilla (*Helenium puberulum*), coyote bush, and giant creek nettle (*Urtica holosericea*) (USAF, 1980). The existence of *M. crispa* was confirmed during an August 1990 site visit.

Farther inland, stabilized dunes continue to an elevation of at least 600 ft. Here, dunes are covered with chaparral vegetation containing a few elements of coastal sage scrub. Conspicuous plants here are: Lompoc manzanita, interior live oak (*Quercus wislizenii* var. *frutescens*), sticky monkey flower (*Diplacus aurantiacus*), mock heather, black sage, cudweed-aster, bracken fern (*Pteridium aquilinum*), and a rush rose (*Helianthemum scoparium*). These shrubs and subshrubs are mostly low-growing, covering most of the dune substratum. Even at this distance from the ocean, exposed shrubs show evidence of wind-trimming by persistent onshore winds.

Scattered large shrubs of coast live oak (*Quercus agrifolia*) are present on favorable slopes. They are conspicuously wind-trimmed, and bear hanging beard-like epiphytic growths of a lichen (*Ramalina reticulata*), commonly known as Spanish moss.

At the northeastern edge of the area previously surveyed, stabilized dune vegetation gives way to a highly disturbed annual grassland, with scattered individuals of mock heather as the dominant shrub. Soil is sandy, and terrain slopes gently. Due to the disturbed nature of the habitat and the probable absence of special interest plant or animal species dependent on this habitat, this portion of the area is the least ecologically sensitive.

SLC-4W

The terrestrial biota of SLC-4W has been reported (USAF, 1987b and 1988a; Versar, 1987). Vegetation of the SLC-4 area on South VAFB consists of central dune scrub, central coastal scrub, coastal sage-chaparral scrub, freshwater wetlands, riparian woodlands (at Spring Canyon), and ruderal vegetation, as shown in Figure 2.1.6-4. Many of these plant communities contain rare plants and provide habitat for regionally rare or declining wildlife.

Because of its susceptibility to damage from development and recreational use, central dune scrub has been classified as a threatened and declining vegetation type in California. Central dune scrub vegetation found at the SLC-4 area is relatively undisturbed. Flora common to this area include: chamise, black-flowered figwort, Santa Barbara ceanothus, black sage, mock heather, dune lupine, cudweed aster, croton, Blochman's leafy daisy, and soft-leaved Indian paintbrush, with scattered occurrences of coast live-oak (Versar, 1987). Sensitive plants and wildlife of the SLC-4 area are shown on Table 2.1.6-2.

The Spring Canyon wetland is composed of riparian forest, emergent wetlands, and arroyo willow scrub. Riparian woodlands support a diverse group of wildlife, including many species of nesting passerines. Emergent vegetation such as cattail, sedge and ferns help stabilize stream banks, and provide cover for a variety of wildlife. The Spring Canyon roost for the monarch butterfly supports a winter population of 2,000 to 4,000 individuals. Dense willow stands in the Spring Canyon area are an important element in the riparian corridor, providing wildlife habitat and stabilization of stream banks.

SLC-5

The existing Scout facility at SLC-5 is located in a coastal sage scrub (normal phase) plant community, which borders a stabilized dune (coastal sage scrub) along the coast. Riparian vegetation associated with Cañada Honda Creek is present near the facility. The existing facility occupies a relatively small percentage of the area. Additional construction is limited by the hilly terrain around the site. Areas within the existing perimeter fence have been disturbed, and contain some ruderal vegetation and ice plant used for slope stabilization. Floral species expected to occur around the site area include: coastal sagebrush, lemonade berry, sage, California buckwheat, and various grass species. Mulefat and willows may appear in riparian areas associated with Cañada Honda Creek.

Wildlife expected on site are those species common throughout the base such as western

Figure 2.1.6-4 Vegetation at SLC-4

Table 2.1.6-2

Sensitive Plants and Wildlife in the SLC-4 Area

Plant Community	Rare Plants of this Plant Community	Regionally Rare or Declining Wildlife of this Plant Community
Central Dune Scrub	Soft-leaved Indian paintbrush San Luis Obispo monardella Blockman's leafy daisy Large-leaved wallflower Black-flowered figwort	Cooper's hawk Northern harrier Burrowing owl
Central Coastal Scrub	Plummer's baccharis Hoffman's snakeroot	Cooper's hawk Northern harrier Merlin Short-eared owl Burrowing owl
Coastal Sage-Chaparral Scrub	Santa Cruz Island oak	Cooper's hawk Tree swallow
Grasslands		Black-shouldered kite Northern harrier Burrowing owl
Riparian Woodlands		Warbling vireo Yellow warbler

Source: USAF, 1988a and additions.

fence lizard, striped skunk, black-tailed jackrabbit, California ground squirrel, harvest mouse, house finch, European starling, and red-tailed hawk. The area has not previously been evaluated for biological resources.

Cypress Ridge

The Cypress Ridge site on South VAFB has previously been evaluated for biological resources in USAF (1990c). In that document, the site evaluated was being proposed for a larger facility. Cypress Ridge is characterized by four vegetation communities, but primarily central coastal scrub, grassland (predominantly non-native grassland), and Venturan coastal sage scrub. In addition, some areas have sparse shrub cover, with openings dominated by grasses and herbs, classified as grassland-coastal scrub. Ruderal vegetation occurs along Coast Road and around the Monterey cypress trees located west of Coast Road. Small amounts of riparian wetland vegetation occur on the southwestern area of the site. Table 2.1.6-3 shows the distribution of vegetation located at the Cypress Ridge site (USAF, 1990c). Figure 2.1.6-5 shows the vegetation communities at the Cypress Ridge site.

Table 2.1.6-3

Approximate Distribution of Vegetation at Cypress Ridge Site

Plant Community	Primary Site[a] (Acres)	Total	Percent of Plant Community Disturbed
Venturan coastal sage scrub	4.5	4.5	2.4
Grassland - coastal scrub	8.5	16.5	9.0
Grassland - non-native	18.5	27.5	14.9
Ruderal	4.5	8.5	4.7
Central coastal scrub	83.5	120.5	65.0
Riparian/wetland	0.5	5.5	3.0
Central dune scrub	0.0	2.0	1.0
Chaparral	0.0	0.1	0.0
	120.0	**185.1**	**100.0**

Source: USAF, 1989c.

[a]Based on 120-acre site proposed for SLC-7 (USAF, 1989c).

The wildlife species present at Cypress Ridge are composed of common, wide-ranging species that are found at other locations on VAFB. Among these are: western fence lizard, gopher snake, western rattlesnake, Bewick's wren, bushtit, white-crowned sparrow, song sparrow, Botta's pocket gopher, and deer mouse. Bird of prey found in the area include the turkey vulture, red-tailed hawk, and American kestrel. Coyote, bobcat, raccoon, and striped skunk are known to forage at this site (USAF, 1990c).

Boathouse Flats

The Boathouse Flats site is located in a nonnative grassland community. The 130-acre site has previously been studied in USAF (1989c), and is shown in Figure 2.1.6-5. Distribution of vegetation at Boathouse Flats is shown on Table 2.1.6-4. Vegetation at the site is similar to that described for Cypress Ridge, but with scattered coyote brush, coastal sagebrush, goldenbush (*Haplopappus squarrousus*), and herbs, including vetch (*Vicia* sp.) and locoweed (*Astragalus nuttallii*). Slopes of the Space Shuttle External Tank Tow

Figure 2.1.6-5 Vegetation at Cypress Ridge and Boathouse Flats

Table 2.1.6-4

Approximate Distribution of Vegetation at the Boathouse Flats Site

Plant Community	Primary Site[a] (Acres)	Total	Percent of Plant Community Disturbed
Grassland - non-native	130.0	149.0	68.0
Grassland - coastal scrub	0.0	10.0	4.6
Ruderal	0.0	8.0	3.6
Riparian/wetland	0.0	5.0	2.2
Central coastal scrub	0.0	42.0	19.1
Central dune scrub	0.0	2.0	1.0
Venturan coastal sage scrub	0.0	3.0	1.4
Chaparral	0.0	0.1	0.1
	130.0	**219.1**	**100.0**

Source: USAF, 1989c

[a]Based on 219-acre site proposed for SLC-7 (USAF, 1989c).

Route bisecting the site have revegetated since construction, with fescues, tarweeds, and Australian saltbush (*Atriplex semibaccata*). The invasive succulent, *Mesembryanthemum cyrstallinum*, is scattered on the site. Some rockier soils in the northern portion of the site are vegetated by purple needlegrass. However, these areas are not extensive. An area of willow- and coyote brush-dominated riparian scrubland is present at Oil Well Canyon. A site visit in August 1990 confirmed previous observations. Red-tailed hawks, pocket gophers, and domestic cattle currently use this site for forage and grazing.

- **Edwards AFB**

Biological resources of the Edwards AFB area have been previously described in USAF (1989d). This report identifies six primary plant communities on the base. These are: the Joshua tree woodland, creosote bush scrub, Mojave saltbrush scrub, shadscale scrub, desert saltbrush scrub, and alkali sink scrub. A vegetation map showing these communities is presented in Figure 2.1.6-6.

Joshua trees (*Yucca brevifolia*), the largest of the yuccas, occur sporadically throughout EAFB. They become more dense on alluvial fans around dry lake beds. Undergrowth shrub species common to the Joshua tree woodland include: burroweed (*Ambrosia dumosa*), Mormon tea (*Ephedra nevadensis*), creosote bush (*Larrea* *tridentata*), cholla (*Opuntia* spp.), and several species of saltbrush (*Atriplex* spp.). Herbaceous species

Figure 2.1.6-6 Plant Communities at Edwards AFB existing in the Joshua tree woodland also occur throughout the other major plant communities. These include: spineflower (*Chorizanthe spinosa*), desert cymopterus (*Cymopterus deserticola*), wild buckwheat (*Erigonum* spp.), fiddleneck (*Amsinckia* spp.), forget-me-not (*Cryptantha* spp.), red stem filaree (*Erodium texanum*), desert candle (*Caulanthus inflatus*), brome grasses (*Bromus* spp.), and Indian rice grass (*Oryzopsis hymenoides*) (USAF, 1989d).

The creosote bush scrub is generally confined to slopes, hills, and well drained sandy slopes and washes. Scrub occurs in widely-spaced communities. Perennial species often associated with the creosote bush scrub include: burroweed, Mormon tea, brittleweed (*Enecelia farinosa*), matchweed (*Gutierrezia* spp.), a saltbush (*Atriplex canescens*), winter fat (*Eurotia lanata*), cheesebush (*Hymenoclea salsola*), and rabbit-brush (*Chrysothamus* spp.). Herbaceous species that often occur in the creosote bush scrub community are similar to those discussed in the Joshua tree woodland, with the addition of the desert evening primrose (*Oenothera deltoides*). The alkali mariposa lily (*Calochortus striatus*) is found in the alkali sink and saltbush scrub community (USAF, 1989d).

The Mojave saltbrush scrub community is dominated by spiny saltbrush (*Atriplex spinifera*). This species forms sizeable, nearly monotypic stands at low elevations surrounding playas. This species occurs in more alkaline soils than other saltbush species found in the area.

The shadscale scrub is commonly found on poorly-drained flats or well-drained slopes at higher elevations. It is dominated by a saltbush (*Atriplex confertifolia*). Other species present include: Mormon tea, winter fat, small-headed matchweed (*Gutierrezia microcephala*), Indian rice grass, and bald leaved felt-thorn (*Tetradymia glabrata*). The desert saltbush scrub community covers low depressions and the margins of Rogers Dry lakebed within Edwards AFB, on soils intermediate in alkalinity between Mojave saltbush scrub and shadscale scrub. Dominant shrub species in this community include a variety of *Atriplex* other than that of the spiny saltbush. Shrub species common to this community include: cheesebush, goldenhead (*Acamptopappus sphaerocephalus*), burroweed, spiny hopsage (*Grayia spinosa*), winterfat, and thornbush *(Lycium* spp.).

Herbaceous species in the desert saltbush scrub community include: scale bud (*Anisocoma acaulis*), pebble pincushion (*Chaenactis carphoclinia* var. *attenuata*), Fremont pincushion (*Chaenactis fremontii*), fiddleneck, forget-me-not, matted cryptantha (*Cryptantha circumscissa*), phacelia (*Phacelia* spp.), buckwheat, and an eriastrum (*Eriastrum eremicum*).

The alkali sink vegetation often referred to as saltbush scrub community covers low depressions and margin of the dry lakes throughout Edwards AFB. This community consists of widely spaced low shrubs, a growth form that develops in response to limited rainfall. They occur on poorly-drained soils with extremely high alkalinity and/or salt content. Shrub species conspicuous to this community include: Parry saltbush (*Atriplex parryi)*, wedgescale (*Atriplex truncata*), seep-weed (*Suaeda torreyana*), blunt-leaf stinkweed (*Cleomella obtusifolia*), pepper-grass (*Lepidium dictyotum*), and Chinese pulsey (*Heliotropium curassavicum* var. *oculatum*). Scattered Joshua trees, as well as the alkali mariposa lily, are also found in this community.

Wildlife on EAFB area consists primarily of small mammals, reptiles and birds (USAF, 1989d). Mammals known to inhabit the area include: the desert kit fox (*Vulpes macrotis* var. *arsipus*), coyote (*Canis latrans*), black tailed jack rabbit (*Lepus californicus*), desert cottontail rabbit (*Sylvilagus auduboni*), badger (*Taxidea taxus*), whitetail antelope squirrel (*Ammospermophilus leucurus*), mice (*Peromyscus* spp.), kangaroo rats (*Dipodomys* spp.), desert woodrat (*Neotoma lepida*), California ground squirrel (*Spermophilus beecheyi*), and Mojave ground squirrel (*Spermophilus mohavensis*, a federal candidate species). Small seed-eating mammals are particularly abundant in the playa vegetation during the winter and spring.

Reptiles are common throughout the EAFB. The federally threatened desert tortoise (*Gopherus agassizi*) uses most of the habitat areas. Lizard species are abundant, and include the collared lizard (*Crotaphytus collaris*) and the desert horned lizard (*Phrynosoma platyrhinos*). The Mojave green rattlesnake (*Crotalus scutulatus* ssp. *scutulatus*), garter snakes (*Thamnopphis* spp.) and the coachwhip (*Masticophis flagellum*) occur in the area. Predatory birds common to the area include: northern harrier (*Circus cyaneus*), red-tailed hawk (*Buteo jamaicensis*), American kestrel (*Falco sparverius*), turkey vulture (*Cathartes aura*), barn owl (*Tyto alba)*, and the great horned owl (*Bubo viginianus*). Other common birds in the area include: horned lark (*Eremophila alpestris*), common raven (*Corvus corax*), roadrunner (*Geococcyx californianus*), white crowned sparrow (*Zonotrichia leucophrys*), western meadowlark (*Sturnella neglecta*), and cactus wren (*Campylorhynchus brunneicapillum*). The mourning dove (*Zenaida macroura*) and California quail (*Lophortyx californicus*) are game birds that frequent the area.

A heavy-lift transport plane carrying the ALV, upon liftoff from EAFB, will fly toward the Pacific Ocean on a designated flight path. Biota of the overflight path has been previously described in USAF (1989d).

- **San Nicolas Island**

San Nicolas Island is approximately 23 square miles in area. Four major plant communities are present on the island.

Southern beach and dune communities are present where active dune-building is occurring, predominantly at the windiest sandy locations on the northwest portion of the island. Plant species associated with this community include: sand verbena (*Abronia maritima*), an aster *(Ambrosia chamissonis)*, sea rocket *(Cakile maritima)*, an evening primrose *(Camissonia cheiranthifolia* ssp. *cheiranthifolia*). A particularly large portion of the northwest portion of the island is covered by the lupine *Lupinus albifrons*. Special status plants associated with this habitat are Trask's milk vetch (*Astralagus traskiae*--a California rare and Federal Category 2 candidate), Trask's cryptantha (*Cryptantha traskiae*--a Federal Category 2 candidate), and beach spectacle pod (*Dithyrea maritima*--a Federal Category 2 candidate and State-listed threatened species) (Barbour & Major, 1988; CNPS, 1988; Munz, 1974).

Coastal sage scrub is present around dry, rocky, predominantly south-facing slopes throughout the island. Plant species associated with this community include: coastal sagebrush *(Artemisia californica*), bush sunflower (*Encelia californica*), prickly-pear *(Opuntia littoralis*), cholla *(Opuntia oricola)*, lemonade berry *(Rhus integrifolia*), black sage *(Salvia mellifera*) which is found on dry, off-shore slopes on parts of the island, and the particularly dominant coyote bush *(Baccharis pilularis* ssp. *consanguinea*). Special status plants associated with coastal sage scrub include: Trask's milk vetch, Trask's cryptantha, bright green dudleya (*Dudleya virens*--a Federal Category 2 candidate), San Nicolas Island buckwheat (*Eriogonum grande* var. *timorum*--a California endangered and Federal Category 3 candidate), island marrow (*Lavatera assurgentiflora* ssp. *assurgentiflora*--a Federal Category 3 candidate), and Hoffmann's sanicle (*Sanicula hoffmannii*--a Federal Category 2 candidate) (Barbour & Major, 1988; CNPS, 1988; Munz, 1974).

Valley and foothill grassland is found in areas of seasonally dry, but deep soils on San Nicolas Island. Needle grass (*Stipa* spp.) is the most common Genus of native grass found, with many introduced invasives also present. The ashy phacelia (*Phacelia cinerea*--a Federal Category 1 plant) was associated with freshwater seeps and meadows which have sometimes been found in this community. The ashy phacelia has not been seen since 1901. It is now presumed extinct (Barbour & Major, 1988; CNPS, 1988; Munz, 1974).

Coastal marsh, typically located at the interface of land and sea, is found on the southeastern end of San Nicolas Island near Jehemy Beach. Pickleweed (*Salicornia* sp.), salt grass *(Distichlis spicata)*, and alkali heath *(Frankenia grandifolia*) are plants common to this community. The San Nicolas Island boxthorn (*Lycium verrucosum*--a Federal Category 1 plant) was associated with dry mesas and slopes that may show signs of alkalinity, which is sometimes typical of coastal marsh. It is now presumed extinct (Barbour & Major, 1988; CNPS, 1988; Munz, 1974).

Terrestrial biota on the island includes various birds, mammals, and reptiles. With the exception of birds, the diversity of terrestrial biota on San Nicolas Island is not expected to be great. This is due to the island's limited size and its distance from the mainland.

Depending upon the season, there may be as many as 100 or more species of birds present on San Nicolas Island, with the vast majority of these being shore and pelagic sea birds. Brandt's cormorant, western gulls, and Western snowy plovers (a federal Category 1 candidate species) are shore birds known to breed upon San Nicolas Island and nearby Begg Rock (USAF, 1978). The breeding area for Western gull is found on the western shore of the island, a restricted beach that is closed during the breeding period for this species, from May 1 to August 1 of each year. The breeding area for Brandt's cormorant is found along the southern shore of the island. The breeding period for Brandt's cormorant is from March to September each year. Brown pelicans were seen in large numbers in 1990, and they may begin breeding on the island.

Mammals on San Nicolas Island include terrestrial species like the ornate shrew (*Sorex ornata*), mice (*Peromyscus* sp.), California vole (*Microtus californicus*) and the island fox (*Urocyon littoralis dickeyi*, a federal Candidate 2 and state-listed threatened species). Marine species often found on shore include up to 2,000 harbor seals (*Phoca vitulina*), 20,000 California sea lions (*Zalophus californicus*) and 10,000 Northern elephant seals (*Mirounga angustirostris*), all of which breed on the south side of the island in increasing numbers. Harbor seal rookeries are also found on the north side of the island. Sea otters (*Enhydra lutris*) a federally threatened species, have been introduced to the island and are generally found in the kelp beds just off the west side of the island. They move through the kelp beds to the southwest as well (USAF, 1978; Westec, 1978; Jameson & Peeters, 1988; Navy, 1986). As a result of the presence and breeding of these species, the south side of the island is closed from December 15 to October 1 of each year. This closure period also encompasses the breeding period for Brandt's cormorant. Unauthorized human access is restricted along the south side of the island because of the heightened sensitivity of these species to humans during courtship and breeding periods.

Reptiles found on San Nicolas Island are predominantly lizard species. The most notable species is the island night lizard (*Xantusia riversiana*), a threatened species.

2.1.6.2 Freshwater Biota

The freshwater resources of VAFB and EAFB are described in this section. San Nicolas Island does not have freshwater resources that support any biological species.

- **Vandenberg Air Force Base**

Seven streams (Cañada del Norte, Shuman Creek, San Antonio Creek, Santa Ynez River, Cañada Honda Creek, Cañada del Jolloru, and Jalama Creek) and five lakes (Mod III, Punchbowl, and Upper, Middle, and Lower Pine Canyon Lakes) constitute the major freshwater resources of the VAFB region. Other freshwater resources include Umbra Pond, Bear Creek, Spring Creek, an unnamed marsh, and an unnamed pond.

Cañada del Norte, Shuman Canyon, and several seasonal stream drainages are located on the northern area of VAFB. The north-central area includes the San Antonio Creek drainage, the Santa Ynez River drainage north of the river, and several smaller drainages. Because this area also contains the main cantonment area of VAFB and highly agriculturized land outside VAFB, it is heavily influenced by human activity. Santa Ynez Lagoon covers 58 acres in the southwestern corner of this area. The south-central area includes the southern part of the Santa Ynez River drainage, Cañada Honda Creek, and several small, seasonal stream drainages. In the south-central area, alkalinities and nutrient levels are low in comparison with those of the other three areas. The southern area, encompassing the Sudden Ranch area, consists primarily of Cañada del Jolloru, Jalama Creek on the southern boundary of the base, numerous and small streams and two permanent ponds. The southern area is lightly to moderately grazed and nutrient levels are between those of the north-central and south-central areas. Freshwater biotic resources, in proximity to each of the potential AFSLV sites, are described below.

Launch Facility 6

Cañada del Norte and Shuman Creek are intermittent drainages located 0.5 and 2 miles south of LF 06, respectively. Freshwater biotic resources are not found in the immediate vicinity of LF 06.

Test Pad 1

Test Pad 1 is located on San Antonio Terrace. An unnamed marsh, approximately 600 ft by 200 ft in size, is located on the southwest side of the facility. Although the marsh has not been sampled, cattails, rushes, willows, and other aquatic or riparian plants have been noted in the past. A variety of vertebrates may inhabit or frequent the area, such as snakes, salamanders, and birds.

Umbra Pond and Mod III Lake are situated on the southern edge of San Antonio Terrace, south of Test Pad 1. Umbra Pond is a small, shallow pond that was once 0.2 acres in size and averaged 1.6 ft in depth. Riparian vegetation included willows, eucalyptus, and poison oak. The most notable aquatic macrophytes are duckweed (*Lemna minor*), watercress (*Nasturtium officinale*), fern (*Marsilea* sp.), cattail (*Typha* sp.), and bulrush (*Scirpus* sp.).

Mod III Lake is an impoundment that was formed before 1959 and enlarged in 1962-63. The lake has been recorded as 23 ft deep, with a sandy substrate nearshore and undecomposed plant material in deeper waters. Natural inflow comes from a small stream that flows through Umbra Pond, and the water level is maintained during dry periods by pumping water from San Antonio Creek. Aquatic macrophytes recorded include: pondweed (*Potamogeton sp*.), arrowhead (*Sagittaria sp*.) and rushes (*Juncus sp*., *Scirpus californicus*, and *S. robustus*), while eucalyptus, willow, and several other species characterize the riparian habitat. Algae in the lake include diatoms (*Suriella sp.*), green algae (*Spirogyra sp*.), and euglenoids (*Colacium sp*.). Benthic invertebrates are dominated by amphipods (*Hyalella azteca*) and chrionomids (fly larvae). In addition, water boatmen (*Corixidae*), mayflies (*Ephemeroptera*), dragonflies (*Odonata*), and molluscs (*Physa* sp. and *Gyralus* sp.) are also present.

Fish found in Mod III Lake are all introduced species, and include bluegill (*Lepomis macrochirus*), channel catfish (*Ictalurus punctatus*), mosquito fish (*Gambusia affinis*) and largemouth bass (*Micropterus salmoides*). Frogs, turtles, and snakes probably are present, and the American coot frequents the area. The Southwestern pond turtle (*Clemmys marmorata* -- a federal Category 2 species) and California red-legged frog are found at Mod III Lake and surrounding riparian areas. In addition, the federally endangered California least tern utilizes Mod III lake periodically for foraging during the nesting season. The federally endangered unarmored threespine stickleback is found in San Antonio Creek and in adjoining feeder streams during the wet season.

ABRES A-3

The ABRES A-3 site is located in Burton Mesa, and is approximately 2,200 feet south of San Antonio Creek. This creek flows between the San Antonio Terrace and Burton Mesa to the ocean, where it forms an esturarine lagoon. It is one of the largest streams on VAFB draining 154 square miles, and its discharge can exceed 100 cfs after storms. Beaver dams greatly influence its physical characteristics. A number of fresh-water marshes have been present. Thick growths of willow often form an overstory, especially in the lower reaches of the creek. At least 11 species of vascular plants are common along the stream (USAF, 1977).

Several freshwater marshes have been recorded along San Antonio Creek. Numerous riparian and aquatic macrophytes are present, with one species of algae (*Enteromorpha* sp.) in the lagoon. Willows offer an overstory toward the lower reaches of the creek. Predominant invertebrates are snails (*Gyralus* sp.) and water boatmen (*Corixidae*) in freshwater, and isopods and amphipods in the estuary. The Pacific treefrog (*Pseudacris regilla*) and other frogs and turtles are common, including two federal Candidate 2 species, the California red legged frog and Southwestern pond turtle. Beaver (*Castor canadensis*) also inhabit the creek, building dams that alter the flow. In 1988, it was estimated that a population of 100 beavers inhabited the 8.2 mile-long San Antonio Creek.

Fish in the creek include carp (*Cyprinus carpio*), arroyo chub (*Gila orcutti*), mosquito fish, and the unarmored threespine stickleback, which is the only native species. Other species that may inhabit the creek are: largemouth bass, bluegill, white catfish (*Ictalurus* *catus*), redear sunfish (*Lepomis microlophus*), and rainbow trout. The stickleback is classified as endangered by the U.S. Fish and Wildlife Service, and this population may be at the northern limit for the species. These fish require weedy areas for breeding and may not reproduce in stagnant waters. The lagoon at the mouth of the creek varies from one large pool to a series of connected pools. Pondweed and filamentous algae occasionally become very dense in the lagoon and creek, and low dissolved oxygen conditions occur when they decompose. Pacific staghorn sculpin and tidewater goby (a federal Category 2 species) have also been recorded.

The creek, lagoon, and marshes are frequented by many mammals (e.g., feral pigs, deer, and raccoon) and birds, including the California least tern, which is a federally endangered species.

The ABRES A-3 site is also near an unnamed pond, located at the northwest end of a deep arroyo that traverses Burton Mesa. The invertebrate fauna is expected to be similar to that in Mod III Lake, and it is not likely that any fish other than mosquito fish are present (USAF, 1980).

Punchbowl Lake is located over 4 miles east of ABRES A-3. The lake is supplied by surface runoff and does not contain perennial water or freshwater biotic resources.

SLC-4W

Freshwater bodies in proximity to SLC-4W are the Santa Ynez River, Santa Ynez Lagoon, Bear Creek, and Spring Canyon Creek. SLC-4W is located over 4 miles south of the Santa Ynez River. This river drains approximately 900 square miles; less than 5 percent of this area is within VAFB. Much of the river is dry during the summer, and currently during other seasons due to recent drought conditions. The combination of a high nutrient level and a low current velocity supports extensive plant growth (such as pondweed, duckweed fern, and watercress) in the river. The invertebrate fauna includes fewer species and individuals (except oligochaete worms at one site) than does the fauna of San Antonio Creek.

The vertebrate fauna of the Santa Ynez River is more populous and diverse than that of any other stream on VAFB. The fish fauna includes: mosquito fish, threespine stickleback (*Gasterosteus aculeatus microcephalus*), bass (*Micropterus* spp.), bluegill (*Lepomis macrochirus*), fathead minnow (*Pimephales promelas*), arroyo chub (*Gila orcutti*), and tidewater goby (*Eucyclogobius newberryi*). Anadromous steelhead trout (*Salmo gairdneri*) once bred abundantly in the upper reaches of the Santa Ynez River and its tributaries. Now only small numbers of steelhead trout are present when conditions are appropriate. According to a study by the U.S. Fish and Wildlife Service, a population of 20 individuals existed at this location in 1987. Tree frog and beaver are also present along the river.

Santa Ynez Lagoon is located at the mouth of the Santa Ynez River and exhibits great fluctuations in temperature and salinity. Because it is generally brackish, the lagoon commonly supports transient populations of euryhaline marine fish, such as starry flounder (*Platichthys stellatus*), Pacific herring (*Clupea harengus*), staghorn sculpin (*Leptocottus armatus*), and tidewater goby.

Perennial Cañada Honda Creek is the largest stream on South VAFB. This stream supports dense bank vegetation, but only low densities of green algae, cattail, and tule, except near the ocean where densities are higher. Dominant invertebrates include stonefly, (*Plecoptera*), caddisfly (*Trichoptera*), snails, and amphipod crustaceans. The invertebrate fauna of this stream is the most diverse on VAFB and includes at least 25 species. This high diversity is attributable to abundant plant life, clear running water, and year-round flow. Nonintermittent portions of this creek support an introduced population of the Federally-listed endangered unarmored threespine stickleback.

Bear Creek is located 1.5 miles from SLC-4W. Beer Creek is an intermittent creek at its mouth, with some perennial stream flow farther downstream. Biotic resources have not been recorded from Beer Creek.

Spring Canyon is located adjacent to SLC-4 and contains a unique assemblage of wetland communities, including riparian forest, arroyo willow scrub and emergent wetlands. Wetlands, like those in Spring Canyon, are declining in the region and comprise only 5 percent of the total acreage on VAFB.

Riparian forest portions of the Spring Canyon wetlands are dominated by blue gum trees (*Eucalyptus globulus*). These trees exist in two groves along lower reaches of the canyon. *Eucalyptus* is not native to California, however, it is commonly found in riparian settings where it was planted historically. It has become naturalized in the vicinity of SLC-4, and seedlings and saplings are abundant throughout lower reaches of Spring Canyon. This abundance suggests that existing groves are capable of self-replacement.

About half of the existing *Eucalyptus* trees show fire damage from a Titan explosion. This explosion did not, however, result in the loss of many trees, and most of the fire-damaged trees have regenerated vigorously.

Eucalyptus globulus provides important habitat for wildlife in Spring Canyon. Eucalyptus flowers produce large quantities of nectar, which is utilized by numerous insects and birds. These trees provide both shelter for migratory songbirds, and roost and nest sites for many raptors such as red-tailed hawks (*Buteo jamaicensis)*. In addition, Eucalyptus trees in Spring Canyon and other coastal areas are used by monarch butterflies as winter roost sites. Butterfly roosts are considered an environmentally sensitive habitat and are a protected resource within Santa Barbara County. In the vicinity of SLC-4, the perennially wet soil and partially open canopy have resulted in the formation of dense stands of California and small-fruited bulrushes *(Scirpus californica* and *S. microcarpus*), with adjacent scattered clumps of the rush, *Juncus effusus* var. *brunneus*. The emergent flora in Spring Canyon provides important habitat for amphibians, such as tree frogs and salamanders.

Dense stands of arroyo willows (*Salix lasiolepis*) are also found in the Spring Canyon wetlands. These willows are adapted to colonizing and growing in wet areas, and their roots help to stabilize stream banks and prevent erosion. Willows flower early in the spring, and produce copious quantities of pollen that provide an important food resource for insects, which are, in turn, prey for birds. Willows also contribute to structural habitat diversity.

The final vegetational element of the Spring Canyon wetlands is emergent vegetation, including broadleaf cattail *(Typha latifolia*) and narrowleaf cattail (*T. domingensis*). Within and around the cattails are other wetland species, including: coastal woodfern (*Dryopteris arquta*), western sword fern (*Polystichum munitum*), bracken fern (*Pteridium aquilinum*), stinging nettle (*Urtica holosericea*), giant horsetail (*Equisetum telmateia*), and sedge (*Carex* sp.). Emergent vegetation helps to stabilize stream banks, and provides cover for wildlife and insects. On VAFB there are 16 documented winter roosts of the monarch butterfly (*Danus plexippus*), a species of concern among scientists and citizens. Spring Canyon roosts support a winter population of approximately 2,000 to 4,000 individuals.

Riparian woodland and wetland habitats near SLC-4 support a diverse assemblage of amphibians and reptiles. The more common species expected to occur near SLC-4 include pacific tree frog, western toad (*Bufo boreas*), western aquatic garter snake (*Thamnophis hammondii*), and western rattlesnake. *Ensatina* is common in riparian woodlands on VAFB (USAF, 1976d). Red-legged frog (*Rana aurora*) and Southwestern pond turtle are known to frequent freshwater wetlands on VAFB. Neither species is expected to occur in the Spring Canyon wetlands, because stream flow during the dry summer and during recent droughts is insufficient for survival of these species. There is no state or federally-listed threatened or endangered species of amphibian or reptile expected or known to frequent the Spring Canyon wetlands.

Riparian woodland supports many species of resident and migrant birds. Some of the characteristic nesting species in this habitat that are expected to occur near SLC-4 are: black-chinned hummingbird (*Archilochus alexandri*), hairy (*Picoides villosus*) and downy (*P. pubescens*) woodpeckers, Nuttall's woodpecker (*P. nuttallii*), black phoebe (*Sayornis nigricans*), western wood pewee (*Contopus sordidulus*), western flycatcher (*Empidonax difficilis*), Hutton's vireo (*Vireo huttoni*), warbling vireo (*Pheucticus melanocephalus*), yellow warbler (*Dendroica petechia*), common yellowthroat (*Geothlypis trichas*), black-headed grosbeak (*Pheucticus melanocephalus*), and song sparrow. Some of the more common winter visitors to riparian woodlands include: ruby-crowned kinglet (*Regulus calendula*), hermit thrush (*Catharus guttatus*), American robin (*Turdus migratorius*), yellow-rumped warbler, and pine siskin (*Carduelis pinus*).

As a result of the loss and/or alteration of riparian woodlands throughout southern California, a number of birds, including yellow-billed cuckoo (*Coccyzus americanus*), long-eared owl (*Asio otis*), willow flycatcher (*Empidonax traillii*), and Wilson's warbler (*Wilsonia pucilla*), have shown significant population declines over the past century. An additional factor contributing to these declines has been an increase in the population of a brood parasite, the brown-headed cowbird (*Molothrus ater*). Today, yellow-billed cuckoo, long-eared owl, and willow flycatcher occur in a few isolated locales in north-western Santa Barbara County. Warbling vireo and yellow warbler are local but uncommon nesters in the riparian woodlands remaining in Santa Barbara County, including those near SLC-4. All of the above rare species no longer breed south of Point Conception.

Twenty-nine species of mammals are expected to occur in riparian woodlands in northern Santa Barbara County, while a total of seven species of small mammals have been recorded in riparian woodlands on VAFB. Some of the more abundant small mammals characteristic of this habitat that are expected to occur at SLC-4 include: trowbridge and ornate shrews, Botta's pocket gopher, California pocket mouse, deer mouse, brush mouse (*Peromyscus boylii*), dusky-footed woodrat, and California vole. Riparian woodlands also provide excellent foraging habitat for a number of large mammals, such as: brush rabbit, Virginia opossum (*Didelphis virginiana*), raccoon, long-tailed weasel, striped skunk, bobcat, mule deer, and feral pig. The western gray squirrel is the only regionally rare or declining mammal expected to occur in riparian woodlands on VAFB. This species was not found in Spring Canyon during field surveys conducted in October and November of 1986 (Versar, 1987).

Raptors, such as the red-tailed hawk, American kestrel, barn owl (*Tyto alba*), and great-horned owl (*Bubo virginianus*) use *Eucalyptus* woodlands in Spring Canyon for roosting and nesting. Common birds associated with *Eucalyptus* woodlands and expected to occur near SLC-4 include: northern flicker (*Colaptes auratus*), Nuttall's and acorn (*Melanerpes formicivorus*) woodpeckers, Anna's hummingbird, ruby-crowned kinglet, yellow-rumped warbler, dark-eyed junco (*Junco hyemalis*), house finch, and American goldfinch (*Carduelis tristis*). Cooper's hawk and western gray squirrel are the only regionally rare or declining wildlife species expected to frequent *Eucalyptus* woodlands in the vicinity of SLC-4.

SLC-5

The SLC-5 site is located due north of Cañada Honda Creek. This perennial creek is the largest stream on South VAFB. This stream supports dense bank vegetation, but low densities of green algae, cattails, and tules, except near the ocean where they are abundant. Dominant invertebrates include stoneflies, caddisflies, snails, and amphipod crustaceans. The invertebrate fauna of this stream is the most diverse on VAFB and includes at least 25 species. This high diversity is attributable to abundant plant life and clear running water. In 1984, a population of the unarmored threespine stickleback were introduced to Honda Creek.

Cypress Ridge and Boathouse Flats

The only drainage in the vicinity of the Cypress Ridge and Boathouse Flats sites is Oil Well Canyon which does not support freshwater biota.

- **Edwards Air Force Base**

Freshwater bodies at EAFB are small and artificial, with limited biological importance. Two locations contain biological resources that are maintained by well water. Branch Memorial Park Pond is a 1.5-acre pond with cattails, cottonwoods, and pine tree vegetation. The pond is stocked periodically with fish. Red Barn Marsh is approximately 10 acres with seasonal fluctuations in size.

Every 5 to 7 years, Rogers and Rosamond Dry Lakes occasionally flood and hold water for a short period of time, usually between the months of October and February. Piute Ponds exist year round, and are maintained by secondary treated and disinfected sewage water at the extreme southwest corner of EAFB. The remainder of freshwater bodies on EAFB consist of stormwater retainment basins and sewage evaporation ponds. These basins and ponds are scattered throughout the base and are of marginally significant biological importance (Phillips, 1990b).

2.1.6.3 Marine Biota

Marine biota of the VAFB area and San Nicolas Island are summarized in this section.

- **Vandenberg Air Force Base**

Detailed studies of the marine biology of the coastal region from Point Sal to Cojo Bay, including the coast of VAFB, is available in USAF (1977a). The intertidal zone from Point Sal to Cojo Bay comprises a variety of habitat types, including rocky shores, sandy beaches, and lagoons. Biota north of Point Arguello is generally typical of the central California coast.

In rocky habitats adjacent to the coast of South VAFB, the high intertidal zone commonly contains acorn barnacles, periwinkle snails, and limpets; the middle intertidal zone, in addition to these groups, also contains brown and red algae. Slightly lower in the zone are sea anemones, black turban snails, shore crabs, polychaete worms, tidepool sculpins, and green and red algae. Mussels, gooseneck barnacles, starfish, and coralline red algae also are common. The low intertidal zone contains stands of surfgrass and brown and red algae. Turban snails, starfish, and purple sea urchins are common at extreme low-tide levels, as are crabs and giant kelp. Red and black abalone (*Haliotus crocherodii* and *H. rufescens*, respectively) also occur in the area.

Sandy beaches alternate with rocky points and bluffs along the coastline. In the sandy habitats, the high intertidal zone often contains amphipod crustaceans associated with drift kelp, while the middle intertidal zone supports sand crabs and polychaete worms. The low intertidal zone contains polychaete worms, razor clams, and Pismo clams. The microscopic interstitial biota of sandy beaches is poorly known, but diatoms, protozoans (especially ciliates), nematode worms, and copepod crustaceans constitute the more common taxa.

Highly exposed rocky points, such as Point Arguello, support an abundance of intertidal algae, including *Fucus distichus*, *Halosaccion glandiforme*, *Pelvetiopsis limitata*, and well-developed subtidal beds of giant kelp.

Santa Ynez Lagoon, the largest lagoon in the project region, usually supports relatively little phytoplankton. Dominant organisms are invertebrates, and include nauplius larvae, as well as isopod (*Gnorimosphaeroma lutea*) and mysid (*Neomysis mercedis*) crustaceans.

The subtidal region offshore varies greatly in habitat type and biotic composition. Nearshore habitats support a variety of benthic plants, predominantly green and brown algae. Fauna varies with depth. Offshore, at depths of 50 to 75 feet, polychaete worms, speckled sanddabs, and dark-blotched rockfish are dominant. Brittlestars, other starfish, white croakers, yellowtail rockfish, blue rockfish, and pink surfperch dominate at depths of 125 to 150 feet.

At least 297 species of marine fish occur in the Point Arguello region (USAF, 1977). The most diverse groups are the surfperch, rockfish, sculpins, clinids, and flatfish.

Three species of sea turtle are the only marine reptiles expected in the project region. Vagrant loggerhead turtles (*Caretta caretta*), leatherback turtles (*Dermochelys coricea*; endangered species), and green turtles (*Chelonia mydas*; threatened species) occasionally occur as far north as the project region.

A large variety of marine birds occur in the project region. These species include truly oceanic birds, shorebirds, and a variety of species that frequent coastal lagoons. The snowy plover (*Charadrius alexandrinus*), a federal Category 1 species, nests from 1.5 miles south of the Santa Ynez lagoon to north of Minuteman Beach. The predominant offshore species is the sooty shearwater (*Puffinus griseus*), which occurs by the tens of thousands throughout the summer, and roosts in groups of 100 to 200 individuals.

Forty-three bird species have been observed in coastal lagoons around VAFB. Shorebirds and gulls are the most abundant. The species that occur year-round include the western gull, ring-billed gull (most abundant species), and ruddy duck. Birds are often abundant near the mouth of Santa Ynez Lagoon. Species that frequent this area include the black turnstone, knot, whimbrel, willet, and a variety of sandpipers. The mid-lagoon area also supports numerous species, including: marsh wren, dowitchers, green heron, great blue heron, common egret, least tern, violet-green swallow, and ruddy duck.

Brown pelicans and cormorants are common around the Point Arguello area, and black oystercatchers nest on the sheer sandstone cliffs. The area is frequented by surf scoters, western kingfishers, black oystercatches, and other marine birds. Jalama Beach supports an avifauna similar to that of sandy beaches farther north. Willets and juvenile gulls are common, and sandpipers are often abundant in the small lagoons. Cojo Bay, just east of Point Conception, supports gulls, brown pelicans, cormorants, a variety of shorebirds, and other species.

The California least tern (*Sterna albifrons browni*), a state and federally-listed endangered species, has historically established nesting colonies at the mouths of both the Santa Ynez River and San Antonio Creek, and also at Purisima Point. The breeding period for this species occurs between April and September. These colonies are small, representing only 5.8 to 12.5 percent of the estimated California nesting population for this species.

Key factors limiting the number of least terns on VAFB are the presence of areas for feeding, roosting, and congregation of fledged juveniles and adults. The Santa Ynez River mouth, in particular, provides an optimal habitat for these activities.

A summary of data on numbers of breeding pairs and fledglings on VAFB, for the ten years 1980 to 1989, reveals declines in breeding pairs for the years 1984, 1985, 1986, and 1988, with a fairly constant downward trend in the number of fledglings over the same period (USAF, 1990d). The absence of breeding pairs at the Santa Ynez River mouth, a historical breeding area, may be related to summer flooding in 1984, 1985, and 1987, which rendered the habitat unsuitable to the least terns (USAF, 1990d). Most least terns on VAFB nest at Purisima Point. The decline in fledglings at Purisima Point is most probably due to predation by coyotes *(Canis latrans)* on least terns eggs and chicks (Atwood, 1984).

Another endangered avian species that is commonly observed in the VAFB area is the California brown pelican (*Pelecanus occidentalis*). The savannah sparrow (*Passerculus sandwichensis bryanti*) is reported to occur in the Santa Ynez marsh. It is not known whether the endangered subspecies Beldings savannah sparrow (*P.s. beldingi*) also occurs in the VAFB area.

A variety of marine mammals occurs in the project region. California sea lions have been observed on sandy beaches in the project region and harbor seals are reported to breed on rocky coastal and sandy strand areas at Purisma Point and Rocky Point (Versar, 1987). Harbor seals also haul out along Sudden Ranch on South VAFB, while a few Northern elephant seals haul out at Point Arguello (Versar, 1987). Stellar sea lions (*Eumetopias jubata*), California sea lions, Northern elephant seals and Northern fur seals (*Callorhinus ursinus*) have breeding populations at San Miguel Island and may occur sporadically along the coast at VAFB.

Cetaceans (whales, dolphins, porpoises) also occur in the area. Gray whales (*Eschrichtius robustus*) are probably the most conspicuous species. During the spring and fall, individuals and small groups are frequently seen in the project area.

The project region is within the former breeding range of the southern sea otter, a threatened species, and the Guadalupe fur seal (*Arctocephalus townsendi*), a rare and threatened species. Neither species is known to breed in the region at this time, but suitable habitat is present. Sea otters have been observed foraging and rafting off Purisima Point possibly indicating habitat expansion.

- **San Nicolas Island**

The marine biota of San Nicolas Island includes over 100 species of sea and shore birds, pinnipeds and cetaceans, and sea otters, as previously described in Section 2.1.6.1.

Marine invertebrate species on San Nicolas Island include: sea urchins, mussels, abalone, snails, barnacles and crabs. These species are important, providing forage for fish, sea otters and many species of shore and sea birds. The abundance of these species is important in maintaining current populations and overall species diversity of marine biota on San Nicolas Island.

The waters around San Nicolas Island and Begg Rock, to a distance of one nautical mile offshore or to the 300-foot isobath, whichever is the greatest distance, have been designated as an “Area of Special Biological Significance” by the Los Angeles Regional Water Quality Control Board (Region 4). In 1978, the Navy enacted regulation COMPMTCINST 5090.3, which protects biological resources on the island, and requires the evaluation of impacts from any project on such resources. Future development or disruptive military exercises near bird or marine mammal breeding grounds, is prohibited by Navy regulations (Navy, 1986). This planning consideration was designated because of the small size of the island and the extreme sensitivity of most of its endemic resources to disturbance.

2.1.6.4 Channel Islands Biota

The biota of the Channel Islands is generally similar to that of the nearby coast of Santa Barbara and San Luis Obispo counties. However, notable and significant biological differences do exist. Historically, the introduction of pigs, sheep, and cattle has had a devastating impact on parts of the islands, especially in areas that have burned. These species have been responsible for the destruction of much of the native vegetation, and for the associated success of many introduced weeds and grasses. Recovery of the native vegetation is occurring where feral sheep have been removed.

Relict populations of species, subspecies, and races persist in isolation from the current centers of their distribution. Other populations are relicts of formerly widespread species that are now extinct, or nearly extinct, throughout the rest of their former ranges. Still other forms, which developed on the islands, represent variants of mainland forms. The islands represent a unique biological resource.

- **Vegetation and Flora**

Vegetation types on the Channel Islands are generally comparable to those on the mainland. They include: coastal strand (dune) vegetation, coastal sage scrub, chaparral, oak woodland, coniferous woodland (closed-cone and Torrey pines), riparian woodland, riparian scrub/freshwater marsh, grassland, and planted trees and ornamentals. Chaparral and woodland vegetation are essentially absent from San Miguel and Anacapa Islands. Several endemic species occur only on the islands.

- **Fauna**

Faunal communities of the Channel Islands resemble those of similar habitats on the mainland, but fewer species occur in the island habitats. Consequently, individual species often use habitats on the islands that they seldom use on the mainland.

Terrestrial avifauna of the islands generally resembles that of similar habitats on the mainland; however, the Santa Cruz Island jay (a subspecies of the common scrub jay) and several other avian taxa are recognized as subspecies of mainland forms. Oceanic and shorebirds are relatively common on the islands. California's only nesting colony of the endangered brown pelican occurs on West Anacapa Island, and in recent years on an islet adjacent to Santa Cruz Island.

The islands include some of the most important California breeding grounds (rookeries) for pinnipeds, and migration areas for cetaceans. The distribution of breeding populations of marine mammals and seabirds are shown in Figure 2.1.6-7.

Six pinniped species occur in the Northern Channel Islands. The islands are the northern limit for the Guadalupe fur seal, and the southern limit for the Northern fur seal and the Steller sea lion. About three-fourths of the estimated 74,000 seals and sea lions that occur in the Southern California Bight spend at least part of the year in the northern Channel Islands, primarily at San Miguel Island.

In addition to sustaining large pinniped populations, San Miguel Island is the principal seabird rookery of the northern Channel Islands. The world's second largest colony of the ashy storm petrel is found on San Miguel Island, as are nesting populations of the double-crested cormorant, Brandt's cormorant, pelagic cormorant, pigeon guillemot, and Cassin's auklet.

2.1.6.5 Threatened, Endangered and Special Status Species

Federal and state-listed threatened, endangered, and candidate species of plants and animals, known or expected to occur at each of the areas proposed AFSLV sites on VAFB, are shown on Table 2.1.6-5.

Special status species on EAFB are shown on Table 2.1.6-6. In addition to the species described in Table 2.1.6-6, the desert kit fox (*Vulpes macrotis*) is classified by the CDFG as a non-game animal that cannot be trapped or hunted. Several species of falcons and eagles that overwinter in the area are listed as federal endangered species by the U.S. Fish and Wildlife Service. These include the bald eagle (*Haliaeetus leucocephalus*) and peregrine falcon (*Falco peregrinus*).

Special status species that occur on San Nicolas or offshore of the island are shown on Table 2.1.6-7.

Figure 2.1.6-7 Occurrence of Breeding Populations of Marine Mammals and Sea Birds on Northern Channel Islands

Table 2.1.6-5

Special Status Plants and Animals of VAFB

Common Name Ridge	Status: Federal Flats		State	Occurrence at Proposed AFSLV Sites: Other	LF 06	ABRES	TP1	A-3	Cypress SLC-4W	Boathouse SLC-5
Plants										
Beach spectacle pod	C2	T								
Lompoc Yerba Santa	C1	R	1B							
Blochman's leafy daisy	C3C		1B				■	■		
Black-flowered figwort	C2		3				■			
Shagbark manzanita	C2		1B			■				
LaGraciosa thistle	C2		1B							
Surf thistle	C1	T	1B							
Soft-leaved Indian paintbrush	C2		1B			■	■			
Crisp Monardella	C2		1B		■					
San Luis Obispo Monardella	C2		1B						■	■
El Segundo dunes Monardella			1B			■				
Beach Layia		R								
Amphibians										
California red-legged frog	C2	SC								
Arroyo toad	C2									
California tiger salamander	C2	SC								
Reptiles										
Southwestern pond turtle	C2	SC								
Terrestrial Mammals										
Townsend's Western big-eared bat	C2	SC								
Badger		SC								■
Mountain lion		P								
Birds										
Calif. brown pelican	E	E		■	--	--	--	--	--	■
American peregrine falcon	E	E								
California least tern	E	E		--			--	--		--
California black rail	C2	SC								
White-faced ibis	C2	SC		--			--	--		--
Ferruginous hawk	C2	SC								
Western snowy plover	C1	SC		--	--	--	--	--	--	
Long-billed curlew	C2			--						--
Tricolored blackbird	C2									

Table 2.1.6-5 (Cont'd)

Special Status Plants and Animals of VAFB

	Status			Occurrence at Proposed AFSLV Sites						
Common Name Ridge	Federal Flats		State	Other	LF 06	ABRES	TP1	A-3	Cypress SLC-4W	Boathouse SLC-5
Birds (Cont'd)										
Black-shouldered kite		P					■			
Northern harrier		SC					■			
Cooper's hawk		SC					■			
Prairie falcon		SC								
Burrowing owl		SC					■			
Long-eared owl		SC								
Short-eared owl		SC					■			
Fish										
Unarmored threespine stickleback	E	E								
Tidewater Goby	C2									
Marine Reptiles										
Leather-back sea turtle	E			--			--	--		--
Loggerhead sea turtle	T			--			--	--		--
Green sea turtle	T			--			--	--		--
Pacific Ridley sea turtle	T			--			--	--		--
Marine Mammals[a]										
Southern sea otter	T	R		--			--	--		--
Harbor seal	P			--			--	--		--
Northern elephant seal	P			--			--	--		--
Northern fur seal	P			--			--	--		--
Guadalupe fur seal	T			--			--	--		--
California sea lion	P			--			--	--		--
Stellar sea lion	P			--			--	--		--
Gray whale	E			--			--	--		--
Sei whale	E			--			--	--		--
Fin whale	E			--			--	--		--
Blue whale	E			--			--	--		--
Humpback whale	E			--			--	--		--
Sperm whale	E									
Right whale	E			--			--	--		--

T Threatened
E Endangered
P Protected by State or Federal law (s)
R Rare
C1 Candidate species with sufficient information to support listing as threatened or endangered
C2 Candidate species possibly appropriate for listing, but information is insufficient to support listing at this time
C3C Candidate species not subject to identifiable threat, further research or change in land use may cause reevaluation for possible inclusion in Category 1 or Category 2
SC CDFG Species of Special Concern
a All mammals in U.S. waters are protected under the Marine Mammal Protection Act. Animals protected by this act include, but are not limited to, all whales, dolphins, porpoises, seals, sea lions and otters
1B Candidate plants considered by the California Native Plant Society (CNPS) to be of highest priority, rare and endangered in California and elsewhere

3 Candidate plants considered by the CNPS to be possibly appropriate for candidate listing but for which more information is needed
- - Offshore
■ Previously or currently identified on site Possibly on site or suitable habitat available on site

Table 2.1.6-6

Special Status Plants and Animals of EAFB

Common Name	Status Federal[(1)]	State	Other[(2)]
<u>Plants</u>			
Alkali mariposa lily	Category 2		CDFG Special Plant
Mojave spineflower	Category 3C		CDFG Special Plant; CNPS List 4
Desert cymopterus	Category 2		CDFG Special Plant; CNPS List 1B
<u>Mammals</u>			
Mojave ground squirrel	Category 2	Threatened	
<u>Reptiles</u>			
Desert tortoise	Threatened	Threatened	
<u>Birds</u>			
Western snowy plover	Category 1		

(1) Category 1 = A candidate species with sufficient information exists to support listing as threatened or endangered.
Category 2 = A candidate species possibly appropriate for listing, but information is insufficient at this time).
Category 3C = A candidate species not subject to identifiable threat, further research or change in land use may cause reevaluation for possible inclusion in Category 1 or 2

(2) California Native Plant Society (CNPS) lists:
1B = Plants of highest priority, rare and endangered in California and elsewhere
2 = Rare and endangered in California but more common elsewhere
3 = Plants about which more information is needed
4 = Plants of limited distribution in California (a watch list)

Table 2.1.6-7

Special Status Plants and Animals of San Nicolas Island

Common Name	Scientific Name	Status Federal	 State	 Other/Remarks
<u>Plants</u>				
Trask's milk vetch	*Astralagus traskiae*	C2	R	
Trask's cryptantha	*Cryptantha traskiae*	C2		
Bright green dudleya	*Dudleya virens*	C2	T	
San Nicolas Island buckwheat	*Eriogonum grande* var. *timorum*	C2	E	
Island marrow	*Lavatera assurgentiflora* ssp. *assurgentiflora*	C3C		
Hoffman's sanicle	*Sanicula hoffmannii*	C2		
Ashy phacelia	*Phacelia cinerea*	C1		a
San Nicolas Island boxthorn	*Lycium verrucosum*	C1		a
Beach spectacle pod	*Dithyrea maritima*	C2		
<u>Birds</u>				
Brown pelican	*Pelecanus occidentalis*	E	E	
Western snowy plover	*Charadrius alexandrinus*	C1	SC	
<u>Mammals</u>				
Island fox	*Urocyon littoralis dickeyi*	---	R	b
<u>Reptiles</u>				
Island night lizard	*Xantusia riversiana*	T	-	b
<u>Marine Reptiles</u>				
Loggerhead sea turtle	*Caretta caretta*	T	T	
Pacific Ridley sea turtle	*Ledidochelys olivacea*	T		
Green sea turtle	*Chelonia mydas*	T		c
Leatherback sea turtle	*Dermochelys coriacea*	E		
<u>Marine Mammals</u>[d]				
Southern sea otter	*Enhydra lutris nereis*	T	R	
Harbor seal	*Phoca vitulina*	P		b
Northern elephant seal	*Mirounga angustirosis*	P		b
Northern fur seal	*Callorhinus ursinus*	P		
Guadalupe fur seal	*Arctocephalus townsendi*	T		
California sea lion	*Zalophus californianus*	P		b
Stellar sea lion	*Eumetopias jubatus*	P		
Gray whale	*Eschrichtius robustus*	E		c
Sei whale	*Balaenoptera borealis*	E		c
Fin whale	*Balaenoptera physalus*	E		c
Blue whale	*Balaenoptera musculus*	E		c
Humpback whale	*Megaptera novaeangliae*	E	c	
Sperm whale	*Physeter macrocephalus*	E		c
Right whale	*Balaena glacialis*	E		c

T Threatened
P Protected by State or Federal law (s)
E Endangered
R Rare
C1 Candidate species with sufficient information to support listing as threatened or endangered
C2 Candidate species possibly appropriate for listing, but information is insufficient to support listing at this time
C3C Candidate species not subject to identifiable threat, further research or change in land use may cause reevaluation for possible inclusion in Category 1 or Category 2
SC CDFG Species of Special Concern
a Presumed extinct
b Species breeds on San Nicolas Island
c Species expected to occur on San Nicolas Island or offshore
d All mammals in U.S. waters are protected under the Marine Mammal Protection Act. Animals protected by this act include, but are not limited to, all whales, dolphins, porpoises, seals, sea lions and otters

2.1.7 Visual Resources

The visual environment of VAFB offers a variety of scenic vistas, which include rolling hills covered with oaks and chaparral vegetation, valleys, floodplains, beaches, and dramatic ocean cliffs. VAFB has been described as a military base with a national park setting (USAF, 1989e). Topography is dominated by the east-west trending Santa Ynez Mountains, which narrow toward the coast and terminate at Point Arguello (USAF, 1989c).

The nearby city of Lompoc is characterized by sprawling urban and commercial development, surrounded by agricultural and scattered residences. The Santa Ynez River provides drainage for the Lompoc Valley, with its terminus in the ocean. Due to access limitations and intervening topography, views of the coastline are generally not available from inland locations (USAF, 1989c).

The main on-base viewpoints are those from the primary roads on North VAFB and Coast Road on South VAFB. None of these roads are accessible to the public, but they still offer viewsheds to base personnel. Launch facilities on VAFB are generally only viewable by the public from the marine vessels (i.e., fishing and pleasure boating, oil platforms), the Southern Pacific Railroad which runs the coastal length of VAFB, and nearby public beaches. These public beaches include Point Sal, Ocean Beach County Park and Jalama Beach County Park.

- **North Vandenberg Air Force Base**

The visual character of North VAFB includes extensive development in the cantonment area, located near the center of the base near the airfield. Other areas on North VAFB exhibit comparative openness with rugged mountains and steep canyons, along with remote coastal launch facilities and technical support areas. Launch facilities on North VAFB consist of mostly isolated complexes, and are generally smaller in size than those found on South VAFB. The terrain and flora found on North VAFB contributes to its rustic visual appearance.

Many of the existing, isolated launch facilities on North VAFB, are fairly concealed by hills, or are located underground. Each of the four proposed sites for the AFSLV on North VAFB are coastally located. With the exception of LF 06, which is visible from marine vessels, all sites are concealed from marine traffic by hilly terrain. The ABRES A-

3 tower may be momentarily visible by passengers on the railroad. With the exception of LF 06, which may be viewed from locations north of the VAFB boundary, there are no public beaches which offer a view of any of the proposed North VAFB sites.

- **South Vandenberg Air Force Base**

The view of South VAFB and its 50 miles of coastline is similarly restricted from view by topography. Views of South VAFB are only available from marine vessels, the railroad and from the nearest public access points at Ocean Beach County Park and Jalama Beach County Park.

Because its Mobile Service Tower is visible above the terrain, the SLC-4W launch complex is visible from Coast Road. This facility is not visible from any public beach, and is momentarily visible from a passing train.

At an elevation of 200 feet, the SLC-5 facility is set back from Coast Road, and shielded by the surrounding hills of the Lompoc Terrace. It is not visible from any public beaches, marine traffic or the railroad.

The Cypress Ridge site is difficult to view from Coast Road because of its elevation. The site lies on the lower limits of Cypress Ridge, which slopes toward the south onto an elevated marine terrace at an elevation between 250 and 450 feet. The site is partially disturbed by fire breaks, and a road cut for the External Tank Tow Route which dissects the site. From Jalama Beach, Cypress Ridge can be seen on clear days (USAF, 1989c). It is visible from marine vessels and the railroad.

A distant view of Boathouse Flats is visible from the accessible portions of Coast Road past the Cypress Ridge site. The Boathouse Flats site can be seen on clear days from Jalama Beach (USAF, 1989c). Since it is not concealed by features of terrain, the site is also visible from marine vessels and the railroad.

- **Edwards Air Force Base**

The EAFB area is characterized by gently undulating hills, alluvial plains and fans, several rugged ranges and buttes, and playas or dry lake beds. Scattered mountains and hills are found throughout the region, which is bordered by the San Gabriel Mountains to the south and the Tehachapi Mountains to the west. Dry lake beds are also found in the region, with Rogers Dry Lake and Rosamond Dry Lake located on EAFB. The Mojave

River valley is found east of EAFB. The character of the region is rural in nature, with several major highways and railroads traversing the valley (ES, 1989).

The character of EAFB is generally typical of most military installations. The base provides testing facilities for different experimental military and civilian aviation programs, in addition to technical support and housing. The base includes numerous man-made structures in support of aircraft operations. Although the visual character is influenced by such structures, the base offers a sense of openness as facilities of the North, Main and South Base areas of EAFB are centrally located on the western edge of Rogers Lake, with relatively fewer structures on the remote portions of the base. The wide open spaces of the base are characterized by rugged ranges, scrub-covered hills, and areas of Joshua tree woodland which offer visual variety in the terrain. Existing facilities for the proposed AFSLV at EAFB are not visible from public view, and public railroads are not located in the immediate vicinity. Takeoff of the carrier aircraft from EAFB would be visible from public roads in the vicinity of the base.

- **San Nicolas Island**

San Nicolas Island is situated approximately 55 miles due south of NAS Point Mugu, with an elevation of 900 ft above sea level. It is relatively flat on top, drops off sharply on its south side, and features a more gradual slope to the ocean on the north sides. Most of the island is in a natural state, with military/industrial facilities located upon the central plateau.

The character of San Nicolas Island is predominantly rustic, with scattered man-made structures. The island provides military support facilities for missile testing, launching, observation, instrumentation, and research. Primary launch activities conducted by the Navy are launching of drones, probes and other small missiles. Although the visual character includes facilities and activities to support Navy programs, the island offers a sense of remote ruggedness because it is largely inaccessible to the general public. The only public who would have a view of the island are boaters who are allowed to bring their vessels up to the shore of the island. From the shoreline, a launch of the AFSLV from the proposed site at Pad 192 would be visible. At certain times of the year when fishing activities are high, great numbers of fishing vessels may be situated offshore of San Nicolas Island.

2.2 MAN-MADE ENVIRONMENT

Regional and local environments are the same at the seven sites at VAFB. Therefore, the environmental discussion on population, housing, community facilities and services, transportation, and the economy are not analyzed individually. The sites at EAFB and San Nicolas Island are treated separately.

- **Vandenberg Air Force Base**

The influence of VAFB on population, housing, community facilities and services, employment, and the economy varies widely within Santa Barbara County. Community patterns for current VAFB workers generally indicate that the VAFB area of influence is the North County region of Santa Barbara County, which encompasses the area north of Lompoc. Although VAFB draws commuters from southern San Luis Obispo County, commuters are estimated to comprise less than five percent of the total San Luis Obispo County labor force of approximately 86,000 persons (USAF, 1989c). Therefore, the subsequent assessment of VAFB's socioeconomic role focuses primarily on the North County region of Santa Barbara County.

Within North County, the economic influence of VAFB centers on the Lompoc and Santa Maria Valleys. The area south of these valleys is defined as the South Coast area.

- **Edwards Air Force Base**

EAFB is located approximately 60 miles north of Los Angeles, at the boundaries of Kern, San Bernardino and Los Angeles Counties. The influence of EAFB on population, housing, community facilities and services, employment, and the economy is primarily on the towns of Lancaster and Palmdale in northern Los Angeles County, and the communities of Mojave and Rosamond in Kern County. In addition, numerous military personnel and civilian contractors live in the communities of North Edwards, California City, Boron, and Tehachapi in Kern County. Hence, the assessment of the socioeconomic role of EAFB focuses on these regions in Los Angeles and Kern Counties. EAFB does not contribute appreciably to the economy of San Bernardino County.

- **San Nicolas Island**

San Nicolas Island, located 60 miles offshore, has negligible influence on the population, housing, community facilities and services of either Los Angeles or Ventura

Counties. Because of its small size and relatively negligible population, San Nicolas Island has little of no impact on employment levels or the economics of these two counties.

2.2.1 Population

2.2.1.1 Demography

- **Vandenberg Air Force Base**

The current population of Santa Barbara County is estimated at 354,100. The City of Santa Barbara (pop. 80,400), in the South Coast region, is the area's largest incorporated community. Santa Maria (pop. 55,200) and Lompoc (pop. 33, 850) and are the principal communities of north Santa Barbara County. Population trends in Santa Barbara County are presented on Table 2.2.1-1.

Table 2.2.1-1

Total Population of Santa Barbara County and Cities

	1987	1988	1990
Santa Barbara County	340,000	345,000	354,100
Carpinteria	11,650	13,050	12,600
Guadalupe	5,350	5,425	5,650
Lompoc	31,200	32,350	33,850
Santa Barbara	78,700	79,000	80,400
Santa Maria	51,800	53,000	55,200
Solvang	3,950	4,130	4,450
Unincorporated Areas	157,300	158,100	161,900

Sources: CDF, 1986; 1988.

Note: Because of rounding, the City estimates, when added, are not equal to the total county population.

The population of Santa Barbara County was 298,700 in 1980, and increased at an annual rate averaging approximately 2 percent per annum from 1980 to 1988. The North County area increased by 20 percent between 1980 and 1985, while the South Coast area increased by about five percent (USAF, 1989c). Increased activity at VAFB, associated with the construction of Space Shuttle facilities and MX missile testing in the early and mid 1980s, the influx of population from the South Coast area in response to that area's housing construction limitations, along with the area’s tourist industry growth were both factors in the more rapid growth of the North County.

The current population of Santa Barbara is expected to increase by approximately 10 percent, to 390,100 persons, by July 1995 (CDF, 1986).

As the regional aerospace industry has grown over the last 30 years, activities at VAFB have influenced population growth patterns in Santa Barbara County during this period. The working population at VAFB was 15,016 in 1986, an increase of more than 4,600 from the population ten years earlier. These figures are down substantially from the mid-1960's, when the VAFB working population was above 18,000 (USAF, 1988a). The working population of VAFB is currently 10,100 (Johnson, 1990).

- **Edwards Air Force Base**

EAFB is the permanent home of Air Force, Army and NASA personnel. In addition, numerous enlisted personnel and civilian contractors live in the nearby communities of Lancaster, Palmdale, Mojave, North Edwards, Rosamond, California City, Boron, and Tehachapi.

The current population of Los Angeles County is 8,769,900. It is expected that this population will increase to 8,885,800 by 1995 (CDF, 1986). The current population of Lancaster and Palmdale are 97,291 and 68,842, respectively (U.S. Census, 1990).

The current population of Kern County is 549,100, and an increase to 602,100 is projected by 1995. The current population of Mojave is 3,763. North Edwards, Rosamond, California City, Boron, and Tehachapi have a current population of 1,259, 7,430, 5,955, 2,101, and 5,795, respectively (U.S. Census, 1990).

The current population of San Bernardino County is 1,418,380 (U.S. Census, 1990). It is projected to increase to 1,476,200 by 1995 (CDF, 1986).

The EAFB population is concentrated in three main areas; South Base, Main Base, and the Base housing. The population concentrations at the Air Force Flight Test Center (AFFTC) facilities and the housing area leave large portions of the base’s 301,000 acres as open space. Total daytime population at EAFB is 11,713, including 315 non-Air Force employees, 32 prison inmates, and 3,744 civilian contractor personnel. The daytime population of 11,713 includes 6,923 civilians. It is estimated that 17,834 people use EAFB on a daily basis (ES, 1989). The population at EAFB is summarized on Table 2.2.1-2.

Table 2.2.1-2

Distribution of Population at EAFB

	Officer	Enlisted	Civilian	Total
AFFTC	498	2,972	2,146	5,616
Army	25	23	111	159
NASA	0	0	450	450
Contractors	0	0	3,749	3,749
AFAL	60	90	299	449
Tenants	192	583	168	943
Subtotal	**775**	**3,668**	**6,923**	**11,366**
NAF Employees	0	0	315	315
Fed Prison Program	0	0	32	32
Total	**775**	**3,668**	**7,270**	**11,713**[b]
Dependents[a]	1,262	4,859		6,121
Grand Total				**17,834**[c]

Source: ES, 1989

[a] Represents dependents of military personnel serviced by CBPO.
[b] Daytime, on-base population: no allowance for military holding extra jobs, etc.
[c] Does not include UTTR Personnel.

■ San Nicolas Island

Approximately 150 personnel are currently stationed on the island. This number includes enlisted persons, civilians, and some contractors. The population of San Nicolas Island fluctuates depending on missions and construction projects that are going on at any particular time. Previously, there were over 200 personnel, but because of water shortages on the island, approximately 50 people had to leave. No children reside on the island.

2.2.1.2 Housing

■ Vandenberg Air Force Base

VAFB has 2,078 family housing units and space for 172 mobile homes. The estimated number of housing units in Santa Barbara County in 1985 was 131,000, an increase of over 20 percent above the 1980 level of 109,000. The number of housing units increased more rapidly in the North County area than the South Coast area during this period. This resulted from the population growth and increased economic activity in the North County area, and housing constraints, such as building moratoria and high costs, in the South

Coast area (USAF, 1989c and USAF, 1989d). Current housing estimates for Santa Barbara County and its cities are presented on Table 2.2.1-3.

Table 2.2.1-3

1990 Housing Estimates For Santa Barbara County

Area	Housing Units
Santa Barbara County	134,572
Carpinteria	5,430
Guadalupe	1,446
Lompoc	12,707
Santa Barbara	36,387
Santa Maria	20,081
Solvang	2,068
Unincorporated	56,453

Source: CDF, 1990a.

The estimated number of housing units in Santa Barbara County is expected to increase from 134,572 in 1990, to 142,900 in 1995 (CDF, 1989).

In 1987, Santa Barbara County had approximately 8,500 temporary housing units, such as hotels and motel rooms. Vacancy rates currently range between 2 and 5 percent, with the higher rates generally being in North County (USAF, 1989c).

Vacancy rates for housing in Lompoc was 6.27 percent, with a vacancy rate of 3 percent for single-family residential units, 6 percent for condominiums, and nearly 11 percent for apartments. The average apartment rental rate for a 2-bedroom apartment was approximately $575 per month (T. Martin, 1990).

- **Edwards Air Force Base**

On-base housing at Edwards AFB has a population of 9,496. This includes both base personnel and their dependents. Total base housing at Edwards AFB is 1,989 units (Martin, 1990).

The estimated number of housing units in Los Angeles County in 1990 is 3,174,142. An increase to 3,955,443 is expected by 2010 (SCAG, 1991). The current estimated number of housing units in Lancaster and Palmdale is 36,525 and 24,051, respectively.

The estimated number of housing units in Kern County is 186,253. An increase to 210,200 is projected by 1995 (CDF, 1990a). In 1980, the town of Mojave had 1,253 housing units, and Rosamond had 1,320 housing units (U.S. Census, 1983).

■ **San Nicolas Island**

Nine bachelor housing buildings are located on San Nicolas Island. Office personnel and equivalent grades of civilians are housed separately. Separate buildings are available for temporary personnel, special groups and women (Navy, 1986). Because the island does not have sufficient living quarters, the Navy is in the process of constructing new barracks. Even with this additional structure, it is not certain whether additional housing will be available for Air Force and contractor personnel, if required.

2.2.2 Socioeconomics

2.2.2.1 Land Use

Existing land use conditions are summarized in the following narrative. This section describes existing land use conditions in terms of regional (county), local (municipalities), basewide, and project site conditions.

■ **Vandenberg Air Force Base**

Vandenberg Air Force Base is located in the western part of Santa Barbara County, in southern California. Less than three percent of the county is urbanized. Approximately six per cent (98,000 acres) of county land is occupied by VAFB. Predominant land uses in the county are natural forest and agriculture, of which more than 80 percent is devoted to agriculture.

Several communities are located within five miles of VAFB's boundaries including Casmalia, Guadalupe, Santa Maria, Orcutt, Vandenberg Village, Mission Hills and Lompoc. These communities are separated by wide buffers of agricultural areas. The Federal Correctional Institution is situated beside VAFB's eastern boundary and Vandenberg Village.

Vandenberg Air Force Base is a military community with all the services and functions found in a civilian municipality. The composition of land uses on the base consists of residential, commercial, industrial, services, and administrative activities. Much of the open space land on the base is available for outdoor recreation activities.

The base is separated into two distinct planning areas, identified as North VAFB and South VAFB. The original space and missile operations at Vandenberg were located on North VAFB. Community and airfield facilities are also located on North VAFB. This area of the base is used for research, testing and training activities related to various launch programs.

South VAFB is used for launch facilities that serve active roles in the current satellite launch missions. If required, this area can also be used for any future expansion of missile operations.

Each of the proposed AFSLV sites on VAFB are located in the Launch Area portion of VAFB, a coastal corridor along VAFB where high priority missions have occurred for over 30 years. Suitable locations for new launch facilities on VAFB are limited to existing active and inactive launch facilities, and a few sites that allow for safety considerations and avoidance of important environmental resources. Purposes of the Launch Area are reserving land for locating new facilities, and protecting the capabilities of existing launch facilities by excluding development of non-launch-essential facilities in this zone (USAF, 1989e).

- **Edwards Air Force Base**

Edwards Air Force Base is located in the western part of the Mojave Desert known as Antelope Valley. The area south of EAFB, around the communities of Palmdale and Lancaster, is the fastest growing part of Los Angeles County. Congestion and escalating land costs in regions closer to Los Angeles are making this more distant area an attractive place in which to live and work.

Ninety percent of EAFB is within Kern County. Nearest communities are: Mojave, at the junction of State Routes 14 and 58, approximately 10 miles northwest of the base boundary; the mining community of Boron, adjacent to the Base's north boundary line; Lancaster, eight miles south of the base; and the community of Rosamond, located directly west of the base on State Route 14. California City, a retirement community, is also located approximately eight miles north of the base.

Muroc Army Air Field was originally activated during World War II, in the Edwards AFB South base area. The base was renamed Edwards Air Force Base, and primary facilities were relocated to the north, at the current Main base. The base's primary mission is experimental aviation.

The base is an Air Force Flight Test Center (AFFTC) and, in that capacity, supports a diversity of military and civilian activities. Current AFFTC operations include conducting and supporting tests of aircraft systems, operating the USAF Test Pilot School, and the conducting of flight evaluation and recovery of aerospace research vehicles. Other AFFTC operations include: (1) development and management of aerodynamic decelerators, (2) the Edwards Flight Test Range, and (3) support and participation in USAF, DOD, and other government agency, foreign, and contractor test and evaluation programs.

■ San Nicolas Island

San Nicolas Island is approximately 55 miles due south of the U.S. Naval Missile Center, Point Mugu, California (located on the Ventura County coast of Southern California), and 127 miles due west of Oceanside, California (north of San Diego). It is the outermost Island of the Channel Island group of Southern California.

San Nicolas Island is approximately 9 miles long with an average width of 3 miles and an area of approximately 23 square miles. The shore line is formed by cliffs averaging less than 100 feet in height. Marine terraces are present at an elevation of 500 to 600 feet above sea level, and the island reaches a height of about 900 feet. The interior is a rolling mesa, badly eroded with little vegetation, mostly coarse grasses, and a few large bushes. The erosional processes of rain and wind, together with the sparseness of vegetation and lack of soil stability under the influence of water, tend to create the island's physical features.

Development occupies a very small portion of available land on the island. The pattern of land use is dispersed, largely as a result of the type of operations taking place, and specific siting requirements of the various facilities. At San Nicolas Island, ten distinct land use categories have been identified as shown on Table 2.2.1-4 (Navy, 1986).

Table 2.2.1-4

Land Use Categories on San Nicolas Island

Category	Typical Facilities
Airfield Support	Aircraft Fire and Rescue Station, fueling facilities, Air Terminal Building
Test and Evaluation	ITCS Radar Building, Range Operation Building, 16 radar facilities
Ordnance	High explosive magazines, explosive ordnance disposal site
Operations	Airfield, NAVFAC facilities
Public Works	Public works storage, auto supply storage, construction equipment shop
Community Support	Housing areas, recreational facilities, dining facilities
Administration	Administration Building
Supply/Storage	Fuel farm, general warehousing
Utilities	Power plant, sewage treatment plant
Open Space/Environmentally Constrained Land	(Vacant)

2.2.2.2 Community Facilities and Services

- **Vandenberg Air Force Base**

Schools. The VAFB-related school population is concentrated in the Lompoc Unified School District, which includes two elementary schools, a middle school, and a high school. Most high school students from VAFB attend Cabrillo High School in Vandenberg Village.

In May 1990, total enrollment in the Lompoc Unified School District was 10,105, while adult education enrollment was 1,716 (CDE, 1990). As of 1987, the Lompoc Unified School District had ample classroom capacity, as did the Orcutt Elementary and Santa Maria Joint Union High School Districts (USAF, 1990a).

In February 1990, the County of Santa Barbara had a public school enrollment of 50,173, which is below the 1970 peak enrollment of 61,818 students, and less than the 54,459 students enrolled in 1977. During 1990, 25,387 students were enrolled in elementary school districts and 24,786 students in unified and secondary schools. The County also has 104 private schools with 1989-90 enrollment totalling 6,318 (CDE, 1990).

There are several institutes of higher education in Santa Barbara County. The University of California at Santa Barbara had an enrollment of 19,082 in the fall of 1989 (personal communication, UCSB, 1990). Santa Barbara City College has a current enrollment of 11,700, and Allan Hancock College in Santa Maria had an enrollment of 8,900 in the fall of 1989 (SBCC/AHC, 1990).

Water. VAFB currently supplies over 99 percent of its own water, purchasing less than 0.5 percent from the adjoining Park Water Company. VAFB obtains its water from groundwater sources via wells on base. The main portion of the VAFB supply currently comes from the western portion of the San Antonio aquifer, while South VAFB is supplied with water from the Lompoc Terrace aquifer. The current water use rate at VAFB is 4,396 acre-ft. per year. The amount of water in storage is approximately 13 million gallons (Johnson, 1990).

Water usage in many areas of Santa Barbara County exceeds the safe yield capacity of water sources. County-wide water deficits were approximating 90,000 acre-feet in 1985. Approximately 21 percent of the County's water is derived from surface sources and 43 percent from groundwater (White, 1990).

Power. The Southern California Gas company provides natural gas to both North County and South Coast areas. VAFB is supplied through an 8-inch gas main, capable of transporting 600,000 cubic feet per hour. In 1989, total usage at VAFB was 598,940,000 cubic feet (Johnson, 1990).

The North County is included within Pacific Gas and Electric's service area. Power from the Morro Bay plant is transmitted to a single metering point near VAFB's main substations. VAFB owns its internal distribution system. The base maintains diesel-powered generating plants to support various technical facilities (USAF, 1988a). Electricity usage was 183,250,000 kwh in 1989 (Johnson, 1990).

Police Service. All police services for VAFB are provided by the Air Force, which has cooperative aid agreements with local area police departments.

Fire Protection. All fire protection services for VAFB are provided by the Air Force. The base fire department has mutual aid agreements with local area fire districts.

Health Care. VAFB has a 40-bed hospital and outpatient treatment facilities. Santa Barbara County has many medical resources to support its residents, including two hospitals in the Santa Maria area and one hospital in Lompoc.

Recreation. Community parks, public beaches, golf courses, and wilderness areas are all found within the immediate vicinity of VAFB. Recreational activities at these facilities include swimming, boating, surfing, surf fishing, hiking, biking, camping, barbecuing, field sports, golfing, picnicking, and horseback riding (USAF, 1988a). Recreational areas located on VAFB are open to active and retired military personnel, and not available to the general public.

Point Sal Beach County Park, Ocean Beach County Park, and Jalama Beach County Park are public beaches located in the immediate vicinity of VAFB. Point Sal Beach County Park, located north of the base boundary, is restricted to day use only, and is closed two to three times per year for Minuteman launches from North VAFB (Cortopassi, 1990). Ocean Beach County Park, also known as Surf, is located between North and South VAFB, and is also restricted to day use only. It is occasionally closed for Titan and Atlas launches from South VAFB. Jalama County Beach Park, located south of the base boundary, has overnight camping and a concession area. Jalama is occasionally closed during launches of the Atlas and Titan from South VAFB. In the past four years, Jalama has been closed on three occasions for a total of 35 hours (Clements, 1990). Each launch must be evaluated in terms of mission specific information, fuel loading and prevailing weather pattern before any decision is made to close a public beach. Not every planned launch will result in a beach closure. All three County beaches are never closed at the same time (Cortopassi, 1990).

- **Edwards Air Force Base**

Schools. There are two elementary schools, one intermediate school and a high school on EAFB (Rush, 1990).

Water. Currently there are three well fields supplying the domestic system at EAFB: the South Track and South Base well fields (linked together in the South Track/South Base supply system), and the North Base well field (supplying the North Base system). In addition to the domestic water supply system, there are several smaller systems supplying other water uses. The Rocket Site well field feeds a separate supply system east of Rogers Dry Lake, and also provides water to the Boron Federal Prison. Two remote wells, Graham Ranch and C-2, supply the golf course, and one remote well (Well 22) supplies the areas at Branch Park.

All nine wells supplying the domestic system are located in the North Base, South Base, and South Track well fields. North Base wells are located in the North Muroc subunit. South Base and South Track well fields are located in the Lancaster subunit. Depths of these wells range from 360 to 700 feet, with the deeper wells located in the more productive areas. The South Track well field, which taps the thickest and most permeable portions of the deep aquifer beneath EAFB. The Lancaster subunit is the most productive. The South Base well field is the least productive of the well fields supplying the domestic system. Approximately 4,450 acre-feet per year are pumped from the domestic supply system, including 3,400 acre-feet per year from the South Track/South Base system, and 1,050 acre-feet per year from the North Base system. Annual pumpage from other systems is estimated at 580 acre-feet per year from the Rocket Site well field, and 370 acre-feet per year from the three remote wells combined (ES, 1989). EAFB is considering supplementing their water by developing an interconnection to State Water Project water sources from the Antelope Valley East Kern Water agency by mid 1991.

Power. Southern California Edison provides electrical power to EAFB. In addition, the base has several generators to provide electricity for emergency use (Rush, 1990).

Police Services. All police services for EAFB are provided by the Air Force, which has cooperative agreements with local area police departments.

Fire Protection. All fire protection services for EAFB are provided by the Air Force.

Health Care. EAFB has a 25-bed hospital and outpatient treatment facilities (Bueno, 1990).

Recreation. Community parks, a golf course, softball fields and playgrounds are found on-base and are open to active and retired military personnel (Mullen, 1990).

- **San Nicolas Island**

Schools. Schools are not available on the island.

Water. The primary source of water on San Nicolas Island has been from developed springs. A secondary source has been shallow wells. Water sources, which are mostly on the west end of the island, are located remotely from areas of use. A seawater desalinization plant was built on the east end of the island in 1979, but the facility was costly to operate and maintain, and it has since become unusable. Output of springs are heavily dependent on rainfall (Navy, 1986). All water is currently barged to the island because existing wells are depleted. Potable water is stored on the island in 4 main tanks with a combined total capacity of 1.8 million gallons. A reverse osmosis plant to generate potable water is currently being installed.

Power. Electricity is generated on the island by a diesel generator with a 24 hour back-up. The generator has a capacity of approximately 4,000 kw, including a 750 kw mobile utilities support equipment unit. The plant is operating at 20 percent of its capacity at the current time. The electrical distribution system will be upgraded in the near future. It is planned that some power lines will be placed underground. In the past, some power poles have been blown down by severe winds.

Police Services. All police services are provided by the Navy. The police force on San Nicolas Island is currently comprised of four military personnel.

Fire Services. One fire station is located on San Nicolas Island. The Navy is responsible for fire protection services.

Health Care. The island has a medical clinic to provide emergency first-aid and limited medical services. A new medical clinic is presently under construction. Extreme emergency cases are air evacuated back to the mainland. Three medical corps personnel are stationed on San Nicolas Island. A search and rescue station is located on Point Mugu.

Recreation. Recreation facilities include a bowling alley, tennis courts, sauna, handball courts, a recreation hall, movie theater, gymnasium, softball field, handball court, library, and pool room. A swimming pool is being constructed.

The waters around San Nicolas Island are used by commercial and sport fisherman, and by other marine craft. These waters are evacuated in coordination with the U.S. Coast Guard during Navy launches.

2.2.2.3 Transportation

- **Vandenberg Air Force Base**

Highways. Highways in the vicinity of VAFB include State Highways 1, 135, and 246.

Highway 1 generally proceeds in a north-south direction in the VAFB area. Traffic volumes on Highway 1, at a location north of Jalama Road, are 460 vehicles for the peak hour and 5,300 vehicles for the peak-month average day. Volumes increase east of the Highway 1 junction with Highway 246 (also known as Ocean Avenue), with a peak-hour traffic volume of 1,150 vehicles, and a peak-month average daily traffic of 15,000 vehicles. Traffic also increases west of this junction, with a peak-hour traffic volume of 1,500 vehicles, and a peak-month average daily traffic volume of 17,200 vehicles. At the location where Highway 1 crosses the Santa Ynez River, the peak-hour traffic volume is 2,800 vehicles, and the peak month average daily traffic volume is 31,500 vehicles. Based on a peak-hour traffic volume of 500 vehicles and the peak-month average daily traffic volume of 5,800 vehicles north of the intersection of Lompoc-Casmalia Road with Cabrillo Highway (on Cabrillo Highway), it is inferred that traffic is probably accessing Lompoc via Lompoc-Casmalia Road. Highway 1 also receives a large amount of traffic from Vandenberg Road; the peak-hour traffic volume is 270 vehicles, and the peak-month average daily traffic volume is 3,050 vehicles. North of this intersection, the peak-hour traffic volume is 2,300 vehicles, and the peak-month average daily traffic volume is 20,100 vehicles (USAF, 1988a).

Highway 246 generally proceeds in an east-west direction to VAFB, and bisects the base into North and South VAFB. Traffic volume on Highway 246 in the Surf area during the peak hour is 430 vehicles, and the peak-month average daily traffic volume at this location is 3,900 vehicles. Southeast of Arguello Boulevard, the peak-hour is 430 vehicles, and the peak-month average daily traffic volume at this location is 3,900 vehicles. Southeast of Arguello Boulevard, the peak-hour traffic volume is 690 vehicles, and the peak-month average daily traffic volume is 4,850 vehicles. Southeast of Leege Road, the peak-hour traffic volume is 740 vehicles, and the peak-month average daily traffic volume is 5,700 vehicles. As Highway 246 approaches Highway 1, it passes through Lompoc, increasing its peak-hour traffic volume to 1,500 vehicles, and the peak-month average daily traffic to 14,600 vehicles (USAF, 1988a).

Highway 135 in the VAFB area is aligned in a northwesterly direction. Although Highway 135 does not approach VAFB as closely as Highways 1 and 246, it connects Los Alamos to Santa Maria while bypassing the VAFB area. South of the Highway 135 intersection with Highway 1 near Harris Canyon, the peak-hour traffic volume is 110 vehicles and the peak-month average daily traffic volume is 1,050 vehicles. North of the Highway 135 junction with Highway 1, the peak-hour traffic volume is 1,750 vehicles, and the peak-month average daily traffic volume is 13,900 vehicles (USAF, 1988a).

Roadways in the VAFB area are generally at Level of Service C (stable flow but maneuverability limited by high volume) or better, except in a limited number of locations. One such location is the section of Highway 1, known as H Street, in downtown Lompoc. This section frequently operates at Level of Service D (approaching unstable flow, affected by fluctuating high traffic volume) during peak traffic periods (USAF, 1988a).

Traffic on Ocean Avenue, west of 13th Street, has declined significantly since 1986, largely because of cutbacks in the Space Shuttle program. In early 1988, the hours when the Coast Gate was open were decreased from 13.5 hours (5:30 a.m. to 7:00 p.m.) to 2.5 hours (6:00 a.m. to 8:30 a.m.) (USAF, 1990a).

Rail. Three railroads provide service in the vicinity of VAFB: the Southern Pacific, Santa Maria Valley, and Ventura County Railroads. The Southern Pacific Transportation Company line serves as the main line of the Los Angeles to San Francisco coastal rail transportation corridor. Freight service is provided to most cities along the coast. AMTRAK passenger service is available in Oxnard, Santa Barbara, and San Luis Obispo (USAF, 1988a).

Three branch lines at VAFB connect to the Southern Pacific main line. The Ventura County Railroad connects the Southern Pacific main line in Oxnard with the harbor facility at Port Hueneme. The Santa Maria Valley Railroad connects the Southern Pacific main line to the Santa Maria Valley (USAF, 1988a).

On VAFB, Southern Pacific tracks pass between the launch facilities and the ocean, and therefore, are overflown during all launches. To minimize the potential risk to people and property, trains are not subject to overflights. An electronic surveillance system, posted schedules, and close coordination, including radio communication between train engineers and VAFB launch personnel, are used to minimize the possibility of an overflight (USAF 1988a). Launches are not scheduled for times when the train would pass through VAFB.

Air Transportation. There are seven active airports in the vicinity of VAFB: Santa Barbara Municipal, Santa Ynez, Lompoc and Santa Maria Public Airports, Ventura County Airport at Oxnard, Point Mugu Naval Air Station, and VAFB. Flight operations include jet air carriers, air taxis, and military aircraft, but the vast majority of operators are general aviators. It should be noted that the Lompoc and Santa Ynez Airports do not provide scheduled commercial air service, and Point Mugu Naval Air Station is used only by military traffic (USAF, 1978).

Marine Transportation. The major operational harbor in the region is Port Hueneme, which is the fourth largest harbor in Southern California (by traffic volume). However, most of the commercial vessel traffic in the Santa Barbara Channel is from Los Angeles and Long Beach Harbors; only a small proportion of this traffic is contributed by Port Hueneme. Traffic passes through the Santa Barbara Channel at a rate of one ship per hour (USAF, 1988a).

Current space and missile operations at VAFB require the designation of danger zones. Marine traffic is advised by radio broadcasts, announcements in the Notice to Mariners, current status announcements at local harbors, and sea and air patrols to avoid these danger zones. Launches are programmed to confine potentially dangerous debris to the danger zones. However, some debris may fall outside the designated area (USAF, 1988a).

- **Edwards Air Force Base**

Regional access to EAFB is provided by Highway 14 (Antelope Valley Freeway), U.S. Highway 395, State Route 18, State Route 138, and State Route 58, all of which connect the EAFB vicinity with other areas of Southern California. Direct access to the base is provided by three highway facilities, each of which is equipped with a guard station: Rosamond Boulevard on the north, which connects with Route 58 at North Edwards; Rosamond Boulevard on the west, which traverses the community of Rosamond and connects with Route 14; and Lancaster Boulevard on the south, which is a continuation of 120th Street northeast of the city of Lancaster. Rosamond Boulevard is a four-lane facility, divided in some locations, while Lancaster Boulevard is two lanes in width with no median (VERAC, 1986).

The heaviest traffic volumes occur on streets in the downtown area of Lancaster, with Avenue J experiencing up to 20,000 vehicles per day. The three access routes to the base experience 3,500, 4,600, and 5,300 vehicles per day, respectively, at the north, south, and west gates to the base. Table 2.2.2-1 shows the average daily traffic for both AM peak-hour, and the PM peak-hour traffic volumes at each entrance to EAFB. As shown, the total number of daily base-related traffic is 13,400 vehicles, while the heaviest peak hour flow is 2,255 vehicles. This peak flow represents the inbound stream of commuter traffic travelling toward the base in the morning peak hour (VERAC, 1986).

Table 2.2.2-1

Traffic Volumes at EAFB

		AM Peak Hour[a]		PM Peak Hour[b]	
	Daily	In	Out	In	Out
North Gate (Rosamond Blvd.)	3,500	455	90	110	400
West Gate (Rosamond Blvd.)	5,300	940	65	65	845
South Gate (Lancaster Blvd.)	4,600	860	85	45	755
Total Base-Related Traffic	**13,400**	**2,255**	**240**	**220**	**2,000**

Source: VERAC, 1986.

[a]The inbound AM peak hour occurs between 6:30 a.m. and 7:30 a.m.
[b]The outbound PM peak hour occurs between 3:45 p.m. and 4:45 p.m.

Traffic volume data shown on Table 2.2.2-1 represent only external trips, in which vehicles pass one of the security gates upon entering or leaving the base. This data is for the year 1986; more recent studies have not been conducted. It is important to note that current traffic volumes will be higher, because there has been significant build up in the surrounding area and a population increase at the base since 1986.

Several notable travel patterns have been identified through the analysis of traffic volume data. For example, traffic counts administered at the three entrance gates indicates that 26 percent of the daily traffic uses the north gate (Rosamond Boulevard), 40 percent uses the west gate (Rosamond Boulevard), and 34 percent uses the south gate (Lancaster Boulevard). Based on peak hour traffic volumes, which are representative of commuter traffic, the distribution among the three gates is 20 percent to the north gate, 42 percent to the west gate, and 38 percent to the south gate (VERAC, 1986).

Rail. The Atchiskon, Topeka, and Santa Fe Rail Line provides freight service to the EAFB area. Passenger service is unavailable.

Air Transportation. There are two active public airports in the vicinity of EAFB: Palmdale Municipal Airport and Lancaster Airport (Fox Field). Flight operations include commercial jet air carriers, air taxis, and general aviators. Military aircraft do not use these two airports. Military and commercial test flight operations occur at the airfields on Air Force Plant 42, south of EAFB.

- **San Nicolas Island**

Transportation. The majority of personnel who work on San Nicolas Island commute to and from the island via a contract commercial airline, Renown Aviation, from Point Mugu. Heavy cargo, aviation fuel, motor gasoline, and diesel oil are transported by barge. Oil is piped ashore from barges to holding tanks. Aviation fuel and motor gasoline are transported in fuel trucks to point of use.

The Navy uses a barge, transporting materials to the island approximately every 2 weeks. During certain construction periods, raw materials are barged in more frequently. The barge is brought in close to the beach at a designated location on the southeast side of the island. An earthen dam is constructed at this designated location, using beach sand and borrow sand from a nearby area. Cargo is then offloaded and trucked to other sites. The earthen dam is rebuilt for each unloading operation. After barge landings, the earthen material used to construct the ramp is mechanically removed to the extent possible. The remainder eventually washes away. Since a pier would wash out, this method is more economical and reliable for the island. The sand spit at the southeast corner of the island has washed away.

There are approximately 12.5 miles of paved roads on San Nicolas Island, and a number of improved unpaved roads. Average daily vehicle movement involves 25 to 30 cars and trucks. Approximately 100 vehicles are stationed on the island. About half are government-owned, while the rest are owned by contractors. Parking space is adequate at all areas on the island (Navy, 1986).

2.2.2.4 Economy

- **Vandenberg Air Force Base**

VAFB is the source of major economic influence in northern Santa Barbara County and the Lompoc Valley. Approximately 40 percent of the Lompoc Valley and 9 percent of the Santa Maria Valley labor forces are employees at VAFB (VERAC, 1986; USAF, 1989c).

In 1987, direct and indirect employment related to VAFB in Santa Barbara and San Luis Obispo Counties was estimated at approximately 1,400 (USAF, 1989c). This included 11,100 jobs on-base, as well as 4,300 jobs in the general community. The latter is attributable to expenditures of both VAFB employees and VAFB agencies. In addition, since much of the hardware needed for military and aerospace operations at VAFB comes from outside the Lompoc-Santa Maria area, some expenditures occur outside the local area (USAF, 1989c). In 1987, an additional 5,100 jobs outside of Santa Barbara and San Luis Obispo Counties were attributable to VAFB-related expenditures (USAF, 1989c).

Current military employment at VAFB is approximately 3,500 (Riley, 1990). In addition, 1,420 civilian personnel, not including those employed by contractors, are employed on base (Hernandez, 1990).

Total current employment in Santa Barbara County is 173,300, with an unemployment rate of 4.2 percent (CDF). The total employment of Lompoc is 16,068 (T. Martin, 1990). Table 2.2.2-2 presents an employment breakdown of Santa Barbara County.

Table 2.2.2-2

Santa Barbara County Jobs by Industry Division
(Annual Averages 1988)

Sector	Percent of Total Employment
Services	25.8
Retail Trade	18.8
Government	17.6
Manufacturing	14.2
Agriculture	6.1
Finance, Insurance and Real Estate	5.5
Construction	4.3
Wholesale Trade	3.7
Transportation; Public Utilities	3.2
Mining	0.8

Source: CEDD, 1989

- **Edwards Air Force Base**

EAFB's primary economic ties are with Los Angeles and Kern Counties. Direct access from population centers in San Bernardino County to EAFB do not exist. Consequently, few base employees live in San Bernardino County and little income is spent there. Base procurements from merchants in San Bernardino County are relatively insignificant, and do not contribute appreciably to the county's economy.

The economy of northern Los Angeles County is dominated by the airplane and aerospace industry. This area is sensitive to fluctuations in federal spending for military aerospace activities. The Palmdale-Lancaster area serves as a manufacturing, trade, and service center. In the past, this area has been fairly rural and isolated, but it has become rapidly urbanized and industrialized. EAFB civilian employees tend to live in this area, and base procurements from merchants in the area are common.

In contrast, the southeastern Kern County economy is based on agriculture and mining, with relatively few industries related to aerospace. The main EAFB community is located in Kern County, and economic benefits to Kern County are derived from the spending of disposable income generated at EAFB from base procurements (USAF, 1986c). The towns of Mojave and Rosamond had total employments of 1,177 and 1,179, respectively, in 1980 (U.S. Census, 1983).

Total civilian employment (excluding contractor personnel) was 3,521 in 1989 (ES, 1989). There were 4,443 military personnel employed at EAFB in 1989 (ES, 1989). Military personnel were divided between 3,668 enlisted personnel and 775 officers.

- **San Nicolas Island**

Economy. San Nicolas Island is part of Ventura County. The entire island is owned and used by the Navy. A Naval Exchange Retail Store, club/bar and a snack bar are available for use by all personnel. The economic influence of the facility, resulting from military purchases and the spending of personnel, is distributed primarily between Ventura and Los Angeles Counties. Waters around the island are used for commercial fishing activities.

2.2.3 Waste Management

Waste management consists of the treatment and disposal of domestic, industrial, and hazardous wastes. This section describes the regional and basewide environment in relation to waste management. The existing regional environment includes VAFB and the surrounding Lompoc Valley. The basewide environment includes proposed AFSLV sites. The AFSLV sites include active launch facilities and undeveloped sites at VAFB as well as active launch facilities on EAFB and San Nicolas Island.

2.2.3.1 Regional Environment

- **Domestic Waste**

Wastewater treatment facilities in the immediate regional area include publicly-owned treatment works (POTW) in the City of Lompoc, Vandenberg Village, and the government-owned plant at the Federal Correctional Institution located adjacent to VAFB. The City of Lompoc treats domestic waste generated by residences, businesses, and industrial facilities in the area, including North VAFB. In 1989, an average of 0.8 to 0.9 million gallons of waste per day (gpd) flow from North VAFB administrative, industrial, and housing areas was treated at the Lompoc POTW. This treatment facility provides secondary treatment and nitrification. It has a capacity of 5 million gpd, and currently operates at 3.5 million gpd. Solid domestic waste generated on VAFB is disposed of at the Class III landfill located on North VAFB (USAF, 1989c).

Domestic waste on South VAFB is generated at the industrial areas and space launch complexes (SLC). These areas have their own packaged sanitary sewer treatment plant (STP) or septic tank-leach field systems. Larger STPs with higher capacities and evaporation/percolation ponds are used at SLC-4 and SLC-6, with rated capacities of 15,000 and 28,000 gpd, respectively. Due to noncompliance with the standards for 5-day biochemical oxygen demand and suspended solids, the STP at SLC-4 is currently being replaced with a larger 25,000 gpd unit (Toft, 1990b).

- **Industrial Waste**

Manufacturing facilities in Lompoc and industrial areas on North VAFB generate most of the industrial waste in the region. The POTW in Lompoc also receives liquid industrial waste from launch support facilities on North VAFB that is in compliance with POTW discharge standards.

The City of Lompoc accepts various domestic and industrial wastes from the regional area at its Class II landfill. This landfill, however, is not used by VAFB for waste disposal. Some of the solid industrial waste generated on VAFB is accepted at the base Class III landfill (USAF, 1989c).

Launch complexes and their ancillary facilities are the primary sources of industrial waste generated on South VAFB. At the present time, the majority of this industrial waste on South VAFB is generated at SLC-3 and SLC-4. The major source of industrial waste is launch wastewater generated before, during, and after a launch. This wastewater contains metals and acidic compounds. Water collects at the individual flame duct wastewater retention basin. This wastewater is sampled and analyzed for hypergolic fuels and pretreated, if necessary, with hypochlorite before being transported by tanker truck to the wastewater treatment facility at SLC-6 (Toft, 1990a).

- **Hazardous Waste**

VAFB generates hazardous wastes from industrial operations and launch facilities. Hazardous waste generated on VAFB is transferred, in properly-labeled Department of Transportation (DOT) approved containers, from their point of origin within 60 days. When a container is full, or 60 days have passed from the first day the container received waste (whichever is first), it is transferred from its point of origin to a collection accumulation point (CAP) within 3 days for temporary storage. The USAF Western Test and Missiles Center (WSMC) owns three CAPs, one on North VAFB, one on the south end of North VAFB (for storing hypergolic fuels), and one on South VAFB. Activities performed at CAPs include: preparing for consolidated shipment of hazardous wastes to VAFB's permitted hazardous waste storage facility (HWSF), preparing "turn-in" documentation, and verifying hazardous waste type by chemical analysis if necessary.

Hazardous waste is shipped from the CAP, within 30 days of receipt, to the HWSF, located at Building 3300 on North VAFB. The HWSF is operated by the Defense Logistics Agency (DLA), and is authorized to operate under a State hazardous waste facility permit issued by the California Department of Health Services (USAF, 1990b). Wastes at the HWSF are transported off base, by licensed hazardous waste carriers and disposal firms under contract to the DLA. Information on the hazardous waste disposal locations from this contract is not available (Kolakowski, 1990). A detailed list of the types and quantities of hazardous wastes stored during 1989, in VAFB's HWSF, is included as Appendix B of this document. A majority of the waste generated of VAFB falls into EPA D001 (ignitables) and D002 categories (corrosives). During 1989, approximately 50 percent of VAFB's hazardous wastes came from waste oils and soils contaminated with JP-5 fuels.

Launch complexes and their ancillary facilities are the primary sources of hazardous waste generated on South VAFB. Typical hazardous wastes include high concentrations of hypergolic fuel-contaminated water, various solvents, paints and primers, sealants, photo-developing solutions, adhesives, alcohol, oils, and various process chemicals. Hazardous wastes on South VAFB are stored at the CAP located at SLC-6.

Water contaminated with hypergolic fuels is generated from launch operations at the SLCs on South VAFB. Any spills of hypergolic fuels that might occur, and washdowns of the launch pad, are diluted with water. Concentrations of hypergolic fuels in the water range from 10 parts per million (ppm) to 100,000 ppm. Hypochlorite is presently used to treat the contaminated water in the flame duct retention basin (USAF, 1989c).

VAFB is presently considering the possibility of treating hazardous wastes with an ultra-violet/ozone generator treatment system to remove contaminants from waste streams. The base is applying for a RCRA Part B permit, and evaluating design parameters for the treatment facility (Toft, 1990a).

2.2.3.2 AFSLV Facilities

- **Domestic Waste**

The only launch facilities proposed for the AFSLV program that have existing packaged STPs or septic tank-leach systems are the active launch sites on VAFB. The only active site which has a packaged STP is SLC-4W. This unit has a maximum design capacity of 15,000 gpd. The remaining active sites (LF 06, Test Pad 1, SLC-5, and Pad 192 on San Nicolas Island) have septic tank-leach systems. Except for the system at ABRES A-3 which has a capacity of 7,000 gpd, the septic tank-leach systems on VAFB have capacities that range from 1,000 to 1,500 gpd (Peterson, 1990).

Each of the active launch sites, except LF 06 and Pad 192, have running water at the facility. The contractors operating LF 06 and Pad 192 require water deliveries to each site so that pressurized systems can be utilized for the septic tank-leach system.

The site for the air platform facility at EAFB is connected to the base sanitary sewer system (Phillips, 1990a).

- **Industrial Waste**

As previously discussed, most industrial waste generation on South VAFB occurs at SLC-3 and SLC-4. Generation of industrial waste at SLC-5 is probably minimal, if any, because no deluge water or launch complex washdown water is used at this facility. Most of the liquid industrial wastes on North VAFB are currently generated from industrial areas. Launch support facilities, such as those at LF 06 and Test Pad 1, generate very little industrial waste (Benier, 1990). Liquid industrial wastes from those facilities are disposed of at facilities on South VAFB.

The launch pad and launch operations building at ABRES A-3 were modified by AMROC to launch a commercial expendable vehicle in the summer of 1989. However, the launch failed and the vehicle burned on the pad (Toft, 1990b). Future operations of the AMROC launch vehicle at this site are undetermined at this time. Since normal operations preclude the use of deluge water and launch complex washdown water at the site, the generation of industrial waste from the AMROC vehicle launch program is probably minimal.

Industrial waste is not generated at the project site for the ALV program at EAFB (USAF, 1989d).

Since Pad 192 does not have washdown facilities, industrial waste generated at the site on San Nicolas Island is probably minimal. All the industrial wastes are collected and transported by barge, off San Nicolas Island, approximately once a month.

- **Hazardous Waste**

The generation of hazardous waste at LF 06 and Test Pad 1 is minimal compared to what is normally generated at SLC-4. Since both launch facilities are used for the testing and evaluation of the Minuteman III and Peacekeeper missiles, minimal amounts of hazardous waste are generated as a result of these operations. Typical kinds of hazardous waste include paints, waste oils, lubricants, rags, and minor amounts of solvents (Benier, 1990). Washdown water from existing launch facilities also contain high metals concentration approximately 50 percent of the time. If the waste water is hazardous, it is containerized and disposed of as hazardous waste. Otherwise the water is considered industrial waste and disposed of at facilities on South VAFB.

As previously discussed in Section 2.1.4, washdown water will be used at the launch facilities for the AFSLV program. The launch pad at LF 06 will be scraped down with wire brush brooms after each launch. Waste material will be containerized and disposed of as hazardous waste. However, the potential generation of hazardous waste will be increased after a rainfall event. Hazardous material from the launch vehicle exhaust cloud will settle onto the launch pad. Surface water runoff from the pad would most likely contain high levels of metals and hydrogen chloride, which would discharge to the surrounding drainage areas.

Hazardous wastes generated at ABRES A-3, as a result of the AMROC expendable launch vehicle program, consisted of small amounts (less than 5 gallons) of solvents, paint thinners, hydrogen peroxides (50 and 85 percent), and triethylaluminum (10 gallons) per flight (USAF, 1989b).

A majority of the hazardous waste presently generated on VAFB comes from launch operations at SLC-4. The majority of the wastes are classified as ignitable (waste oils) or corrosive (acids and bases). Other hazardous wastes include solvents, paints, and sealants.

Hazardous wastes generated at SLC-5, as a result of the NASA Scout vehicle program, is presented in Appendix B. Types of hazardous wastes generated at SLC-5 are similar to types of wastes generated at ABRES A-3. These wastes are typical of those hazardous wastes that the AFSLV program will likely generate.

Approximately 10 pounds of solid hazardous waste are generated by the ALV operation at EAFB. No liquid waste are generated by the ALV operation at EAFB (USAF, 1989d).

The primary generators of hazardous waste on San Nicolas Island are the Navy and contractors. These wastes include paints, solvents, waste fuel, waste oil, batteries and other chemicals. Wastes are classified in all categories (corrosive, ignitable, reactive, and toxic). Hazardous wastes are temporarily stored at collection areas, then taken to a central staging area for transportation off the island. Hazardous wastes are not stored on San Nicolas Island for longer than 90 days.

Several of the proposed sites at VAFB have been included in the VAFB Phase I and II Installation Restoration Program (IRP). Preliminary investigations have been completed and recommendations include remedial investigations and feasibilities studies for ABRES A-3 and Test Pad 1 (Murphy, 1990).

Activities that generate hazardous waste do not occur at the two undeveloped sites on VAFB.

2.2.4 Health and Safety

Protection of health and safety in space launch vehicle programs is mandated by the military System Safety Program Plan, which assures compliance with federal, state, and Air Force Occupational Safety and Health regulations. Compliance with Navy range safety requirements is also required for the San Nicolas Island site. Regional and local safety elements in the Santa Barbara and Lompoc vicinities have previously been described in USAF (1989c). Transportation of rocket motors to EAFB and air-launched vehicle related accidents at EAFB has previously been evaluated in USAF (1989d).

Safety regulations that govern siting of launch facilities include restrictions on use of launch safety zones and explosives. Safety reviews are required for any program on VAFB, EAFB and San Nicolas Island. Safety reviews will be applicable to the launch vehicle, payload, support equipment, and facilities. The safety review procedure provides the means of substantiating compliance with program safety requirements, and encompasses all system safety analyses and testing as required by DOD.

A detailed range safety certification must be completed and filed 6 months before reaching initial launch capability. AFSLV operations requiring special attention, due to hazard potential, will be identified as safety critical operations. Risk associated with the AFSLV program at VAFB, EAFB or San Nicolas Island will be evaluated before safety certification is granted. The AFSLV program will be certified in accordance with regulations established and administered by the Air Force 1st Strategic Aerospace Division (1STRAD) and WSMC Range Safety Group, and the Navy Range Safety Office for the San Nicolas Island site. This section describes Air Force safety approvals that would be required for AFSLV program. A similar procedure for range and explosive safety approvals would also be required, in addition to Air Force approval, for the site on San Nicolas Island.

The contractor selected to provide AFSLV launch services will be required to provide a launch vehicle that meets range safety requirements, and that will receive approval of the Air Force. For the San Nicolas Island site, Navy approval is also required. The contractor selected to provide AFSLV launch services will also establish and maintain a system safety program identifying and controlling system and subsystem hazards. This range safety program and its system safety requirements must comply with all appropriate range safety regulations, including WSMC Regulation 127-1, AFR 127-2, and documentation requirements.

WSMC safety requirements are divided into five basic areas, in accordance with WSMC 127-1: (1) Flight Analysis, (2) System Ground Safety, (3) Flight Termination and Tracking Transponder Systems, (4) Space and Missile Systems Ground Operations, and (5) Missile Launch Operations. In order to obtain final approval for launch, range users must satisfy all requirements in each of the above areas by obtaining the following sequential and incremental approvals.

- Statement of Program Acceptance (SPA) - This item assures the user that the specific test program is conceptually acceptable from a flight safety standpoint. The user provides mission concepts, general vehicle/payload description, propellant characteristics, siting issues, mission scenarios, trajectory data, turn rates/capabilities, break-up data, and impact characteristics. WSMC Safety reviews the data and, if the program concept is acceptable, issues the SPA.

- Flight Plan Approval (FPA) - This item acknowledges that a specific mission can be supported within the limits of flight safety control capabilities to provide positive protection to life and property. The user submits data to WSMC that expands and details the SPA data to include: intended launch dates, expanded vehicle/payload hazard data destruct system data, tracking aids, propellant definitions, more detailed trajectory data, break-up data, buoyancy analysis, and probability studies, as required. Upon review and approval, WSMC Safety issues an FPA.

- Missile System Ground Safety Approval (MSGSA) - This item constitutes approval for hazardous ground operations, up to and including launch. The user submits data describing missile system operation/functions, support equipment and facilities, handling equipment, and applicable hazard data relating to noise, radiation, toxic materials, propellants, pressure systems, ordnance systems, electrical/electronics, software safety, and processing procedures. The user must also submit data describing detailed hazardous waste procedures. This information is compiled as an Accident Risk Assessment Report, and reviewed along with the project System Safety Program Plan and Launch Complex Safety Plan. Upon review and approval by WSMC Safety, the user is issued an MSGSA.

- Flight Termination System Approval (FTSA) - This item constitutes approval of the flight termination and tracking transponder systems. The user submits design, operation, and reliability data on tracking, communication and destruction capability of the system. The system is required to ensure that no public and/or property damage would be incurred from an errant missile/thrust malfunction. In the event an air-launched system is selected, the user must evaluate two plausible accident scenarios as part of this submittal. The first is crash of the launch aircraft with the payload aboard. The second, if applicable, is fire involving the launch aircraft, either during maintenance, or engine start and taxi in preparation for takeoff with the payload aboard, or during landing. Upon review and approval by WSMC Safety, the user is issued a FTSA.

- Operations Approval Letter (OAL) - Once all of the above approvals have been granted by WSMC Safety, and technical requirements as specified in WSMC 127-1 have been fulfilled, an Operations Approval Letter (OAL) is issued by WSMC/CC to acknowledge that the program presents an acceptable level of risk. The OAL is issued for each separate mission, and specifies the vehicle and the payload for each launch.

The primary purpose of the AFSLV system safety program will be to identify, and eliminate or control hazards associated with design and operation of the AFSLV. Residual risks from unmitigated hazards are subject to formal written acceptance by the Program Office. Potential hazards associated with the AFSLV program are listed on Table 2.2.4-1.

Table 2.2.4-1

Potential Hazards of AFSLV Program

Hazard	Source
Fire and Explosion	Fuels (liquid and solid)
Pressure	Pneumatics, Hydraulics
Structural Failure	Structures, Pressure Systems, Mechanisms
Electrical/Electronics	Power Systems, Electronics, Batteries
Collision	Transport, Material Handling
Detonations	Ordnance
Toxics/Asphyxiants	Propellants, Solvents, GN_2
Corrosion	Propellants, Environments
Stress	Materials, Loads
Acceleration	Transport, Material Handling
Shock (Mechanical)	Ordnance, Material Handling
Human Factors	Operating Errors

The AFSLV program will also involve exposure to ordnance systems, hydraulic fluid, and various manufacturing material, such as paint, solvent, and alcohol. Ordnance checkout and installation involves the handling, transporting, installing, and removing of ordnance devices, checking such devices as engine-start cartridges, explosive bolts, retro-rocket motors, and vehicle destruct systems. Additional discussions of associated hazardous waste was presented in Section 2.2.3.

Other possible incidents that could cause injury or damage include oil/propellant spills, and the hazardous effects of a persistent post-launch ground cloud. Pre-launch meteorological monitoring and launch constraints minimize the potential for a persistent post-launch ground cloud.

Land-based AFSLV launch pad design will include spill containment structures. In the event of an oil spill, procedures of the VAFB Spill Prevention Control and Countermeasure (SPCC) Plan will be followed. Propellant spills will be confined within impervious holding areas surrounding propellant storage and handling areas. All propellant handling operations are conducted in closed systems.

In the event of a propellant spill, exposure to level in excess of the recommended safe levels would result for only a short time because the propellant would evaporate rapidly. Spilled propellant would be removed by an emergency support team. This team would collect, containerize, and transport recovered propellant to the HWSF on the base, pending off-site disposal (Toft, 1990c). In the event a spill involves resources beyond the guidance listed in the current Operations Plan (OP-234-89), an on-scene coordinator (OSC) will notify Region IX of the EPA. The U.S. Coast Guard is notified through EPA if a spill occurs offshore. Because hydrazine is an industrial substance suspected of inducing cancer in humans, special precautions are taken to ensure safe handling. VAFB is currently reviewing plans and procedures for response to spills of oil and hazardous substances. This review will result in revisions to the SPCC Plan, which integrates base plans for emergency response.

VAFB operates under an operational emergency contingency plan developed by WSMC. The plan delineates the roles and responsibilities of Base personnel in the event of any emergency. Emergency support teams at VAFB include:

- Specialized Operations Support Team - This team provides response to an emergency occurring during hazardous/dangerous non-launch operations.

- On-scene Disaster Group - This team augments and supports the specialized operations support team. In the event of an off-base missile impact, the commander of this team would lead a missile accident convoy to the impact point.

- Missile Potential Hazard Team - This team assumes control in the unusual situation of a missile becoming uncontrollable due to data, equipment, or personnel limitations. This team would stay in control until return of the missile to a stable condition.

- Launch Support Team - This team is responsible for holding damage or injury to a minimum in the event of an emergency occurring during a missile launch.

2.2.5 Noise and Sonic Boom

Ambient and existing project-generated noise levels at VAFB, EAFB and San Nicolas Island are discussed in this section.

Noise is often defined as objectionable sound or unwanted sound. Sound is detected by the human hearing mechanism as vibratory pressure waves, and is generated by objects oscillating in rapid motion at audible frequencies. Measurement of sound includes detecting the magnitude of the sound pressure, distribution of the sound as a frequency spectra and the time duration of individual sound frequencies, and overall sound events. Thus, sound levels can be easily measured, but the variability in subjective and physical response to sound complicates the analysis of its impact on people. People judge the relative magnitude of sound sensation in subjective terms such as "loudness" or "noisiness." Physically, sound pressure magnitude is measured and quantified in terms of a level scale in units of decibels (dB).

- **Noise Descriptors**

The hearing system is not equally sensitive to sound at all frequencies. Because of this variability, a frequency-dependent rating scale called the A-weighted sound level scale has been devised to measure sound in a manner similar to the way the human hearing system responds. The use of the A-weighted scale is abbreviated "dBA" or "dB(A)". Typical A-weighted sound levels (or just "sound levels") for various sources are provided in Figure 2.2.5-1.

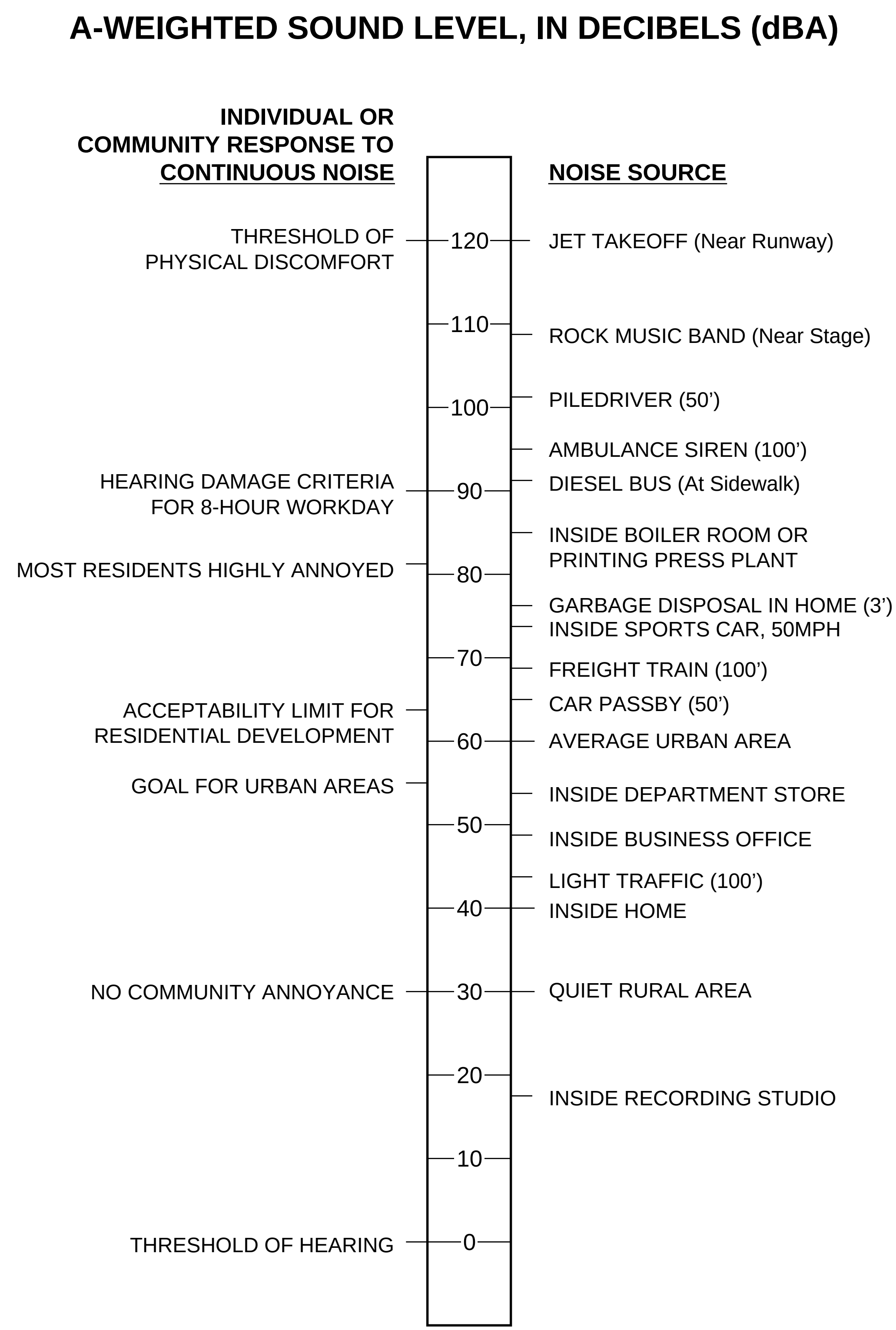

FIGURE 2.2.5-1

TYPICAL SOUND LEVELS FROM INDOOR AND OUTDOOR NOISE SOURCES AND THEIR EFFECT ON PEOPLE

When sound levels are measured and recorded for a distinct time period, they provide the statistical distribution of sound during the measurement period. The most common parameter derived from such measurements is the energy equivalent sound level (L_{eq}). L_{eq} is the level of a constant sound that has the same amount of sound energy as the actual time-varying sounds for a given time period.

While the A-weighted scale is often used to quantify the individual event sound level and is related to subjective response ranking, the degree of annoyance depends on a number of factors. Some of the factors that cause us to categorize a sound as noise are: magnitude of the event sound level in relation to the background (i.e., ambient) sound level, duration of the sound event, repeating occurrence of events, and time of day the events occur.

Several methods have been devised to relate noise exposure over time to community response. The Environmental Protection Agency (EPA) has developed the day-night average sound level (L_{dn}) as the rating method to describe environmental noise. L_{dn} is an A-weighted L_{eq} sound level during a 24-hour period, with a 10 dB penalty factor added to nighttime (10 p.m. to 7 a.m.) sound levels. The Air Force also uses the L_{dn} descriptor for determining community noise impacts.

L_{dn} levels are useful in comparing noise environments and indicating the potential degree of adverse noise impact. However, there are limitations in its usefulness. For example, averaging the noise event sound levels over a 24-hour period tends to obscure the periodic high noise levels of individual events. In recognition of this limitation of the L_{dn} scale, the EPA uses single-event noise impact analyses (SEL) for sources with a high noise level and short duration. The maximum sound level (L_{max}) is another noise descriptor used for high-noise sources of short duration, such as missile launches. The L_{max} is the greatest (A-weighted) sound level that occurs during any noise event.

- **Sonic Boom Descriptor**

The common method of describing the magnitude of a sonic boom is in terms of "overpressure." This pressure magnitude refers to the additional pressure pulse over and above the normal atmospheric pressure at the time. The units of overpressure are Newtons per square meter (N/m^2), or pounds per square foot (psf) in the English system. Magnitudes usually range from 50 to 100 N/m^2, and last from about 100 to 300 milliseconds (ms) in duration. The relatively high overpressure of sonic booms have caused community problems, and have been observed to startle wildlife.

A type of sonic boom of concern during missile and rocket launches often occurs when a trajectory arches in such a way that shock waves from the missile intersect at a focal point on the ground. This is a focus boom. Focus booms are louder and more intense than are single or double sonic booms that originate the same distance from the source.

- **Noise Criteria**

Federal and state governments have established noise guidelines and regulations for the purpose of protecting citizens from potential hearing damage, and various other adverse physiological, psychological, and social effects associated with noise.

The California Division of Aeronautics has set noise standards governing airports that operate under a valid permit issued by the Division. These regulations are designed to control the noise in communities within the vicinity of regulated airports. State noise standards require that new airports meet a 65 dBA, L_{dn}.

- **Sonic Boom Criteria**

The Committee on Hearing, Bioacoustics, and Biomechanics (CHABA) has developed criteria for impulse noise, including an upper tolerance limit. Impulse noise levels which exceed the CHABA limit can produce cochlear damage and hearing loss in humans. This limit, for one impulse per day lasting about 200 ms (similar to a sonic boom), is an overall sound pressure level of about 145 dB or 365 N/m^2.

The acceptability of sonic booms to the public is based on research data reported in the EPA "Levels Document" (EPA, 1974), which shows that the peak overpressure of a single sonic boom should not exceed 36 N/m^2 (0.7 psf) in order to avoid annoying the population.

The effects of sonic booms on marine pinnipeds are reported by San Diego State University Center for Marine Studies (SDSU, 1980). Sound levels from sonic booms ranged between 80-90 dBA on a fast response sound level meter. This level resulted in a startle effect on 50 percent of the pinnipeds observed, and movement to the nearby surf by 10 percent of those observed.

2.2.5.1 Existing Ambient Noise Levels

To evaluate existing ambient noise levels in the areas surrounding VAFB, data from noise elements of the Cities of Santa Maria (Santa Maria, 1987) and Lompoc (Lompoc, 1986), and measured data from ten different sites at VAFB were used.

According to noise measurements and noise contours of Lompoc Valley, noise levels in rural portions of Lompoc Valley, VAFB, and Santa Maria are less than 45 dBA. Areas closer than 1 mile to the major transportation corridors will have higher noise levels. Occasionally, storm activity can increase the ambient noise level to as high as 70 dBA. Similar ambient noise would be expected for L1011 overflight areas between EAFB and the air-launch area.

The largest urban community near the proposed AFSLV project sites is Lompoc. Automobiles, trains, trucks, and aircraft are the most important sources of noise in Lompoc.

- **Vandenberg Air Force Base**

Noise monitoring conducted at VAFB during 1984 and 1985 provided measured data for ten different sites on base and for nearby surrounding areas. These data show average measured noise levels (L_{eq}) ranging from 48 dBA to 67 dBA. There were some high noise levels measured during this monitoring. These high levels were not included in calculating average noise levels, because they were not representative of the background noise levels.

- **Edwards Air Force Base**

Ambient noise readings near NASA facilities are reported to be about 5 to 10 dB below the 85 to 105 dBA measurements taken during aircraft operations (NASA, 1981). This would mean that ambient noise near NASA facilities would range from 80 to 95 dBA. The ambient noise near main base facilities, adjacent to the active flight line area, ranges from 65 to 70 dBA and drops off rapidly away from this area (about 40 to 60 dBA). The more rural settings would be about 30 to 40 dBA without aircraft operations.

- **San Nicolas Island**

The ambient noise level on San Nicolas Island has not been measured. During periods when Navy launch and testing operations are not conducted, the background noise on the island is expected to be low. Ambient noise is expected to be in the range of 30 to 40 dBA, with occasional elevations in noise levels from wind and wave action.

2.2.5.2 Existing Operations Noise

- **Vandenberg Air Force Base**

The controlled airfield on North VAFB serves only military traffic. The 65 CNEL contour represents a minor impact to Lompoc, because it covers either federally or state-owned land, or floodway/floodplain-restricted and agricultural preserve land. The number of flights and types of operation will not be changed in the near future (Lompoc, 1986). Another noise source in areas adjacent to AFSLV project sites is other missile launches at VAFB. Other missile launches will generate high noise levels, but due to their short duration and infrequent occurrence, they do not influence CNEL contours for the Lompoc Valley or Santa Maria.

Maximum noise level contours for larger launch vehicles at both North and South VAFB are shown in Figures 2.2.5-2 and 2.2.5-3, respectively. As shown, the A-weighted noise from Minuteman launches are predicted to be from about 11 to 24 dBA lower than for Titan III measured launch noise, for distances ranging from 1.8 miles to about 11 miles. However, the overall unweighted noise levels are only 0 to 5 dB lower over the same distances. This implies that the smaller Minuteman vehicle has similar low frequency launch noise and lower mid- to high frequency launch noise as the Titan III. It is this low frequency acoustic noise that often is the cause of structure and window rattling, a secondary annoyance factor for affected receptors. Figure 2.2.5-4 shows the predicted noise levels for a Titan II launch. These A-weighted noise contours show that the Titan II was predicted to be about 10 dB quieter than the Titan III. This represents a launch noise that is subjectively about one-half as loud.

- **Edwards Air Force Base**

Operations noise at Edwards AFB is due mainly to jet aircraft engine run-ups, trim runs and test flights in the general area (NASA, 1981). During these operations, noise levels

Figure 2.2.5-2 Predicted Maximum Noise Level Contours for Minuteman Missiles from a Coastal Launch Site, VAFB

Figure 2.2.5-3 Location of Acoustic Measuring Stations and Approximate Titan III Noise Level Contours from SLC-4, VAFB

Figure 2.2.5-4 Location of Acoustic Measuring Stations and Approximate Titan II Noise Level Contours from SLC-4, VAFB near the hanger areas can be near 100 dBA. Noise levels near office and research facilities can be around 90 dBA. These events are usually intermittent and of short duration.

- **San Nicolas Island**

Operations noise on San Nicolas Island is generated from aircraft and missile operations on, and in the vicinity of, the island. Operational noise levels have not been recorded from the island. Navy operations are intermittent and of short duration.

2.2.6 Cultural Resources

- **Vandenberg Air Force Base**

VAFB lies within an area that was occupied by the Chumash people during late prehistoric and historic time. The area occupied by the Chumash consisted of a stretch of about 150 miles of California coastline, from San Luis Obispo to Malibu Canyon. This area included the northern Channel Islands, and valleys as much as 60 miles inland from the coast (USAF, 1987b).

Chumash culture was considered, by the Spanish responsible for settling California, the most advanced native society of Spanish California (USAF, 1989c). Principle economic pursuits were fishing and trading. Numerous villages have been documented in coastal and inland regions, some of which may have been seasonal residential bases or temporary hunting camps (COE, 1984b). Detailed descriptions of Chumash culture can be found in King (1981), Arnold (1987), Grant (1978a; 1978b), Greenwood (1978), COE (1984b), and USAF (1988e).

Historic resources of the VAFB area are associated with the establishment of missions by the Spanish, ranching empires first granted to Mexican citizens and subsequently transferred to U.S. citizens, industrial usage in the late 19th and early 20th centuries by the Southern-Pacific railroad and the Union Sugar Company, and military use of the area dating back to the early 1940's. La Purisima Concepcion, the eleventh Spanish mission in the state of California and the fourth in Chumash territory, is the only archaeological site in the VAFB area listed in the National Register of Historic Places (NRHP). The original buildings were destroyed in the 1812 earthquake, and the mission was rebuilt at its present site northeast of Lompoc. Activities of non-Native Americans in the area are described in Dibblee (1950), COE (1984b), and USAF (1988e).

Over 712 known archaeological sites have been recorded on VAFB. Although much of the base has been surveyed for cultural resources, many of these surveys do not meet current standards. Future archaeologists will undoubtedly discover many more archaeological sites in the area (USAF, 1989e). The cultural resources of portions of VAFB have been previously studied as part of site planning for many other space programs. These are summarized here where they are pertinent to the present project.

Launch Facility 6

The area in the vicinity of LF 06 was surveyed during two investigations (USAF, 1984; 1987c). Surface transects and auger borings around the facility did not reveal any cultural sites beneath or in the immediate perimeter of the facility. Two sites in close proximity to the launch facility are a large site located immediately north of the intersection of the entrance road to the launch facility and Point Sal Road (SBa-1866), and a small site about 200 feet northwest of the facility (SBa-1-87-c). These sites yielded shellfish fragments, fire cracked rock, chert flakes, and chert choppers (USAF 1987c). Other sites in the vicinity are historical, and include: (1) the "1920's Buckaroo Camp" (SBa-228), which once had a house, barn and corrals, (2) the Pioneer Cemetery (SBa-759), which contains graves dating between 1871 and 1888, and may be related to the town of Morrito, and (3) another site of probable historic nature (SBa-1-87-b) at which generally rare glass, ceramic and brick fragments were found with abundant shellfish fragments (USAF, 1987c; COE, 1984b).

Test Pad 1

Test Pad 1 is located in the center of the San Antonio Terrace National Register District. A Historic Preservation Plan for the district recorded 146 archaeological sites, including the prehistoric Chumash village of Lospe (USAF, 1988e). The test pad was constructed over at least one-half of a prehistoric site (SBa-1155). This site, of undetermined eligibility for listing in the NRHP, was most likely a hunting location (USAF, 1988e). It was described as containing sparse shell and flaked stone scatter (USAF, 1987d). Testing and monitoring during construction produced 149 chipped stone flakes, in addition to bone, carbon, shell, and a projectile point fragment (COE, 1984b). A portion of the site may be intact beneath the test pad (COE, 1984b). Any future construction at this site involving surface disruption will require on-site monitoring by a qualified archaeologist and a Native American observer.

ABRES A-3

Burton Mesa is a geomorphic area south of the San Antonio Terrace. The ABRES A-3 facility is located in an area of very high archaeological sensitivity (USAF, 1980) on the northern part of this mesa. It is not known if there are any sites in close proximity to the facility. A site survey for cultural resources would be required for this facility if selected.

SLC-4W

On South VAFB, 7 archaeological sites have been recorded in the vicinity of SLC-4W (SBa-537, -678, -1125, -1127, -1815, -1816, and -1940) (USAF, 1987b; 1989f). At least two of these sites (SBa-537, and -1125) were determined eligible for NRHP listing. The eastern portion of one site (SBa-537) was buried and/or disturbed during construction of the SLC-4W complex (USAF, 1989f). This site, which is estimated to be 50 percent intact, was a limited activity site with stone tool, shell and bone fragments, and fire affected rock (USAF, 1989f). Another site (SBa-678) is also partially covered by Old Surf Road. Since known archaeological resources underlie the facility, any ground-disturbing construction will require on-site monitoring by a qualified archaeologist and a Native American Observer.

SLC-5

At least 2 archaeological sites are located in the immediate vicinity of the SLC-5 facility (SBa-538, and -1120). One of these sites (SBa-538) is partially buried underneath the facility. Two sites (SBa-2229, and -2230) are present south of the facility on the southern and northern rim of Honda Canyon. Both sites have low artifact density, producing ground stone, chipped stone debitage, shell, and bone material (USAF, 1989f). At least six other sites (SBa-530, -539, -669, -670, -1119, and -1144) are located to the east of the facility, along both sides of Honda Canyon closer to the coast.

A historic marker has been established at Point Pedernales, southwest of SLC-5, in memory of a multi-ship wreck in 1923. The hulls of the ships can be seen from the Point. This site is also known as Destroyer Rock.

Cypress Ridge

The proposed Cypress Ridge area is an archaeologically sensitive area in which buried site deposits were consistently found (USAF, 1989c). Two sites (SBa-1116, and -1118) have been recorded within the eastern portion of the Cypress Ridge area. One large site (SBa-1941) is located near the top of Cypress Ridge. A cluster of seven early archaeological sites is located immediately south of the Cypress Ridge area, where Oil Well Canyon extends onto the coastal plain near Coast Road (SBa-712, -1117, -1543, -1544, -1545, -1546, and -1547) (USAF, 1989c). All of these sites, termed the Oil Well Canyon Site Cluster, appear to be eligible for inclusion in the NRHP (USAF, 1989c). Another site (SBa-1149) west of the Cypress Ridge area, along Coast Road, was first recorded as a historic ranch site with a cypress tree windbreak. Surface material recovered includes porcelain fragments, pink glass, iron fragments, red brick, and abalone shell. Subsequent subsurface testing also revealed chert flakes, and shellfish fragments. Construction of a facility in this area may uncover buried archaeological sites.

Boathouse Flats

The Boathouse Flats area is located south and slightly southwest of the Cypress Ridge area. Six archaeological sites (SBa-637, -1559, -1560N, -1560S, -1561, and -1562) are located along the Oil Well Canyon drainage between the Oil Well Canyon Site Cluster and the ocean. One of these sites (SBa-637) is a large site that stretches northwest along the coast nearly to Point Arguello. Two historic sites in the vicinity are an old Coast Guard dump (SBa-1558) and the Point Arguello Boathouse. The Point Arguello Boathouse, formerly the Point Arguello U.S. Coast Guard Rescue Station, consists of an administration/barracks building and a garage. Buildings are wood frame structures, representative of the Eastern U.S. Colonial Revival style of architecture popular in the 1920's. This facility, which was constructed in 1936 and deactivated in 1952, is a historic resource eligible for inclusion in the NRHP (USAF, 1989c). Investigations of submerged lands in the vicinity of the boathouse revealed no underwater resources of archaeological or historic interest (USAF, 1983a). No archaeological sites are known in the central part of the flats.

- **Edwards Air Force Base**

EAFB is located in central Antelope Valley, an area of low rainfall, extreme summer heat, and desert plant cover. It is believed that the area was occupied primarily by the Kitanemuk people. However, due to the nature of the environment and the political organization of groups inhabiting the region, the area may have been used for resource procurement for several groups in the region. In addition to the Kitanemuk, the Serrano, the Vanyume, and possibly other groups may have used the area (York, 1990).

The archaeological record in the Antelope Valley Region reveals two major changes, or shifts, in settlement patterns. The first occurrence, at 3,000 B.P. (Before Present), indicates an apparent shift from a mobile, egalitarian, gathering economy to a complex, sedentary economy based primarily on trading (York, 1990). Causes of this shift are uncertain. However, it may be, at least in part, the result of population movements and possibly a favorable geographical position with respect to trade (Sutton, 1980). Another major change occurred at about 300 B.P., when occupation of the valley decreased dramatically, followed by only sporadic use. Several explanations have been proposed for this abandonment, including: a collapse in the economic system due to a disruption in trade routes, a region-wide disruption due to the desiccation of Lake Cahuilla to the southeast, decimation of the population as a result of diseases introduced by the Spanish, and the physical transfer of large portions of the valley population to the San Fernando Mission (Sutton, 1980).

The EAFB area contains archaeological resources due, in part, to the presence of shallow lakes that once existed in the area. The margins of these now dry lakebeds are repositories for archaeological remains. There are 1,130 cultural resource sites on EAFB; 470 of these are prehistoric and 660 are historic (Bowholtz, 1990).

A field survey and literature search and review were conducted for the existing ALV program at EAFB (USAF, 1989d). Existing facilities are proposed for use of the AFSLV program at EAFB. That survey found no historic or prehistoric cultural resources either within or near the project area. Subsurface occurrences are not expected. These findings were concurred with by the California Office of Historic Preservation (USAF, 1989d).

■ San Nicolas Island

San Nicolas Island is a rich source of prehistoric and historic cultural material. Investigations over the past 90 years, by the University of California Archaeological Survey, the Santa Barbara Museum of Natural History, the Southwest Museum, the Los Angeles Museum of Natural History, and other museums and investigators, have revealed numerous grave sites and artifacts. Material recovered from the island numbers in the thousands, and is often concentrated in areas of prehistoric settlements called middens. This material includes: human bones, bone implements, baskets and a water bottle woven from sea grasses, shell fish hooks, stone material such as mortars, pestles, bowls and hammers, steatite ornaments and charms, wooden objects such as knife handles, bowls and dippers, and sculptured stone animal fetishes (de Cessac, 1951; Meighan and Eberhart, 1953; Heizer, 1957, 1960a and 1960b; Rozaire, 1959; Reinman and Townsend, 1960; Reinman, 1964; and Jones, 1969).

The island was inhabited by a tribe of Indians known as Nicoleño, probably Shoshone in origin (Kroeber, 1953). Knowledge of the Nicoleño is based primarily on archaeological investigations. Little is known of their lifestyles or society. This is primarily due to the location of the island far enough at sea to be off the main coastal sea route, and the rugged coastline that did not have any large, secure harbors for ships (Westec, 1978). Four badly preserved words and several songs are all that remain of the Nicoleño speech.

At the time of their maximum development, the Nicoleño are estimated to have had a population of close to 2,000 inhabitants (Reinman, 1962). Due to the incursions by early 19th century Aleut sea otter hunters from Alaska and continuing recruitment by Spanish missionaries, there were only a few Nicoleño left on the island by the 1830's. In 1935, about 20 remaining Nicoleño, with the exception of one woman, were removed by the Franciscan missionaries to the mainland. This woman, known as the "Lone Woman of San Nicolas Island", or "Juana Maria" as she was christened by the priests at Santa Barbara Mission, lived for 18 years alone on the island. She was found and taken to Santa Barbara in 1853, where despite good care, she died in seven weeks. Her speech was unintelligible by the Chumash of the vicinity, and no other Indians could be found who could understand her dialect. Her story had aroused a great romantic interest, and there are several published accounts of her life (Heizer and Elsasser, n.d.).

Several archaeological surveys have been conducted on the island, the most recent of which was in 1984 (Reinman & Lauter, 1984). The entire island has been surveyed for middens and other areas of archaeological sensitivity, and has yielded about 500 sites (Glidden, 1991). Almost 75% of the sites are located in the western half of the island, along the coastal sand dunes and the more eroded dunes on the plateau.

Pad 192 lies above a previously recorded site, San Nicolas Island-44 (Reinman & Lauter, 1984). Due to the numerous buildings and military related facilities constructed at this location, this site is mostly disturbed. It is classified as a poor site and is not considered to have archaeological research potential (Reinman & Lauter, 1984). The project area is mapped as having low archaeological sensitivity (Westec, 1978).

The path of AFSLV across the island will pass over areas of high archaeological sensitivity. One site of particular interest is the petroglyph cave at Sea Lion Cove. This cave contains both incised petroglyphs and pictographs in black, depicting primarily various types of sea life. These drawings are distinctive, because they constitute one of the rare occurrences of petroglyphs for coastal southern California (Rozaire and Kritzman, 1960). This site is of moderate to marginal research potential (Reinman & Lauter, 1984).

SECTION 3

ENVIRONMENTAL CONSEQUENCES

Analysis of potential impacts requires an evaluation of changes that will likely result from implementation of the AFSLV project at any of the nine possible sites. These effects are evaluated relative to both regional and local environments, as described in Section 2. Potential effects from either of the three possible launch systems are also evaluated. Analyses utilize existing data from the USAF, the Navy, the County of Santa Barbara, and other public and private sources.

Anticipated direct and indirect impacts are assessed quantitatively and/or qualitatively, with consideration to both short-term (project construction period) and long-term (project operations period) effects. The relative degree of impact will depend upon the extent of new construction or facility modifications conducted at a site, which is not known at this time. In general, it is expected that use of the undeveloped sites would result in greater environmental impacts than use of the active sites. For some analysis, notably vegetation, wildlife, and cultural resources, further specific site studies will be required to evaluate resources that could be affected by project implementation.

Environmental consequences of the proposed action are addressed by environmental area, followed by an evaluation of potential cumulative impacts beginning in Section 3.3. At the end of each environmental analysis, a summary of impacts is presented for each AFSLV site. A comparative summary of impacts to each environmental resource as a result of the AFSLV program is presented in tabular form. The five symbols used to indicate the extent of impact are: ○ (lowest impact), ◌ (low impact), ◍ (moderate impact), ● (highest impact), and ◉ (same impact as other sites). Comparisons shown in each table are relative and do not indicate an absolute magnitude or level of impact. The level of effect may be greater at one launch site as compared to another, however, the actual effect on the environment may be minimal or insignificant. Certain impacts may occur at only one site, in which case the symbol shown indicates the extent of the impact only at that site without comparison to other sites. Blank spaces represent no impact. Footnotes are used to compare the relative impact of a conventional launch system to a truck/trailer launch system at a site, unless the impact is the same for both systems.

3.1 NATURAL ENVIRONMENT

3.1.1 Air Quality

This section describes emissions attributable to construction of support facilities, support operations, and launch operations.

3.1.1.1 Emissions from Construction of Support Facilities

Representative sites for the AFSLV program include both active launch facilities and undeveloped sites. Potential AFSLV launch systems would result in varying amounts of air pollutant emissions, dependent primarily upon the relative amount of new construction required at each site.

- **Land-Based Launch System**

Potential sites for land-based launches are active launch facilities at VAFB and San Nicolas Island. Construction-related emissions would be generated at launch facilities requiring modification for the AFSLV, and where no existing payload and payload fairing processing facilities are present. Fugitive dust emissions from demolition and earthmoving activities would be generated at a rate of 1.2 tons per acre month. Exhaust emissions of NOx, CO and HC from heavy-duty construction machinery would also be generated. Emissions could be quantified when the project area requirements and the construction mobilization schedule are defined. Construction-related emissions may exceed ambient air quality standards for a short period of time.

Of the land-based fixed launch pad sites, it is expected that SLC-5, ABRES A-3 and Pad 192 would not require extensive modifications or additional processing facilities, and therefore, would have lower construction-related emissions. These sites are currently in use for other launch programs and could be adaptable to the AFSLV program. Payload processing would be completed off site for launches from Pad 192.

The remaining three launch sites, LF-06 , Test Pad 1, and SLC-4W, may require some launch pad modifications. LF-06 and Test Pad 1 may also require new processing facilities. Construction-related emissions would depend on the amount of demolition and earthwork required at each site, and would be moderate in comparison to other sites.

- **Transportable Launch System**

There are two transportable launch systems proposed for the AFSLV program, namely, truck/trailer and air. These options provide for a transportable launch platform. They may or may not include support facilities on site. Except for the proposed project at EAFB where fixed, land-based support facilities already exist, the following analysis will assume that support facilities are transportable and self-sufficient.

A transportable launch system at an undeveloped site, such as the truck/trailer system at Cypress Ridge, would generate the most construction-related emissions. Earthmoving activities would be necessary for the construction of a roadway into Cypress Ridge and a parking lot for the transportable launch system and support facilities. This would result in fugitive dust and exhaust emissions of NOx, CO and HC. Emissions could be quantified when the roadway length, parking lot size, and construction equipment mobilization schedule are defined. Construction-related emissions may result in the exceeding of ambient air quality standards for O_3, CO, NO_2, SO_2, and PM_{10} for a short period of time.

A truck/trailer system at Boathouse Flats would result in emissions, but to a lesser degree than that at Cypress Ridge, provided that the existing access road (External Tank Tow Route constructed for the Space Shuttle program) is used. Emissions would be generated from the construction of a parking lot, adjacent to the roadway and wide enough to accommodate the launch platform and support trailers.

A truck/trailer system at any of the active launch sites (LF 06, Test Pad 1 and SLC-5) would require minimal modifications, because existing access roads and launch platforms could be used. Construction-related emissions would be lower than other sites.

Assuming that existing support facilities at EAFB are adaptable to the AFSLV program and new facilities are not required, use of these facilities would not result in any construction-related emissions.

3.1.1.2 Emissions from Launch Preparation Operations

- **Preparation of the SLV**

It is not known at this time if the payload fairing (PLF) will be prepared on site or off-site. From an emissions potential standpoint, on-site preparation would generate the most emissions, mostly consisting of volatile organic compounds (VOC). The following discussion considers on-site preparation and assembly of the SLV.

The PLF is usually manufactured outside of the military installations and transported to the site, either by rail, truck or air cargo. At the site, the PLF undergoes various coating operations prior to assembly. The surface of the PLF is cleaned by wiping with an organic solvent, usually methylethylketone (MEK). After cleaning, the PLF may be wiped with a liquid containing chromic acid to form a conversion coat on the surface.

The PLF is then painted with primer, usually consisting of two coats. The primer is carried in an organic compound vehicle such as naphtha. Between primer coats, the surface may be wiped with an organic solvent to ensure a clean surface.

Ablative material is then sprayed onto the PLF surface. This coating may consist of a silicone elastomer base, an organic silicate catalyst coat, a dispersion coat, and a silicone enamel. Ablative coating materials are usually thinned with Freon and/or naphtha for spray painting.

Emissions of VOCs used in PLF processing are subject to regulation by the local air pollution control district. The majority of these compounds are non-photochemically reactive. However, the silicone enamel may contain some photochemically reactive organic compounds (i.e., toluene). In addition to VOC emission thresholds, the local air pollution control district has separate emission thresholds for photochemically reactive compounds.

Booster configurations proposed for the AFSLV include a 3-stage SLV and a 4-stage SLV. The surface area of each SLV increases with the number of stages. Usage of processing materials (cleaning solvents and coatings) increases proportionately. Consequently, emissions are higher for launch vehicles with more stages.

- **Payload Processing**

Payloads transported in the SLVs may be processed on-site or off-site. Since both the payload and PLF will be exposed to the same atmospheric conditions, it is assumed that payload processing will be similar to processing for the PLF. On-site payload processing will result in emissions similar to those from PLF processing.

Emission levels will vary depending primarily on size and mission. A larger payload will have a greater surface area, and its processing would result to higher emission levels. Payloads requiring special handling due to extended missions may also result in more emissions. Each payload will be for R & D purposes and will be unique. Specific air quality impacts from payload processing activities will be evaluated in a separate environmental analysis for the payload.

- **Propellant Loading**

Liquid propellants are transferred from storage vessels to the space vehicle's fuel tanks in a closed loop system. Displaced propellant vapors generated during loading will be conveyed to a vapor control system. The vapor control system could either be an incinerator or a scrubber. In the event of an emergency during propellant transfer, propellant may be released directly to the atmosphere.

Emissions from the incinerator include CO, SO_X, NO_X, HC, and some uncombusted propellant. Emissions of propellants may also be released during an emergency, such as an accidental propellant spill or during a by-pass of the vapor control system.

There are associated toxicity problems with propellant releases, and these would be dependent on the strength of the release. Personnel involved in propellant transfer will be provided with protective clothing and breathing equipment. Personnel not involved in propellant transfer operations will be restricted from the area.

- **Booster Assembly**

The booster is assembled on site near the launch pad. In order to ensure proper electrical conductivity, solvent is used to clean the electronic mating surfaces and ground connections. This is either done manually with rags dipped in solvent ,or by using aerosol for those surfaces that are not readily accessible. In the ALV program, the booster mating surfaces are cleaned using isopropyl alcohol. Perchloroethylene may also be used for cleaning surfaces that will be bonded.

In previous programs, Freon was also used to clean mating surfaces. Freon is identified as an ozone-depleting substance, and its manufacture and use is being phased out under the 1990 Clean Air Act Amendments. For this reason, Freon will not be used the AFSLV program.

Emissions from booster assembly operations consist of fugitive volatile organic compounds from the solvents used for surface cleaning operations. The volume of emissions is dependent upon the amount of volatile organic compounds used. A booster with more stages would have more mating surfaces that require cleaning. Consequently, more solvent would be used resulting in a relatively higher level of volatile organic compound emissions.

3.1.1.3 Launch Emissions

Launch operations constitute the largest source of uncontrollable emissions into the atmosphere. These emissions are generated in the ground cloud at lift-off, and along the launch trajectory. Emissions are also associated with the aircraft takeoffs and landings for the air-launched vehicle. An analysis of the effects of the AFSLV program on ozone depletion and global warming is provided in Appendix A.

Emissions are associated with the oxidation of fuel and propellants. Emission composition is determined by the type and composition of the various propellants and oxidizers. In general, AFSLV propellants consist of various polybutadienes, perchlorates hydrazines, and aluminum. Minor quantities of other materials such as iron oxide (Fe_2O_3), graphite, and nitrogen-based materials are also added. Combustion products from these propellants are as shown on Table 3.1.1-1. The AFSLV may also include the use of a small amount of strontium perchlorate, $Sr(ClO_3)_2$, for the propellant reaction control system. As a result, hydrochloric acid (HCl) and strontium peroxide (SrO_2) may also be generated.

In a land-based launch, the combustion products which may potentially impact ground level air quality are those that are generated below 5,000 feet. This occurs at lift-off in the ground cloud, and along a very short portion of the launch vehicle trajectory. The quantity of trajectory emissions is greatest at ground level, and decreases continuously with vehicle acceleration and staging. Potential effects of ground cloud emissions on air quality are governed by speed and direction of movement, local meteorological conditions, and the concentration of pollutants in the ground cloud.

At VAFB, fixed pad and truck/trailer launch operations using 3-stage or 4-stage SLVs are proposed. Emissions associated with 3-stage or 4-stage SLVs are shown on Table 3.1.1-1. HCl is toxic and Al_2O_3 occurs as nuisance dust. These are generated in significant quantities during lift-off, and have the potential for migration to uncontrolled populated areas. Civilian population outside of VAFB is about 6.5 kilometers (4 miles) from any of the proposed launch sites. Strontium peroxide and HCl from $Sr(ClO_3)_2$ combustion are released during Stages II and III, high above the earth's surface, and would have no impact at ground level.

Table 3.1.1-1

AFSLV Propellant Combustion Products

Name	Chemical Formula
Carbon dioxide	CO_2
Carbon monoxide	CO
Hydrochloric acid	HCl
Aluminum oxide	Al_2O_3
Nitrogen oxides	NO_x
Nitrogen molecule	N_2
Hydrogen molecule	H_2
Hydroxyl ion	OH^-
Chloride ion	Cl^-
Hydrogen ion	H^+
Water	H_2O

In order to avoid impacting the civilian population, launches at VAFB for the other space programs are conducted during favorable meteorological conditions. Before each launch, a Toxic Hazard Corridor (THC) forecast is prepared by the USAF duty forecaster to assure safe launch conditions. Launching the AFSLV during favorable meteorological conditions should result in minimal short-term impacts to air quality and the civilian population surrounding VAFB.

For the air launch system at EAFB, propellant combustion products would be released at an altitude of 40,000 ft when the AFSLV separates from the Lockheed L1011 carrier aircraft. These pollutants would dissipate in the upper atmosphere, and would not affect ground level air quality. However, emissions from the carrier aircraft at landing and takeoff (LTO) will result in short-term impacts to ground level air quality. The quantity of air pollutants for a Lockheed L1011 LTO cycle is shown on Table 3.1.1-2.

Another factor that contributes to launch emissions would be vehicle failure. These include vehicle destruction on the pad, in-flight failure, and commanded vehicle destruction. Air pollutants generated by a launch failure would be similar to those generated by a normal launch, except that quantities and concentrations would be undetermined. With the exception of a launch pad accident, emissions would be generated at some altitude from the pad, and dilution would have occurred before detection at ground level. Launch pad accidents would result in short-term impacts on the ambient air quality.

Table 3.1.1-2

Emissions Associated with Lockheed L1011 Landing and Takeoff

Pollutant	Quantity, lbs
CO	132
NO_X	60
HC	89
SO_X	4
PM	3

3.1.1.4 Summary of Air Quality Impacts

Potential impacts of the AFSLV program on air quality are summarized Table 3.1.1-3.

Table 3.1.1-3

Summary of Potential Air Quality Impacts of the AFSLV Program

	LF 06	Test Pad 1	ABRES A-3	SLC-4W	SLC-5	Cypress Ridge [1]	Boathouse Flats [1]	EAFB	Pad 192
Construction emissions (fugitive dust and vehicle exhaust emissions)	◔ 1 ◑ 2	◔ 1 ◑ 2	◔	◑	◔	●	●	○	◔
Launch processing emissions (i.e., volatile organic compounds and payload processing emissions)	◑	◑	◑	◑	◑	◑	◑	◑	◑
Launch emissions (HCl, Al_2O_3)	◑	◑	◑	◑	◑	◑	◑	---	◑
Aircraft emissions	---	---	---	---	---	---	---	◑	---
Accident emissions	◑	◑	◑	◑	◑	◑	◑	◑	◑
Contribution to stratospheric O_3 depletion and global warming	◑	◑	◑	◑	◑	◑	◑	◑	◑

= Lowest impact compared to other sites
= Low impact compared to other sites
= Moderate impact compared to other sites
= Highest impact compared to other sites
= Same impact compared to other sites
--- = No impact

1 Truck/Trailer launch system
2 Launch Pad system

3.1.2 Hydrology

3.1.2.1 Surface Water

Impacts to surface water could occur as a result of wastewater discharges from launch sites into creek basins. Creeks and drainage basins located adjacent to the LF-06, ABRES A-3, SLC-4W, SLC-5 and Pad 192 launch sites are low flow, intermittent streams. Since any routine launch washdown water will be contained, these sites would have the potential for impacts to surface water resources only in the event wastewater were inadvertently discharged into adjacent creeks.

During past Titan launch activities at SLC-4, discharges of approximately 50,000 gallons of deluge and washdown water were routed to Spring Canyon Creek. Discharges increased flow in the creek, but because of the intermittent nature of these discharges, significant impacts to hydrologic features of the creek did not occur. Because of the intermittent and infrequent nature of the proposed AFSLV launches, any discharges would not be expected to have a significant impact to surface water hydrologic features. It is not expected that wastewater discharges to creeks would occur without approval of the RWQCB.

3.1.2.2 Groundwater

The activities of the proposed project will not require new wells to be drilled. Potable water demand for any construction and launch activities will be taken from the existing VAFB water supply. Impacts to groundwater resources from construction within the project sites will not be significant because major groundwater disturbing activity is not expected to occur. Although the operational water demand for the AFSLV program is considered a short term impact to the VAFB water supply, the increased demand will contribute to the current overdraft of the total groundwater basin supply. Such an increase is not expected to cause any significant long-term impacts on groundwater resources.

Any increase in groundwater extraction at EAFB, or in the vicinity, will contribute to regional overdraft. This overdraft contributes to existing problems related to ground subsidence, and the creation of associated surface cracks or fissures. Although any increase in groundwater use will contribute to overdraft, the amount of groundwater expected to be used for an air-launched AFSLV system at EAFB, in consideration of the total amount of groundwater consumed at EAFB, is not expected to result in a significant impact on groundwater resources.

3.1.3 Water Quality

3.1.3.1 Surface Water

The discharge of any launch process and washdown water after a launch would have a direct impact on surface water quality. As is the case with SLC-4, higher concentrations of iron, copper, zinc, calcium, magnesium, and chloride occur at sampling points downstream than at the sampling points upstream of SLC-4. In the event that the AFSLV program involves the use of launch pad washdown or deluge water, collection and testing of wastewater will be required. Disposal at facilities on South VAFB, in accordance with RWQCB requirements, will be required if contaminants are detected.

A surface water quality consideration from a launch is the potential interaction between the exhaust ground cloud produced by vehicle launch and surface water. Intermittent water is found in the vicinity of LF-06, ABRES A-3, SLC-4W, SLC-5 and Pad 192. The effect of the ground cloud on water quality would be a function of the exhaust cloud composition, duration of its contact with the water, wind speed and direction, and other atmospheric conditions. An exhaust ground cloud from the proposed AFSLV would consist primarily of HCl, Al_2O_3, and CO_2. The primary concern associated with the ground cloud impacts on water quality is the formation of large quantities of HCl. Short-term acidification of surface water may result from both direct contact with the ground cloud, and through precipitation of HCl as droplets form around dust particles. Deposition of Al_2O_3 affects water quality with high levels of aluminum. Since permanent surface water bodies are not located in the immediate vicinities of any potential AFSLV launch sites, adverse effects, such as short-term acidification of surface water would not be anticipated.

Exhaust cloud deposits and fuel residues are left on the pad after launch. In the event that pad washdown does not take place following a launch, contaminants will be transported to surface waters by stormwater runoff. Stormwater runoff, which serves as a means of washdown, would be diverted to drainage gullies adjacent to the launch pad. Such a discharge may be considered an industrial waste and would be subject to the provisions of the NPDES permit requirements and the Waste Discharge Permit issued by the RWQCB.

3.1.3.2 Groundwater

VAFB obtains its water from wells in the San Antonio Valley, Lompoc Valley, and Lompoc Terrace. In the event of any new construction, soil compaction caused by the operation of heavy construction equipment may reduce the rate of infiltration over much of the site. Although decreases in infiltration rates would contribute to current overdraft of the aquifers, the decrease associated with the AFSLV project would occur over a limited area, and is not expected to result in a significant impact.

Potential impacts to the local groundwater at VAFB and San Nicolas Island could result from sanitary waste disposal, soil compaction from construction equipment, wash water disposal, and spills of petroleum products from equipment used during construction. Potential impacts to the principal aquifer in the Lancaster Groundwater Basin at EAFB could result from spills of petroleum products from launch support equipment, and spills of fuel during carrier aircraft refueling. In consideration of the depth of groundwater at EAFB and spill response plans in place, the impact associated with the AFSLV project is not expected to be significant.

3.1.3.3 Summary of Hydrology and Water Quality Impacts

Potential impacts on hydrology and water quality are summarized on Table 3.1.3-1.

3.1.4 Geology and Soils

Geologic impacts are primarily related to earthquakes and associated hazards, while impacts to soils are related to erosion.

3.1.4.1 Topography and Physiography

- **Vandenberg Air Force Base**

Impacts to topography or physiography could possibly occur as a result of modifications to existing sites and facilities. These sites include LF 06, Test Pad 1, ABRES A-3, SLC-4W, and SLC-5. Topography and physiography would be altered and impacted by the construction of facilities at the undeveloped sites, Cypress Ridge and Boathouse Flats.

Table 3.1.3-1

Summary of Potential Hydrology and Water Quality Impacts of the AFSLV Program

	LF 06	Test Pad 1	ABRES A-3	SLC-4W	SLC-5	Cypress Ridge [1]	Boathouse Flats [1]	EAFB	Pad 192
Hydrology									
Contamination of groundwater from wastewater discharge	●	---	●	●	●	---	---	---	●
Increased demand on groundwater	●	●	●	●	●	●	●	---	---
Water Quality									
Contamination of water by HCl and Al_2O_3	●	---	●	●	●	---	---	---	●
Contaminated stormwater runoff	⬭	---	⬭	⬭	⬭	---	---	---	⬭
Decrease in infiltration rates contributing to overdraft[a]	●	●	●	●	●	●	●	●	●
Contamination from accidental spills	●	●	●	●	●	●	●	●	●

● = Same impact compared to other sites ⬭ = Moderate impact compared to other sites
--- = No impact
1 Truck/Trailer launch system
a In the event new construction occurs

- **Edwards Air Force Base**

Since excavation and grading at EAFB is not expected, impacts to topography or physiography would not occur as a result of the proposed project.

- **San Nicolas Island**

Since excavation and grading at San Nicolas Island would be limited to reconstruction of existing Pad 192, impacts to topography and physiography are not anticipated.

3.1.4.2 Stratigraphy

Unique geologic structures or formations are not present at VAFB or EAFB. Therefore, significant impacts to stratigraphy are not anticipated as a result of the proposed project.

Existing or new surface cracks or fissures in the Quaternary age playa deposits, associated with groundwater extraction, could adversely impact future operations at EAFB.

Stratigraphic units on San Nicolas Island are primarily sandstone and sand dunes. These formations are highly susceptible to erosion, especially when disturbed by excavation or grading activities.

3.1.4.3 Paleontologic Resources

- **Vandenberg Air Force Base**

Many of the formations underlying VAFB contain fossils. These fossils are not unique, and generally widespread throughout the region. Terrace deposits throughout VAFB have the highest potential for yielding significant vertebrate fossils. Any grading and excavation at the undeveloped Cypress Ridge and Boathouse Flats sites, and at LF 06 and SLC-4W, could result in significant impacts to paleontologic resources. It is not likely that paleontologic resources would be significantly impacted at the other VAFB sites.

- **Edwards Air Force Base**

Excavation and construction are not anticipated at EAFB as part of the AFSLV program. Therefore, impacts to paleontologic resources would not occur.

- **San Nicolas Island**

Any construction at Pad 192 involving excavation may result in significant impacts on paleontologic resources, although the significance of these impacts cannot be judged at the present time. Additionally, surface activities, such as foot and vehicle traffic, can destroy fossils that have weathered out of rocks on the surface.

3.1.4.4 Mineral Resources

- **Vandenberg Air Force Base**

Oil and gas reserves represent the most important commercial mineral resources at VAFB. The proposed project would not be expected to result in significant impacts to these resources.

- **Edwards Air Force Base**

It is unlikely that any mineral resources at EAFB would be impacted by the proposed project. Since lands at EAFB have been withdrawn from mineral entry, the probability of future discoveries of commercial resources is extremely low.

- **San Nicolas Island**

It is unlikely that mineral resources on San Nicolas Island would be impacted by the proposed project.

3.1.4.5 Soils

- **Vandenberg Air Force Base**

The primary impact to soils is erosion. Both improper grading for sites, or disturbance of surface vegetation can lead to increased runoff and erosion of soil. This is especially true in areas underlain by sand dunes. Sand dunes are also subject to wind erosion. Both Test Pad 1 and ABRES A-3 sites are located on sand dunes.

Modification of the land surface and drainage patterns, through excavation and grading, could result in increased erosion, especially for undeveloped sites at Cypress Ridge and Boathouse Flats. This erosion could increase siltation in streams, and impact wildlife habitat.

- **Edwards Air Force Base**

Since excavation and grading will not occur, soils at EAFB would not be impacted by the proposed project.

- **San Nicolas Island**

Excavation for reconstruction of Pad 192 could disrupt soils locally. If roads leading to Pad 192 require reconstruction to accommodate SLV loads, additional disruption of soils would occur. This disruption of soil would increase erosion. Pad 192 is located in an area underlain by inactive eolian sands. These stabilized sands are sensitive to disruptions. If disrupted, they would be subject to both wind and water erosion.

3.1.4.6 Geologic Hazards

- **Vandenberg Air Force Base**

Landslide hazards could be significant at VAFB, especially at sites located in or adjacent to the Santa Ynez Mountains or Casmalia Hills. Additional landslide hazards are associated with sites above sea cliffs. Improper grading activities, or undercutting by streams or wave action, can trigger or accelerate landslides in these areas.

The LF 06 site is located at the base of the Casmalia Hills and it could be subject to landslide hazards from the hillside above. The Cypress Ridge site, located on an elevated marine terrace cut into the Santa Ynez Mountains, could also be subject to landslide hazards from slopes above. The Boathouse Flats site, located on the lower most marine terrace, could be subject to slope failures resulting from wave action undercutting the sea cliff below.

Flooding along the Santa Ynez River, San Antonio Creek, or one of the other drainages at VAFB could inundate improperly located facilities. None of the proposed sites are located within stream or river drainages. Therefore, no flooding hazards to sites from these drainages are present.

Historic seismic activity in the region around VAFB indicates a high probability that VAFB will continue to experience strong to intense ground motion from future moderate and major earthquakes centered on faults in the region. Extended periods of ground shaking, localized high ground acceleration, and possible surface rupture could cause severe damage to facilities at VAFB. All proposed sites would be subject to strong or intense ground motion resulting from future earthquakes. In addition, the following sites are located in areas that could experience ground rupture along unmapped fault segments: LF 06, SLC-4W, SLC-5, Cypress Ridge, and Boathouse Flats.

Extended periods of ground shaking, produced by moderate or major earthquakes in the vicinity, could produce localized liquefaction along San Antonio Creek and the Santa Ynez River, causing damage to facilities constructed in these areas. Although none of the proposed sites are located in areas that have been designated as having high liquefaction potential, pipelines and utilities crossing areas subject to liquefaction could be severed during extended periods of ground shaking.

These moderate and major earthquakes could also trigger landslides, creating the potential for additional damage to facilities sited below hillsides or above sea cliffs. Major earthquakes, along offshore faults, could possibly generate tsunamis that could inundate sites along the coastline.

- **Edwards Air Force Base**

Historic seismic activity in the region around EAFB indicates a high probability that EAFB will continue to experience strong to intense ground motion from future moderate and major earthquakes centered on faults in the region. Extended periods of ground shaking, localized high ground acceleration, and possible surface rupture could cause severe damage to facilities at EAFB.

Extended periods of ground shaking could produce localized liquefaction in areas with shallow perched groundwater, causing the ground surface to loose its load bearing capacity. Tanks and other engineered structures in these areas may settle, resulting in ruptured pipelines and severed utilities.

Any increase in groundwater extraction at EAFB, or in the vicinity, will contribute to regional overdraft. This overdraft contributes to existing problems related to ground subsidence, and the creation of associated surface cracks or fissures. Existing or new surface cracks or fissures could adversely impact future operations at EAFB.

Flooding along swollen streams and arroyos, or from sheet wash, could result from severe thunderstorms and inundate improperly located facilities at EAFB.

- **San Nicolas Island**

Historic seismic activity in the San Nicolas Island region indicates a high probability that San Nicolas Island will continue to experience moderate to strong ground motion from future moderate and major earthquakes centered on faults in the region. Movement on faults found throughout San Nicolas Island could possibly result in surface rupture near Pad 192. Facilities used for docking and unloading materials barges would be exposed to potential tsunamis of both local and distant origin. Pad 192 is located on gently sloping terrain. Therefore, landslides at the site would not present a hazard. However, access roads crossing or passing beneath steep slopes could be exposed to landslide hazards, especially if grading activities are required to modify or reconstruct these access roads.

3.1.4.7 Summary of Geology, Soils and Geologic Hazards Impacts

Potential impacts of the AFSLV program on geology, soils and geologic hazards are summarized on Table 3.1.4-1.

Table 3.1.4-1

Summary of Potential Geology, Soils and Geologic Hazards Impacts of the AFSLV Program

	LF 06	Test Pad 1	ABRES A-3	SLC-4W	SLC-5	Cypress Ridge [1]	Boathouse Flats [1]	EAFB	Pad 192
Changes in topography or physiography from site modification	◉	◉	◉	◉	◉	◉	◉	---	---
Erosion of stratigraphic units from any construction	---	---	---	---	---	---	---	---	●
Loss of potentially significant fossils from older alluvium in the event of construction	◍	○	○	◍	○	◍	◍	○	◉
Erosion of sand dunes from construction (eolian sands at Pad 192)	---	◉	◉	---	---	---	---	---	●
Landslide hazards	◉	---	---	---	---	◉	---	---	---
Slope failure from wavecutting of sea cliffs	---	---	---	---	---	---	◉	---	---
Strong to intense ground motion from future earthquakes	◉	◉	◉	◉	◉	◉	◉	◉	◉
Possible ground rupture along unmapped fault segments	◍	---	---	◍	◍	◍	◍	◍	◍
Surface cracks or fissures associated with ground-water extraction	---	---	---	---	---	---	---	●	---

= Lowest impact compared to other sites	= Same impact compared to other sites
= Low impact compared to other sites	= Highest impact compared to other sites
= Moderate impact compared to other sites	--- = No impact

1 Truck/Trailer launch system

3.1.5 Biota

The impacts of the AFSLV program on biological resources of VAFB, EAFB and San Nicolas Island will be described in this section.

3.1.5.1 Terrestrial Biota

Construction and operation of the AFSLV program at VAFB, EAFB or San Nicolas Island could result in impacts to vegetation and wildlife. Impacts could occur due to loss or removal of habitat by construction activities such as grading. In general, these effects would be the same for a conventional launch pad and a truck/trailer system. Impacts to wildlife behavior and distribution could result from increased human activity in an area. Impacts from operations could occur from post-launch ground clouds and launch noise.

Impacts to vegetation would be considered significant if rare or endangered species of plants were affected, a regionally or locally important plant community or species habitat were substantially diminished, or if large numbers of exotic species were to invade areas containing native vegetation. Impacts to wildlife would be considered significant if habitat, including that of any listed species, were substantially diminished, or if movement of resident or migratory wildlife and reproductive behavior were substantially disrupted (USAF, 1989c).

The removal and alteration of vegetation during construction would be a local impact. determined by the specific siting and extent of construction required and the extent of removal of regionally or locally important plant communities.

In general, minimal effects would occur from use of an active launch complex if modifications were to take place only within the existing perimeter fence and access roads were to be used. This would be expected at SLC-4W and SLC-5 on South VAFB, and at the EAFB existing facility. Modification of active launch complexes at Test Pad 1, ABRES A-3 and Pad 192 on San Nicolas Island would require careful evaluation since these facilities are situated in stabilized dunes. Additional impacts to terrestrial biota may occur if additional roadwork or utility corridor construction is necessary. Any use of land outside the existing perimeter fence at LF 06 would require a survey of biological resources (Sabol, 1990). This site is located in grasslands but may be biologically valuable due to its proximity to coastal sage scrub and stabilized dunes.

Impacts to vegetation could occur on undeveloped sites for construction and operation of the AFSLV program at VAFB. Use of the Cypress Ridge and Boathouse Flats sites would require installation of new utility corridors and access roads. This activity could result in loss of habitat from removal of vegetation including possible loss of some individuals of the federal candidate plant, San Luis Obispo monardella, which occurs at both sites.

If deluge water is used for the AFSLV, acid deposition (HCl) may occur upon contact of the deluge water with propellant exhaust products. Acute vegetation damage has occurred in Space Shuttle exhaust cloud paths less than 0.5 mile from the launch pad at Kennedy Space Center. These results suggest that similar impacts could occur at VAFB from AFSLV launches. Preliminary studies from Titan IV launches from Cape Canaveral Air Force Station, Florida, did not report acidic deposition in the near- or far-field regions. Analyses of launch-related deposition of aluminum oxide have not shown damage to plant life (USAF, 1990c). Because the proposed AFSLV launch would generate a smaller ground cloud than the Titan, it is not expected that these effects would result in significant impacts to vegetation on the site in the event that launch deluge water is used.

Impacts to terrestrial biota on San Nicolas Island would not be expected from the use of Pad 192 assuming new construction is not required. In the event any earthmoving activities were required at this site, removal of vegetation may result in impacts to terrestrial species. This impact may be significant if special status species are affected. The potential effects from a launch ground cloud could also be expected on San Nicolas Island, although such effects are not expected to result in significant impacts.

3.1.5.2 Freshwater Biota

The primary potential impact to freshwater resources would be from discharge of washdown water into intermittent creek and canyon streams. The AFSLV program launch operation will require the containment of any post-launch washdown water in an on-site retention basin. This wastewater will require testing and possible pretreatment in accordance with RWQCB requirements. It is unlikely that post-launch washdown water will be discharged into any freshwater body on VAFB before it is tested. The AFSLV sites located in proximity to freshwater resources are LF 06, ABRES A-3, SLC-4W, and SLC-5.

3.1.5.3 Marine Biota

The primary impacts to marine biota would occur at sites located close to the coast. These sites are LF 06, ABRES A-3, Boathouse Flats and San Nicolas Island. The increase in activities during construction and operations would result in impacts to marine mammals and marine birds. Any blasting during construction could result in a sudden "startle response" to marine life along the coast. Noise generated during launch of the AFSLV could result in short-term, localized effects on marine birds. The "startle effect" associated with the ignition and lift-off of a launch vehicle rocket engine will, at worst, be a momentary negative effect, which has been identified in other environmental assessments of larger more power vehicles operating from VAFB as insignificant (USAF, 1989b).

The primary concern with "startle effect" noise is its impact upon the California least tern, which has identified nesting sties near the shoreline approximately 1.5 miles northwest of ABRES A-3 and at Point Purisima, 2.8 miles southwest of ABRES A-3. The thrust rating and associated noise levels for the AFSLV will be studied in a site specific environmental analysis in order to determine any noise-related impacts on species of concern like the least tern. Additional discussion is provided in Section 3.1.5.5.

The potential exists for release of spilled propellant or other substances into the ocean. Specific impacts associated with leaks or spills of toxic substances can be evaluated based on specific program information such as propellant quantities. These impacts will be evaluated in a site specific environmental analysis.

Launch operations from San Nicolas Island may have potential for adverse effects on marine biota of the island. The Navy currently launches smaller vehicles to the northwest. The AFSLV would be a larger space vehicle that would be launched to the south over seal, sea lion and gull rookeries on the southern and western shores of the island. The overflight path would extend over breeding grounds for three federally protected marine mammal species and the foraging habitat of the federally threatened sea otter. This action may be considered a disruptive military activity as defined in Navy regulation COMPMTCINST 6280.1 (as superceded by COMPMTCINST 5090) which states that future facility development or disruptive military activities should not be built near the rookeries or marine mammal breeding grounds (Navy, 1986).

3.1.5.4 Channel Island Biota

Construction and operation of the proposed AFSLV program at VAFB would not result in any impacts to Channel Islands biota from emissions of air pollutants. The post-launch ground cloud generated by the AFSLV at VAFB would dissipate significantly by the time it reaches the Channel Islands due to the size and short-term nature of the ground cloud.

The potential for generation of a launch-related sonic boom from the AFSLV is expected to be minimal based on its weight class. The weight class of the launch vehicle also influences the magnitude of the sonic boom. The effects of a sonic boom on biota of the Channel Islands have previously been studied in USAF (1988d, 1990c). Potential impacts that have been identified include physical effects and startle effects on marine mammals, cetaceans, and seabirds. Physical effects include temporary hearing damage as a result of response to sudden impulse sound. Startle effects include sudden disruption or alteration of normal behavior including normal breeding, roosting or movement patterns. On San Nicolas Island, the potential for such effects is magnified because of the close proximity of the launch site to large populations of these species, many of which breed on the island. The proposed AFSLV launch to the south may result in direct physical and startle effects on wildlife.

3.1.5.5 Threatened and Endangered Species

There are no federally-listed threatened or endangered plant species on VAFB. Two species are state-listed as threatened, the beach spectacle pod, and the surf thistle. Two species also are state-listed as rare, the Lompoc Yerba Santa and the beach layia. Nine federal candidate, seven Category 2, two Category 1, and one state-listed Candidate species of plants have been recorded from VAFB (CNDDB, 1989). These species occur mostly along the coast, particularly on San Antonio Terrace, Burton Mesa and Cypress Ridge. The likelihood of encountering any of these candidate species of plants would be greatest at Test Pad 1 (on San Antonio Terrace), ABRES A-3, SLC-4W, SLC-5, Cypress Ridge and Boathouse Flats. One of these candidate plant species, the San Luis Obispo monardella, has been documented at Cypress Ridge and Boathouse Flats. Loss of this particular population would be considered a significant impact because this species is at the southern limit of its range. The primary impacts to these special status plant species would occur as a result of locating proposed facilities in areas where these species occur.

A few of the special status birds species that occur on VAFB may nest on base. Nesting by the peregrine falcon is probable but unconfirmed on South VAFB. Confirmed nesting sites for the California least tern are located at San Antonio Creek, Purisima Point and the Santa Ynez River. Nesting activities may be affected by launch operations associated with the AFSLV at Test Pad 1, ABRES A-3 and SLC-4 which are the closest to nesting locations.

Birds similar to the California least tern have a sound sensitivity frequency range from approximately 100 Hz to 10,000 Hz with maximum sensitivity around 2,000 Hz. Seals and sea lions have sound sensitivity from 500 Hz to 45,000 Hz (EPA, 1980). In comparison, humans hear at about the same frequency range as birds, but at a lower overall frequency range than seals and sea lions. Section 3.2.5.3 of this document notes that chemical rocket propulsion systems generate energy fields in a wide frequency spectrum (1 Hz to 100,000 Hz). Comparable actual noise measurements for Titan III D showed that maximum sound pressure levels occurred from 20-50 Hz, which is inaudible to seals, sea lions, and birds. This, however, does not mean that the launch would be inaudible to these animals due to the wide frequency spectrum associated with launch, since there is significant acoutic energy in the frequencies above 50 Hz.

Intensity and the audible sound frequency cause potentially adverse impacts to biota. The vocalization mean peak sound pressure level for 18 species of birds (variable body mass and measured 1 m from the birds) was found to be approximately 84 dB. No correlation was found between intensity and mass (SANDAG, 1990). The critical ratio, a ratio of sound intensity to frequency, for birds and most other vertebrates measured increases 3 dB with each doubling in frequency (SANDAG, 1990). For example, at 2,000 Hz the critical ratio for birds is about 27 dB. This means for a noise in the 2,000 Hz band to be discerned, it would have to be 27 dB above the existing background noise (SANDAG, 1990). The higher the frequency, the greater the sound intensity must be for it to be heard over ambient noise levels. The inverse is also true.

Data presented in Table 3.2.5-1 estimates the overall sound pressure level contour for the AFSLV as 120 dB, at 0.5 miles from the source. At audible frequencies, this is great enough over ambient noise levels to be discerned. In the audible frequency range of seals and sea lions which falls above that of birds and humans, the intensity of launch noise should not be great enough over ambient noise levels to be discerned. Frequencies at the low end of the discernible range from the AFSLV will be most easily heard over ambient noise. The most significant impact on fauna expected due to launch of the AFSLV is a temporary startle effect. A hearing threshold shift, the correlated increase of hearing threshold level and partial or total hearing loss, is not expected because exposure is episodic and of an insufficiently high intensity (EPA, 1980). One area of uncertainty is the effect of low (but indiscernible) frequency noise levels on reproductive behavior and development.

The California least tern nesting sites on VAFB is of sufficient distance from proposed launch sites to substantially reduce any potential harmful effects from AFSLV launches. It is important to note, however, that AFSLV launch from the ABRES A-3 site will require Section 7 consultation with the U.S. Fish and Wildlife Service because of the launch site's proximity to least tern breeding areas. In the past, prior notification of scheduled launch times were required to be given to VAFB Environmental Management in order to monitor noise levels and determine effects on marine life. Launches occurring from late September to early March will have no effect on the California least tern due to their migration pattern.

Seals and seal lions are expected to exhibit a temporary startle effect, at most, during launch of the AFSLV. This effect would be most intensely felt at known haul out areas; such as those near the Point Arguello Boathouse (Boathouse Flats) and Purisima Point.

Effects on the Western snowy plover, a candidate species which nests in the Santa Ynez River area, would be similar to effects on the least tern. Such effects would be expected from launch at SLC-4W only. AFSLV launch noise is expected to be of a magnitude and frequency similar to that occurring at the active launch sites, therefore, impacts on the breeding behavior would not be significant.

The endangered unarmored three-spine stickleback fish in San Antonio Creek and Cañada Honda Creek will not be impacted since no activities associated with the AFSLV will directly or indirectly affect this area.

Since the proposed AFSLV project at EAFB does not include construction of new facilities, impacts to special status species on EAFB will not occur. Launches from EAFB may overfly the California Condor Refuge near Mt. Pinos. Though all California Condors are now in captivity, a re-release program is currently under consideration; therefore, avoidance of this area is recommended. Current air launches from B-52 aircraft based at EAFB maintain an envelope of approximately 3,000 ft around the California Condor

Refuge. Boosters are launched 50 miles off shore to avoid impacts to the refuge (USAF, 1989d). Biota over the open ocean is found almost exclusively under water; and, therefore, is unaffected by noise associated with this type of launch. In the event any new construction were to occur at EAFB, a site specific environmental analysis would be required to determine potential impacts on any of the four candidate plant species and special status terrestrial species which include the federally-listed threatened desert tortoise and state-listened threatened Mojave ground squirrel.

Use of Pad 192 on San Nicolas Island for the AFSLV program is not expected to result in any effects on habitat for any special status species. In the event any new construction were to occur, a site specific investigation would be required to determine potential impacts on any special status species. Launch from Pad 192 may have adverse effects on special status reptiles and marine mammals as a result of response to noise and/or sonic booms particularly during breeding periods for these species. Additional barge landing operations for the AFSLV program will have adverse effects on marine mammals and seabirds that use the coastal area. In particular, such operations may affect sensitive breeding habitat of the candidate Western snowy plover.

3.1.5.6 Summary of Biological Impacts

Potential impacts of the AFSLV program on biological resources are summarized in Table 3.1.5-1.

3.1.6 Visual Resources

The proposed AFSLV may result in impacts to the existing visual environment of VAFB, depending on which launch system and site is selected. The construction and operation of the proposed launch program may alter the existing visual character in varying degrees, depending on the extent of construction and associated disturbances such as traffic and illumination. The extent of visual impacts would be determined by factors such as the acreage to be disturbed, the degree of grading and other construction, the amount of vegetation removed, and the number of personnel to be at the facility.

The proposed project, if located on VAFB, could result in the loss of visual resources in the region if a site that offers scenic resources to the public is selected. The loss of visual resources would be those aesthetic views that are available from public beaches, marine vessels and railroad views. Because of base restrictions to the general public, potential areas of impact would not be closely visible to the public. The nearest public views are

Table 3.1.5-1

Summary of Potential Biological Impacts of the AFSLV Program

	LF 06	Test Pad 1	ABRES A-3	SLC-4W	SLC-5	Cypress Ridge [1]	Boathouse Flats [1]	EAFB	Pad 192
Loss of habitat from construction of new facilities	◍	◍	◍	◍	○	●	●	◍	◍
Potential effects on sensitive sand dune habitat	◍	◍	◍	---	---	---	---	---	◍
Possible loss of special status species as a result of any construction	---	---	---	○	---	◍	◍	○	○
Inadvertent contamination of adjacent freshwater resources from wastewater discharge	◉	---	◉	◉	◉	---	---	---	---
Potential effects on marine mammals and birds along the coast from construction, noise, ground cloud contamination, and accidental spills	○	---	---	---	---	---	◍	---	●
Potential effects on breeding species of protected marine mammals and sea birds	---	---	---	---	---	---	---	---	●

○ = Low impact compared to other sites
◍ = Moderate impact compared to other sites
◉ = Same impact compared to other sites
● = Highest impact compared to other sites
--- = No impact
1 Truck/Trailer launch system

those momentary views seen by passengers aboard the Southern Pacific Railroad line that runs through VAFB.

On-base visual resources, such as those from VAFB primary roads that offer views to base personnel, may be affected by the addition of man-made structures and any additional illumination of the site that alter the character of an area from undeveloped to industrial. The visual perception of terrain may also be negatively affected by structures that interrupt the continuity of the natural terrain at VAFB.

Visual impacts are not expected to occur at EAFB since the required support facilities are already in place and additional support facilities would not be constructed.

- **North Vandenberg Air Force Base**

The visual character of North VAFB would not be expected to experience adverse effects since each of the three proposed AFSLV sites are existing active facilities that are already in the designated Launch Area of the base where other launch activities currently take place. In addition, effects to visual resources would not be expected as long as the design modifications proposed for the selected North VAFB site does not include the construction of facilities that result in extreme alteration of topography or placement of structures that visually alter the natural terrain (i.e., extreme protrusions or large-scale structures).

The addition of any new facility in this coastal launch corridor, however, would require careful evaluation to determine if the overall wide-open visual character of North VAFB would be altered. Although the launch corridor has been designated for launching activities, it still is characterized by its unique, rustic nature. Careful planning and siting of facilities on this part of the base is important in the preservation of these aesthetic values.

In planning for any facility modifications or additions on North VAFB, it will be important to incorporate design considerations that maximize the natural shielding effects of terrain. This will serve to conceal facilities from any marine vessel or railroad views, and, if possible, from access and primary roads on North VAFB.

Launch Facility 6

This launch complex is remotely located and not visible from Point Sal, (the nearest public beach) or from the railroad. It is visible from marine vessels because it is located so close to the coast and not concealed by terrain. Impacts to visual resources may occur if modifications include structures that visually alter or obstruct the terrain.

Test Pad 1

Test Pad 1 is not visible from any of the primary roads on North VAFB. It is setback from the coast and concealed by terrain such that views from marine vessels would be obstructed. It is not visible from the railroad or public beaches. Impacts to visual resources would not be expected.

ABRES A-3

The ABRES A-3 facility located on Burton Mesa is not generally visible to the public or to travelers on any primary roads. It is setback from the coast such that views from marine vessels would be obstructed. There are no public beaches which offer a view of this site. It is visible from the railroad. Impacts to visual resources may occur if modifications to this facility include structures that visually alter or obstruct the existing terrain at this location.

- **South Vandenberg Air Force Base**

Impacts to visual resources of South VAFB are not expected because the view of South VAFB and its coastline is similarly restricted by topography. The visual character of South VAFB could experience adverse effects if an undeveloped site is selected or if extensive, view-obstructing structures are added to an existing facility. As on North VAFB, effects to visual resources are not expected as long as the design modifications for a South VAFB site do not include the construction of facilities that alter the topography or add structures that visually change the continuity of the natural terrain.

Like North VAFB, the construction of any South VAFB facility on an undeveloped site within the coastal launch corridor would require careful evaluation to determine if the overall rustic character of South VAFB would be modified. Careful planning and siting of facilities on South VAFB is also important to retain the aesthetic value unique to the entire base.

As on North VAFB, planning for any facility modifications or additions on South VAFB should incorporate design considerations that maximize the natural shielding effects of the terrain which, on South VAFB, offers canyons and coastal setbacks. This will serve to minimize the effect of the appearances of these facilities from distant viewing from public beaches, marine vessels or trains, and, if possible, from access and primary roads on South VAFB.

The potential impacts to visual resources from selection of each of the representative sites for the AFSLV program are discussed herein. This evaluation is a preliminary review conducted in the absence of detailed facility designs for each location.

SLC-4W

Because the SLC-4W launch complex is already visible from Coast Road and from passing trains, any additional structural modifications or additions within the present limits of the facility would not alter the existing industrial character of the site. Impacts to visual resources would not be expected.

SLC-5

The SLC-5 facility is not visible from any public viewpoints and is shielded by terrain features. Any modifications to this facility within the present limits would not result in impacts to visual resources.

Cypress Ridge

Implementation of the proposed AFSLV project at the Cypress Ridge site may alter the visual character of the site from undeveloped to active industrial use. Although close public viewing of the site is limited by restricted access to South VAFB, the site is visible from occasional marine and train traffic as well as from Jalama Beach County Park. When viewed from nearby locations, new structures at Cypress Ridge would have a contrasting appearance in relation to its natural surroundings. Views of the coastline would not be affected, although views of the inland site location may be altered by the presence of new man-made structures and any artificial illumination that may be required. Impacts to visual resources may occur.

Boathouse Flats

Construction of a launch facility at Boathouse Flats may alter the visual character of this site from undeveloped to active industrial use. Because of its close proximity to the coast, views of the coastline from railcars would be interrupted by the presence of a launch complex. Distant views of this section of the coast may also be affected since the Boathouse Flats site can be seen on clear days from Jalama Beach County Park and from marine vessels. Siting of the AFSLV facility at Boathouse Flats may result in impacts to visual resources.

- **Edwards Air Force Base**

Takeoff of the carrier aircraft for the AFSLV from the main runway on EAFB would not be visible from nearby public roads, however, aircraft climbout would be noticeable from public roads. The additional AFSLV launches using commercial aircraft is expected to be a maximum of 5 per year which would not result in any impact on existing visual resources in the area.

Use of existing facilities at EAFB would not result in any impact to visual resources. Construction of any new facilities on EAFB for the AFSLV is not expected to result in impacts to visual resources since most facilities would not be visible from public roads.

- **San Nicolas Island**

Use of the existing launch facilities at Pad 192 on San Nicolas Island for the AFSLV program may result in an impact to visual resources of the island. Launch of an AFSLV booster from the island would introduce a larger class of space vehicle to the types of missiles currently launched at this location. Pad 192 is located atop the plateau and is currently used for northwesterly launches. The AFSLV booster is proposed for a southerly oriented launch. Current launching activities from the island do not include southerly launches. Therefore, the AFSLV launch from this site would represent launch of a larger space booster in a direction where previous launches have not occurred. This action, at a maximum of 5 launches per year, would result in an increase in the industrial nature of the island.

Assuming new construction of launch and support facilities would not be required, the operational impact of a maximum of 5 AFSLV launches per year is not expected to be significant since launches would be an infrequent and short-term effect. In the event any construction of new launch or support facilities (i.e., roads, and utility corridors) are required, impacts to visual resources may occur.

3.1.6.1 Summary of Impacts to Visual Resources

Potential impacts of the AFSLV program on visual resources are summarized on Table 3.1.6-1.

Table 3.1.6-1

Summary of Potential Impacts to Visual Resources from the AFSLV Program

	LF 06	Test Pad 1	ABRES A-3	SLC-4W	SLC-5	Cypress Ridge [1]	Boathouse Flats [1]	EAFB	Pad 192
Loss of visual resources from public views if placement of new structures alter terrain	---	---	○	---	---	●	●	---	◐

○ = Low impact compared to other sites
◐ = Moderate impact compared to other sites
● = Highest impact compared to other sites
--- = No impact

1 Truck/Trailer launch system

3.2 MAN-MADE ENVIRONMENT

3.2.1 Population and Socioeconomics

The impacts on population, housing, community facilities and services, transportation and the economy would depend on the size and scope of the project. Information on total labor force for construction, duration of the construction period, construction costs, operational costs and employment, and the number of vehicle trips per day during construction and operation would be needed to evaluate the specific impacts of the program.

For this analysis, it was assumed that 4 construction and 10 operational personnel would be associated with the AFSLV program at existing conventional launch sites. Additional construction personnel would be required for construction activities at the undeveloped sites. Operational personnel would be slightly higher for the truck/trailer launch system.

AFSLV launches from VAFB sites may result in temporary closure of County beaches. Launch from San Nicolas Island may also result in temporary evacuation of surrounding waters.

■ **Active Conventional Launch Facilities at VAFB**

The impact of using an active launch facility at LF 06, Test Pad 1, ABRES A-3, SLC-4W and SLC-5 would be less than from the use of undeveloped sites because new construction would not be required. The addition of 4 construction personnel and 10 operational personnel will not impact the population of VAFB or Santa Barbara County. Due to current vacancy rates of between 2 and 6 percent in local communities, housing would not be impacted. The AFSLV program is not expected to increase the permanent workforce significantly.

Water, power and communications are available at the active sites. Schools, water, police services, fire protection, health care and recreational facilities would not be impacted, due to the negligible increase in population and employment resulting from this project.

Transportation of materials and equipment to an active site may temporarily impact traffic flows on the highways leading to VAFB, if transportation entails a convoy consisting of several oversized or large trucks and trailers. This would not be considered a significant impact.

Use of an active above-ground launch pad would require modification or reconstruction to accommodate the AFSLV. The addition of 4 construction and 10 operational personnel is not expected to have an observable impact on the economy although some positive economic impacts resulting from this construction activity could be anticipated. Impacts from this activity on the overall economy of the county would be insignificant.

Launch from SLC-4W and SLC-5 may result in an estimated maximum of five temporary beach closures per year.

■ **Truck/Trailer Launch from VAFB**

Use of a truck/trailer launch system at LF 06, Test Pad 1 and SLC-5 is expected to result in the addition of 4 construction personnel and more than 10 operational personnel. This action will not impact the population and housing of VAFB or Santa Barbara County.

The transportation of equipment to the site may temporarily disrupt traffic on highways and roads leading to, or on, VAFB. During a truck/trailer operations, all equipment will be removed from the site once a launch is completed. Due to the anticipated number of launches per year (five maximum), impacts would be short-term and localized. Effects are not expected to be significant.

Impacts from this activity on the overall economy of the county would be insignificant.

Launch from SLC-5 may result in an estimated maximum of five temporary beach closures per year.

- **Truck/Trailer Launch from Undeveloped Sites at VAFB**

The truck/trailer system of launch from Cypress Ridge and Boathouse Flats would involve the most construction since these sites are vacant. New roads would be required for access to the Cypress Ridge site. Road access and electrical service are available at the Boathouse Flats site. Depending on the extent of construction planned, and on the personnel employed for launch operations, it is expected that impacts would be greater than use of an active site.

In the short-term, community facilities may be impacted, depending on the number of construction personnel and the duration of the construction period. Long-term impacts on community facilities and services will not be significant, assuming the number of operational personnel involved are slightly greater than a conventional launch pad operation.

Transportation of materials and equipment to the site may temporarily impact traffic flow on the highways leading to VAFB, especially if transportation entails a convoy consisting of several oversized or large trucks and trailers. Due to the anticipated number of launches per year (five maximum), impacts would be short-term and localized. Effects will not be significant.

Impacts on the local economy resulting from operations will be insignificant, assuming the number of personnel employed is approximately the same as in the conventional launch proposal. Construction-related impacts on the economy would be short-term and are not expected to be significant.

Launch from Cypress Ridge and Boathouse Flats may result in a maximum of five temporary beach closures per year.

- **Air Platform Launch from EAFB**

It is expected that twelve temporary workers would be brought onto EAFB for a duration of about two weeks in conjunction with the assembly of an air platform launch of the AFSLV from EAFB. Eight permanent workers would be employed at EAFB for the project. They will reside in the vicinity of EAFB and use available community services. The addition of 12 temporary workers and 8 permanent workers is not expected to have an observable impact on population, housing, community facilities and services, or the economy. This increase would be considered insignificant.

AFSLV rocket motors would be delivered in a truck transportation trailer called the TARVAN which is a specially designed covered trailer measuring about 60 ft long and 9 ft wide. Each AFSLV launch vehicle will require two shipments from Hercules Aerospace Company, in Magna, Utah, to EAFB in the TARVAN by a commercial trucking firm. The second-and third-stage motors will be transported together; the first-stage motor will be shipped separately because of its size. The primary route of AFSLV transport will most likely be from Magna, Utah, on U.S. Highway 15, through Las Vegas, Nevada, into California. The TARVAN will proceed to Barstow where it will most likely turn west on California State Highway 58 to the North Gate of EAFB. The total distance is about 700 miles. Approximately 12 rocket motor shipments are planned for the six potential rocket assemblies. When rocket components arrive at EAFB, they will be transported through the base to the existing ground support facilities located within the NASA DFRF adjacent to the western edge of Rogers Dry Lake. Because this operation would result in a continuation of existing transport of materials to EAFB, observable impacts on traffic congestion in the EAFB area are not expected.

Impacts on the local economy from operations are expected to be insignificant.

- **Launch from San Nicolas Island**

The addition of 4 construction personnel and 10 operational personnel is not expected to impact the population of San Nicolas Island. Office space will be needed for 6 engineers. Housing on the island may, however, be a problem, due to the current lack of sufficient living quarters. It is likely that the contractor will have to bring in one or more temporary trailers to house personnel.

All water on San Nicolas Island is barged onto the island. The contractor will be expected to bring in all water needed for project personnel and operation. The provision of electrical power by the host facility would not be impacted because the system is currently operating under capacity. Police, fire, health care and recreational services and facilities should not be significantly impacted due to the comparatively low number of personnel to be brought to San Nicolas Island for the AFSLV program.

The Navy uses a barge to transport equipment to San Nicolas Island. This entails the construction of a new earthen dam on the beach for each unloading operation. The earthen material is mechanically removed to the extent possible. The remainder eventually washes away. The contractor will be responsible for transporting all personnel and equipment to, and removing waste materials from, San Nicolas Island. The barging of equipment would necessitate the contractor to coordinate barging operations or schedule separate barging operations.

The contractor will also have to make arrangements to air transport personnel to and from the Island. Depending on the scheduling of personnel, additional flights may be required.

It is assumed that 4 personnel would be employed during the construction phase of the project to remove an existing steel launch rack on the pad emplacement, and for installation of a steel reflection plate. It is further assumed that 10 personnel will be employed in conjunction with launches. Due to the small number of personnel employed, economic impact resulting from such activities would be insignificant because of the infrequent and short duration of evacuations.

Commercial fishermen that use the waters around the island would be temporarily evacuated during launches from San Nicolas Island. The anticipated maximum of five AFSLV launches per year is not expected to conflict directly with the fishing season, although it is possible that some economic impacts to fishing activities may occur as a result of evacuations. Such impacts are expected to be insignificant because of the infrequent and short duration of evacuations.

3.2.1.1 Summary of Impacts to Population and Socioeconomics

Potential impacts of the AFSLV program on population and socioeconomics are summarized on Table 3.2.1-1.

Table 3.2.1-1

Summary of Potential Impacts to Population and Socioeconomics from the AFSLV Program

	LF 06	Test Pad 1	ABRES A-3	SLC-4W	SLC-5	Cypress Ridge [1]	Boathouse Flats [1]	EAFB	Pad 192
Possible effect on community services due to construction personnel	---	---	---	---	---	●	●	---	---
Possible need for additional temporary housing	---	---	---	---	---	---	---	---	●
Possible effect on water supply	---	---	---	---	---	---	---	---	●
Possible effect on barge operations	---	---	---	---	---	---	---	---	◐
Possible need for additional flights to transport personnel	---	---	---	---	---	---	---	---	◐
Temporary closures of beaches	○	○	○	●	●	●	●	---	---
Possible economic impacts to fishing activities during evacuation of waters	---	---	---	---	---	---	---	---	◐

○ = Lowest impact compared to other sites

◐ = Low impact compared to other sites

● = Moderate impact compared to other sites

1 Truck/Trailer launch system

--- = No impact

3.2.2 Land Use

Construction and operation of the proposed AFSLV program will not result in any significant impacts to land use at VAFB, EAFB and San Nicolas Island since the project would be located in an area that is currently used for similar launch activities.

Two of the proposed sites for the AFSLV program are currently undeveloped. Use of the Cypress Ridge site would require some construction activity, such as the installation of concrete pads and access roads. Use of the Boathouse Flats site would also require some construction, although an access road already exists. Although this would result in a change in local land use from undeveloped to industrial, such activity would be compatible with the general use of land in the location since the site is located on the designated launch corridor of VAFB.

3.2.3 Waste Management

Potential environmental impacts related to waste management of the AFSLV project include the generation of domestic, industrial, and hazardous wastes from construction and operational activities. Impacts relative to waste management are evaluated for active launch facilities and undeveloped sites at VAFB as well as the active launch facilities at EAFB and San Nicolas Island.

A hazardous waste report is provided in Appendix B of this EA. The purpose of this report is to provide a preliminary overview of hazardous wastes likely to be produced at the launch site by the proposed AFSLV program. In addition, the report identifies regulatory compliance and needs for permitting, existing hazardous waste programs and methods of hazardous waste minimization. Hazardous and other industrial waste streams are identified along with control and treatment options for the AFSLV program. A comparison between launch vehicle systems and sites is also provided.

- **Domestic Waste**

During the construction phase of the project, domestic waste may be generated. Waste generated by chemical toilets at the undeveloped sites on VAFB would be disposed of at a permitted POTW. This additional waste generation is expected to be a relatively small amount and regional impacts will not be significant.

Domestic wastes produced during operations on VAFB would be treated by either a packaged sanitary sewage treatment plant (STP) or a septic tank leach-field system, depending on the launch site. The sludge from the sedimentation tanks of the treatment system would be collected and taken to a permitted POTW for disposal. Septic tanks systems used at some existing facilities at VAFB have capacities of less than 2,500 gpd. Packaged STPs have higher capacities of up to 28,000 gpd at some SLCs. The amount of waste would only be generated a few months out of the year during pre-launch, launch, and post-launch operations; therefore, no significant impact on the treatment system will occur as a result of this program.

The existing sanitary sewer treatment facilities may be used during the construction of operational phases of the AFSLV project at any of the proposed active launch sites. The design capacities of these treatment units range from 1,000 to 15,000 gpd, as previously discussed in Section 2.2.3.2. Using a capacity of 40 gpd per person as the design criteria, the existing facilities could treat a waste flow equivalent of 25 to 375 people, depending on the site (Peterson, 1990). The sanitary treatment facilities for the existing Scout vehicle program at SLC-5 has the smallest capacity at 1,000 gpd. The amount of domestic waste generated from the proposed AFSLV project is likely to be similar to the Scout program.

Additional sanitary treatment capacity may be required during operation of the proposed project if more than 25 people are needed to perform the work at any of the proposed active launch sites on VAFB and San Nicolas Island. In this case, portable chemical toilets could be provided by the contractor. It is estimated that one toilet would be needed for every 30 to 40 construction workers. Chemical toilets would also be provided at the undeveloped sites since sanitary treatment facilities do not exist at those sites. Significant impacts would not be expected.

During operations the proposed project would require new septic tank treatment systems at the undeveloped sites. The treatment system would normally treat up to 2,500 gpd or less. This capacity is equivalent to a working crew of about 60 people generating 40 gpd of domestic waste. The new septic systems could be added to the existing RWQCB permit held by VAFB.

The capacity of the sewage treatment units would be a requirement for the design criteria for the proposed AFSLV project. Significant impact to the environment would not be expected, provided the design of the treatment system was adequate to meet the permit requirements of the RWQCB.

The existing air platform site at EAFB is connected to the base sanitary sewer system; therefore, significant impacts from construction or operational activities would not occur at this site.

- **Industrial Waste**

Industrial waste generated during the construction phase of the project would consist of building materials such as solid pieces of concrete and metal, lumber, and demolition debris. These materials would be disposed of at an approved Class II or Class III landfill near VAFB. Although these additional waste materials would reduce the overall life of the landfills, this activity would not cause a significant impact.

The generation of industrial waste from washdown water during operational conditions at the proposed sites is not expected. However, if any liquid industrial waste were generated as a result of the AFSLV program (contaminated stormwater runoff) on VAFB, if would be disposed of at facilities on South VAFB according to RWQCB requirements. Small amounts of solid waste may be generated and could be disposed of either at the North VAFB Class III landfill or a similar approved landfill off site. The addition of these industrial wastes would not significantly reduce the overall life of the landfill or the base treatment facilities and, therefore, would not adversely impact waste disposal facilities in the region.

In the event construction and minor building modification activities occur at the launch site, industrial waste generation during the construction phase would consist of materials such as metal and concrete. These materials could be disposed of at either the North VAFB Class III landfill or an off-site Class II landfill. Industrial waste generated at Pad 192 on San Nicolas Island would be transported by barge off the island to Port Hueneme by the contractor. The proposed launch sites requiring the greatest amount of solid waste are the facilities which require construction of new structures (vehicle pedestal, launch stand or pad, pipelines, etc.) or modifications to existing buildings. Table 3.2.3-1 presents a ranking of launch system/launch site combinations in order of highest potential for generation of industrial solid waste. This table only represents a measure of the amount of solid waste that could be generated as a result of the program since it is not possible to approximate the amounts until a specific launch system and site have been selected. However, adverse impacts from solid industrial waste are not expected from these construction activities at any of the potential AFSLV launch sites.

Table 3.2.3-1

Ranking of Launch System/Launch Site Combinations
Based on Solid Industrial Waste Generation

LAUNCH SYSTEM	LAUNCH SITE
Truck/Trailer (new roads)	1. Cypress Ridge 2. Boathouse Flats 3. SLC-5, Test Pad 1, LF 06
Launch Pad (existing)	4. LF 06, ABRES A-3, SLC-4W, SLC-5, Test Pad 1, Pad 192
Air	5. EAFB

Generation of industrial waste from deluge water at the proposed sites is not expected. Deluge water is typically only used for launch vehicles such as the Titan IV where a reservoir below the launch pad is flushed with water (deluge) immediately after launch to suppress high noise levels and flames from the exhaust system. Therefore, the AFSLV program is not expected to result in any adverse impact from liquid industrial waste.

- **Hazardous Waste**

During AFSLV construction activities, hazardous wastes such as cleaning fluids, hydraulic fluids, cutting fluids, waste oils, and waste antifreeze would be generated. The individual contractors in charge of the construction work would be responsible for the proper containerization and disposal of the wastes. This waste would either be disposed of at Class I landfill or recycled. Therefore, generation of hazardous waste during construction would not result in significant impacts.

Hazardous waste generated during operations would consists of materials such as various solvents and cleaners, paints and primers, small amounts of water contaminated with hypergolic fuels, adhesive, alcohol, lubricant, propellant, and contaminated clothing and cleaning rags. An example of some of the typical hazardous waste chemicals which may be generated by the AFSLV program is shown in Appendix B. These types and quantities of hazardous waste are similar to the kinds of hazardous waste generated from the existing Scout vehicle program on VAFB (USAF, 1990d). The total amount of chemicals used for the Scout program is approximately 38,000 lb annually, However, most of this would be consumed during operational activities and not left over as waste. For instance, approximately 34,000 lb of the chemicals listed in Appendix B are gasoline and diesel fuel. The remaining 4,000 lb represents less than 0.1 of a percent increase of the total annual waste generated in 1989. In contrast, the existing ALV program at EAFB generates less than 10 pounds per year and no liquid hazardous wastes (USAF, 1989d).

Hazardous wastes associated with the proposed project at VAFB would be containerized and sent to the North VAFB CAP or the South VAFB CAP, then transferred to the North VAFB HWSF for disposal or recycle as discussed in Section 2.2.3.1. Use of the HWSF is expected to increase during AFSLV project operations, however, impacts to regional waste disposal facilities are expected to be minimal.

The management of hazardous waste will be done in accordance with the VAFB, EAFB, or San Nicolas Island Hazardous Waste Management Plan. These plans outline standardized procedures for hazardous waste operations involving the identification, accumulation, labeling, storage, record keeping, transfer, disposal, and personnel protective equipment and safety training. Compliance with these procedures is required to effectively and legally manage hazardous waste generated from the proposed AFSLV program. The hazardous waste management plans are further described in Appendix B.

As previously discussed in Section 2.2.3.2, hazardous waste contamination has been found at Test Pad 1 and ABRES A-3. These three sites are being investigated as part of the VAFB IRP in order to define a course of action for the remediation of these sites. Site remediation activities can take up to two years to complete, depending on the extent of contamination. IRP investigations could delay construction efforts at these sites.

3.2.3.1 Summary of Waste Management Impacts

Potential impacts of the AFSLV program to waste management are summarized on Table 3.2.3-2.

Table 3.2.3-2

Summary of Potential Waste Management Impacts of the AFSLV Program

	LF 06	Test Pad 1	ABRES A-3	SLC-4W	SLC-5	Cypress Ridge [1]	Boathouse Flats [1]	EAFB	Pad 192
Domestic Waste									
Construction	●	●	●	●	●	●	●	○	●
Operations	●	●	●	●	●	●	●	○	●
Industrial Waste									
Construction	◌ 1	◌ 1	●	●	◌ 1	●	●	○	●
	● 2	● 2	---	---	● 2	---	---	---	---
Operations	●	●	●	●	●	●	●	○	●
Hazardous Waste									
Construction	●	●	●	●	●	●	●	○	●
Operations	●	●	●	●	●	●	●	○	●
IRP Investigations[3]	---	●	●	---	---	---	---	---	---

○ = Lowest impact compared to other sites
● = Same impact compared to other sites
○ = Low impact compared to other sites
● = Moderate impact compared to other sites
--- = No impact

1 Truck/Trailer launch system
2 Launch Pad system
3 Installation Restoration Program - This site is under investigation for contaminated from previous operations or spills.

3.2.4 Health and Safety

Facility and ground equipment modifications would not introduce unreasonable risk. Because of safety and disaster planning and preparedness requirements that must be followed by all tenants on VAFB, EAFB or San Nicolas Island, it is not expected that AFSLV construction or modification activities and operations at either base will result in the introduction of any unreasonable risk that may result in a hazard to which local response groups cannot adequately address.

Protection of human health associated with development of the AFSLV program focuses on the potential for exposure of human populations to harmful elements such as noise and hazardous/toxic materials. This exposure could occur as part of vehicle processing, testing and launching in addition to catastrophic events, both natural and consequential, to space launch operations. The primary health effects associated with exposure to hazardous/toxic materials would be related to handling operations and launch combustion byproducts.

Although the specific amount of hypergolic propellants required for the AFSLV launch schedule is not known at this time, the historical risk associated with shipment of potentially toxic propellant and oxidizer is relatively low and has been estimated at 1.56 accidents per million round-trip vehicle miles traveled between the manufacturing plants in Mississippi and Alabama and VAFB (USAF, 1989c).

Launch combustion byproducts of primary concern are hydrochloric acid (HCl) and aluminum oxide. The potential for toxic HCl ground level concentrations is determined during pre-launch air dispersion computer modeling which is conducted for the normal anticipated launch and aborted launch scenarios. The model, called REEDM, produces a Toxic Hazard Corridor (THC) plot of ground level HCl concentrations in the surrounding area. In the event the THC covers an unprotected populated area, the launch is put on hold until more favorable meteorological conditions occur (USAF, 1989c).

Aluminum oxide is a combustion byproduct of polybutadiene acrylic acid acrylonitrile (PBAN)-based solid propellant. PBAN is one of several propellant types proposed by the AFSLV program.The scientific literature has identified a possible correlation between aluminum and the incidence of Alzheimer's disease since abnormal accumulations of aluminum have been identified in the neurons of Alzheimer's disease patients. The potential role of aluminum is still under investigation, and, according to the National Institute of Occupational Safety and Health (NIOSH), no causal link has been identified to date in individuals with industrial exposure to aluminum. This substance would be present as nuisance particulate matter following takeoff, and initially would be present in excess of the regulatory standard for the workplace. The exposure would be short-term, yet the long-term implications from repeated release would need further examination.

3.2.5 Noise and Sonic Boom

The potential impacts due to noise and sonic boom exposure are discussed in this section. The event sources considered are construction activities, AFSLV launch noise, ascent sonic boom, and launch vehicle explosion on the ground and during early flight.

3.2.5.1 Construction Noise Impacts

Construction activities will temporarily increase ambient noise levels adjacent to the project site which requires modification or full new construction. Noise levels from most construction equipment on VAFB will not be noticeable at sensitive receptors in the Lompoc Valley or Santa Maria due to the distances of these areas from the potential project sites. Some construction activities such as pile driving can generate a noise level of 115 dBA at 50 feet. If impact-type pile drivers are used, impulse noise levels of about 42 to 45 dBA could be expected in Lompoc, which is from 6 to 12 miles from the potential project sites. Noise levels from south VAFB will be dissipated by the 400 to 500 foot high mountains located between those proposed project sites and Lompoc. Construction noise could be noticeable in some areas of the city having very low ambient noise levels, but these levels will not be of sufficient magnitude to be objectionable or cause annoyance.

- **Proposed Sites Requiring All New Construction**

Two locations on South VAFB will require all new construction for launch and support facilities, one of which may require new roadway construction as well. Moderate to major local construction noise would be expected on an intermittent and temporary basis at Boathouse Flats and Cypress Ridge (new road required).

- **Proposed Sites Requiring Minor Modification**

Seven sites have existing facilities in place that would require only minor modifications to prepare them for AFSLV launch service. Local construction noise would be of much shorter duration and intensity at LF 06, Test Pad 1, ABRES A-3, SLC-4W, SLC-5, an air platform at EAFB and Pad 192 on San Nicolas Island.

3.2.5.2 AFSLV Facility Operation Noise Impacts

The major operational noise source is rocket launch noise. Other noise sources in the launch area, such as pumps and compressors, are minor compared to the launch noise of a rocket. Fabrication, assembly, painting, and other related operational activities are conducted inside buildings. These activities are typical for an industrial facility and similar activities occur at different locations on VAFB, EAFB and San Nicolas Island. All necessary and feasible noise control mitigation measures will be implemented at the affected facilities to meet worker noise exposure limits as specified by the Occupational Safety and Health Administration (OSHA). Due to the distances involved, there will be no noise impact at sensitive receptor locations in public residential areas as a result of the normal operation of the proposed AFSLV project facilities.

3.2.5.3 AFSLV Launch Noise Impacts

The source of rocket launch noise is from interaction of the exhaust jet with the atmosphere in the combustion chamber and post-burning of fuel rich combustion products in the atmosphere. The emitted acoustic power from a rocket and frequency spectrum of the noise are related to the size of the rocket engine, its thrust level and the specific impulse which relates to the selected propellants. Chemical rocket propulsion systems generate acoustic energy fields that encompass a wide frequency spectrum (1 Hz to 100,000 Hz). Normally, a large portion of the total acoustic energy is contained in the low frequency end of the spectrum. Noise measurements conducted for launching Titan IIID (Burnett, 1975) indicate that the maximum sound pressure levels occurred around 20 to 50 Hz.

- **Occupational Impacts**

To evaluate noise impacts of a rocket, it is necessary to consider, not only the overall sound level, but also 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 per 8 hour work shift. The OSHA standards are the maximum allowable noise levels for the workers in the vicinity of the rocket launch pad.

Noise levels around the launch pad could reach an absolute overall sound pressure level of about 160 dB, which for rocket engine type frequency spectra could be about 140 dBA. This sound level can cause hearing damage, even for short exposures. Workers around the launch pad will be protected from launch noise by wearing protective devices or by moving inside buildings that are acoustically insulated.

- **Community Impacts**

OSHA standards cannot be used for evaluating community noise exposures. A time-weighted noise level (L_{eq}) of 70 dBA is recommended by EPA for the general public as a noise exposure level that will not cause hearing damage. Noise levels higher than 55 dBA in a residential area can cause annoyance and communication interference.

The proposed AFSLV space launch vehicles have not yet been launched and actual noise measurements of these vehicles are not available. However, measured noise levels of Titan IIID launches at SLC-4E on VAFB can be adjusted, based on the gross lift-off weights (GLOW) of each vehicle. Titan IIID has a GLOW of 1,364,000 lbs. at zero altitude, while the proposed AFSLV vehicles only have a GLOW ranging from about 30,000 to 180,000 lbs. The lower thrust and gross weights of the proposed SLV vehicles would yield approximate noise levels as shown in Table 3.2.5-1. The projected 120 dB overall sound pressure level (OASPL) contour for an AFSLV launch is expected to be at a radius of about one-half mile from the respective launch site. This estimate does not consider the South VAFB shielding effects due to nearby mountains nor the noise reduction for all sites due to atmospheric absorption.

Table 3.2.5-1

Estimated AFSLV Overall and A-Weighted Sound Levels vs. Ground Distance

Distance (miles)	OASPL (dB)	SL (dBA)
0.5	120	110
1.0	113	99
2.0	106	89
5.0	97	75

The predicted resulting noise levels in the City of Lompoc and vicinity would be about 35 dBA for North VAFB proposed sites and about 65 dBA for closer proposed sites west of Lompoc. These levels are about the same as measured ambient noise levels depending on the location and time of day. These noise levels will be for a very short period and would occur a maximum of five times a year. Such levels will not cause any hearing damage to residents. From an annoyance standpoint, it is unlikely that there will be people in the area who find this short duration noise objectionable.

Noise levels from an AFSLV launch should be about 10 dB lower in the vicinity of Santa Maria than they are for Lompoc. These levels will not cause any hearing damage or annoyance to residents of Santa Maria. Because of their very short duration, noise levels from an AFSLV launch will not affect existing noise conditions in Lompoc or Santa Maria.

Because many residents of the Lompoc and Santa Maria areas identify activities at VAFB with space vehicle launches, they are generally not annoyed by sporadic launch noise. Launch noise is an infrequent and short-term phenomenon, lasting only a few minutes at most.

- **Sonic Boom Impacts**

The potential for generation of a launch-related sonic boom from the AFSLV would be dependent on shape factor which is a function of vehicle length and length of the exhaust plume. The sound level generated by the AFSLV would be sonic, however, it cannot be determined whether a boom would be produced since this would depend on the specific launch profile and the possibility of “pitch over”. It is possible that launch from VAFB or San Nicolas Island could result in a focused sonic boom over the Channel Islands or the mainland. Launch from EAFB using an air launch platform would not result in a focused sonic boom since the booster is launched into orbit from an aircraft, unless a “dog leg” maneuver is performed. The potential for a focused sonic boom occurring over the Channel Islands will be further evaluated in a site specific environmental analysis.

- **Structural Damage**

Measurements were taken to evaluate the potential for acoustically induced structural damage to La Purisima Mission (Burnett, 1975). This mission is the only structure in the VAFB area listed in the National Register of Historic Places. The measurements taken during launch of a Titan IIID indicate that the acoustic energy is not enough to cause any structural damage. Launch of an SLV should not cause any structural damage because the SLV would generate less acoustical energy than the Titan IIID.

- **AFSLV Explosion**

A preliminary study has been conducted to calculate overpressure and sound level generated from the explosion of an AFSLV on the launch pad. Based on Air Force explosive safety regulations, AFR 127-100 (dated 1985), every 100 pounds of proposed AFSLV propellant is equal to approximately 10 pounds of conventional explosive (i.e., TNT). Therefore, the AFSLV vehicle would have an explosive equivalency of about 31,930 pounds of TNT. Overpressures at different distances were calculated, based on the curve provided in the Air Force Safety regulations.

If an AFSLV space vehicle exploded on the launch pad, it would result in a blast wave of about 120 lb/sq. in. at about 100 feet from the explosion. At 800 feet the overpressure would be about 2.2 lb/sq. in. This overpressure could cause damage to buildings. At 2,200 feet the overpressure would drop to about 0.53 lb/sq. in. The overall noise equivalent at 100, 800, and 2,200 feet would be 212 dB, 177 dB, and 165 dB, respectively. These calculations are theoretical maximas that do not take into account overpressure attenuation through atmospheric absorption or the shielding effect of local topography. Due to atmospheric attenuation and topography, calculated overall noise levels for Lompoc will not exceed 110 dB. While this noise level may be annoying to residents of Lompoc, no structural or glass window pane damage would occur in Lompoc.

If an AFSLV space vehicle explodes at an altitude of approximately 900 feet, an overall noise level of approximately 125 dB would be expected in Lompoc. Mountains will not provide any shielding effect for an explosion at this or higher elevations but there would be some reduction of noise levels due to atmospheric absorption. An AFSLV vehicle would have burned only a negligible amount of its propellant to reach this altitude. Thus, the overpressure generated by this explosion will be essentially the same as an explosion at ground level. Again, for this overpressure, there would be no damage to structures or glass window panes. This noise level may be annoying to some noise sensitive receptors in the City of Lompoc.

3.2.5.4 Summary of Noise and Sonic Boom Impacts

Impacts to the noise environment would not be expected as a result of AFSLV launch or explosion at or above the launch site. A focused sonic boom could occur from any of the launch sites with the exception of the air launched system from EAFB. The potential for a sonic boom from the AFSLV program is summarized on Table 3.2.5-2.

Table 3.2.5-2

Summary of Potential Sonic Boom Impact of the AFSLV Program

	LF 06	Test Pad 1	ABRES A-3	SLC-4W	SLC-5	Cypress Ridge [1]	Boathouse Flats [1]	EAFB	Pad 192
Potential sonic boom over Channel Islands	●	●	●	●	●	●	●	---	●

● = Same impact compared to other sites
--- = No impact

1 Truck/Trailer launch system

3.2.6 Cultural Resources

In order to determine the potential impacts of a project on cultural resources, a cultural resources literature search and surface inventory must be conducted for the specific site. Impacts to historic and prehistoric cultural resources would be considered significant if they were to result in: disruption to an eligible historic or prehistoric site before data recovery or other appropriate mitigation, and/or disruption to a noneligible site before adequate documentation or other, appropriate mitigation.

The archaeological sensitivity of proposed locations of the AFSLV is considered low to high. It will be necessary to conduct a literature search and possibly a ground survey of cultural resources for the selected AFSLV site. For many of the proposed sites where previous cultural resource investigations have been conducted, the specific layout of any new AFSLV facilities will require an additional review to define the potential for site-specific impacts.

The potential effects of the AFSLV program on cultural resources are difficult to determine or quantify without more detailed program information. Based on past studies, potential impacts could include disturbance or loss of buried cultural resources due to construction of facilities, overpressure associated with a normal launch or explosion of a launch vehicle on the pad leading to structural damage at the Point Arguello Boathouse, and acid deposition resulting in damage to historic sites. Such effects would be expected to be more significant for new undeveloped sites on South VAFB, particularly in consideration of the proposal to create a historic district at South VAFB. In the event that any unknown archaeological resources are discovered during construction, or if known resources are impacted, the Air Force will consult with the State Historic Preservation Officer as required by Section 6 of the National Historic Preservation Act.

- **Vandenberg Air Force Base**

Disturbance to archaeological resources would occur as a result of disturbance to subsurface deposits from both grading and trenching activities. Based on the information available to date, the greatest impacts would occur with development of the proposed Cypress Ridge area since this area is presently undeveloped and numerous archaeological sites are known in the area. Expansion or alteration involving ground disruption of the Test Pad 1, SLC-4W, and SLC-5 facilities would impact known or potential resources. Selection of any of these sites will require review of the specific AFSLV facilities to define the potential for further disturbance. Lesser impacts would occur with development of the Boathouse Flats area, since most archaeological resources at this area are located on or near the western edges of the area. Impacts to cultural resources at the ABRES A-3 facility are unknown, and, if selected, this site would require a specific ground survey for cultural resources. Impacts to cultural resources are not anticipated at LF 06 since this facility is not known to overlie any buried archaeological sites.

Operation of the proposed project at Boathouse Flats may impact known prehistoric and historic sites. The Point Arguello Boathouse, the Chumash rock art site northeast of SLC-6, and the large pictograph and rock shelter sites above Sudden Flats could be affected, primarily by noise-induced vibrations and air emissions associated with normal vehicle launches and catastrophic accidents.

- **Edwards Air Force Base**

At EAFB, additional facilities would not be required for the AFSLV program, and no additional excavation and construction are anticipated. Therefore, impacts to cultural resources would not occur.

- **San Nicolas Island**

Impacts to cultural resources due to potential construction at the Pad 192 site are not expected to be significant. While there is a documented site underneath the facility, this site has already been extensively disturbed due to previous excavation and grading activities related to construction. Excavation or grading at Pad 192 may result in additional impacts to this site, however, the significance of these impacts cannot be judged at this present time.

Operation of the proposed project may impact known archaeological sites on the island. The petroglyph cave could be affected by noise-induced vibrations and air emissions associated with normal vehicle launches as well as catastrophic accidents. These operational factors may also increase the rapid rate of natural erosion at some archaeological sites under the pathway of the AFSLV. Impacts to archaeological resources are also expected with continued use of the barge landing borrow pit. The pit has destroyed one site, and two others are near the present boundaries.

3.2.6.1 Summary of Impacts to Cultural Resources

Potential impacts of the AFSLV program on cultural resources are summarized on Table 3.2.6-1.

Table 3.2.6-1

Summary of Potential Impacts to Cultural Resources from the AFSLV Program

	LF 06	Test Pad 1	ABRES A-3	SLC-4W	SLC-5	Cypress Ridge [1]	Boathouse Flats [1]	EAFB	Pad 192
Disturbance to archaeological resources from any construction activities	○	◐	◐	◐	◐	●	◌	---	◌
Impacts to archaeological sites from launch operations noise and air emissions which accelerate natural erosion	---	---	---	---	---	---	◐	---	◐

○ = Lowest impact compared to other sites
◌ = Low impact compared to other sites
◐ = Moderate impact compared to other sites
● = Highest impact compared to other sites
--- = No impact

1 Truck/Trailer launch system
2 Launch Pad system

3.3 CUMULATIVE IMPACTS

The Air Force Small Launch Vehicle Program is one of many programs being considered for development in the Santa Barbara County region and one of a number of ongoing programs on VAFB that may contribute to cumulative environmental impacts in the area. To meet National Environmental Policy Act (NEPA) requirements, adverse impacts that may be contributed by the proposed AFSLV program must be considered in combination with those of other current and proposed projects in the area. Other likely projects on VAFB and in the region include: military-related programs and modifications; offshore and onshore oil and gas development and construction and operation of processing and transportation facilities; urban and industrial development, road construction, and harbor improvements.

The proposed AFSLV program represents a continuation of the existing military and commercial launch programs. In the event an existing launch facility is modified for the AFSLV, it would be expected that the natural environment will not experience any impact of greater intensity than those resulting from the previous military and commercial space programs. These impacts include temporary increases in air emissions and the noise level during a launch. The anticipated launch rate of a maximum 5 launches/year would result in an increase of overall annual launches from VAFB or an increase in overall annual flight activities at EAFB. This overall increase would not be considered significant in relation to the current overall launch rate at either base. Therefore, there will be no net increase in adverse impacts to the environment as a result of the proposed project and, therefore, no cumulative impact. Potential impacts are discussed below by issue area.

In the event an undeveloped site on VAFB is selected for the AFSLV program, the cumulative effects of region-wide loss of environmental resources may occur. Cumulative effects on existing resources on San Nicolas Island would result from the selection of Pad 192.

3.3.1 Meteorology

The AFSLV program will result in emissions of greenhouse gases that may contribute to global warming effects. The AFSLV is one of several space launch programs with similar emissions and cumulative effects on ozone depletion. It is not expected that the AFSLV program will result in a significant cumulative impact on global warming. Additional analysis is provided in Appendix A.

3.3.2 Air Quality

The effect of the proposed AFSLV program on local air quality is short-term and is not anticipated to be significant, whether at VAFB, EAFB and San Nicolas Island. This is because there are a maximum of five scheduled launches per year and launch-related emissions are generated only during and a few days before launch.

At VAFB, major sources of air pollutant emissions in the area include three offshore platforms and the Space Transportation System (STS) Power Plant at VAFB. The Titan IV program has a greater potential for emissions compared to the AFSLV program and the AFSLV would, therefore, constitute a much smaller percentage. Although the AFSLV program would be a new emissions source, its cumulative impact on local air quality is considered insignificant because the quantity of emissions to be generated is relatively lower and the occurrence is intermittent.

Except for additional on-site emissions at EAFB if the Air Force requires on-site payload processing, the impact to local air quality of the AFSLV would be limited to emissions from aircraft takeoff and landing. The AFSLV program at EAFB using an air launch could be construed as a continuance of the existing ALV program. However, the AFSLV program would add 2 additional flights since the ALV program is limited to 3 launches per year. Overall, the cumulative effect of the program to regional air quality is not anticipated to be significant as the emissions generated are expected to be low in quantity and occurring only during a launch.

At San Nicolas Island, the Navy conducts two major launch programs: the Vandal surface-to-air missile/supersonic target system and the Standoff Land Attack Missile (SLAM) program. The Vandal program is a land-based launch system with an average weekly launch frequency. The SLAM program is an aircraft launch system with a schedule of 20 launches per year. The additional five launches from the AFSLV program would constitute less than 10 percent of the existing programs at San Nicolas Island. The cumulative effect of the AFSLV program to the local and regional air quality is not anticipated to be significant because emission quantities are low and generated very infrequently. Furthermore, strong winds over the island would rapidly disperse any launch-generated pollutants.

3.3.3 Hydrology

A maximum net increase of five additional launches to existing launch operations at VAFB, EAFB and San Nicolas Island would not be expected to result in cumulative effects on hydrologic resources.

3.3.4 Water Quality

The effect of the proposed AFSLV program on regional water quality would be short-term and would not be expected to be significant. A net increase of five additional launches to the existing launch operations at VAFB, EAFB and San Nicolas Island would not cause adverse cumulative affects to water quality.

The surface water creeks and seasonal streams would show increase in contaminant levels from ground cloud emissions and stormwater runoff for a short period following launch. Because of the ephemeral nature and intermittent flow of the streams, the proposed project is not expected to have a cumulative impact to water quality.

EAFB has documented groundwater quality problems that have occurred as a result of fueling operations of aircraft. The extent of groundwater contamination is significant. The total aircraft operations at EAFB would increase by a maximum of five per year. The Air Forces policy is to no longer wash down propellants, aircraft fuel, and degreaser spills with water. Therefore, it would be expected that the increase of five aircraft operations to the total operations currently taking place at EAFB would not cause adverse cumulative effects to water quality.

3.3.5 Geology and Soils

Cumulative impacts to geologic resources or soils are not expected at VAFB, EAFB or San Nicolas Island.

3.3.6 Biota

Cumulative impacts to wildlife would occur from implementation of the proposed project at one of the two undeveloped sites on South VAFB in combination with other existing and proposed projects on South VAFB. The cumulative effect to terrestrial and marine wildlife from an additional launch facility is expected to be regionally insignificant, although the project, combined with others on South VAFB, would act to further reduce and fragment undisturbed local wildlife habitats and wildlife movement corridors. To the extent that the AFSLV results in additional launches from South VAFB, there could be additional potential disruptions to wildlife behavior as a result of sonic booms. Use of one of the undeveloped sites would be an extension of industrial/military development further south and east into an area of VAFB which presently is undeveloped. Such impacts would not occur if the project were implemented at any of the active sites on South or North VAFB, or at EAFB.

The proposed action at one of the two undeveloped sites would contribute to incremental losses of potential foraging habitat for peregrine falcons and other regionally rare or declining raptors on South VAFB. The lost habitat is not expected to have a significant effect on any of these species nor on the potential for successful reestablishment and population expansion of the peregrine falcon within the study region. Impacts to other regionally rare and declining wildlife species known or suspected to occur in the project area are not expected to be increased as a result of the proposed action (USAF, 1990c).

Cumulative impacts to vegetation and wildlife on EAFB would not be expected. The proposed action at VAFB would not represent a continuation of the existing ALV program at this location and would not result in a cumulative reduction of wildlife habitat assuming existing facilities would be used.

It is expected that cumulative impacts to biological resources would not occur on San Nicolas Island since existing facilities would be used. In the event additional construction for AFSLV is required on San Nicolas Island, cumulative effects to habitat could occur as a result of this program in combination with other ongoing Navy construction projects. This impact could be significant if habitat for any special status species were affected.

3.3.7 Visual Resources

Cumulative impacts to visual resources could occur in the event that either of the undeveloped sites on South VAFB were selected. In part with other projects on South VAFB, a launch facility at Cypress Ridge or Boathouse Flats would increase the visibility of industrial/military structures at this location. The installation of truck/trailer structures would be expected to have less of an impact than a permanent launch pad at these locations and therefore, cumulative impacts would not be significant. Cumulative effects on visual resources at EAFB or on San Nicolas Island would not be expected from the use of active launch facilities.

3.3.8 Population and Housing

It is anticipated that cumulative effects on population and housing would not occur since changes in the work force is not expected to occur.

3.3.9 Socioeconomics

Cumulative socioeconomic impacts resulting from use of active launch facilities are not expected to be significant. Use of one of the undeveloped sites is not expected to result in significant cumulative effects since changes in the workforce are not expected.

The proposed project is not expected to result in a change to any land use designation or an increase in the need for additional community services and facilities at VAFB, EAFB or San Nicolas Island. Cumulative effects on the economy are not expected.

Current closures of county parks are related to projected space vehicle launches from VAFB. Currently, these are comprised of Minuteman, Atlas (two to three per year), Titan II (one to two per year), and Titan IV (two to three per year). The Air Force is currently assessing the Atlas program for launch from SLC-3 at VAFB for the mid-1990's. The Titan IV/Centaur program would also launch at a rate of three per year beginning in 1995.

Activation of the proposed AFSLV project in 1993 would result in an increase of three launches per year. A cumulative total of six launches could result in County beach closures in 1993 and 1994. With the proposed Titan IV/Centaur launch program, a cumulative total of twelve launches could occur in 1995. It is possible that the AFSLV program could result in a maximum of five launches per year which would contribute to a cumulative maximum total of fifteen launches per year. It is not expected that all launches would result in beach closures. Significant impact to public recreation opportunities is not expected to result from these closures.

3.3.10 Waste Management

- **Domestic Waste**

Cumulative impacts caused by the generation of domestic waste from the AFSLV program at VAFB and EAFB would cause an incremental increase to the bases and surrounding region. However, the majority of the waste would only be generated a few months out of the year. Using the AMROC commercial expendable small launch vehicle as an example, normal day to day operations requiring full time personnel involved less than 20 people. Up to 40 people were required to support pre-launch, launch, and post-launch operations (USAF, 1989b). Assuming a domestic waste flow of 1,200 gpd, about 1,000 gallons per year of sludge would be added to the POTW in the city of Lompoc. Since the capacity of the POTW is 5 million gpd, the overall net increase in domestic was 0.02 percent. This increase would not result in significant cumulative impacts to the surrounding areas.

Cumulative impacts caused by the generation of domestic waste from the AFSLV program at San Nicolas Island would cause an incremental increase to the existing sanitary treatment system on San Nicolas Island. The estimated domestic waste flow of 1,000 gallons per year of sludge is minimal when combined with a treatment system capable of handling 40,000 gpd. An average of 25,000 gpd of domestic waste is currently being treated on San Nicolas Island. Therefore, the increase would not result in significant cumulative impacts to the island.

- **Industrial Waste**

Cumulative impacts caused by the generation of industrial waste would be the result of concurrent operations with existing programs at VAFB. A major source of industrial waste is presently generated at SLC-3 and SLC-4 from deluge and washdown water operations. The AFSLV program is expected to generate minimal amount of industrial wastewater. The majority of industrial solid waste would be generated from construction activities at the proposed launch site. The volume of waste would, therefore, depend on the site designated for the project. Depending on the general location of the proposed launch site (VAFB, EAFB or San Nicolas Island), the volume of industrial waste would add to the area landfills. However, the amount of waste is not expected to be high since minimal amounts of demolition and construction work would be expected at the proposed sites. Therefore, this additional solid industrial waste would cause some decrease in the life of the landfill used to dispose of the waste.

- **Hazardous Waste**

As previously discussed in Section 3.2.3, the amount of hazardous waste generated from the AFSLV program is expected to be similar to that generated by the existing Scout vehicle program on VAFB. It is estimated that all of the launch systems would generally produce the same types and quantities of hazardous waste, except for the air launch system of operation. The ALV program at EAFB generates less than 10 pounds of hazardous wastes per year and no liquid hazardous waste. Therefore, if the ALV site at EAFB is selected for the AFSLV program, then the amount of hazardous waste generated would be similar to the existing ALV program.

An increase in the amount of hazardous waste that will be generated at VAFB, EAFB and San Nicolas Island as a result of the AFSLV program will be mitigated by management practices, as stipulated by applicable federal, state, and base regulations. At San Nicolas Island, any hazardous waste generated would be removed from the island by the contractor within 90 days and transported by barge to the Port Hueneme storage facility. Since the HWSF on North VAFB operates below its capacity of about 5 million lb (approximately 33 percent), and the estimated amount of hazardous waste from the AFSLV program is about 4,000 lbs, the AFSLV program would not significantly impact the storage facility by the addition of hazardous waste generated from the proposed project (USAF, 1989c). Any hazardous waste added to Class I landfills would decrease its design life. VAFB practices recycling and waste minimization of hazardous waste whenever possible. VAFB waste minimization and recycling programs would reduce the impacts from the addition of hazardous wastes generated by the AFSLV program. Therefore, hazardous waste from the proposed project is not expected to have a cumulative impact on the environment.

3.3.11 Health and Safety

The proposed project is not expected to result in a cumulative impact on health and safety because of the stringent procedures that will be followed to ensure program safety.

3.3.12 Noise and Sonic Boom

The proposed AFSLV program will result in an increased noise level during a launch, but this effect will be temporary and infrequent in nature. The magnitude of this effect will not be greater than for the previous Atlas or Scout programs. In addition, the AFSLV impact effect will be much less than Titan and Delta launch noise effects. Therefore, the proposed AFSLV program will not have a cumulative noise impact on the environment.

3.3.13 Cultural Resources

Implementation of the proposed action at one of the undeveloped sites could result in impacts to certain archaeological sites that cannot be avoided. However, as a result of cultural resources surface and subsurface investigations, evaluations, and any required data recovery conducted in compliance with state and federal regulations, these impacts will be mitigated to a level of insignificance. The proposed action may contribute to the knowledge gained to data pertinent to the archaeological record in general and the Chumash, Nicoleño and Serrano Group cultures in particular. Therefore, the proposed action will not result in a cumulative impact on cultural resources.

SECTION 4

MITIGATION MEASURES

4.1 AIR QUALITY

Construction-related emissions of fugitive dust and exhaust pollutants would depend on the amount of demolition and earthwork to be conducted on a site and the construction mobilization schedule. Fugitive dust from ground-disturbing activities can be reduced up to 50 percent by regular site watering practices. Exhaust emissions from construction machinery can be reduced by proper tuning of construction vehicles. Fugitive dust and exhaust emissions can be minimized by enforcing speed limits on the construction site.

Potential impacts from AFSLV launches could be mitigated by applying process and launch operational controls. Process control is applicable to support operations such as preparation of the SLV, including booster assembly. Operational control includes consideration of meteorological conditions as determined by the THC forecast. This has particular application to launches at VAFB.

For onsite processing of the AFSLV, control equipment on paint spray booths such as water curtains or dry filters would minimize the emission of particulate matter from paint spray operations. Volatile organic emissions from surface cleaning operations could be minimized by controlling the amount of solvent used during each wiping and by putting all spent rags containing solvent in covered containers. At existing facilities, emissions from liquid propellant loading operations could be controlled by collecting the vapors and burning them in existing incinerators or removing them in scrubbers. It is important to note that permits are necessary to operate the control equipment and are independent of the permits for the main process equipment.

Because of the onshore wind patterns and inversion at VAFB, it is important to base a decision to launch on the THC forecast. The uncontrolled areas surrounding VAFB are at least only 4 miles away from any of the proposed launch sites and the exposure of humans and other life forms to unhealthful air quality is possible under adverse conditions and events. The THC forecast would mitigate potential adverse impacts to air quality during and after a launch.

4.2 HYDROLOGY AND WATER QUALITY

Potential contamination of groundwater resulting from the discharge of deluge and washdown water will be minimized by collection, testing and treatment of wastewater. All wastewater should be contained on site. Testing for trace metals and sediments should be conducted. Following treatment, wastewater should be reused for industrial purposes.

In order to avoid the potential for impacts to water quality from contaminated stormwater runoff, the launch area should be washed down. This wastewater should be collected, tested and treated, if necessary. As long as the launch area is kept clean, rainwater may be pumped to grade with the approval of RWQCB.

Potential impacts due to accidental spills of petroleum products will be mitigated through the use of spill containment structures surrounding the fuel handling area. Potential impacts due to accidental spills of propellant will be mitigated by following Air Force fuel handling and safety procedures and through the use of spill containment structures surrounding the fuel handling area.

In order to mitigate the overdraft of groundwater basins used for potable water supplies, contractors should provide drinking water supplies for temporary employees on VAFB, EAFB, and San Nicolas Island. Water conservation should be practiced during project related activities. Any new construction should include the installation of water saving devices.

4.3 GEOLOGY AND SOILS

- **Vandenberg Air Force Base**

Limited detailed geologic mapping is available for VAFB. As a result, potential geologic hazards present at the base may not yet be identified. Therefore, site specific geologic investigations are necessary to assess potential hazards including, but not limited to, changes in topography, erosion, surface rupture, ground shaking and ground accelerations, liquefaction, and landslide potential.

Topography and Erosion

Sites should be located and designed to minimize grading wherever possible. The areal extent of the disturbed area, including both the site and new access roads, should be minimized. All exposed slopes should be protected during construction, especially sand dunes. All disturbed areas should be revegetated where practical. Gravel should be used on sites and roads to minimize the potential for water erosion.

Paleontologic Resources

During excavation and grading activities at Launch Facility 6, SLC-4W, Cypress Ridge or Boathouse Flats, a part-time paleontologic monitor should be utilized to evaluate recovered fossil remains. In the event of unearthing potentially significant fossils, earth moving activities should be diverted away from fossil sites until the remains are removed. Excavated samples should be processed at the Los Angeles County Natural History Museum or the University of California, Berkeley. Following sample processing, mitigation monitoring reports should prepared detailing the inventory of recovered remains.

Surface Rupture

Preliminary geologic reconnaissance studies should be conducted to identify unmapped faults that may represent potential surface rupture hazards crossing proposed sites located within known fault zones. Locating launch facilities in areas where faults have been identified should be avoided. When areas with unmapped faults cannot be avoided, the site should be designed with facility setbacks to minimize the potential for damage from surface rupture.

Ground Shaking and Ground Acceleration

Where practical, new facilities should incorporate earthquake resistant designs beyond those required by building codes. Foundations for new facilities should incorporate engineering designs appropriate to support these facilities during extended periods of ground shaking.

Any piping that supplies fuel should incorporate flexible connectors or expansion loops, especially where pipes are attached to stationary facilities. An alternative design would include emergency shut-off sensors and valves. These measures will greatly reduce the probability of pipe ruptures and fuel spills during earthquakes.

Liquefaction

Preliminary engineering geologic studies should be conducted to insure that potential liquefaction hazards are not present at proposed sites. Locating facilities in liquefaction prone areas should be avoided. When the crossing of liquefaction prone areas by pipelines and utilities cannot be avoided, these services should be designed to minimize the potential for damage in the event of liquefaction occurrences.

Landslides

Preliminary geologic reconnaissance studies should be conducted to identify potential landslide hazards. Locating facilities in landslide prone areas should be avoided. When landslide prone areas cannot be avoided, the site should be designed to minimize the potential of landslide occurrences. Facilities should be set back from sea cliffs.

Tsunamis

Locating of facilities in areas susceptible to tsunami inundation should be avoided.

- **Edwards Air Force Base**

Limited detailed geologic mapping is available for EAFB. As a result, potential geologic hazards present at the base may not yet be identified. Therefore, site specific geologic investigation are necessary to assess potential hazards, including, but not limited to, surface rupture, ground shaking and ground accelerations, and liquefaction.

Conduct a preliminary geologic reconnaissance to identify unmapped faults and surface cracks or fissures, representing potential surface rupture hazards, crossing proposed facilities.

Avoid locating facilities in areas where faults or surface fissures have been identified.

When areas with identified previously unmapped faults or surface fissures cannot be avoided, design the site layout with facility setbacks to minimize the potential for damage from surface rupture.

Ground Shaking and Ground Acceleration

Where practical, new facilities should incorporate earthquake resistant designs, beyond those required by building codes. Foundations for new facilities should incorporate engineering designs appropriate to support these facilities during extended periods of ground shaking.

Any piping that supplies fuel should incorporate flexible connectors or expansion loops, especially where pipes are attached to stationary facilities. An alternative design would include emergency shut-off sensors and valves. These measures will greatly reduce the probability of pipe ruptures and fuel spills during earthquakes.

Liquefaction

Preliminary engineering geologic studies should be conducted to identify potential liquefaction hazards present at proposed sites. If possible, locating facilities in liquefaction prone areas should be avoided. Engineering designs appropriate to support these facilities during liquefaction should be incorporated.

When the crossing of liquefaction prone areas by pipelines and utilities cannot be avoided, these services should be designed to minimize the potential for damage in the event of liquefaction occurrences.

- **San Nicolas Island**

Limited detailed geologic mapping is available for San Nicolas Island. As a result, potential geologic hazards present on the island may not yet be identified. Therefore, site specific geologic investigation are necessary to assess potential hazards, including, but not limited to, changes to topography, erosion, surface rupture potential, ground shaking and ground accelerations, and landslides potential.

Topography and Erosion

Sites and access roads should be located and designed to minimize grading wherever possible. The areal extent of the disturbed area, including both the site and new access roads, should be minimized. All exposed slopes should be protected during construction, especially sand dunes. All disturbed areas should be revegetated where practical. Gravel should be used on sites and roads to minimize the potential for water erosion. Adequate drainage structures on roads should be provided to prevent erosion.

Paleontologic Resources

A field assessment should be conducted before developing a paleontologic resource impact mitigation program. During excavation and grading activities, a part-time paleontologic monitor should be utilized to evaluate recovered fossil remains. In the event of unearthing potentially significant fossils, earthmoving activities should be diverted away from fossils until the remains are removed. Process excavated samples at the Los Angeles County Natural History Museum or the University of California, Berkeley. Following sample processing, mitigation monitoring reports should be prepared detailing the inventory of recovered remains.

Surface Rupture

Preliminary geologic reconnaissance studies should be conducted to identify unmapped faults that represent potential surface rupture hazards crossing beneath the Pad 192 site. Locating of sites should be avoided in areas where active or potentially active faults have been identified. When areas with identified previously unmapped faults cannot be avoided, the site should be designed with facility setbacks to minimize the potential for damage from surface rupture.

Ground Shaking and Ground Acceleration

Where practical, new facilities should incorporate earthquake resistant designs, beyond those required by building codes. Foundations for new facilities should incorporate engineering designs appropriate to support these facilities during extended periods of ground shaking. By incorporating earthquake resistant design into newly engineered facilities, and by following these recommended mitigation measures, impacts from future seismic activity can be reduced, but for the infrequent major or great earthquakes, impacts would remain significant.

Any piping that supplies fuel to facilities on San Nicolas Island should incorporate flexible connectors or expansion loops, especially where pipes are attached to stationary facilities. An alternative design would include emergency shut-off sensors and valves. These measures will greatly reduce the probability of pipe ruptures and fuel spills during earthquakes.

Landslides

Preliminary geologic reconnaissance studies should be conducted to identify potential landslide hazards. Locating access roads in landslide prone areas should be avoided.

Roads should be set back from steep slopes such as sea cliffs. When landslide prone areas cannot be avoided, the roads should be designed to minimize the potential of landslide occurrences. Undercutting steep slopes and sea cliffs should be avoided.

- **Tsunamis**

Locating of facilities in areas susceptible to tsunami inundation should be avoided when possible.

4.4 BIOTA

The AFSLV program is not expected to have any significant impact on the local or regional biota if careful planning is undertaken to locate final siting of facilities in areas that do not contain sensitive biological resources. Facilities should not be sited in areas containing unique or regionally rare or declining species of plants or habitat for endangered or threatened species of wildlife. Efforts should be made to minimize the amount of natural habitat that will be removed during construction and modification activities. Any areas used for temporary construction and any construction-scarred areas should be revegetated with native species appropriate for the specific location as determined by a qualified botanist. The specific impacts, if any, of the AFSLV program on threatened and endangered species will be addressed in a site-specific environmental assessment to be prepared by the Air Force. A Biological Assessment may also be prepared by the Air Force as part of the Section 7 consultation process with the U.S. Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service.

For launch from ABRES A-3, consultation with the USFWS would be required due to the proximity of the site to known nesting habitat for the endangered Least tern. Prior notification of scheduled launches to SMC/ET (VAFB Environmental Management) may be required to enable launch noise monitoring to be conducted. Previously, the USFWS issued an informal finding of No Jeopardy for AMROC launches from the ABRES site, which include launches during the Least tern nesting season (USAF, 1989b). This opinion was issued with the condition that launch noise would be monitored by SMC/ET to document specific noise levels (USAF, 1989c). The AFSLV program will be evaluated in a site specific environmental analysis and it is possible that similar requirements may be imposed for the ABRES A-3 site.

4.5 VISUAL RESOURCES

Mitigation measures for impacts to visual resources will be required if an undeveloped site is selected, or if view-obstructing structures are planned as part of the facility.

4.6 POPULATION

No mitigation measure is necessary.

4.7 SOCIOECONOMICS

No mitigation measure is necessary.

4.8 HEALTH AND SAFETY

No mitigation measure is necessary.

4.9 WASTE MANAGEMENT

Existing waste management and recycling programs will be reevaluated to the extend applicable mitigative elements to the AFSLV program. Compliance with California’s Hazardous Waste Source Reduction and Management Review Act of 1989 (Senate Bill

14) will also require reduction of hazardous waste generation for the AFSLV and other programs.

4.10 NOISE AND SONIC BOOM

Mitigation measures will not be required for AFSLV launch noise levels affecting the cities of Lompoc or Santa Maria. The launch noise levels are not high enough to cause hearing damage or other health hazards. In addition, a maximum of only six launches per year is planned; therefore, there will be no significant impact or extended annoyance from SLV launch operations originating from any of the proposed launch sites.

Mitigation measures are required to protect the hearing of workers at the launch facilities proposed for VAFB and nearby areas from high construction noise and the very high launch noise levels. All construction workers on site and other launch operations personnel within one-half mile of the launch site must wear protective hearing devices.

Workers and participating personnel located at the launch facility will be inside during an actual SLV launch, thus the buildings and shelter will require adequate acoustical protection. These buildings and shelters must be so constructed and have adequate components, such as doors, air conditioning systems, windows, etc., to meet an inside communications noise level requirement of 50 to 60 dBA.

Road blocks and other security methods should be used to prohibit entry to the launch facility and surrounding areas that will experience high noise levels during an SLV launch from VAFB.

4.11 CULTURAL RESOURCES

The AFSLV project will not result in significant impacts to cultural resources as long as facilities are limited to areas of previous disturbance. In the event that archaeological resources are unearthed during construction, construction activities will be temporarily halted or redirected to another location until a qualified archaeologist and Native American Observer have evaluated the find and allowed work to proceed in the area affected. In addition, the Air Force will consult with the State Historic Preservation Officer before resuming construction activities in the affected area.

In the event that an AFSLV site is selected which is in proximity to known cultural resources or for which no previous archaeological investigations have been performed, a site-specific survey for cultural remains will be required. For those sites in proximity to known cultural deposits, archaeological monitoring by a qualified archaeologist and a Native American Observer during earthmoving activities will be required.

SECTION 5

REGULATORY REVIEW AND PERMIT REQUIREMENTS

This section presents an overview of the environmental regulatory and permit requirements that may be applicable to the AFSLV Program. Environmental permit requirements were identified from an analysis of previous Air Force space launch programs and an evaluation of federal, State of California, and local laws and regulations applicable to the construction and operation of the proposed AFSLV Program. These requirements are discussed in the following sections for each environmental area. The AFSLV program will be required to comply with all applicable Air Force environmental regulations. In the event that the San Nicolas Island site is selected for the AFSLV program, all Navy environmental regulations and coordination procedures will be required in addition to those of the Air Force. Navy environmental requirements are specified in OPNAVINST 5090.1A which implements the provisions of the National Environmental Policy Act (NEPA) for the Navy. Specific regulatory requirements of the AFSLV program will be identified when final siting and configuration are determined.

A list of potential permits and regulatory requirements of the AFSLV Program and the agency responsible for each is listed on Table 5.1. Permit applications and/or agency consultations may require additional interagency consultation. Provisions of regulations may be jointly administered by federal, state, or local agencies.

5.1 AIR QUALITY

Operations or activities that result in emission of any air contaminant are regulated by Region IX of the U.S. Environmental Protection Agency (EPA) under the federal Clean Air Act. The California Air Resource Board is responsible at the state level for mobile sources. The local Air Pollution Control Districts (APCD), either the Santa Barbara County Air Pollution Control District (SBCAPCD), Kern County Air Pollution Control District (KCAPCD) or Ventura County Air Pollution Control District (VCAPCD), would have authority over stationary sources of air pollutants emitted from VAFB, EAFB or San Nicolas Island, respectively.

Under the provisions of the Clean Air Act, the local agency is delegated the authority to administer federal policies and grant permits. Sites for the AFSLV Program at VAFB have been proposed for traditional launch concepts using land-based (i.e., pad, rail, truck) operations. Thus, potential sites that would require air quality permits will be those located in Santa Barbara County and Ventura County. SBCAPCD and VCAPCD have primary regulatory review authority over potential stationary sources of air pollution associated with the proposed sites in these areas. The proposed site on EAFB located in Kern County would utilize the airborne launch concept of which regulated air contaminant emissions from stationary sources will not occur assuming payload fairing processing is accomplished off-site.

Table 5.1

AFSLV Program Potential Permits, Approvals, and Administering Agencies

Permit or Approval	Agency
Air Quality	
Authority to Construct, Permit to Operate	Santa Barbara County Air Pollution Control District Kern County Air Pollution Control District Ventura County Air Pollution Control District
Water Quality	
National Pollution Discharge Elimination Permit (NPDES), Waste Discharge Requirements	RWQCB, Central Coast Region RWQCB, Central Valley Region
Hazardous Waste	
Treatment, Storage, and Disposal Facility Permit, Extremely Hazardous Waste Permit	California Department of Health Services
Coastal Resources	
Coastal Consistency Determination	California Coastal Commission
Biological Resources	
Section 7 Consultation	U.S. Fish and Wildlife Service U.S. National Marine Fisheries Service
Cultural Resources	
Section 106 Consultation	State Historic Preservation Officer

A number of launch modes are being considered at VAFB, EAFB and San Nicolas Island. Active sites where all support equipment exists (i.e., new stationary sources of air emissions will not be installed) would be the simplest from a regulatory compliance and permitting standpoint because new permits would not be required. This assumes that the existing support equipment hold active permits from the SBCAPCD and the VCAPCD, and that the additional operations from the AFSLV program will not result in the violation of emission limits as indicated in the permit conditions, or that the equipment is exempt under APCD regulations. If the support operations of the AFSLV require new equipment or exceed any of the given permit conditions, it will be necessary to file for a new Permit to Operate or a revision to the existing permit conditions. Sources would include paint booths, fuel storage tanks, boilers, generators, and vapor incinerators that are installed on site.

The number of permits required depends on the activities and/or operations performed, the mode of space vehicle launch, and the launch site. The maximum number of permits will be required where extensive site construction and/or modification is required using a conventional land-based vehicle launch configuration. Equipment associated with ground support facilities that would require air quality permits includes but is not limited to:

- Aboveground or Belowground Fuel Storage Tanks, Transfer Systems and Emissions Controls
- Aboveground Propellant Storage Tanks, Transfer Systems and Emissions Controls
- Diesel-fired Engines and Generators
- Boilers
- Paint Spray Booths
- Abrasive Blasting Equipment

Additional permits would be required if payload fairing processing and refurbishment are done on-site. The proposed site at EAFB is currently the site of support operations for the ALV program. The ALV program is designed such that the only support operation at EAFB is assembly of the booster. All other operations such as processing the PLF are conducted in Tempe, Arizona. If the Air Force chooses to require that payload processing and other support operations be conducted on site, permits will need to be acquired from the KCAPCD.

5.1.1 Santa Barbara County Air Pollution Control District

Under SBCAPCD Rule 201, an Authority to Construct (ATC) is required for any device that emits or controls air contaminant emissions to the atmosphere. The ATC will remain in effect until a Permit to Operate (PTO) for the equipment is granted, denied, or cancelled. SBCAPCD has specific air pollutant emission limitation for numerous types of equipment.

SBCAPCD Rule 202 allows an exemption for aircraft used to transport passengers or freight. Therefore, a PTO is not required for a space launch vehicle. This exemption, however, does not include ground operational support facilities and equipment used in support of a space launch program.

VAFB is located in an area that is designated by the SBCAPCD as non-attainment for ozone, or not meeting the state ambient air quality standard for ozone. When applying for an ATC or a PTO, the new stationary source will require a new source review (NSR) if the source emits NO_x and reactive organic compounds (ROCs) (known precursors to the formation of ozone). NSR rules require: application of Best Available Control Technology (BACT), which is triggered at net emissions increase levels of 2.5 lbs/hr; and, an Air Quality Impact Analysis (AQIA) at net emissions increase levels of 5 lbs/hr but not more than 10 lbs/hr, 240 lbs/day, or 25 tons/yr. BACT requires that the Lowest Achievable Emission Rate (LAER), as defined in Rule 205.C.1.a.6, be met. Emission offsets are required for net emissions increases greater than 10 lbs/hr, 240 lbs/day, or 25 tons/yr. For emissions increases less than 10 lbs/hr, 240 lbs/day, or 25 tons/yr, emissions offsets are required if the AQIA demonstrates that the NAAQS will be exceeded or interference in the maintenance or attainment of the NAAQS will occur. Although AFSLV emissions cannot be quantified at this time, it is expected that NSR limits and emission offset thresholds would not be exceeded based on a comparison of the projected operations of this project to that of the Titan IV program (USAF, 1988).

A permit is not required for repair or maintenance of equipment but anticipated emissions from maintenance need to be recorded on the PTO for informational purposes. Emissions from new and modified stationary sources are recorded when the ATC and the PTO are issued.

Rule 330.C exempts coating operations of aerospace vehicles in paint spray booths having emissions control from complying with limits for volatile organic compound

(VOC) content of coating materials. The rule requires that the VOC content of coatings which are air-dried or force air-dried is not to exceed 340 grams per liter or 275 grams per liter if the coating is baked. Rule 322 prohibits the use of photochemically-reactive thinners and solvents. Rule 324 limits the amount of photochemically-reactive materials emitted to atmosphere to 1.5 gallons per day.

Of these rules, only Rule 324 is identified as potentially impacting launch support operations if the such operations are to be conducted on site. Toluene is a known component of coating materials for most aircraft and aerospace applications and is photochemically reactive. The use of coating materials containing toluene or any other photochemically reactive compound could be controlled by conducting coating operations over a longer schedule to prevent exceeding of the limit or by providing emission controls.

On July 10, 1990, the SBCAPD adopted Rule 337 which regulates the use of surface coatings on aircraft or aerospace vehicle parts and products. The rule sets (1) limits on reactive organic compound (ROC) contents of affected coatings; (2) acceptable methods of applying affected coatings; (3) use of closed containers for storing affected coatings; and (4) record keeping of use and types of affected coatings. The rule allows sources to meet the intent of the law without using compliant coatings if the sources use add-on exhaust control equipment that would have an overall control efficiency of at least 85.5 percent (at least 90 percent for the collection system and at least 95 percent for the control device). In addition, a source may be exempt if the amount of coatings used (applicable to separate formulations) is less than 20 gallons in any calendar year and the source could demonstrate the lack of available equivalent compliant coatings.

Rule 337 would likely affect the application of silicone enamel on the payload fairing and the payload itself, as the coating contains toluene. In the EA for the Titan IV program, it was determined that only 3.5 gallons of silicone enamel are required for one payload fairing. The AFSLV is considerably smaller than the Titan IV launch vehicle and it is assumed that less silicone enamel would be required. If the Air Force chooses to prepare the AFSLV onsite and claim exemption from this rule, the Air Force must demonstrate that no other equivalent coatings could be used for this application. It should be noted, however, that Rule 322 still applies and limits the evaporation of photochemically reactive materials such as toluene to maximum amount of 1.5 gallons per day.

Construction activities and related equipment will not require permits under Rule 202.C. However, if the combined emissions from all construction equipment used to construct a stationary source (which requires an ATC) have the potential to exceed 25 tons of any pollutant (except carbon monoxide) in a 12-month period, offsets under the provisions of Rule 205.C.3.a.4 will be required.

5.1.2 Kern County Air Pollution Control District

In general, the rules and regulations of the KCAPCD are the same as those of the SBCAPCD. The following analysis is presented to cover the scenario where on-site launch support operations are required.

Since the only operation currently conducted at EAFB for the ALV program is booster assembly, it would be necessary to install paint spray booths for payload fairing processing if this activity is to be done at EAFB. Under Rule 201(a), an ATC would be required from the KCAPCD before the installation of any sources of air pollutant emissions. The ATC remains in effect until a PTO is issued under Rule 201B, or denied, or the ATC is cancelled. The launch vehicle and the aircraft from which the launch is executed are exempt from a permit under Rule 202(b) (exemption for vehicles transporting freight or passengers).

The KCAPCD rules and regulations require that BACT (Rule 210.1.5.A) be applied to new or modified stationary sources who emissions result in a cumulative net increase of 150 lb/day or more of any air contaminant for which there is a NAAQS (except carbon monoxide) or any precursor of such contaminant. Rule 210.1.5.B requires that LAER and mitigation measures (after the application of LAER) be provided for all new and modified stationary sources whose net increase in fugitive and secondary emissions equal or exceed 200 lb/day or more of any air contaminant or precursor of such contaminant (excluding carbon monoxide). This rule applies to a cumulative net increase in emissions of 550 lb/day or more of carbon monoxide.

5.1.3 Ventura County Air Pollution Control District

VCAPCD rules and regulations parallel those of SBCAPCD. The main launch preparation at San Nicolas Island will be booster assembly since payload fairing processing, check-out, and tests will be done off-site. This may involve the use of organic solvents. Rule 66.C limits evaporation of photochemically-reactive solvents (as defined in Rule 66.A.10) to 1.5 gallons per day.

5.2 WATER QUALITY

5.2.1 Wastewater Discharge

The Regional Water Quality Control Board (RWQCB), either the Central Coast Region for Santa Barbara County, the Central Valley Region, Fresno Branch Office, for Kern County, or the Los Angeles Basin Region for Ventura County administers the federal Clean Water Act and State Porter-Cologne Act of 1969. The State issues one discharge permit for purposes of both state law and federal law. Under the state law, the permit is called a Waste Discharge Requirement (WDR). Under the federal law, the permit is called a National Pollutant Discharge Elimination System (NPDES) permit, which is required of all point source discharges of pollutants into surface waters of the United States.

The State Porter-Cologne Act requires anyone who plans to discharge waste which could affect the state's surface and groundwater quality to file a "Report of Waste Discharge" (ROWD) with the RWQCB in order to obtain a WDR. This is considered the equivalent of an NPDES permit application.

Discharge of industrial wastewater which contains hazardous waste into a public sewer system (i.e., publicly owned treatment work or POTW) is regulated by federal EPA categorical pretreatment standards and will require a Hazardous Waste Discharge Permit from the RWQCB.

If sanitary waste is discharged to an existing permitted sanitary sewer system, a permit will not be required from the RWQCB as long as capacity is less than 2,500 gpd.

Wastewater discharges resulting from the launch operations include fire suppression and launch complex washdown water. Such discharges may require a WDR from the RWQCB if such discharge affects groundwater quality or is discharged in a diffuse manner (e.g., erosion from soil disturbance). Soil-disturbing operations such as grading, road construction, and dredging will not require permitting if these activities do not involve discharge of wastewater that could affect the quality of surface and groundwater. Any discharge of washdown and deluge water into any surface waters would require an

NPDES permit. The procedure for VAFB would involve collection, testing, treatment (if necessary) and disposal or reuse of any washdown water.

Industrial and sanitary wastewater discharge is further discussed in Section 5.3.

5.2.2 Stormwater Discharge

At certain times of the year, stormwater is a significant portion of the wastewater discharged between launches. Discharge of contaminated stormwater runoff may be considered an industrial waste and require a NPDES permit from RWQCB if residues present on the launch pad are present in the stormwater (Meece, 1990). The EPA issued final rules on stormwater discharge requirements on November 16, 1990. Testing of washdown water and stormwater runoff will be required for the AFSLV program, if the launch pad is not washed down and stormwater serves to transport contaminants into any surface waters.

5.3 WASTE MANAGEMENT

5.3.1 Industrial Wastewater Discharge

The Air Force has submitted Reports of Waste Discharge (ROWD) for SLC-3 and SLC-4; however, the RWQCB considered the wastewater quality poor enough to require some mitigation before discharge. The RWQCB will not issue a discharge permit for this wastewater even if treated. Therefore, deluge and washdown water presently generated from launch complexes on North and South VAFB are transported by tanker truck to the wastewater treatment facility at SLC-6 (Toft, 1990b).

Wastewater discharges resulting from the AFSLV program operations at VAFB may include water for fire suppression and surface water runoff. Deluge and complex washdown waters would not be generated from launch operations for this program. The discharge of washdown water from the proposed sites will not require a permit. It is expected that the discharge water from the proposed sites on VAFB could be transported and disposed of at the treatment plant at SLC-6 (Toft, 1990b).

5.3.2 Sanitary Wastewater Discharge

Sanitary waste produced at any of the active launch facilities on VAFB will be treated in an onsite package sewage treatment plant (STP) or septic tank leach system. The treatment capacities of the existing STPs and septic tanks vary, however the capacities of the existing STP at SLC-4 and SLC-6 are 15,000 and 28,000 gallons per day, respectively. Waste from the treatment systems go to evaporation/percolation ponds and fields located near the facilities. The RWQCB regulates all sanitary wastewater treatment facilities that discharge their effluent to lagoons and septic tank leach systems. RWQCB's Order 89-98 regulates all sewage discharges in outlying areas of VAFB that do not discharge into the sewer (Griffin, 1990). The only treatment plant that has periodically failed to conform with the standards for 5-day BOD and suspended solids is the STP at SLC-4. In order to comply with regulatory requirements and adequately dispose of sewage waste from SLC-4, a replacement STP will need to be constructed. Plans for replacing the STP are currently being evaluated by VAFB (Toft, 1990a,b).

Sanitary waste produced at the undeveloped sites on VAFB will probably discharge into a septic tank leach field system. If sanitary sewage is the only type of waste to be discharged and the design capacity of the system is less than 2,500 gpd, a permit will not be required from the RWQCB (Peterson, 1990a).

Sanitary waste produced at the air launch site at EAFB will be treated at the sanitary sewer treatment plant located on the south end of the base. The treatment plant has oxidation ponds. In Kern County, the Lahontan RWQCB administers the federal Clean Water Act and State Porter-Cologne Act of 1969. The Permit to Operate the treatment plant at EAFB is reviewed every three years by the Lahontan RWQCB. This treatment plant has no conformance violations. EAFB is currently evaluating the need to upgrade some of its treatment facilities at the plant (Phillips, 1990c).

The sanitary sewer treatment plant on San Nicolas Island has an NPDES permit. The facility has the capacity to treat 40,000 gpd but is currently treating an average of 25,000 gpd. The treated effluent is discharged to settling ponds, aerated and sprinkled onto the adjacent hillsides. The septic tank systems on San Nicolas Island are not permitted by RWQCB.

5.3.3 Hazardous Waste

Handling of hazardous waste from all launch programs requires permits and licences from federal, state, and local agencies. The Resource Conservation and Recovery Act (RCRA) of 1976 delegates the EPA to administer a nationwide program to regulate hazardous wastes from generation to disposal. On the state level, Chapter 6.5 of Division 20 of the California Health and Safety Code and the Porter-Cologne Act water quality control provisions operate jointly in the regulation and issuance of permits for hazardous waste facilities. The California Department of Health Services (CDHS) administers the state's hazardous waste program and maintains the authorization from the EPA to implement the federal program in California. If the operation involves waste discharge that affects water quality, permits must include any limits or requirements imposed by the RWQCB. A waste is considered hazardous if it contains substances on the lists of hazardous wastes included in 40 CFR Part 261, and the California Code of Regulations (CCR) Title 22 Section 66680.

Under RCRA regulations, VAFB and EAFB and their tenant programs are considered a hazardous waste treatment, storage, and disposal facility (TSDF) because waste is stored on the base for more than 90 days. Therefore, the base must comply with general facility standards and technical requirements established by the EPA and CDHS.

Hazardous wastes are not stored on San Nicolas Island for longer than 90 days and, therefore the facility is not considered a TSDF. Wastes are transported by barge off the island to a TSDF facility in Port Hueneme. The Port Hueneme facility is permitted by CDHS and is in the process of applying for a State and Federal permit. A draft Hazardous Waste Management Plan for PMTC Pt. Mugu Naval Air Station, which also includes the handling and management of wastes on San Nicolas Island, is currently being revised. Compliance with this plan will be a requirement of the contractor for the AFSLV program if San Nicolas Island is selected.

At present, a permitted Hazardous Waste Storage Facility (HWSF) operates at both VAFB and EAFB. The HWSF at VAFB is currently permitted under a CDHS TSDF permit issued in November 1986. Launching of government payloads for the proposed AFSLV Program would fall under the existing VAFB and EAFB permitted hazardous waste handling systems. However, once this program operates as a commercial enterprise providing launch services for non-government payloads, the contractor/operator will have to obtain a separate TSDF permit from the CDHS, or make arrangements to have its waste transported off base within the 90 days allowed under the California law (Toft, 1990b).

Any generator of hazardous wastes in California is required to have an EPA identification number, report the generation of hazardous waste to the CDHS, and if applicable, apply for an Extremely Hazardous Waste Permit (for waste designated with an asterisk on the list included in CCR Title 22, Section 66680) from the CDHS. The AFSLV operator will be required to obtain its own EPA identification number (since it will be a commercial enterprise) unless VAFB, EAFB or San Nicolas Island wishes to accept responsibility for the handling, treating, storing and disposing of hazardous wastes generated at each site.

The California Source Reduction and Hazardous Waste Management Review Act of 1989, commonly referred to as Senate Bill (SB) 14 (as introduced by Senator Roberti, approved by the Governor and filed with the Secretary of State on 1 October 1989), requires examination of current hazardous waste generating processes for hazardous waste minimization opportunities, and creation of a plan to implement workable alternatives. Generators of hazardous waste in excess of 26,400 lb of hazardous waste and 26.4 lb of extremely hazardous wastes would be subject to this Act. These generators must prepare a “Source Reduction Evaluation Review and Plan”, a “Hazardous Waste Management Performance Report”, and a “Report Summary” by 1 September 1991, and every four years thereafter. According to SB 14, if spills of liquid propellants (i.e., hydrazine, polybutadiene acrylonitrile) or other hazardous waste generated from emergency response actions were to occur, the waste would be excluded by the CDHS. Any hazardous waste that is treated or recycled onsite and hazardous waste that is manifested for offsite recycling, treatment, or disposal are subject to the requirements of SB 14. This would include any dilute hazardous waste streams such as contaminated surface water runoff from launch pads and hazardous waste streams that are pretreated before being discharged to sewers.

5.4 SPILL PREVENTION

EPA's Oil Pollution Prevention Regulation requires facilities to prepare and implement a plan to prevent any discharge of oil (petroleum products) into waters of the United States. This plan is referred to as the Spill Prevention Control and Countermeasure (SPCC) Plan.

VAFB is currently operating under the SPCC plan, OP-234-90. This plan is reviewed every year by the Environmental Management organization at VAFB and requires a facility evaluation by a registered engineer. Compliance with this plan will be required by the contractor in the event that any site on VAFB is selected for the AFSLV program.

EAFB is not required to develop a SPCC Plan because the Antelope Valley is an enclosed drainage basin that does not possess any waters of the United States. The U.S. Army Corps of Engineers has declined to assume jurisdiction for isolated waters in the area (Bowholtz, 1990).

San Nicolas Island has a SPCC Plan and a Spill Contingency Plan which are currently in draft form and undergoing review. Compliance with this plan will be required by the contractor in the event that San Nicolas Island is selected for the AFSLV program.

5.5 COASTAL ZONE MANAGEMENT

The federal Coastal Zone Management Act of 1972, as amended (16 USC Section 1456(c)), Section 307(c)(1), and with Section 930.34 et seq. of the National Oceanic and Atmospheric Administration (NOAA) Federal Consistency Regulations (15 CFR 930, revised), requires that a Coastal Consistency Determination (CCD) be submitted by the Air Force for proposed actions within the coastal zone. Generally, the coastal zone extends from the State's three-mile seaward limit to an average of approximately 1,000 yards inland from the mean high tide of the sea. In coastal estuaries, watersheds, wildlife habitats, and recreational areas, the coastal zone may extend inland to the ridge of the nearest mountain range or farther. In urban areas, the coastal zone may extend inland less than 1,000 yards from the mean high tide of the sea.

The purpose of the CCD is to assure that proposed undertakings by the federal agencies are consistent to the "maximum extent practicable" with the NOAA-approved state Coastal Management Plan (CMP). In California, the California Coastal Commission (CCC), as lead agency for the CMP, coordinates the evaluation of a determination and develops a formal state consistency response. As stated in 15 CFR 930, federal activities on federal property are excluded from state-designated coastal zones. If the activity has an impact off federal property that could result in a direct impact to the state coastal zone, these activities must be consistent with the state CMP. All potential launch sites being considered for the AFSLV Program are located within federal property but proposed actions may impact off federal property. Construction and operational activities of the AFSLV Program such as diking, filling, dredging, land development, and impact of sonic boom that will affect marine resources, biological productivity and the quality of coastal waters, public access to the sea, and other environmental issues for which the CCC will express concern will require that: (1) a review of all the AFSLV projects and potential effects on the coastal zone must be done by the Air Force in coordination with the CCC; (2) the CCC must concur with the findings of the survey and any mitigative actions recommended; and (3) in the event the CCD results in the AFSLV Program being consistent as practicable with the California Coast Act of 1976, as amended, the CCC must also concur with this determination.

In the event that the AFSLV program involves new construction or activities in the California Coastal Zone, it is possible that impacts may result outside of federal property and within the state coastal zone.

5.6 THREATENED AND ENDANGERED SPECIES

The Federal Endangered Species Act (ESA) of 1973, as amended, extends legal protection to plants and animals listed as endangered or threatened by the U.S. Fish and Wildlife Service (USFWS) and the U.S. National Marine Fisheries Service (NMFS). Section 7(c) of the ESA authorizes the USFWS and/or NMFS to review proposed major federal actions to assess potential impacts on listed species. In accordance the Section 7(c) of the ESA, the Air Force, in consultation with the USFWS and NMFS must identify potential species in areas of concern. Three of the potential AFSLV sites have previously been evaluated for biological resources: SLC-4W, Cypress Ridge and Boathouse Flats If the selected site has not previously been evaluated and threatened and/or endangered species are present, the Air Force may be required to perform a Biological Assessment for that area of potential impact.

The Air Force is cognizant of the importance of protecting endangered and threatened species and their critical habitats. The Air Force has begun an early consultation process with the USFWS Endangered Species Office in Ventura, California, and the NMFS office office on Terminal Island, California, to identify potential species and areas of concern.

Once the specific location for the AFSLV is selected, the Air Force will prepare, if required, a Biological Assessment for those endangered and threatened species known or expected to occur in the vicinity of the AFSLV facilities. In accordance with Section 7(c) of the ESA, this Biological Assessment will address the modifications to the existing structures, construction of new facilities, and subsequent launch operations as they may affect threatened and endangered species. The Biological Assessment will provide greater detail on the potential effects of the program and will be submitted to the USFWS and NMFS in support of a "No Jeopardy Opinion," if determined to be appropriate.

In addition to species listed by the USFWS, the California Department of Fish and Game (CDFG) protects species listed as threatened, endangered, or rare. Candidate species that are proposed for listing by the USFWS and CDFG will also be included in the Biological Assessment.

5.7 MARINE MAMMALS PROTECTION

The NMFS is responsible for the administration of the Marine Mammals Protection Act of 1972 (PL 92-522) which provides protection to whales, pinnipeds, and sea otters in the project area. The Act authorizes the NMFS to review proposed federal actions, potential impacts and mitigation measures. Marine mammals are also included in Section 7(c) of the ESA and are part of the NMFS consultation process.

5.8 NATIONAL HISTORIC PRESERVATION

The National Historic Preservation Act of 1966 (PL 89-665; 80 Stat. 915; 16 USC 470) sets forth a national policy of historic preservation. The act defines the term historic preservation as "the protection, rehabilitation, restoration, and reconstruction of districts, sites, buildings, structures, and objects significant in American history, architecture, archaeology, or culture." It establishes the National Register of Historic Places and includes resources of state and local, as well as national significance; establishes the President's Advisory Council on Historic Preservation; provides for states to conduct statewide surveys and prepare State Historic Preservation Plans; authorizes grants by the Secretary of the Interior to the states to support surveys, planning, and preservation activities, and prescribes certain procedures (Section 106) to be followed by federal agencies in the event that a proposed project might affect significant properties. 36 CFR 60 defines the appropriate terms and sets forth in detail the procedures for nominating sites to the National Register of Historic Places.

Section 106, as amended and implemented by the “Protection of Historic Properties" (36 CFR 800), requires that where sites listed on or eligible for inclusion in the National Register will be affected by federally funded, assisted, or licensed projects, the responsible agency shall consult with the State Historic Preservation Office (SHPO) and, where necessary, with the Keeper of the National Register (Secretary of Interior) to determine the significance of the property, then consult with the SHPO and the Advisory Council to develop methods of mitigating the effect. Compliance procedures are provided for federal agencies under Section 106 of the National Historic Preservation Act, and Executive Order 11593, by 36 CFR 800.

36 CFR 800 sets forth procedures for reviewing projects to determine whether they affect in any way properties on or eligible for the National Register. Additional review procedures are established for those instances where an adverse effect can be established. This regulation also sets forth the power of the Advisory Council to comment upon all such instances and the criteria for "effect" and "adverse effect." Both regulations list criteria for determining whether a property is eligible for the National Register.

Executive Order 11593 of May 13, 1971 (Protection and Enhancement of the Cultural Environment, 36 CFR 8921, 16 USC 470) directs all federal agencies to conduct an inventory of historic properties under their ownership or control, nominate eligible properties to the National Register of Historic Places, and give priority in inventory to federally-owned properties to be transferred or altered. It also directs federal agencies to develop policies that will contribute to the preservation of non-federally owned historic properties, to exercise caution until inventories and nominations to the National Register are complete, and to ensure that eligible properties are not inadvertently damaged or destroyed.

The Archaeological and Historical Preservation Act (PL 86-523 et seq.) states that whenever any federal agency finds, or is notified, in writing, by an appropriate historical or archaeological authority, that its activities in connection with any federal construction project or federally licensed project, activity, or program may cause irreparable loss or destruction of significant scientific, prehistorical, historical, or archaeological data, such agency shall notify the Secretary, in writing, and shall provide the Secretary with appropriate information concerning the project, program, or activity. Such agency may request the Secretary to undertake the recovery, protection, and preservation of such data (including preliminary survey, or other investigation as needed, and analysis and publication of the reports resulting from such investigation), or it may, with funds appropriated for such project, program, or activity, undertake such activities. Copies of reports of any investigations made pursuant to this section shall be submitted to the Secretary, who shall make them available to the public for inspection and review. The Act also provides for (a) initiation of survey or investigation by the Secretary, (b) an exemption of such requirements for emergency projects, (c) time limits for initiation of the survey, (d) compensation for damage and delay in construction, and(e) progress reports for funding or licensing.

The American Indian Religious Freedom Act (42 USC 1996) states that it shall be the policy of the United States to protect and preserve for American Indians their inherent right of freedom to believe, express, and exercise the traditional religions of the American Indian, Eskimo, Aleut, and Native Hawaiian, including but not limited to access to sites, use and possession of sacred objects, and the freedom to worship through ceremonials and traditional rites. The purpose of the Act is to require federal agencies to consider, but not necessarily to defer to, Indian religious values; it does not prohibit agencies from adopting all land uses that conflict with traditional Indian religious beliefs or practices, rather, an agency undertaking a land use project will be in compliance with this Act if, in the decisionmaking process, it obtains and considers views of Indian leaders and if, in project implementation, it avoids unnecessary interference with Indian religious practices.

The AFSLV program will have no effect on any known archaeological or historic site if construction involving earthmoving activities will not take place or if construction is limited to areas found not to contain archaeological or historical resources.

The active launch sites proposed for the AFSLV program have previously been subjected to extensive disturbance from past construction activities and, in most cases, have previously been surveyed for cultural resources. Any areas proposed for new construction at the active launch sites that have previously not been surveyed for cultural resources will require a site survey.

In the event an undeveloped site is selected for the AFSLV program, an archaeological investigation to determine presence of cultural resources will be conducted in the area of potential impact before final siting of facilities is approved. Two undeveloped sites on South VAFB, Cypress Ridge and Boathouse Flats, are being considered for the AFSLV program. Both of the undeveloped sites have previously been evaluated for the proposed SLC-7 project. The AFSLV program is a separate and different project from the proposed SLC-7 project and may include different siting of facilities, structures, utilities and road alignments. For this reason, a site-specific cultural resources evaluation would be required. As with the active launch sites, any areas proposed for new construction, and not previously surveyed for past projects, will require a site survey. Because both undeveloped sites have been recently surveyed, however, it would be expected that the site-specific evaluation would draw heavily upon the findings of the recent SLC-7 evaluation.

The cultural resources study is done in three phases and in consultation with the SHPO. In order to conduct the evaluation of cultural resources, the Air Force will engage the services of a qualified archaeologist who will initiate the investigation by conducting a literature review. This literature review is done to summarize the relevant findings of all past surveys of the site. In the event that the literature review does not cover the entire area to be potentially affected by the proposed project, a site survey is conducted to determine the presence of any cultural remains on the site. An inventory of archaeological and historic sites in the affected area is compiled. The preparation of this inventory constitutes the first phase of the study. At this point, the inventory would be submitted to the SHPO for review and advisement.

Depending on the findings in this inventory, an evaluation of the potential for impacts on cultural resources is conducted. Completion of this evaluation is the second phase, and the evaluation would be submitted to the SHPO for review and advisement.

In the event that the proposed project may result in significant impacts to these properties, a treatment plan is developed. The treatment plan may include mitigation measures such as a data recovery program which would involve the careful removal of artifacts which would be recorded and place in scientific institutions. Development of the treatment plan is the third phase of the study, and this plan is also submitted to the SHPO for review and advisement.

In the event that the proposed project is not located in an area found to contain cultural resources or is not expected to result in significant impacts to cultural resources, only the first and second phases of the study may be required. If determined to be appropriate by the SHPO, it may also be possible to submit both phases to the SHPO as a single submittal for review.

As part of mitigation, archaeological monitoring will be conducted during earthwork in proximity to any known sites. This will minimize the potential for impacts to archaeological resources in the event that artifacts are encountered during the construction phase of the project. For sites on VAFB, it is also required that a Native American Observer be present during archaeological monitoring. The presence of a Native American Observer is not required for any archaeological monitoring on EAFB or San Nicolas Island.

The SHPO must concur with the findings of the study and any mitigative actions recommended. If the AFSLV is determined not to have any effect on cultural resources then, in accordance with the requirements of Section 106 of the National Historic Preservation Act, a "No Effect Determination" would be appropriate. Results of recent surveys and a literature review in support of a "No Effect Determination" for the proposed AFSLV Program would be required to support this finding. If determined to be appropriate for the selected AFSLV site, Air Force will submit a "No Effect Determination" with the site-specific environmental analysis to the SHPO for concurrence.

5.9 PROCESSING OF PERMIT APPLICATIONS

This section identifies the time required to process permit applications, permit application fees, and the number of copies of applications that must be submitted. This information is shown on Table 5.2.

Table 5.2

Environmental Permit Processing Information

Name of Permit	Permitting Agency	Estimated Processing Time	Permit Filing Fee	Number of Copies be to Filed with Permitting Agency
Authority to Construct	SBAPCD	6-8 months	$230.41[a]	1
Permit to Operate	SBAPCD	6-8 months	$230.41[a,b]	1
Authority to Construct	KCAPCD	6-8 months	$60.00	1
Permit to Operate	KCAPCD	6-8 months	$80.00-$8,300.00[a]	
NPDES Water Discharge	RWQCB	3-6 months	$200-$1,300	1

Requirements	RWQCB	3-6 months	$100-$1,100	1
Hazardous Waste Discharge Permit	RWQCB	3-6 months	$300-$3,100	1
Treatment, Storage, and Disposal Facility Permit	CDHS	6-18 months	$18,000-$65,000[c]	2
Extremely Hazardous Waste Permit	CDHS	2-3 weeks	$200.00	2
Costal Consistency Determination	CCC	90 days	no charge	3
Section 7 Consultation	USFWS	3 months	no charge	1
	CDFG	30-45 days	no charge	1
Section 106 Consultation	SHPO	1-12 months	no charge	1

a A permit evaluation fee is required with the application fee. The fee is based on type of equipment and ranges from $35.00 to $4,000.00.

b In addition to an evaluation fee, a PTO fee shall include an annual emission fee for the first year of operation based on total emissions of each air contaminant. It ranges from $12.00 - $40.00 per ton of annual emission.

c This is an application fee. The amount depends on size of the facility.

5.9.1 Permit Application Processing Time

The processing times for environmental permit applications vary according to statutory limitations and individual agency requirements. The application package must usually contain specific program information, a site layout, calculations and other materials as specified by the permitting agency. A permit application package is determined to be complete when all the required information is assembled in the required format. Once the application package is determined to be complete, the processing time begins.

The estimated permit processing time for permits represents the period of time beginning from agency receipt of a complete permit application package and ending upon permit approval, denial, or rejection.

5.9.2 Permit Application Fees

Environmental permit applications usually require the submittal of an application fee with the application materials. These fees will vary according to the type of permit and the type of equipment being permitted.

5.9.3 Permit Application Filing Requirements

Regulatory agencies have different requirements for the number of copies of an application package that must be submitted. The VAFB, EAFB and San Nicolas Island host base environmental contacts must also approve and retain a copy of each application package for their records.

5.10 PERMIT ACQUISITION STRATEGY

The general approach for acquisition of various environmental permits required for the AFSLV program will require the close coordination of environmental issues with VAFB and/or EAFB before any contacts or involvement with regulatory agencies are made.

On VAFB, there are three (3) entities who will assist in this coordination. The WSMC/XR is the VAFB point of contact for AFSLV bidders. The SSD/DEC at VAFB is WSMC's environmental advisor and supports the WSMC/XR. Lastly, the SMC/ET, or Environmental Management, is the host environmental manager. All environmental issues and document review must be directed through these entities.

The environmental review process will initiate through SSD/DEV and include SSD/JA (Legal), SSD/SE (Safety), SSD/DEG (Bioenvironmental), SSD/WE (Meteorology), SSD/DE (Public Affairs), and SSD/CLMA (AFSLV Program Office). The Air Force Systems Command (AFSC) in Maryland is also involved in review and approval of environmental documentation.

A similar environmental review procedure takes place for projects on EAFB. All environmental permit review and coordination including agency consultation at EAFB is accomplished by 6500 ABW/DEV, the environmental office at EAFB.

The permit acquisition strategy envisioned would begin with specific program definition leading to preparation of application packages that identify the proposed elements of the program in the most effective and accurate manner possible. Because the AFSLV program is not well-defined in terms of site location, vehicle configuration, materials use, and resultant emissions at this stage, it is not possible to prepare meaningful permit applications at this time. Once the specific AFSLV contractor and a specific launch site are selected, then required data will become available for preparation of permit applications in coordination with base entities. The AFSLV contractor will be responsible for permit application packages and supplementing them as required during the permitting process.

SECTION 6

SUMMARY OF IMPACTS

The potential environmental impacts associated with construction and operation of the proposed AFSLV program, as currently defined, are summarized for each site on Table 6.1. In the event that new construction and/or modifications are not required, construction-related impacts would not occur. Impacts associated with launch preparation and support activities would be expected to occur at all sites. Impacts related to processing would not be expected to occur at EAFB and Pad 192 since process operations are expected to be conducted off-site.

Environmental resources at some sites may be more sensitive to disturbance than at other sites. The potential for significant impacts is greater for a site with higher environmental sensitivity. If such a site was selected, some potential impacts could be avoided through project design or operational procedures, adherence to regulatory and permit requirements, or the application of mitigation measures.

Potential environmental consequences of the proposed AFSLV program have been evaluated in this EA. Specific environmental impacts associated with the AFSLV program cannot be evaluated until detailed project and site information is known. The Air Force will prepare a site specific EA or Environmental Impact Statement (EIS) when detailed information on the selected launch system and site becomes available.

The environmental sensitivity of the potential AFSLV sites has been evaluated to provide information on the potential for causing significant environmental impacts. A projection of the potential for causing significant environmental impacts based on the sensitivity of environmental resources at each AFSLV site is shown on Figures 6.1 through 6.9. As shown on these summaries:

- Sites with the highest environmental sensitivity, and the highest potential for causing significant environmental impacts, are San Nicolas Island and Cypress Ridge. This is because of the potential effects on protected marine mammal species that breed on San Nicolas Island, and the presence of important biological and cultural resources at Cypress Ridge.

- Because of modifications required at Boathouse Flats, Test Pad 1 and ABRES A-3 these sites have moderate environmental sensitivity and moderate potential for causing significant environmental impacts. While Boathouse Flats is an undeveloped site in close proximity to marine mammal haul-out areas, the use of a transportable launch system at this site would not require construction of any new access roads. All three sites have important biological and cultural resources present.

- Because active launch facilities would be used with minimal modification required, LF 06, SLC-4W, SLC-5, and EAFB have the lowest environmental sensitivity and a low potential for causing significant environmental impacts. Site-specific studies will be required to determine potential impacts to any biological and cultural resources at any of these sites, especially if any disturbances outside of the perimeter fence occur. In the event of new construction, and depending on the scale of construction, at these four sites, the sensitivity and potential for causing significant environmental impacts might increase to a moderate level.

Table 6.1

Potential Environmental Impacts of the AFSLV Program

	LF 06	Test Pad 1	ABRES A-3	SLC-4W	SLC-5	Cypress Ridge [1]	Boathouse Flats [1]	EAFB	Pad 192
Air Quality									
Construction emissions (fugitive dust and vehicle exhaust emissions)	◎ 1 ◉ 2	◎ 1 ◉ 2	◎	◉	◎	●	●	○	◎
Launch processing emissions (i.e., volatile organic compounds and emissions associated with payload processing)	◉	◉	◉	◉	◉	◉	◉	◉	◉
Launch emissions (HCl, Al_2O_3)	◉	◉	◉	◉	◉	◉	◉		◉
Aircraft emissions								◉	
Accident emissions	◉	◉	◉	◉	◉	◉	◉	◉	◉
Contribution to stratospheric O_3 depletion and global warming	◉	◉	◉	◉	◉	◉	◉	◉	◉
Hydrology									
Contamination of groundwater from wastewater discharge	◉		◉	◉	◉				◉
Increased demand on groundwater	◉	◉	◉	◉	◉	◉	◉		
Water Quality									
Contamination of water by HCl and Al_2O_3	◉		◉	◉	◉				◉
Contaminated stormwater runoff	◉		◉	◉	◉				◉
Decrease in infiltration rates contributing to current overdraft[a]	◉	◉	◉	◉	◉	◉	◉	◉	◉
Contamination from accidental spills	◉	◉	◉	◉	◉	◉	◉	◉	◉

Table 6.1 (Cont'd)

Potential Environmental Impacts of the AFSLV Program

	LF 06	Test Pad 1	ABRES A-3	SLC-4W	SLC-5	Cypress Ridge [1]	Boathouse Flats [1]	EAFB	Pad 192
Geology and Soils									
Changes in topography or physiography from site modification	◉	◉	◉	◉	◉	◉	◉		
Erosion of stratigraphic units from any construction									●
Loss of potentially significant fossils in the event of construction	◎	○	○	◎	○	◎	◎	○	◉
Erosion of sand dunes from construction (eolian sands at Pad 192)		◉	◉						●
Landslide hazards	◉					◉			
Slope failure from wavecutting of sea cliffs							◉		
Strong to intense ground motion from future earthquakes	◉	◉	◉	◉	◉	◉	◉	◉	◉
Possible ground rupture along unmapped fault segments	◎			◎	◎	◎	◎	◎	◎
Surface cracks or fissures associated with ground-water extraction								●	
Biota									
Loss of habitat from construction of new facilities	◉	◉	◉	◉	◎	●	●	◉	◉
Potential effects on sensitive sand dune habitat	◉	◉	◉						◉
Possible loss of special status species as a result of any construction				◎		◉	◉	◎	◎

Table 6.1 (Cont'd)

Potential Environmental Impacts of the AFSLV Program

	LF 06	Test Pad 1	ABRES A-3	SLC-4W	SLC-5	Cypress Ridge [1]	Boathouse Flats [1]	EAFB	Pad 192
Biota (cont'd)									
Inadvertent contamination of adjacent freshwater resources from wastewater discharge	◉		◉	◉	◉				
Potential effects on marine mammals and birds along the coast from construction, noise, ground cloud contamination, and accidental spills	◎						◉		●
Potential effects on breeding species of protected marine mammals and sea birds									●
Visual Resources									
Loss of visual resources from public views if placement of new structures alter terrain			◎			●	●		◉
Population and Socioeconomics									
Possible effect on community services due to construction personnel						◉	◉		
Possible need for additional temporary housing									◉
Possible effect on water supply									◉
Possible effect on barge operations									◎
Possible need for additional flights to transport personnel									◎
Temporary beach closings	○	○	○	◉	◉	◉	◉		

Table 6.1 (Cont'd)

Potential Environmental Impacts of the AFSLV Program

	LF 06	Test Pad 1	ABRES A-3	SLC-4W	SLC-5	Cypress Ridge [1]	Boathouse Flats [1]	EAFB	Pad 192
Population and Socioeconomics (cont'd)									
Possible economic impacts to fishing activities during evacuation of waters									Low
Waste Management									
Domestic Waste									
Construction	Same	Same	Same	Same	Same	Same	Same	Lowest	Same
Operations	Same	Same	Same	Same	Same	Same	Same	Lowest	Same
Industrial Waste									
Construction	Low [1] / Same [2]	Low [1] / Same [2]	Same	Same	Low [1] / Same [2]	Moderate	Moderate	Lowest	Same
Operations	Same	Same	Same	Same	Same	Same	Same	Lowest	Same
Hazardous Waste									
Construction	Same	Same	Same	Same	Same	Same	Same	Lowest	Same
Operations	Same	Same	Same	Same	Same	Same	Same	Lowest	Same
IRP Investigations[3]		Moderate	Moderate						
Noise									
Potential sonic boom over Channel Islands	Same	Same	Same	Same	Same	Same	Same		Same
Cultural Resources									
Disturbance to archaeological resources from any construction activities	Lowest	Moderate	Moderate	Moderate	Moderate	Highest	Low		Low
Impacts to archaeological sites from launch operations noise and air emissions which accelerate natural erosion							Moderate		Moderate

○ = Lowest impact compared to other sites

● = Highest impact compared to other sites

Low impact compared to other sites

Same impact compared to other sites

Moderate impact compared to other sites

1 Truck/Trailer launch system
2 Launch Pad system
3 Installation Restoration Program - Site is under investigation for past contamination.

FIGURE 6.1 AFSLV SITE SUMMARY FOR LAUNCH FACILITY 6

SITE LOCATION: LF 06 is located on North VAFB off Point Sal Road at the end of Occulto Road, approximately 900 ft from the coast.

SITE DESCRIPTION: The LF 06 site is located on a marine terrace in a remote, relatively flat grasslands area.

SITE HISTORY: LF 06 was built in 1961 for the Minuteman I ICBM program. The facility is currently used for Minuteman III.

FACILITIES / UTILITIES AVAILABLE ON SITE: LF 06 includes a launch silo and underground facilities enclosed by a perimeter fence. Parking is available for 20-25 cars. Water, power and communications are available at the site.

POTENTIAL ENVIRONMENTAL IMPACTS

AIR QUALITY
Construction emissions would be minimal provided roads are not required. If processing is done on site, VOC may be emitted. Launch would result in generation of HCl, Al_2O_3 NO_X, and CO_2.

NOISE / SONIC BOOM
Potential impacts would depend on vehicle size, weight, thrust, no. of engines in 1st stage, trajectory and azimuth.

BIOLOGICAL RESOURCES
Any new construction outside the existing perimeter fence would require evaluation. LF 06 is within the range of many special status mammal and bird species.

VISUAL RESOURCES
Possible impact to visual resources as seen by marine vessels if modifications include structures that visually alter or obstruct the terrain.

CULTURAL RESOURCES
Cultural resources are not found beneath or in the immediate perimeter of the existing facility. Other archaeological and historic sites are in the vicinity of LF 06. Any new construction outside existing perimeter fence would require survey, mitigation plan and data recovery.

GEOLOGIC RESOURCES / HAZARDS
Strong ground shaking and landslides could result from a major earthquake on one of many onshore or offshore faults in the vicinity. Strong traces are visible in the Monterey Formation underlying the terrace deposits. These faults may cross beneath the site are possibly branches of the Lions Head Fault and may cause possible surface rupture. A site specific geologic investigation is necessary to determine recency of movement, and therefore the potential impact of these faults. Possible impact to paleontologic resources due to excavation in the terrace deposits underlying LF 06.

POPULATION AND SOCIOECONOMICS
Temporary beach closings may occur during launch peridos.

WASTE MANAGEMENT
Domestic, industrial and hazardous wastes are expected to be produced. They will be treated, stored or disposed of properly. Transport distance from this site is greater than other VAFB sites.

WATER RESOURCES / WATER QUALITY
Possible contamination of ground and surface water will increase the demand on groundwater.

LIKELIHOOD OF CAUSING SIGNIFICANT ENVIRONMENTAL IMPACTS	EXISTING LAUNCH PAD	TRUCK/ TRAILER
	LOW	LOW

FIGURE 6.2 AFSLV SITE SUMMARY FOR TEST PAD 1

SITE LOCATION: Test Pad 1 is located on North VAFB at the end of Rhea Road, approximately 9,000 ft from the coast and approximately 3,500 ft from San Antonio Creek.

SITE DESCRIPTION: Test Pad 1 is located on San Antonio Terrace in stablized sand dunes.

SITE HISTORY: Test Pad 1 was built in 1982 for the first cold launch of the Peacekeeper. It is currently an active AFSC facility used for the Peacekeeper.

FACILITIES / UTILITIES AVAILABLE ON SITE:
Test Pad 1 has an aboveground launch mount on concrete area enclosed by a perimeter fence. Parking is available adjacent to the site. Water, power and communications are available at the site.

POTENTIAL ENVIRONMENTAL IMPACTS

AIR QUALITY
Construction emissions would be minimal provided existing facilities are used as new access roads are not required. If processing done on-site, VOC may be emitted. Launch would result in emissions of HCl, Al_2O_3, and NO_x.

BIOLOGICAL RESOURCES
Monardella crispa, a candidate for the federal endangered species list, is a plant that occurs at the Test Pad 1 site. Modifications to this site will require careful evaluation since facilities are located on stabilized dunes.

CULTURAL RESOURCES
Test Pad 1 is located in the center of the San Antonio Terrace National Register District which has 146 recorded archaeological sites. The facility is located over a prehistoric site. Any new construction would require a survey, mitigation plan, data recovey and monitoring by an archaeologist and a Native American observer.

GEOLOGIC RESOURCES / HAZARDS
Strong ground shaking could result from a major earthquake on one of many onshore of offshore faults in the vicinity.

NOISE / SONIC BOOM
Potential impacts would depend on vehicle size, weight, thrust, no. of engines in 1st stage, trajectory and azimuth.

VISUAL RESOURCES
No effect on visual resources.

POPULATION AND SOCIOECONOMICS
Temporary beach closings may occur during launch periods.

WASTE MANAGEMENT
No potential impact is expected to result from the generation of domestic, industrial and hazardous wastes. All wastes will be treated, stored and disposed of properly.

TP 1 is an IRP site.

WATER RESOURCES / WATER QUALITY
Project may increase demand on groundwater.

LIKELIHOOD OF CAUSING SIGNIFICANT ENVIRONMENTAL IMPACTS

TRUCK / TRAILER	EXISTING LAUNCH PAD
MODERATE	MODERATE

Note: Primary concerns would be biological and cultural resources.

FIGURE 6.3 AFSLV SITE SUMMARY FOR ABRES A-3

SITE LOCATION: ABRES A-3 is located on North VAFB at the end of 13th Street, approximately 2,200 ft from San Antonio Creek and approximately 8,200 ft from the coast.

SITE DESCRIPTION: ABRES A-3 is located on Burton Mesa on stabilized sand dune in a combination grasslands / coastal sage scrub plant community. The area is characterized by a steep walled deep canyon that supports riparian type vegetation.

SITE HISTORY: Built in 1959 for ICBM and Atlas D, and previously used for BMRS, ABRES A-3 is currently an active commercial facility used by the AMROC SMLV program.

FACILITIES / UTILITIES AVAILABLE ON SITE:
The launch complex includes a launch pad and a Launch Operations Bldg. Full utilities are available.

POTENTIAL ENVIRONMENTAL IMPACTS

AIR QUALITY
Construction emissions would be minimal provided existing facilities are used and new access roads are not required. If processing done on-site, VOC may be emitted. Launch will generate emissions of HCl, Al_2, O_3, and NO_X .

NOISE / SONIC BOOM
Potential impacts would depend on vehicle size, weight, thrust, no. of engines in 1st stage, trajectory and azimuth.

POPULATION AND SOCIOECONOMICS
Possible temporary beach closings.

BIOLOGICAL RESOURCES
Any construction in the canyon portion of the site should be avoided. ABRES A-3 is approximately 8,000 ft from the mouth of San Antonio Creek, a breeding site for the endangered California least tern. Prior notification of launch and launch noise monitoring may be required. Launch may be restricted from April to September each year. Construction will have a potential effect on sensitive sand dune habitat.

VISUAL RESOURCES
Possible impact to visual resources as seen by the public railroad if modifications to this facility include structures that visually alter or obstruct the existing terrain.

CULTURAL RESOURCES
This facility is located on Burton Mesa in an area of very high archaeological sensitivity. Any new construction outside the perimeter fence would require a survey, mitigation plan and data recovery.

WASTE MANAGEMENT
No potential impact is expected to result from the generation of domestic, industrial, and hazardous wastes. All wastes will be properly treated, stored and disposed.

ABRES A-3 is an IRP site.

GEOLOGIC RESOURCES / HAZARDS
Strong ground shaking could result from a major earthquake on one of many onshore or offshore faults in the vicinity.

WATER RESOURCES / WATER QUALITY
Possible contamination of ground and surface water will increase demand on groundwater.

	EXISTING LAUNCH PAD
LIKELIHOOD OF CAUSING SIGNIFICANT ENVIRONMENTAL IMPACTS	MODERATE

Note: Section 7 consultation with U.S. Fish and Wildlife Service will be required for endangered species.

FIGURE 6.4 AFSLV SITE SUMMARY FOR SLC-4W

SITE LOCATION: SLC-4W is located on south VAFB at the end of Agena Road approximately 300 ft from the coast.

SITE DESCRIPTION: SLC-4W is located on an elevated terrace in a central dune/coastal scrub plant community with some riparian vegetation in Spring Canyon south of the complex.

SITE HISTORY: The SLC-4W is an active AFSC facility currently used for Titan II launches. Built in 1962 for Atlas-Agena launches, the facility was modified in 1988 to accomodate Titan II space vehicle launches. There are several Titan II launches remaining.

FACILITIES / UTILITIES AVAILABLE ON SITE:
SLC-4W is an above-ground launch pad with full facilities and utilities available.

POTENTIAL ENVIRONMENTAL IMPACTS

AIR QUALITY
Construction emissions would be minimal if existing facilities are used. If processing is done on site, VOC may be emitted. Launch would result in generation of HCl, Al_2O_3, NO_x, and CO_2.

BIOLOGICAL RESOURCES
Any modifications in or near the Spring Canyon portion of the site should be avoided, because it would result in a loss of habitat. Modifications outside the existing perimeter fence would require additional evaluation.

CULTURAL RESOURCES
Seven archaeological sites are recorded in the vicinity of SLC-4W, including two eligible for listing in the National Register of Historic Places. Any new construction will require a survey, mitigation plan, data recovery and monitoring by a qualified archaeologist and a Native American observer.

GEOLOGIC RESOURCES / HAZARDS
Strong ground shaking could result from a major earthquake on one of many onshore or offshore faults in the vicinity. An earthquake could cause surface rupture at the site. Possible impact to paleontologic resources due to excavation in terrace deposits underlying SLC-4W.

NOISE / SONIC BOOM
Potential impacts would depend on vehicle size, weight, thrust, no. of engines in 1st stage, trajectory and azimuth.

VISUAL RESOURCES
No effect on visual resources since SLC-4 is already visible from Coast Road and from public railroad.

POPULATION AND SOCIOECONOMICS
Possible temporary beach closings.

WASTE MANAGEMENT
No potential impact is expected to result from the generation of domestic, industrial, and hazardous wastes. All wastes will be treated, stored and disposed of properly.

WATER RESOURCES / WATER QUALITY
Possible change in water quality in Spring Canyon from stormwater discharge. Very high concentrations of iron, zinc, calcium, magnesium, copper, and chloride are found in Spring Canyon after discharge. Possible contamination of surface and groundwater. Increased demand on groundwater.

	EXISTING LAUNCH PAD
LIKELIHOOD OF CAUSING SIGNIFICANT ENVIRONMENTAL IMPACTS	LOW

FIGURE 6.5 AFSLV SITE SUMMARY FOR SLC-5

SITE LOCATION: SLC-5 is located on South VAFB where Delphy Road and Avery Road intersect. It is located approximately 3,000 ft from the coast.

SITE DESCRIPTION: SLC-5 is located on hilly terrain north of Honda Canyon in a stabilized dune (coastal stage scrub) plant community.

SITE HISTORY: Built in 1961 for the Scout Launch System, SLC-5 is an active NASA facility. Four Scout launches are planned through FY 92. SLC-5 may also be used for the NASA SELV.

FACILITIES / UTILITIES AVAILABLE ON SITE:
SLC-5 has an above-ground shelter-type launch platform and a launch control center located in a blockhouse which can accomodate 50 personnel. Full utilities are available including diesel generator and battery pack-up power.

POTENTIAL ENVIRONMENTAL IMPACTS

AIR QUALITY
Construction emissions would be minimal provided existing facilities are used. If processing is done on site, VOC may be emitted. Launch emissions may include HCl, Al_2O_3, NO_x, and CO_2 (no CO_2 if 4-stage).

NOISE / SONIC BOOM
Potential impacts would depend on vehicle size, weight, thrust, no. of engines in 1st stage, trajectory and azimuth.

BIOLOGICAL RESOURCES
Any modifications outside the existing perimeter fence would require additional evaluation.

VISUAL RESOURCES
No effect on visual resources since SLC-5 is shielded from public views.

POPULATION AND SOCIOECONOMICS
Possible temporary beach closings.

CULTURAL RESOURCES
At least two archaeological sites and one historic site are located south of SLC-5. Any new construction would require site survey, mitigation plan and data recovery.

WASTE MANAGEMENT
No potential impact is expected to result from the generation of domestic, industrial, and hazardouse wastes. All wastes will be treated, stored and disposed of properly.

GEOLOGIC RESOURCES / HAZARDS
Strong ground shaking could result from a major earthquake on one of many onshore or offshore faults in the vicinity. The site is located near the Honda Fault Zone. A major earthquake on this fault could generate high ground accelarations, instense ground shaking, and possible surface rupture in the area.

WATER RESOURCES / WATER QUALITY
No potential impact unless wastewater is discharged into Canada Honda Creek. Possible contamination of surface and groundwater. May increase demand on groundwater.

	EXISTING LAUNCH PAD	TRUCK/TRAILER
LIKELIHOOD OF CAUSING SIGNIFICANT ENVIRONMENTAL IMPACTS	LOW	LOW

FIGURE 6.6 AFSLV SITE SUMMARY FOR CYPRESS RIDGE

SITE LOCATION: Cypress Ridge is a vacant site on South VAFB located south of SLC-6 and east of Coast Road, approximately 2,100 ft from the coast.

SITE DESCRIPTION: Cypress Ridge is located on an elevated, undeveloped marine terrace currently used for cattle grazing.

SITE HISTORY: The Cypress Ridge site has been considered for development of SLC-7 and has been evaluated in an EIS prepared in 1989-1990.

FACILITIES / UTILITIES AVAILABLE ON SITE:
Cypress Ridge has no facilities, utilities or site access roads available.

POTENTIAL ENVIRONMENTAL IMPACTS

AIR QUALITY
Construction of access and transport roads at this undeveloped site would result in greater emissions. If processing done on-site, VOC would be emitted. Launch will generate HCl, Al_2O_3, and NO_X.

BIOLOGICAL RESOURCES
Southwestern portions of the site containing riparian-type vegetation should be avoided. The candidate plant *M. undulata* occurs on this site and should be avoided. Construction activities will impact existing habitat.

CULTURAL RESOURCES
The site is in an archaeologically sensitive area that includes eight prehistoric sites and numerous buried site deposits. Any construction of new access roads and utility corridors may require archaeological survey, mitigation plan or data recovery.

POPULATION AND SOCIOECONOMICS
Possible effect on community services during construction. Possible temporary beach closings.

WASTE MANAGEMENT
No potential impact is expected to result from the generation of domestic, industrial, and hazardous wastes. All wastes will be treated, stored and disposed of properly.

NOISE / SONIC BOOM
Potential impacts would depend on vehicle size, weight, thrust, no. of engines in 1st stage, trajectory and azimuth. Launch from this site may also result in generation of a sonic boom over San Miguel Island due to its southerly location.

VISUAL RESOURCES
Significant impact to visual resources expected as seen from railroad, marine traffic and Jalama Beach County Park. Visual character would change from undeveloped to active industrial.

GEOLOGIC RESOURCES / HAZARDS
Strong ground shaking could result from a major earthquake on one of many onshore or offshore faults in the vicinity. A major earthquake could cause surface rupture and landslide at the site. Possible impact to paleontologic resources due to excavation in the terrace deposits at the site.

WATER RESOURCES / WATER QUALITY
May increase demand on groundwater. Collection of surface water runoff will be required for NPDES permits.

LIKELIHOOD OF CAUSING SIGNIFICANT ENVIRONMENTAL IMPACTS

TRUCK / TRAILER
HIGH[1,2,3]

Note: 1. Additional consultation and approval from Coastal Commission and Native American involvement will be required.
2. Although as EIS has already been prepared for Cypress Ridge, AFSLV would be a separate action.
3. Major concerns would be cultural and biological resources.

FIGURE 6.7 AFSLV SITE SUMMARY FOR BOATHOUSE FLATS

SITE LOCATION: Boathouse Flats is located on South VAFB northwest of Boat Dock Harbor on a marine terrace that overlooks the coast.

SITE DESCRIPTION: The site is located on an undeveloped marine terrace used for grazing.

SITE HISTORY: The site has previously been considered for development of SLC-7 and has been evaluated as an alternative site in a Draft EIS prepared in 1989 - 1990.

FACILITIES / UTILITIES AVAILABLE ON SITE: There are no facilities on the site although road access and electrical service to the site are available on the External Tank Tow Route constructed for the Space Shuttle project. Water, communication and sewer service are not available.

POTENTIAL ENVIRONMENTAL IMPACTS

AIR QUALITY
Construction of a new launch pad would result in greater emissions of fugitive dust. Construction of rail or truck trailer launch facility would result in moderate emissions if existing access roads are used. VOC from on-site processing. Launch will generate HCl, Al_2O_3, NO_X, and CO_2 (no CO_2 if 4-stage).

BIOLOGICAL RESOURCES
Boathouse Flats is located near marine mammal haul out areas along the coast of VAFB near Rocky Point. The candidate plant *M. undulata* occurs on this sie and should be avoided. Construction activities will impact existing habitat.

CULTURAL RESOURCES
Seven prehistoric and historic sites are located in the Boathouse Flats area, and all are eligible for the National Register. These sites would have to be avoided and mitigation would include data recovery if sites cannot be avoided.

GEOLOGIC RESOURCES / HAZARDS
Strong ground shaking could result from a major earthquake on one of the many onshore or offshore faults in the vicinity. A major earthquake could cause surface rupture and trigger slope failure. Possible impact to paleontologic resources due to excavation in the terrace deposits at Boathouse Flats.

NOISE / SONIC BOOM
Potential impacts would depend on vehicle size, weight, thrust, no. of engines in 1st stage, trajectory and azimuth. Launch from this site may also result in generation of a sonic boom over San Miguel Island due to its southerly location.

VISUAL RESOURCES
Significant impact to visual resources expected since site would be visible from railroad, marine vessels and Jalama Beach. Character of site would change from undeveloped to active industrial.

WASTE MANAGEMENT
No potential impact is expected to result from the generation of domestic, industrial, and hazardous wastes. All wastes will be treated, stored and disposed of properly.

POPULATION AND SOCIOECONOMICS
Possible effect on community services during construction. Possible temporary beach closings.

WATER RESOURCES / WATER QUALITY
May increase demand on groundwater. Collection of surface water runoff will be required for NPDES permits.

LIKELIHOOD OF CAUSING SIGNIFICANT ENVIRONMENTAL IMPACTS	TRUCK / TRAILER
	MODERATE

Note: Additional consultation and approval from Coastal Commission and Native American involvement will be required. Major concerns would be cultural resources and marine mammal locations. Likelihood of an EIS would be low assuming no new construction of roads or platforms; moderate for any new construction.

FIGURE 6.8 AFSLV SITE SUMMARY FOR EDWARDS AFB

SITE LOCATION: Edwards AFB is located in the Mojave Desert approximately 50 miles north of Los Angeles.

SITE DESCRIPTION: The air-launched vehicle (ALV) site at EAFB is located at the NASA Dryden Flight Research Facility west of Rogers Day Lake.

SITE HISTORY: This site is being used for an existing air-launched space vehicle program, with six potential launches remaining.

FACILITIES / UTILITIES AVAILABLE ON SITE:
The DFRF facility has office trailers, a vehicle assembly bldg, an assembly integration trailer and landing field at Rogers Dry Lake. Full utilities are available at the site.

POTENTIAL ENVIRONMENTAL IMPACTS

AIR QUALITY
Construction emissions will not be generated if existing air-launch platforms and support structures are used. Vehicle assembly may emit insignificant amounts of IPA, perchloro-ethylene, triethylenetetramine, Versamid 140, Epon resin and graphite dust. Propellent transfer to the ALV may result in emissions of propellant and combustion products from an incinerator-type vapor control system. Launch emissions would not be significant.

NOISE / SONIC BOOM
Potential impacts would depend on vehicle size, weight, thrust, no. of engines in 1st stage, trajectory and azimuth. A focused sonic boom would not be expected unless doglegging occurs.

BIOLOGICAL RESOURCES
The existing ALV program has been evaluated in an EA. Any construction of new facilities at EAFB would require additional evaluation, as there are several special status plants and animals present on the base.

VISUAL RESOURCES
It is not expected that visual resources would be affected.

CULTURAL RESOURCES
No impact expected if existing facilities are used.

WASTE MANAGEMENT
No potential impact is expected to result from the generation of domestic, industrial, and hazardous wastes. All wastes will be treated, stored, and disposed of properly.

GEOLOGIC RESOURCES / HAZARDS
Strong or intense ground shaking would result from a major earthquake on either the San Andreas or Garlock Faults. Moderate to strong ground motion, and possible surface rupture, could result from earthquakes along faults of the Mojave Desert. Surface cracks or fissures could adversely impact operations.

WATER RESOURCES / WATER QUALITY
No potential impact.

LIKELIHOOD OF CAUSING SIGNIFICANT ENVIRONMENTAL IMPACTS	AIR-LAUNCH USING EXISTING FACILITIES
	LOW

FIGURE 6.9 AFSLV SITE SUMMARY FOR SAN NICOLAS ISLAND

SITE LOCATION: San Nicolas Island is located 60 miles off the coast of California. It is one of the eight Channel Islands.

SITE DESCRIPTION: San Nicolas Island is owned by the Navy and is under the jurisdiction of the Pt. Mugu Pacific Missile Test Center. It is also currently used by the FAA for radar tracking operations including air traffic control for LAX.

SITE HISTORY: San Nicolas Island has been used by the Navy for launching / testing of drones and small probe-type rockets.

FACILITIES/ UTILITIES AVAILABLE ON SITE:
San Nicolas Island has existing roads, a boat loading area, an air strip, launch pads, blockhouses, an ordnance assembly bldg and a magazine area for storage. Utilities are available, with the exception of water. All facilities are used 100% of the time.

POTENTIAL ENVIRONMENTAL IMPACTS

AIR QUALITY
All new equipment units must comply with Ventura County APCD rules and permit requirements.

NOISE / SONIC BOOM
Potential impacts would depend on vehicle size, weight, thrust, no. of engines in 1st stage, trajectory and azimuth. Current launch noise does not appear to be a problem to the resident population of 250 personnel.

BIOLOGICAL RESOURCES
Federal- and State-listed species of animals and plants may be impacted by the proposed project, especially because the island is a breeding area for many marine mammals and birds.

VISUAL RESOURCES
Visual resources may be affected because Pad 192 is visible from marine vessels especially during the fishing season.

POPULATION AND SOCIOECONOMICS
Temporary impact on housing and water demand. Possible need for additional barge opertions and flights. Additional temporary evacuation of surrounding waters.

CULTURAL RESOURCES
Approximately 500 archaeological sites have been recorded on San Nicholas Island. Any new construction would require a survey, mitigation plan, data recovery, and SHPO consultation.

GEOLOGIC RESOURCES / HAZARDS
The island is almost completely sandstone. Any grading would cause erosion. Pad 192 is underlain by eolian sands that are highly susceptible to erosion. Strong to intense ground motion could result from earthquakes along faults in the Channel Island area. The potential for surface rupture in the immediate area should be evaluated. Possible impact to paleontologic resources due to excavation.

WASTE MANAGEMENT
No potential impact is expected to result from the generation of domestic, industrial, and hazardous wastes. The Navy barges its wastes off island. Contractor will be required to make its own arrangements for waste transport and disposal.

WATER RESOURCES / WATER QUALITY
Water is currently barged onto the island (wells have been depleted). Water is not available for additional programs or personnel. Streams or other water bodies are not present on the island.

LIKELIHOOD OF CAUSING SIGNIFICANT ENVIRONMENTAL IMPACTS

EXISTING LAUNCH PAD
HIGH

Note:New construction would probably be required. Primary concerns would be biological resources and cultural resources. Section 7 consultation on endangered species will be required. The island has not previously been assessed for environmental resources. Previous EAs are not available.

SECTION 7

PERSONS AND AGENCIES CONSULTED

The following individuals were consulted during the preparation of this Environmental Assessment.

FEDERAL AGENCIES

U.S. Air Force

Vandenberg Air Force Base

Benier, Dennis	AFSC/EGG
Clements, SSgt Tom	WSMC / Public Affairs
Cortopassi, Ron	WSMC/SEY
Glinski, Capt Robert A.	WSMC/XR
Griffin, John	SMC/ET
Hernandez, J.	Civilian Personnel Office
Johnson, B.	Civil Engineering Squadron
Kolakowski, Capt William	SMC/ETC (Environmental Compliance Division)
Murphy, Morene	SMC/ETC
Peterson, Douglas	Civil Engineering Squadron
Riley, Maj	Military Personnel Officer
Spanne, Lawrence	SMC/ETC
Toft, Paul	SSD/DEC

Edwards Air Force Base

Bueno, Sgt	Hospital Administration
Harrison, Sgt	Military Personnel Office
Kautch, R.	Military Personnel Office
Martin, J.	Housing Office
Mullen, D.	Environmental Planning and Compliance Office
Phillips, Mike	AFFTC/DEV
Rush, Chris	Environmental Planning and Compliance Office

Norton Air Force Base

Sabol, Dr. John	AFRCE/BMO-DEV

U.S. Navy

Dow, Ron	PMTC Environmental Division

Keeney, Tom	PMTC Environmental Division
McConnall, Mike	Range Safety Office
Schwartz, Steve	PMTC Environmental Division
Shide, Dan	PMTC Environmental Division

FEDERAL AGENCIES (CONT'D)

U.S. Army Corps of Engineers

Salas, Gerry	Los Angeles, CA

U.S. Fish and Wildlife

Bransfield, Ray	Ventura, CA
Brewer, Donna	Ventura, CA

STATE AGENCIES

Carder, Nancy	California Department of Health Services
Moheban, Arman	California Department of Health Services
Raines, James	California Coastal Commission (San Francisco, CA)
White, C.	California Department of Water Resources

LOCAL AGENCIES

Angel, Jose	Regional Water Quality Control Board, Central Valley Region
Erikson, Lance	Kern County Air Pollution Control Board
Barnes, Dr. Lawrence	Natural History Museum of Los Angeles County
Gary, Morris	Santa Barbara County Air Pollution Control Board
Gray, Dr. Robert	Santa Barbara City College
Jefferson, George	Page Museum
Martin, T.	City of Lompoc
Meece, Bill	Regional Water Quality Control Board, Central Coast Region
Reynolds, Robert	San Bernardino County Museum

SECTION 8

REFERENCES

Allen, C.R., et al., 1965. Relationship between seismicity and geologic structures in Southern California, Bull. of the Seismological Society of America, v. 55, no. 4, p. 753-797.

Allen, C.R., et al., 1975. Seismological studies of the San Fernando earthquake and their tectonic implications, in San Fernando, California, Earthquake of 9 February 1971, Calif. Div. Mines and Geol. Bulletin 196.

Arnold, J.E., 1987. Craft specialization in the Prehistoric Channel Islands, California. University of California Publications in Anthropology, 18.

Atwater, Tanya, 1970. Implications of plate tectonics for the Cenozoic tectonic evolution of western North America: Geol. Society of America Bull. v. 81, p. 3513-3535.

Baldwin, K., 1990. Personal communication between Kevin Baldwin, herpetologist, University of California Santa Barbara, and J. Galizio, ES, 13 July.

Barbour, M.G. and J. Major, 1988. Terrestrial Vegetation of California. California Native Plant Society. p. 893-908.

Barnes, Dr. Lawrence, 1990. Los Angeles Museum of Natural History. Telephone conversation with Lisa Luptowitz, ES, 27 September.

Barrows, Allan G., 1974. A Review of the Geology and Earthquake History of the Newport-Inglewood Structural Zone, Southern California, Calif. Div. Mines and Geol. Special Report 114.

Benier, D., 1990. Personal communication between Dennis Benier (AFSC/EGG-VAFB) and A. Davis, ES, 31 July.

Benson, F.C., 1969. Archaeological Survey of Sudden Flats and Associated Canyons, Vandenberg Air Force Base, 1 September.

Bowholtz, Daniel W., Capt, 1990. Review Comments on Draft Environmental Assessment for Air Force Small Launch Vehicle Program (December 1990), submitted Capt Richard Lamb, HQ SSD/DEV, 28 December.

Bowman, Kenneth P., 1988. Global Trends in Total Ozone. Science 239, p. 48-49.

Bueno, Sgt, 1990. Personal communication between Sgt. Bueno (Edwards Air Force Base, Hospital Administration) and K. Choksy, ES, 19 June.

Burnett, Ronald D., 1975. Noise Monitoring Titan IIID Launch, prepared for USAF Environmental Health Laboratory, McClellan Air Force Base, California, January.

Burnham and Kunkel, 1958. USGS Geologic and Hydrologic Reconnaissance and Suggested Test Drilling Program, San Nicolas Island, CA.

CARB (California Air Resources Board), 1988. California Air Resources Board 1988 Quarterly Summaries.

CDE (California Department of Education), 1990. "California Baseline Educational Data System Collection 1989-90," Sacramento, California, June.

CDE, 1990. *California Public School Directory*.

CDF (California Department of Finance), 1986. *Projected Total Population of California Counties, Report T-7*, Sacramento, California, December.

CDF, 1988. *California Statistical Abstract*, Sacramento, California.

CDF, 1989. Household Projection for California Counties: 1985-2020," Report 89, Sacramento, California, February.

CDF, 1990a. Population and Housing Estimates, January 1, 1990," Sacramento, California, May.

CDF, 1990b. *Labor Market Conditions in California*, Sacramento California, 1 June.

CDMG (California Division of Mines and Geology), 1979. CDMG Note 23.

CEDD (California Employment Development Department), 1989. Annual Planning Information: Santa Barbara-Santa Maria-Lompoc, Los Angeles, California, June.

CEDD, 1989-90. *City and County Population Estimates*, *Report E1*, Sacramento, California.

Clarke, S.H. et al, 1985. Identifying Potentially Active Faults and Unstable Slopes Offshore, in Evaluating Earthquake Hazards in the Los Angeles Region, U.S. Geol. Survey Prof. Paper 1360, p. 357-373.

Clements, T., 1990. Personal communication between Staff Sgt Tom Clements (WSMC Range Safety Public Affairs Office) and R. Crisologo, ES, 30 November.

CNPS (California Native Plant Society), 1988. Inventory of Rare and Endangered Vascular Plants of California. Sacramento, CA. 168p.

COE (U.S. Department of the Army, Corps of Engineers), 1984a. Least Tern Breeding Biology at Vandenberg Air Force Base, 1984, prepared by COE, Los Angeles District, September.

COE, 1984b. Archaeological Investigations on the San Antonio Terrace, Vandenberg Air Force Base, California, in connection with MX Facilities Construction, prepared by Chambers Consultants and Planners, prepared for COE Los Angeles District, in partial fulfillment of Contract No. DACA09-81-C-0048, January.

Cortopassi, R., 1990. Personal communication between Ron Cortopassi (WSMC/SEY) and R. Crisologo, ES, 30 November.

Crowell, J.C., 1962. Displacement along the San Andreas fault, California, Geol. Soc. America Spec. Paper 71.

Crowell, J.C., 1968. Movement histories of faults in the Transverse Ranges and speculations on the tectonic history of California, Proceedings of Conference on Geologic Problems of San Andreas Fault System, Stanford University, p. 323-341.

Crowell, J.C., ed., 1975. San Andreas Fault in Southern California, A guide to San Andreas Fault from Mexico to Carrizo Plain, Calif. Div. Mines and Geol. Special Report 118.

Davis, J.F., et al., 1982. Earthquake Planning Scenario for a Magnitude 8.3 Earthquake on the San Andreas Fault in Southern California, Calif. Div. Mines and Geol. Special Publication 60.

deCessac, L., 1951. “Observations on the Sculptured Stone Fetishes in Animal Form Discovered on San Nicolas Island (California)”. Reports of the University of California Archaeological Survey, No. 12.

Dibblee, T.W., Jr., 1950. Geology of southwestern Santa Barbara County, California. California Division of Mines and Geology, Bulletin 150.

Dibblee, T.W., Jr., 1967. Areal Geology of the Western Mojave Desert California. U.S. Geologic Surv. Prof. Paper 522.

Dutcher, L.C. and G.F. Worts, Jr., 1963. Geology, Hydrology, and Water Supply of Edwards Air Force Base, Kern County, California. U.S. Geologic Surv. Open-File Report.

Ember, Lois R., “EPA urged to tackle, solve highest risk pollution problems” in Chemical and Engineering News Vol. 68, No. 42, p. 24-25, 15 October.

EPA, 1974. Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety. U.S. Environmental Protection Agency, 55019-74-004, March.

EPA, 1980. Effects of Noise on Wildlife and Other Animals: Review of Research Since 1971. Report No. 550/9-80-100.June.

ES (Engineering-Science, Inc.), 1989. Draft Remedial Investigation Report (for) Site 21, Edwards Air Force Base, California, prepared for District Engineer, U.S. Army Corps of Engineers, Missouri River Division, Omaha District, Omaha, Nebraska, June.

ESA (Earth Sciences Associates), 1982. Supplemental Water Study for Vandenberg Air Force Base, Tasks IC and II, Groundwater Option, March.

Evernden, J.F. and Thomson, J.M., 1985. Predicting Seismic Intensities, in Evaluating Earthquake Hazards in the Los Angeles Region, U.S. Geol. Survey Prof. Paper 1360, p. 151-202.

Fugro National, Inc., 1978. General Geotechnical Site Feasibility Analysis for the Environmental Assessment of an MX Test Facility, Vandenberg Air Force Base, California.

FWS (U.S. Fish and Wildlife Service), 1989. Endangered and Threatened Wildlife and Plants, January.

Gibson, R.O., 1986, Results of Archaeological Surface Survey for Proposed Replacement Fence Project on the Sudden Ranch Lease, Southern Vandenberg Air Force Base, Ca., prepared for Mr. John Ruffoni, Santa Monica, 7 November.

Glidden, S.W., 1991. Comments from Department of the Navy, Naval Air Station, Point Mugu, California on Draft Environmental Assessment for Air Force Small Launch Vehicle (December 1990), 31 January.

Grant, C., 1978a. Chumash: Introduction. Handbook of North American Indians: California, v. 8, Heizer, R.F., ed., p. 505-508.

Grant, C., 1978b. Eastern Coastal Chumash. Handbook of North American Indians: California, v.8, Heizer, R.F., ed., p. 520-519.

Gray, R.S., 1985. Addendum to technical appendix A: geology, paleontology. In: EIS/EIR Union Oil Project/Exxon Project Shamrock and Central Santa Maria Basin study area. Prepared for County of Santa Barbara, U.S. Minerals Management Service, California State Lands Commission, California Coastal Commission, California Office of Offshore Development. Prepared by Arthur D. Little, Inc., Santa Barbara, California.

Greenwood, R.S., 1978. Obispeno and Purisimeno Chumash. Handbook of North American Indians: California, v.8., Heizer, R.F., ed., p. 520-529.

Griffin, J., 1990. Personal communication between John Griffin (1STRAD/ET) and A. Davis, ES, 19 July.

Hart, Earl W., 1988. Fault-Rupture Hazard Zones in California, Alquist-Priolo Zones Act of 1972, Calif. Div. Mines and Geol. Special Publication 42.

Harte, John, 1988. Consider a Spherical Cow: A Course in Environmental Problem Solving. University Science Books, Mill Valley, California, p. 128-149.

Heizer, R.F., 1957. “A Steatite Whale Figure from San Nicolas Island”. Reports of the University of California Archaeological Survey No. 38.

Heizer, R.F., 1960a. “A San Nicolas Island Twined Basketry Water Bottle”. Reports of the University of California Archaeological Survey, No. 50.

Heizer, R.F., 1960b. “Some Prehistoric Wooden Objects from San Nicolas Island”. Reports of the University of California Archaeological Survey, No. 50.

Heizer, R.F., and Elsasser, A.B., 1980. “The Natural World of the California Indians.” Reports of the University of California Archaeological Survey, No. 46.

Heizer, R.F., and Elsasser, A.B., n.d. “The Lone Woman of San Nicolas Island”. University of California, Berkeley.

Hernandez, J., 1990. Personal communication between Jose Hernandez (Civilian Personnel Office, VAFB) and K. Choksy, ES, 18 June.

Hileman, J.A. and Hanks, T.C., 1975. Seismicity Along the San Andreas Fault, Southern California, Calif. Div. of Mines and Geol. Special Report 118.

Hill, R.L. et al., 1979. Earthquake Hazards associated with faults in the Greater Los Angeles Metropolitan area, Los Angeles County, California, including faults in the Santa Monica-Raymond, Verdugo-Eagle Rock, and Benedict Canyon Fault Zones, Calif. Div. Mines and Geol. Open File Report 79-16.

Iacopi, Robert, 1973. Earthquake Country, How, Why and Where Earthquakes Strike in California, Lane Magazine and Book Company.

Jameson, E.W. and H.J. Peeters, 1988. California Mammals. University of California Press. Berkeley, CA. 403p.

Jennings, C.W., 1975. Fault Map of California, Calif. Div. Mines and Geol., Calif. Geol. Data Map Series, Map No. 1, Scale 1:750,000.

Johnson, B., 1990. Personal communication between B. Johnson (VAFB Civil Engineering Squadron) and K. Choksy, ES, 14 June.

Jones, P.M., 1969. “San Nicolas Island Archaeology in 1901”. The Masterkey, V. 43, no. 3.

Ken O'Brien & Associates, 1987. Vandenberg Air Force Base Master Plan - Development Plan, prepared for Strategic Air Command, 30 September (revision), as referenced in USAF, 1989c. Note: This document has been modified in USAF, 1989e.

Kennedy, George, 1990. Los Angeles Museum of Natural History. Telephone conversation with Lisa Luptowitz, ES, 27 September.

Kennett, James, 1982. Marine Geology. Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 813 p.

King, C.D., 1981. The evolution of Chumash society: A comparative study of artifacts used in social system maintenance in the Santa Barbara Channel Region before A.D. 1804. University of California, Davis, Ph.D. dissertation.

Kolakowski, W., 1990. Personal communication between William Kolakowski, (1STRAD/ETC) and A. Davis, ES, 18 June.

Kroeber, A.L., 1953. Handbook of the Indians of California. California Book Company.

Lamar, D.L., et al., 1973. Earthquake Recurrence Intervals on Major faults in Southern California, in Geology, Seismicity and Environmental Impact, Association of Engineering Geologists Special Publication.

Loel, W., and Corey, W.H., 1932. The Vaqueros Formation, Lower Miocene of California. University of California Publications in Geological Science, v. 22, p. 31-410.

Lompoc, 1986. City of Lompoc Noise Baseline Summary Report, prepared by Endo Engineering, 17 October.

Margulis, Lynn and J.E. Loveluck, 1974. Biological Modulation of the Earth's Atmosphere. Icarius 21 p. 471-489.

Martin, J., 1990. Personal communication between J. Martin (Edwards Air Force Base Housing Office) and K. Choksy, ES, 19 June.

Martin, T., 1990. Personal communication between T. Martin (Principal Planner, City of Lompoc) and K. Choksy, ES, 12 June.

Matthews, Samuel W., 1990. Is Our World Warming? National Geographic Vol. 178, No. 4, p. 66-69, October.

McCulloch, D.S., 1985. Evaluating Tsunami Potential, in Evaluating Earthquake Hazards in the Los Angeles Region, U.S. Geol. Survey Prof. Paper 1360, P. 375-413.

Meece, B., 1990. Personal communication between Bill Meece, Central Coast RWQCB and K. Kroner, ES, 1 October 1990.

Meighan, C.W., and Eberhart, H., 1953. "Archaeological Resources of San Nicolas Island, California". American Antiquity, v. XIX, No. 2.

Mullen, D., 1990. Personal communication between Dan Mullen (Environmental Planning and Compliance Office, Edwards Air Force Base) and K. Choksy, ES, 19 June.

Munz, P.A., 1974. A Flora of Southern California. University of California Press. Berkeley, CA. 1086p.

Murphy, M., 1990. Personal communication between M. Murphy (1STRAD/ETC) and A. Davis, ES, 1 August.

NAS (Naval Air Station, Pt. Mugu), 1988. Fifth Biennial Mugu Lagoon/San Nicolas Island Ecological Research Symposium, 25 October.

NASA, 1981. Environmental Resource Document - Hugh L. Dryden Flight Research Center, Prepared for NASA-DFRC, DeLeuw, Cather and Company, Edwards Air Force Base, California.

Navy (U.S. Department of the Navy), 1976. San Nicolas Island General Development Map of the Navy, Naval Facilities Engineering Command, Pacific Missile Test Center, Naval Air Station, Pt. Mugu, California. NAVFAC Drawing No. 6002241, updated to reflect existing condition as of May 14, 1976.

Navy, 1986. Master Plan, Pacific Missile Test Center.

Norris, Robert M., 1951. Marine Geology of the San Nicolas Island Region, California, PhD. thesis, Univ. of Calif., Los Angeles.

Parsons, Ralph M., Co., 1981. Environmental Surveillance Report No. 7. Prepared for the Vandenberg Space Shuttle Project. 15 July.

Parsons, Ralph M., Co., 1982. Environmental Surveillance Report No. 11, 15 July.

Peters, Robert L. and Joan Darling, 1985. The Greenhouse Effect and Nature Reserves. BioScience 35 p. 707-717.

Peterson, D., 1990. Personal communication between Douglas Peterson, VAFB Civil Engineering Squadron, and A. Davis, ES, 19 July.

Phillips, M., 1990a. Personal communication between Mike Phillips (AFFTC/DEV) and A. Davis, ES, 11 June.

Phillips, M., 1990b. Personal communication between Mike Phillips (AFFTC/DEV) and J. Galizio, ES, 26 July.

Phillips, M., 1990c. Personal communication between Mike Phillips (AFFTC/DEV) and A. Davis, ES, 1 August.

Phillips, M., 1990d. Personal communication between Mike Phillips (AFFTC/DEV) and R. Crisologo, ES, 1 October.

Phillips, M., 1990e. Personal communication between Mike Phillips (AFFTC/DEV) and R. Crisologo, ES, 9 October.

Reinman, Fred M., 1962. “New Sites on San Nicolas Island, California”. Annual Report, Archaeological Survey, Department of Anthropology-Sociology, University of California, Los Angeles.

Reinman, Fred M., 1964. “Maritime Adaptation on San Nicolas Island, California”. Annual Report, Archaeological Survey, Department of Anthropology, University of California, Los Angeles.

Reinman, Fred M., and Townsend, S.J., 1960. “Six Burial Sites on San Nicolas Island”. Annual Report, Archaeological Survey, Department of Anthropology-Sociology, University of California, Los Angeles.

Reinman, Fred M. and Gloria A. Lauter, 1984. San Nicolas Island Cultural Resources Survey Report, prepared for Department of the Navy, Pacific Missile Test Facilities, Point Mugu, California, Contract No. N62474-83-R-6611.

Riley, Maj, 1990. Personal communication between Major Riley, Military Personnel Office, (VAFB) and K. Choksy, ES, 18 June.

Rozaire, C.E., 1959. “Archaeological Investigations at Two Sites on San Nicolas Island, California”. The Masterkey, v. 33, No. 4.

Rozaire, C.E., and Kritzman, 1960. “A petroglyph cave on San Nicolas Island”. The Masterkey, v. 34, No. 4.

Rush, C., 1990. Personal communication between Chris Rush (Environmental Planning and Compliance Office, Edwards Air Force Base) and K. Choksy, ES, 14 June.

Sabol, J., 1990. Personal communication between Dr. John Sabol (AFRCE/BMO-DEV, Norton Air Force Base) and R. Crisologo, ES, 18 June.

SANDAG (San Diego Association of Governments), 1990. Draft Comprehensive Species Management Plan for the Least Bell’s Vireo, prepared by RECON, January.

Santa Maria, 1987. City of Santa Maria Noise Element, prepared by Michael Brandman Associates, Inc., February.

SBCC/AHC (Santa Barbara City College and Allan Hancock College), 1990. Personal communication between SBCC/AHC Admissions Offices and K. Choksy, ES, 14 June.

SCAG (Southern California Association of Governments), 1991. Population and Housing Projections, electronic data file.

SCAQMD (South Coast Air Quality Management District), 1989. Global Warming and Stratospheric Ozone Depletion: Informal Report for Policy Development, Planning Division, August.

SCS (Soil Conservation Service), n.d. Soil Survey of Channel Islands Area, California, San Nicolas Island Part, Interim Report, prepared in cooperation with Department of the Navy Pacific Missile Test Center Point Mugu, CA and the Regents of the University of California (Agricultural Experiment Station).

SDSU (San Diego State University), 1980. Potential Effects of Space Shuttle Sonic Booms on the Biota and Geology of the California Channel Islands: Research Reports, Technical Report 80-1, Center for Marine Studies, San Diego State University, December.

Smith, J.L. and Fallgren, R.B., 1975. Ground displacement at San Fernando Valley Juvenile Hall and the Sylmar Converter Station, in San Fernando, California, Earthquake of 9 February 1971, Calif. Div. Mines and Geol. Bulletin 196.

Stearns Catalytic, 1987. Hydrology Study of Space Launch Complexes 3 and 4, South VAFB, 20 February.

Stebbins, R.C., 1985. Western Reptiles and Amphibians. Houghton Mifflin Company. Boston, MA. 278p.

Summers, P., 1990. Letter to SSD/DEV from Capt Paul A. Summers, AFSLV Project Manager, Medium Launch Vehicles SPO, SSD/CLM, prepared in response to SSD/DEV letter dated 11 May 1990, no date on CLM letter, received by ES on 19 June 1990.

Tenera, 1990. Evaluation of Vandenberg Air Force Base Launch Risk Model and Application, January.

Thomas, H.W., Kennedy, G.L., and Guthrie, D.A., in press. *Fratercula dowi* n. sp., an extinct late Pleistocene puffin from the southern Channel Islands.

Toft, 1990a. Personal communication between Paul Toft (SSD/DEC, VAFB) and Anthony Davis, ES, 11 June.

Toft, 1990b. Personal communication with A. Davis, ES, 15 June.

Toft, 1990c. Personal communication with A. Davis, ES, 27 July.

Toppozada, Tousson R. and Parke, David L., 1982. Areas Damaged by California Earthquakes 1900-1949, Calif. Div. Mines and Geol. Open File Report 82-17.

Toppozada, Tousson R. et al, 1988. Planning Scenario for a Major Earthquake on the Newport-Inglewood Fault Zone, Calif. Div. Mines and Geol. Special Publication 99.

Toppozada, Tousson R. et al, 1989. Earthquake Planning Scenario for a Major Earthquake on the Newport-Inglewood Fault Zone, California Geology, April, 1989.

U.S. (Bureau of the) Census, 1983. Census of Population and Housing: 1980, Washington, D.C.

U.S. (Bureau of the) Census, 1990. Population and Percent Distribution by Race: 1990 Report C-90-PL-1, Washington, D.C.

U.S. Department of Agriculture, n.d. Soil Survey of Channel Islands Area, San Nicolas Island Part, Interim Report.

U.S. Department of Agriculture, 1988. Soil Survey of Edwards Air Force Base, California, Interim Report.

U.S. Department of Agriculture, 1989. Soil Survey of Edwards Air Force Base, California, NASA Ames-Dryden Flight Research Facility Part, Interim Report.

UCSB (University of California at Santa Barbara), 1990. Personal communication between UCSB Admissions Office and K. Choksy, ES, 14 June.

USAF (United States Air Force), 1975. Final Environmental Statement, United States Air Force Space Launch Vehicles, 1 February.

USAF, 1976. Aerospace Medical Research Laboratory/BBE, Miscellaneous Noise Data, letter dated 4 February.

USAF, 1977. Environmental Impact Analysis Process, Reference Document to Environmental Impact Statement, Space Shuttle Program, Vandenberg Air Force Base, California, Volumes I and II, August.

USAF, 1978. Final Environmental Impact Statement, Space Shuttle Program (at) Vandenberg Air Force Base, California.

USAF, 1980. Final Environmental Impact Statement, MX: Milestone II (III - Missile Flight Testing).

USAF, 1983a. Supplement to Final EIR, Space Shuttle Program, Vandenberg Air Force Base, California.

USAF, 1983b. (Final Biological Assessment), Finding of No Significant Impact (for) Peacekeeper in Minuteman Silos, Flight Test Program Facilities, Vandenberg Air Force Base, California.

USAF, 1984. Replacement Cable Project and Fibre Optic Cable Project, Vandenberg Air Force Base, Santa Barbara County, Final Report, prepared for the U.S. Air Force, Space and Missiles Center, Vandenberg Air Force Base, California, prepared by Roberta S. Greenwood and John M. Foster, October.

USAF, 1986a. Environmental Assessment for the Complementary Expendable Launch Vehicle Program, Cape Canaveral AFS, Florida, June.

USAF, 1986b. Environmental Assessment for the Titan IV Program at Cape Canaveral AFS, Florida, July.

USAF, 1986c. Environmental Assessment, Testing of Titan Solid Propellant Rocket Motors, Edwards Air Force Base, California, December.

USAF, 1987a. Draft Environmental Impact Statement for the Mineral Resource Management Plan: Potential Exploration, Development, and Production of Oil and Gas Resources, Vandenberg Air Force Base, June.

USAF, 1987a. Environmental Risk Assessment, Air Force, Space Division, Beryllium Propellant Facility, Edwards Air Force Base, California, February.

USAF, 1987b. Environmental Assessment (of the) Titan II Space Launch Vehicle Modifications and Launch Operations Program, Vandenberg, Air Force Base, California, August.

USAF, 1987c. Results of Archaeological Surface Survey and Limited Subsurface Testing for the Launch Support System Cable, Northern Vandenberg Air Force Base, Santa Barbara County, California, prepared by Robert O. Gibson, Archaeologist, for Base Contracting, Contract No., F0468486M752, Vandenberg Air Force Base, CA, 19 February.

USAF, 1987d. Cultural Resources Survey of Proposed Small Intercontinental Ballistic Missile and Peacekeeper Rail Garrison Test Areas, San Antonio Terrace, prepared by Tetra Tech, December.

USAF, 1988a. Environmental Assessment for Titan IV Space Launch Vehicle Modification and Operation, VAFB, February.

USAF, 1988b. Supplement to the Environmental Assessment for the Titan IV Program at Cape Canaveral AFS, Florida, May.

USAF, 1988c. Finding of No Significant Impact for Environmental Assessment Supplement to Peacekeeper Rail Garrison and Small ICBM Flight Test Program, 19 May.

USAF, 1988d. Biological Assessment for the Titan II and Titan IV Space Launch Vehicle Modifications and Launch Operations Programs, Vandenberg Air Force Base, California, June.

USAF, 1988e. Historic Preservation Plan, San Antonio Terrace National Register District, Vandenberg Air Force Base, California, prepared for United States Air Force, AFRCE-BMS, Norton Air Force Base, California by Tetra Tech, Inc., San Bernardino, California, December.

USAF, 1988f. Paleontologic Resource Overview and Management Plan for Edwards Air Force Base, California, by Robert E. Reynolds, San Bernardino County Museum, Contract No. F04700-87-C0196, September.

USAF, 1989a. Environmental Assessment for the Medium Launch Vehicle II Program, Cape Canaveral AFS, Florida, February.

USAF, 1989b. Environmental Assessment for the American Rocket Company (AMROC) Commercial Expendable Launch Vehicle, Initial Evaluation Launch Phase, Vandenberg Air Force Base, California, July.

USAF, 1989c. Draft Environmental Impact Statement, Construction and Operation of Space Launch Complex 7, Volume I (DEIS) and II (Appendices), Vandenberg Air Force Base, California, 20 July.

USAF, 1989d. Environmental Assessment for the Pegasus Air-Launched Space Booster, Edwards Air Force Base/Western Test Range, California, October.

USAF, 1989e. Vandenberg Air Force Base Comprehensive Plan, Santa Barbara County, California, August.

USAF, 1989f. Documentation in Support of U.S. Air Force No Effect Determination (for) the Space Launch Complex 4 Power System Upgrade Project, Vandenberg Air Force Base, Santa Barbara County, California, prepared by Kathleen Ann Bergin, Environmental Solutions, Inc., submitted to Martin Marietta Corporation and U.S. Air Force, SSD/DEV, September.

USAF, 1990a. Environmental Assessment for the U.S. Air Force Titan IV/Solid Rocket Motor Upgrade Program, Cape Canaveral AFS, Florida and Vandenberg Air Force Base, California, February.

USAF, 1990b. Supplement to the Environmental Assessment for the Pegasus Air Launched Space Booster, Edwards Air Force Base/Western Test Range, California, April.

USAF, 1990c. Biological Assessment, Titan IV/Centaur Launch Complex, Vandenberg Air Force Base, California, March.

USAF, 1990d. Attachment A, Environmental Assessment Information Scout Facilities, Launch Complex SLC-5, VAFB, California, April.

USAF, 1990e. Operations Plan 85JOS-90, Hazardous Waste Management Plan, VAFB, 1STRAD, June.

USAF, 1990f. Final Environmental Impact Statement Construction and Operation of Titan IV/Centaur Launch Complex. Volume III (see USAF, 1989c). Vandenberg Air Force Base, California. August.

USGS (United States Geological Survey), 1958. Geologic and Hydrologic Reconnaissance and Suggested Test-Drilling Program, San Nicolas Island, California. Closed-file Report prepared at the request of the Department of the Navy.

VAFB, 1991. 4392 CES/DEEC Groundwater Production Data on VAFB for 1990.

Vedder, J.G. and Norris, R.M., 1963. Geology of San Nicolas Island, U.S. Geol. Survey Prof. Paper 369.

VERAC, Inc., 1986. "Diagonal Road Interconnect Study", Edwards Air Force Base, California, Final Report.

Versar, 1987. Environmental Assessment for the Repair and Restoration of Space Launch Complex 4 at Vandenberg Air Force Base, California, 5 May.

Weber, F.H. et al, 1980. Earthquake Hazards Associated with the Verdugo-Eagle Rock and Benedict Canyon Fault Zones, Los Angeles County, California, Calif. Div. Mines and Geol. Open File Report 80-10.

Wesson, R.L., et al., 1974. Expectable Earthquakes and Their Ground Motions in the Van Norman Reservoirs Area, U.S. Geol. Survey Circular 691-B.

Westec (Westec Services, Inc.), 1978. Survey of Archaeological and Biological Resources of San Nicolas Island.

White, C., 1990. Personal communication between C. White (California Department of Water Resources) and K. Choksy, ES, 14 June .

Whittaker, Robert H., 1975. Communities and Ecosystems. MacMillan Publishing Co., Inc., New York. p. 322-325.

Woodford, A.O. et al, 1954. Geology of the Los Angeles basin, pt.5, Chap. 2 in Jahns, R.H., ed., Geology of Southern California, Calif. Div. Mines and Geol. Bull. 170, p. 65-81.

Woodring, W.P. and Bramlett, M.N., 1950. Geology and Paleontology of the Santa Maria District, California, U.S. Geol. Survey Prof. Paper 222.

XonTech, 1986a. Operation of the Vandenberg Ambient Air Quality Monitoring Program, prepared for County of Santa Barbara Air Pollution Control District, January.

XonTech, 1986b. Operation of the Vandenberg Ambient Air Quality Monitoring Program, prepared for County of Santa Barbara Air Pollution Control District, April.

XonTech, 1986c. Operation of the Vandenberg Ambient Air Quality Monitoring Program, prepared for County of Santa Barbara Air Pollution Control District, July.

XonTech, 1986d. Operation of the Vandenberg Ambient Air Quality Monitoring Program, prepared for County of Santa Barbara Air Pollution Control District, September.

Yeats, Robert S., 1973. Newport-Inglewood Fault Zone, Los Angeles Basin, California, Am. Assoc. Petro. Geol. Bull. vol 57, no. 1, p.117-135.

York, A.L., 1990. Archaeological Investigations of CA-KER-2816 and -2817, Edwards Air Force Base, CA.

Ziony, J.I. and Yerkes, R.F., 1985. Evaluating Earthquake and Surface-Faulting Potential, in Evaluating Earthquake Hazards in the Los Angeles Region, U.S. Geol. Survey Prof. Paper 1360, p. 43-91.

SECTION 9

LIST OF PREPARERS

Name	Professional Discipline	Experience	Document Responsibility
9.1 U.S. Air Force			
Edwards, John R. (SSD/DEV)	Environmental Engineering	12 yrs. Environmental Science and Management	Technical Review
Capt Lamb, Richard W. (SSD/DEV)	Civil/Engineering Management	8 yrs. Civil Engineering	Project Manager
Lt Scott, Shelia P. (AFOEHL/EQC)	Chemical Engineering	4 yrs. Chemical Engineering	Technical Project Manager
9.2 Aerospace Corporation			
Dowling, Noble F.	Systems Engineering	27 yrs. Aerospace Engineering	Technical Advisor
9.3 Engineering-Science, Inc.			
Alfasso, Alexis	Technical Specialist	2 yrs. Environmental assessments; 2 yrs. Environmental field technician	Technical Assistance
Choksy, Khursheed	Economist/Demographer	4 yrs. Economics	Socioeconomics, Population Transportation
Connally, David W.	Water Science	12 yrs. Environmental Science	Water Quality, Hydrology
Crisologo, Rosemarie S.	Biology/Environmental Engineering	12 yrs. Environmental Sciences	Project Manager, Project Description & Alternatives, Biological Resources, Health and Safety, Visual Resources, Cultural Resources
Davis, Anthony	Civil/Environmental Engineering	5 yrs Remedial Investigations, Feasibility Studies, and RCRA Facility Assessments	Waste Management
Gaddi, Elvira V.	Chemical Engineering	5 yrs. Environmental Sciences; 4 yrs. Chemical Engineering; 3 yrs. Research & Development	Meteorology, Air Quality
Galizio, Jeffrey	Biology	2 yrs. Biology	Biological Resources

List of Preparers (Cont'd)

Name	Professional Discipline	Experience	Document Responsibility
9.3 Engineering-Science, Inc. (Cont'd)			
Hale, Marlund E.	Mechanical Engineering	22 yrs. Noise & Vibration Control and Acoustics	Noise and Sonic Boom
Holland, Carleen	Physics/Geology	1 yr. Geology	Geology
Kroner, Kurt	Natural Resources	4 yrs. Natural Resource Management	Biological Resources, Coastal Resources, Water Quality
Luptowitz, Lisa	Geology/Paleontology	1 yr. Geology/ Paleontology	Geology Paleontology Cultural Resources, Technical Review
Marfori, Anna Liza	Chemical Engineering	8 yrs. Industrial Engineering & Environmental Sciences	Regulatory Requirements and Permitting
Miyazaki, Brent	Geology	14 yrs. Geology, Hydrology	Geology
Riva, Paul R.	Publications	3 yrs. Document production and Computer Systems	Document Coordination and Production
Rojas, Angelina M.	Publications	18 yrs. Document production and Word Processing	Document Coordination and Word Processing
Skutnik, Edmund	Urban Planning	30 yrs. Urban Planning	Land Use
Wooten, R.C.	Environmental Science	4 yrs. Research & Development; 12 yrs. NEPA Documentation (EA, EIS); 5 yrs. Remedial Investigations/Feasibility Studies	Technical Advisor

SECTION 10

ACRONYMS AND ABBREVIATIONS

ABRES	Advanced Ballistic Reentry System
AFB	Air Force Base
AFFTC	Air Force Flight Test Center
AFR	Air Force Regulation
AFSC	Air Force Systems Command
AFSLV	Air Force Small Launch Vehicle
AHC	Allan Hancock College
Al_2O_3	Aluminum oxide
ALV	Air Launched Vehicle
AMROC	American Rocket Company
AQIA	Air Quality Impact Analysis
ATC	Authority to Construct
BACT	Best Available Control Technology
BMRS	Ballistic Missile Reentry Systems
CAA	Clean Air Act
CAAQS	California Ambient Air Quality Standards
$CaCO_3$	calcium carbonate
CAP	Collection Accumulation Point
CARB	California Air Resources Board
CCC	California Coastal Commission
CCD	Coastal Consistency Determination
CCR	California Code of Regulations
CDE	California Department of Education
CDF	California Department of Finance
CDFG	California Department of Fish and Game
CDHS	California Department of Health Services
CDMG	California Division of Mines and Geology
CDWR	California Department of Water Resources
CEDD	California Employment Development Department
CELV	Complementary Expendable Launch Vehicle
CEQ	Council on Environmental Quality

CERCLA	Comprehensive Environmental Response, Conservation, and Liability Act
CFC	chlorofluorocarbon
CFR	Code of Federal Regulations
cfs	Cubic feet per second
CHABA	Committee on Hearing Bioacoustics and Biomechanics
CH_4	methane
CMP	Coastal Management Program
Cl^-	chlorine atom
CNDDB	California Natural Diversity Data Base
CNEL	Community Noise Equivalent Level
CO	carbon monoxide
CO_2	carbon dioxide
COD	chemical oxygen demand
COE	Army Corps of Engineers
DARPA	Defense Advanced Research Projects Agency
dB	decibel
dBA	decibel (A-weighted)
DEC	Directorate of Acquisition Civil Engineering (Division C, Vandenberg AFB)
DEV	Directorate of Acquisition Civil Engineering (Division V, Los Angeles AFB, Environmental Management Division)
DLA	Defense Logistics Agency
DOD	Department of Defense
DOT	Department of Transportation
EA	Environmental Assessment
EAFB	Edwards Air Force Base
EIAP	Environmental Impact Analysis Process
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
ES	Engineering-Science
^{o}F	degrees Fahrenheit
Fe_2O_3	iron oxide
FMS	Foreign Military Sales
FPA	Flight Plan Approval
FTSA	Flight Termination System Approval

FY	Fiscal Year
GLOW	Gross lift-off weights
gpd	gallons per day
HCl	hydrochloride acid
HMHWM	Hazardous Materials and Hazardous Waste Management
HSWA	Hazardous and Solid Waste Amendments
HTPB	Hydroxyl-terminated polybutadiene
HWSF	Hazardous Waste Storage Facility
Hz	Hertz
ICBM	Intercontinental Ballistic Missile
ILC	Initial Launch Capability
IR	infrared
IRP	Installation Restoration Program
KCAPCD	Kern County Air Pollution Control District
Kw	Kilowatt
Kwh	Kilowatt hours
LAER	Lowest Achievable Emission Rate
L	Liter
L_{dn}	average day-night sound level
L_{eq}	equivalent sound level
lb./sq. in.	pounds per square inch
lbs/hr	pounds per hour
lbs/day	pounds per day
LF	launch facility
L_{max}	maximum sound level
LTO	Landing and Takeoff
M	Richter Magnitude
m^3	cubic meter
MCL	Maximum Contaminant Level
mg	milligram
μg	microgram
MMH	Monomethyl hydrazine
mph	miles per hour
ms	milliseconds
MEK	methyl ethyl ketone

MSGSA	Missile System Ground Safety Approval
MX	Peace Keeper Missile
N/m^2	Newtons per square meter
NAAQS	National Ambient Air Quality Standards
NAFB	Norton Air Force Base
NAS	Naval Air Station
NASA	National Aeronautics and Space Administration
NDDB	Natural Diversity Data Base
NEPA	National Environmental Policy Act
$NH_4Cl O_4$	ammonium perchlorate
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NO_2	nitrogen dioxide
N_2O	nitrous oxide
NO_x	nitrogen oxides
NPDES	National Pollutant Discharge Elimination System
N_2	nitrogen molecule
NSR	New Source Review
O_3	ozone
OAL	Operations Approval Letter
OSC	On-scene Coordinator
OSHA	Occupational Safety and Health Administration
PBAN	Polybutadiene acnylonitrile
PLF	Payload Fairing
PM	Particulate Matter
PMTC	Pacific Missile Test Center
POTW	Publicly Owned Treatment Works
ppm	parts per million
PSD	Prevention of Significant Deterioration
psf	pounds per square foot
PTO	Permit to operate
QD	Quantity-distance
RCRA	Resource Conservation and Recovery Act
RCS	Reaction Control Systems
R & D	Research and Development

ROC	Reactive Organic Compounds
ROWD	Reports of Waste Discharge
RP-1	kerosene-type hydrocarbon fuel
RWQCB	Regional Water Quality Control Board
SAC	Strategic Air Command
SARA	Superfund Admendments and Reauthorization Act
SBCAPCD	Santa Barbara County Air Pollution Control District
SBCC	Santa Barbara Community College
SDSU	San Diego State University
SLAM	Standoff Land Attack Missile
SELV	Small Expendable Launch Vehicle
SLC	Space Launch Complex
SLV	Space Launch Vehicle
SMC	Strategic Missile Center
SMLV	Single Module Launch Vehicle
SSD	Space Systems Division
SO_2	sulfur dioxide
SPA	Statement of Program Acceptance
SPCC	Spill Prevention, Control, and Countermeasure
SPR	Southern Pacific Railroad
$Sr(ClO_3)_2$	strontium perchlorate
SrO_2	strontium peroxide
SSD	Space Systems Division
STEP	Space Test Experiment Platform
STP	Space Test Program (p.1-1, 1-15); Sewer Treatment Plant (p. 2-134, 2-136, 3-38)
STS	Space Transportation System
TDS	Total Dissolved Solids
THC	Toxic Hazard Corridor
TPCA	Toxic Pits Control Act
TSDF	Treatment Storage, and disposal facility
USAF	United States Air Force
USC	United States Code
USFWS	U.S. Fish and Wildlife Service
UV	ultraviolet

VAFB	Vandenberg Air Force Base
VCAPCD	Ventura County Air Pollution Control District
VOC	volatile organic compounds
WDR	Waste Discharge Requirements
WSMC	Western Space and Missiles Center
WTR	Western Test Range

APPENDIX A

GLOBAL WARMING EFFECTS
OF THE
AIR FORCE SMALL LAUNCH VEHICLE PROGRAM
AT
VANDENBERG AIR FORCE BASE,
EDWARDS AIR FORCE BASE AND
SAN NICOLAS ISLAND, CALIFORNIA

TABLE OF CONTENTS

APPENDIX A

GLOBAL WARMING EFFECTS OF THE AFSLV PROGRAM

The possibility of accelerated global warming and stratospheric ozone (O_3) depletion due to the increased introduction of the greenhouse gases carbon dioxide (CO_2), methane (CH_4), chlorofluorocarbons (CFC), nitrous oxide (N_2O), water vapor and tropospheric ozone (O_3) into the atmosphere through human activity is a global issue with potential major long-term implications to global climate and ecosystems. The proposed Air Force Small Launch Vehicle (AFSLV) program has the potential to contribute to these effects as a result of emissions from rocket exhaust and associated ground support operations.

1.0 BACKGROUND

Visible and ultraviolet (UV) solar radiation enters the earth's atmosphere 50 percent of which is reflected by stratospheric (upper atmosphere) O_3, clouds, and the earth. The remainder is absorbed in the troposphere (lower atmosphere) by clouds, pollution, and the earth, then converted to infrared (IR) heat radiation. The greenhouse gases accumulate in the stratosphere and contribute to global warming by reducing the amount of UV radiation which is initially reflected back into space. This results in an increase in the amount of IR heat radiation which can then be absorbed in the troposphere (Matthews, 1990; SCAQMD, 1989; Margulis and Lovelock, 1974).

Possible ecological effects of increased global warming include: higher ocean temperatures severely affecting climate and phytoplankton abundance; polar ice-cap melting which will release significant quantities of CO_2 and CH_4 (currently trapped as gas) from the ice which will further contribute to global warming; a potential rise in sea level which could result in the destruction of coastal wetland habitat; increase in temperature could result in a decrease in accessible freshwater drinking supplies and an increased rate of mortality in plant and animal species (particularly those of limited distribution, movement and reproductive capabilities) due to related climatic change. The severity of expected impacts will vary with latitude. Areas in some latitudes may benefit from an increase in temperature through an increase in plant life resulting from climatic changes brought about by global warming (SCAQMD, 1989; Matthews, 1990; Peters and Darling, 1985).

The warming effects of greenhouse gases have provided a global environment suitable for the development of living organisms. The metabolic processes of these organisms have contributed to, and have helped maintain, the amounts of these atmospheric gases at near steady-state levels (Margulis and Lovelock, 1974). Today the greenhouse gases are estimated to be present in higher concentrations than at any other time over the past 160,000 years. This is largely due to the direct and indirect influence of human activity. By most accounts and estimates, the levels of these gases are still rising (Matthews, 1990; Kennett, 1982).

CO_2 is the most abundant heat absorbing gas (after water vapor) and accounts for about 50 percent of the human-induced effects on global warming. Atmospheric CO_2 increases as a result of biological respiration, fossil fuel use, and forest clear-cutting. Atmospheric CO_2 decreases through conversion by photosynthetic plants and phytoplankton to carbohydrates. CO_2 is also removed from the atmosphere through dissolution into the oceans where it is held in calcium carbonate ($CaCO_3$) deposited by living organisms. Forest clear-cutting, particularly in tropical rainforests, significantly affects the global efficiency of photosynthetic plants to remove CO_2 from the atmosphere. CO_2 can persist in the atmosphere up to 100 years (Matthews, 1990; SCAQMD, 1989; Harte, 1988).

CH_4 absorbs over 20 times more heat than CO_2 and accounts for 15-20 percent of the human-induced effects on global warming. Atmospheric CH_4 increases as a result of anaerobic biological processes associated with ruminant cattle, flooded areas, landfills, and other anoxic areas. CH_4 persists in the atmosphere for about 10 years (Matthews, 1990; SCAQMD, 1989; Margulis and Lovelock, 1974).

CFCs absorb 16,000 times more heat than atmospheric CO_2 and account for approximately 20 percent of the human-induced effects on global warming. CFCs have been used since the 1930s as refrigerants and coolants. CFCs are broken down in the atmosphere by UV radiation thereby releasing a chlorine (Cl^-) atom which then catalyzes the breakdown of stratospheric O_3 at a rate greater than that of the UV catalyzed formation of O_3. The net result of these reactions is the depletion of stratospheric O_3. The Cl^- released from the CFCs can catalyze over 100,000 of these reactions which, in turn, result in greater potential stratospheric O_3 depletion. The consequential result of this is an increase in the amount of UV radiation that penetrates the atmosphere. This UV radiation could ultimately contribute to global warming through conversion into IR radiation and its absorption as heat energy by the other greenhouse gases. Some CFCs can persist in the atmosphere for nearly 400 years (Matthews, 1990; SCAQMD, 1989; Bowman, 1988).

N_2O absorbs 200 times more heat than CO_2 and accounts for approximately 5 percent of the human-induced effects on global warming. Atmospheric N_2O increases as a result of continued use of fossil fuels and “slash and burn” forestry techniques. N_2O persists in the atmosphere up to 180 years (Matthews, 1990; SCAQMD, 1989).

Water vapor is the most abundant heat absorbing gas in the atmosphere and is increasing as a result of evaporation due to global warming. Increased atmospheric water vapor both alleviates and contributes to global warming. It alleviates global warming through increased cloud cover which reflects more of the initial UV radiation back into space, thus preventing its absorption and conversion into IR heat radiation. The abundance of this resource on earth, as well as the results from experiments on the effects of cloud cover on temperature, leads some to the conclusion that the cooling effect will dominate the warming effect thus leading to global cooling. This increased cloud cover also contributes to global warming by more efficiently absorbing the IR heat radiation which passes through the atmosphere and is radiated by the planet. This water vapor remains in the atmosphere indefinitely (SCAQMD, 1989; Kennett, 1982; Margulis and Lovelock, 1974).

Tropospheric O_3 is a caustic and common component of surface air pollution throughout the industrialized world and is increasing in frequency. This is due largely to the greater amount of UV radiation which is reaching the earth’s surface and the earth’s increasing temperature. UV radiation catalyzes the reaction between free oxygen atoms and oxygen molecules to form O_3. At higher altitudes, this O_3 formation would have the benefit of preventing UV penetration of the atmosphere, however, at lower altitudes significantly higher levels of IR heat radiation can be absorbed by the O_3 to further contribute to global warming (SCAQMD, 1989).

Data analyzed from geologic records show temperature variations comparable to those which have been recorded over the last 100 years, but as having occurred over thousands or hundreds of thousands of years (Kennett, 1982). Over the last century, it is estimated that the overall temperature of the globe has increased and average of 0.6 C. Modelling predicts that, over the next 50 years, greenhouse gas accumulations may result in increases between 0.1 and 3 C, depending on whether aggressive limits to greenhouse gas releases are instigated or current trends are continued. Further evidence of global warming can be derived from data which shows that the 1980's, with an overall average temperature of 15 C, produced the six warmest years recorded in modern weather records (Matthews, 1990).

2.0 IMPACT OF THE PROPOSED PROJECT ON GLOBAL WARMING

Exact quantities of the exhaust products of the AFSLV will not be known until the design and operational features of the launch system are determined. However, the nature and ratio of these exhaust products are known since the AFSLV will use launch propellants, oxidizers and other chemical components that have been widely studied. This information was compared with other data for similarly fueled launch vehicles (i.e., those with exhaust product ratios approximating those of the AFSLV). It was assumed that the ratio of exhaust products (by mass) remained constant regardless of the size of the launch vehicle; therefore, the amount (by mass) of the exhaust products is assumed to be directly proportional to the mass of the launch vehicle. Reliable data is available in USAF (1989c) for exhaust products of the Titan IV/Centaur launch vehicle and in USAF (1989b) for the American Rocket Company Commercial Expendable Launch Vehicle (AMROC/CELV). The Titan IV/Centaur launch vehicle data is used as the basis for comparison with the AFSLV even though the AMROC/CELV is closer to AFSLV's size and weight. The AFSLV is approximately 1 percent, by weight, of the Titan IV/Centaur launch vehicle, so all comparisons are made using the assumption that impacts due to the AFSLV will be approximately 1 percent of those associated with the Titan IV/Centaur.

USAF (1989c) estimated the total annual CO_2 emissions (based on three launches per year) for Titan IV/Centaur launch vehicle and launch support emissions at 1,236 tons per year. One percent of this number (assuming three AFSLV launches per year) is approximately 12.5 tons of CO_2 per year. This estimate, when compared with the current estimated global emissions of 5.5 billion tons of CO_2 from fossil fuels per year, would contribute a 23 ten-millionths of 1 percent increase to the global emissions of this greenhouse gas per year.

CH_4 is not an expected exhaust product of the AFSLV, nor is it an expected emission from support operations. Therefore, the expected contributions of this gas from these sources is negligible.

The exhaust products from the AFSLV solid propellant motors as they pass through the altitudes of 25 to 45 km will cause additional ozone depletion as a result of the release of HCl. HCl is produced in the combustion of solid propellants that use ammonium perchlorate (NH_4ClO_4) as the oxidizer. It is assumed that all of the Cl^- in the oxidizer is released as, or rapidly transformed into, HCl.

It is estimated that each AFSLV will result in 4 to 4.5 tons of solid propellant which will be consumed between 25 and 45 km in altitude. Therefore, approximately 42 to 45 one-hundredths of a ton of potentially O_3 depleting HCl will be released into the stratosphere. Based on analysis done for the Titan IV/Centaur (USAF,1990f), and the assumption that the AFSLV impacts will be approximately 1 percent of that number, it is predicted that each AFSLV will deplete the global stratospheric O_3 concentration by 33 millionths of 1 percent. (Dowling, 1990).

N_2O is not a specific exhaust product of the AFSLV, though potential precursors are present, some of which may catalyze O_3 depletion. However, total annual nitrogen emissions associated with AFSLV (when compared with the Titan IV/Centaur) are assumed to contribute approximately 35 ten-millionths of 1 percent annually to total O_3 depletion and negligibly to global warming (USAF, 1989c).

Water vapor will be an exhaust emission of the AFSLV. The emission of approximately 86 one-hundredths of a ton per launch (or 2.58 tons per year) of this water vapor will contribute an unknown percentage to the amount of this gas introduced to the atmosphere annually as estimated from USAF (1989c). At this time, however, it is uncertain what net effect this will have on global warming, because water vapor has both a warming and a cooling effect on global temperatures. By most estimates, however, the AFSLV contribution of this gas should be considered negligible (SCAQMD, 1989; Kennett, 1982; Margulis and Lovelock, 1974).

Tropospheric O_3 formation due to AFSLV emissions of exhaust products and support operations cannot quantitatively be estimated, however, some assumptions can be made with the information that is available on the exhaust products. The ratio of potential O_3 precursors (free atomic and molecular oxygen) and O_3 depletors (CFC) significantly favors the O_3 depletors; therefore, it is assumed any increase in the direct or indirect formation of tropospheric O_3 as a result of implementation of the AFSLV program should be negligible.

3.0 CONCLUSION

A comparison of global, Titan IV/Centaur and AFSLV emissions of greenhouse gases is provided in Table A-1. On the basis of these analysis, emissions of greenhouse gases as a result of the proposed AFSLV program are not expected to contribute significantly to global warming.

Table A-1

Relative Emissions of Greenhouse Gases

	Global[a]	Titan IV/Centaur[b]	AFSLV[b]
CO_2	5.5×10^9 tons/yr	1.24×10^3 tons/yr	1.24×10^1 tons/yr
CH_4	1.13×10^4 tons	negligible	negligible
CFCs	unknown	1.45×10^2 tons/yr	1.45 tons/yr
N_2O	2.83×10^3 tons	negligible	negligible
H_2O	1.43×10^{14} tons	8.6 x 10 tons/yr	8.6×10^{-1} tons/yr
O_3 (total)	8.5 x 10 tons	unknown	unknown
Stratospheric O_3	unknown	unknown	unknown
Tropospheric O_3	unknown	unknown	unknown

[a]Atmospheric mass = 5.66×10^{15} tons
[b]Assuming three launches per year

4.0 REFERENCES

Brown, Kenneth P., 1988. Global Trends in Total Ozone. Science 239, pages 48-49.

Dowling, N., 1990. Aerospace Corporation interoffice correspondence to J. Yakura regarding AFSLV Impact on Stratospheric Ozone, 12 November.

Ember, Lois R., 1990. EPA urged to tackle, solve highest risk pollution problems in Chemical and Engineering News Vol. 68, No. 42 (October 15), pages 24-25.

Harte, John, 1988. Consider a Spherical Cow: A Course in Environmental Problem Solving. University Science Books, Mill Valley, CA pages 128-149 and 232-260.

Kennett, James, 1982. Marine Geology. Prentice-Hall, Inc., Englewood Cliffs, NJ. 813 pp.

Margulis, Lynn and J. E. Lovelock, 1974. Biological Modulation of the Earth's Atmosphere. Icarius 21, pages 471-489.

Matthews, Samuel W., 1990. Is our world warming? in National Geographic Vol. 178, No. 4 (October), pages 66-99.

Peters, Robert L. and Joan Darling, 1985. The Greenhouse Effect and Nature Reserves. Bioscience 35, pages 707-717.

SCAQMD, 1989. Global Warming and Stratospheric Ozone Depletion: Informal Report for Policy Development. Planning Division (August).

USAF, 1989b. Environmental Assessment for the American Rocket Company (AMROC) Commercial Expendable Launch Vehicle, Initial Evaluation Launch Phase. Vandenberg Air Force Base, CA (July).

USAF, 1989c. Draft Environmental Impact Statement (for) Construction and Operation of Space Launch Complex 7. Volume I. Vandenberg Air Force Base, California. 20 July.

USAF, 1990f. Final Environmental Impact Statement (for) Construction and Operation of Titan IV/Centaur Launch Complex. Volume III (see USAF, 1989c). Vandenberg Air Force Base, California. August.

Whittaker, Robert H., 1975. Communities and Ecosystems. MacMillan Publishing Co., Inc.. New York, pages 322-325.

APPENDIX B

HAZARDOUS WASTE REPORT
FOR THE
AIR FORCE SMALL LAUNCH VEHICLE PROGRAM
AT
VANDENBERG AIR FORCE BASE,
EDWARDS AIR FORCE BASE AND
SAN NICOLAS ISLAND, CALIFORNIA

TABLE OF CONTENTS

HAZARDOUS WASTE REPORT
FOR THE
AIR FORCE SMALL LAUNCH VEHICLE PROGRAM

This hazardous waste report has been prepared to provide an overview of hazardous wastes likely to be produced by the U.S. Air Force Small Launch Vehicle (AFSLV) program at Vandenberg Air Force Base (VAFB), Edwards Air Force Base (EAFB) or San Nicolas Island. This report evaluates potential hazardous wastes associated with the AFSLV program, control/treatment options and opportunities for minimization. In addition, this report identifies regulatory compliance requirements for permitting, and existing hazardous waste management programs at each base. A comparison between launch vehicle alternatives is also presented. This report has been prepared as an Appendix to the Environmental Assessment (EA) for the AFSLV which has been prepared in accordance with the Air Force Environmental Impact Analysis Process (EIAP).

1.0 REGULATORY COMPLIANCE REQUIREMENTS

The AFSLV operations at VAFB will be subject to federal, state, and local rules and regulations pertaining to the generation and control of hazardous wastes. Both VAFB and EAFB have permits issued by the State of California Department of Health Services (CDHS) for storing hazardous wastes generated by base activities. San Nicolas Island is not a permitted facility since hazardous wastes are not stored longer than 90 days. Wastes are transported by barge off the island to Port Hueneme, which is under a CDHS permit. Additional regulations that apply to aspects of the proposed action involving the management of hazardous waste include the following acts and codes.

1.1 California Code of Regulations, Title 23

The California Code of Regulations (CCR), Title 23, Water, September 1985, Chapter 3, Subchapter 15, defines regulations for waste disposal to landfills, surface impoundments, and waste piles. Discharge to surface impoundments is further regulated by California Assembly Bill 1723 (the Katz Bill), which prohibits discharging hazardous wastes into new land treatment units unless the unit has been equipped with double liners, a leachate collection and removal system, and a ground water monitoring system.

1.2 Toxic Pits Control Act

The Toxic Pits Control Act (TPCA) of 1984 requires that all surface impoundments containing liquid hazardous waste or hazardous waste containing free liquids be closed or retrofitted unless the owner applies for and receives an exemption. It also requires all owners to submit a hydrogeological assessment report for their impoundments. Retrofitting means installation of double liners, a leachate collection system, and monitoring devices. Provisions of the TPCA are jointly administered by the CDHS and the California Regional Water Quality Control Board (RWQCB).

1.3 Resource Conservation and Recovery Act

The Resource Conservation and Recovery Act (RCRA) was enacted in 1976, and implementing regulations were promulgated in May 1980. These regulations are intended to ensure that hazardous wastes are disposed of in an environmentally safe manner, and facilities that store, treat, or dispose of hazardous waste do so in a way that protects human health and the environment. The Hazardous and Solid Waste Amendments (HSWA) of 1984 created restrictions on land disposal of hazardous wastes unless certain treatment standards can be satisfied. The HSWA also places increased emphasis on waste minimization activities and serves as a mechanism to enforce cleanup.

In response to the 1984 HSWA to the RCRA, the U.S. Environmental Protection Agency (EPA) promulgated regulations concerning the land disposal of hazardous wastes listed in 40 CFR 268.10. These regulations set forth treatment standards for so-called "First Third" listed hazardous wastes, specified in 40 CFR 268.10. The "Second Third" listed hazardous wastes, as specified in 40 CFR 268.11, were evaluated in June 1989, and come under the same types of restrictions as the First Third listed wastes. Treatment standards for "Second Third" listed wastes are based on the use of a specified technology. The "Third Third" listed hazardous wastes, as specified in 40 CFR 268.12, were evaluated May 8, 1990. A three-month extension on the land disposal ban for "Third Third" listed wastes was granted by EPA so that industries affected by the rule could prepare to comply with the new regulations. After August 8, 1990, only hazardous wastes meeting the specified treatment standards can be disposed of in a Class I landfill.

CCR Title 22 - Environmental Health, Chapter 30, also sets minimum standards for the management of hazardous wastes and contains all the elements of RCRA. Title 22 is administered by CDHS and by the RWQCB.

1.4 Comprehensive Environmental Response, Compensation, and Liability Act

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) requires identification, characterization, and cleanup of inactive waste sites or other releases of hazardous materials by the responsible party. The Superfund Amendments and Reauthorization Act (SARA) of 1986 emphasizes the use of treatment technologies, and meeting state requirements and standards of cleanup. U.S. Government owned or operated facilities must comply with the requirements of CERCLA and SARA.

2.0 BASE HAZARDOUS WASTE PROGRAMS

Hazardous waste programs on military bases include the treatment and disposal of hazardous wastes generated as a result of base activities. This section discusses the current hazardous waste programs at VAFB, EAFB and San Nicolas Island.

Hazardous wastes are potentially harmful to humans and wildlife, and can be difficult to treat and/or dispose. Hazardous wastes can be either solid or liquid. Characteristics that make a waste hazardous are listed by EPA in 40 CFR Part 261 and by the CDHS regulations in CCR Title 22, Chapter 30.

CFR Part 261 lists common characteristics of hazardous wastes, such as ignitability, corrosivity, reactivity, an toxicity. Part 401.15 identifies predetermined toxic pollutants. Wastes considered to be hazardous by the EPA have been categorized and grouped by similar characteristics. Each category of similar compounds has been assigned an EPA waste identification number.

The State of California recognizes more wastes as being hazardous than does EPA, and also assigns identification numbers to wastes. Extremely toxic wastes are listed as restricted, as specified in CCR Title 22, Chapter 30, Article 15, Section 66900.

Strict state regulations govern disposal of hazardous wastes. Wastes classified as hazardous may be disposed only in a Class I landfill or an approved treatment facility.

Disposal specifications are detailed in CCR Title 23, Chapter 2, Subchapter 15, Article 2, Section 2531.

2.1 VAFB Hazardous Waste Program

A major feature of the VAFB hazardous waste program which has been implemented by the Western Space and Missile Center (WSMC) is the "60-3" Rule procedure for improved handling of hazardous waste. This procedure was developed to make hazardous waste handling operations more efficient and to keep AFSC elements at VAFB in compliance with applicable federal and state regulations. All hazardous waste generators under the direction of AFSC on VAFB were subject to the new rule as of December 1986. The procedure allows for consolidation of hazardous waste handling activities into fewer facilities that are already in conformance with RCRA Part B requirements (40 CFR 264). The procedure also keeps AFSC in compliance with the CDHS requirement for a 90-day limit on interim storage for hazardous waste. The "60-3" Rule applies only to WSMC units on VAFB and not the host base (SAC) or other tenants.

The WSMC at VAFB uses a computer tracking system to record and monitor hazardous waste flows from the point of origination through the entire system to final disposal. The type and quantity of hazardous waste, process definition, sample analyses results, data summaries, container status and all other pertinent hazardous waste management information is available on the computer system to authorized personnel.

As a part of the VAFB Hazardous Waste Management Plan (Operations Plan 8550S-90), hazardous wastes are allowed to accumulate in properly-labeled, DOT-approved containers at origination sites for up to 60 days. Wastes generated vary from ignitables (such as waste oils) and corrosives (such as acids and bases) to halogenated and non-halogenated solvents. When the container is full, or 60 days have passed from the first day the container received waste (whichever is first), it is transferred from its point of origin to a collection accumulation point (CAP) within 3 days for temporary storage (less than 30 days).

WSMC owns three CAPs, one on North VAFB, one on the south end of North VAFB (for storing hypergolic fuels), and one on South VAFB. Activities performed at CAPs include preparing for consolidated shipment of hazardous wastes to VAFB's permitted hazardous waste storage facility (HWSF), preparing "turn-in" documentation, and verifying hazardous waste type by chemical analysis if necessary. The host base currently has 19 CAPs, but has plans to consolidate them as WSMC as done.

Hazardous waste is shipped from the CAP within 30 days of receipt to the permitted Hazardous Waste Storage Facility (HWSF) located at Building 3300 in North VAFB. The HWSF is operated by the Defense Logistics Agency (DLA) and is authorized to operate under a state hazardous waste facility permit issued by the CDHS. Wastes at the HWSF are transported off base by licensed hazardous waste carriers and disposal firms under contract to DLA (USAF, 1990a). Information as to where the hazardous waste is transported to is not available (Kolakowski, 1990). A detailed list of the types and quantities of hazardous wastes stored during 1989 at VAFB's HWSF is shown on Table B-1.

VAFB follows a waste minimization program to reduce the total amount of waste sent to Class I landfills. This program involves product substitution and waste recycling, where feasible. In 1987, approximately 436,000 pounds, or 28 percent of the total hazardous waste generated on VAFB was recycled (USAF, 1989a). The recycled waste included solvents, oils, paint primers, and batteries. Waste minimization for the AFSLV program is discussed in Section 3.3 of this report.

An onsite hazardous waste treatment facility is being considered for VAFB. Efforts are currently underway to identify the treatment facilities which are currently in laboratory development. A RCRA Part B permit application was submitted to CDHS in October 1990. To prevent spills of hazardous substances and prepare for cleanup of any spills that might occur, VAFB prepared a Spill Prevention and Response Plan (SPRP). At VAFB, requirements for reporting a spill state that if a spill involves resources beyond the capability of the Operations Plan, the on-scene coordinator (OSC) will notify Region IX of the EPA. If the spill occurs offshore, the U.S. Coast Guard is to be notified through the EPA (USAF, 1989a).

2.2 EAFB Hazardous Waste Program

EAFB currently follows their 1988 Hazardous Materials and Hazardous Waste Management (HMHWM) Plan for handling hazardous waste. This plan is being evaluated to consider consolidating their waste at collection-accumulation points. EAFB currently has about 56 accumulation points and about 12 satellite storage areas (Phillips, 1990).

Table B-1

1989 VAFB HWSF Hazardous Waste Inventory

Waste Description	EPA Number	California Number	Quantity (pounds)*
Acid liquid	D002	791	19,371
Adhesive	D001	281	1,239
Alkaline liquid	D002	122	50
Aluminum metallic powder	D001	---	8
Ammonium hydroxide	D002	122,331	1,285
Asbestos	---	151	700
Battery dry	D002	181	6,703
Batteries filled with acid	D002	724	483
Batteries (Lithium)	D003	181	40
Butyl alcohol	F003	212	1,008
Carbonate pesticide liquid	---	232	2,224
Cement liquid	D001	181	2,144
Charcoal, crushed	U133	---	
Chloroform	U044	---	118
Combustible liquid	D001	221, 343	7,602
Compound rust remover (phosphoric acid)	D002	141, 791	496
Compressed gas (flammable gas)	D001	343,211	3,423
Compressed gas (non-flammable gas)	---	223	9
Contaminated soil (JP-5)	---	611	504, 120
Corrosive liquid	D002	342, 791	166, 765
Corrosive solid	D002	331, 141	2,808
Dichloromethane	F001	211	2,562
Dioxane	U108	---	8
Empty containers	---	512, 513	57,068
Epichlorohydrin	D001	211	8
Ethylene dichloride	D001	211	8
Ethylene glycol	---	343, 311	21,896
Flammable liquid	D001	331, 343	19,226
Flammable solid	D001	281, 272	4,332
Formaldehyde	U122	---	1,260
Freon	D001	---	9,335
Fuel aviation	D001	331	33
Fuel oil	D001	221, 223	17,791
Grease	---	331, 223	109
Hazardous waste liquid	Numerous	Numerous	184,096
Hazardous waste solid	Numerous	Numerous	67,401
Hydraulic fluid	---	223, 221	3,116
Hydrazine solution	D002, U113	122, 331	11,222
Hydroquinone	---	352	200
Ink	D001	211	17
Isopropanol	D001	212, 331	5,754
Kerosene	D001	221, 331	638
Mercury, metallic	D009, U151	611, 725	67
Methyl alcohol	D001, U133	212, 331	3,158
Methylethylketone	D001, F003	211	8,416
Methyl methacrylate monomer	D001, F005	271	8
Naptha	D001	221, 331	1,831

Table B-1 (Cont'd)

1989 VAFB HWSF Hazardous Waste Inventory

Waste Description	EPA Number	California Number	Quantity (pounds)*
Nitric acid	D002	791	6,762
Oil	D001	221, 331	334, 849
Oil filters	---	221, 352	3,539
Oily rags	---	223, 352	2,688
ORM-A	F001, F004	211, 343	27,216
Oxidizer	D001, D002	181, 331	103
Paint	D001, F003	461, 331	20,875
Paint (latex)	---	291, 461	2,999
Paint-related materials, combustible liquid	D001	211	8
Paint-related materials, corrosive material	F001, F005	211, 212	168
Paint-related materials, flammable liquid	Numerous	Numerous	49,621
Petroleum distillate	D001	223, 221	9,987
Petroleum naptha	D001	221, 223	24,688
Photo	---	343	8
Polychlorinated biphenyls	---	261	9,437
Potassium hydroxide solution	D002	122	126
Sealing compound	---	281	1,144
Silicone fluid	---	331	67
Sodium dichromate	D007	181	8
Sodium hydroxide	D002	122, 141	16,597
Sodium nitrate	---	331, 343	966
Sodium phosphate tribase	---	561	90
Spill residue	---	223, 352	32,216
Sulfuric acid	D002	791, 141	4,774
1,1,1-Trichloroethane	F001	211, 741	3,016
Zinc	---	141	383
		Total	**1,692,558**

* All quantities have been converted to pounds

Source: USAF, 1989b

EAFB has a permit issued by the CDHS for the storage of hazardous wastes generated at the base. This permit requires that hazardous wastes be packaged, stored at the hazardous waste facility, and then transported off site by a registered hauler to an approved disposal site. Other than rocket fuel, the existing ground support facilities used for an air-launched space vehicle program at EAFB does not involve the use of any hazardous substances, as defined under CERCLA, Clean Air Act (CAA), or RCRA (USAF, 1989c).

EAFB is considering including the HMHWM Plan into a base disaster preparedness plan. Their hazardous waste minimization plans are incorporated into the HMHWM Plan. This plan calls for a 50 percent reduction of hazardous materials by 1991 (Phillips, 1990).

2.3 San Nicolas Island Hazardous Waste Program

The Navy has developed a draft hazardous waste management plan for the Pacific Missile Test Center Point Mugu Naval Air Station which also covers any hazardous waste generated on San Nicolas Island. San Nicolas Island does not have a permitted HWSF so any hazardous waste must be transported by barge off the island to Port Hueneme. The Port Hueneme HWSF is permitted by the CDHS and is currently in the process of applying for a state and federal permit.

The Navy generates hazardous industrial waste in the form of paints, solvents, waste fuel, waste oil, batteries, and other chemicals. The wastes are temporarily stored at collection areas at each facility on the island which generates the waste. The wastes are then transported from the collection areas to a central staging facility near the airfield. The wastes are then transported by barge off the island approximately once a month.

The hazardous waste on San Nicolas Island are classified as ignitable, corrosive, reactive, and toxic. According to the Navy, hazardous wastes were not stored on the island in 1989.

3.0 AFSLV HAZARDOUS WASTE STREAMS

The kinds of hazardous waste likely to be generated from the AFSLV program at VAFB will depend on the launch preparation and processing activities required. At this time, various scenarios are possible due to the alternative launch possibilities proposed. The specific processing, launch, and support activities associated with the AFSLV program will be described in greater detail as part of a site-specific EA which will be prepared when a site and launch system are selected.

The nine representative sites for the AFSLV program are either active launch facilities or undeveloped sites. The three launch systems (land-based, air, truck-trailer) and sites available for the AFSLV are shown on Table B-2.

The AFSLV program will generate various kinds of hazardous waste depending on support equipment, processing activities to be done on-site, and specific chemicals and propellants to be used. Table B-3 is a summary of potential launch systems and propellants for the AFSLV program.

Table B-2

Potential Launch Systems at Representative AFSLV Sites

		LAUNCH MODE		
		Launch Pad	Truck/ Trailer	Air Launch
North VAFB	LF 06	■	■	
	ABRES A-3	■		
	Test Pad 1	■	■	
	SLC-4W	■		
South VAFB	SLC-5	■	■	
	Cypress Ridge		■	
	Boathouse Flats		■	
Edward AFB	Air Platform			■
San Nicolas Island	Pad 192	■		

3.1 DESCRIPTION OF HAZARDOUS WASTES

Waste stream products generally consist of paint, solvent, adhesive, alcohol, lubricant, oil, grease, hydraulic fluid, fuel, propellant, contaminated rags, and some process chemicals. An example of the typical hazardous waste streams which can be generated by processing facilities for the AFSLV program is shown in Table B-4. These types and quantities of hazardous wastes are based on the waste streams from an existing land based small launch vehicle program at VAFB. In contrast, the existing air-launched space vehicle program at EAFB generates less than 10 pounds per year of solid hazardous waste and no liquid hazardous wastes (USAF, 1989c). A more detailed description of the types and quantities of hazardous wastes streams associated with the selected AFSLV program will be provided in a site-specific environmental analysis to be prepared by the Air Force.

Table B-3

Summary of Potential Launch Systems and Types of Propellants

Launch System	Air platform	Launch pad	Truck-Trailer
Sites Proposed[a]	NASA DFRF at Edwards Air Force Base	San Nicolas Island, Pad 192	(1) Cypress Ridge (2) Boathouse Flats
Propellant(s)	HTPB, Al, NH_4ClO_4, HX-752, Polyguard HR, DOS, DDI, TPB, $C_4H_2O_3$, cold gas (N_2), hydrazine	Ammonium perchlorate-based solid fuels	PBAN, Sr $(ClO_4)_2$, MMH and N_2O_4
Support Equipment	Lockheed L1011 aircraft, Motor dollies, portable diesel generator, MSGE, EGSE and ASE	Crane and forklift	

a = Additional representative sites are available at VAFB.
PBAN = Polybutadiene acrylonitrile composite propellant designated TP-H1123, with MIL Hazard Class 1.3.
HTPB = Composite ammonium perchlorate propellant that uses hydroxyl-terminated polubutadiene fuel binder, with MIL Hazard Class 1.3.
MMH = Monomethyl hydrazine
N_2O_4 = Nitrogen tetroxide
$Sr(ClO_4)_2$ = Strontium perchlorate

3.2 CONTROL AND TREATMENT OPTIONS

The control and treatment of hazardous waste from the AFSLV program will be required to follow the same procedures and policies of the VAFB, EAFB, and San Nicolas Island hazardous waste management plan as applicable.

The quantity of hazardous waste generated per launch from the AFSLV program is expected to be similar to that shown on Table B-4 for VAFB and San Nicolas Island, or similar to the existing air launch space vehicle program at EAFB. Most of the hazardous solids and liquids will be used during launch resulting in minimum generation of hazardous waste. Changes in the hazardous waste handling procedures currently being implemented by VAFB, EAFB and San Nicolas Island or new control or treatment options, are not expected to be required for the proposed AFSLV program.

VAFB is presently planning to treat hazardous waste onsite. A treatment system to remove organics from waste streams is currently under development.

Table B-4

Typical Estimated Quantities of Chemicals to be Used for AFSLV

Product Name	Quantity Used Per Launch	Annual Quantity
Hydrogen peroxide 35 %	---	800 lbs
Hydrogen peroxide 90%	425 lbs	500 lbs
Potassium hydroxide	flight-1425 cc test - 550 cc backup-1225 cc total: 3510 cc	40 cc
Ethylene glycol	---	1 gallon
Zinc chromate putty	50 grams	---
Zinc chromate primer (paint)	---	4 aerosol cans
1202 glyptal	---	4 ounces
1103 clear sealant	1 pint	---
C7/W resin and activator	2 pints	---
A851B adhesive	---	1 pint
Epon 828 resin	1/2 pint	---
Ethyl acetate	---	1 pint
DBT-catalyst for RTV-88	10 ounces	20 ounces
Data catalyst	2 ounces	---
Polyamide epoxy coating	1/2 pint	---
Surf-Kote A1625	---	2 aerosol cans
No. 29 low expansion cement	1 ounce	1 ounce
847 Industrial adhesive	2 pints	1 pint
EC 1293 sealant	---	2 ounces
PC-20 GLU-Bond	---	2 ounces
Compound, corrosion preventive	---	6 aerosol cans
Compound, walkway	--	1 quart
Trabond K5NA compound	1/2 pint (3 ea.)	---
CRC 2-28 compound	---	4 aerosol cans
544 soldering flux	--	2 ounces
AP-20, flux remover	---	8 ounces
Paint remover	---	2 gallon
Metal conditioner & neutralizer	1 ounce	1 ounce
Oil SAE 10	---	2 quarts
Oil SAE 20	---	4 quarts
Oil SAE 30	---	40 quarts
Oil SAE 40	---	20 quarts
EP 90 gear oil	---	10 gallon
Clavus 68 oil	---	1 pint
Mobil gear 628 oil	---	1 quart
Mobil gear 632 oil	--	2 gallons
Mobil DTE-BB oil	--	2.5 gallons
Crater A, oil	---	5 gallons
WD-40, oil	---	6 aerosol cans
Hydraulic fluid MIL-H-6083	---	2 gallons
Hydraulic fluid MIL-H-3606	2 quarts	20 gallons

Table B-4 (Cont'd)

Typical Estimated Quantities of Chemicals to be Used for AFSLV

Product Name	Quantity Used Per Launch	Annual Quantity
Grease - Marfax #1	---	1 lb
Grease - Marfax #2	---	5 lbs
Grease - Marfax #3	---	1 lb
Grease - Marfax #5	---	1 lb
PD-680, cleaning solvent	---	1 gallon
Paint-thinner-mineral	---	6 gallons
Paint-thinner-lacquer	---	2 gallons
Freon - PCA	3 gallon	7 gallons
Linseed oil	---	2 quarts
Isopropyl alcohol	1 quart	2 quarts
OT-620	1 gallon	2 gallons
190-Alcohol	4 ounces	---
Methylethylketone	---	6 gallons
Freon-12, refrigerant	---	20 lbs
Freon-22, refrigerant	---	20 lbs
Acetylene - welding	---	400 ft.
Argon - welding	---	600 ft.
EA934 A/B adhesive	---	4 ounces
DC 140 silicone	---	4 ounces
2216 B/A epoxy adhesive	---	6 ounces
RTV 102 sealant	---	3 pints
RTV 108 sealant	---	2 pints
S-1006 adhesive	---	2 ounces
845 rubber cement	---	1/2 pint
910 adhesive	---	2 ounces
Thread, 222 loctite	---	2 ounces
SS 4004 primer	1 pint	2 pints
RTV-60	16 ounces	16 ounces
RTV-55	40 lbs	120 lbs
LG-160 flurolube oil	2 ounces	4 ounces
No. 1 cutting oil	---	8 ounces
No. 2 cutting oil	---	8 ounces
MS 122 dry lubricant	1 aerosol can	2 aerosol cans
Inspection kit - dye penetrant	--	1 each
Paint aerosol Krylon brand	---	20 each
Paint aerosol Rustoleum brand	---	30 each
Bulk primers/coating paint	---	25 each
Kerosene - steam cleaner	---	10 gallons
Gasoline - unleaded fuel	---	2880 gallons
Diesel - fuel	---	1440 gallons
Anti-seize compound, FEL-FRO-C5A	2 ounces	1 ounce
Molybdenum disulfide	1 ounce	2 ounces
Oil, instrument-aircraft	---	4 ounces
2600005A LOX compatible grease	---	5 ounces
25-10M grease - H202 pump	---	4 ounces

Table B-4 (Cont'd)

Typical Estimated Quantities of Chemicals to be Used for AFSLV

Product Name	Quantity Used Per Launch	Annual Quantity
Grease, Novatex #-1	---	1 lb
MIL-G-81322, Grease GP	---	5 lbs
MIL-G-23827, Grease A/C	---	5 lbs
MIL-G-10824, Grease auto	---	5 lbs
Grease, Alvania #2	---	5 lbs
Grease silicone, DC-4	2 ounces	10 ounces
Grease, silicone, DC-7	2 ounces	4 ounces
Grease, silicone, DC-33	5 ounces	4 ounces
Grease, silicone, DC-111	1 ounces	4 ounces

Source: This information reflects typical chemicals which would be used during AFSLV processing. The annual quantities shown represent the typical annual use and do not reflect any specific launch rate.

3.3 MINIMIZATION OPPORTUNITIES

The Air Force has developed a comprehensive hazardous waste minimization program implementing improved management of hazardous waste product substitution, and reuse/recycling. Generic waste minimization options that may be available to the AFSLV program include:

- Improved management
  - Waste segregation to increase quantities of waste available for reuse/recycling
  - Handling procedures and equipment to reduce spills and leaks
  - Use of bulk storage where possible to minimize the number of drums or containers sent to CAPs.
  - Offsite processing of major components and offsite rocket engine testing.
- Product substitution
  - Replace flammable and/or toxic solvents with less hazardous solvents or non-hazardous solvent substitutes
  - Replace chlorinated solvent paint strippers with less toxic paint removers.
- Reuse/recycle

- Purchase solvent distillation units and recycle solvents and paint thinners on site
- Contract with local solvent recycling company to recover solvents and paint thinners off site.

- Onsite treatment: Onsite treatment of hazardous waste is presently being considered at VAFB. It is estimated that the treatment facility could be fully permitted and operational by October 1991 (Toft, 1990a).

3.4 PERMIT REQUIREMENTS

As discussed in Section 2, hazardous waste to be produced as a result of the government program would be permitted under each base's current state hazardous waste facility permit. However, when the contractor begins commercial launch services, a permit will be required unless VAFB, EAFB, or San Nicolas Island wishes to accept responsibility for handling, treating, storing, and disposing of hazardous wastes generated for other potential responsible parties (Toft, 1990b). At this time, VAFB intends to consider the AFSLV contractor as a commercial enterprise who will be responsible for obtaining its own hazardous waste generator identification number and any required permits.

At this time, applications for hazardous waste generator permits for AFSLV launch site operations have not been submitted. Approval of this permit can take as long as two years to obtain.

3.5 COMPARISON OF LAUNCH SYSTEM AND SITES

The management of hazardous wastes in relation to processing and support activities associated with each AFSLV launch system and site will be evaluated in the following paragraphs.

3.5.1 Hazardous Waste Management

The management of hazardous waste for each AFSLV launch action will depend on the type of launch system and its relationship to a specific launch site. Booster stage configurations would have only minor impacts on management of hazardous waste.

The transportation distances of hazardous waste from each proposed launch site at VAFB are shown on Figure B-1. In relation to the general location of the proposed launch sites (North VAFB and South VAFB) and the location of the CAPs, each of the proposed launch sites generally compare equally with one another, except for the proposed site at

Figure B-1 Hazardous Waste Collection Areas on VAFB

Launch Facility 6. This site is located the farthest away from its CAP. Therefore, Launch Facility 6 has more of a potential impact from transportation of hazardous waste than any of the other potential launch sites, except Pad 192 on San Nicolas Island. Hazardous waste generated at any of the proposed AFSLV sites on VAFB, EAFB, and San Nicolas Island would be temporarily stored at a designated hazardous waste storage area at the launch complex. The contractor would be required to transport all hazardous waste off base within 90 days in accordance with California law.

Hazardous wastes generated on San Nicolas Island would require more handling and transportation than the proposed sites on VAFB and EAFB. The wastes stored at the central staging facility at the airstrip will require transportation to the southeast side of the island before being barged to Port Hueneme. In order to transfer the drums of wastes from a truck to the barge, an earthen dam must be constructed by caterpillars using beach sand and borrow sand from a nearby area. The cargo is then loaded onto the barge where it will be shipped to the Port Hueneme HWSF. Therefore, Pad 192 on San Nicolas Island has the greatest potential impact from handling and transportation of hazardous wastes than any of the other potential launch sites.

Of the proposed AFSLV sites, the undeveloped sites would require construction of containment structures and facilities to temporarily store hazardous wastes. By comparison, designated hazardous waste storage areas already exist at the active launch facilities. Therefore, the active launch sites would have the least impact on the storage of hazardous waste.

Comparison of the various launch concepts reveals that certain launch systems may require more control and waste management measures than others. For example, the truck/trailer and launch pad systems at LF 06 and Test Pad 1 would require less control measures for containment of spills of process chemicals and propellants in comparison to other conventional land and truck/trailer launch systems. The launch pad at LF 06 contains a concrete channel for collecting and discharging stormwater runoff to an adjacent drainage ditch. The launch pad at Test Pad 1 contains stormwater drains which collect and discharge water to the sand dunes and into the ocean. The remaining launch pads at the active (excluding EAFB) or abandoned sites cannot contain spills or surface water runoff because their surfaces are only sloped to carry runoff away from the pads. These launch sites, as well as the undeveloped sites at Cypress Ridge and Boathouse Flats will require modification or construction to collect and store surface water runoff or spills so that the wastewater can be disposed of as hazardous waste or at the facility on South VAFB.

Since the concrete pads will not be washed down after launching the vehicles, the surfaces of the pads will contain residues of hazardous constituents (metals and hydrogen chloride) which will be washed away during a storm to the surrounding drainage areas. All of the proposed launch systems, except the air platform launch, will also require the same control measures for the containment of spills of process chemicals and propellants. Therefore, LF 06 and Test Pad 1 would require the least amount of modification and construction followed by the other launch sites. The concrete pads to be installed at Cypress Ridge and Boathouse Flats would need to be designed to collect and store surface water runoff and spills. The air platform support facilities at EAFB would not require any modification.

3.5.2 Processing and Support Activities

AFSLV processing and assembly, including preparation of the PLF, would generate hazardous wastes. In the event AFSLV processing and support activities are performed off site, most hazardous wastes would be generated and managed at other locations before final assembly of the vehicle is completed at VAFB, EAFB or San Nicholas Island. Offsite processing and support activities would not result in any impact to hazardous waste management at the launch locations. Although the majority of the processing and assembly will be performed offsite for these launch systems, some hazardous wastes will still be generated during the final preparation and assembly of the launch vehicle.

3.6 COMPARATIVE SUMMARY

A comparative summary of impacts of hazardous waste generated, stored, contained, and transported at the proposed sites as a result of the AFSLV program is presented in Table B-5. The five symbols used to indicate the extent of impact are (lowest impact), (low impact), (moderate impact), (highest impact), and (same impact as other sites). The comparisons shown in Table B-5 are relative and do not indicate an absolute magnitude or level of impact. The level of effect may be greater at one launch site as compared to another, therefore the actual effect on the environment may be minimal or insignificant.

Table B-5

Comparative Summary of Hazardous Waste Impacts at AFSLV Sites

Launch Site	Launch Mode	Generation of Waste	Storage of Waste	Spill Containment	Transportation of Waste
LF 06	Launch Pad	Moderate	Lowest	Lowest	Moderate
	Truck/Trailer	Low	Lowest	Lowest	Moderate
ABRES A-3	Launch Pad	Moderate	Lowest	Lowest	Same
Test Pad 1	Launch Pad	Moderate	Lowest	Lowest	Same
	Truck/Trailer	Low	Lowest	Lowest	Same
SLC-4W	Launch Pad	Moderate	Lowest	Lowest	Same
SLC-5	Launch Pad	Moderate	Lowest	Lowest	Same
	Truck/Trailer	Low	Moderate	Moderate	Same
Cypress Ridge	Truck/Trailer	Low	Highest	Highest	Same
Boathouse Flats	Truck/Trailer	Low	Highest	Highest	Same
EAFB	Air Platform	Lowest	Lowest	Lowest	Same
San Nicolas Island	Launch Pad	Moderate	Low	Lowest	Highest

○ = Lowest impact compared to other sites

● = Highest impact compared to other sites

= Low impact compared to other sites

= Same impact compared to other sites

= Moderate impact compared to other sites

4.0 CONCLUSIONS

The following conclusions can be made from the comparative analysis presented earlier:

- The least amount of hazardous waste, excluding propellants, generated as a result of the AFSLV program would most likely occur from a mobile (truck/trailer) or air launch system.

- The active launch sites would require the least amount of new construction of control measures for the storage of hazardous waste than the undeveloped sites. Launch sites having the most impact would be the undeveloped sites.

- The active launch sites would require the least amount of new construction of spill containment structures than other sites because structures already exist at these sites. Mobile launch systems at undeveloped sites may require more stringent control measures to prevent and contain spills because of their potential for affecting environmentally sensitive areas.

- The sites having the greatest potential impact on transportation of hazardous waste, excluding propellants, are the active launch sites at LF 06 and Pad 192 on San Nicolas Island. All other launch sites on VAFB are similar in the distance which wastes would be transported.

Overall, the AFSLV program at any of the proposed launch sites would have minimal impact on the management of hazardous material and waste. Although some launch sites have more of an impact on certain aspects of hazardous waste management than others, the impact is less when considering other factors. For instance, mobile launch sites may have the most impact on containment of spills in comparison to other sites; however, these sites may also generate the least amount of wastes because most of the processing and support activities are performed off site.

The active launch sites would have the least impact on the AFSLV program as compared to the undeveloped sites. Of the active launch sites, the air platform at EAFB would have the least impact on hazardous waste management.

5.0 REFERENCES

Kolakowski, W., 1990. Personal communication between Capt Kolakowski (Environmental Compliance Division, VAFB) and Anthony Davis, ES, 18 June.

Phillips, Mike, 1990. Personal communication between Mike Phillips, AFFTC/DEV, EAFB, and Anthony Davis, ES, 11 June.

Toft, Paul, 1990a. Personal communication between Paul Toft, SSD/DEC, VAFB, and Anthony Davis, ES, 11 June .

Toft, Paul, 1990b. Personal communication between Paul Toft, SSD/DEC, VAFB, and Anthony Davis, ES, 15 June.

USAF, 1989a. Draft Environmental Impact Statement, Construction and Operation of Space Launch Complex 7, Volume I and II, Vandenberg AFB, CA, July 20.

USAF, 1989b. VAFB Hazardous Waste Inventory Records for year 1989, as reported to the U.S. EPA and the California Department of Health Services.

USAF, 1989c. Environmental Assessment for the Pegasus Air-Launched Space Booster, Edwards AFB/Western Test Range, CA, October.

USAF, 1990. Operations Plan 8550S-90, Hazardous Waste Management Plan, VAFB, ISTRAD, June.