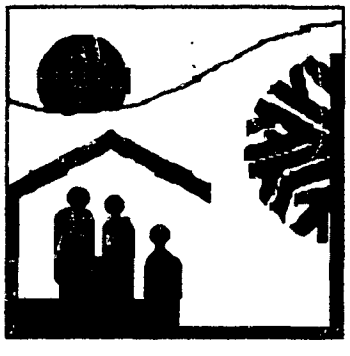
Environmental Impact Analysis Process



BIOLOGICAL ASSESSMENT

U. S. AIR FORCE
TITAN IV/CENTAUR LAUNCH COMPLEX
VANDENBERG AIR FORCE BASE, CALIF.
MARCH 1990

DEPARTMENT OF THE AIR FORCE

BIOLOGICAL ASSESSMENT

TITAN IV/CENTAUR LAUNCH COMPLEX
VANDENBERG AIR FORCE BASE, CALIFORNIA

Prepared For:

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS SPACE SYSTEMS DIVISION
ENVIRONMENTAL PLANNING DIVISION
EL SEGUNDO, CALIFORNIA

March, 1990

ENVIRONMENTAL SOLUTIONS, INC.

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1.0 INTRODUCTION

1. The United States Air Force (USAF), Headquarters Space Systems Division, proposes to construct and operate a space launch complex on South Vandenberg Air Force Base (VAFB), California. The launch complex would: (1) support timely and reliable launch of critical Department of Defense (DOD) satellites from a location from which highly inclined and polar orbits can be safely achieved, (2) provide capability to launch payloads in the 10,000-pound class to high energy, inclined orbits, and (3) maintain assured access to space by providing backup launch capability for the Titan IV/Centaur and Titan IV/NUS (no upper stage) space launch vehicles. Associated support facilities and other ancillary improvements are planned in connection with the proposed project. A detailed project description is presented in Chapter 2.0.

2. The USAF Headquarters Space Systems Division in Los Angeles, California, is responsible for meeting environmental requirements under the National Environmental Policy Act (NEPA) and USAF regulations. Section 7(c) of the Endangered Species Act requires the USAF to evaluate the effects of the project on federally-listed threatened and endangered species. In accordance with the Act, as amended, this Biological Assessment has been prepared for the USAF by Environmental Solutions, Inc., to meet the requirements of Section 7(c). The Draft Environmental Impact Statement (EIS) for the proposed project (USAF 1989a) was released in July 1989.

3. This Biological Assessment addresses South VAFB, the adjacent coastal zone, and the offshore Channel Islands that may be affected by the proposed project. A determination of the species to be assessed and the analyses contained in this Assessment were based on the technical reports prepared in support of the Draft EIS and summarized in Appendices A, B, and C (Collins 1988b; Hickson 1988; Woodhouse 1988b). The Section 7 consultation on this proposed project will be conducted by the U. S. Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (NMFS).

4. Table 4.1 (Special Interest Species Known or Expected to Occur Within Study Region) lists special interest species, including plants and animals that are federally- and state-listed as threatened or endangered candidates for listing, and other special interest biological resources that could be affected by the proposed project. This assessment addresses species currently listed under the Endangered Species Act and those protected by the Marine Mammal Protection Act (MMPA).

5. This Biological Assessment is organized as follows:

- **2.0 Proposed Action and Alternatives** - This chapter describes the proposed action and alternatives considered.
- **3.0 Biological Setting** - This chapter provides a detailed description of the types and characteristics of local and regional biological resources.
- **4.0 Special Interest Species** - This chapter identifies and presents information on aquatic, terrestrial, and marine threatened, endangered, and candidate species in the study area. It also addresses regionally rare and declining species.
- **5.0 Impact Assessment** - This chapter discusses the potential impacts resulting from implementation of the proposed action and alternatives. Mitigation measures to avoid or reduce potential impacts also are described.
- **6.0 Mitigation Measures** - This chapter provides mitigation measures to be adopted to minimize impacts from project construction and operations.
- **7.0 Conclusion** - This chapter presents a summary of impacts and evaluation of their potential significance for each threatened, endangered candidate and protected species known to frequent the potential impact area.
- **8.0 References** - This chapter contains a list of materials and persons consulted in preparation of this document.
- **9.0 List of Abbreviations** - This chapter provides a reference list of abbreviations and acronyms utilized in the Biological Assessment.
- **Appendices** - The appendices contain relevant supporting material to the descriptions and evaluations presented in the text of the Biological Assessment.

2.0 THE PROPOSED ACTION AND ALTERNATIVES

2.1 PROPOSED ACTION

2.1.1 INTRODUCTION

1. The USAF has proposed the construction and operation of a Titan IV/Centaur space launch complex in support of the DOD space program. The proposed project would be located at South VAFB, California, and would be designed for a minimum operational period of 25 years.

2. The Titan IV/Centaur is an unmanned, expendable space launch vehicle capable of launching critical DOD satellites, including payloads in the 10,000-pound class, to high energy orbits. The proposed project would allow achievement of polar and highly inclined orbits. The project would be designed specifically to accommodate the Titan IV/Centaur, but would also be able to serve as a backup to other facilities for launch of the Titan IV/NUS to assure access to space and timely and reliable launch of critical missions. The proposed facility represents the latest modification to the continuing Titan program at VAFB.

3. VAFB is assigned to the USAF Strategic Air Command (SAC). As host command, SAC's 1st Strategic Aerospace Division (1STRAD) is responsible for providing management, operational analysis, and material support for SAC and over 40 federal and civilian tenant agencies located at VAFB, as well as for controlling and conducting the SAC Intercontinental Ballistic Missile (ICBM) operational flight tests into the western test range. VAFB provides extensive launch and technical support facilities for the variety of space and missile systems that operate from the base.

4. In addition to the Titan program, VAFB has been a base of operations for ongoing space launch activities associated with the Scout, Delta, Atlas, and Space Shuttle launch programs for over 25 years. Space Launch Complex 6 (SLC-6), the most recently constructed launch facility, was modified from its original configuration for the Manned Orbital Laboratory program to support Space Shuttle launches, but has since been placed in mothball status. It is evaluated as an alternative site for the proposed action in Section 2.2 (Alternatives to the Proposed Action) of this chapter. Other recent construction activities at VAFB have occurred at Space Launch Complex 4 (SLC-4). SLC-4 East is being modified for processing and launch of the Titan IV/NUS. SLC-4 West has been modified and is currently an operational Titan II facility.

5. VAFB is located on a promontory along the California coast where space vehicles can be launched in southerly directions over the Pacific Ocean without overflying populated areas. These launch directions (azimuths) facilitate near polar (rather than equatorial) satellite orbits and sub-orbital westerly test and developmental flights of the ICBM. The ability to launch over unpopulated areas is necessary for the maintenance of a controlled launch safety program. VAFB provides the only location within the contiguous United States where hazards from southerly launches of large boosters can be maintained at acceptable levels. In general, the VAFB launch azimuths are complementary to the over-water launch azimuths available at Cape Canaveral Air Force Station (CCAFS) and the National Aeronautics and Space Administrations (NASA) Kennedy Space Center in Florida, which provide launch locations for near equatorial satellite orbits.

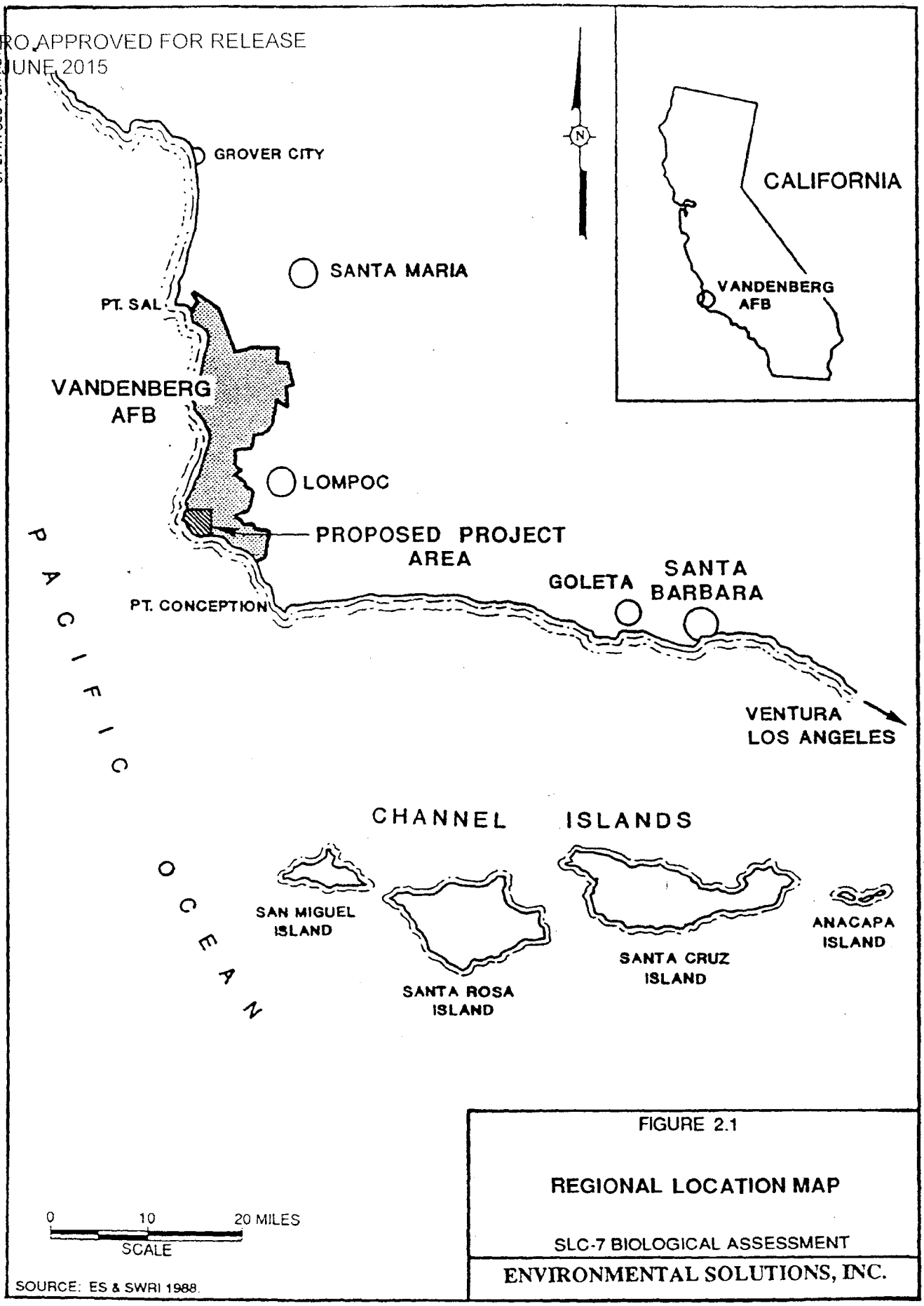
6. VAFB occupies an area of 98,400 acres and is situated approximately 140 miles northwest of Los Angeles and about 50 miles northwest of the northern (Santa Barbara) Channel Islands as shown in Figure 2.1 (Regional Location Map). Originally known as Camp Cooke Army Post, VAFB was transferred to USAF in 1957. The southern portion of the base, previously assigned to the U.S. Navy, was known as the Naval Missile Facility, Point Arguello, before being transferred to USAF in 1964 as shown in Figure 2.2 (Vicinity Map).

7. The proposed action would be situated within an area of South VAFB which consists primarily of existing space launch complexes and grazing land. The four alternative sites considered are located as shown in Figure 2.3 (Alternative Sites). Three of the four alternative sites, Boathouse Flats, Cypress Ridge, and Vina Terrace are undeveloped. The fourth, SLC-6 as described above, is a developed launch complex.

2.1.2 PROJECT ELEMENTS

1. Project elements necessary for the proposed Titan IV/Centaur program would include onsite facilities, adjacent offsite facilities (such as utilities), other existing VAFB facilities (such as the launch control center), and the Titan IV/Centaur vehicle itself. A schematic diagram of the facilities as constructed at the Cypress Ridge site is shown in Figure 2.4 (Conceptual Drawing, Cypress Ridge Site and Facilities). A conceptual site plan developed for Cypress Ridge is shown in Figure 2.5 (Preliminary Launch Complex Plan). Implementation of the project at the rest of the undeveloped sites (i.e., Vina Terrace and Boathouse Flats) would result in a site plan similar to that shown for Cypress Ridge. The layout at SLC-6 would contain the same major project elements in a different configuration. The configuration of the

87-271H SLC-7BA REV 1/90



SOURCE: ES & SWRI 1988.

FIGURE 2.1

REGIONAL LOCATION MAP

SLC-7 BIOLOGICAL ASSESSMENT

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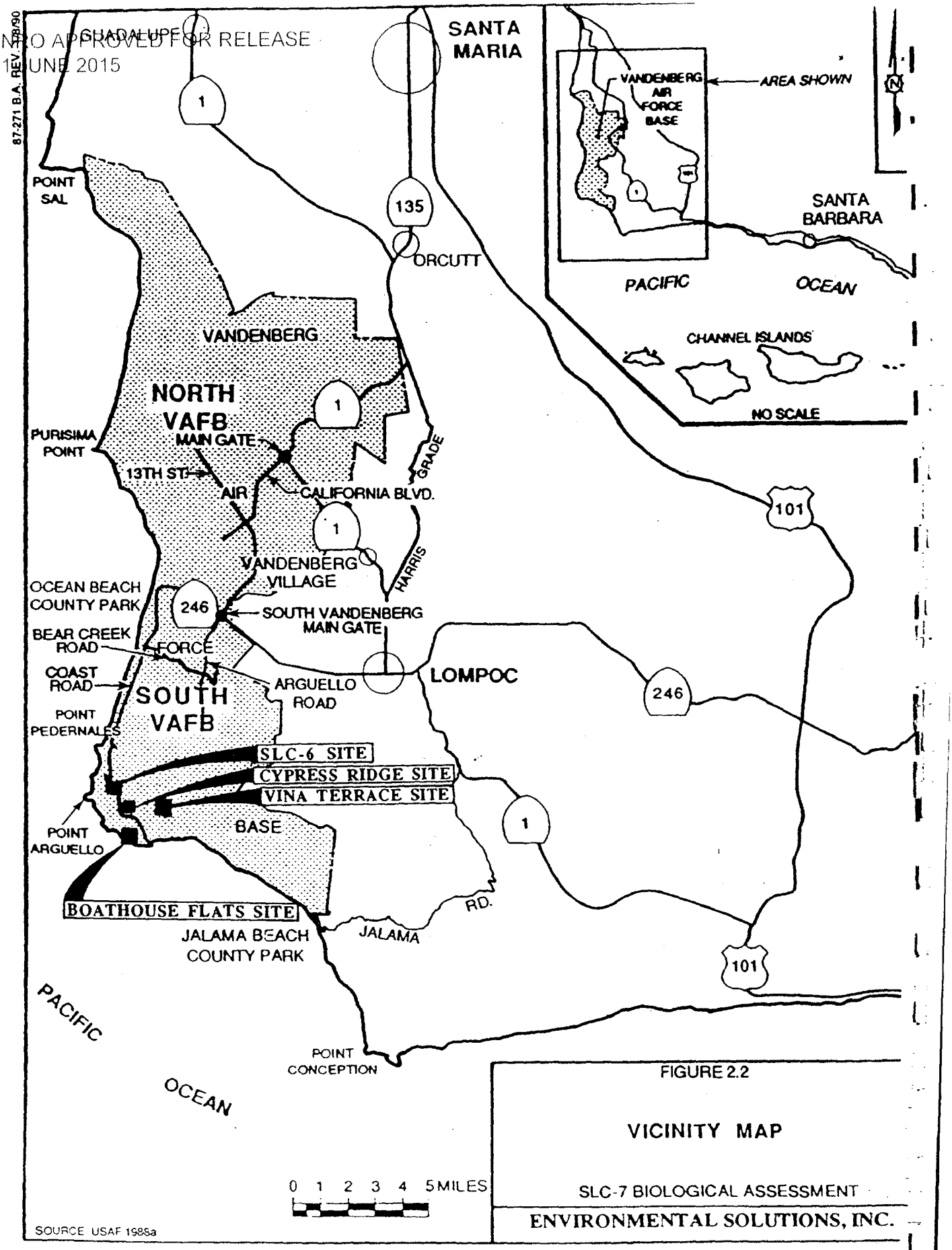

FIGURE 2.2

VICINITY MAP

SLC-7 BIOLOGICAL ASSESSMENT

ENVIRONMENTAL SOLUTIONS, INC.

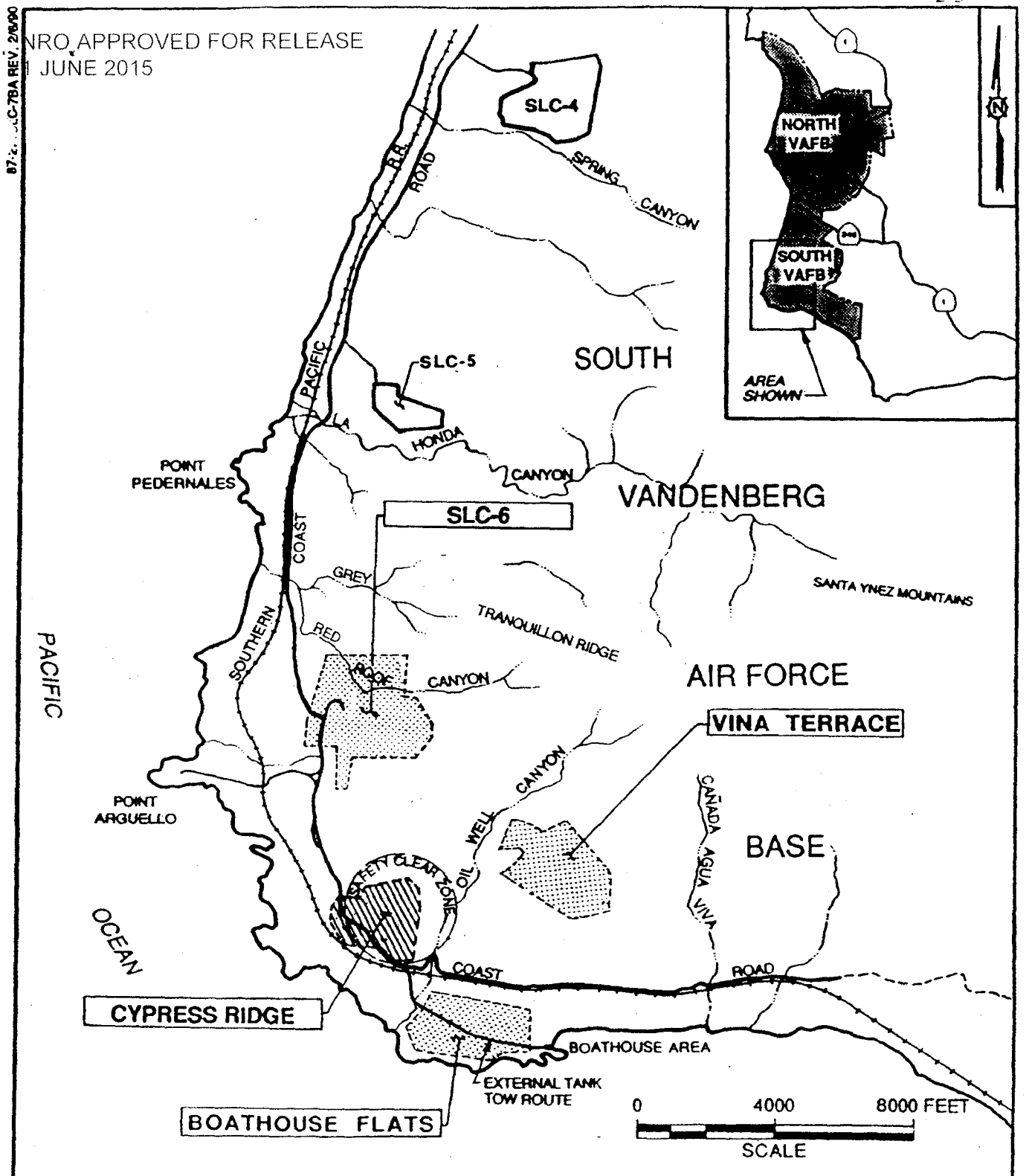

FIGURE 2.3

ALTERNATIVE SITES

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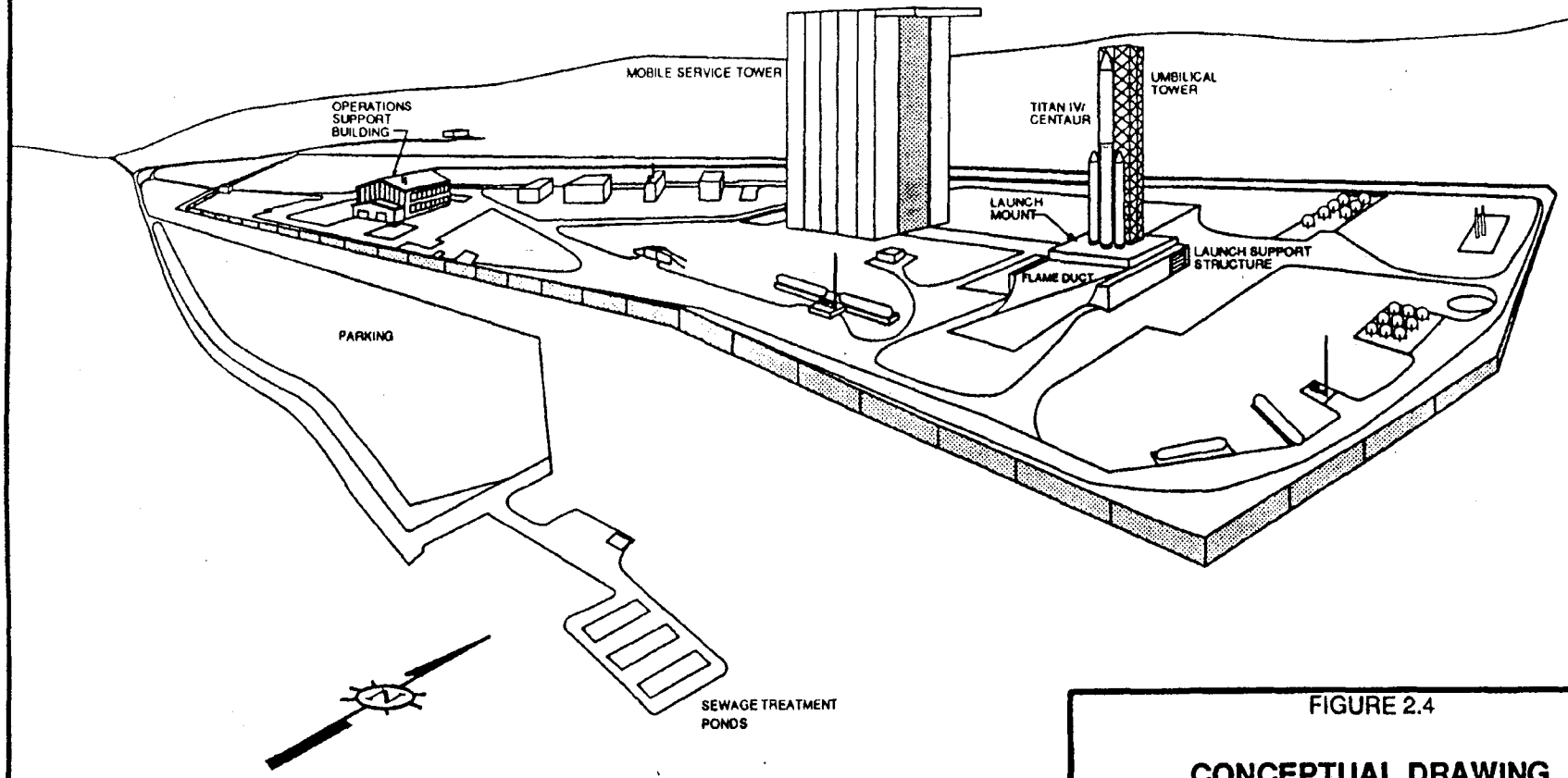
SOURCE: USAF 1986



NOTE: ACTUAL PLACEMENT OF FACILITIES SUBJECT TO USAF CRITERIA AND FINAL DESIGN CONSIDERATIONS.

SOU[illegible]SAF 1988b.

FIGURE 2.4

CONCEPTUAL DRAWING
CYPRESS RIDGE SITE AND FACILITIES

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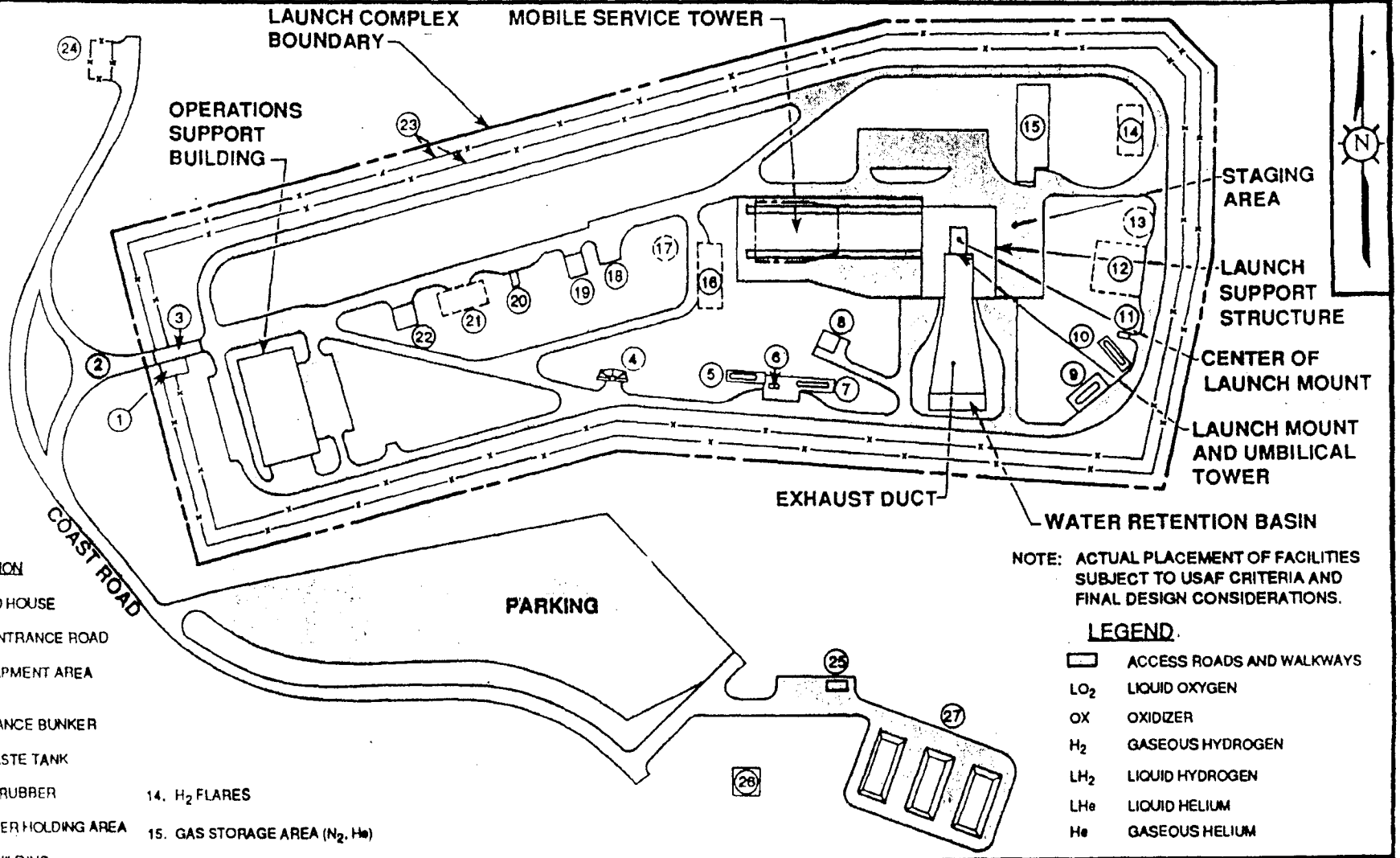

EXPLANATION

1. GUARD HOUSE
2. SITE ENTRANCE ROAD
3. ENTRAPMENT AREA ROAD
4. ORDNANCE BUNKER
5. OX WASTE TANK
6. OX SCRUBBER
7. OXIDIZER HOLDING AREA
8. FAN BUILDING
9. FUEL HOLDING AREA
10. FUEL WASTE TANK
11. INCINERATOR
12. LH_2 AREA
13. LH_2 TRLR. VENT
14. H_2 FLARES
15. GAS STORAGE AREA (N_2, He)
16. LO_2 AREA
17. LO_2 STORAGE
18. STRADDLE CRANE PARKING
19. FAN BUILDING
20. ESSENTIAL POWER BUILDING
21. LHe CONVERTER/ He COMPRESSOR BUILDING
22. SUPPORT EQUIPMENT STORAGE
23. SECURING FENCING
24. ELECTRICAL SUBSTATION
25. SEWAGE TREATMENT
26. WEATHER STATION
27. SEWAGE EVAPORATION/ PERCOLATION PONDS

0 100 200 300 FEET
SCALE

SOURCE: USAF 1988b.

NOTE: ACTUAL PLACEMENT OF FACILITIES SUBJECT TO USAF CRITERIA AND FINAL DESIGN CONSIDERATIONS.

LEGEND

	ACCESS ROADS AND WALKWAYS
LO_2	LIQUID OXYGEN
OX	OXIDIZER
H_2	GASEOUS HYDROGEN
LH_2	LIQUID HYDROGEN
LHe	LIQUID HELIUM
He	GASEOUS HELIUM

FIGURE 2.5

PRELIMINARY LAUNCH COMPLEX PLAN

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SLC-6 site is described in more detail in Section 2.2. This preliminary layout is based upon current concepts for the facility, which may be revised when detailed engineering studies are completed. As shown in Figure 2.5, the launch complex would be an area about 2,300 feet long, 1,000 feet wide, and about 53 acres in size. This site area would be surrounded by security fencing and accessed through a single location.

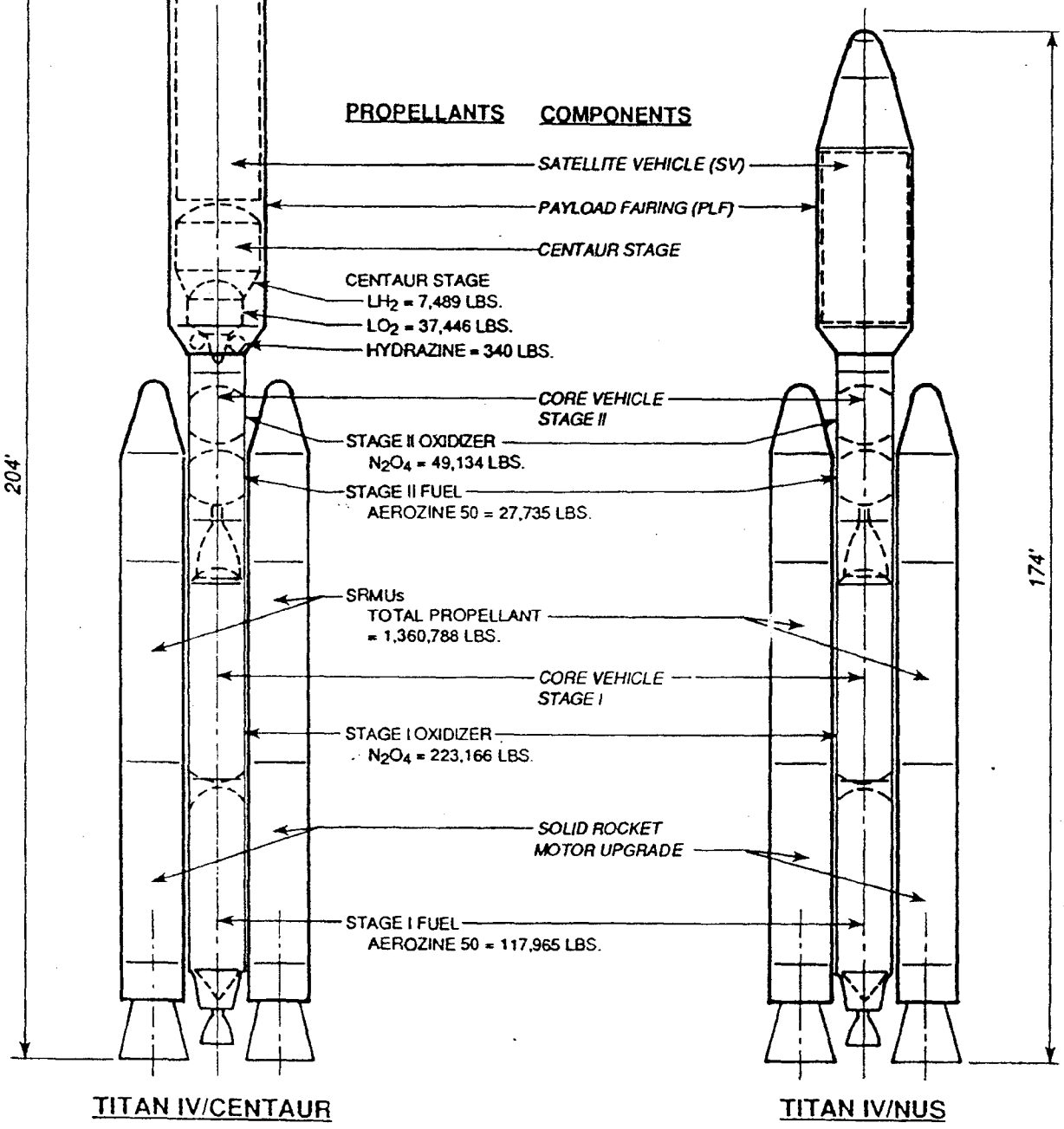
2. The launch complex provides the ability to assemble, check out, and launch the Titan IV/Centaur or, in the case of a launch abort, to safely shut down the vehicle systems. Following a launch, post-launch refurbishment and preparation for the next launch would begin according to specific mission requirements. Storage capacity for propellants (fuels, oxidizers, etc.) is planned to meet a timely turnaround requirement for successive launches.

3. Ancillary facilities adjacent to the launch complex would include a parking area for privately-owned vehicles, a weather station, a sanitary sewage treatment plant, evaporation/percolation ponds, an electrical substation, and utility corridors. Elements of the launch complex, including the Titan IV/Centaur vehicle, primary support structures, and ancillary structures, are described below.

2.1.2.1 Titan IV/Centaur Space Launch Vehicle

1. The Titan IV/Centaur is the latest development in the continuing Titan program. This launch vehicle will provide high energy, earth orbit delivery of satellites weighing up to 10,000 pounds and has thrust capability of 3.2 million pounds. Components of the Titan IV/Centaur include two upgraded solid rocket motors (SRMUs), core vehicle (stages I and II), Centaur stage, payload fairing (PLF), and satellite vehicle (SV) as shown in Figure 2.6 (Titan IV Vehicle Configurations). Another configuration that could be supported from the proposed launch complex is the Titan IV/NUS launch vehicle (see Figure 2.6).

2. The SRMUs, which power the initial liftoff, together contain a total of approximately 1.4 million pounds of solid rocket propellant, consisting of ammonium perchlorate and an aluminum binder fuel. The SRMUs fire for approximately 2.5 minutes, at which time they separate from the core vehicle. The expended SRMUs fall into the ocean and are not recovered. The core vehicle consists of two stages and uses liquid propellants consisting of a fuel, Aerozine 50 (50 percent hydrazine and 50 percent unsymmetrical dimethyl hydrazine [UDMH]), and an oxidizer, nitrogen tetroxide (N_2O_4). Stage I burns for approximately three minutes, at which time it separates from stage II. Stage II then burns for approximately four



LEGEND

LH_2	-	LIQUID HYDROGEN
LO_2	-	LIQUID OXYGEN
N_2O_4	-	NITROGEN TETROXIDE
AEROZINE	-	50% HYDRAZINE, 50% UDMH

SOURCE: USAF 1988b

FIGURE 2.6

TITAN IV
VEHICLE CONFIGURATIONS

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minutes, at which time it separates from the remainder of the space vehicle. These stages also fall into the ocean and are not recovered. The Centaur is the last stage of the space launch vehicle and is used to boost the satellite into high energy orbit with one to three burns, depending on the desired orbit altitude for the satellite. After the final burn, the Centaur separates from the satellite and remains in orbit. The PLF, which houses the satellite, is a cylindrical encasement which is 16.7 feet in diameter and up to 84 feet long. The PLF consists of three sections called "trisectors" which, when joined, form the cylindrical satellite housing. The PLF is jettisoned during Stage I burn, falls into the ocean, and is not recovered.

2.1.2.2 Primary Support Structures

1. Various support structures and equipment are necessary to process and launch the Titan IV/Centaur. These consist of specific structures at the proposed launch complex, as well as facilities and utilities located elsewhere on VAFB. The primary support structures described below would be located within the launch complex area (see Figure 2.5).

Launch Support Structure

1. The launch support structure (LSS) is a partially underground concrete structure, which is topped by the Titan IV/Centaur launch deck. The LSS provides the staging area and necessary facilities to support launch-related activities, including assembly of the Titan IV/Centaur vehicle components, systems check-out, and launch.

2. The LSS also contains an open channel, known as the exhaust duct, that directs the exhaust flame from the two SRMUs during ignition of the launch vehicle for safe dispersal of the exhaust plume away from the launch deck and complex. The exhaust duct also serves as a retention basin for wastewater runoff from water sprayed for deluge and fire suppression during launch and from post launch cleanup activities. The LSS is designed to withstand the effects of a launch by providing flame shields, protective coatings, and cooling water to reduce the effect to the structure from heat generated by the SRMUs.

Launch Mount and Umbilical Tower

1. The launch mount (LM) and umbilical tower (UT) are situated over the LSS. The LM provides structural support for the launch vehicle. The UT provides electrical, propellant, and air conditioning systems to support the launch vehicle while it is on the LM. The UT also provides personnel access to various levels of the space launch vehicle during final launch preparation.

Mobile Service Tower

1. The mobile service tower (MST) is a structure approximately 300 feet high, housing a 220- to 240-ton crane for vehicle assembly and a clean enclosure for satellite vehicle integration and testing. The MST has internal platforms that provide access to the launch vehicle. The MST is mounted on a track and is moved into place surrounding the LM. Launch vehicle components arrive at the launch pad deck on transporters and are positioned under the MST crane to be hoisted into a vertical position on the LM.

Operations Support Building

1. The operations support building (OSB) is a two-story, 56,000 square foot structure located in the westerly portion of the complex, with facilities necessary for daily engineering and operations support and coordination of the proposed project. Included within the OSB are: briefing/training room, technical operations area, offices, data library, communications equipment, complex management center, maintenance and machine shops, storage, toilets, lockers, showers, lunchroom, and other necessary personnel support areas.

2.1.2.3 Ancillary Project Elements

1. Ancillary project elements necessary for the launch of the Titan IV/Centaur include roads, buildings, storage facilities, and utilities, as depicted in Figure 2.5. Roads and utilities would link the proposed complex with existing systems at other locations within VAFB.

Roads and Parking

1. New paved road construction for access to the launch complex and other offsite facilities would include a realignment of a portion of the existing Space Shuttle external tank tow route (Coast Road) and provision for other roads to give access to the site, the electrical substation, and the sanitary sewage treatment plant. Existing roads to the north and south of the proposed Cypress Ridge site would be repaired, as necessary, and utilized as security patrol roads. New roadways within the launch complex area would include the perimeter road, the entrapment area road, and other access roads linking project elements and associated parking. An approximate 5-acre parking area would be located adjacent to the launch complex within the site boundary (see Figure 2.5).

Support Equipment Buildings

1. Support equipment buildings would be provided within the fenced area and include a paint and lubricant storage building, an ordnance bunker, a storage facility, an essential power building, and other structures, as necessary.

Propellant and Gas Holding Areas

1. Propellant and gas holding areas include a gas storage area, Titan IV core vehicle fuel and oxidizer holding areas, payload fuel and oxidizer holding pads, and cryogenic holding areas. The various holding areas also would include pollution control devices, as appropriate. Storage facilities and approximate commodity quantities are as follows:

   - **The Gas Storage Area** would include storage and handling facilities for approximately 3,000 cubic feet of gaseous helium, at 6,000 pounds per square inch, gauge (psig), and 5,000 cubic feet of gaseous nitrogen, also at 6,000 psig. Gaseous nitrogen is used in the pressure testing of the Titan IV/Centaur fuel and oxidizer storage tanks. It is also used as a purge gas for the hypergolic propellant lines after propellant transfer.
   - **The Titan Core Vehicle Oxidizer (N_2O_4) Storage Area** would consist of a 40,000-gallon ready storage vessel (RSV), pump, vapor control system, propellant loading unit, and a 40,000-gallon waste vessel. Separate containment areas are provided for the storage and waste vessels. These areas are sized to contain about 60,000 gallons each.
   - **The Titan Booster Vehicle Fuel (Aerozine 50) Storage Area** would consist of a 40,000-gallon RSV, pump, vapor control system, propellant loading unit, and 40,000-gallon waste vessel. In addition, an automatic deluge water system would dilute any spill, thereby reducing the chance of vapors escaping to the atmosphere. There would be two separate containment areas for the RSV and waste vessel. Each containment area would have a volume of approximately 175,000 gallons and is designed to hold the contents of each vessel plus deluge water at a ratio of 1:3. In addition, there is a 1,500-gallon sump within the waste tank containment area. The sump functions as a drain from each area and is designed for one-way flow so that fluid which enters cannot flow out.
   - **The Payload Fuel and Oxidizer Holding Pads** would be used for short- term storage until payload fuel and oxidizer can be transferred to the satellite vehicle.
   - **The Cryogenic Holding Areas** would include storage for about 15,000 gallons of liquid oxygen (LO_2), about 40,000 gallons of liquid hydrogen (LH_2), and about 4,000 gallons of liquid helium (LHe). The LH_2 area would use a flare stack to burn excess vapor, and the LO_2 area would use a dump pond to evaporate LO_2 spills. LHe spills would be contained by a wall surrounding the LHe tank. LO_2 and LH_2 are used as propellant for the Centaur stage of the Titan IV. LHe is used for Titan IV/Centaur processing and engine conditioning and for payload fairing processing.

Utilities/Utility Corridors

1. Utilities necessary for operation of the proposed project would include a series of onsite systems, including water (potable, wastewater, and deluge), sanitary sewer, propane gas, communications, and electrical. New utility lines would connect the launch complex systems to existing VAFB facilities.

Electrical

1. Electrical demand for the launch complex is estimated to be approximately 6,000 kilovolt-ampere (kVA). This demand would be met by a new electrical substation located northwest of the launch complex. Power to the substation would be provided by dual 12.47 kilovolt (kV) overhead transmission lines, one from a commercial power source, and one a new line from the space transportation system (STS) power plant. The new line would be used as a standby power source in the event that commercial power is lost. A switching mechanism in the substation would allow either commercial or standby power to be fed to the secondary power distribution system. During launch processing, the 12.47 kV line from the STS power plant would be used, with commercial power providing a standby power source. For launch, commercial power would be used, with the STS power plant providing backup.

2. An essential power generator has also been included in conceptual plans. This would be a 480 volt, three-phase generator capable of supplying a minimum of 500 kVA. In case of a power failure during launch operations (i.e., in the event of failure of both the STS power plant and commercial power supply), the essential power generator would supply power for the launch site security system and for essential launch shutdown and safety functions.

Propane

1. Propane gas would be utilized for heating and cooling and as auxiliary fuel for flare stack pilot flames, if required. Appropriate storage vessels and distribution lines would be constructed in support of these needs. In addition, there would be a utility corridor easement in the event of natural gas being provided to the site at some future date.

Potable Water

1. A water distribution system would be developed to supply the launch complex with water for fire suppression, launch deluge, washdown, and domestic uses. For each Titan IV/ Centaur launch, approximately 146,000 gallons of water would be required. Of this amount, 80,000 gallons would be used for pre-launch check-out, 26,000 gallons for launch deluge, and 40,000 gallons for post-launch washdown. Of the 146,000 gallons, 20,000 would

evaporate during launch and form a ground cloud. Based on fire suppression water requirements, a minimum of 800,000 gallons would be stored in reserve. This storage and distribution would be achieved through a local water distribution system, interconnected with the existing VAFB water supply system. Lines would be extended from the Space Shuttle external tank processing and storage facility and an existing tank located north and east of the proposed Cypress Ridge site. In addition, an easement for a second water storage tank would be reserved.

Domestic Wastewater Treatment Facility

1. A sanitary sewage treatment facility would be located outside the fenced launch complex. The facility would be designed to accommodate domestic sewage discharge from project facilities. Treated effluent would be disposed of in new evaporation/percolation ponds.

Industrial Wastewater Treatment and Disposal

1. Disposal of wastewater from launch deluge and washdown would be accomplished by use of existing VAFB treatment and disposal facilities. Transfer of wastewater would be by tank truck from the project site, directly to the treatment plant at SLC-6, then to the SLC-6 evaporation ponds. Easements for future wastewater pipelines and tank between the undeveloped sites and SLC-6 has been provided, in the event transportation by tank truck should become economically unfeasible. A ultraviolet (UV)/ozone wastewater treatment system would be used to treat launch deluge and washdown water, if available at VAFB.

Communications

1. Communications would be provided for voice (intercom and telephone), closed circuit TV, computer data, public address, and area warning systems. Remote TV and film cameras would be positioned at offsite locations surrounding the launch complex. Communications would be via buried fiber-optic cable, scheduled for completion prior to the initial launch.

2.1.2.4 Other VAFB Facilities

1. There are facilities and systems at VAFB that serve as common support for the existing array of launch complexes. The proposed project would utilize a number of these facilities during various launch preparation and operations activities. For example, facilities are in place for the receipt, testing, inspection, and assembly of vehicle components. Building 8510 on North VAFB would be used as a launch control center (LCC) during launch operations to communicate with the launch complex and the Titan IV/Centaur vehicle. Other systems are in place for transportation and utilities (power, water, gas, and communications). Existing

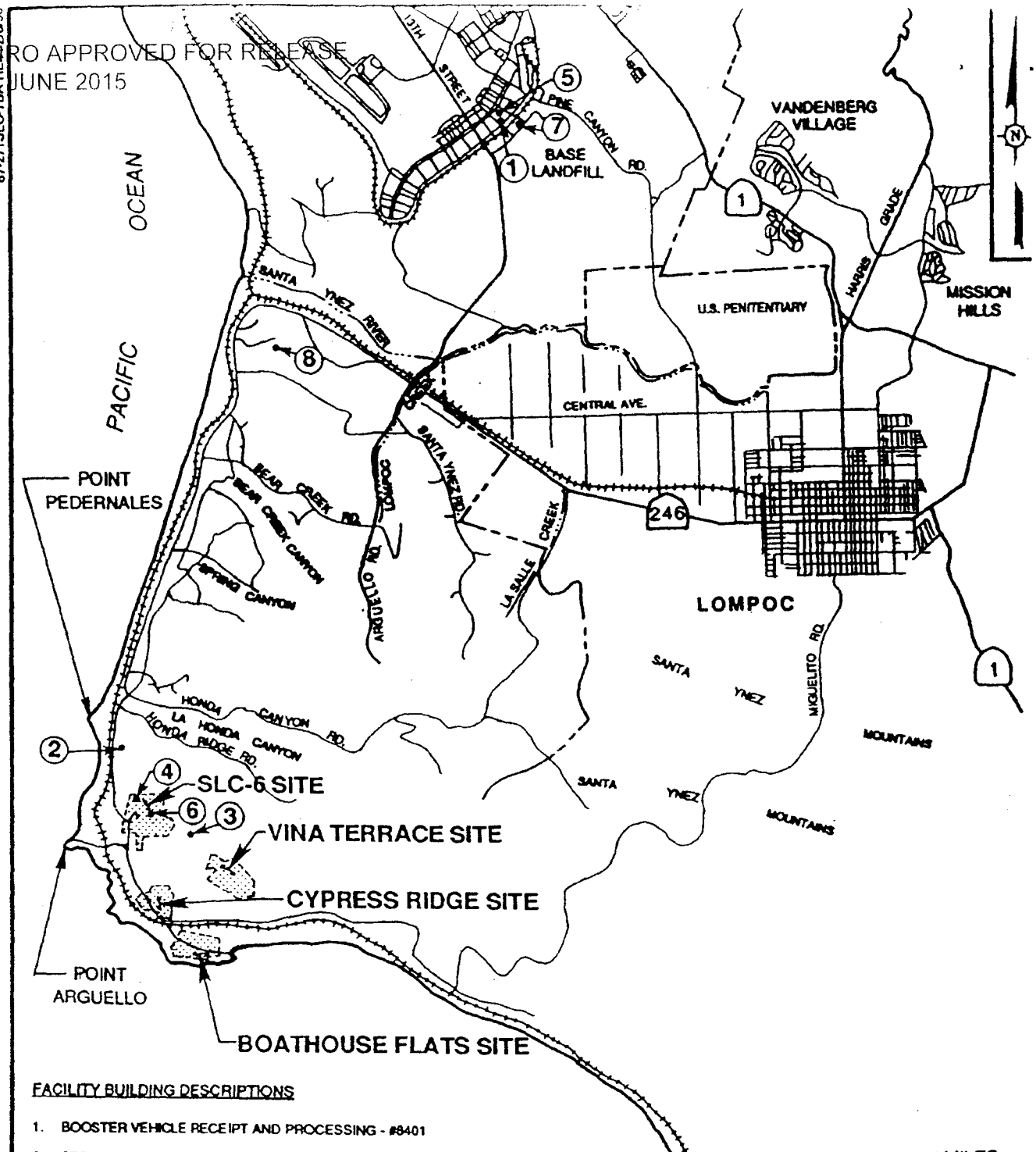
industrial wastewater storage and treatment facilities are available at SLC-6. The specific functions and locations of other existing facilities are shown in Figure 2.7 (Titan Program Existing VAFB Facilities).

2.1.3 PROJECT CONSTRUCTION ACTIVITIES

1. It is anticipated that construction of the proposed project would be accomplished over a period of approximately four years, beginning in 1991, as shown in Figure 2.8 (Preliminary Construction Schedule and Personnel Requirements). There is the potential for this schedule to extend to five years, in which case the activation/operations phase would occur in Year 6.
   - **Facility Construction (36 months)** - involves facility design, grading, utility and road construction, Operations Support Building construction, Launch Support Structure and flame duct construction, fencing, and landscaping.
   - **Ground Support Systems Design, Procurement, and Installation (42 months)** - involves installation of Mobile Service Tower, Launch Mount, Umbilical Tower, storage tanks, and other aerospace ground equipment and systems.

2. Initial construction activities after final design would primarily entail grading for the project site, the parking area, roads, and evaporation/percolation ponds.

3. In order to accommodate the engineering design of the planned 50-acre space launch complex, approximately 120 acres would be disturbed by grading activities, equipment movement and storage, and the establishment of temporary construction "laydown" areas. Depending upon the final design and grading plans, earth movement would involve a minimum about 1.5 million cubic yards (CY) of cut and 1.5 million CY of fill. Between 0.2 and 0.6 million CY of fill would come from borrow areas located on VAFB (see Figure 2.9, Proposed Borrow and Spoil Locations). The balance of the unused cut material would be removed from the project area and transferred to a spoil site located about three miles north of the Cypress Ridge site near Point Arguello or other, approved location. The top six inches of topsoil would be removed and stockpiled onsite for re-spreading on disturbed areas for revegetation and erosion control after completion of construction. Appropriate erosion control measures would be implemented at the stockpile. Corridors for communication, water, electrical, and other utilities would temporarily disturb about 65 acres of land. The majority of utility distribution lines are planned to be underground. For electrical power lines, only those portions crossing existing roads or railroads would be located underground. Utilities would



FACILITY BUILDING DESCRIPTIONS

1. BOOSTER VEHICLE RECEIPT AND PROCESSING - #8401
2. STS POWER PLANT
3. WATER STORAGE
4. SRMU RECEIPT, INSPECTION AND STORAGE - #398
5. PAYLOAD FAIRING RECEIPT AND PROCESSING - #8337
6. SLC-6 WASTEWATER TREATMENT PLANT - SLC-6 SITE
7. LAUNCH CONTROL CENTER - #8510
8. HYPERGOLIC PROPELLANT STOCKPILE FACILITIES #975 AND #977

SOURCE: USAF 1989a

FIGURE 2.7

TITAN PROGRAM
EXISTING VAFB FACILITIES

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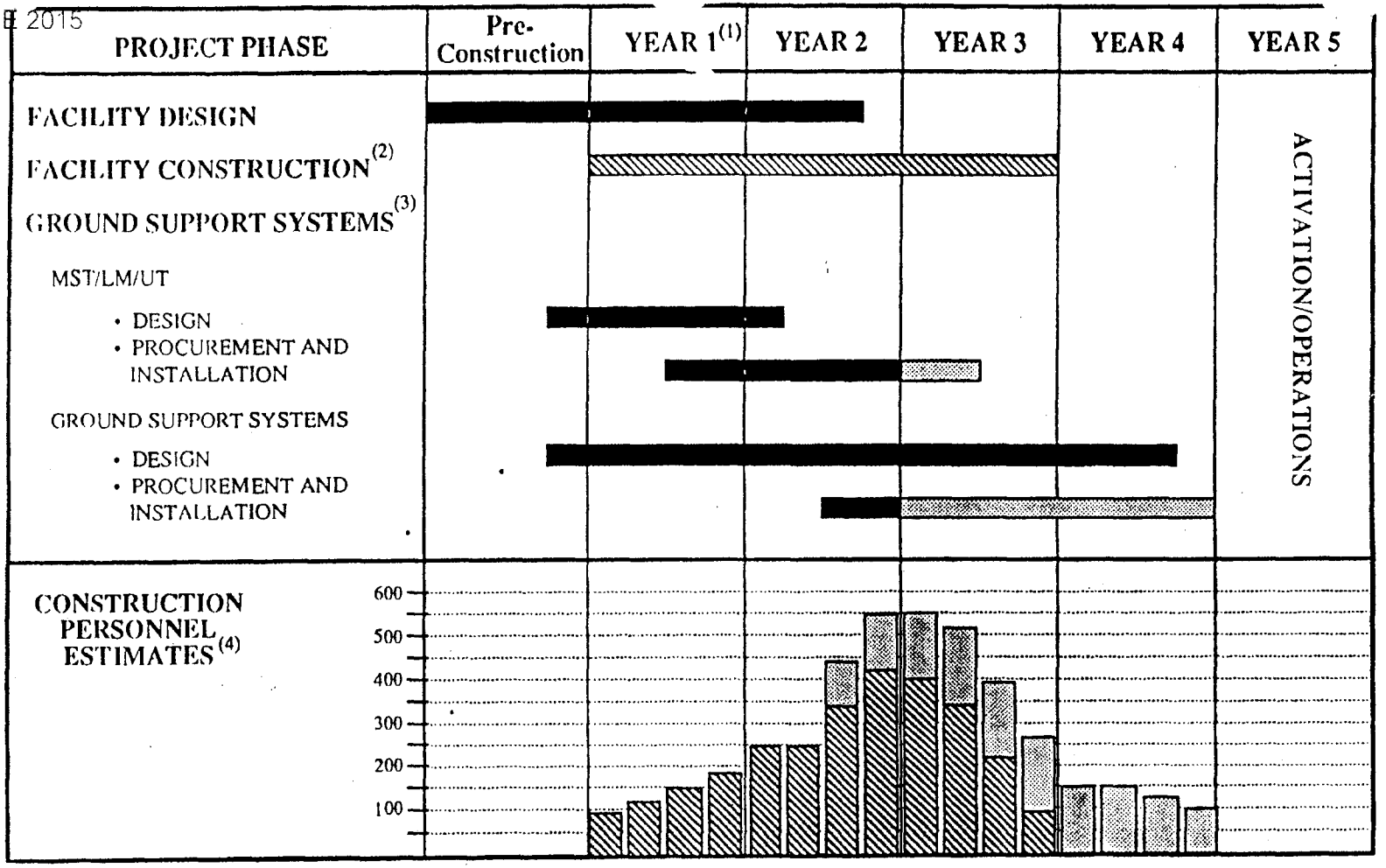

(1) Years indicated do not necessarily correspond to calendar dates and indicate the least time anticipated for completion of activities. Actual construction may extend through Year 5, with Activation/Operations occurring in Year 6.

(2) Facility construction includes grading, road construction, utilities, Operations Support Building, Launch Service Structure, fencing, and reclamation.

(3) Ground Support Systems include Mobile Service Tower, Launch Mount, Umbilical Tower, and other ground equipment.

(4) Includes USAF, Aerospace, Army Corps of Engineers, and private contractor construction personnel.

Off-Site Facility Construction

Off-Site Aerospace Equipment Installation

FIGURE 2.8

PRELIMINARY CONSTRUCTION SCHEDULE AND PERSONNEL REQUIREMENTS

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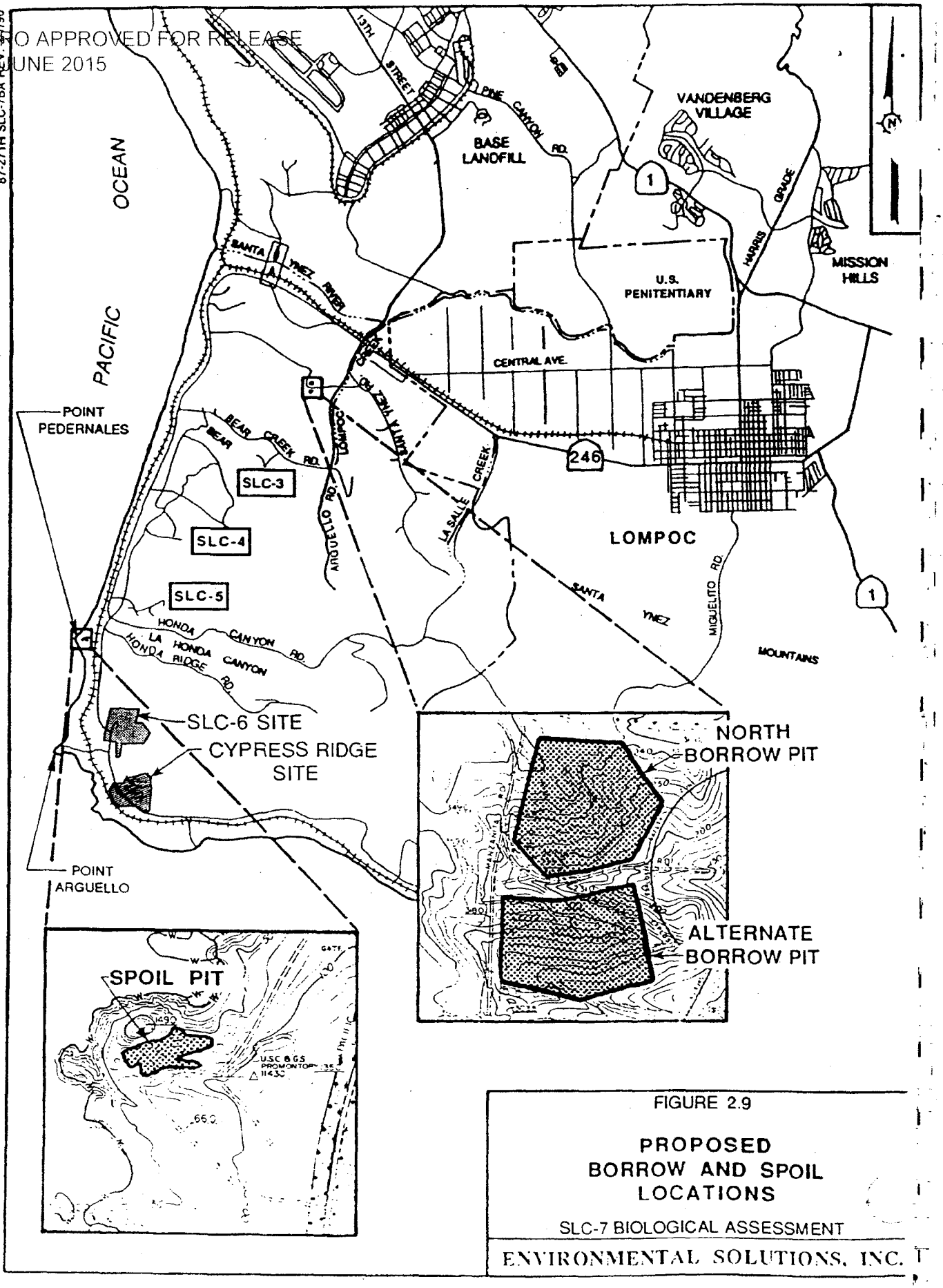

FIGURE 2.9

PROPOSED BORROW AND SPOIL LOCATIONS

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be extended within one of two corridors: (1) along the Coast Road from existing lines in the vicinity of SLC-6, or (2) substantially east of Coast Road from the vicinity of the SLC-6 wastewater treatment ponds. Water distribution lines would be extended from an existing water storage site located on a knoll about 1.5 miles north and east of the Cypress Ridge site, and from the Space Shuttle external tank processing and storage facility.

4. Construction of the launch complex facilities would include previously discussed structures, such as the launch support structure, operations support building, and ancillary support facilities. Fencing and landscaping would be completed after construction of these buildings.

2.1.4 LAUNCH ACTIVITIES

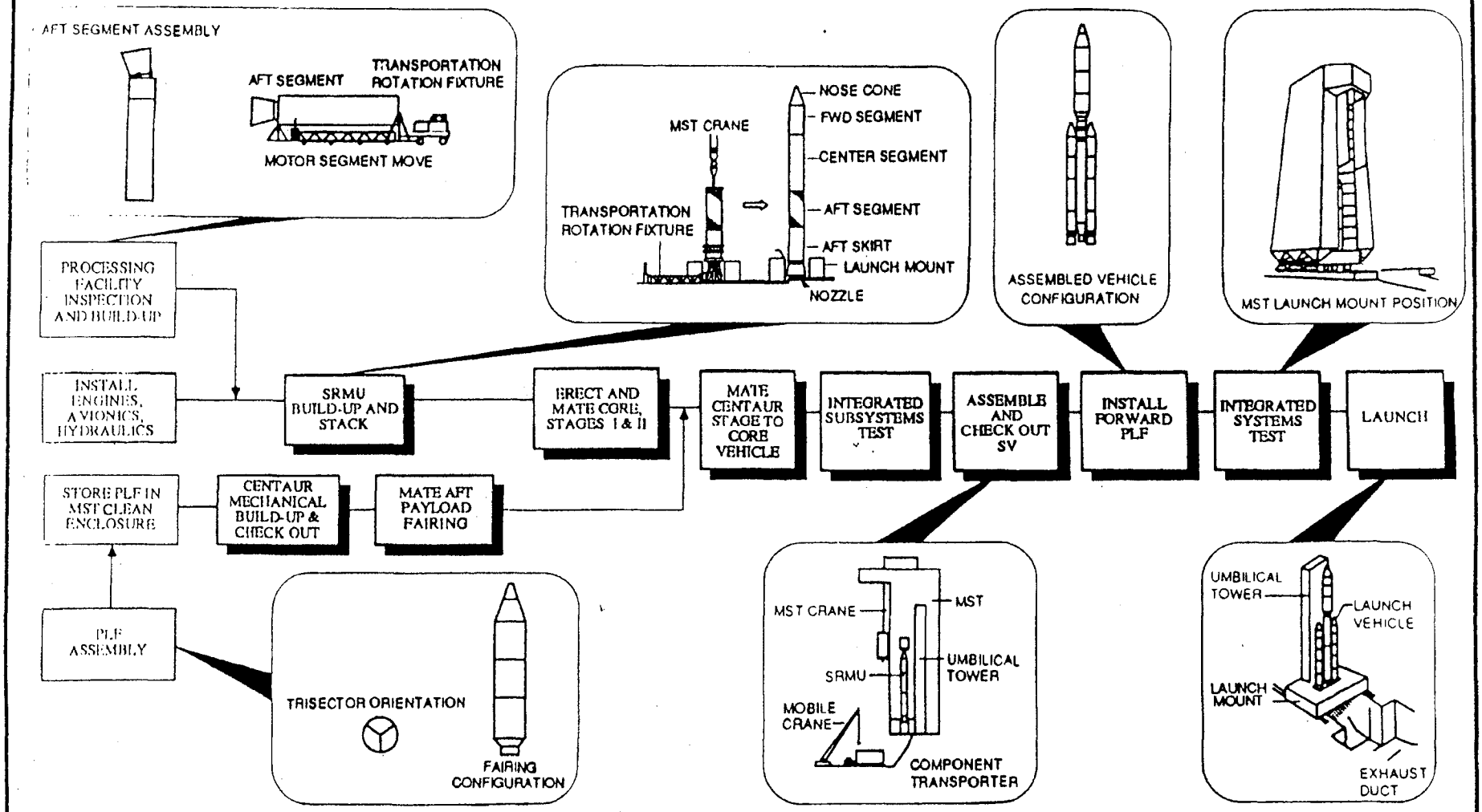
1. The Titan IV/Centaur launch vehicle components would be shipped separately to VAFB. Upon arrival, the components would undergo a variety of receiving inspections and off-line processing before being transported to the launch pad for integration, test, and launch.

2. The SRMU segments would arrive by rail at a receiving facility on South VAFB. The Titan IV core vehicle stages I and II would arrive at the airfield on North VAFB and be transported to Building 8401, the vehicle assembly building/horizontal test facility (VAB/HTF). The liquid propellant rocket engines would arrive for installation on the core vehicle at the VAB/HTF. The Centaur stage would be received and sent directly to the launch complex for processing. The payload fairing sections would be trucked to Building 8337, the payload fairing processing facility, where each would be received, inspected, and processed, then transported to the launch complex.

3. Launch process operations that would occur at the launch complex include launch preparation, launch operations, and post-launch refurbishment. These activities are planned to begin in 1994 or 1995.

2.1.4.1 Launch Preparation

1. Launch preparation activities involve assembly and testing of the Titan IV/Centaur vehicle. Vehicle assembly is depicted in Figure 2.10 (Titan IV/Centaur Typical Vehicle Assembly Flow Diagram). The launch vehicle components and payload elements would be transported to the launch pad from their off-line processing areas, or from the point of arrival at VAFB, on their individual transporters. The elements would be sequentially erected on the LM. The individual SRMU segments would be erected and assembled, followed by the Titan IV core



LEGEND:

MST = MOBILE SERVICE TOWER
PLF = PAYLOAD FAIRING
SV = SATELLITE VEHICLE
SRMU = SOLID ROCKET MOTORS

= DENOTES ON-PAD ACTIVITY

SOUI AF 1988b. OPERATIONS CONCEPT, SLC - 7, [illegible]

FIGURE 2.10

TITAN IV/CENTAUR TYPICAL VEHICLE ASSEMBLY FLOW DIAGRAM

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vehicle, stages I and II, and the Centaur stage with the aft PLF section installed. In this assembled configuration, the booster vehicle would undergo check-outs, including subsystem verification, integrated system tests, and Centaur tests, to verify all systems and interfaces.

2. Following successful completion of integrated system tests, the satellite would be brought to the launch site and erected in a clean enclosure in the MST, where prelaunch check-outs would be conducted. Testing would be performed on the satellite to verify interfaces and functions. The forward PLF sections then would be installed. Completion of the vehicle assembly and testing activities leads to a prelaunch phase in which the launch vehicle and payload are prepared for launch countdown. This includes battery installation, propellant loading, ordnance installation (e.g., stage separation charges), and other selected hookups.

3. Titan IV core vehicle commodity servicing is provided by propellant loading systems (oxidizer and fuel) installed at the launch pad and comprised of ready storage vessels, propellant loading units, and piping. Piping from the LSS and UT would be used to fill and drain umbilical connections from the UT to the vehicle. Centaur stage commodity servicing includes loading of liquid hydrogen, liquid oxygen, gaseous nitrogen, hydrazine, gaseous helium, and liquid helium. Support equipment systems are provided at the launch pad to accommodate these requirements. Propellants would be piped from onsite storage vessels and transfer systems to the launch vehicle through umbilicals at the UT.

4. Scheduling of launch preparation activities is depicted in Figure 2.11 (Titan IV/Centaur Typical Vehicle Assembly Time Line). As shown, off-line processing of vehicle components would occur over a 70-day period. Components then would be transferred to the launch complex for approximately 150 days of vehicle assembly and testing, which are necessary prior to launch.

2.1.4.2 Launch Operations

1. Countdown and launch activities are divided into two parts, known as the R-count and terminal count. The R-count begins approximately two weeks prior to launch and involves activities such as installation of flight batteries, oxidizer and propellant loading, and ordnance installation. The terminal count begins about one day prior to launch and includes activities such as Centaur propellant loading, vehicle verification and guidance checks, range safety checks, moving of the MST away from the vehicle, and the final countdown to launch. The launch complex would be evacuated of all nonessential personnel prior to fueling the Centaur stage. After Centaur fueling has started and been stabilized, all other personnel are evacuated.

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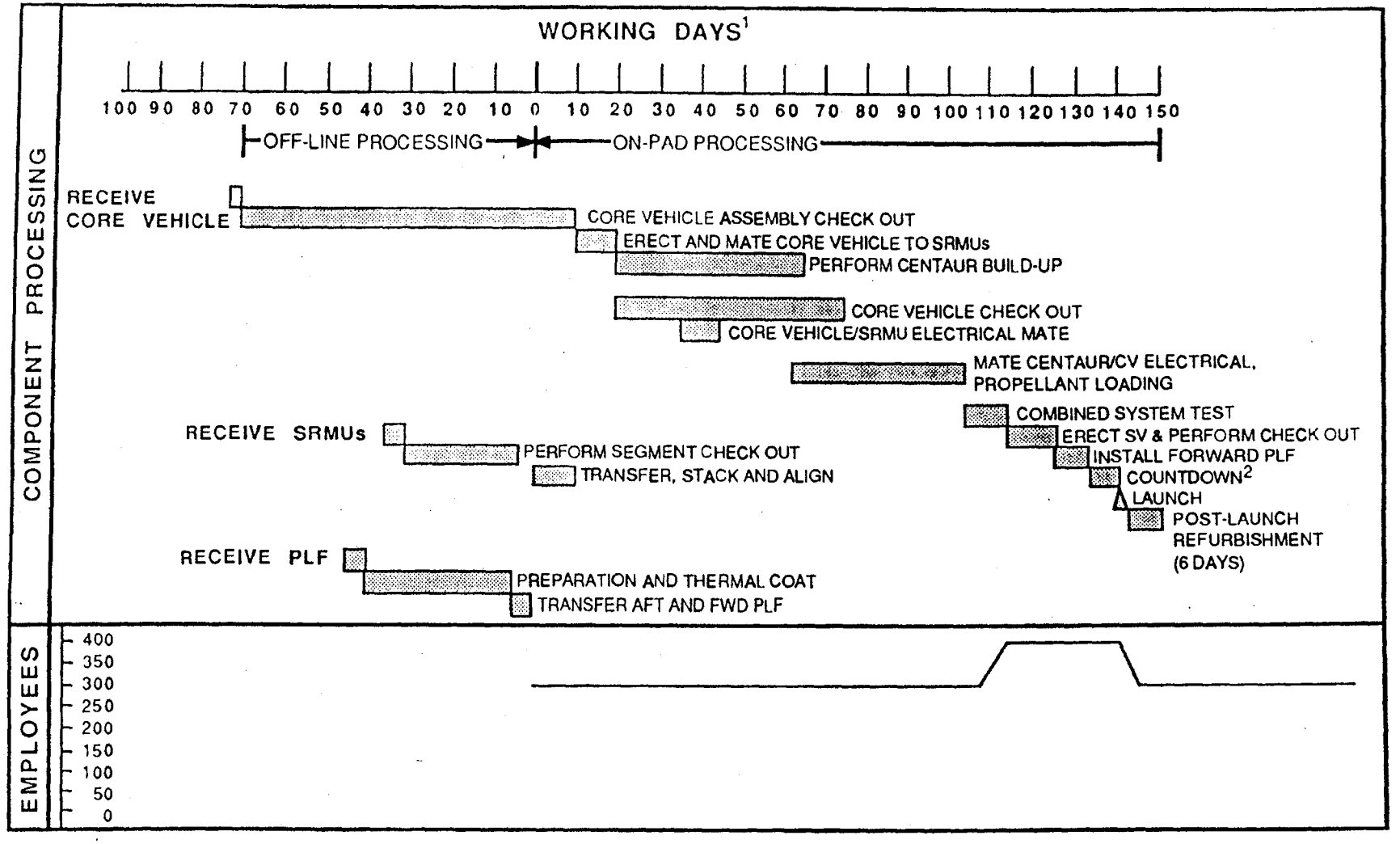

NOTES

1. Time line shown as working days based on 8-hour/day, 5-day/week schedule.
2. 24-hour/day work schedule.

LEGEND

▲ Component transferred to SLC-7 for integration with core vehicle

S USAF 1988b. Operations Concept, SLC-7, Titan IV/Centaur Launch
V[illegible] WSMC/SE.

FIGURE 2.11

TITAN IV/CENTAUR TYPICAL VEHICLE ASSEMBLY TIME LINE

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2. Launches from the proposed launch complex would be controlled from an LCC located on North VAFB. The LCC would communicate by means of a fiber-optic cable, with a launch complex computer receiving commands from the LCC. The LCC would be used to perform the prelaunch testing and check-out and would run the entire countdown and launch phase. Selected prelaunch onsite testing and check-out functions would be performed at the project site. The terminal launch countdown would start approximately 500 minutes prior to launch and could include built-in time delays. The MST would be moved back to the park position and away from the launch pad during the countdown.

3. At launch, water would be sprayed at the vehicle exhaust from valves located at the UT, LM, LSS, and exhaust duct. This spray serves the function of exhaust cooling in order to minimize damage to the launch pad. Approximately 26,000 gallons of water could be sprayed during the vehicle launch. Wastewater from this process would be retained in the exhaust duct.

2.1.4.3 Post-launch Refurbishment

1. Following a launch, washdown and cleanup of the launch area would be completed. Post-launch activities would also entail replenishment of commodities such as propellants, cryogenics, and gases, and minor repair to launch support facilities.

2. Other activities following a launch would be centered on completion of receipt and off-line processing of vehicle components in preparation for the next launch. The initiation of this phase would be concurrent with and overlap the previously described on-pad launch preparation activities.

2.1.5 OVERALL PROJECT SCHEDULE AND PERSONNEL

1. A schedule for the proposed action, including employee requirements, is shown in Figure 2.8. The schedule indicates that the two construction phases would overlap and continue over a period of about four years. Initial launch capability (ILC) is scheduled for 1994 or 1995.

2. Personnel requirements are estimated to vary from about 550 individuals at the peak of construction activities to about 100 at the termination of construction. Operations personnel are estimated at 300 during normal launch operations. About 400 persons would be onsite during an approximate one-month period prior to launch for final vehicle processing.

3. As depicted in Figure 2.11, the on-pad receipt and processing of Titan IV/Centaur components would require about 150 working days. Overlap of off-pad processing schedules for some components is planned. Within a period of one year, a maximum of three vehicles could be launched from the proposed space launch complex.

2.2 ALTERNATIVES TO THE PROPOSED ACTION

1. Alternatives to the proposed action must have the potential to achieve the basic objectives of the proposed action, which are to provide a facility with the capability to safely launch a Titan IV vehicle to a polar orbit, to achieve highly inclined orbits with payloads in the 10,000-pound class, and to back up existing launch facilities to assure access to space for critical satellite missions. Basic criteria necessary to support this objective include siting of the facility to obtain the proper satellite orbit and availability of support facilities, which include launch support infrastructure, such as a launch control center, telemetry and tracking facilities, propellant storage, and vehicle component processing facilities. In addition, community-provided facilities, such as access roads and utilities (power, sewer, water, and communications), port availability, and employee housing are necessary. Other related considerations include availability of a local work force, construction costs, operation and maintenance costs, and availability of land for the project site. Alternatives that meet these basic criteria are evaluated to determine if they are capable of eliminating significant adverse environmental effects or reducing adverse effects to a level of insignificance.

2. Feasibility criteria are reviewed in the following sections for alternate launch vehicles, other launch locations, existing VAFB launch sites, and the "no action" alternative. Four alternative sites are evaluated in detail.

2.2.1 OTHER LAUNCH VEHICLES

2.2.1.1 Space Shuttle

1. The Space Shuttle program resumed launches in 1988 at NASA's Kennedy Space Center, Florida, following the more than two-year delay resulting from the January 1986 Challenger accident. The Space Shuttle vehicle is not available for launches from VAFB, and launches from Cape Canaveral in Florida cannot safely provide a polar orbit. Since one element of the project objective is to launch critical DOD payloads into near-polar orbit, use of the Space Shuttle has been determined not to be viable and has been eliminated from further consideration.

2.2.1.2 Other Vehicles

1. Use of other available launch vehicles was considered relative to the desired mission objectives. The current Titan IV/NUS can achieve a low energy, but not a high energy, orbit. Other available launch vehicles are designed for lighter weight payloads. For example, the Titan 34D can deliver a 27,500-pound satellite to low earth orbit. However, modification for a high earth orbit reduces its capacity to approximately 4,200 pounds.

2. Since the objective of the proposed action includes launching satellites in the 10,000-pound class to a high energy orbit, the Titan IV/Centaur is required.

2.2.2 OTHER LAUNCH LOCATIONS

2.2.2.1 Existing Government Sites

Cape Canaveral Air Force Station/Kennedy Space Center

1. Facilities are available to launch the Titan IV/Centaur at the eastern test range (ETR) (CCAFS). Launch azimuths from the ETR are generally limited to between 35 and 120 degrees, as shown in Figure 2.12 (Over-water Launch Azimuths). Consequently, space vehicles launched from this location cannot safely achieve polar orbit.

Naval Pacific Test Range

1. The U.S. Department of the Navy maintains a missile test range base on San Clemente Island, off the coast of Southern California. It is operated by the Naval Pacific Test Range, located at Point Mugu Naval Air Station, California. Use of the Navy's Pacific Test Range for launch of the Titan IV/Centaur would permit attainment of a polar orbit. However, the launch support infrastructure that currently exists on the island is not capable of accommodating the large Titan IV/Centaur space launch vehicle.

2. Location of the space launch complex on this island was eliminated from further consideration based primarily upon the lack of available launch support work force, housing, and infrastructure, which includes power, sewer, water supply, communications, and vehicle and payload processing and preparation facilities.

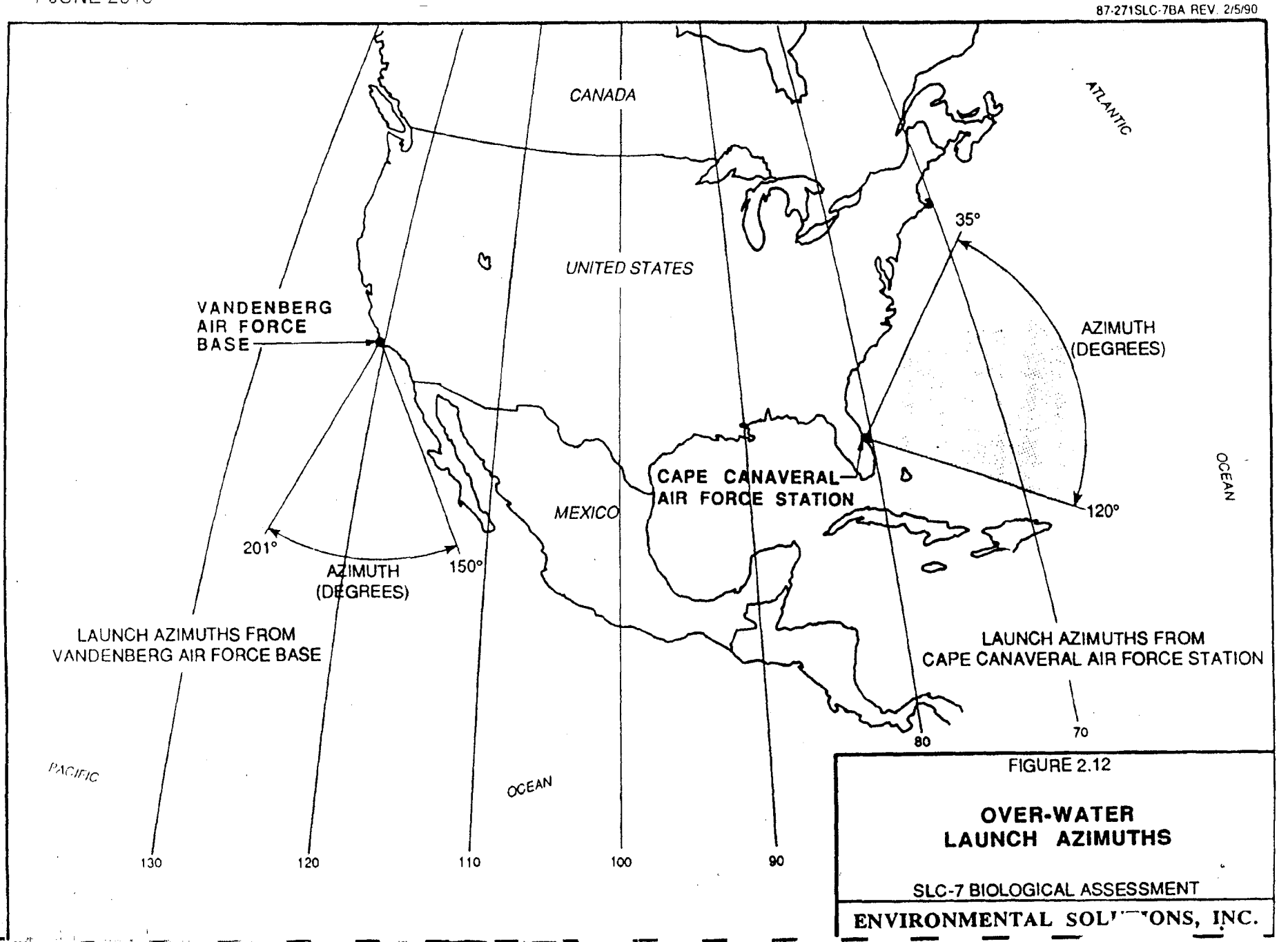

FIGURE 2.12

OVER-WATER LAUNCH AZIMUTHS

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2.2.2.2 Remote, Undeveloped Sites

Territories/Possessions of U.S.

1. The proposed action could be constructed at another Pacific Ocean location, thereby enabling a near polar orbit to be achieved. Available locations to accomplish this objective are primarily located on remote islands in the south Pacific Ocean. However, necessary community support facilities, including access roads, adequate utilities (power, sewer, water supply, and communications), and port access, if available, are generally not adequate on these islands. Additionally, there is only limited availability of a trained local work force and employee housing. Further, there would be the need to establish an entirely new launch support infrastructure, which would include a new launch control center, telemetry and tracking facilities, propellant storage, and vehicle component processing facilities.

2. It is anticipated that environmental considerations for construction of a new space launch complex at a south Pacific location would be similar to or greater than those at the proposed VAFB site. Additional issues of environmental concern, including expanded land use and land restrictions, could occur, since the complex would be independently located, could not share existing facilities, and would likely be lacking a suitable supporting infrastructure. This alternative was, therefore, eliminated from further consideration.

Hawaii

1. The state of Hawaii has been evaluated as a potential site for space vehicle launch activities. In two separate reports prepared by Arthur D. Little, Inc. (1987, 1988), Hawaii was evaluated as being in an advantageous position to serve the market for commercial launch services for small and mid-sized payloads.

2. The study concluded that "... a launch facility developed on Hawaii should be designed to fill a niche market: the launch of small to mid-sized commercial payloads. Such a launch facility would be of modest size, of a scale similar to Wallops Island" (Arthur D. Little, Inc. 1987). This assessment was based on the market outlook for launch services and the availability of launch capacity at existing ranges. The potential sites were identified and evaluated for their ability to accommodate expendable launch vehicles in the size range of the Scout vehicle and not larger than the commercial Titan III.

3. Based on the results of these studies, and the inherent limitations of the identified sites to accommodate military requirements for facilities of the size and complexity required for the proposed action, this alternative was eliminated from further consideration.

2.2.3 VAFB LAUNCH SITES

2.2.3.1 Sites Considered and Rejected

1. VAFB is the primary location for launching USAF space vehicles that must achieve near polar orbit. The base has an array of launch complexes to support the current range of launch activities. Support systems, such as centers for launch control, component receipt and processing facilities, warehouses, roads and utilities, are available. Neighboring communities supply labor and other services.

2. An alternative to constructing a new launch complex would be to raze and reconstruct or to modify one of the existing SLCs for use by the Titan IV/Centaur. SLC-2 (Delta) is located on North VAFB, and, although it has current mission requirements, the Delta program is in a phase-out period. Use of SLC-2 would require razing and reconstruction to meet Titan IV/Centaur requirements. More important, however, North VAFB locations require a dog-leg maneuver to avoid over-flight of populated areas. This maneuver reduces the required payload capacity below the required 10,000 pounds necessary for a high earth orbit.

3. Launch facilities located on South VAFB consist of SLC-3 (Atlas), SLC-4 (Titan), SLC-5 (Scout), and SLC-6 (Space Shuttle). SLC-5 (Scout) has scheduled missions and is not large enough to accommodate a Titan IV/Centaur. SLC-4 East is being refurbished to accommodate Titan IV/NUS missions, and SLC-4 West is an operational Titan II facility. Since each existing launch complex is designed to accommodate a particular launch vehicle, reconstruction or modification for the Titan IV/Centaur would reduce the base capabilities for current launch programs.

4. SLC-3 (Atlas) also has current mission requirements but is in a phase-out period. Although located on South VAFB, the SLC-3 complex at launch requires direct over-flight of existing SLC-4 and SLC-6 facilities, which poses human health and safety risks. Also, SLC-3 is too small in its current configuration to accommodate the Titan IV/Centaur and would require significant demolition prior to building. Additionally, SLC-3 is closer to Lompoc than other space launch facilities on South VAFB, and Titan IV/Centaur activities there would result in increased impacts to the Lompoc community.

5. Based on the above considerations, SLC-2, SLC-3, SLC-4, and SLC-5 were eliminated from further consideration. However, based upon the range of alternatives considered, it was determined that development of the Titan IV/Centaur program at another VAFB location would be reasonable, based upon mission requirements, technical needs, engineering and design factors, cost, and environmental factors.

2.2.3.2 SLC-6 Conversion

Introduction

1. VAFB covers about 98,400 acres of land bordering the Pacific Ocean. While this area is large, the sites available for new launch complexes are limited, due to factors including topography, access, environmental constraints, and proximity to other space launch complexes, since they must be spaced at appropriate distances according to the required safety clear zone. Based upon these siting factors and mission requirements, appropriate sites for locating the proposed launch complex are generally restricted to South VAFB. In this area, four sites have been selected for engineering and technical evaluation: (1) Cypress Ridge, (2) SLC-6, (3) Boathouse Flats, and (4) Vina Terrace. These locations are shown in Figure 2.13 (Project Alternatives Access and Utility Corridors). The Cypress Ridge, Boathouse Flats, and Vina Terrace sites are undeveloped and located in an area of South VAFB that is utilized for grazing. The SLC-6 site is a developed space launch complex, with facilities which were modified for the Space Shuttle.

2. Because of the proximity of these four potential sites and the size of the area evaluated relative to biological resources, unless otherwise noted, the results of this Biological Assessment apply equally to each of the four sites under consideration.

3. Launching the Titan IV/Centaur from SLC-6 would involve establishment of the capabilities described above. The SLC-6 site was originally constructed in 1970 for the Titan IIIM manned launch space vehicle. The Titan IIIM was to be used for the manned orbital laboratory (MOL) program. Subsequent to cancellation of the MOL program, the SLC-6 site was modified for the Space Shuttle. However, primarily as a result of the 1986 Challenger disaster, the USAF has not used SLC-6 for Shuttle launches. Use of the facility to fulfill the objectives of the proposed project would result in utilization of some of the structures and equipment intended for the Space Shuttle program.

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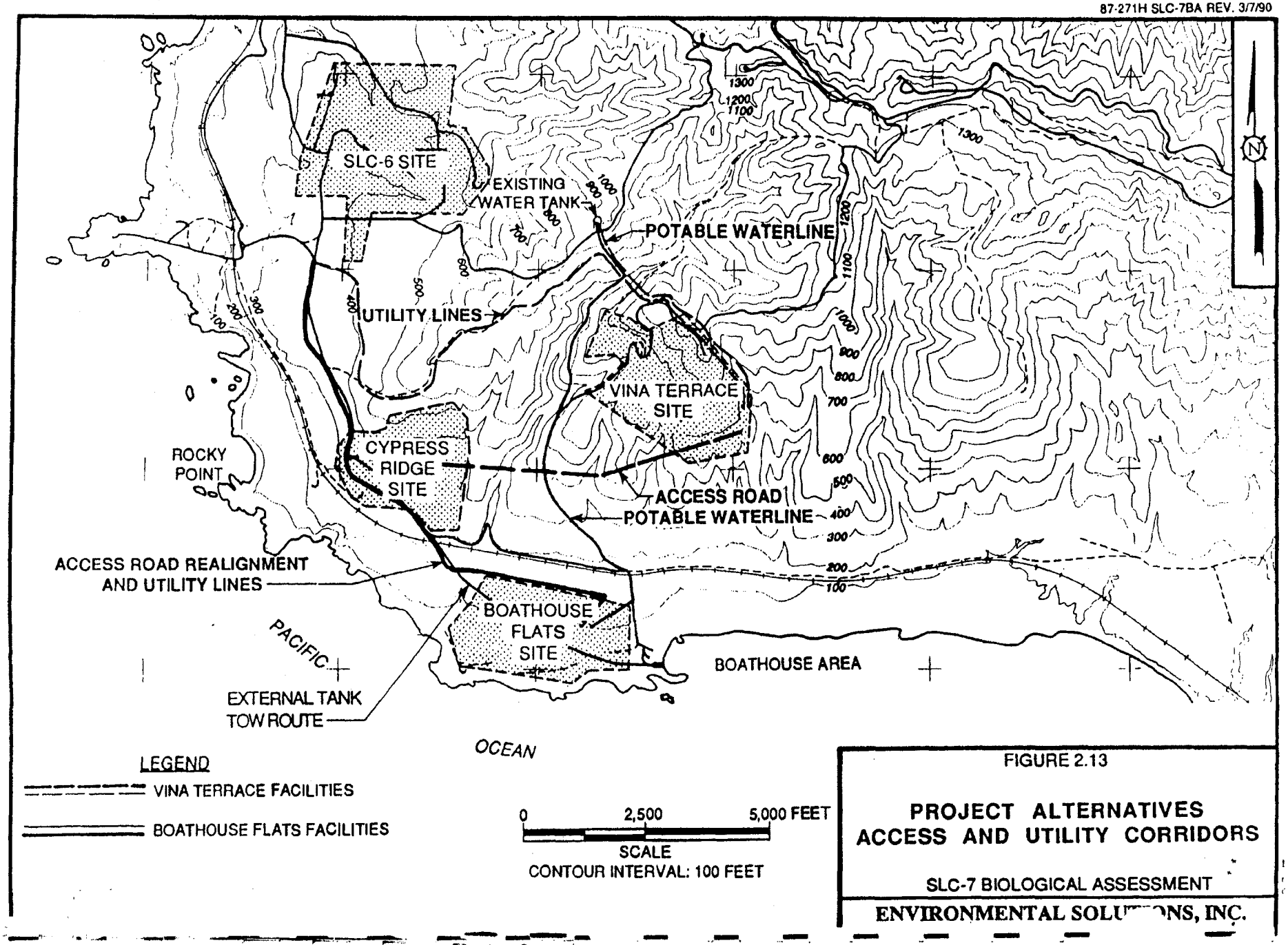

FIGURE 2.13

PROJECT ALTERNATIVES
ACCESS AND UTILITY CORRIDORS

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4. The SLC-6 facility is located about one mile north of the Cypress Ridge site and about one mile inland from the Pacific Ocean. The fenced SLC-6 complex covers an area of about 100 acres, although the area including ancillary structures that would be utilized for Titan IV/Centaur launches is estimated to be about 280 acres, as shown in Figure 2.14 (SLC-6 Site). Access to SLC-6 is primarily through the VAFB south gate. The location of SLC-6 in relation to the Cypress Ridge, Boathouse Flats, and Vina Terrace sites is shown in Figure 2.3.

5. As planned, implementation of the SLC-6 alternative would involve retention of some facilities, modification or demolition of others, and some new construction. All construction or modification activities for the Titan IV/Centaur are planned to occur in areas disturbed by previous construction. A list of major facilities and their utilizations, given conversion of the SLC-6, is shown in Table 2.1 (Existing SLC-6 Facilities and Proposed Utilization).

2.2.3.3 Boathouse Flats

1. The 130-acre site known as Boathouse Flats is located adjacent to the coastline, south of the Cypress Ridge site. The site is relatively level, with elevations ranging from 50 to 150 feet. This site was selected based upon an anticipated reduction of project costs and engineering requirements from grading, access, and utilities extensions.

2. Grading for the launch complex at this site would require about 0.6 million CY of cut and about 0.4 million CY of fill. A maximum of 0.4 million CY of fill would be taken from a borrow area located on VAFB (see Figure 2.9). The amount of fill needed would depend on the suitability of cut material for use as fill.

3. The Space Shuttle external tank tow route bisects the site and would provide access. Some modifications to the tow route would be necessary. Electric, underground piping, and communication lines would be extended to the site from SLC-6, along the existing Coast Road and external tank tow route, then along the northern boundary to the launch complex. The area of disturbance for utilities would be about 90 acres, as shown in Figure 2.13. A distribution line for potable water would be extended about two miles from the existing water tank, disturbing an area of about one acre.

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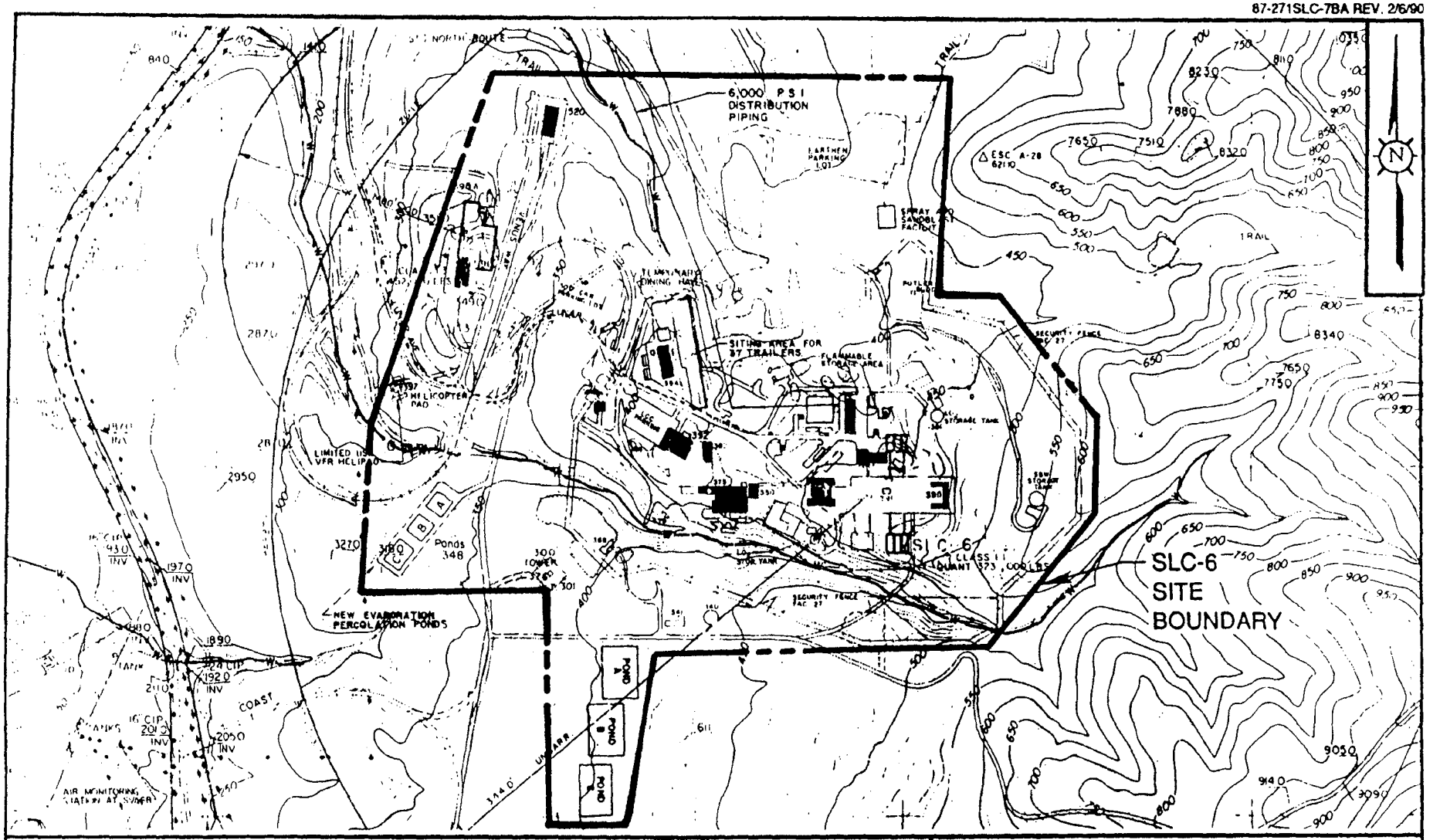

0 800 1,600 FEET
SCALE

CONTOUR INTERVAL: 10 FEET

TOPO: IG DONE BY INTERNATIONAL MAPPING OF L.A.

FIGURE 2.14

SLC-6 SITE

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EXISTING SLC-6 FACILITIES AND PROPOSED UTILIZATION

FACILITY	STATUS				PROPOSED UTILIZATION
	UTILIZED IN PRESENT CONFIGURATION	UTILIZED WITH MODIFICATIONS	MOTHBALLED OR UTILIZED FOR OTHER PROJECTS	DEMOLITION	
Payload Processing Room (PPR)			X		Utilized in present configuration
Payload Changeout Room (PCR)			X		Backed up to PPR
Shuttle Assembly Building (SAB)	X				Utilized in present configuration
Access Tower		X			Modified to accommodate Titan IV/Centaur
Aerial Escape Tram				X	Disassembled and disposed of offsite
Launch Mount (LM)				X	Subject to demolition
Launch Exhaust Ducts (LD)		X			Modified to accommodate Titan IV/Centaur.
Mobile Service Tower (MST)		X			Interior to be modified from Shuttle to Titan IV configuration
Operations Support Building (OSB)	X				Modified to accommodate Titan IV/Centaur
Launch Control Center (LCC)		X			Utilized for office space
Security Systems, guard shack		X			Completed, modify as necessary
Hydrazine Storage and Transfer		X			Modified, prepared for use, APCD permit
Nitrogen Tetroxide (N_2O_4) Storage and Transfer		X			Modified, prepared for use, APCD permit
Cryogenic Storage Areas		X			Modified, prepared for use
Industrial Wastewater Treatment Facility		X			Modified with addition of equipment and storage capacity, cleaned, prepared for operation.
Deluge Water Transfer System	X				Inspected, cleaned, prepared for operation
Communications System		X			Modified to accommodate Titan IV/Centaur
Utilities					Inspected, cleaned, prepared for operation
Water	X				
Electricity	X				
Propane	X				
Sewage Disposal	X				
Water Tank	X				Inspected, cleaned, prepared for use
Parking	X				Utilized in present configuration

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2.2.3.4 Vina Terrace

1. The Vina Terrace site is located about one-half mile east of the Cypress Ridge site. It occupies about 150 acres on a westerly sloping terrace at an elevation between 600 and 800 feet. This site was selected based upon an anticipated reduction in impacts to cultural resources. The complex would require grading in the amount of about 10 million CY of cut. (No fill is anticipated.) It also would require construction of a new access road approximately three miles in length.

2. To accommodate the six percent road grade limitation for transportation of vehicle components, an access road would be extended about one and one-half miles from the Coast Road, primarily winding along a ridge top (see Figure 2.13). Utilities, including electricity, underground piping, and communications, would be extended along this new roadway. The area of disturbance for the road and utilities would be about 100 acres.

2.2.4 NO ACTION

1. If the Titan IV/Centaur project proposed for VAFB were not implemented, the USAF would not be able to achieve the required high energy, near polar orbit for DOD satellites in the 10,000-pound class, and there would not be backup launch capability for other Titan IV/Centaur and Titan IV/NUS vehicles. The absence of this capability would unacceptably impact national security, since current defense programs rely on the capability to launch heavy payloads into near polar orbit.

2. If the no action alternative were pursued, the Titan IV/Centaur program would not be developed at VAFB. As a consequence, potential adverse environmental impacts of program implementation would be avoided. Since there are no other space launch vehicles available to meet mission requirements, there would be no displacement effect to result in environmental impacts elsewhere.

3.0 BIOLOGICAL SETTING

1. The project area is located within a biogeographic boundary area between coastal southern and central California provinces (USAF 1976; 1977; 1983; 1987b). Being situated at the southern end of the coast range and at the western end of the transverse ranges, there are a number of plants and animals that reach their northern, southern, or western limits in the VAFB-Point Conception area of western Santa Barbara County. For this reason, the project area is situated in a region of ecological and biogeographical interest.

2. Detailed reviews of biological resources in the VAFB region can be found in a number of studies (Coulombe and Cooper 1976; Coulombe and Mahrdt 1976) and in environmental documents prepared for projects on VAFB (USAF 1976; 1977; 1978; 1987a, 1988a; Engineering-Science 1987; Versar 1987; Howald et al. 1985). In particular, the Environmental Assessment for the SLC-4 area on South VAFB (Versar 1987; Engineering-Science 1987) contains baseline data that are directly applicable to habitats in the project area.

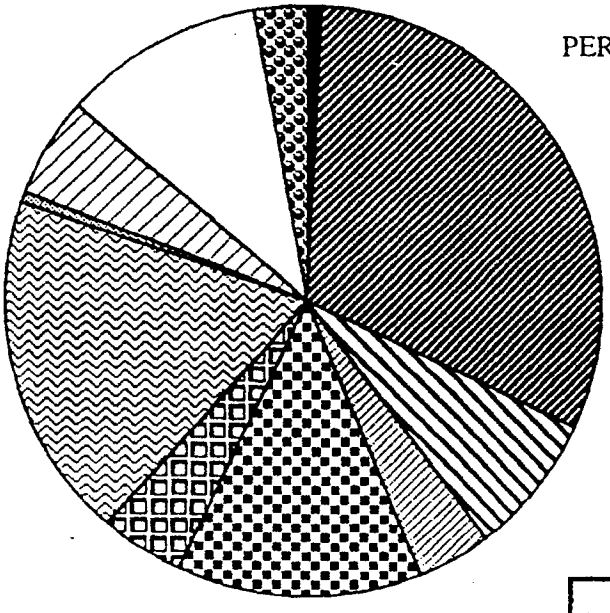
3.1 TERRESTRIAL AND AQUATIC BIOTA

3.1.1 REGIONAL BIOTA

1. A wide variety of vegetation communities occur on VAFB. Following the California Department of Fish and Game (CDFG) non-game heritage program classification of the natural communities of California (Holland 1986), they 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, including coastal salt marsh, freshwater marsh, riparian forests, scrub, and vernal pools. The areal extent of each plant community on VAFB is shown in Figure 3.1 (VAFB Vegetation Communities). Many of these are of limited distribution and considered "high priority" by the Department of Fish and Game California Natural Diversity Data Base (CNDDB). These varied plant communities provide terrestrial wildlife habitats that are regionally diverse, although limited within the South VAFB project area.

2. Much of the vegetation on VAFB has been modified or otherwise disturbed by humans over the past century. Roads, USAF facilities, housing, and agricultural lands, which make up a portion of the disturbed area, occupy approximately eight percent of the base (Provancha 1988). Ruderal vegetation, which includes mainly introduced species, covers many extremely

LEGEND	COMMUNITY NAME	APPROXIMATE ACRES	PERCENT OF TOTAL
	Southern foredunes	760	0.8
	Coastal scrub*	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



PERCENT DISTRIBUTION OF VEGETATION COMMUNITIES AT VAFB

*Coastal scrub includes southern coastal bluff scrub, central coastal scrub, and grassland - coastal scrub.

Reference: Provancha 1988.

FIGURE 3.1

VAFB VEGETATION COMMUNITIES

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or repeatedly disturbed areas. In some cases, these plants are replacing rare or other native species and habitats. One introduced community, annual grassland, is commercially important for cattle grazing. Much of the remaining natural vegetation has been disrupted by firebreaks and communication and utility lines. Grazing and fires are causes of disturbance to many communities on the base. Purposely or accidentally introduced exotic species such as ice plant (*Carpobrotus* sp.), Veldt grass (*Ehrharta calycina*), and pampas grass (*Cortaderia jubata*) are now dominants in some areas of VAFB (Schmalzer and Hinkle 1987).

3.1.2 LOCAL BIOTA

1. For purposes of this analysis, the project study area consists of the southern portion of South VAFB, within an area that incorporates the Cypress Ridge, SLC-6, Boathouse Flats, and Vina Terrace sites, associated utility corridors, and proposed borrow sites located near Manzanita and Mesa Roads. Boundaries of the study area (excluding the borrow sites) are shown in Figure 3.2 (Environmental Study Area and Vegetation Communities).

2. The following descriptions of the vegetation communities found on the Cypress Ridge, SLC-6, Boathouse Flats, and Vina Terrace sites are based on Holland (1986) and a field inventory in support of this analysis, including surveys for special interest plants, conducted in March through June 1988 and March 1989. The plant communities occurring within the project site area are shown in Figure 3.3 (Vegetation Communities Project Site Area). No federal- or state-listed endangered or threatened plant species were found in the study area, and none is expected to occur. An inventory of plant species observed is included in Appendix A (Plant Species).

3. Based on historical air photos, the vegetation on the three undeveloped sites has been subjected to cattle grazing for at least the past 60 years. It also has been subjected to occasional fires, both intentional, for range improvement in accordance with the Wildland Fuel Management Plan (USAF 1980), and accidental, usually as a result of sparks from passing trains (Hickson 1987).

4. Within the project study area, wildlife is not as diverse as elsewhere on VAFB, due to: (1) the absence of habitats that are known to support higher species diversities, such as coastal wetlands, riparian woodlands, Bishop pine forests, live oak woodlands, tanbark oak forests, and (2) the occurrence of habitats that are widespread on VAFB and known to contain relatively limited species diversity (e.g., grasslands and three phases of coastal sage scrub).

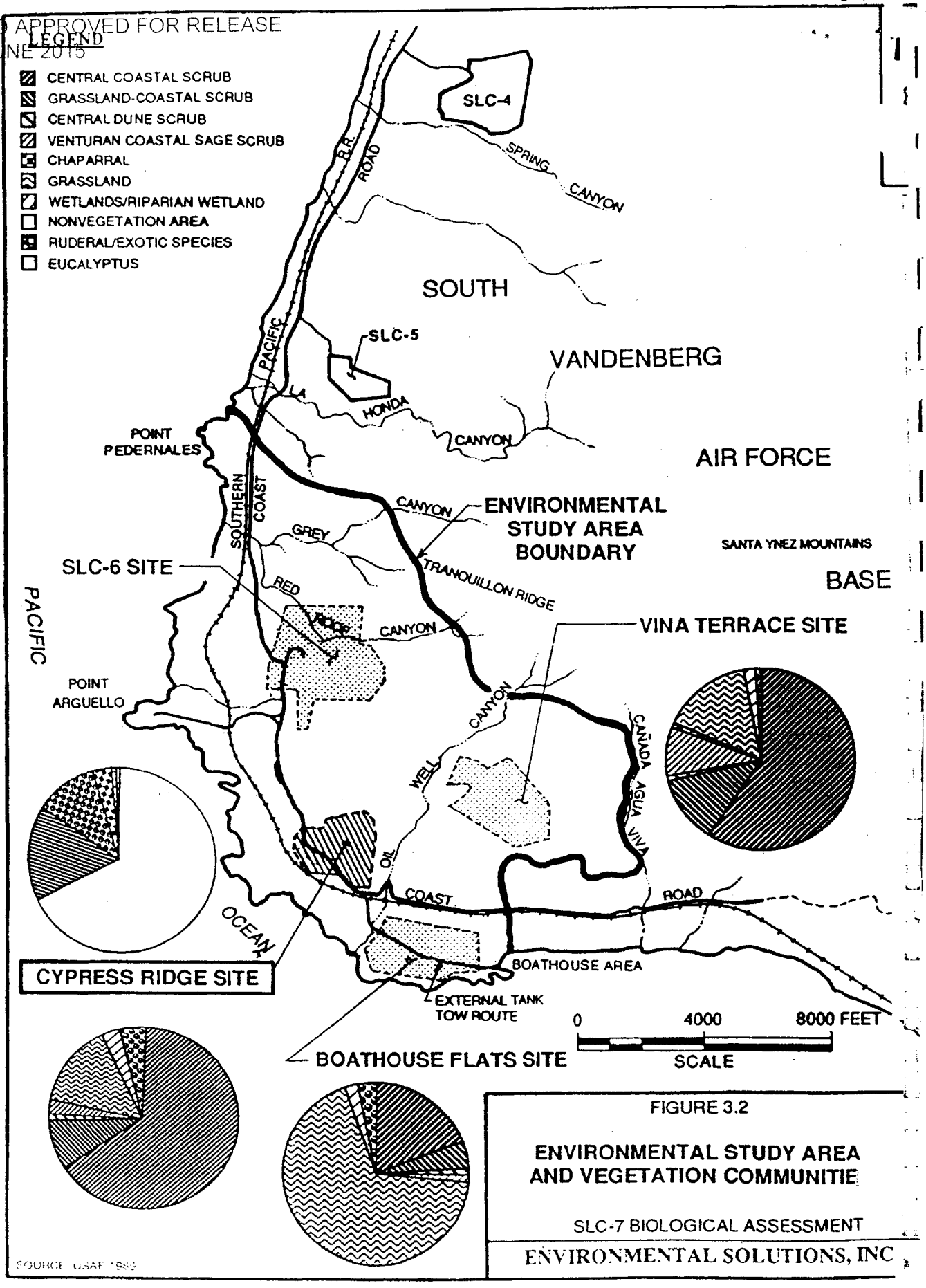

FIGURE 3.2

ENVIRONMENTAL STUDY AREA AND VEGETATION COMMUNITIE

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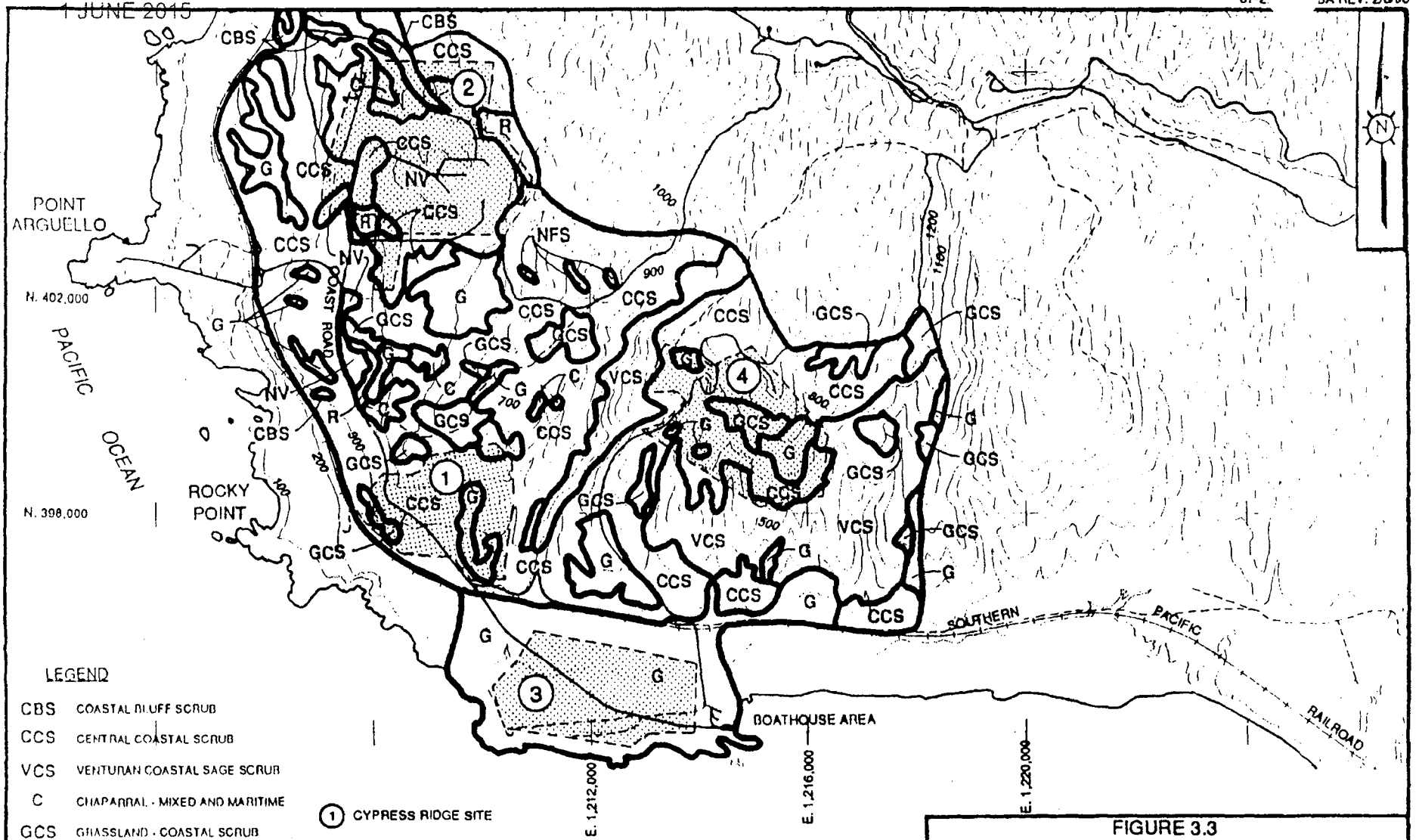
SOURCE USAF 1989



LEGEND

CBS	COASTAL BLUFF SCRUB
CCS	CENTRAL COASTAL SCRUB
VCS	VENTURAN COASTAL SAGE SCRUB
C	CHAPARRAL - MIXED AND MARITIME
GCS	GRASSLAND - COASTAL SCRUB
G	GRASSLAND
R	RUDERAL
NV	NON-VEGETATION
NFS	NORTH FACING SLOPE - DOMINATED BY HUCKLEBERRY AND SALAL

(1) CYPRESS RIDGE SITE
(2) SLC-6 SITE
(3) BOATHOUSE FLATS SITE
(4) VINA TERRACE SITE

SOURCE: USAF 1987b.

FIGURE 3.3

VEGETATION COMMUNITIES PROJECT SITE AREA

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3.1.2.1 Cypress Ridge

3.1.2.1.1 Project Site

1. The Cypress Ridge site covers approximately 120 acres and includes four vegetation communities, 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 herein as grassland-coastal scrub. Ruderal vegetation occurs along Coast Road and around the Monterey cypress trees (*Cupressus macrocarpa*) located west of Coast Road. Small amounts of riparian wetland occur on the southwestern area of the site. Table 3.1 (Approximate Distribution of Vegetation Located at Alternative Sites) shows the plant communities and the area each community occupies, including proposed utility corridors. Figure 3.2 shows the proportion of each community within the site area.

2. In general, the wildlife community present at the Cypress Ridge site is composed of common, wide-ranging species that frequent a variety of habitat types found throughout the study region and project area. These habitats support a variety of ubiquitous species such as western fence lizard (*Sceloporus occidentalis*), gopher snake (*Pituophis melanoleucus*), western rattlesnake (*Crotalus viridis*), Bewick's wren (*Thryomanes bewickii*), bushtit (*Psaltriparus minimus*), white-crowned sparrow (*Zonotrichia leucophrys*), song sparrow (*Melospiza melodia*), Botta's pocket gopher (*Thomomys bottae*), and deer mouse (*Peromyscus maniculatus*). Wide-ranging birds of prey like the turkey vulture (*Cathartes aura*), red-tailed hawk (*Buteo jamaicensis*), and American kestrel (*Falco sparverius*), along with large, wide-ranging carnivores, such as coyote (*Canis latrans*), raccoon (*Procyon lotor*), striped skunk (*Mephitis mephitis*), and bobcat (*Felis rufus*), are known to forage in the vegetation types found at the Cypress Ridge site.

Central Coastal Scrub

1. The most extensive vegetation community within the Cypress Ridge site is central coastal scrub, covering approximately 85 acres. This community is characterized by a dense cover of shrubs approximately three to five feet in height. Dominant shrub species include mock heather (*Haplopappus ericoides*), coastal sagebrush (*Artemisia californica*), black sage (*Salvia mellifera*), bush monkey flower (*Mimulus aurantiacus*), and coyote brush (*Baccharis pilularis* ssp. *consanguinea*). Small openings and disturbed areas are inhabited by such sub-shrubs as golden yarrow (*Eriophyllum confertiflorum*) and cudweed aster (*Corethrogyne filaginifolia*) and annual and perennial herbs such as bedstraw (*Galium* spp.), *Chorizanthe* spp., and everlastings (*Gnaphalium* spp.).

TABLE 3.1

APPROXIMATE DISTRIBUTION OF VEGETATION LOCATED AT ALTERNATIVE SITES

PLANT COMMUNITY	PRIMARY SITE (ACRES)	UTILITY CORRIDORS (ACRES)	TOTAL (ACRES)	PERCENT PLANT COMMUNITY DISTURBED
CYPRESS RIDGE				
Venturan coastal sage scrub	4.5	0.0	4.5	2.4
Grassland - coastal scrub	8.5	8.0	16.5	9.0
Grassland - nonnative	18.5	9.0	27.5	14.9
Ruderal	4.5	4.0	8.5	4.7
Central coastal scrub	83.5	37.0	120.5	65.0
Riparian/wetland	0.5	5.0	5.5	3.0
Central dune scrub	0.0	2.0	2.0	1.0
Chaparral	0.0	0.1	0.1	0.0
	120.0	65.1	185.1	100.0
SLC-6				
Not vegetation	140.0	Corridors in place.	144.0	61.0
Ruderal	44.0	No additional	44.0	12.0
Central coastal scrub	82.0	disturbance.	82.0	23.0
Chaparral	9.5		9.5	3.0
Maritime chaparral	1.0		1.0	1.0
Riparian/wetland	3.5		3.5	
	280.0		280.0	100.00
BOATHOUSE FLATS				
Grassland - nonnative	130.0	19.0	149.0	68.0
Grassland - coastal scrub	0.0	10.0	10.0	4.6
Ruderal	0.0	8.0	8.0	3.6
Riparian/wetland	0.0	5.0	5.0	2.2
Central coastal scrub	0.0	42.0	42.0	19.1
Central dune scrub	0.0	2.0	2.0	1.0
Venturan coastal sage scrub	0.0	3.0	3.0	1.4
Chaparral	0.0	0.1	0.1	0.1
	130.0	89.1	219.1	100.0
VINA TERRACE				
Central coastal scrub	90.0	60.0	150.0	59.2
Grassland - nonnative	25.0	14.0	39.0	15.4
Grassland - coastal scrub	20.0	11.0	31.0	12.2
Venturan coastal sage scrub	15.0	7.0	22.0	8.7
Ruderal	0.0	2.0	2.0	0.8
Chaparral	0.0	2.0	2.0	0.8
Riparian/wetland	0.0	5.0	5.0	2.0
Central dune scrub	0.0	2.0	2.0	0.8
Not vegetation	0.0	0.2	0.2	0.1
	150.0	103.2	253.2	100.0

2/1/90 (87-271)

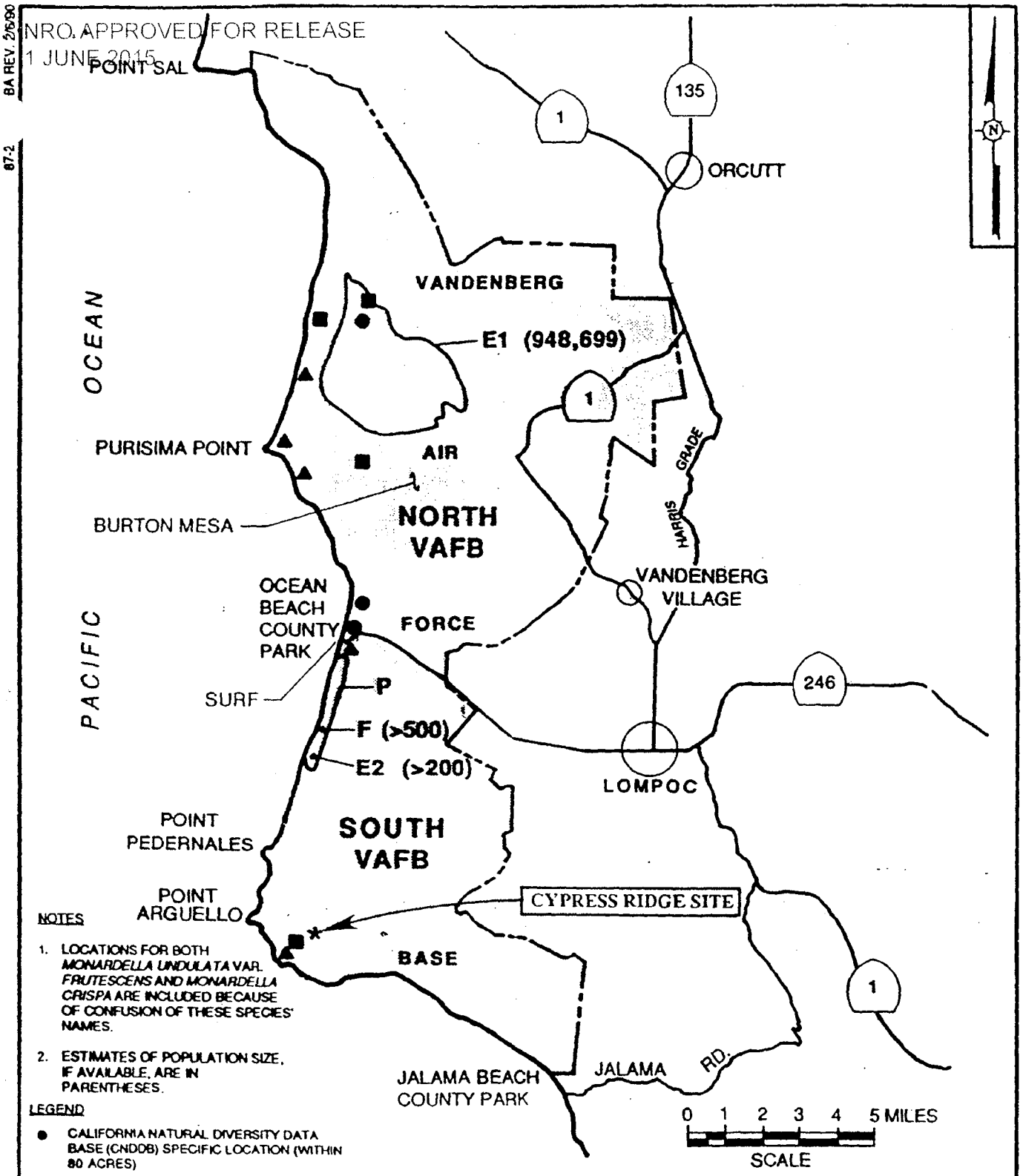
2. Special interest species (discussed in detail in Chapter 4.0) that occur in the central coastal scrub community at the Cypress Ridge site include large-leaved wallflower (*Erysimum suffrutescens* var. *grandifolium*), primarily on the upper slopes east of Coast Road, western dichondra (*Dichondra occidentalis*), common on upper slopes of site, and a few scattered individuals of Santa Barbara ceanothus (*Ceanothus impressus* var. *impressus*), also on the upper slopes.

3. Some central coastal scrub on the proposed site is transitional to central dune scrub, particularly where the sandy soil has been disturbed. These areas are devoid of introduced ice plants and veldt grass, which are common elsewhere on VAFB in similar situations.

4. In this transitional community, a population of over 650 mature individuals (greater than six inches tall) of the federal Category 2 candidate species curly-leaved monardella (*Monardella undulata* var. *frutescens*) occurs along two old roads just east of Coast Road, and small populations of between 10 and 60 plants are scattered in openings in central coastal scrub throughout the site, as shown in Figure 3.4 (Locations of Curly-leaved Monardella and Crisp Monardella on VAFB) and Figure 3.5 (Environmental Study Region, Colonies of *Monardella undulata* var. *frutescens*). In total, approximately 800 to 1,000 mature plants, and many more seedlings, occur on the Cypress Ridge launch complex site. The populations on and near this site represent the southern limit of this species (Smith 1976; Howald et al. 1985). Some plants appear to be what has been identified by an expert in the genus (Jokerst 1988) as a hybrid between curly-leaved monardella and another federal Category 2 candidate, dune mint (*M. crispa*).

5. Central coastal scrub is adapted to periodic burning and many of the shrub species regenerate by crown-sprouting after fires. This was evident during the field inventory of May and June 1988 in the portion of the site to the east of Coast Road. Shrubs such as mock heather and black sage were vigorously resprouting in the area that had been burned, but not crushed, and the open areas were dominated by annual and perennial herbs. These included blue dicks (*Dichelostemma pulchellum*), fairy mist (*Pterostegia drymarioides*), *Camissonia micrantha*, and *Cryptantha leiocarpa*.

6. Two special interest plants were also noted in the burned area: (1) western dichondra, commonly scattered on the upper slopes, and (2) fiddleneck (*Amsinckia spectabilis* var. *microcarpa*), endemic to western Santa Barbara and San Luis Obispo Counties, which was common to abundant on the lower slopes.



NOTES

1. LOCATIONS FOR BOTH *MONARDELLA UNDULATA* VAR. *FRUTESCENS* AND *MONARDELLA CRISPA* ARE INCLUDED BECAUSE OF CONFUSION OF THESE SPECIES' NAMES.
2. ESTIMATES OF POPULATION SIZE, IF AVAILABLE, ARE IN PARENTHESES.

LEGEND

- ● CALIFORNIA NATURAL DIVERSITY DATA BASE (CNDDB) SPECIFIC LOCATION (WITHIN 80 ACRES)
- ▲ CNDDB NONSPECIFIC LOCATION (WITHIN 1 MILE)
- ■ CNDDB GENERAL LOCATION (WITHIN 5 MILES)
- E1 HDR 1980
- E2 USAF 1987a
- F FIELD OBSERVATIONS DURING THIS STUDY
- P R. NICHOLS (PERS. COMM.), GENERAL LOCATION

FIGURE 3.4

LOCATIONS OF CURLY-LEAVED MONARDELLA AND CRISP MONARDELLA ON VAFB

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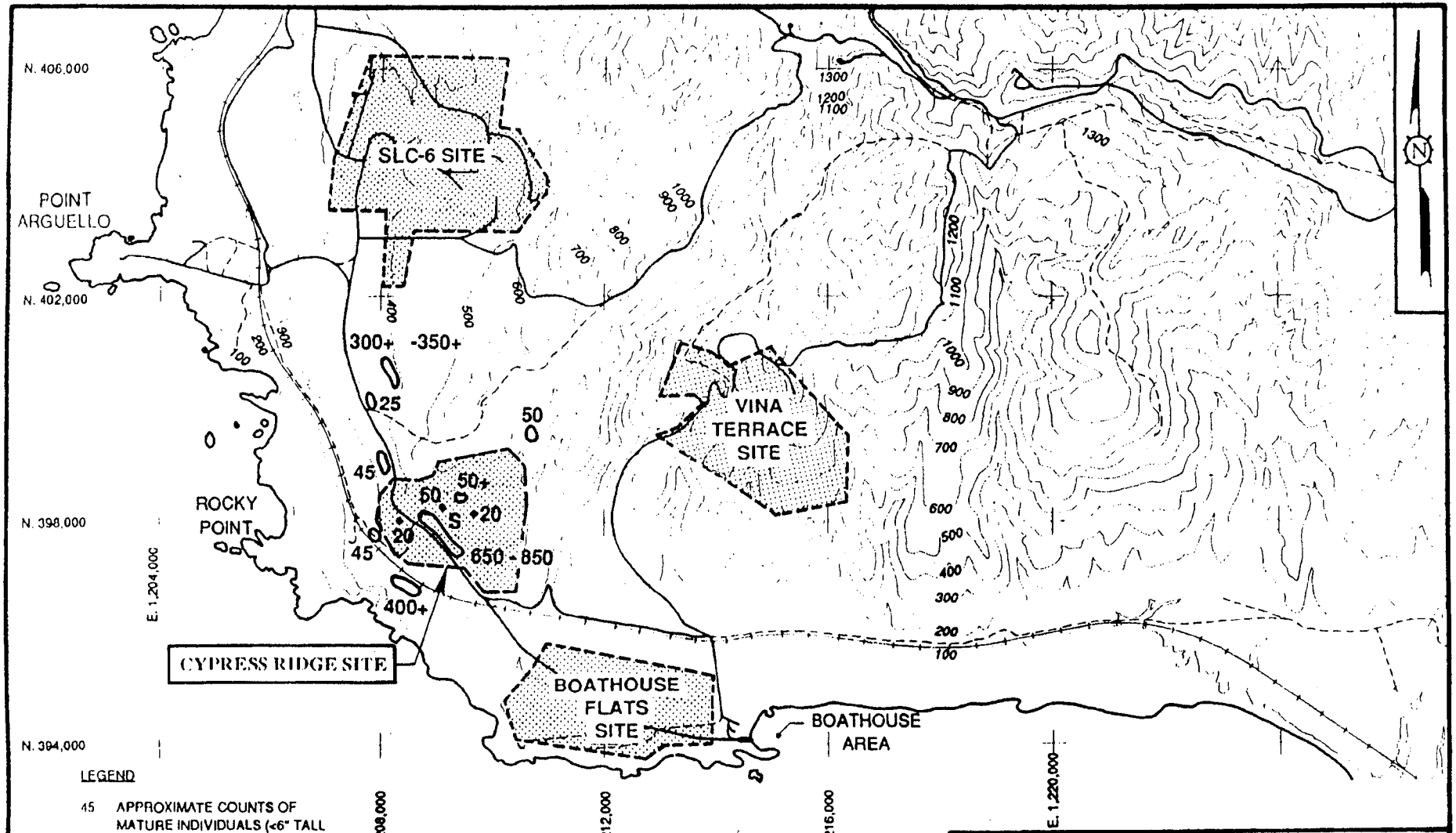

FIGURE 3.5

ENVIRONMENTAL STUDY REGION COLONIES OF MONARDELLA UNDULATA VAR. FRUTESCENS

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7. As many as 12 species of reptiles have been found to inhabit the three stages of coastal scrub habitat on VAFB (Coulombe and Cooper 1976; Coulombe and Mahrdt 1976). Western fence lizard, California legless lizard, (*Anniella pulchra),* western spotted skunk (*Spilogale gracilis*), striped racer (*Masticophis lateralis*), and western rattlesnake are some of the more common species of coastal scrub habitats. Amphibians are uncommon in this dry environment, generally occurring only during the winter months. Ensatina (*Ensatina eschscholtzii*), blackbelly slender salamander (*Batrachoseps nigriventris*), and Pacific tree frog (*Pseudacris [=Hyla] regilla*) are the most likely species to occur. No threatened, endangered, federal Category 2 listed, or regionally rare or declining amphibians or reptiles are expected to inhabit coastal scrub in the project area.

8. California quail (*Callipepla californica*), Anna's (*Calypte anna*) and Costa's (*C. costae*) hummingbirds, bushtit, Bewick's wren, California thrasher (*Toxostoma redivivum*), rufous-sided (*Pipilo erythrophthalmus*) and brown (*P. fuscus*) towhees, song sparrow, white-crowned sparrow, and house finch (*Carpodacus mexicanus*) are characteristic breeding species of coastal scrub habitats in the project area. Locally common nesting species are the greater roadrunner, loggerhead shrike, and rufous-crowned sparrow (*Aimophila ruficeps*). Other species of birds known or expected to occur in coastal scrub habitats within the project area are listed in Appendix B.4. There are no threatened or endangered species of birds known or expected to frequent coastal scrub habitats in the project area. Ferruginous hawk (*Buteo regalis*), a federal Category 2 candidate species, can be expected to forage over this habitat during the fall and winter. Regionally rare and declining bird species that are expected to forage in coastal scrub habitats at the Cypress Ridge site include black-shouldered kite (*Elanus caeruleus*), northern harrier (*Circus cyaneus*), Cooper's hawk (*Accipiter cooperii*), Merlin (*Falco columbarius*), prairie falcon (*Falco mexicanus),* burrowing owl (*Athene cunicularia*), and short-eared owl (*Asio flammeus*).

9. Coastal scrub is an important habitat for mammals, with 14 species of rodents and nine mammalian predators known or expected to occur in this habitat (see Appendix B.3). The dense cover of coastal scrub vegetation makes it ideal habitat for small mammals, which in turn are prey for a number of resident carnivores and birds of prey. Some of the more common small mammals include Botta's pocket gopher, California pocket mouse (*Perognathus californicus*), Heermann's (*Dipodomys heermanni arenae)* and agile (*Dipodomys agilis fuscus*) kangaroo rats, California mouse (*Peromyscus californicus*), deer mouse, pinyon mouse (*Peromyscus truei*), and desert (*Neotoma lepida*) and dusky-footed

(*N. fuscipes*) woodrats. Carnivores of this habitat include coyote, raccoon, long-tailed weasel (*Mustela frenata*), western spotted and striped skunks, and bobcat. Dense stands of brush in this habitat also provide shelter and browse for mule deer (*Odocoileus hemionus*).

10. There are no threatened or endangered species of mammals expected to occur in the project area. Badger (*Taxidea taxus*) is the only regionally rare or declining species of mammal known or expected to occur in this community type at the Cypress Ridge site. Active sign of badger was observed on the Cypress Ridge site during field inventories conducted in the spring of 1988.

Venturan Coastal Sage Scrub

1. Venturan coastal sage scrub occurs in the northeast portion of the Cypress Ridge site, covering approximately four acres. It is characterized by a dense cover of shrubs two to five feet in height, many of which crown-sprout after fire, and is dominated by purple sage (*Salvia leucophylla*), coastal sagebrush, and bush sunflower (*Encelia californica*).

2. The community at this site is typical of the Venturan coastal sage scrub on the rest of VAFB, where it occupies approximately 3,900 acres (Provancha 1988), predominantly on the south-facing slopes to the east of the Cypress Ridge site.

3. The wildlife species that are common to Venturan coastal sage scrub are the same as those previously addressed above in the portion of Section 3.1.2.1 that addresses central coastal scrub.

Nonnative Grassland

1. Nonnative grassland occupies approximately 18 acres within the Cypress Ridge site. The dominant species are introduced annual grasses such as wild oaks (*Avena* spp.), fescues (*Vulpia* spp.), and bromes (*Bromus* spp.). Annual herbs found in grassland include tarweeds (*Hemizonia* spp.), thistles (*Cirsium* spp.), and the showy wildflowers tidy tips (*Layia platyglossa*), California poppy (*Eschscholzia californica*), and sky lupine (*Lupinus nanus*). Native perennial bunchgrasses are infrequent. The grassland here is typical of grassland on the rest of VAFB, where it occupies approximately 19,000 acres. One special interest plant, fiddleneck, is common to abundant in the grassland at the Cypress Ridge site.

2. Although grasslands are low in species diversity, they often support large numbers of individuals in a few vertebrate populations. The Pacific treefrog and blackbelly slender salamander are the only amphibians expected to occur commonly in grasslands. Western skink (*Eumeces skiltonianus*), western fence lizard, southern alligator lizard (*Elgaria multicarinatus*), common kingsnake (*Lampropeltis getulus*), and gopher snake are the most common reptile species expected to occur in grasslands in the Cypress Ridge site. No sensitive amphibians or reptiles are expected to occur.

3. Western meadowlark (*Sturnella neglecta*), Savannah sparrow (*Passerculus sandwichensis*), and European starling (*Sturnus vulgaris*) can be found in large flocks in grasslands during the winter months. Several species of raptors, including the black-shouldered kite, northern harrier, red-tailed hawk, American kestrel, common barn-owl (*Tyto alba*), and burrowing owl rely on open expanses of grasslands for hunting. Short grass areas in northern Santa Barbara County are favored by large flocks of horned larks (*Eremophila alpestris*), water pipits (*Anthus spinoletta*), and long-billed curlews (*Numenius americanus*). Tall grass hillsides at Point Sal and, locally, south of Lompoc to Point Conception, are the last sites in Santa Barbara County known to support populations of grasshopper sparrows (*Ammodramus savannarum*), a regionally rare and declining species (Lehman 1982). Grasslands in the vicinity of the Cypress Ridge site provide essential foraging habitat for two federal Category 2 candidate species of birds (ferruginous hawk and long-billed curlew) and nine regionally rare and declining birds (black-shouldered kite, northern harrier, Cooper's hawk, merlin, prairie falcon, burrowing owl, short-eared owl, tree swallow [*Tachycineta bicolor*], and grasshopper sparrow). Only the northern harrier has been observed foraging in grasslands at the Cypress Ridge site.

4. Grasslands in the project area are favored habitat for broad-footed mole (*Scapanus latimanus*), California ground squirrel (*Spermophilus beecheyi*), Botta's pocket gopher, western harvest mouse (*Reithrodontomys megalotis*), and California vole (*Microtus californicus*). Mammalian predators, including the coyote, long-tailed weasel, and badger, depend on grasslands for foraging and denning sites. Places where grasslands are bordered by woodland or dense brush are excellent foraging areas for mule deer. The badger is the only regionally rare mammal known to frequent grasslands in the project study area. Active badger sign was found on the Cypress Ridge site during field inventories conducted in the spring of 1988.

Grassland - Coastal Scrub

1. An area of grassland - coastal scrub of approximately eight acres on the western edge of the Cypress Ridge site is characterized by widely scattered coastal sagebrush and mock heather. The native bunchgrass, purple needlegrass (*Stipa pulchra*), dominates much of the open areas within the scrub there and on the northern edge of the site east of Coast Road. The presence of this native grass is notable. The eastern edge of the site is bounded by a seasonally flowing stream. The vegetation in the stream bed is dominated by coyote brush and coastal sagebrush, with occasional elderberry (*Sambucus mexicanus*).

2. The widespread destruction of native grassland habitat has led the Nature Conservancy to consider it threatened throughout its range (Jensen 1983), and the County of Santa Barbara (1979) to consider it "an ecological community of great interest."

Ruderal Vegetation

1. Ruderal vegetation (characterized by disturbance-tolerant, predominantly exotic species) covers roughly four acres of the Cypress Ridge site, occurring along the portion of Coast Road within the site, and includes milk thistle (*Silybum marianum*), bull thistle (*Cirsium vulgare*), and annual grasses. The road cuts are dominated by introduced annual grasses, clovers (*Trifolium incarnatum*, T. *hirtum*), Australian saltbush (*Atriplex semibaccata*) and native lupine (*Lupinus arboreus*) used in a revegetation program in 1984 (Parsons 1984), and mustards (*Brassica* spp.).

2. These ruderal areas tend to support a subset of ubiquitous wildlife which are characteristic of the surrounding coastal scrub, grassland, and chaparral habitats. However, by the nature of the past and ongoing disturbances associated with these modified habitats, the vertebrate fauna tends to be depauperate. Some of the more common wildlife species of ruderal habitats include western fence lizard, gopher snake, western rattlesnake, American kestrel, red-tailed hawk, rock dove (*Columba livia*), American crow (*Corvus brachyrhynchos*), Bewick's wren, California thrasher, European starling, white-crowned sparrow, song sparrow, Brewer's blackbird (*Euphagus cyanocephalus*), house finch, Botta's pocket gopher, California ground squirrel, deer mouse, and California vole. Wide-ranging carnivores such as coyote, bobcat, striped skunk, Virginia opossum (*Didelphis virginiana*), and raccoon occasionally forage in these disturbed habitats. However, their densities tend to be low due to the low abundance and diversity of available vertebrate prey, and to the continuing nature of disturbance.

3. There are no threatened or endangered species of wildlife expected to frequent these disturbed areas. The badger, northern harrier, Cooper's hawk, and burrowing owl are the only regionally rare or declining wildlife species which could forage in disturbed/modified habitats within the project area.

Planted Windbreaks

1. The planted windbreaks of Monterey cypress and eucalyptus trees at the Cypress Ridge site and at the external tank landing facility in the project area are habitat for migratory landbirds. These trees act like plant islands which tend to concentrate migrant landbirds such as flycatchers, kinglets, vireos, warblers, sparrows, and orioles. This effect, along with the Point Arguello area projecting substantially into the Pacific Ocean, make these planted trees good spots to observe migrant landbirds, as the trees provide resting and feeding habitat for birds which have been flying long distances over the ocean.

2. Common raptors like the red-tailed hawk, American kestrel, common barn-owl, and great howned owl (*Bubo virginianus*) are known to utilize these trees for roosting and nesting. For most of the year, only a few common species of birds such as rock dove, northern flicker (*Colaptes aurates*), Anna's hummingbird, ruby-crowned kinglet (*Regulus calendula*) (winter only), European starling, yellow-rumped warbler (*Dendroica coronata*) (winter only), dark-eyed junco (*Junco hyemalis*), Brewer's and red-winged blackbirds (*Agelaius phoeniceus*), house finch and American goldfinch (*Carduelis tristis*) tend to frequent these planted trees.

3. These Monterey cypress and eucalyptus trees provide sites for occasional roosting of regionally rare or declining raptors such as ferruginous hawk, northern harrier, Cooper's hawk, or prairie falcon, and overwintering sites for the monarch butterfly (*Danaus plexippus*). No other sensitive wildlife species and no threatened or endangered species are expected to utilize these planted windbreaks.

3.1.2.1.2 Utility Corridors

1. The proposed utility corridors encompass approximately 65 acres and include seven vegetation communities, primarily central coastal scrub. The electrical utility corridor includes 36 acres of central coastal scrub and contains a population of about 45 mature curly-leaved monardella. The corridor also includes two small wetlands (less than one-quarter acre each), about four acres of riparian scrub/woodland, and small areas of central dune scrub and chaparral. The underground water supply line corridor consists of approximately seven acres and follows an existing, partially paved road. The corridor passes through central coastal scrub and

grassland. The corridor for underground communication cables, gaseous nitrogen line, and an easement for a future natural gas line follow existing roads through primarily ruderal vegetation.

Central Coastal Scrub

1. The central coastal scrub crossed by the utility corridors is characteristic of the entire project area, as discussed for Cypress Ridge in Section 3.1.2.1. The wildlife also does not differ from that discussed previously.

Riparian Wetlands

1. The two small wetlands occur west of the external tank building (building 330). In this location they are dominated by sedges and rushes (*Carex praegracilis, Juncus balticus*, and *Juncus effusus* var. *brunneus*).

2. Wildlife within these areas is addressed below, under riparian scrub woodland.

Riparian Scrub Woodland

1. The utility corridors also includes about four acres of riparian scrub/woodland at the Red Roof Canyon and Grey Canyon crossings. This vegetation type is dominated in these locations by arroyo willow (*Salix lasiolepis*) with mugwort (*Artemisia douglasiana*) and poison oak (*Toxicodendron diversilobum*).

2. Riparian woodland and freshwater habitats support a diverse assemblage of amphibians and reptiles. The California red-legged frog (*Rana aurora draytoni*) and western pond turtle (*Clemmys marmorata*) are the only regionally rare or declining amphibians or reptiles known to frequent freshwater wetland habitats on VAFB. Neither of these species, and no threatened or endangered species of amphibian or reptile, is expected to occur within the utility corridor area because there is not a sufficient year-round flow to sustain deeper pools necessary for their survival during the dry summer months.

3. Riparian woodlands support a diverse assemblage of resident and migrant landbirds. As a result of loss and alteration of habitat, there are a number of riparian dependent birds which have shown significant declines in their populations over the past century throughout Southern California. Species like the yellow-billed cuckoo (*Coccyzus americanus*), long-eared owl (*Asio otus*), willow flycatcher (*Empidonax traillii*), and Wilson's warbler (*Wilsonia pusilla*) have been completely extirpated as breeders south of Point Conception. Today, only three of

these species occur in a few isolated locales in northwestern Santa Barbara County. Cooper's hawk, Swainson's thrush (*Catharus ustulatus*), and yellow-breasted chat (*Icteria virens*) are now rare throughout much of Santa Barbara County, while warbling vireos (*Vireo gilvus*) and yellow warblers (*Dendroica petechia*) are, at present, local and uncommon as nesters in the project area.

4. Twenty-nine species of mammals are expected to occur in riparian woodlands in northern Santa Barbara County (Howald et al. 1985). Coulombe and Cooper (1976) recorded a total of seven species of small mammals in riparian woodlands on VAFB. Some of the more common species known to occur include Towbridge (*Sorex trowbridgii*) and ornate (*Sorex ornatus*) shrews, California mouse, and dusky-footed woodrat. Riparian woodlands also provide excellent foraging habitat for a number of large mammals, such as brush rabbit (*Sylvilagis bachmani*), bobcat, mule deer, and introduced wild pigs (*Sus scrofa*). Western gray squirrel (*Sciurus griseus*) is the only regionally rare or declining mammal expected to occur in riparian woodlands on South VAFB. This species is not expected to occur in the willow woodlands within the project area due to the limited extent of this habitat. There are no threatened or endangered species of mammals expected to occur in these habitats in the project study area.

Central Dune Scrub

1. Central dune scrub occurs on stabilized back dunes and comprises about two acres of the utility line corridors. It is characterized by a number of low shrubs, including mock heather, coastal bush lupine, dune lupine and coyote brush. California wax myrtle can occur in this habitat in moist places with willows. It is uncommon in the project area having only been observed in small patches within areas vegetated with coastal scrub and grassland.

2. Central dune scrub is depauperate of wildlife species due to its arid and saline aspects and to the sparse nature of its protective vegetative cover. In general, this habitat supports a subset of wildlife which is characteristic of the coastal scrub habitats. Because of its arid and saline aspects, amphibians are uncommon. Common wildlife species include western fence lizard, southern alligator lizard, California legless lizard, gopher snake, American kestrel, Say's phoebe (*Sayornis saya*) (winter only), Bewick's wren, California thrasher, yellow-rumped warbler (winter only), white-crowned sparrow, song sparrow, Botta's pocket gopher, deer mouse, California ground squirrel, and desert cottontail (*Sylvilagus audubonii*). Breeding species in this habitat are few, and include Bewick's wren, California thrasher, and white-crowned sparrow. The most abundant mammal species are Botta's pocket gophers and deer

mice. Mule deer, and carnivores like coyote, raccoon, bobcat, and striped skunk, are expected to occasionally forage in coastal dune scrub but are not expected to be permanent residents.

3. There are no threatened or endangered species of wildlife expected to frequent central dune scrub habitats in the project area. Ferruginous hawk, a federal Category 2 candidate species, can be expected to occasionally forage over this habitat during the fall and winter. Regionally rare and declining bird species which are expected to forage in the central dunes scrub habitats include black-shouldered kite, northern harrier, Cooper's hawk, merlin, prairie falcon, burrowing owl and short-eared owl. Badgers are the only regionally rare or declining species of mammal expected to occur.

Chaparral

1. Small areas of chaparral are crossed by the proposed electrical utility corridor. As habitat, chaparral supports species adapted to an arid environment. Therefore, amphibian diversity is relatively low, with blackbelly slender salamander, ensatina, and Pacific tree frogs known to occur during the winter. In contrast to the amphibians, there are a number of reptiles that are known to inhabit the dense stands of brush typical of chaparral communities. The western fence lizard, side-blotched lizard (*Uta stansburiana*), striped racer, western terrestrial garter snake (*Nerodia elegans*), and western rattlesnake are among the commonly occurring chaparral associates. No regionally rare or declining amphibians or reptiles occur in chaparral habitat of the project study area.

3. Many of the bird species characteristic of chaparral plant communities also tend to be similar to those found in coastal scrub, with which it is often contiguous or even intergraded. Birds characteristic of chaparral habitats in the project area include California quail, greater roadrunner, Anna's and Costa's hummingbirds, Bewick's wren, scrub jay (*Aphelocoma coerulescens*), wrentit (*Chamae fasciata*), California thrasher, white-crowned sparrow, golden-crowned Sparrow (*Zonotrichia atricopilla*), rufous-sided and brown towhees, and lesser goldfinch (*Carduelis psaltria*). Regionally rare and declining bird species expected to forage over chaparral in the project area include northern harrier, Cooper's hawk, prairie falcon, and tree swallow.

4. Chaparral supports a reasonably diverse assemblage of mammals. Rodents are well represented in regional plant communities, with 13 species recorded in Santa Barbara County chaparral (Howald et al. 1985). Some of the more common rodents include Botta's pocket

gopher, California pocket mouse, agile kangaroo rat, California mouse, piñon mouse, and desert and dusky-footed woodrats. Brush rabbits are common in areas of dense scrub, and black-tailed jackrabbits (*Lepus californicus*), although much less common, may frequent openings within chaparral. Because of the wide diversity and abundance of available rodent prey, and the dense protective cover provided by chaparral, a number of large, wide-ranging carnivores frequent this habitat. The most common species include coyote, gray fox (*Urocyon cinereoargenteus*), striped skunk, and bobcat. Mule deer utilize chaparral for cover and forage.

5. Mountain lion (*Felis concolor*), a fully protected species in the state of California, is the only regionally rare or declining species that is expected to occur in chaparral habitats in the project study area.

3.1.2.2 SLC-6

1. The SLC-6 site covers approximately 280 acres and includes central coastal scrub, ruderal, vegetation, chaparral, riparian/wetlands, eucalyptus, and nonvegetation areas. Because SLC-6 is developed, a major portion of the area does not contain vegetation. The nonvegetation area, which accounts for about 50 percent of the total, includes the launch complex located inside the security fence, wastewater treatment plant and evaporation ponds, sewage treatment plant, evaporation/percolation ponds, roads, and other facilities. No federal- or state-listed threatened or endangered plants or candidate species are known to occur at this site.

2. Ruderal vegetation, characterized by disturbance-tolerant, predominantly exotic species, covers about 44 acres of SLC-6. It occurs in the vicinity of the security fence, roads, and evaporation ponds and consists primarily of introduced grasses. Other vegetation on the site includes about 82 acres of central coastal scrub, 9.5 acres of chaparral, 3.5 acres of riparian/wetlands and eucalyptus, and one acre of maritime chaparral.

3. The area inside the security fence consists of about 100 acres, most of which (70 acres) is developed. The remainder contains central coastal scrub (18 acres), ruderal species (11 acres), and maritime chaparral (one acre).

4. The predominant wildlife habitats in the vicinity of SLC-6 are central coastal scrub, ruderal vegetation, and chaparral. Wildlife species associated with the central coastal scrub and chaparral are the same as discussed for the Cypress Ridge site. Wildlife associated with the

ruderal habitat would be similar to that found in the grassland area. The most common species expected to be seen at SLC-6 would be western fence lizard, western skink, western rattlesnake, Pacific tree frog, and blackbelly slender salamander, as well as such wide ranging species as coyote, bobcat, mule deer, and red-tailed hawk.

5. No threatened or endangered species of wildlife are expected to occur at SLC-6. The site does, however, provide suitable foraging habitat for ferruginous hawk and long-billed curlew, two federal Category 2 candidate species, and for a number of regionally rare and declining species, such as black-shouldered kite, northern harrier, Cooper's hawk, merlin, prairie falcon, burrowing owl, short-eared owl, tree swallow, grasshopper sparrow, badger, and mountain lion. All of these species could be expected to occur occasionally.

3.1.2.3 Boathouse Flats

3.1.2.3.1 Project Site

Nonnative Grassland

1. Nonnative grassland is the only community found on the 130 acres of Boathouse Flats. It is similar to that described for Cypress Ridge, but with scattered coyote brush, coastal sagebrush, sawtooth goldenbush (*Haplopappus squarrosus*), and herbs, including vetch (*Vicia* spp.), and locoweed (*Astragalus nuttallii*). The slopes of the Space Shuttle external tank tow route bisecting the site have revegetated since construction, with fescues, tarweeds, and Australian saltbush. Some rockier soils in the northern portion of the site have purple needlegrass growing on them. However, these areas are not extensive. No federal- or state-listed threatened or endangered plants or candidate species were observed at the Boathouse Flats site. Fiddleneck, a special interest plant, is scattered at the site.

2. Heavy cattle grazing, along with development of the V-33 tow road, the NASA VLBI tracking station, and a series of dirt roads, have reduced the value of the grassland present in the Boathouse Flats area for wildlife species. Wildlife associated with grassland habitats in the project area were described in Section 3.1.2.1. The most common species observed at this site were western fence lizard, red-tailed hawk, European starling, house finch, and California ground squirrel.

3. The peregrine falcon (*Falco peregrinus*) is the only federal- or state-listed threatened or endangered wildlife species likely to regularly use the grasslands at the site. However, two additional endangered species, the California brown pelican (*Pelecanus occidentalis*) and the California least tern (*Sterna antillarum*), are known to forage in adjacent nearshore waters.

The brown pelican is also known to roost in sizeable numbers on the Boathouse breakwater, near the site. Regionally rare and declining species which have been observed in the grasslands at or adjacent to the Boathouse Flats site are black-shouldered kite, northern harrier, prairie falcon, burrowing owl, and badger. Additional regionally rare or declining species that could occur occasionally are the Cooper's hawk, merlin, short-eared owl, and tree swallow. Excellent habitat exists for the regionally rare burrowing owl and badger, due to the high density of California ground squirrels present on the site. Abandoned ground squirrel burrows are used by burrowing owls, while California ground squirrels are a major prey item in the diet of badgers.

3.1.2.3.2 Road and Utility Corridors

1. The proposed road and utility corridors associated with the Boathouse Flats site cover approximately 90 acres. Corridors for communication, gaseous nitrogen, natural gas, and electric power utilities are the same as those proposed for the Cypress Ridge site, with an extension to the Boathouse Flats site, primarily through grassland and central coastal scrub. The proposed underground water line corridor passes through Venturan coastal sage scrub, central coastal scrub, and grassland, paralleling an existing patrol road part of the distance. It crosses an area of willow- and coyote brush-dominated riparian scrubland at Oil Well Canyon.

3.1.2.4 Vina Terrace

3.1.2.4.1 Project Site

1. The Vina Terrace site covers approximately 150 acres and contains four plant communities: (1) central coastal scrub, (2) Venturan coastal sage scrub, (3) grassland-coastal scrub, and (4) nonnative grassland similar to Cypress Ridge. Approximately 90 acres are occupied by central coastal scrub, dominated at this site by coyote brush and coastal sagebrush. Silver lupine (*Lupinus albifrons* var. *douglasii*) is predominant on rock outcrops, and one special interest plant, western dichondra, is scattered under the shrubs. With these exceptions, the central coastal scrub at this site appears similar to that on the Cypress Ridge site.

2. Eleven acres of Venturan coastal sage scrub occur on the steeper slopes, and grassland covers approximately 25 acres. Both of these communities on the Vina Terrace site are similar to those occurring on the Cypress Ridge site. Grassland-coastal scrub occupies about 20 acres and is characterized by scattered shrubs, with openings dominated by annual grasses and herbs and, commonly, *Stipa pulchra*.

3. Wildlife habitats present at the Vina Terrace site include coastal scrub and introduced grasslands. Wildlife associated with these communities are discussed in greater detail in Section 3.1.2.1. Species observed at this site during the Spring 1988, inventory are listed in Appendix B. In general, they were composed of taxa that are widespread and abundant in the study region. Some of the more common were western fence lizard, western rattlesnake, desert cottontail, Botta's pocket gopher, Costa's hummingbird, Bewick's wren, wrentit, California thrasher, brown towhee, and white-crowned sparrow, as well as such wide ranging species as coyote, mule deer, turkey vulture, and red-tailed hawk. The most significant species observed on this site were three regionally rare and declining species, the Northern harrier, Wilson's warbler (migrant), and badger. The most important feature of the Vina Terrace site for wildlife is its relatively pristine condition and its remoteness from existing development. Aside from two seldom used roads and a buried utility line corridor, the only other evidence of disturbance at the Vina Terrace site was grazing cattle. Due presumably to the limited human access, evidence of species such as coyote, badger, and mule deer was more numerous than would be expected if the area were more accessible.

4. The grassland habitat is the most important habitat for wildlife at this site. Undisturbed grassland, like that found along the eastern edge of the project site, is the type required by grasshopper sparrows for nesting and by northern harriers and black-shouldered kites for foraging. This kind of habitat is now very localized in distribution and has been declining throughout Santa Barbara County.

5. No threatened or endangered species of wildlife are expected to occur at the Vina Terrace site, although the area provides suitable foraging habitat for ferruginous hawk, a federal Category 2 candidate species, and for a number of regionally rare and declining species such as northern harrier, Cooper's hawk, merlin, prairie falcon, burrowing owl, grasshopper sparrow, badger, and mountain lion. All of these species could be expected to occur with uncommon but regular frequency at this site. They are discussed in greater detail in Chapter 4.0.

3.1.2.4.2 Road and Utility Corridors

1. The proposed access road and utility corridors associated with the Vina Terrace site cover approximately 105 acres, beginning at Coast Road at the Lockheed temporary storage facilities and extending south to the Vina Terrace site, through central coastal scrub, Venturan coastal sage scrub, grassland, and willow-dominated and, at Oil Well Canyon, coyote brush-dominated riparian scrub. Small occurrences of ruderal vegetation, chaparral, and central

dune scrub were also noted. Some of the distance is along an existing dirt road that passes through some area of *Stipa pulchra*-dominated grassland. North of the Lockheed facilities, the electrical, gaseous nitrogen, natural gas, and communication corridors are the same as for the Cypress Ridge site.

2. No federal- or state-listed threatened or endangered plants or candidate species were found within the utility corridors leading to the Vina Terrace site.

3.2 CHANNEL ISLANDS TERRESTRIAL AND AQUATIC BIOTA

1. The Channel Islands are included within the study region because they occur below the overflight area predicted for the Titan IV/Centaur. Therefore, potential impacts from sonic booms may occur to wildlife there. 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 occur. Historically, the introduction of pigs, sheep, and cattle has 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 (ES and SWRI 1988).

2. Relict populations of species, subspecies, and races of vegetation and wildlife persist on the Channel Islands, 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 (ES and SWRI 1988).

3.2.1 VEGETATION

1. The 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 (ES and SWRI 1988).

3.2.2 AMPHIBIANS AND REPTILES

1. Seventeen species of amphibians and reptiles have been recorded on the Channel Islands. The island night lizard (*Xantusia riversiana*) is the only endemic, as well as the only federally-listed threatened, species on the islands and is confined to San Nicolas, Santa Barbara, and San Clemente Islands which are outside of the study area. The northern Channel Islands contain a depauperate herpetofauna, composed of species that are common and widespread along the adjacent mainland (Savage 1967). Only three species, the Pacific slender salamander (*Batrachoseps pacificus*), the Channel Island fence lizard (a subspecies of the western fence lizard), and the Santa Cruz gopher snake (a subspecies of the gopher snake), have differentiated sufficiently to warrant subspecific recognition.

3.2.3 LAND MAMMALS

1. As with the other terrestrial vertebrate groups, the land mammal fauna of the Channel Islands is depauperate, with 16 native species and at least 19 introduced species recorded. The native mice, skunks, and foxes are represented by endemic subspecies or species. The Channel Islands gray fox (*Urocyon littoralis*), which occurs on the six largest of the islands, is the only land mammal that is endemic at the species level; it is a state-listed threatened species.

3.2.4 LAND BIRDS

1. The avifauna of the Channel Islands is reasonably well known, with more than 320 species of birds, primarily migrant or transient visitors, recorded on the northern Channel Islands and Santa Barbara Island (Jones et al. 1989). The land birds on the northern Channel Islands are unique in that they represent a portion of the species that inhabit similar habitats on the adjacent California mainland. Of the 39 species of land birds recorded nesting on these islands, ten are represented by endemics, the most distinctive being the Santa Cruz Island scrub jay (*Aphelocoma coerulescens insularis*).

2. The bald eagle (*Haliaeetus leucocephalus*) and peregrine falcon are the only federal- or state-listed endangered or threatened species of land birds that are known to frequent the northern Channel Islands. The bald eagle, formerly a resident breeder on all the islands (Kiff 1980), is now known only to frequent the area as an uncommon to rare winter visitor (Garrett and Dunn 1981). The American peregrine falcon formerly nested on all of the islands off the coast of Southern California (Kiff 1980). Today it is an uncommon to rare winter visitor to the Channel Islands. In 1989, the peregrine falcon nested again on San Miguel, Santa Cruz, and Anacapa Islands (Nixon 1989).

3.2.5 MARINE BIRDS

1. Hunt et al. (1980) recorded that the Channel Islands off the coast of Southern California support breeding colonies of 11 species of marine birds composed of about 24,000 pairs. The largest and most important colonies occur at San Miguel Island and its two associated islets, Prince Island and Castle Rock, where 14,000 to 15,000 pairs of nine species nest. Sixty percent of the seabirds recorded nesting in the Channel Islands occur at San Miguel Island, and seven of the 11 species that breed in the region have their largest colonies there, these include Leach's (*Oceanodroma leucorhoa*) and ashy (*Oceanodroma homochroa*) storm-petrels, Brandt's (*Phalacrocorax penicillatus*), double-crested (*Phalacrocorax auritus*), and pelagic (*Phalacrocorax pelagicus*) cormorants, pigeon Guillemot (*Cepphus columba*), and Cassin's auklet (*Ptychoramphus aleuticus*) (Hunt et al. 1980). Brown pelicans, federally- and state-listed endangered species, are known to breed regularly on west Anacapa and Santa Barbara Islands, and occasionally on Scorpion Rock off Santa Cruz Island (Hunt et al. 1980).

3.3 MARINE WILDLIFE

3.3.1 MARINE MAMMALS

1. The region of the California coast that incorporates Point Arguello and Point Conception, the northern Channel Islands, and related offshore waters contains one of the world's most diverse marine mammal assemblages. One marine mustelid, six species of pinniped, and 25 to 30 or more cetacean species may be found there, either as resident or transitory species (Woodhouse 1988b).

2. Oceanographically, the region has long been recognized as a transition zone dominated by two major water masses and influenced to a degree by a third. Within this transition zone, biological boundaries with respect to breeding ranges may be defined for some of the pinnipeds, and the occurrences of certain cetaceans may be generally correlated to prevailing oceanographic conditions. The region is characterized by an overlap between certain pinniped and cetacean species that extend south from more northerly climes and north from more southerly climes.

3. The region is further characterized by an eastern boundary current that is seasonally influenced by winds, creating coastal upwelling. As such, biological productivity is relatively high, thus contributing to the abundance of key prey species sought by marine mammals. Dense swarms of planktonic calanoid copepods occur at depth (Robison 1988), euphausiids may be locally

abundant (Ebeling et al. 1970; Brinton 1973; Isaacs et al. 1969), and nektonic species, including Pacific Hake, Mackerel, Anchovy, and several cephalopods are prevalent (Kramer and Ahlstrom 1968; Ahlstrom 1969).

4. The marine mammal fauna reflects several patterns of origin and subsequent radiation (see Appendix C, Marine Animals). Some are denizens of the North Pacific Rim, others represent species populations that are known only from the northern hemisphere, some appear to be northward extensions of related species known only from the southern hemisphere, and others represent Pacific stocks of more cosmopolitan species (see Appendix C.2, Marine Mammals within Five Nautical Miles of Point Arguello). A few are known only from the north Pacific Ocean.

3.3.1.1 Marine Mustelid

1. The only true marine mustelid, the sea otter (*Enhydra lutris*), was known historically from the northern coast of Hokkaido, Japan, to Baja, California (Kenyon 1969; Ogden 1941; Scammon 1874). In California, sea otters currently range from Coho Anchorage (34° 27'N, 120° 27'W) to Point Año Nuevo (37° 07'N, 122° 20'W). Translocation efforts undertaken in 1987 have effectively extended the contemporary range of the sea otter to one of the southern Channel Islands, San Nicolas (USFWS 1987). Some of the translocated otters have reappeared along the central California coast, and presumably have moved past the Point Arguello area.

2. Regular sightings of sea otters have been recorded from Santa Barbara northward by CDFG and the Santa Barbara Museum of Natural History (SBMNH). For the past seven years, the museum's records indicate an average of three to four otters per year seen along the coast from Santa Barbara to Cojo Anchorage. The breeding range of California sea otters, as judged by sightings of mother-pup pairs, incorporates the coast from Sandhill Bluff (37° 01'N, 122° 10'W) just north of Santa Cruz, California, to Shell Beach (35° 10'N, 120° 40'W), just north of Pismo Beach, California.

3.3.1.2 Pinnipeds

Introduction

1. Within the marine region of the project area, there are several locales of importance to marine mammals. The shoreline between Point Conception and Point Arguello supports several haul out sites for harbor seals (*Phoca vitulina richardsi*) and, to a lesser extent, California sea lions (*Zalophus californianus californianus*). Northern elephant seals (*Mirounga angustirostris*)

occasionally may haul out along this section of coast, as may northern fur seals (*Callorhinus ursinus*). Harbor seals are the only pinnipeds to use these hauling grounds as rookeries. Harbor seal rookery use of these areas occurs during the spring.

2. The 1986 harbor seal census from 0.8 mile east of Point Conception to Point Arguello produced a count of 1,012 animals (Hanan et al. 1987). The pocket beach immediately north of the mouth of Oil Well Canyon (about 0.5 mile south of Rocky Point) is an important hauling ground and rookery for the area. Additional haul out sites occur towards Rocky Point and, to the south, the rocks immediately seaward of the Boathouse breakwater are used as haul outs. The 1986 census produced counts totaling 500 seals for these sites (Hanan et al. 1987).

3. Nearshore waters in the vicinity (0 to 5 miles) of the project area are used by sea otters, harbor seals, California sea lions, and probably occasionally by northern fur seals and elephant seals. Because harbor seals tend to occur predominantly nearshore, these waters are probably used extensively by them as foraging grounds. From the point of view of prey availability, the area appears suitable relative to attracting and perhaps sustaining modest numbers of sea otters.

4. Any of the migratory pinniped species can be expected to pass through the oceanic region offshore of the project area. Hence, California sea lion males will pass through during their fall and spring migrations. Further offshore, migratory northern fur seals will move through the region in the winter during their non-breeding season.

5. Offshore, San Miguel Island supports an extensive rookery for California sea lions, northern elephant seals, and northern fur seals with a total pinniped population of over 30,000 in the summer, and 25,000 in the winter and spring (UC Santa Cruz 1983). Harbor seals also pup and breed on the island. In the past, the island was utilized by Guadalupe fur seals (*Arctocephalus townsendi*) and Steller sea lions (*Eumetopias jubatus*). The waters west and north of San Miguel appear to be important foraging areas for northern fur seals and California sea lions that use the island (Antonelis et al. 1987).

Ranges and Origins

1. The six pinniped species may be grouped according to their ranges and presumed origins. The northern fur seal and northern or Steller's sea lion are two that range from the north, with a southern breeding limit at San Miguel Island. Until 1977, Steller sea lions maintained a small rookery at San Miguel (Antonelis and Fiscus 1980). More recently, their southernmost

3.3.2 MARINE TURTLES

1. Four species of sea turtle are known to occur in waters offshore of Southern and Central California (see Table 4.1, Special Interest Species Known or Expected to Occur Within Study Region). The leatherback (*Deremochelys coriacea*), loggerhead (*Caretta caretta*), green (*Chelonia mydas*), and Pacific ridley (*Lepidochelys olivacea*) sea turtles all nest on tropical to subtropical shores. However, while at sea, certain numbers make their way into eastern north Pacific temperate waters, perhaps as a function of ocean currents. All four species could occur in the project area, but would likely be beyond their normal range.

2. The SBMNH records for leatherback and loggerhead sea turtles are summarized in Table C.3., Recorded Marine Turtle Sightings, Central California. They include a leatherback sighted alive in June 1985, about two miles offshore of Naples (about 35 miles south and east of the project area). Other records include six beach-cast leatherbacks that came ashore between 1977 and 1988 from Ventura County to Monterey County, including one specimen from the northern Channel Islands. Two loggerheads have been recorded as taken incidentally by fishing operations. The third loggerhead is a beach-cast, immature specimen from Jalama County Beach, about six miles south of the project area.

3.3.3 MARINE BIRDS

1. The marine bird fauna of the waters offshore of VAFB and the northern Channel Islands is both large and complex. Many of the 101 species of seabirds recorded for California (Jones et al. 1985; Binford 1983) could occur at one time or another within the region. Table B.4 (Birds Observed or Expected to Occur Within the Study Region and Project Area) contains a listing of the species which would be expected to occur with some regularity in the project area. Of those listed, as many as 30 could be moderately common during certain seasons of the year. The abundance and diversity of the marine avifauna in the study region is due in part to the presence of the Channel Islands, to the Santa Barbara Channel's position along the Pacific Flyway, and to the occurrence of a boundary zone between warm southern and cold northern/offshore water masses within the study region.

2. The waters in the study region represent one of the most important seabird use areas in California (Briggs et al. 1981, 1983). Average seabird densities over the shelf waters (0 to 199 meters) of the Santa Maria Basin were found to range from 20 to 100 birds per square kilometer, while densities in the Santa Barbara Channel region ranged from 28 to 67 birds per square kilometer (Briggs et al. 1981). This compares to a density of 7 to 38 birds per square kilometer for the state (Briggs et al. 1983). Within the study region, seabirds tend to be most

abundant in fall and least abundant in spring with species diversity highest in winter and lowest in summer. The seabird fauna of the study region tends to be dominated by non-breeding (visiting) species (Briggs et al. 1983).

3. The pelagic or open ocean waters off the coast of Central and Southern California can be divided into three distinct zones based primarily on water depth: (1) the continental shelf (0 to 199 meters), (2) the continental slope (200 to 1,999 meters), and (3) offshore (greater than 2,000 meters). Each of these zones tends to have its own representative avifauna. Only the continental shelf will be dealt with in this review; the other two zones are open ocean habitats which are outside of the study area.

4. The continental shelf tends to be the most biologically productive of the three zones and thus the most important to seabirds, with 10 to 30 species known to frequent these waters. The continental shelf is quite broad within the study region, extending to 20 kilometers off Point Conception. Seabird numbers are highest over the shelf during the summer, with sooty shearwaters (*Puffinus griseus*) predominating, and lowest during the winter (Briggs et al. 1983). Large numbers of arctic loons (*Gavia arctica*), sooty shearwaters, red (*Phalaropus fulicaria*) and red-necked (*Phalaropus lobatus*) phalaropes, and Bonaparte's gulls (*Larus philadelphia*) pass across the shelf waters during their annual spring and fall migrations, and the area is especially important as a feeding area for seabirds during the fall. Cassin's auklet, common murre (*Uria aalge*), and western gull (*Larus occidentalis*) are the most abundant seabirds during the winter.

5. Nearshore waters (within one kilometer of shore) tend to be used as loafing and foraging areas by loons, grebes, cormorants, scoters, phalaropes, gulls, terns, and some alcids during all seasons of the year. Peak numbers occur during the spring and summer. During the fall (October to mid-December) and spring (March to May) migration periods, a large percentage of the populations of loons, brant, scoters, gulls, and terns that winter south of Point Conception pass through nearshore waters adjacent to the project area, many within one mile of the shoreline (Lehman, 1982). It has been estimated that as many as 100,000 loons, 40,000 to 50,000 scoters, and 40,000 brant frequent nearshore waters adjacent to the project area during migration. Gulls, cormorants, and brown pelicans predominate nearshore waters of the study region during the summer and fall, with cormorants most abundant in the winter, and gulls and western grebes most abundant in the spring. During the winter, larger flocks of gulls and terns can be found on beaches in the study region.

6. Rocky shorelines, which include rocky cliffs, offshore rocks and islets, and rocky intertidal areas, are used for roosting and nesting by pelicans, cormorants, gulls, and terns, and for foraging by a variety of shorebirds such as black oystercatcher (*Haematopus bachmani*), wandering tattler (*Heteroscelus incanus*), black (*Arenaria melanocephala*) and ruddy (*Arenaria interpres*) turnstones, willet (*Catoptrophorus semipalmatus*), and surfbird (*Aphriza virgata*). Significant rocky shoreline habitat occurs around the northern Channel Islands and in a somewhat disjunct form on the mainland in the Point Conception and Rocky Point to Point Pedernales areas. Cormorants, brown pelicans, and a variety of gulls are known to utilize the breakwater at the Boathouse for roosting during the fall and winter (Chambers Group, Inc. 1980). Sowls et al. (1980) documented that 1,084 pairs of seabirds nested at four sites between Point Conception and Point Arguello. The principal locations and species are Point Pedernales and Destroyer Rock (pigeon guillemot), Point Arguello (pelagic cormorant, black oystercatcher, western gull, pigeon guillemot, and rhinoceros auklet [*Cerorhinca monocerata*]), Rocky Point (black oystercatcher, and pigeon guillemot), and Point Conception (pelagic cormorant and pigeon guillemot).

7. Sandy beach habitat is widespread along the south coast of Santa Barbara County, on the northern Channel Islands, and in the Point Conception to Point Arguello area, but has been disturbed by human use. Moderately sized coastal dunes occur on North VAFB from Shuman Creek, south to the mouth of the Santa Ynez River. Sizeable numbers of shorebirds, such as black-bellied plover (*Pluvialis squatarola*), snowy plover (*Charadrias alexandrinus*), willet, whimbrel (*Numenius phaeopus*), long-billed curlew, marbled godwit (*Limosa fedoa*), and sanderling (*Calidris alba*), along with a number of species of gulls and terns are known to frequent sandy beaches in the study region for foraging and roosting (Lehman 1982). Water pipit, yellow-rumped warbler, black turnstone, and short- (*Limnodromus griseus*) and long-billed (*Limnodromus scolopaceus*) dowitchers are known to forage along the upper portions of beaches where rotting kelp attracts invertebrate prey. The only species known to breed in sandy beach and backdune habitats in the region include horned lark, Brewer's blackbird, and house finch (Lehman 1982).

8. In addition, the federal- and state-listed endangered least tern, and the federal Category 2 candidate snowy plover are known to utilize this habitat exclusively for nesting. Least terns are known to nest near the mouth of the Santa Maria River, and on VAFB at the mouth of the Santa Ynez River, Purisima Point, and San Antonio Creek (USAF 1987a). Snowy plovers are known to nest on San Nicolas, Santa Rosa, and San Miguel Islands, and on VAFB near

the mouth of the Santa Ynez River and on the Purisima Point Beach (Page and Stenzel 1981). Known nesting locations for least terns and snowy plovers within the project region are shown in Figure 3.6 (Nesting Locations of California Least Tern and Western Snowy Plover).

9. Because of its proximity to the coast, the marine bird population of the project area reflects the general marine bird population which occurs within the larger region (see Section 3.2.5), with the number of overflying birds decreasing with distance from the ocean. Due to its nearshore location, more marine birds would be expected at the Boathouse Flats site than at the Cypress Ridge, SLC-6, or Vina Terrace sites. The fewest marine birds would be expected at the Vina Terrace site. The three inland sites would be expected to be overflown, while the shoreline at the Boathouse Flats site could experience some nesting activity. The sandy beaches in the vicinity of the Boathouse Flats site are potential habitat for shorebirds such as black-bellied plover, snowy plover, willet, whimbrel, long-billed curlew, marbled godwit, and sanderling, as well as a number of species of gulls and terns.

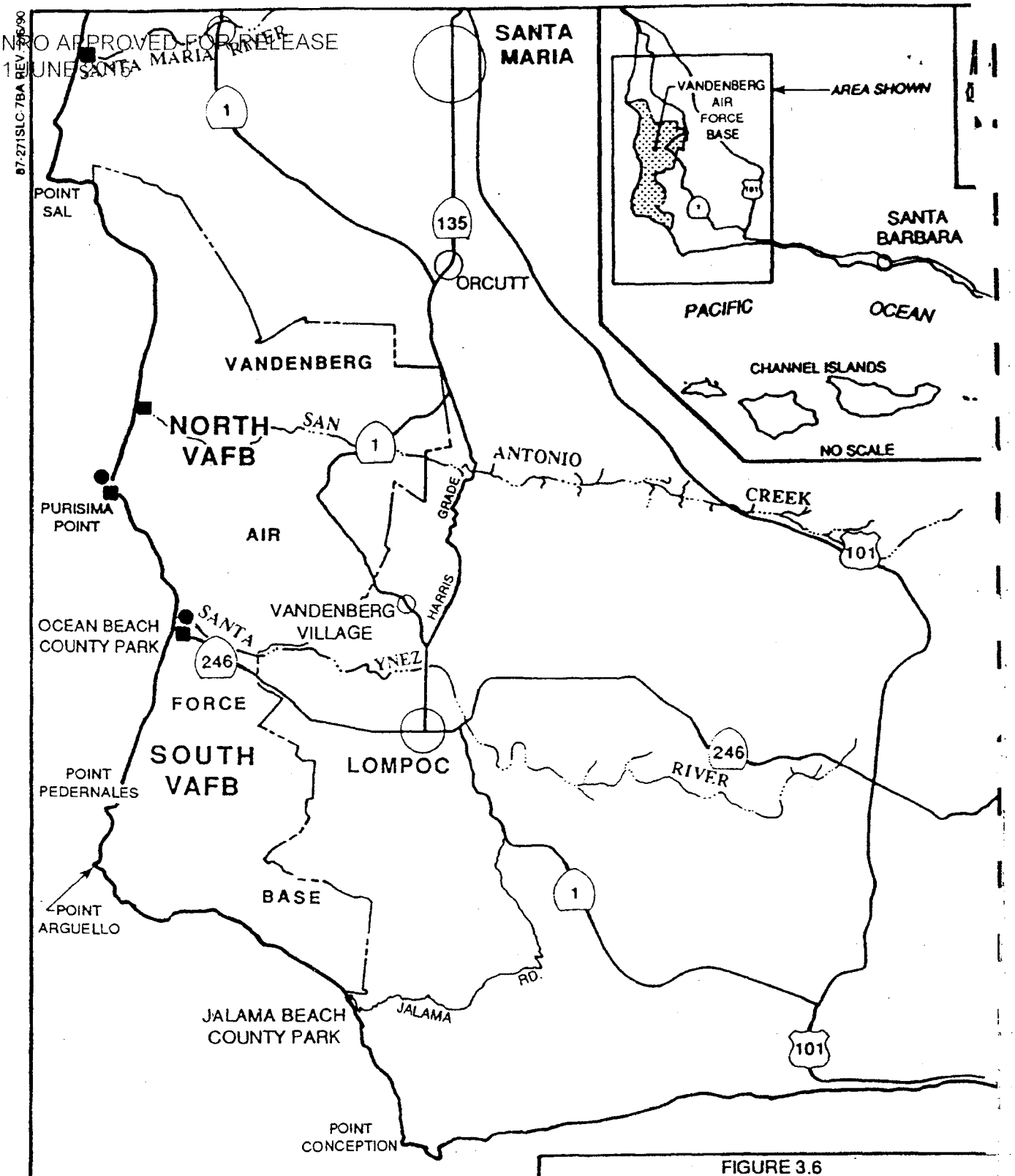


FIGURE 3.6

NESTING LOCATIONS OF CALIFORNIA LEAST TERN AND WESTERN SNOWY PLOVER

SLC-7 BIOLOGICAL ASSESSMENT

ENVIRONMENTAL SOLUTIONS, INC.

4.0 SPECIAL INTEREST SPECIES

1. This chapter addresses plant and animal species of special interest that are known to occur within the study region and which are either known to occur or may occur specifically within the project area. A species is considered to be of "Special Interest" if it is: (1) federally- or state-listed as threatened or endangered, (2) a candidate to be federally- or state-listed, or (3) considered to be regionally rare and/or declining. Agencies with responsibility and/or authority for the species addressed in this document include the USFWS, the NMFS, the CDFG and the California Native Plant Society (CNPS).

2. There are no threatened or endangered species of plants, amphibians, reptiles, or land mammals known or expected to occur within the study region or project area. There are, however, one species of fresh-water fish, five bird species, four marine amphibians, seven cetaceans, one pinniped, and one mustelid which are federally- or state-listed as endangered. There also are a number of declining species of plants and animals that occur in Santa Barbara County which presently have no specific legislative protection. Some of these are Category 2 candidates for federal listing as threatened or endangered. Others are of special concern to the CDFG (Remsen 1978; Williams 1986), on the National Audubon Society's "Blue List" (Tate 1986), CNPS, or considered by local biologists to be regionally rare and/or declining. Plant and wildlife species that are threatened, endangered, or candidates for federal listing are discussed in Section 4.1. Those considered sensitive or regionally rare and/or declining are discussed in Section 4.2. The status of all species known or expected to occur within the study region is shown in Table 4.1 (Special Interest Species Known or Expected to Occur Within Study Region).

4.1 THREATENED, ENDANGERED, AND CANDIDATE SPECIES

1. Species that are federally-listed as threatened or endangered are protected under the Endangered Species Act of 1973 (Federal Register 41 (110):22915-22922. June 7, 1976), as amended (P.L. 94-325, P.L. 94-359, P.L. 95-212, P.L. 95-632, P.L. 96-159, P.L. 97-304). Under this legislation, a species is considered endangered if it is "... in danger of extinction throughout all or a significant portion of its range...," and threatened if it is "likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range."

TABLE 4.1
SPECIAL INTEREST SPECIES
KNOWN OR EXPECTED TO OCCUR WITHIN STUDY REGION

SPECIES	FEDERAL STATUS [1]	STATE AND OTHER STATUS [2]
THREATENED, ENDANGERED, AND CANDIDATE SPECIES		
PLANTS		
Crisp monardella	Category 2	CNPS List 1B
Curly-leaved monardella	Category 2	CNPS List 1B
Black-flowered figwort	Category 2	CNPS List 3
Shagbark manzanita	Category 2	CNPS List 4
Soft-leaved Indian paintbrush	Category 2	CNPS List 1B
TERRESTRIAL/AQUATIC ANIMALS		
Tidewater Goby	Category 2	CDFG Special Status Species
Unarmored three-spine stickleback	Endangered	Endangered
AMPHIBIANS		
California red-legged frog	Category 2	CDFG Species of Special Concern
Southwestern pond turtle	Category 2	CDFG Species of Special Concern
MAMMAL		
Townsend's western big-eared bat	Category 2	CDFG Species of Special Concern
BIRDS		
California brown pelican	Endangered	Endangered
Southern bald eagle	Endangered	Endangered
American peregrine falcon	Endangered	Endangered
California least tern	Endangered	Endangered
Least Bell's vireo	Endangered	Endangered
Western yellow-billed cuckoo	Category 2	Threatened
California black rail	Category 2	Threatened
Elegant tern	Category 2	CDFG Species of Special Concern
White-faced ibis	Category 2	CDFG Species of Special Concern
Ferruginous Hawk	Category 2	Species of Special Concern, Audubon Blue List
Western snowy plover	Category 2	Species of Special Concern, Audubon Blue List
Long-billed curlew	Category 2	Species of Special Concern, Audubon Blue List
Tricolored blackbird	Category 2	None
MARINE AMPHIBIANS		
Leather-back sea turtle	Endangered	None
Loggerhead sea turtle	Threatened	None
Green sea turtle	Threatened	None
Pacific Ridley sea turtle	Threatened	None
MARINE MAMMALS		
Pacific right whale	Endangered	None
Gray whale	Endangered	None
Blue whale	Endangered	None
Fin whale	Endangered	None
Sei whale	Endangered	None
Humpback whale	Endangered	None
Sperm whale	Endangered	None
Guadalupe fur seal	Threatened	Rare, Protected
California sea otter	Threatened	Rare, Protected
Northern fur seal	Depleted	None
PROTECTED OR REGIONAL RARE AND DECLINING SPECIES		
MARINE MAMMALS		
California sea lion	Protected under MMPA	None
Northern elephant seal	Protected under MMPA	None
Harbor seal	Protected under MMPA	None
Northern (Steller) sea lion	Protected under MMPA	None
PLANTS		
Fiddleneck	None	CNPS Appendix 1
Purisima manzanita	None	CNPS Appendix 1
Santa Barbara Ceanothus	None	CNPS Appendix 1
Western dichroendra	None	CNPS List 4
Saint's daisy	None	CNPS List 4
Large-leaved wallflower	None	CNPS List 4
TERRESTRIAL/AQUATIC ANIMALS		
Badger	None	CDFG Species of Special Concern
Mountain lion	None	CDFG Protected nongame mammal
Monarch butterfly	IUCN Top Priority Species [3]	None
BIRDS		
Black-shouldered kite	None	Fully protected
Northern harrier	None	CDFG Species of Special Concern, Audubon Blue List
Cooper's hawk	None	CDFG Species of Special Concern, Audubon Blue List
Merlin	None	CDFG Species of Special Concern, Audubon Blue List
Prairie falcon	None	CDFG Species of Special Concern
Burrowing owl	None	CDFG Species of Special Concern, Audubon Blue List
Long-eared owl	None	CDFG Species of Special Concern
Short-eared owl	None	CDFG Species of Special Concern, Audubon Blue List
Willow flycatcher	None	Special Status Species
Purple martin	None	Audubon Blue list, Locally Rare and Declining
Tree swallow	None	Uncommon, but localized breeder in Santa Barbara County
Swainson's thrush	None	Uncommon localized breeder, Spring transient South Coast-Uncommon to rare nester
Warbling vireo	None	North Coast-Common breeder
Yellow warbler	None	Audubon Blue List
Wilson's warbler	None	Extirpated as breeder along South Coast
Yellow-breasted chat	None	CDFG Species of Special Concern
Blue grosbeak	None	Declined as breeder
Grasshopper sparrow	None	Audubon Blue List

NOTES: [1] C1 = Federal Category 1 Candidate (sufficient information exists to support listing as threatened or endangered).
C2 = Federal Category 2 Candidate (possibly appropriate for listing, but information is insufficient at this time).

3/7/90 (87-2711)

[2] California Native Plant Society 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)
Appendix 1 = plants considered for Lists 1 through 4 but not included

[3] International Union of the Conservation of Nature and Natural Resources (Nagano and Lane 1985).

2. As indicated in Table 4.1, within the study region, there are five federally-designated endangered species of birds (California brown pelican, southern bald eagle, American peregrine falcon, California least tern, and least Bell's vireo), one endangered and three threatened species of marine amphibians (respectively, the leatherback [endangered] and the loggerhead, green, and Pacific Ridley [threatened] sea turtles), one endangered fish (unarmored threespine stickleback), and seven endangered and two threatened marine mammals (respectively, the Pacific right, gray, blue, fin, sei, humpback, sperm whales [endangered] and Guadalupe fur seal and California sea otter [threatened]).

3. The candidate species discussed herein are being considered for possible addition to the list of federally-listed threatened and endangered wildlife (Federal Register 50 [181]:37958-37967 September 18, 1985). Candidate species are classified as either Category 1 ("substantial information on hand to support the biological appropriateness of proposing to list as endangered or threatened") or Category 2 (USFWS has sufficient information to indicate the probable appropriateness for listing as threatened or endangered, but for which conclusive data on biological vulnerability and threat are not currently available to support listing). There are five Category 2 species of plants and 14 Category 2 species of animals under review for federal listing as threatened or endangered that could occur within the study region. Thus, more detailed information for each species is included in the following sections.

4.1.1 PLANT SPECIES

1. This section presents information on the appearance, distribution, and habitat affinities of the federal Category 2 candidates crisp monardella, curly-leaved monardella, black-flowered figwort, shagbark manzanita, and soft-leaved Indian paintbrush. There are no known federally listed threatened or endangered plant species on VAFB.

4.1.1.1 Crisp Monardella

1. Crisp monardella (*Monardella crispa*) is a federal Category 2 candidate and is on CNPS List 1B (plants rare and endangered in California and elsewhere).

2. According to widely used identification manuals, crisp monardella (Hoover 1970; Munz and Keck 1959), is a perennial herb in the mint family, with fragrant foliage, large heads of purple flowers, and stems densely covered with short, white hairs. It is found in sparsely vegetated dunes, behind foredunes, and on the edges of blowouts at Point Sal and Mussel Rock, at the Nipomo Dunes, Oso Flaco Lake, and in the Dune Lakes area of San Luis Obispo County

(Howald et al. 1985). There is no information on the size of the total population, although Howald et al. (1985) suggest there are "certainly hundreds and perhaps thousands" of individuals.

3. There is some confusion concerning the nomenclature of crisp monardella and curly-leaved monardella (*Monardella undulata* var. *frutescens*). Smith (1983) examined both types of specimens and plants from VAFB and areas to the north. He suggested that both *Monardella crispa* and *M. undulata* var. *frutescens* may be two geographical species or subspecies of *M. crispa*. However, current names are used in this report. The locations of crisp monardella within the study region are shown in Figure 3.4.

4.1.1.2 Curly-leaved Monardella

1. Curly-leaved monardella (*Monardella undulata* var. *frutescens*) is a federal Category 2 candidate and is on CNPS List 1B.

2. Curly-leaved monardella differs from crisp monardella in having smaller flower heads and bracts, narrower leaves, and fewer hairs on the stems. The primary flowering period is from May to July. It is known from the Cypress Ridge area to near Oceano in San Luis Obispo County (Smith 1976; Smith 1983). This plant requires open, sandy habitat to become established and, therefore, is found primarily in partially-stabilized dunes and other disturbed, sandy areas. However, it cannot withstand persistent disturbance, such as from off-road vehicle use.

3. As shown in Figure 3.4, curly-leaved monardella occurs on VAFB in backdunes and some disturbed areas, primarily along the coast, including the dunes at Casmalia Beach, near Purisima Point, immediately to the north of Surf, and from just south of Surf to Honda Canyon (Smith 1983; CDFG 1988; Nichols 1988). It also occurs on the San Antonio Terrace dune system, on Burton Mesa, and at Cypress Ridge in disturbed central coastal scrub and along sandy roadsides. There are no estimates of the total population size, although Smith (1983) thought the plant was moderately abundant in some areas. In a study of the San Antonio Terrace backdunes, east of the railroad tracks, an estimate was made of roughly 950,000 individuals (HDR 1980). A population of more than 200 individuals was noted near SLC-4 (USAF 1987a). Counts taken during the 1988 field inventory of "mature" individuals in populations south of Honda Canyon yielded a total of approximately 1,600 to 1,800 plants greater than six inches in height (see Figure 3.5). Many more seedlings were observed between populations, ranging from about one to ten times the number of mature individuals.

4. The individuals on and near the Cypress Ridge launch complex site probably represent the southern limit of the range of curly-leaved monardella; the CDFG (CNDDB) and local herbaria have no record of it occurring south or east of Cypress Ridge.

5. The degradation and destruction of habitat at Surf, San Antonio Terrace, and the Guadalupe and Pismo Dunes have resulted in the loss of an unknown portion of the total population of curly-leaved monardella (Howald et al. 1985). At least 12,000 individuals were destroyed on San Antonio Terrace during construction of facilities related to testing of the MX missile (HDR 1980), and an estimated 14,000 more will be destroyed by construction of facilities related to the Peacekeeper in the Rail Garrison/Small ICBM flight test program (USAF 1987b).

4.1.1.3 Black-flowered Figwort

1. Black-flowered figwort (*Scrophularia atrata*) is a federal Category 2 candidate and is on CNPS List 3 as a plant about which more information is needed.

2. Black-flowered figwort is a tall, perennial herb with small, dark maroon flowers that bloom from April to June. It is endemic to coastal San Luis Obispo County and northern Santa Barbara County, although its exact range is in question because it apparently hybridizes extensively with California figwort. Smith (1983) studied *Scrophularia* on VAFB in detail and found that most populations showed evidence of hybridization. He also found that *S. atrata* occurs on all types of soils, not just those derived from diatomaceous shale, as previously suggested by Munz and Keck (1959). Small populations with flower characteristics close to black-flowered figwort were found in the study area in Southern Canyon, east of SLC-6, and along Coast Road, north of the road to Point Arguello.

3. Most *Scrophularia* plants found during the 1988 field inventory were typical of California figwort, or appeared to be hybrids.

4.1.1.4 Shagbark Manzanita

1. Shagbark manzanita (*Arctostaphylos rudis*) is a federal Category 2 candidate and will probably be elevated from CNPS List 4 to List 1B in the next CNPS Inventory (Howald 1988).

2. Shagbark manzanita is a shrub that grows to five feet tall with rough, shredding bark and clusters of small white flowers that appear from November to February (Munz and Keck 1959). Smith (1976) states that it is found in sandy soil ranging from Nipomo Mesa to

Corralillos Canyon, Purisima Hills, Burton Mesa, and south to Lompoc Canyon. It is locally dominant in central maritime chaparral (Davis et al. 1988). Population estimates are not available. The CDFG Endangered Plant project is currently soliciting information on its range and population size (Howald 1988). Beauchamp and Oberbauer (1977) found *Arctostaphylos rudis* at the SLC-6 site. It was not found in the study region during the 1988 field inventory. Known populations closest to the Cypress Ridge launch complex site are around Lompoc Canyon (Smith 1976).

4.1.1.5 Soft-leaved Indian Paintbrush

1. Soft-leaved Indian paintbrush (*Castilleja mollis*) is a federal Category 2 candidate and is included in CNPS List 1B.

2. Soft-leaved Indian paintbrush is a low, multi-stemmed perennial herb with yellow to red flower bracts and soft, branched hairs on the stems. It blooms from April to August and typically grows in partly-stabilized to stabilized dunes; primarily foredune vegetation and central dune scrub. It is endemic to at least Santa Rosa Island; the taxonomic status of the mainland plants of this species is uncertain. The mainland distribution of what has been called *Castilleja mollis* includes Pismo Beach and Guadalupe Dunes to Oceano in San Luis Obispo County, and east of Casmalia, Surf, Point Arguello, and Point Conception in Santa Barbara County (Smith 1976). It shows much variation over this range (Howald et al. 1985) and appears to hybridize with *C. affinis* var. *contentiosa* in some areas. However, the population at the base of Cypress Ridge is the most variable on VAFB and is believed to be a hybrid swarm and *C. affinis*. Heckard (1988), an authority on the genus, believes that all mainland plants are *C. affinis*.

3. There is insufficient information to estimate the size of the mainland population of the plant referred to as *C. mollis*. Smith (1983) suggested there were "thousands of plants" on VAFB; one study yielded an estimate of 2,140 individuals on the backdunes of San Antonio Terrace alone (HDR 1980). The plants on the Cypress Ridge site and in the rest of the study region do not have characteristics typical of *C. mollis* and appear to be *C. affinis*.

4.1.2 TERRESTRIAL AND AQUATIC ANIMAL SPECIES

4.1.2.1 Unarmored Threespine Stickleback

1. This species (*Gasterosteus aculeatus williamsoni*) is listed as endangered by the USFWS(1985b) and CDFG (1986).

2. In the past, the species was widely distributed throughout Southern California, being found in the Santa Clara, Los Angeles, San Gabriel, and Santa Ana Rivers, and at some locations in Santa Barbara County (Sasaki et al. 1977; Irwin and Soltz 1982). Today, this species only occurs in the headwaters of the Santa Clara River and its tributaries in Los Angeles County, in San Antonio and Shuman Creeks on North VAFB and in Honda Creek on South VAFB. It can be found throughout most perennially flowing sections of San Antonio Creek, including a section near Los Alamos (Howald et al. 1985). In San Antonio Creek, unarmored threespine sticklebacks occur with Arroyo chub, prickly sculpin, tidewater goby, carp, and mosquitofish (Irwin and Soltz 1982; Howald et al. 1985).

3. According to Baskin and Bell (1976), unarmored threespine sticklebacks prefer clear flowing freshwater in densely vegetated small stream pools or backwaters, and they can tolerate a wide range of temperatures and opportunistically accept a wide variety of foods (Baskin 1974; 1975). This subspecies spawns throughout most of the year, with highest recruitment occurring between May and September. Sticklebacks commonly forage on aquatic invertebrates such as amphipods, ostracods, snails, and a variety of insects (Irwin and Soltz 1982).

4. Much of the preferred habitat for this subspecies has been destroyed as a result of urban and agricultural developments. Primary threats to habitats in Southern California include increasing urban development and agricultural expansion which result in the degradation of water quality via increased sediment, nutrient, or toxic chemical inputs (Sasaki et al. 1977; Irwin and Soltz 1982; Howald et al. 1985). Channelization of streams may increase the frequency and intensity of floods and may eliminate pools which are prime stickleback habitats. Expanded ground water pumping may decrease water tables and surface water flows in San Antonio Creek.

5. Also, the introduction of exotic fish, turtle, or amphibian species could result in the decline of stickleback populations through predation or competition. The morphological uniqueness of stickleback populations could be lost through introgression if other populations of sticklebacks with higher plate counts were introduced. Oil spills reaching the water could have direct deleterious consequences, as could increased sediment inputs resulting from overgrazing. Finally, beavers introduced into San Antonio Creek by the CDFG in the 1940s could be affecting stickleback populations by altering or stopping the flow of water (Dial 1980).

6. In efforts to increase its range and thus reduce its vulnerability to extirpation, the CDFG, with the approval of the Stickleback Recovery Team, recently introduced unarmored threespine sticklebacks from San Antonio Creek into Shuman and Honda Creeks on VAFB (Howald et al. 1985). Also, a small number of sticklebacks were inadvertently introduced into El Rancho Pond on VAFB (Coulombe and Mahrdt 1976).

4.1.2.2 Island Night Lizard

1. The island lizard is the only federally-listed threatened reptile species which inhabits the Santa Barbara Channel Islands. However, this species is confined to three of the southern Channel Islands (San Nicolas, Santa Barbara, San Clemente). The study region for this assessment incorporates only the northern Channel Islands of San Miguel, Santa Rosa, Santa Cruz, and Anacapa. Therefore, since the island night lizard inhabits areas outside the study region, it will not be addressed further (Collins 1988b).

4.1.2.3 California Red-legged Frog

1. This species is a Category 2 candidate for federal listing (USFWS 1985b) and is a CDFG "Species of Special Concern" (CDFG 1986).

2. Red-legged frogs have declined significantly during the past century throughout Southern California due to degradation and loss of critical riparian and freshwater habitat, predation from introduced freshwater fish, and competition from introduced bullfrogs (*Rana catesbeiana*) (Hayes and Jennings 1986; Jennings and Hayes 1985). In the past they were common along most of the creeks in Southern California. Their preferred habitat is freshwater ponds and pools associated with streams and coastal estuaries (Sweet, 1988). In Santa Barbara County, red-legged frogs are found to be intimately associated with plunge pools that are found in thick growths of emergent aquatic vegetation, especially arroyo willow and cattails (Hayes 1988; Sweet 1988).

3. In the past, this species could be found along the lengths of most of the creeks and rivers in northern Santa Barbara County. However, degradation and loss of suitable freshwater riparian habitats and their associated watersheds have resulted in the loss of many local populations. Red-legged frogs have been found at Bark Slough on San Antonio Creek (Dial 1980), in Honda Creek on South VAFB (Coulombe and Cooper 1976), off Santa Rosa Road east of Highway 1, in Salsipuedes Creek, in the Santa Ynez River at the 13th Street Bridge,

in San Miguelito Canyon south of Lompoc, off Jalama Road, in ponds near the junction of Yridisis and Llanito Creeks along Highway 1, and at the Campbell Road vernal ponds along Highway 246 east of Lompoc (Howald et al. 1985; 1986; Collins 1988a; 1988b; Sweet 1988).

4. There are no records of red-legged frogs from within the proposed project area. Further, the riparian habitats at Red Roof, Spring, Oil, Wells and Agua Viva Canyons are not suitable for sustaining a red-legged frog population. Red-legged frog colonies nearest the project area occur in Honda and Jalama Creeks.

4.1.2.4 Arroyo Toad

1. This species (*Bufo microscaphus californicus*) is a Category 2 candidate for federal listing and is a CDFG "Species of Special Concern" (CDFG 1986).

2. Its range in California is from San Luis Obispo County southward into northwestern Baja California (Stebbins 1985). Its preferred habitat includes dry arroyos and sandy washes where streams are usually intermittent (Stebbins 1954; 1985). In Southern California, arroyo toads frequent sandy washes and riverbanks which are bordered by willows, cottonwoods, sycamores, or coast live oaks (Stebbins 1954). Its preferred breeding habitat is long, shallow pools with gravel beds which are situated adjacent to elevated sandy terraces with dense growths of willows and cottonwoods (Sweet 1988).

3. In Santa Barbara County, the arroyo toad has only been found at Mormon Camp along the Sisquoc River, at Mono Creek, and in the upper reaches of the Santa Ynez River east of Gibraltar Reservoir (Sweet 1988; Collins 1988a). Factors limiting its distribution in Santa Barbara County are not readily apparent as many canyons, especially the Santa Ynez River east of Lake Cachuma, have habitats that are apparently suitable for the arroyo toad.

4. This species has not been recorded on VAFB and is not expected to occur within the project area.

4.1.2.5 Southwestern Pond Turtle

1. This species is classified as a Category 2 candidate for federal listing (USFWS 1985b) and is a CDFG "Species of Special Concern" (CDFG 1986).

2. Southwestern pond turtles occur throughout Southern California, including parts of the Mojave Desert (Stebbins 1985). Their preferred habitat includes unpolluted rivers, streams, reservoirs, ponds, marshes, canals, and floodplain backwaters where water is present year-round (Stebbins 1985). The species frequents quiet water and generally selects deeper pools which are lined with aquatic vegetation, such as cattails (Sweet 1988).

3. The southwestern pond turtle is widespread in Santa Barbara County, although populations have shown a gradual decline along much of the south coast during the past century as a result of alterations to many south coast watersheds and over-collecting for the pet trade (Sweet 1988). Pond and deep pool habitats, essential for the survival of this species, have been eliminated from many streams in Santa Barbara County. Although this species does not appear to be in danger of extinction in areas north of the Santa Clara River in Ventura County, it is subject to local perturbations where there are high levels of human disturbance (Sweet 1988).

4. Within the study region, southwestern pond turtles have been recorded at the Campbell Road vernal ponds, the Santa Ynez River between Buellton and its mouth, San Antonio Creek at Barka Slough, Gaviota Creek, Jalama Creek, and at 12 sites on the Hollister and Bixby Ranches (Howald et al. 1986; Collins 1988b; Storrer 1988; Dial 1980). Based on available information, this species does not appear to be in danger of extirpation in northern Santa Barbara County. However, it is subject to local extinctions as a result of agricultural and stock pond developments and ground water pumping.

5. This species has not been observed nor is it expected to occur within the project area. The nearest suitable habitat for southwestern pond turtles occurs in Honda Creek on South VAFB and in Jalama Creek south of VAFB. Southwestern pond turtles in Jalama Creek are not expected to be impacted by construction or operation of the proposed project.

4.1.2.6 Tidewater Goby

1. The tidewater goby (*Eucyclogobius newberryi*) is a Category 2 candidate for federal listing (USFWS 1985b) and is a CDFG "Special Status Species" (CDFG 1986).

2. This species is confined to fresh or brackish water coastal lagoons from San Diego County north to Del Norte County (Miller and Lea 1972; Swift et al. 1989). Although the tidewater goby can breed throughout the year in Southern California, spawning generally occurs from late April to July (Irwin and Soltz 1984; Swift 1984). Formerly, tidewater gobys inhabited

coastal lagoons from the Smith River in Del Norte County to Agua Hedionda Lagoon in San Diego County (Lea et al. 1980). Today its distribution extends south only to San Onofre Creek in northern San Diego County. As of 1984 there were only 55 populations of this species remaining in the state of California, having disappeared from 74 percent of the coastal lagoons it once inhabited between Morro Bay and San Diego (Swift 1984). Human activities are thought to have resulted in the elimination of many goby populations in Southern California (Swift 1984; Irwin and Soltz 1984; Howald et al. 1985).

3. In the study region, the tidewater goby inhabits coastal lagoons at the mouths of intermittent and perennial streams. Most lagoons are characterized by sand bars which separate them from the ocean for most of the year. Tidewater gobys have been collected in most of the coastal streams which end in well-defined lagoons, including Gaviota Creek, Jalama Creek, Santa Ynez River from the 13th Street bridge to its mouth, San Antonio Creek from the Lompoc-Casmalia Road to its mouth, Shuman Canyon, and the Santa Maria River mouth (Swift 1984; Howald et al. 1985; Swift et al. 1989).

4. The species is not known to occur within the project area. The tidewater goby populations nearest the project area occur at the mouth of Jalama Creek and in the Santa Ynez River.

4.1.2.7 Townsend's Western Big-eared Bat

1. This species (*Plecotus townsendii*) is a Category 2 candidate for federal listing (USFWS 1985b) and has a second priority listing in the CDFG "Species of Special Concern" list by Williams (1986).

2. Townsend's big-eared bats occur throughout California, with one subspecies (*P.t. townsendii*) inhabiting the humid coastal regions of Northern and Central California and a second subspecies (*P.t. pallenscens*) inhabiting the rest of the state, including the Santa Barbara region (Hall 1981). The species frequents a variety of habitats, including coastal conifer and broad-leaf forests, oak and conifer woodlands, arid grasslands and deserts, and high-elevation forests and meadows (Williams 1986). It has been found roosting in limestone caves, lava tubes, mine tunnels, and other man-made structures. Primary habitat requirements are freedom from disturbance and proximity to fresh water. These bats are so sensitive to disturbance that "a single visit by humans can cause the bats to abandon a roost" (Williams 1986).

3. Active roosts have been found in the Santa Ynez Valley near the town of Santa Ynez and at Prisoner's Harbor on Santa Cruz Island (Collins 1988b; SBMNH, unpublished specimen records). There are no records of Townsend's big-eared bats occurring within the study region or project area and there does not appear to be suitable habitat associated with fresh water in these areas. Thus, this species would be expected to occur in the project area only as an uncommon spring and fall migrant.

4.1.3 MARINE AMPHIBIANS

1. Four species of sea turtle are known to occur in waters offshore of Southern and Central California. These turtles nest on tropical to subtropical shores, but while at sea certain numbers make their way into eastern north Pacific temperate waters, perhaps as a function of ocean currents. The federal and state status of these turtles is shown in Table 4.1. All four of these marine amphibians could occur within the study region, and are listed as endangered or threatened by the USFWS (1985b).

4.1.3.1 Leatherback Sea Turtle

1. The leatherback sea turtle is federally-listed as an endangered species. It nests in the tropics, but its non-nesting range includes temperate to boreal waters (Ross 1981).

2. In the Atlantic, these turtles are known from Newfoundland and the British Isles to Argentina and the Cape of Good Hope. In the Pacific, they are known from British Columbia to Chile, and from Japan through the Indo-Pacific to eastern Africa (Ernst and Barbour 1972). Individuals have been observed as far north as Cordova, Alaska. This turtle is considered to be generally pelagic but may enter bays and estuaries. Its diet consists largely of jellyfish. It shares nesting beaches with other marine turtle species (Ernst and Barbour 1972).

3. Populations are affected by human take of eggs on nesting beaches. In some areas, take of adults are taken by individuals to provide for subsistence; while in other areas, the taking of adults is well organized with large numbers being taken. The world estimate of the nesting female population is approximately 14,300 (Ross 1981).

4. Locally, three beach-cast specimens have been taken by SBMNH from beaches bordering the mainland and island sides of the Santa Barbara Channel (see Appendix C.3). However, the nearest nesting beaches to Central California are along Mexico's Pacific coast (Ross 1981).

4.1.3.2 Loggerhead Sea Turtle

1. The loggerhead sea turtle is a federally-listed threatened species.

2. It ranges from Southern California, south to Chile and through the Pacific and Indian Oceans to Japan, Australia, India, and Kenya. In the Atlantic, this turtle occurs from Newfoundland to Argentina, including the Caribbean and Mediterranean Seas. Loggerheads may wander from the open sea to bays, salt marshes, river mouths, and other areas within its range (Ernst and Barbour 1972). It is often reported from temperate waters, and younger specimens disperse into major oceanic circulations (Ross 1981).

3. The loggerhead uses the same nesting beaches as other sea turtles and tends to be omnivorous, which may account for the species feeding in a variety of shallow water and open ocean habitats. Populations throughout the world are under pressure from exploitation of adults and their eggs. Incidental take in fishing trawls is also a factor affecting population. Populations given protection have shown a tendency to increase, with the world population estimate of nesting females at about 41,000 (Ross 1981).

4. Specimens have been retrieved periodically by SBMNH from the central Southern California coast (see Appendix C.3).

4.1.3.3 Green Sea Turtle

1. The green sea turtle is a federally-listed threatened species.

2. This species is cosmopolitan, known from the coast of Ethiopia, around the Cape of Good Hope to western Africa, and eastward through the Indian and Pacific Oceans. Its Pacific range includes the coastal Americas from the United States to Chile (Ernst and Barbour 1972), where it has been observed primarily in tropical waters and also in subtropical to temperate regions. The species migrates over open seas, but feeds in shallow water where submerged vegetation is abundant. Nesting areas in the eastern tropical Pacific include the Galapagos Islands and the Pacific coasts of Central America and Mexico (Ernst and Barbour 1972).

3. As with other species of sea turtle, the green sea turtle is heavily exploited as a food source with local depletion of populations directly related to large commercial harvests (King 1981).

4.1.3.4 Pacific Ridley Sea Turtle

1. The Pacific Ridley sea turtle is federally-listed as threatened under the Endangered Species Act.

2. This species ranges the tropical Pacific and Indian Oceans and also is known to occur in the warm waters of the Atlantic. California records for the species contain sightings in Monterey Bay and Humboldt County. Generally, it is found in protected, shallow marine waters, but may be found in the open sea. These turtles nest on the same beaches as other sea turtle species (Ernst and Barbour 1972). Extensive commercial exploitation of nesting females for meat and leather has greatly reduced numbers nesting along the coast of Mexico, and exploitation in other areas has caused the collapse or near-depletion of local nesting populations. The world estimate of nesting females is roughly 518,000 (Ross 1981).

4.1.4 MARINE MAMMALS

1. Various species of marine mammals have the potential to pass through or reside in the study region (zero to five miles from the coast) for short periods of time. Many are provided special status under either federal or state of California laws. Of those covered by federal or state statutes, seven species of cetacean, one pinniped, and one marine mustelid are likely to occur within the study region. These are shown in Table 4.1 and are addressed in detail below.

4.1.4.1 Sei Whale

1. The sei whale (*Balaenoptera borealis*) of the North Pacific is federally-listed as an endangered species (USFWS 1985b).

2. The species ranges from summer latitudes of 40 degrees north to winter latitudes of 20 to 23 degrees north. The majority occur off the coast of Central California from May through October and may come within five nautical miles of the project area. Sightings have been recorded in March, May, and September by the SBMNH (Woodhouse in preparation), and a pair was sighted southwest of Point Buchon during the month of September (Dohl et al. 1980). Estimates of northern Pacific stock range from 22,000 to 37,000 (Mizroch et al. 1984a).

4.1.4.2 Pacific Right Whale

1. The right whale of the north Pacific (*Eubalaena glacialis japonica)* is federally-listed as an endangered species (USFWS 1985b).

2. These whales are considered a temperate to boreal species (Townsend 1935; Braham and Rice 1984). In the eastern North Pacific, their summertime occurrence in the Gulf of Alaska was well documented by nineteenth century whalers, but their wintertime grounds are subject to speculation (Townsend 1935; Braham and Rice 1984; Scarff 1987). A few winter sightings have been made in Southern California waters, and one sighting occurred in the Santa Barbara Channel during the month of April (Woodhouse 1982). Although there is a comprehensive analysis of historic and contemporary sighting records for the eastern north Pacific (Scarff 1987), there is still no clear indication whether the species ever wintered off Central and Southern California or migrated through the region to more southerly waters, similar to the pattern of gray whales. Calving grounds for the north Pacific stock are unknown (Scarff 1987), although the size of the population has been estimated from 100 to 500 animals (Braham and Rice 1984; Scarff 1987).

4.1.4.3 Sperm Whale

1. The sperm whale (*Physeter catodon*) is federally-listed as an endangered species (USFWS 1985b).

2. The species is cosmopolitan, with males tending to range more poleward than females and calves which generally occur between 45° north and south latitude (Gosho et al. 1984). In general, the species occurs in deep water and seldom enters the Santa Barbara Channel (Woodhouse in preparation). Among five sighting records in the SBMNH data base, there were four in August and one in December. For Central and Northern California, Dohl et al. (1980) show a peak in sightings in May, with a lesser peak in December. Gosho et al. (1984) report two peaks of abundance off Central California, one in mid-May and a second in mid-September, by which they suggest a spring migration northward and a fall migration southward. They also mention the occurrence of breeding groups present in the winter off California over the continental slope from 33° north to 38° north. Their estimate of stock size in the eastern north Pacific was 111,400 males age 13 or more, and 162,600 females.

4.1.4.4 Gray Whale

1. The gray whale is federally-listed as an endangered species (USFWS 1985b).

2. The species ranges from the Beaufort, Chukchi, and eastern Siberian Seas to western Baja and the Gulf of California, including the coast of Sinaloa, Mexico. The majority occur off

the coast of Central California between December and May and may come within five nautical miles of the project area. The calving period is during December and January. The estimated population of the gray whale is 21,113 plus or minus 688 (Rice et al. 1984).

4.1.4.5 Blue Whale

1. The blue whale is federally-listed as an endangered species (USFWS 1985b).

2. This species ranges from the Chukchi Sea, Gulf of Alaska, and Aleutian Islands south to equatorial seas, including Costa Rica. The majority occur off the coast of Central California from May through October, and these whales may come within five nautical miles of the project area. Calving occurs during the winter months. The estimated population of the blue whale in the northern Pacific is 1,600, with estimates ranging from 1,400 to 1,900 (Mizroch et al. 1984b; Woodhouse in preparation).

4.1.4.6 Fin Whale

1. The fin whale is federally-listed as an endangered species (USFWS 1985b).

2. This whale ranges from the Gulf of Alaska (and may occur in the Chukchi Sea) to Southern California and the Gulf of California. The majority occur off the coast of Central California from May through October and may come within five nautical miles of the project area. Calving occurs during the winter months. The estimated population of the fin whale ranges from 14,600 to 18,600 (Mizroch et al. 1984c; Ohsumi and Wada 1974; Woodhouse in preparation).

4.1.4.7 Humpback Whale

1. The humpback whale is federally-listed as an endangered species (USFWS 1985b).

2. It ranges from the Chukchi and Bering Seas to central Mexico. The majority occur off the coast of Central California from May through October and may come within five nautical miles of the project area. Calving occurs during the winter months. The estimated population of the humpback whale ranges from 410 to 650 (Johnson and Wolman 1984; Woodhouse in preparation).

4.1.4.8 Guadalupe Fur Seal

1. The Guadalupe fur seal is federally-listed as a threatened species (USFWS 1985b) and is listed as Rare, protected by the state of California (CDFG 1986).

2. This species is largely confined to Guadalupe Island and its waters, with stragglers recorded north to San Miguel and San Nicolas Islands (Bonner 1981; Stewart 1981). In the future, it could recolonize its former range, which would include the Point Arguello area.

3. Within the offshore area potentially affected by the proposed project, this fur seal is not likely to occur in significant numbers relative to its population center at Guadalupe Island.

4.1.4.9 California Sea Otter

1. The California sea otter is federally-listed as a threatened species (USFWS 1985b) and listed as Rare, Protected by the state of California (CDFG 1986).

2. The species ranges from Coho Anchorage to Point Año Nuevo. During 1987 and 1988, its range south of Avila Beach has been occupied by sparse or scattered individuals. The breeding range of California sea otters, as judged by sightings of mother-pup pairs, incorporates the coast from Sandhill Bluff just north of Santa Cruz, to Shell Beach, just north of Pismo Beach (USFWS 1987).

3. Sea otters in general do not make the extensive migrations characteristic of some pinnipeds and cetaceans. Males will move throughout the California range, and tagged individuals have demonstrated the ability for males to swim from the southern to the northern end of the range repeatedly (Estes and Jameson 1983). The size of a male's home range can vary seasonally in California, with a narrower range occupied during the summer-fall breeding season (USFWS 1987). Data from 10 tagged males show that they occupied an average home range of about 100 acres along a coastline length of about 0.7 mile during the breeding season. Females tend to stay within a narrower range, previously thought to be limited to about three miles of habitat. However, recent data indicate that females may occupy an average of 11 miles of coastal habitat throughout their lives (USFWS 1987).

4. Typical of marine mammals, sea otters give birth to a single pup after an eight-month gestation period (Kenyon 1981). Pups may be born at any time of the year, but peak pupping has been noted from January to March; breeding tends to peak from July to October (USFWS 1987).

4.1.4.10 Northern Fur Seal

1. The northern fur seal is a federally-protected species under the MMPA and is considered to be depleted.

2. The species ranges through the boreal and temperate regions of the North Pacific rim from the waters of central Japan north to the Aleutian Islands, and south to California. San Miguel Island has been colonized by a relatively small, but reproductively active, group numbering an estimated 6,170 in 1981 (Northwest and Alaska Fisheries Center 1982). The San Miguel Island population stock is believed to remain in California waters throughout the year (Gentry 1981).

3. The breeding sequence at San Miguel Island appears to begin with the arrival of breeding bulls in late April, with breeding females arriving one month later. Bulls remain on the rookeries for 40 to 50 days and depart by early August. Pups remain on the rookeries until early fall, although some immature seals may be seen in nearly all months of the year on San Miguel Island.

4. Northern fur seals spend most of their time at sea where they tend to be solitary, in pairs, or sometimes in groups of three or more (Gentry 1981). While they may occur in loose aggregations over wide areas at sea, they densely aggregate on rookeries. With the exception of neonates, no animals spend more than 60-70 days a year on land.

5. In waters offshore of San Miguel Island, northern fur seals forage over deep water away from the coast (Antonelis et al. 1987). Bonnell et al. (1983) note from their surveys of California waters that the species rarely comes closer than 50 kilometers from shore.

4.1.5 MARINE BIRDS

4.1.5.1 California Brown Pelican

1. This species is federally-listed and California state-listed as endangered (USFWS 1985a; CDFG 1986). Despite an overall increase in the numbers of brown pelicans nesting in the Southern California Bight during the last 10 years (Table 4.2, Yearly Population Data for California Brown Pelican Nesting Colonies in the Southern California Bight), the California brown pelican has retained endangered status because of its low reproductive success and its small U.S. breeding population. Brown pelicans have been shown to be particularly sensitive to environmental perturbations and to human disturbance (Anderson and Keith 1980). Population fluctuation and reproductive success are also directly related to food availability.

YEARLY POPULATION DATA FOR CALIFORNIA BROWN PELICAN NESTING COLONIES IN THE SOUTHERN CALIFORNIA BIGHT

YEAR	ESTIMATED[1] NUMBER OF PAIRS	NUMBER OF YOUNG FLEDGED	PRODUCTIVITY[2]
1969	750	4	0.005
1970	552	1	0.002
1971	540	7	0.013
1972[3]	261	57	0.22
1973	247	34	0.14
1974[3]	416	305	0.73
1975[3]	292	256	0.88
1976	417	279	0.67
1977	76	39	0.51
1978[4]	210	37	0.18
1979	1,258	980	0.78
1980[5]	2,244	1,515	0.68
1981	2,946	1,805	0.61
1982	1,862	1,175	0.63
1983[5]	1,877	1,159	0.62
1984	628	503	0.84
1985[5]	6,194	7,902	1.28
1986[5]	7,349	4,601	0.63
1987	7,317	4,923	0.67

(1) These estimates represent a compromise between maximum numbers of nests constructed, reproductive behavior, and appearance of secondary sexual characteristics.

(2) Expressed as number of young fledged per pair. Data for years 1969 through 1974 are from Anderson et al. (1975), for 1975 to 1980 from Anderson and Gress (1984), for 1981 through 1984 from Gress (1982) and Gress and Anderson (1983 and 1984,) for 1985 and 1986 from Lewis and Gress (1987), and for 1987 from Gress and Lewis (1988).

(3) Nesting occurred on Scorpion Rock in 1972 (112 nests; 31 young), 1974 (105 nests; 75 young), and 1975 (80 nests; 74 young).

(4) Probable renesting occurred on Anacapa Island in 1978 (210 pairs built 340 nests).

(5) Nesting occurred on Santa Barbara Island in 1980 (97 nests; 77 young), 1983 (21 nests; 10 young), 1985 (1,046 nests; 1,515 young), and 1986 (1,441 nests; 615 young).

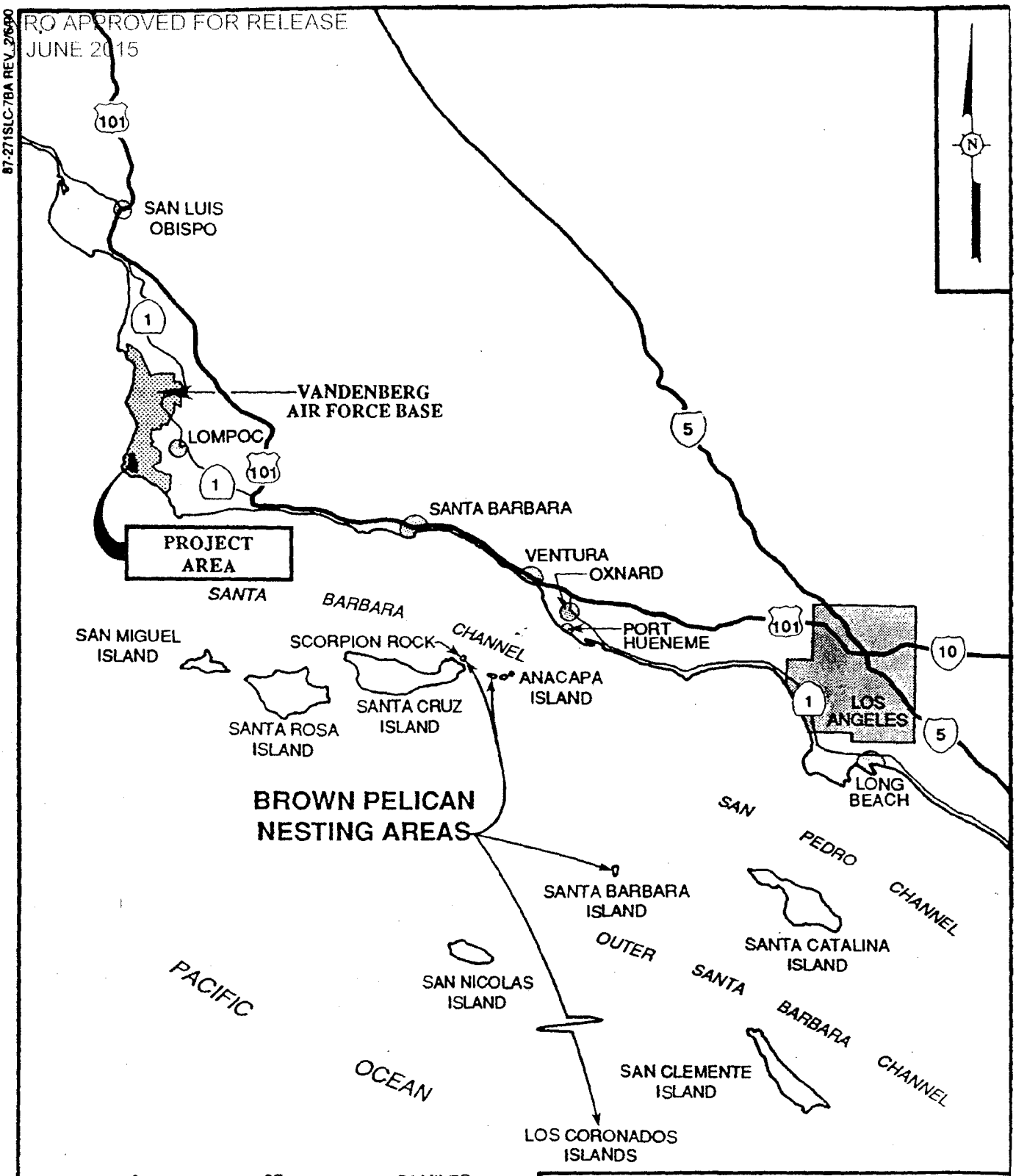
SOURCE: Gress and Anderson 1984; Lewis and Gress 1987; Gress and Lewis 1988.

2. The Pacific coast breeding distribution of the brown pelican can be described as four separate geographical groups: (1) Santa Barbara Channel Islands southward to northern Baja California (Southern California Bight), (2) southwestern Baja California in the vicinity of Bahia Tortugas and Point Cortes, (3) Gulf of California, and (4) mainland Mexico from the islands off Sinaba southward to Islas Tres Marias off Nayarit and Isla Ixtapa off Acapulco, Guerrero, Mexico (USFWS 1983; ES and SWRI 1988). Migratory birds range from Vancouver Island, British Columbia, south to Colima, Mexico (ES and SWRI 1988). As of 1981, the brown pelican colonies of the Southern California Bight comprised about six percent (3,000 pairs) of the total west coast breeding population of about 48,000 pairs (Gress and Anderson 1983).

3. Brown pelicans are a common year-round visitor to open beaches, nearshore waters, and protected bays and harbors in Santa Barbara County (Lehman 1982; Webster et al. 1980). Their numbers are much reduced during the late winter and early spring when most birds are at their nesting sites on islands off the coast of Southern California and Mexico. Peak abundance occurs in Santa Barbara County from July through December when pelican numbers swell with migrants from Mexico. From July to October 25,000 to 35,000 pelicans occupy the nearshore and coastal waters of the study region, as immigrants from Mexican colonies and local nesters disperse after their breeding season (Briggs et al. 1983) (Figure 4.1, Brown Pelican Nesting Areas in Study 6 Region).

4. Large numbers of pelicans congregate regularly during the fall and winter at several roost sites in northern Santa Barbara County, including Point Sal, Purisima Point and, more rarely, the Santa Ynez River mouth. Other important roost and loafing sites for brown pelicans within the study region are located at the mouth of Shuman Creek, the mouth of San Antonio Creek and on the Boathouse breakwater (USAF 1987a). Pelicans are also known to frequent roosts on the northern Channel Islands, at Santa Barbara Harbor, the mouth of the Goleta Slough, Point Mugu, and the mouth of the Santa Clara River (Lehman 1982; Briggs et al. 1983; Chambers Group 1986).

5. Since the early 1970s, brown pelican nesting in California has been limited to the Channel Islands off Southern California. West Anacapa Island contains the only consistently active pelican nesting colony, while Santa Barbara Island has been used increasingly since 1980. Scorpion Rock off Santa Cruz Island was used intermittently for nesting in 1972, 1974, and 1975 (Gress and Anderson 1984). Since detailed counts began in 1969, the west Anacapa



SOURCE: FROM ERT, 1984, IN ES, SWRI, 1988

FIGURE 4.1

BROWN PELICAN NESTING AREAS IN STUDY 6 REGION

SLC-7 BIOLOGICAL ASSESSMENT

ENVIRONMENTAL SOLUTIONS, INC.

Island and Scorpion Rock colonies have ranged from 76 nesting pairs in 1977 to 5,908 in 1986. These colonies produced between 1 and 6,387 fledged young from 1970 to 1985 (see Table 4.2). Brown pelicans nested on Santa Barbara Island in 1980, 1983, 1985, and 1986.

6. Brown pelican habitat consists of coastal waters and shorelines. They generally forage over relatively shallow waters within 15 miles of shore, but have been recorded during calm weather up to 45 miles offshore over waters along the continental slope. Brown pelicans must return to land to roost each night. Preferred roosting and resting areas are provided by offshore rocks and islands, river mouths with sandbars, breakwaters, pilings, and jetties (USFWS 1983). Pelicans often rest at a variety of sites during the day, but return to a major nocturnal roost site each night (Briggs et al. 1983).

7. Brown pelican breeding success and winter populations in the Southern California Bight vary with the abundance of northern anchovy (Anderson et al. 1980, 1982). Historically, pelicans in the Southern California Bight have competed with commercial fisheries for anchovies (Anderson and Gress 1984). Further, the relative proportions of total pelican nesting effort in the Southern California Bight region appear to oscillate between the Channel Islands and Isla Coronada Norte in northwestern Baja California, apparently in response to local anchovy abundance (Gress and Anderson 1983).

4.1.5.2 California Least Tern

1. The California least tern is a federally- and California state-listed endangered species (by USFWS in 1969 and CDFG in 1971).

2. The current distribution of this species extends from the San Francisco Bay area south into central Baja California (Massey 1977). Least terns are a migratory species that begin to arrive in the study region during late April and early May. They depart in August, following breeding, and by late August and early September the species is virtually gone (Lehman 1982). Known nesting locations in the project region are shown in Figure 3.6. Although the winter distribution of this subspecies is currently unknown, it is thought that California least terns probably winter in southern Mexico and Central America (Wilbur 1974). Least terns tend to feed on small fish in nearshore ocean waters, estuaries, and associated freshwater habitats, bays, tidal channels, harbors, and freshwater ponds. They have declined in California due to a variety of factors. Development and recreational use of the coast has led

to the loss of nesting habitat, while foraging and roosting habitats have been destroyed by the dredging and filling of coastal wetlands (Wilbur 1974). The introduction of nonnative predators such as rats, cats, and red foxes have also contributed to the decline of this species.

3. Least terns bred in the past at several sites along the south coast of Santa Barbara County, but today occur only as rare migrants and visitors (Lehman 1982). The species is known to breed south of Santa Barbara County in a disjunct distribution, with nesting colonies in Ventura County near the mouth of the Santa Clara River, at Ormond Beach, and at Point Mugu. In northern Santa Barbara County and southwestern San Luis Obispo County, least terns were recorded breeding at six localities during the 1980s: Pismo Beach, Oso Flaco Lake, Guadalupe Dunes near the Santa Maria River mouth, the mouth of San Antonio Creek, Purisima Point, and the Santa Ynez River mouth (Table 4.3, California Least Tern Breeding Colony Size and Fledging Success for Central California). The nesting colonies in Santa Barbara and San Luis Obispo Counties are small (1 to 30 pairs), containing approximately 5.8 to 12.3 percent of the species' total estimated statewide population. However, they are significant in that they represent the only currently active nesting areas between Ventura County and the San Francisco Bay. These colonies are important to the geographic breeding range of the species and to objectives of the recovery plan (USFWS 1980).

4. Least terns were first noted nesting at the Santa Ynez River mouth and a sandy island along the north shore of the Santa Ynez River estuary in 1983 (Bevier 1983). During the summers of 1984, 1985, and 1987, the Santa Ynez River mouth closed, resulting in high water conditions that flooded the island nesting site. No least terns were found to nest there in 1984 to 1985. There were eight to ten pairs in 1986 and four in 1987. Although the least tern colony at the Santa Ynez River mouth is intermittent and quite low, large numbers have been recorded using the area after the nesting season. The Santa Ynez River mouth is apparently a key area for feeding, roosting, and post-fledgling congregation of adults and juveniles (Bevier 1983). Preliminary observations from least tern banding studies recorded northward movements of post-breeding birds from Venice Beach in Southern California to the Santa Ynez River mouth.

5. The least tern is a fairly common but local summer resident along the north coast of Santa Barbara County from the Santa Ynez River mouth north to the mouth of the Santa Maria River (Lehman 1982). However, it is a rare but regular transient and post-breeding visitor to nearshore habitats in the study region and project area. Although least terns migrate through the study region, they have not yet been observed in the nearshore water adjacent to the project

TABLE 4.3

CALIFORNIA LEAST TERN BREEDING COLONY SIZE AND FLEDGING SUCCESS FOR CENTRAL CALIFORNIA (1980 TO 1989)

LOCALITY	1980		1981		1982		1983		1984		1985		1986		1987		1988		1989	
	N	F	N	F	N	F	N	F	N	F	N	F	N	F	N	F	N	F	N	F
SAN LUIS OBISPO COUNTY																				
Pismo Beach	–	–	..	–	3	5	?	?	0	0	–	–	–	–	..	..	..	..	..	–
Oso Flaco Lake	6-8	0-6	0	0	1-2	0	1	0	0	0	–	–	–	–	..	..	..	..	..	–
SANTA BARBARA COUNTY																				
Guadalupe Dunes	15-18	15	25	5-10	12	3	7	3	8-12	2	10-12	9-11	12-14	?	20-25	34-37	10-12	?	15-20	10-15
San Antonio Creek	2	0	4	4	6	2	14	10	15-19	1	13-15	4-5	3	0	2	0	7	3	3	0
Purisima Point	25-30	18-22	30	12	15-20	1	14	9	17-22	1	15-20	2-3	0	0	14	0	3	1	16-18	2
Santa Ynez River Mouth	..	..	..	..	..	..	8	4	0	0	0	0	8-10	0	4	6	0	0	3	0
VENTURA COUNTY																				
Santa Clara River	13-15	13	20-25	24	17-20	16	3	2	6-9	6	12	6-7	14	15	10-15	10	2-3	4	6	8
Ormond Beach	6?	0	0	0	7	0	4	2	..	..	4-6	0	?	–	0	0	2-4	?	3	1
Point Mugu	10-12	1	12	0	12-14	0	22	15	15-20	5	60	60-80	49	40	20	3	100	25	86	115-120
TOTAL	119-141	47-57	145-150	46-51	73-84	27	73	45	61-82	15	114-125	81-106	86-90	55	70-80	53-56	124-129	33	132-139	136-140

1/3/90

.. = No information recorded for colony for indicated year.
? = Birds were observed at colony, but colony size is uncertain.
N = Estimated number of breeding pairs.
F = Estimated number of fledglings.

SOURCES: Collins 1986; 1988b; CDFG 1989; Howald et al. 1985; Goldwasser 1980; and Webster 1981.

area (Chambers Group, Inc. 1980). Least terns can be expected to occasionally feed on small fish in nearshore waters and migrate through the inshore coastal areas adjacent to the project area from April through early September. During this time, they can be expected to use inshore habitats, such as nearshore kelp beds for foraging and protected beaches for roosting. The closest roosting, nesting, and foraging area for least terns in the study region is the estuary at the mouth of the Santa Ynez River.

4.1.5.3 Elegant Tern

1. This species *(Sterna elegans)* has recently been federally-listed as a Category 2 species (USFWS 1985a) and is considered as a third priority "Species of Special Concern" by the CDFG (1986) (Remsen 1978). Although there has been a long-term pattern of growth in the species population and expansion of its range in California (Unitt 1984), it was included on the Remsen list because it has only one nesting colony in the United States.

2. In Santa Barbara County, the elegant tern is a common post-breeding inhabitant of the coast during the late summer and early fall (Lehman 1982). The species can be found resting in flocks on mudflats, sandbars in coastal lagoons, or on beach dunes, and foraging over nearshore waters, river mouths, and in bays and harbors (Lehman 1982). An elegant tern was observed near the Boathouse harbor in mid-October 1983 during environmental monitoring for the Space Shuttle. This species can be expected to roost at the mouths of both the Santa Ynez River and San Antonio Creek and to forage over the nearshore waters and beaches adjacent to Cypress Ridge during the summer and early fall months.

4.1.6 TERRESTRIAL BIRDS

4.1.6.1 Southern Bald Eagle

1. The southern bald eagle is a federally- and California state-listed endangered species (USFWS 1985a; CDFG 1980).

2. Historically, bald eagles were a common visitor and permanent resident along the coast of Santa Barbara County and on the Channel Islands (Lehman 1982; Kiff 1980). By the 1930s, the species was common only on the Channel Islands and rare on the mainland (Willett 1933) and nested at a few sites along the south coast until the early 1950s (Garrett and Dunn 1981; Lehman 1982). According to Kiff (1980), the species nested on the northern Channel Islands until the early 1950s. Sightings that may have involved the last potential breeders occurred on May 9, 1949 at Gaviota, and a bird was seen at El Capitan State Beach during June-July 1949 (Lehman 1982).

3. Today, bald eagles occur regularly during the winter in small numbers at Lake Cachuma (Lehman 1982), and casually in very small numbers at Santa Rosa Island (Jones et al. 1985). Along the mainland coast they are a very rare migrant, generally occurring in the late fall and early winter (Lehman 1982). There have only been 11 sightings of bald eagles since 1971 away from their known wintering site at Lake Cachuma. Since 1975, a total of 15 bald eagles have been observed on Santa Rosa Island. They occur as a rare winter visitor at Santa Rosa Island (Collins 1988b) from November through February (Jones et al. 1985). The wintering bald eagle population at Lake Cachuma has varied from 13 in 1978-1979 (Lehman 1982), to four in 1980, to 12 to 18 during the winter of 1987-1988 (Table 4.4, Summary of Recent Sightings of Bald Eagles in Santa Barbara County) (Bontrager and Foerster 1987; Collins 1988b). The species typically arrives in November and departs by late March (Lehman 1982). Egg collecting, shooting of adults, and pesticides are factors thought to be responsible for the disappearance of bald eagles in Southern California (Kiff 1980). Accumulation of persistent chlorinated hydrocarbon pesticides, such as DDT and its metabolites, have resulted in lowered productivity and eggshell thinning, which in turn have led to substantial population declines (Sprunt et al. 1973; Wiemeyer et al. 1972).

4. The sightings nearest the project area are of one bird observed on VAFB on February 29, 1976 (Lehman 1982), one bird observed at Refugio Pass on January 5, 1975 (Collins 1984), and one bird observed at El Capitan Beach on November 6, 1974 (see Table 4.4). This species will likely continue to occur in the study region as a very rare fall and winter transient. The most likely site for migrant and wintering bald eagles to occur on VAFB would be along the Santa Ynez River from the base boundary to its mouth. This area provides suitable prey items (i.e., waterfowl and fish) and roost trees adequate for attracting an occasional transient. No concentrations of eagles are known or expected along the coast in the project area.

4.1.6.2 Least Bell's Vireo

1. This species is a federally- and California state-listed endangered species (USFWS 1985a).

2. Formerly, this species was a widespread and common inhabitant of riparian woodlands throughout California and Baja California (Grinnell and Miller 1944), described as "common in summer willow thickets from coast to foothills" (Willett 1933). Noticeable declines were noted in Bell's vireo populations in California beginning in the 1930s. Since that time, the species has declined significantly throughout California, due largely to destruction of lowland

TABLE 4.4

SUMMARY OF RECENT SIGHTINGS OF BALD EAGLES IN SANTA BARBARA COUNTY

LOCALITY	DATE	NUMBER	SOURCE/OBSERVER
MAINLAND SIGHTINGS			
(SANTA BARBARA COUNTY)			
Santa Barbara Bird Refuge	9 November 1971	1	Lehman (1982)
El Capitan Beach	6 November 1974	1	SBMNH Sighting File
Refugio Pass	5 January 1975	1	SBMNH Sighting File
Over Goleta	16 December 1975	1	Lehman (1982)
Vandenberg Air Force Base	29 February 1976	1	Lehman (1982)
Lake Cachuma	13 April 1979	3	Schram
Lake Cachuma	Winter 1979	4 Imm	American Bird Report
Lake Cachuma	24 November 1980	1	American Bird Report
Lake Cachuma	Winter 1981	4	American Bird Report
Lake Cachuma	3 May 1981	2	Lehman
Gibralter Reservoir	2 January 1982	1	Lehman (1982)
Lake Cachuma	Winter 1982	7	American Bird Report
Goleta Area	1 January 1983	1 Imm	Paul Lehman
Lake Cachuma	Winter 1983	4	American Bird Report
Lake Cachuma	27 March 1983	2	Bevier
Lake Cachuma	Winter 1984	4	American Bird Report
Lake Cachuma	Winter 1985	4	American Bird Report
Goleta	19 October 1987	1 Imm	Hamber
Santa Barbara	20 October 1987	1 Imm	Hamber
Carpinteria	10 November 1987	1 Imm	Lehman
Lake Cachuma	Winter 1987	12	Bontrager and Foerster (1987)
Lake Cachuma	Winter 1988	18	Allen
CHANNEL ISLANDS SIGHTINGS			
(SANTA BARBARA COUNTY)			
Windmill Canyon, (SRI)	28-29 January 1975	1 Ad	Wallingford
Santa Rosa Island	26 September 1975	1 Ad	SBMNH Sighting File
Santa Rosa Island	25 February 1976	2	Collins
Brockway Point, (SRI)	19 January 1977	1 Imm	Jones
Santa Rosa Island	26 January 1977	2	Collins
Santa Rosa Island	17 February 1977	1	BLM Data
Santa Rosa Island	4 May 1977	1 Imm	Collins
Santa Rosa Island	16 January 1982	1 Ad	Abbott
Santa Rosa Island	25 February 1982	2 Imm	Wallace
Santa Rosa Island	7 December 1982	1 Ad	Van Riper
Santa Rosa Island	9-13 December 1982	1 Imm	Fellers
Santa Rosa Island	11 November 1986	1	Collins

3/7/90 (87-271H)

Ad = Adult Individual
BLM = Bureau of Land Management
Imm = Immature Individual
SBMNH = Santa Barbara Museum of Natural History
SRI = Santa Rosa Island

SOURCE: Collins 1988b.

riparian habitats and increased rates of brood parasitism by the brown-headed cowbird (Lehman 1982). Today, least Bell's vireos breed at only a few locations in Southern California.

3. In Santa Barbara County, least Bell's vireos are a casual visitor along the coast during migration (Lehman 1982). They are a localized breeder only along the upper Santa Ynez River and nearby Mono Creek (Lehman 1982; Gray and Greaves 1984). In Santa Barbara and Ventura Counties, there have been nine sightings of least Bell's vireos away from their Santa Ynez River nesting locale during the past 12 years (Lehman 1982, 1986; Collins 1986). In 1980, the species was observed in Barka Slough, and a possible nest (inactive) was seen (Dial 1980). Despite intensive surveys of riparian habitats on VAFB, this species has yet to be found again at Barka Slough or in other riparian areas on VAFB (Webster 1980; Howald et al. 1985; Breininger 1988).

4. The present consensus of local ornithologists is that this species is a migrant visitor and does not breed in the VAFB area. The only sightings of this species from within the study region are of a bird seen in Sacate Canyon on the Hollister Ranch in 1975 and of a migrant in the tamarix trees at Gaviota State Beach Park in September 1985 (Chambers Group 1986). Riparian habitats in the project area at Red Roof, Spring, and Agua Viva Canyons are located too close to the coast and are not of sufficient size or quality to provide suitable nesting habitat for least Bell's vireos. Therefore, it is unlikely that this species would attempt to breed in the project area. However, since Bell's vireos migrate through the region, they are expected to occur in riparian habitats in the project area as casual transients during spring and fall migratory movements.

4.1.6.3 California Black Rail

1. The California black rail *(Laterallus jamaicensis coturniculus)* is designated as a Category 2 candidate for federal listing by the USFWS (1985a) and as a threatened species by the CDFG (1986).

2. This species is a small, secretive bird which is little known. Along the coast of California, black rails have been found in fresh and saltwater marshes in scattered localities between the San Francisco Bay area and San Diego (Wilbur 1974; Manolis 1977). On the coast, black rails occur in the upper portion of tidal sloughs and in infrequently flooded marshes

(Malonis 1977). At present, this species occurs regularly along the coast only in the San Francisco Bay area and at Morro Bay (Manolis 1977; CDFG 1985). Historically, black rails nested in 1936 at Port Hueneme (Webster 1980).

3. There are four confirmed sightings of black rails from the Santa Barbara region, all prior to 1940 and from within the city limits (Lehman 1982). There have been no recent confirmed black rail sightings from the study region. However, there is a probable but unconfirmed record of a black rail briefly seen and heard in suitable habitat at the Santa Ynez River mouth in May 1981 (Howald et al. 1985). Potential habitat for black rails is present at the Santa Maria and Santa Ynez River mouths, and they could use the tidal marsh at the Santa Ynez River mouth on an infrequent basis as casual transient or winter visitors. This species is not expected to occur in the project area.

4.1.6.4 Western Yellow-billed Cuckoo

1. This species is designated as a Category 2 candidate by the USFWS (1985a) and a threatened species by the CDFG (CDFG 1980).

2. In the past, the yellow-billed cuckoo nested in dense cottonwood and willow riparian woodlands throughout much of California (Grinnell and Miller 1944; Willet 1933). Today, the species has been extirpated as a breeder from most of California due to loss of suitable riparian habitat (Gaines and Laymon 1984); there are no recent nesting records for Santa Barbara County despite the presence of apparently suitable habitat (Lehman 1982).

3. Recent sighting records suggest that this species is a casual transient in Santa Barbara County (Lehman 1982). It has been observed once on VAFB, a single bird was sighted at Barka Slough on June 19, 1982, in appropriate breeding habitat. However, more intensive surveys of the Barka Slough area failed to turn up any more yellow-billed cuckoos (Breininger 1988; Dial 1980; Webster 1980; Howald et al. 1985). It may be concluded that if the species does breed at Barka Slough, it does so rarely and in very small numbers.

4. Since this species requires relatively large tracts of riparian habitat for nesting, it is unlikely to occur other than as a casual transient in the study region and as a very rare transient in the relatively small riparian habitats in the project area. The riparian woodlands in Red Roof and Agua Viva Canyons are not of sufficient size or quality to attract or support a nesting population of California yellow-billed cuckoos.

4.1.6.5 American Peregrine Falcon

1. The American peregrine falcon is federally- and California state-listed as an endangered species (USFWS 1985a; CDFG 1980).

2. This species can be found along coastlines, in mountainous areas, and in riparian habitats. The American peregrine falcon nests in northern Canada and formerly bred throughout the United States. It winters in Mexico and areas in central South America. Peregrine falcons occur in California as permanent residents and migrants. They were once much more common in Southern California, particularly as a nesting bird (Garrett and Dunn 1981). Bond (1946) recorded 328 peregrine falcon nesting sites and estimated that 750 peregrine falcons inhabited western North America. In 1944, Grinnell and Miller described the species as fairly common in California.

3. The species has declined throughout California and most of North America since the 1940s due to detrimental effects of pesticides, shooting, habitat destruction, and capture of individuals for falconry (CDFG 1980). Eggshell thinning caused by dichlorodiphenyl-trichlaoethane (DDT) continues to be a severe problem with peregrines which nest along the coast (Walton 1988) and they were extirpated as breeders from the Channel Islands between the mid-1940s and early 1950s as a result of DDT-caused breeding failures (Kiff 1980). Since then, they have occurred on the northern Channel Islands as occasional transient and winter visitors.

4. Until the early 1950s, peregrine falcons were resident on all of the Channel Islands (Kiff 1980) and nested in coastal habitats in Santa Barbara County (Collins 1983; Biosystems Analysis, Inc. 1981). Along the county's north coast, peregrines nested into the early 1960s on coastal bluff faces at Point Sal, near the Boathouse area at Point Arguello, and near the lighthouse at Point Conception (Walton, 1988; Howald et al. 1985).

5. Since 1970, there have been only 12 sites along the central coast of California at which peregrine falcons have nested, even though there are 35 known historical nest sites within the same area (Biosystems Analysis, Inc. 1981; Collins 1983). However, since 1970, the number of breeding pairs of peregrine falcons in California has increased. The USFWS estimated that there were 50 to 60 breeding pairs in California in 1979 (USFWS 1982), 64 by 1984, and 80 by 1985. At least 10 of these pairs were located along the coast (Walton 1988).

6. Relative to the study region, the closest known active peregrine nest sites on the mainland are to the north in the Shell Beach/Avila Beach area, at Diablo Canyon, and at Morro Rock adjacent to Morro Bay (Walton 1988; URS 1985). At least one or two individuals are seen somewhat regularly in the Point Arguello to Point Conception area (Walton 1988; Mills 1988). Although there have been no adequate recent surveys for peregrine nests in the Point Conception to Point Arguello area, birds have been observed during the nesting season (February-July) (Walton 1988).

7. Preferred peregrine nesting habitat appears to be protected ledges on high cliffs within woodland and coastal areas of Central and Northern California. Today peregrine falcons are considered a rare transient and winter visitor along the coast in Santa Barbara County where they tend to frequent open country such as grasslands, agricultural areas, ponds, sloughs, river mouths, and seacoasts for hunting (Lehman 1982). Peregrines are known to hunt for shorebirds and waterfowl over the ocean, along beaches, over sloughs, and over reservoirs and ponds. The study region and project area contain a substantial amount of suitable foraging and nesting habitat. Relatively undisturbed coastline is present, and the damming of numerous creeks on the Hollister and Bixby Ranches have formed many small ponds which are frequented by waterfowl.

8. Since the 1970s, there has been an active program underway in California to reintroduce peregrine falcons into their historic range. The recovery program for this species includes captive breeding and rearing of peregrines and placement (hacking) into former nesting areas in order to have these captive-bred birds reestablish themselves in the wild (CDFG 1980). Successful reestablishment of peregrines in the Santa Ynez Range and western Santa Barbara County would change their status to permanent residents within the study region and project area.

9. Six birds were released on San Miguel Island between 1985 and 1987 as part of the captive breeding and release program. Until that time, peregrines were thought to be uncommon but regular visitors to the Channel Islands during the spring and winter (Jehl 1979; 1980; Yochem 1985). Peregrine falcons began nesting on San Miguel Island in the spring of 1988 (Walton 1988), and have been recently found to be nesting on Santa Cruz and west Anacapa Islands (Peregrine Fund 1989). In addition, there was a possible active peregrine falcon nest located at Point Arguello during June 1989. This has not been confirmed by the Peregrine Fund as an active nest (Peregrine Fund 1989). Thus, it appears that the status of peregrine falcons on the northern Channel Islands and within the project area is changing.

10. Until the early 1980s, an average of one or two peregrines per year were sighted along the coast of Santa Barbara County (Lehman 1982). At present, largely as a result of the captive breeding and release program, there have been increasing sightings in the county (see Table 4.5, Summary of Recent Sightings of Peregrine Falcons from the Mainland of Santa Barbara County). Since 1970, 43 peregrine falcons have been sighted on the mainland in Santa Barbara County (Collins 1988b). There are recent sightings for the Santa Maria Valley, the Santa Ynez and Santa Maria River mouths, Jalama, Point Conception, and the Hollister and Bixby Ranches. Single birds were observed on VAFB at Purisima Point in August 1986, at Jalama in January 1987, on North VAFB in December 1988, at Point Sal in February 1989, and at the mouth of the Santa Ynez River in August 1979, December 1987, and April and July 1988 (Collins 1988b). Many of these sightings could be of individuals released as part of the captive breeding program. It appears that the seasonal status and abundance of peregrine falcons in the study region and project area is increasing as a result of the captive breeding and release program (Collins 1988b).

4.1.6.6 White-faced Ibis

1. The white-faced ibis *(Plegadis chihi)* is a Category 2 candidate for federal listing (USFWS 1985b) and has been assigned the highest priority of "Species of Special Concern" by the CDFG (Remsen 1978).

2. Due to loss of much of its preferred freshwater marsh habitat, it has declined during the past 50 years throughout Southern California (Remsen 1978; Garrett and Dunn 1981). Its preferred nesting habitat is extensive marshes, while its foraging habitat includes marshes, flooded fields, ditches, and occasionally estuaries (Garrett and Dunn 1981). In the past, this species was more numerous and nested in Santa Barbara County. Today, white-faced ibis are rare fall transients in coastal areas of Santa Barbara County and are casual in winter, spring, and summer (Lehman 1982).

3. Seven birds were observed in September 1978 in the vicinity of the Boathouse on South VAFB (Chambers Group, Inc. 1980). Although the species can be expected to occur in the project area, its status there would be as a casual fall transient. The nearest suitable foraging habitat occurs at the mouth of the Santa Ynez River.

TABLE 4.5

SUMMARY OF RECENT SIGHTINGS OF PEREGRINE FALCONS FROM THE MAINLAND OF SANTA BARBARA COUNTY

LOCALITY	DATE	NUMBER	OBSERVER
Goleta Slough	March 27, 1970	1	Richard Webster
Hollister Ranch	March 2, 1975	1	R. Bailey
Santa Maria River Mouth	October 1, 1978	1	Louis Bevier
Goleta	October 11, 1978	1	D. L. Dittmann
Santa Maria River Mouth	December 7, 1978	1	Paul Lehman
Refugio State Beach Park	December, 1978	1	Jim Hodgeson
In Goleta	January 19, 1979	1	Gary Fugle
Santa Ynez River Mouth	August 22, 1979	1(1)	Paul Lehman
In Goleta	October 5, 1979	1	E. and J. Gray
In Goleta	April 6, 1980	1	Paul Lehman
Near Santa Maria	August 19, 1980	1(1)	Louis Bevier
In Santa Barbara	February 7, 1981	1	N. S. Crawford
Santa Maria River Mouth	July 10, 1982	1	Louis Bevier
Santa Maria River Mouth	August 29, 1982	1	Louis Bevier
In Santa Barbara	September 12, 1982	1	L. R. Ballard
In Goleta	October 4, 1982	1	Louis Bevier
In Goleta	October 22, 1982	1	Helen Matelson
In Goleta	October 25, 1982	1	Louis Bevier
Gaviota	1982	1	Westec Services
Santa Maria River Mouth	August 24, 1983	1(2)	Paul Lehman
Santa Maria River Mouth	October 18, 1983	1(2)	Curtis Marantz
In Goleta	November 6, 1983	1(1)	Paul Lehman
West Big Pine Mountain	January 13, 1984	1	John Schmitt
Don Victor Valley	February 13, 1984	1	John Schmitt
Near Carpinteria	April 27, 1984	1	L. R. Ballard
In Goleta	December 28, 1984	1	N. S. Crawford
In Santa Barbara	January 18, 1985	1	Pipette Bergman
Bixby Ranch, Wood Canyon	Summer, 1985	1(2)	Tom Mulroy
In Goleta	November 22, 1985	1	Paul Lehman
Little Cojo Point	January 2, 1986	1(2)	Paul Collins
SLC-6 Hazardous Waste Ponds	January 28, 1986	1(2)	Chuck Pergler
Near Santa Maria	April 1, 1986	1	Jon L. Dunn
Purisima Point	August, 1986	1(1)	C. D'Antonio
Santa Maria River Mouth	October 5, 1986	1	C. D. Benesh
Jalama Beach	January 15, 1987	1(2)	Don Clopfen
Santa Maria River Mouth	July 19, 1987	1	S. E. Finnegan
In Santa Maria Area	November 9, 1987	1	Paul Lehman
At Lake Cachuma	August 25, 1987	1	Brian Arnold
One Mile North of Point Conception	December 10, 1987	1(1)	John Storrer
Santa Ynez River Mouth	December 17, 1987	1(1)	Ken Hollinga
In Goleta	January 1, 1988	1(1)	Jon L. Dunn
Santa Ynez River Mouth	April 16, 1988	1(2)	Ken Hollinga
Santa Ynez River Mouth	July 21, 1988	1	Paul Collins
North VAFB	December 18, 1988	1	Paul Collins
Point Sal	February 11, 1989	1	Paul Collins

(1) Immature falcon
(2) Adult falcon

3/1/90 (87-271H)

Source: Collins 1988b.

4.1.6.7 Ferruginous Hawk

1. The ferruginous hawk (*Buteo regalis*) is a Category 2 candidate for federal listing (USFWS 1985b) and appears on the Audubon Society's Blue List as a "Species of Special Concern" (Tate 1986).

2. This species is an uncommon fall transient and winter visitor to grasslands and agricultural fields in Santa Barbara County (Lehman 1982). It is most numerous in agricultural areas in the Cuyama Valley and occurs regularly but in small numbers in the Los Alamos and Santa Ynez Valleys. Along the coast it is a casual fall transient and winter visitor (Lehman 1982). Within the study region, ferruginous hawks have been observed during the winter near the mouth of the Santa Ynez River (Pergler 1988), at Jalama Beach (Lehman 1982), and on the Hollister and Bixby Ranches (Storrer 1988). One ferruginous hawk was reported in the vicinity of the Boathouse at South VAFB in May 1983, perhaps in error, as the species is not known to occur in coastal Southern California after mid-April (Garrett and Dunn 1981).

3. Within the project area, this species can be expected to occur regularly but in small numbers during the late fall and winter. Grasslands and open coastal scrub habitats provide suitable foraging habitat for ferruginous hawks.

4.1.6.8 Western Snowy Plover

1. The western snowy plover is a Category 2 candidate for federal listing (USFWS 1985a), is listed as a second priority "Species of Special Concern" by the CDFG (Remsen 1978), and is a "Species of Special concern" on the National Audubon Society's Blue List (Tate 1986).

2. Western snowy plovers have declined as a nesting species throughout Southern California and the study region due in part to human disturbance of their sandy beach nesting habitat (Remsen 1978). They have been extirpated as a breeding species in southern Santa Barbara County, but continue to breed and winter along undisturbed sandy beaches in northern Santa Barbara County, especially on VAFB.

3. In Santa Barbara County, populations are larger in winter than summer, due to an influx of birds from inland breeding localities. Page et al. (1986) estimated that 329 plovers wintered on beaches in Santa Barbara County, with major concentrations at the Santa Maria River mouth (48 birds), Purisima Point Beach (28 birds), Purisima Point north (22 birds), Santa Ynez River mouth (65 birds), Jalama Beach (25 birds) and Devereux Beach (57 birds). Page and Stenzel (1981) found that Santa Barbara County held 22 percent (138 pairs) of

California's coastal breeding snowy plovers. The species nests on undisturbed sandy beaches at San Miguel Island (35 pairs), Santa Rosa Island (21 pairs), Santa Ynez River Mouth (5 pairs), Purisima Point Beach (55 pairs), south Nipomo Dunes (4 pairs), and the Santa Maria River mouth (18 pairs) (Page and Stenzel 1981).

4. Snowy plovers have not been found nesting on suitable looking sandy beaches between Point Arguello and Point Conception, but can be expected to winter there in small numbers. Their status within the project area is as an uncommon winter visitor, and within the study region as a common winter visitor and an uncommon but localized summer breeder on undisturbed stretches of sandy beach.

4.1.6.9 Long-billed Curlew

1. This species *(Numenius americanus)* is a Category 2 candidate for federal listing (USFWS 1985a) and appears on the Audubon Society's Blue List as a "Species of Special Concern" (Tate 1986).

2. The long-billed curlew is an uncommon transient throughout Southern California, frequenting coastal estuaries, dry grasslands, agricultural fields and, to a lesser extent, sandy beaches along the coast (Garrett and Dunn 1981). This species is not known nor is it expected to breed in the Southern California region. Along the north coast of Santa Barbara County, long-billed curlews are locally common transients and winter visitors and are fairly common in the late spring and early summer (Lehman 1982).

3. Long-billed curlews have been observed on beaches north and south of the project area, with 200 recorded on North VAFB beaches in June 1982, 460 at Point Sal in July 1980, and 20 near Point Conception in January 1988 (Storrer 1988). This species was also recorded regularly in small numbers in the vicinity of the Boathouse on South VAFB during environmental monitoring for the Space Shuttle project (Collins 1988b). Within the project area, this species can be expected to occur regularly in small numbers during the spring and summer and in moderate numbers during the fall and winter.

4.1.6.10 Tricolored Blackbird

1. The tricolored blackbird *(Agelaius tricolor)* is a Category 2 candidate species for federal listing (USFWS 1985a).

2. This species is locally resident throughout coastal areas of Southern California and can be found in large congregations at breeding and wintering localities (Garrett and Dunn 1981). In Santa Barbara County, the species breeds locally in large colonies located in dense stands of bullrushes and cattails (Lehman 1982). Nesting colonies of tricolored blackbirds have been found in the Santa Maria, Buellton, Goleta, and Cuyama Valley areas (Lehman 1982). Summer foraging occurs in agricultural areas, fields, pastures and short grass habitats adjacent to nesting colonies (Lehman 1982). During the fall and winter, this species forages in agricultural areas, cattle pens, pastures, and other short grass habitats (Lehman 1982).

3. The largest concentrations of wintering tricolored blackbirds in the Santa Barbara region have been found in the Santa Maria Valley and near the Santa Ynez River mouth on VAFB (Lehman 1982). This species has not been observed in the project area, but is expected to occur in small numbers during the fall and winter, foraging in grassland and open coastal sage scrub habitats.

4.2 REGIONALLY RARE AND DECLINING SPECIES

1. This section discusses plant and animal species that are of regional importance because they have limited distributions, limited population sizes, and/or have shown regional declines in their distributions and/or numbers. There are six species of plants, 18 species of birds, and two species of mammals that are in this category and have the potential to occur within the study region and project area. The plant species are listed by the CNPS in Appendix 1 of their Rare and Endangered Plant Inventory or in List 4, a watch list of plants with limited distributions. The animal species have shown regional or state-wide declines and have been listed as "Species of Special Concern" by the CDFG (Remsen 1978; Williams 1986), on the National Audubon Society's Blue List (Tate 1986), and/or are considered by local biologists to be rare or decreasing significantly in the Santa Barbara region. The plant species are included in the CNPS's Rare and Endangered Plant Inventory and watch list of plants of limited distribution.

2. The following accounts summarize the available data pertaining to the past and present status and habitat affinities of regionally rare/declining species found or expected to occur in the study region and project area.

4.2.1 PLANT SPECIES

1. This section provides information on the appearance, past and present distribution, and habitat affinities of special interest plants found within the study region and project area.

4.2.1.1 Fiddleneck

1. This species (*Amsinckia spectabilis* var. *microcarpa*) is included in Appendix 1 of the CNPS Rare and Endangered Plant Inventory as a plant considered for listing, but considered too common to list (Smith and York 1984).

2. Fiddleneck is a sprawling annual herb, with orange-yellow flowers that appear from February through June. It is endemic to sandy areas from Nipomo Mesa in San Luis Obispo County to near Surf, Lompoc, and Buellton (Smith 1976) and south along the coast at least to the Boathouse Flats site. The population on VAFB is possibly the largest in existence (Smith 1983), but there is no estimate of its percentage of the total population. Fiddleneck is common to abundant in grassland at lower elevations throughout the study area, including the Cypress Ridge and Boathouse Flats sites. It is less common at the borrow sites.

4.2.1.2 Purisima Manzanita

1. Purisima manzanita (*Arctostaphylos purissima*) is included in CNPS Appendix 1 as a plant considered for listing, but considered too common to list (Smith and York 1984).

2. This species is a shrub with smooth bark and small, white flowers that appear from November to May. It is endemic to northwestern Santa Barbara County, from Point Sal to the Purisima Hills, Burton Mesa, south to Lompoc Terrace and Cypress Ridge, and eastward in the Santa Ynez Mountains to about five miles west of Gaviota Pass (Smith 1976). It is common in central maritime chaparral on VAFB, especially on Burton Mesa and Lompoc Terrace. No estimates of population size are available. In the study region, it occurs on some ridges to the east of SLC-6, on a slope southeast of Building 520 near Venus Way, and in sandy soil on two ridges to the east of Oil Well Canyon at approximately 650 feet in elevation. It occurs on the south, east, and north edges of the proposed borrow site on Mesa Road.

4.2.1.3 Santa Barbara Ceanothus

1. This endemic ceanothus (*Ceanothus impressus* var. *impressus*) is included in CNPS Appendix 1 as a plant considered for listing, but considered too common to list.

2. Santa Barbara ceanothus is an evergreen shrub with blue flowers that bloom from March through May. It occurs from Nipomo Mesa in southern San Luis Obispo County south to Burton Mesa, east to near Buellton (Munz and Keck 1959; Hoover 1970; Smith 1976), and south to the Cypress Ridge site. It is common on the north and south sides of SLC-6 (southwest of Building 520 and near Building 369, respectively), on the north slope of Cypress Ridge (southwest of the V-33 building), and scattered in the recently burned area of the Cypress Ridge site, where there are fewer than 10 plants. It is also scattered on the edges of the existing borrow site on Mesa Road, possibly favored by past soil disturbance.

3. Santa Barbara ceanothus often dominates some areas in chaparral for approximately 10 to 15 years after a fire (Davis et al. 1988); beyond that it is replaced by longer-lived chaparral species. It may be locally common in the study region as a result of a large wildfire that occurred in 1977 and a controlled burn conducted in 1983 (Hickson 1987); it will possibly reestablish in greater numbers in the burned area of Cypress Ridge.

4.2.1.4 Western Dichondra

1. Western dichondra (*Dichondra occidentalis*) is included in CNPS List 4, a watch list of plants of limited distribution.

2. This species is a creeping perennial herb that flowers at or below the soil surface from March to May and occurs in coastal scrub, chaparral, and oak woodland from coastal Ventura County to Baja California and on some California islands (Munz and Keck 1959; Smith and York 1984). The distribution and population size in Santa Barbara County are unknown. This dichondra is common on the upper slopes of the Cypress Ridge site and infrequent on the Vina Terrace site. There are no records of it on VAFB outside of the study region (Schmalzer and Hinkle 1987).

4.2.1.5 Saint's Daisy

1. Saint's daisy (*Erigeron sanctarum*) is included in CNPS List 4, a watch list of plants of limited distribution.

2. This species is a small herb with purple flower heads that bloom from May through July. It is endemic to coastal San Luis Obispo County, Santa Barbara County, and Santa Rosa Island, often associated with chaparral and central coastal scrub. It is known to occur on Burton Mesa and VAFB (Smith 1983; Schmalzer and Hinkle 1987; D'Antonio 1988); there are no

estimates of its total population size on VAFB. A small population (about 20 plants) was found in the study region on a ridge to the northeast of Cypress Ridge, approximately 6,000 feet north of the Southern Pacific Railroad crossing of Oil Well Canyon.

4.2.1.6 Large-leaved Wallflower

1. Large-leaved wallflower (*Erysimum suffrutescens* var. *grandifolium*) is included in CNPS List 4, a watch list of plants and limited distribution.

2. This species is a perennial herb with sprawling branches and yellow flowers. It occurs in coastal bluff scrub and dune scrub on the south coast of Santa Barbara County, and from near Point Arguello to Point Sal, to Morrow Rock in San Luis Obispo County (Smith 1976). Population estimates are not available for this plant. It is scattered in the central coastal scrub on the northern part of the Cypress Ridge site, east of Coast Road.

4.2.2 TERRESTRIAL ANIMAL SPECIES

1. Two regionally rare and declining amphibians, California tiger salamander and California newt, are known to occur within the boundaries of the study region. However, they do not occur within the project area and so are not discussed further.

2. There are a few mammals which show restricted distributions within the study region and project area. These include the western gray squirrel, ringtail, muskrat, and beaver. These species are not included in the following regionally rare and declining species accounts because they are not expected to occur in the project area. However, there are sufficient data to suggest that two species of regionally rare land mammals, badger and mountain lion, may occur within the project area. These species are discussed below.

4.2.2.1 Badger

1. The badger is listed by the CDFG in the third priority of "Mammal Species of Special Concern" (Williams 1986) and is considered by local biologists to be regionally rare and declining in Santa Barbara County.

2. This carnivore is widespread in Santa Barbara County. It inhabits a variety of open habitats such as grassland, oak savannah, and sparse coastal scrub and chaparral. Specimen and sight records suggest that badgers are still reasonably common on VAFB (Coulombe and

Mahrdt 1976) and on ranch lands in northwestern Santa Barbara County (Howald et al. 1985). Coulombe and Mahrdt (1976) list badgers as common in open grasslands, coastal sage scrub, and sparse chaparral habitats on VAFB.

3. Field surveys conducted in the spring of 1988 found that badgers were present in coastal scrub and grassland habitats at the Cypress Ridge site. Active badger sign was found along the electrical transmission line corridor adjacent to the Coast Road, on the southern edge of the Cypress Ridge site, on the eastern edge of the Boathouse Flats site, and on the eastern perimeter of the Vina Terrace site. Excellent badger habitat occurs on the Boathouse Flats site and in the grasslands and open coastal scrub at the Cypress Ridge site. Based on the above data, badgers can be classified as an uncommon resident in the project area.

4.2.2.2 Mountain Lion

1. The mountain lion is listed as a protected nongame mammal by the CDFG (i.e., no hunting without a special license).

2. Mountain lions are reasonably common throughout most of the more remote areas of Santa Barbara County, and their numbers appear to be on the rise (Howald et al. 1985). They are wide-ranging carnivores that frequent mostly wooded or brushy habitats, preferring steep, inaccessible slopes vegetated with a dense cover of chaparral (Koford 1977). Mountain lions have been recorded along most of the Santa Ynez Mountains (Collins 1988b). In the study region, they have been reported from the Santa Rosa Hills, the western end of the Santa Ynez Mountains on the Hollister and Bixby Ranches (Mills 1988; Heubner 1988), and observed on South VAFB in the Bishop pine forest and near Bear Creek (Howald et al. 1985). There are no specimen records of mountain lions from VAFB, but they are expected to occasionally range onto South VAFB from the western end of the Santa Ynez Mountains.

3. Mountain lions may occasionally forage in the project area, especially at the Vina Terrace site and along the ridge east of SLC-6. They are not expected to reside in the project area, due to constant activity (Collins 1988b). Chaparral along Honda Ridge and dense coastal scrub in Oil Well and Agua Viva Canyons and at the Vina Terrace site is the preferred habitat for this species in the project area, where they are considered uncommon to rare.

4.2.2.3 Monarch Butterfly

1. The monarch butterfly has a near-worldwide distribution and is not in danger of extinction as a species. However, both the western and eastern North American populations are vulnerable to heavy loss because of their overwintering strategy, and the North American migration is believed to be in danger in the foreseeable future. As a consequence, the conservation of monarch butterfly overwintering sites has been designated a top priority of the Species Survival Commission of the International Union of the Conservation of Nature and Natural Resources (IUCN) (Pyle 1983). Although monarchs are not specifically protected under either federal or California law, they can be indirectly conserved under the Public Resources and Fish and Game Codes.

2. During the fall months, monarchs west of the Rocky Mountains migrate west to California, while those east of the Rockies migrate south to Mexico. The monarch breeds over much of western North America (Urquhart and Urquhart 1977). However, the main summer breeding grounds of the western North American population are in the Sacramento and San Joaquin Valleys of California, and only this population overwinters on the west coast (Ackery and Vane-Wright 1984). The number of monarchs overwintering in California is estimated at one to 10 million, with populations susceptible to destruction for a variety of reasons, including real estate and agricultural development and other human disturbance. The butterflies congregate in both temporary and permanent clusters, utilizing the same localities from year to year.

3. Monarchs may cluster in a variety of native and introduced trees, commonly blue gum (*Eucalyptus globulus*), river gum (*Eucalyptus camaldulensis*), Monterey Pine (*Pinus radiata*), and Monterey cypress (*Cupressus macrocarpa*). Also, cluster sites are usually characterized by a nearby source of fresh water, either natural or manmade and, to provide nectar, winter-blooming plants such as gum trees (*Eucalyptus*), coyote bush, wild mustard, bottlebrush (*Callistemon*), and other native and cultivated species. Cluster sites typically are located close to the coast, generally within one mile of the shoreline. The sites are generally wooded, with trees of mixed sizes and an understory of brush. The site characteristics provide both protection from wind and freezing temperatures, exposure to sunlight during cold weather, and cool, shady conditions during unusually warm days (Nagano and Lane 1985). Some California overwintering sites are on public land such as parks, nature preserves, and military bases, but roosting butterflies are present only during the fall, winter, and early spring, and the clusters may not be recognized when the butterflies are absent.

4. Cluster sites have been found from Anchor Bay in Mendocino County to approximately Ensenada in Baja California, Mexico. The estimated population sizes range from 171,000 to 50 individuals at the permanent roosts and from 30,000 to 30 individuals at the temporary sites. The monarch is a permanent resident on Santa Cruz Island and was recently recorded on Santa Rosa, Anacapa, and Santa Barbara Islands (Miller 1985). There are 17 monarch roosting and overwintering sites on VAFB that are fairly reliable year to year, generally characterized by eucalyptus groves or Monterey cypress, the presence of freely available water, and shelter from the wind. These sites are shown on Figure 4.2 (Monarch Butterfly Overwintering and Roosting Sites on VAFB).

4.2.3 MARINE ANIMAL SPECIES

1. In addition to the threatened or endangered marine mammals discussed in Section 4.1.4, the northern fur seal, California sea lion, northern elephant seal, harbor seal, and northern (Steller) sea lion may be expected to be present in the study region. These mammals are protected from harassment or taking under the MMPA. These mammals are addressed in the following sections.

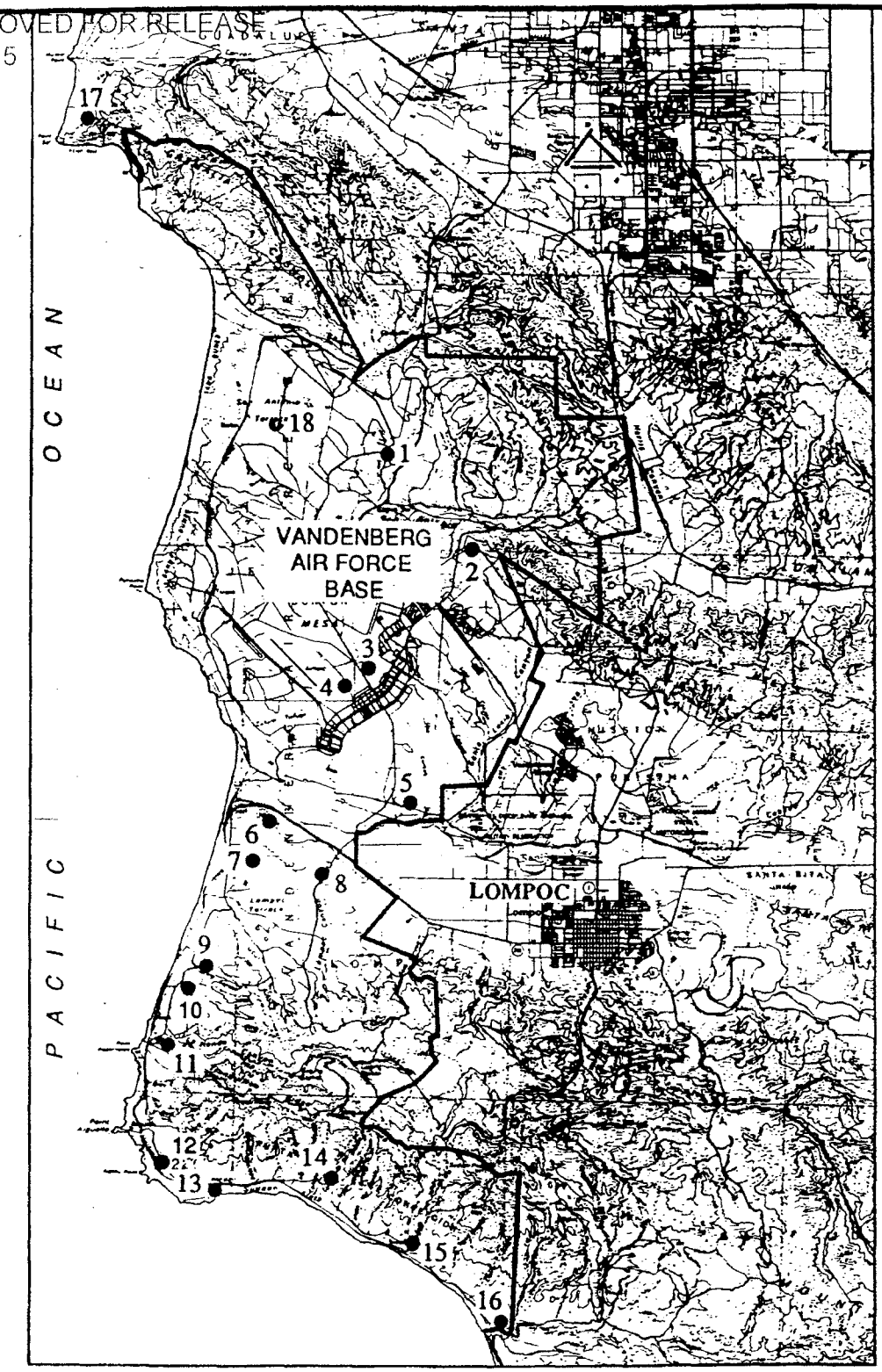
4.2.3.1 California Sea Lion

1. The California sea lion is a federally-protected species under the MMPA.

2. The species of concern ranges from at least as far south as Mazatlan, Mexico and the Tres Marias Islands north to British Columbia (Odell 1981). Population estimates range from 80,000 to 125,000, making it the most abundant pinniped in the Southern California Bight (Antonelis and Fiscus 1980; Bonnell et al. 1983).

3. The breeding range extends from the southern end of the range in Mexico to San Miguel Island although a few pups have been born on Southeast Farallon Island (Odell 1981; Pierotti et al. 1977). The largest aggregations of breeding animals occur on the rookeries of San Nicholas and San Miguel Islands where upwards of 90 percent of the regional population in the Southern California Bight hauls out (Le Boeuf et al. 1978).

4. The breeding season appears to begin on San Miguel Island in mid to late May when bulls and postpartum females begin to arrive. The numbers of territorial males peaks in early July with abandonment of the rookery occurring in the first week of August. Pupping season ends in mid to late June with mating season beginning in early June, continuing until mid to late July.



0 4 8 MILES

SCALE IN MILES

SOURCE: PERGLER 1989

REFERENCE: U.S.G.S. 30 x 60 MINUTE QUADRANGLE OF SANTA MARIA, CALIFORNIA, DATED 1982, NO PHOTOREVISION

FIGURE 4.2

MONARCH BUTTERFLY OVERWINTERING AND ROOSTING SITES ON VAFB

SLC-7 BIOLOGICAL ASSESSMENT

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5. During the summer breeding season in the California Channel Islands, California sea lion population peaks with as many as 35,000 counted on land in 1975 (Le Boeuf et al. 1978). In the winter of 1976, the number of hauled-out animals dwindled to approximately 15,000 (Le Boeuf et al. 1978). The migrating behavior of females and yearlings is not clear (Odell 1981). Females and immatures appear to form up into large feeding groups at sea in winter in the Southern California Bight.

6. Little information has been gathered for sea lions feeding at sea, although recent work on animals from San Miguel Island with implanted radio tags has revealed that regionally they feed over the relatively shallow waters of the continental shelf, to the north and west of San Miguel Island.

4.2.3.2 Northern Elephant Seal

1. The northern elephant seal is a federally-protected species under the MMPA.

2. This species is restricted to the eastern north Pacific Ocean where it hauls out on islands from Baja California to Central California. Recent population estimates put numbers at about 77,000 animals, with about 40 percent associated with the California hauling grounds (Bonnell et al. 1983). In California, San Miguel Island supports the largest aggregation of elephant seals, second only to Guadalupe Island (McGinnis and Schusterman 1981).

3. The breeding season begins as adult males haul out in late November, where they remain until March (Le Boeuf 1974). By mid-December, adult females start to haul out and give birth. Females leave the rookeries after mating, which occurs approximately in mid-January. After mating the females remain at sea for a few weeks, then return to the rookeries to molt and rest for about one month. They then return to the sea for the next eight to nine months before returning for the next breeding season (McGinnis and Schusterman 1981; Bonnell et al. 1983).

4. The majority of pups are born in mid-January to early February. Weaned pups form into groups and remain on the rookeries for about a month or so before leaving in March and April (Bonnell et al. 1983).

5. Elephant seals produce a dramatic molt which apparently necessitates their coming ashore for a second time each year. In late April or early May, adult females and juvenile males and females haul out to shed their pelage for a new coat In late June to early July, adult males haul

out to molt as well (Bonnell et al. 1983). At islands like San Miguel, elephant seals of one age group or another are present in all months of the year, but peaks in abundance occur in the winter breeding period and during the spring/summer molt.

6. Few published accounts of elephant seal observations at sea exist but, from those available, there is a general indication that they tend to be solitary and most were noted over the continental shelf and slope (Antonelis and Fiscus 1980; Bonnell et al. 1983).

4.2.3.3 Harbor Seal

1. The harbor seal is a federally-protected species under the MMPA.

2. This subspecies ranges from central Baja California to the Aleutian Islands, Bristol Bay, and the Pribilof Islands (Shaughnessy and Fay 1977; Bigg 1981). Population estimates for this subspecies have ranged from 50,000 to 200,000 (Scheffer 1958; Lockley 1966). More recently this has been increased to 320,000, with 40,000 from British Columbia to Baja California (Bigg 1981). Population counts for California from 1982 to 1986 have yielded a five year average of 15,148 with a range from 14,103 in 1984 to 16,891 in 1982 (Hanan et al. 1987). The 1986 census figures for the coast 0.8 miles east of Point Conception to Point Arguello show a count of 1,012 harbor seals (Hanan et al. 1987).

3. Harbor seal pups are produced from February to September depending on latitude. In the Santa Barbara area newborn pups have been observed as early as the first week of February, whereas in the Northern Channel Islands, pupping occurs in March. Pupping around Point Arguello has been reported around late March. Estes and Jameson (1983) note that seals congregate in mid-April subsequent to the birth of many pups. At San Miguel Island, pupping has been observed from mid-February through mid-April with a peak in March (Stewart et al. 1988). In California, the mating season may vary with the time of pupping, but once started, it lasts about a month (Bonnell et al. 1983).

4. In California, the largest aggregations of harbor seals occur in late spring and early summer (Bonnell et al. 1983). On San Miguel Island, Stewart et al. (1988) noted peak numbers ashore from late May to early June when the seals were molting. In the Santa Barbara Channel and the coastline to Point Arguello, harbor seals haul out in specific areas, and while numbers may fluctuate between the breeding season and the remainder of the year, no

additional haul outs have been noted during times when dispersal would be greatest. Once breeding and molting are complete, individuals probably spend more time in the water so that at any given time relatively fewer are ashore on the hauling grounds (Le Boeuf et al. 1978).

5. In the vicinity of Point Arguello, there are several small beaches where harbor seals aggregate. The pocket beach immediately north of the mouth of Oil Well Canyon is an important hauling ground and rookery for the area. Additional haul out sites occur in the direction of Rocky Point, and to the south, the rocks immediately seaward of the Boathouse breakwater are used as haul outs (Pergler 1988). The 1986 census produced counts totaling 500 seals for these sites (Hanan et al. 1987). Patterns of movement between mainland and Channel Island populations have not been delineated, but presumably they do occur.

6. Harbor seals rarely move far offshore and appear to stay in water no deeper than 90 m (Antonelis and Fiscus 1980). Consequently their main foraging grounds parallel the coast, where they probably take advantage of concentrations of prey.

4.2.3.4 Northern (Steller) Sea Lion

1. The northern (Steller) sea lion is a federally-protected species under the MMPA.

2. Northern sea lions are limited to the north Pacific Ocean ranging from the north Pacific Rim in a pattern similar to northern fur seals with the exception that they occur in shallower waters. The northern Channel Islands, specifically Santa Rosa and San Miguel Islands were used as hauling grounds and rookeries by the species until recently. The last territorial bull was seen on Castle Rock just off the northwest shore of San Miguel Island in 1985. Currently, Año Nuevo Island is the southernmost rookery although individuals may haul out at a variety of shoreline locations including Point Sal Rock (Bonnell et al. 1983). A range of 232,000 to 262,000 has been estimated for a total population (NMFS 1982). In California, a population decline has been evident for nearly 60 years. It has been speculated that this decline may be due to decreases in sardine stocks (Ainley and Lewis 1974) or increasing water temperatures in the southern portion of the breeding range (Bartholomew 1967). For a 50-year period, the breeding stock at Año Nuevo Island remained at approximately 2,000 individuals (Evermann 1921; Rowley 1929; Ripley et al. 1962; Orr and Poulter 1965; Gentry 1970). Surveys undertaken in 1980, 1981, and 1982, made actual counts during the peak of breeding season which ranged from 882 to 1,325 individuals (Bonnell et al. 1983).

3. Little has been published relative to aggregations of northern sea lions at sea. The most notable aggregations per se are those described above regarding rookery islands (Año Nuevo Island in California). Adult females and juveniles may remain near rookery sites throughout the year. Adult males are the first to leave the rookeries in late summer. The bulk of females leave in September and October. In California, there appears to be a migration northward that some believe involves the entire population that breeds in California waters (Bonnell et al. 1983; Mate 1977; Schusterman 1981).

4.2.4 BIRD SPECIES

1. In addition to the federally-listed, state-listed, and candidate species discussed in Section 4.1, 18 other bird species that occur in the study region have shown regional or state-wide decline. Birds included in this category are considered by the CDFG as "Species of Special Concern" as found in Remsen (1978), included on the National Audubon Society's Blue List (Tate 1986; Tate and Tate 1982), or found by local ornithologists to be rare or declining within Santa Barbara County. These birds are addressed in the following sections as regionally rare and declining species.

4.2.4.1 Black-shouldered Kite

1. The black-shouldered kite is a California state-listed "fully protected" species known to occur in the study region and expected to frequent the project area.

2. This species uses open country such as grazed or lightly grazed grasslands, freshwater marsh, and saltwater marsh for feeding and is known to frequent patches of willows, eucalyptus or oaks for nesting and roosting (Waian and Stendell 1970; Stendell 1967; Waian 1973).

3. Small numbers of kites are known to be resident on VAFB near the mouth of the Santa Ynez River (Lehman 1982) and in the Barka Slough area (Dial 1980), although none have been observed in the project area. There have been recent sightings of kites during the fall and winter months on the Hollister and Bixby Ranches (Storrer 1988). Much of the Cypress Ridge and Boathouse Flats sites, as well as the eastern section of the Vina Terrace site, appear to be suitable foraging habitat. Kites are expected to occasionally forage at the project sites, but are not expected to nest or roost there. The nearest black-shouldered kite nesting area is located in willow woodlands near the mouth of the Santa Ynez River (Lehman 1982).

4.2.4.2 Northern Harrier

1. The northern harrier is listed as a second priority "Species of Special Concern" by the CDFG (Remsen 1978) and is on the most recent Blue List (Tate 1986).

2. This species has declined as a wintering bird throughout much of Santa Barbara County due to loss of extensive open country foraging habitat (e.g., grassland, open coastal sage scrub, marshes, and agricultural areas) (Lehman 1982). In the project area, northern harriers frequent open habitats such as grasslands, coastal scrub, marshes, and agricultural areas for foraging. Adults with recently fledged young have been observed during the summer on VAFB near Point Sal, at the mouths of San Antonio Creek and the Santa Ynez River, and at Bear Creek (Lehman 1982). This species occurs in the study region and project area as an uncommon resident breeder and is a common transient and winter visitor. Northern harriers were observed foraging in the project area during 1988 spring field inventories, but are not expected to nest there (Collins 1988b).

4.2.4.3 Cooper's Hawk

1. This species is listed in the Blue List (Tate 1986) and is listed in the third priority category of "Species of Special Concern" by the CDFG (Remsen 1978).

2. In Santa Barbara County, Cooper's hawks have declined substantially due, in large part, to a loss of relatively undisturbed riparian and oak woodland habitats. The species no longer nests along the south coast, but is believed to nest in small numbers in riparian woodlands on VAFB (Lehman 1982). One or two pairs may still reside in dense riparian woodlands along the Santa Ynez River from Lompoc to its mouth, and in Honda and Bear Creeks. There does not appear to be any riparian habitat in the vicinity of the project sites that could support nesting Cooper's hawks. As such, this species should be considered as an uncommon transient winter visitor to the project area.

4.2.4.4 Merlin

1. This species is listed in the highest priority category of "Species of Special Concern" by the CDFG (Remsen 1978) and is on the Blue List (Tate 1986) due to severe population declines over much of North America .

2. In Santa Barbara County, merlins are rare transient and winter visitors to coastal areas (Lehman 1982). There have been five recent late fall and winter sightings of merlins on the Bixby and Hollister Ranches (Storrer 1988). During the winter months, merlins can be expected to occasionally forage over grassland and coastal scrub habitats in the project area. This species does not nest in the Southern California region.

4.2.4.5 Prairie Falcon

1. This species is listed in the third priority of "Species of Special Concern" by the CDFG due to a decline in their numbers in California during the past two decades from pesticide contamination, falconry, and shooting (Remsen 1978).

2. The prairie falcon is an uncommon fall and winter visitor along the coast of Santa Barbara County, frequenting open country habitats such as grassland, wetlands, and agricultural areas for foraging (Lehman 1982). Suitable foraging habitat exists over much of the project area. Prairie falcons have been sighted four times during the past two winters on the Bixby and Hollister Ranches (Storrer 1988), and an individual has been observed in the vicinity of the Boathouse during four of the past six years (1982-1987) (Crisologo 1983, 1984; Pergler 1988). Thus, this species can be expected to occur in the project area as an uncommon fall and winter visitor.

4.2.4.6 Burrowing Owl

1. This species has shown significant declines throughout California in recent times, is listed in the second priority category of "Species of Special Concern" by the CDFG (Remsen 1978) and is on the Blue List (Tate 1986).

2. Burrowing owls are not known to nest along the coast of Santa Barbara County (Lehman 1982). Sighting records suggest that this species occurs as a rare but regular winter visitor to the project area, with one or two individuals expected each winter. Burrowing owls have been observed in the vicinity of SLC-4 (Versar 1987) and along the Sudden Ranch Road adjacent to the Boathouse Flats site (Lehman 1988). Good foraging habitat exists over much of the project area, especially the Boathouse Flats site, where there is an abundant California ground squirrel population.

4.2.4.7 Long-eared Owl

1. This species is listed in the second priority listing of "Species of Special Concern" by the CDFG (Remsen 1978).

2. Within the project area and along much of coastal Santa Barbara County, long-eared owls are very rare transient and winter visitors. Their only known nesting locale in the study region was at Santa Rosa Park along the Santa Ynez River west of Buellton (Lehman 1982). The species has been observed at Barka Slough on North VAFB where requisite riparian breeding habitat still exists (Webster 1980). A few of the drainages on South VAFB, such as Bear Creek and Honda Creek, contain sufficient willow riparian habitat for migrant and wintering long-eared owls and possibly for breeders. This species could occur as a casual transient visitor in riparian habitat in Red Roof and Agua Viva Canyons.

4.2.4.8 Short-eared Owl

1. This species has shown a drastic decline in numbers in central and southern coastal California and, as such, has been listed as a second priority "Species of Special Concern" by the CDFG (Remsen 1978) and is on the Blue List (Tate 1986).

2. There is suitable foraging habitat at the Boathouse Flats site and along most of the Sudden Ranch area southeast of the project area. There have been only three recent sightings of this species from coastal areas north of Point Conception (Howald et al. 1985; Lehman 1982). As such, this species should be considered as a casual to rare winter visitor to open coastal scrub and grassland habitats in the project area.

4.2.4.9 Willow Flycatcher

1. This species is listed by the CDFG (Remsen 1978) as a special status species of highest priority (i.e., in imminent danger of extirpation if current trends continue) and is on the Blue List (Tate 1986). It has been extirpated as a breeder throughout most of Southern California (Garrett and Dunn 1981), including most of Santa Barbara County (Lehman 1982).

2. Throughout most of Santa Barbara County, willow flycatchers occur only as an uncommon fall transient and rare spring transient to willow-dominated riparian habitat (Lehman 1982) and, despite intensive surveys, have not been found on VAFB (Breininger 1988; Dial 1980; Howald et al. 1985; Webster 1980). The only known breeding colony of willow flycatchers within the study region occurs in dense willow riparian woodlands about one mile west of Buellton along the Santa Ynez River (Versar 1987). A number of canyons on South VAFB contain willow riparian habitat of sufficient size and quality to be used by willow flycatchers

during migration (e.g., Bear and Honda Creeks), although riparian habitats in Red Roof, Spring, Oil, and Agua Viva Canyons are not of sufficient size or quality for nesting. These areas could be visited on an infrequent basis by an occasional fall or spring migrant.

4.2.4.10 Purple Martin

1. This species (*Progne subis*) has been placed on the Blue List (Tate 1986) and is considered by local ornithologists to be regionally rare and declining (Lehman, 1988).

2. The purple martin occurs as a rare spring and very rare fall migrant in coastal areas of Santa Barbara County (Lehman 1982). The nearest consistent lowland breeding population occurs in sycamore trees at Nojoqui Falls County Park in the Santa Ynez Valley, just east of the study region. The sighting of a single bird in June 1986, on the sea cliffs at Point Arguello, is the only known record in the project area (Lehman 1982). There is no suitable nesting habitat for this species on South VAFB.

4.2.4.11 Tree Swallow

1. This species has been extirpated as a breeder along much of the south coast and is considered by local ornithologists an uncommon but localized breeder elsewhere in Santa Barbara County (Lehman 1982).

2. Tree swallows are locally common along the north coast where they can be found breeding in moderate numbers in willow-dominated riparian habitats along the larger water courses such as the Santa Maria River inland to Guadalupe, on San Antonio Creek inland to Barka Slough, and on the Santa Ynez River from Buellton to its mouth (Lehman 1982). Although the species could occur over the project area as a migrant, it is not expected to utilize the willow woodlands on South VAFB in Bear, Honda, Red Roof, Spring or Agua Viva Canyons for nesting. The riparian habitat in these canyons is not of sufficient size or quality to support breeding populations of tree swallows. The nearest concentration of tree swallows to the project area occurs at the mouth of the Santa Ynez River (Lehman 1982).

4.2.4.12 Swainson's Thrush

1. In Santa Barbara County, Swainson's thrush is now considered by local ornithologists to be a very uncommon localized breeder and spring transient along the south coast and a fairly common breeder in the remaining extensive riparian and mixed oak-riparian woodlands along the north coast (Lehman 1982, 1983).

2. The largest breeding population of Swainson's thrush in Santa Barbara County occurs at Barka Slough. Along the north coast, this species is a fairly common breeder in riparian woodlands on VAFB, including Shuman Creek, San Antonio Creek inland to Barka Slough, Santa Ynez River in scattered sites from Buellton to its mouth, and on South VAFB in Bear Creek and Honda Canyons (Lehman 1982; Webster 1980). This species is expected to occur as a common spring and fall migrant in willow riparian habitats found within the project area in Red Roof, Spring, Oil Well, and Agua Viva Canyons.

4.2.4.13 Warbling Vireo

1. The warbling vireo is considered by local ornithologists to be a very uncommon to rare localized nester along the south coast and a rather common breeder along the north coast of Santa Barbara County (Lehman 1982, 1983).

2. Breeding populations of warbling vireos have been found along the Santa Maria River inland to Guadalupe, on San Antonio Creek inland to Barka Slough, along the Santa Ynez River from its mouth to Buellton, and on upper Honda Creek on South VAFB (Lehman 1982; Webster 1980). This species probably occurs in the project area as a common spring and fall migrant in riparian habitat found in Spring, Red Roof, Oil Well, and Agua Viva Canyons. A single bird was observed in Red Roof Canyon during the spring of 1988. Although this bird was observed in suitable nesting habitat, it exhibited no nesting behavior and would therefore be considered a late spring migrant. The warbling vireo is not expected to nest in riparian woodlands in the project area.

4.2.4.14 Yellow Warbler

1. The yellow warbler is on the Blue List (Tate 1986) and has declined regionally.

2. This species is a common spring and fall migrant and is a localized summer breeder in requisite riparian woodland habitat in northern Santa Barbara County. Yellow warblers still breed in moderate numbers in extensive stands of riparian woodlands on Shuman and San Antonio Creeks (especially Barka Slough), the Santa Ynez River from its mouth to Buellton, and possibly on upper Honda Creek (Webster 1980; Lehman 1982). Yellow warblers may nest in the willow woodlands found in Red Roof Canyon and probably occur as common migrants in woodlands in Spring, Oil Well, and Agua Viva Canyons, and in the Cypress trees near the Boathouse and the V-33 tow route.

4.2.4.15 Wilson's Warbler

1. This species has been extirpated as a breeder from much of the south coast of Santa Barbara County due to a loss of riparian woodland habitat and to increased rates of brood parasitism by brown-headed cowbirds (Lehman 1982).

2. Wilson's warbler is still a fairly common breeder in the more extensive riparian areas along the Santa Maria River west of Guadalupe, along San Antonio Creek inland to Barka Slough, along the Santa Ynez River west to Buellton, and in small numbers along Bear and Honda Creeks on South VAFB (Lehman 1982). In the spring of 1988, this species was observed singing in Red Roof Canyon and foraging in coastal scrub in Oil Well Canyon and at the Vina Terrace site. It is a common spring and fall migrant in the project area and may nest in small numbers in the willow woodlands in Red Roof Canyon.

4.2.4.16 Yellow-breasted Chat

1. This species is listed by the CDFG in the second priority of "Species of Special Concern" (Remsen 1978).

2. Historically, yellow-breasted chat were common breeders in coastal riparian habitats throughout Southern California (Grinnell and Miller 1944; Willett 1933). Today, this species is a rare migrant and very rare localized breeder in southern Santa Barbara County and an uncommon breeder in northern Santa Barbara County along San Antonio Creek (fairly common at Barka Slough) and the Santa Ynez River from Buellton west to its mouth (Lehman 1982). Yellow-breasted chat are probably rare spring and fall migrants to riparian woodland habitat on South VAFB in Bear, Honda, Red Roof, Spring, and Agua Viva Canyons. However, the habitat within these canyons is not extensive enough to support a breeding population of this species.

4.2.4.17 Blue Grosbeak

1. This species (*Guiraca caerulea*) has declined as a breeder throughout much of Southern California due in part to a loss of riparian edge habitat and possibly to brood parasitism by the brown-headed cowbird (Lehman 1982).

2. In northern Santa Barbara County, blue grosbeaks continue to nest in riparian and brushy areas bordering weedy fields and pastures in the Barka Slough area, in the Los Alamos Valley, along the Santa Ynez River from Santa Ynez to Lompoc, along Jalama Road, and near New Cuyama (Lehman 1982). Blue grosbeaks are uncommon fall and casual spring migrants

in brushy and weedy areas along creeks and ditches within the study region (Lehman 1982). Suitable breeding habitat is not present on South VAFB or within the project area, but this species is expected to forage in the project area during its annual spring and fall migration, especially in Red Roof and Spring Canyons.

4.2.4.18 Grasshopper Sparrow

1. This species is on the Blue List due to a reduction in its requisite tall grass breeding habitat (Tate 1986). Today, grasshopper sparrows occur in only two isolated locales along the south coast (Lehman 1982).

2. In northern Santa Barbara County, the grasshopper sparrow persists in reasonable numbers in the Point Sal area and, locally, in small numbers south to the Barka Slough area, in San Miguelito Canyon southwest of Lompoc, and in isolated pockets on grassy slopes along the Santa Ynez River west of Buellton to its mouth (Lehman 1982, 1986). Grasshopper sparrows may also occur in suitable ungrazed grassland habitats on South VAFB (especially along the Sudden Ranch portion of the base) and on the Bixby and Hollister Ranches. It is possible that this species nests in grasslands on the eastern edge of the Vina Terrace site and in grasslands on the slopes north of the Coast Road from the Cypress Ridge site east to Agua Viva Canyon. This species was not observed at any of the project sites during the 1988 spring surveys conducted for this project. More intensive late spring surveys would be needed to determine if this species nests in the project area.

5.0 IMPACT ASSESSMENT

5.1 VEGETATION

5.1.1 INTRODUCTION

1. This section addresses potential impacts to vegetation resulting from construction and operation of the proposed action. Such impacts would occur as a result of grading and other construction activities undertaken at the launch complex site, access roads, and utility corridors. During operations, impacts primarily would result from effects of acidic deposition associated with the ground cloud produced during vehicle launch.

   Impacts to vegetation would be considered significant if they:

   - Substantially affect a rare or endangered species of plant.
   - Substantially diminish a regionally or locally important plant community.
   - Substantially diminish habitat for a plant species.
   - Result in a substantial infusion of exotic species.

5.1.2 REGIONAL IMPACTS

1. Project impacts primarily consist of removal and alteration of vegetation during construction at one of the undeveloped alternatives and the potential for disturbance from project-related emissions from all four sites during operations. As these would be local impacts, no regional impacts are anticipated.

5.1.3 LOCAL IMPACTS

1. Implementation of the proposed action at one of the undeveloped sites (Cypress Ridge, Boathouse Flats, or Vina Terrace) would result in impacts to vegetation within the launch complex site, corresponding utility corridors, and additional areas to be used for project facilities and construction needs (see Section 2.1). These impacts would include: (1) removal of portions of vegetation communities, (2) removal of individuals of special interest species, (3) potential for establishment of exotic species in disturbed areas, and (4) effects of launch-related acidic deposition.

2. In addition to the launch complex, areas that would be disturbed due to construction activities would include the contractor village, construction laydown sites, batch plant, truck washdown, access roads, parking, and sewage treatment facility. Therefore, although the final, fenced launch complex would be about 50 acres in size, the total area to be disturbed for the Cypress Ridge, Vina Terrace, and Boathouse Flats sites would be considerably greater,

ranging from approximately 185 to 280 acres, depending on the site chosen. Implementation of the SLC-6 alternative would not result in significant impacts to vegetation from construction, since neither earth moving nor excavation activities are anticipated.

3. In the following sections, impacts are described first as they are expected to occur from implementation of the project at the Cypress Ridge site. Impacts anticipated at the three alternative sites are discussed if they would differ from those projected for the Cypress Ridge site.

5.1.4 CYPRESS RIDGE

5.1.4.1 Construction

1. Construction of the proposed action at the Cypress Ridge site would result in a permanent loss of approximately 90 acres of central coastal scrub and Venturan coastal sage scrub, representing less than one percent of these communities on all of VAFB. Removal of approximately 19 acres of nonnative grassland represents a loss of less than 0.1 percent of that community on VAFB. Since these losses together represent less than one percent of the VAFB community, the impact is considered to be insignificant.

2. Construction of the electrical power line would result in a potential area of disturbance defined by a corridor approximately 125 to 150 feet wide and about three miles long, mostly through central coastal scrub. Disturbance during placement of the electrical power poles and stringing of electric power lines may affect approximately 40 to 50 individuals of the federal candidate *Monardella undulata* var. *frutescens* although, as feasible, the power poles would be placed to avoid this sensitive plant species. Wetlands would be avoided by adjusting pole spacing to clear wetland areas. This design would preserve several small wetland areas covering about one-half of one acre and two areas of willow-dominated riparian scrub/woodland at the Red Roof Canyon and Grey Canyon crossings (near the SLC-6 external tank storage and checkout facility and Lockheed temporary storage facilities).

3. Construction of the underground communication (fiber-optic cable), gaseous nitrogen, and natural gas lines along the proposed alignment would have no significant impact, as these utilities would be placed primarily along existing roads and in ruderal vegetation consisting mainly of introduced species (see Figure 2.2). Construction of the fiber-optic cable along the alternative alignment would be within the electric power corridor and would avoid wetland areas. Construction of the water line would have little impact on vegetation, as the corridor would follow Coast Road over most of its distance.

4. Approximately 800 to 1,000 mature individuals of *Monardella undulata* var. *frutescens* would be lost as a result of construction of the proposed action at the Cypress Ridge site. This represents an estimated 25 to 50 percent of the individuals in known populations south of Honda Canyon. Although there are an estimated 950,000 individuals of this taxon on the San Antonio Terrace (a portion of its suitable habitat) (HDR 1980), the populations at the Cypress Ridge site are important because these plants are at the southern limit of their range (Smith 1983), and their loss, therefore, would be a locally significant impact. This impact would be reduced to an acceptable level by undertaking suggested mitigation measures (see Chapter 6.0). Other special interest plant taxa that could be affected are listed in Appendix A, Table A.3.

5. The invasion of construction-disturbed areas by exotic plants is a potential impact to vegetation. Sites disturbed by construction activities are prone to exotic plant invasion, due to the absence of competing vegetation. Once established, the exotics can spread to previously pristine plant communities. Exotic invasive plants such as hottentot-fig *(Carpobrotus edulis)*, Andean grass *(Cortaderia jubata)*, and slender-leaf iceplant *(Conicosia pugioniformis)* are undesirable on VAFB.

5.1.4.2 Operations

1. Impacts to vegetation near the launch complex may occur during launches as a result of acidic deposition (hydrochloric acid) formed by contact of the deluge water with exhaust components of the SRMUs. Acute vegetation damage has occurred in Space Shuttle exhaust cloud paths less than 0.6 mile from the launch pad at Kennedy Space Center (Schmalzer et al. 1986). Based on space shuttle launches, impacts could include damage to sensitive species, change in vegetation cover type resulting from changes in the soil seed bank as species are lost, soil erosion resulting from loss of vegetative cover (Zammit and Zedler 1988), and loss of special interest plants.

2. Information regarding the impacts to vegetation from launch exhaust from Titan IV launches is sparse since so few launches have occurred. Some preliminary information about potential impacts to vegetation from Titan IV launch-related acidic deposition was collected at the first Titan IV launch from CCAFS (USAF 1989b). The launch report notes that a field investigation of the area under and around the predicted exhaust cloud path (predictions taken from the REEDM Model) did not note acidic deposition in either the near- or far-field regions.

In addition, none of the acid spotting or aroma characteristics of space shuttle launches were noted by pad area workers. It appears that the Titan IV deluge water volume does not generate a ground cloud of the size generated by a Space Shuttle launch.

3. During the initial liftoff, the Titan IV upgraded SRMUs burn, resulting in ignition products of hydrogen chloride gas (HCl), aluminum oxide (Al_2O_3), carbon monoxide (CO), and water (H_2O). The HCl gas contained in the exhaust cloud has a strong tendency to combine with available water used during a launch. Of the approximately 26,000 gallons of deluge water used during liftoff, about 20,000 gallons evaporate and form a ground cloud (this contrasts to approximately 44,000 gallons which evaporate from each launch of the Space Shuttle). As the launch ground cloud condenses, it forms water droplets which scavenge the HCl gas, becoming hydrochloric acid droplets (NASA 1983).

4. Deposition of the hydrochloric acid droplets on surrounding vegetation has been estimated to result in impacts when pH levels approach 3.0. These impacts could include partial or complete defoliation and a decline in seedling survivorship, seed germination response, and seedling emergence (NASA 1987). Figure 5.1 (Near-field Acidic Deposition, Titan IV/Centaur Launch) shows the estimated concentration of acidic deposition at various distances from the launch mount. The figure shows that vegetation within a downwind distance of approximately three miles could be expected to be impacted to some extent due to the low pH content of the exhaust cloud. However, due to dispersion of the ground cloud, potential impacts would decrease with distance from the launch site. After a launch, Al_2O_3 also would be expected to fall out from the ground cloud. However, analyses of launch-related deposition of Al_2O_3 have not shown it to be harmful to plant life (USAF 1983).

5. Populations of *Monardella undulata* var. *frutescens* are located approximately one-half mile southwest of the Cypress Ridge site (about 400 mature individuals), and about 50 individuals are located one-third mile north-northwest of the site. Although unlikely due to prevailing wind direction, these populations may be affected by ground cloud deposition. A population of approximately 50 individuals of surf thistle (*Cirsium rhothophilum*), another federal candidate species, occurs outside of the study area near Rocky Point, approximately 0.7 mile west of the launch pad site. Given the distance and wind direction normally associated with a launch, this plant population may not be affected.

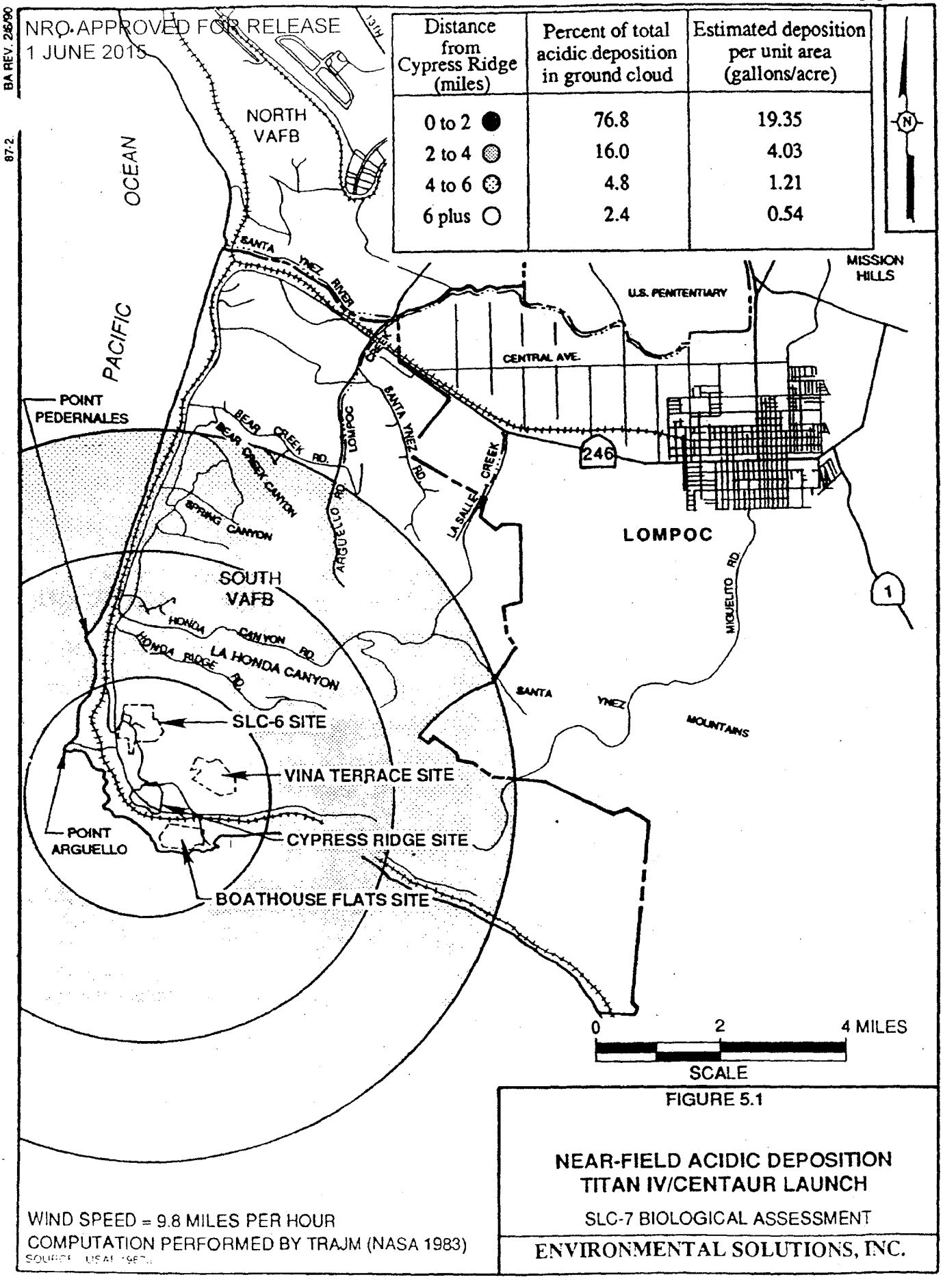

FIGURE 5.1

NEAR-FIELD ACIDIC DEPOSITION
TITAN IV/CENTAUR LAUNCH

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WIND SPEED = 9.8 MILES PER HOUR
COMPUTATION PERFORMED BY TRAJM (NASA 1983)
SOURCE: USAF 1987

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6. There could be impacts to plant life as a result of a catastrophic event, although such impact is expected to be insignificant. For example, the potential for vegetation to experience direct contact with spilled fuel would be minimized by provision of fuel and fuel waste impoundments and the spill retention capability of the flame duct. In the event of a solid rocket anomaly on or near the launch pad, there would be locally high levels of HCl deposition. However, based on observations of nearby vegetation after the Titan 34-D explosion at SLC-4 in April 1986, the occurrence of such impact at the Cypress Ridge site would not be significant. Further, in the case of a wildland fire resulting from a launch anomaly, there would be little long-term impact from the fire itself, as the natural plant communities surrounding the Cypress Ridge site are adapted to periodic burning. However, such fire could result in secondary impacts from invasion by exotic plants (Hickson 1987). Overall, significant impacts from catastrophic events are not anticipated.

5.1.5 SLC-6

5.1.5.1 Construction

1. Since no earth moving or excavation activities are anticipated at the SLC-6 site, impacts to vegetation would be minimal and would not be significant. In addition, selection of the SLC-6 site would avoid construction impacts at an undeveloped site.

5.1.5.2 Operations

1. Impacts from operations at this site would include possible vegetation damage from acidic deposition during launches, as described for the Cypress Ridge site. The approximate boundaries of acidic deposition resulting from a Titan IV/Centaur launch from SLC-6 are shown in Figure 5.2 (Near-field Acidic Deposition SLC-6 Site Titan IV/Centaur Launch). The impacts of this deposition would not be known with certainty until after a launch. However, indications from experience with the Space Shuttle indicate that most of the anticipated impacts to vegetation would occur within three miles of the launch site. The greatest impact would be expected within 0.6 mile (NASA 1987).

2. Special interest species which could be affected include a population of about 300 to 350 mature individuals of *Monardella undulata* var. *frutescens*, located about 2,000 feet southwest of SLC-6. Other populations of this species are located south of Cypress Ridge. Due to topography and distance, the potential effects of acidic deposition on these populations could be somewhat less from a launch at SLC-6 than from a launch at one of the undeveloped sites.

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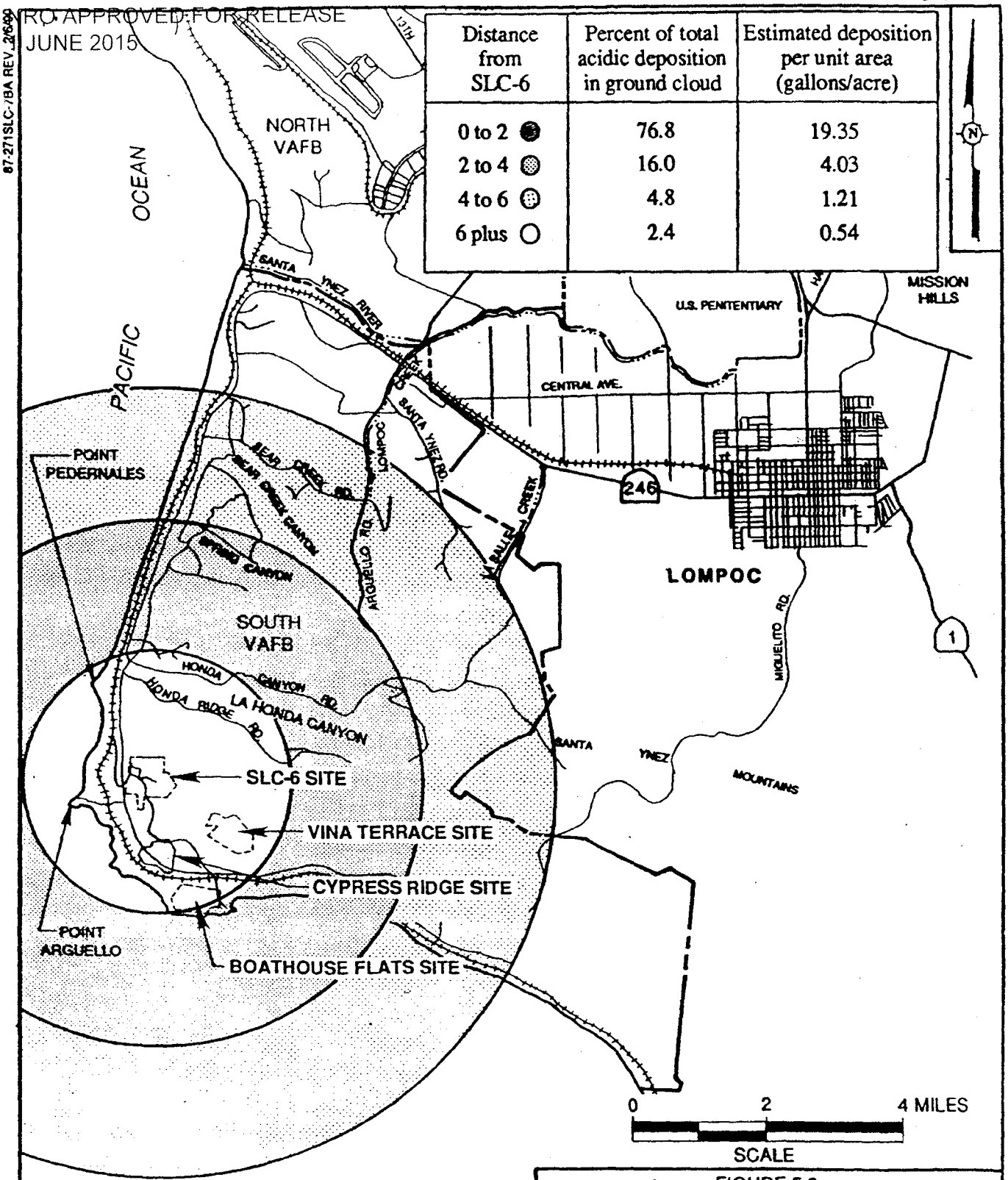

WIND SPEED = 9.8 MILES PER HOUR
COMPUTATION PERFORMED BY TRAJM (NASA 1983)
SOURCE: USAF [illegible]

FIGURE 5.2

NEAR-FIELD ACIDIC DEPOSITION
SLC-6 SITE
TITAN IV/CENTAUR LAUNCH
SLC-7 BIOLOGICAL ASSESSMENT

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3. A large population of surf thistle, a federal candidate species, occurs approximately one mile west of SLC-6 at Point Arguello. A smaller population of about 50 individuals occurs approximately 1.2 miles southwest, at Rocky Point. Given the distance from the potential SLC-6 launch site and the wind direction normally associated with a launch, these plant populations may not be affected.

4. Impacts from catastrophic events would be comparable to those described for the Cypress Ridge site and, therefore, insignificant.

5.1.6 BOATHOUSE FLATS

5.1.6.1 Construction

1. The permanent loss of approximately 130 acres of non-native grassland would result from construction of the launch complex at this site. This would have little regional impact, since it would represent less than one percent of this community on VAFB. Potential impacts from exotic plant invasion are present, but would be less serious here than at Cypress Ridge, since this site is already populated with nonnative plants.

2. Temporary disturbance of 50 to 100 mature individuals of the federal candidate *Monardella undulata* var. *frutescens* could result from construction of the power line, but additional suitable habitat might be created as a result of its construction. Construction of the water pipeline would result in the disturbance of a 5-foot wide corridor, approximately two miles long, through central coastal and Venturan coastal sage scrub, and less than one acre of willow-dominated riparian scrub in Oil Well Canyon. As at the Cypress Ridge site, impacts to wetlands and riparian scrub/ woodlands are not expected due to planned mitigation measures (see Chapter 6.0). Impacts from construction of the underground communication, gaseous nitrogen, and natural gas lines would be insignificant, since primarily ruderal vegetation would be disturbed.

5.1.6.2 Operations

1. Impacts from operations at this site would include possible vegetation damage from acidic deposition during launches, as described for the Cypress Ridge site. The nearest large populations of the federal candidate plant *Monardella undulata* var. *frutescens* (roughly 600 and 400 mature individuals each) occur approximately one mile northeast of the proposed launch pad. The population of surf thistle near Rocky Point is approximately 1.3 miles

northwest of the launch pad. The prevailing wind direction at VAFB makes it unlikely that these populations would be affected by acid deposition. Accelerated soil erosion from loss of vegetative cover is also unlikely on this level site, except possibly on the cliff faces.

2. Impacts from catastrophic events would be the same as described for the Cypress Ridge site.

5.1.7 VINA TERRACE

5.1.7.1 Construction

1. A permanent loss of approximately 65 acres of central coastal scrub and 30 acres of grassland and grassland-coastal scrub would occur from the construction of the proposed action at the Vina Terrace site. Potential impacts of invasion by exotic species would be less serious than Cypress Ridge since the soils are less susceptible to invasion by exotics, but of greater consequence than at Boathouse Flats since it is already populated by nonnative plants.

2. An estimated 60 acres of central coastal scrub, seven acres of Venturan coastal sage scrub, and less than one acre of willow-dominated riparian scrub would be cleared for construction of the access road and utility and water lines across Oil Well Canyon. About one mile of this road would follow an existing unpaved road, the widening of which would impact a small amount native bunchgrass-dominated grassland. The impacts to central coastal scrub along the proposed power line route north of the Lockheed temporary storage facilities and to riparian scrub/woodland at the Red Roof and Grey Canyon crossings would be the same as for the Cypress Ridge site. No known federal candidate species or special interest plants would be affected.

5.1.7.2 Operations

1. Impacts from operations at the Vina Terrace site could include possible vegetation damage and possible accelerated soil erosion due to vegetative cover removal and from acidic deposition during launches, as discussed for the Cypress Ridge site. Because of the steep slopes, the potential for soil erosion is greater at this site than at the Cypress Ridge, SLC-6, or Boathouse Flats sites. No known federal candidate species would be affected by operations at the Vina Terrace site.

2. Impacts from catastrophic events would be insignificant, as they would be the same as described for the Cypress Ridge site.

5.2 WILDLIFE

5.2.1 INTRODUCTION

1. This section addresses potential impacts to terrestrial, aquatic, and marine wildlife that would result from construction and operation of the proposed project. Impacts during project construction would primarily be related to habitat removal during grading at the undeveloped sites. During operations, impacts would primarily be related to launch events and the potential effects of associated launch noise, sonic boom, and acidic deposition at any of the four sites.

2. Impacts to wildlife would be considered significant if they would:
   - Substantially diminish habitat for a terrestrial or marine species.
   - Substantially affect a rare or endangered species of animal or its habitat.
   - Interfere substantially with the movement of resident or migratory wildlife species.
   - Interfere substantially with reproductive behavior.

5.2.2 REGIONAL IMPACTS

1. The primary regional impacts to biota would be potential effects of launch noise and focused sonic boom overpressure on marine mammals and birds in the Channel Island region and offshore. Construction and most operational impacts would be localized and not extend to the offshore/Channel Islands region, due to distance from the launch site. Construction impacts would be confined to the South VAFB area. Potential operations impacts related to air emissions, normal operational noise, and acidic deposition resulting from launch events would occur primarily within the South VAFB area.

2. Launch noise and focused sonic booms and their short- and long-term impacts on marine birds and mammals are addressed herein. Computer modeling to predict the magnitude, footprint, and signature of the focused sonic boom was completed for the proposed action. Documentation of the modeling effort and its results is included as Appendix D (Channel Island Sonic Boom Analysis for Titan IV Launches from SLC-7).

3. The SLC-6, Boathouse Flats, and Vina Terrace sites are near (within about one mile) to the Cypress Ridge site. Therefore, the sonic overpressures and launch-related noise modeled for the Cypress Ridge site would be the same for the three alternative sites.

4. The launch trajectory, nearfield noise signature of the Titan IV/Centaur and local meteorology were input as variables for a computer model (Saber II) to predict the worst-case magnitude, footprint, and signature of the focus sonic boom which would result from launch and ascent

of the Titan IV/Centaur. A worst-case analysis was undertaken by designating an overflight path coincident with the Channel Islands and by assuming meteorological conditions that would result in the greatest noise (i.e., no wind).

5. The Saber II model worst-case analysis predicts 10-pound per square foot (psf) magnitude and footprint of the focused sonic boom, shown in Figure 5.3 (Titan IV/Centaur Sonic Boom Footprint), occurring over the Channel Islands, with the greatest potential impact being to San Miguel Island. As shown in Figure 5.4 (Simplified Focus Signature) the duration of the event is very short (less than one-half second).

6. Impacts to marine birds and mammals from sonic booms and launch-related noise have been assessed for physical effects (physiological damage) and startle effects (behavior, breeding, and stampeding). The threshold for temporary auditory damage from exposure to a single sonic boom has been found to occur in the range of 138 dB to 169 dB (Chappell 1980). The maximum, worst-case, A-weighted sound level expected to be produced during a Titan IV/Centaur launch is 147 dBA based on a predicted overpressure of 10 psf. This level is within the threshold for temporary auditory damage and would cause minor and temporary hearing loss in sensitive wildlife species. Non-worst case launch scenarios (azimuths not coincident with the Channel Islands or varying wind and temperature conditions) would result in lower sound levels and would be expected to incur fewer auditory impacts to marine biota.

7. Startle responses in marine birds and mammals are known to occur at impulses of as little as 80 to 90 dB flat SPL (sound pressure level) (Bowles and Stewart 1980). Noise of this intensity may occur within 20 to 30 miles of the launch site from Titan IV/Centaur launches, thus leading to potential impacts to biota of the northern Channel Islands. Mammals and birds will generally run or fly in response to sonic booms and loud overflights (Speich et al. 1987; Bowles and Stewart 1980). However, despite rather intensive long-term studies, there is no evidence that leaping, self-damage, crushing, or breeding colony abandonment occur with either marine birds or marine mammals as a result of startle responses brought on by sonic booms or loud overflights (Bowles and Stewart 1980; Schreiber and Schreiber 1980; Black et al. 1984; Speich et al. 1987). Therefore, significant impacts are not expected to result from Titan IV/Centaur launch events.

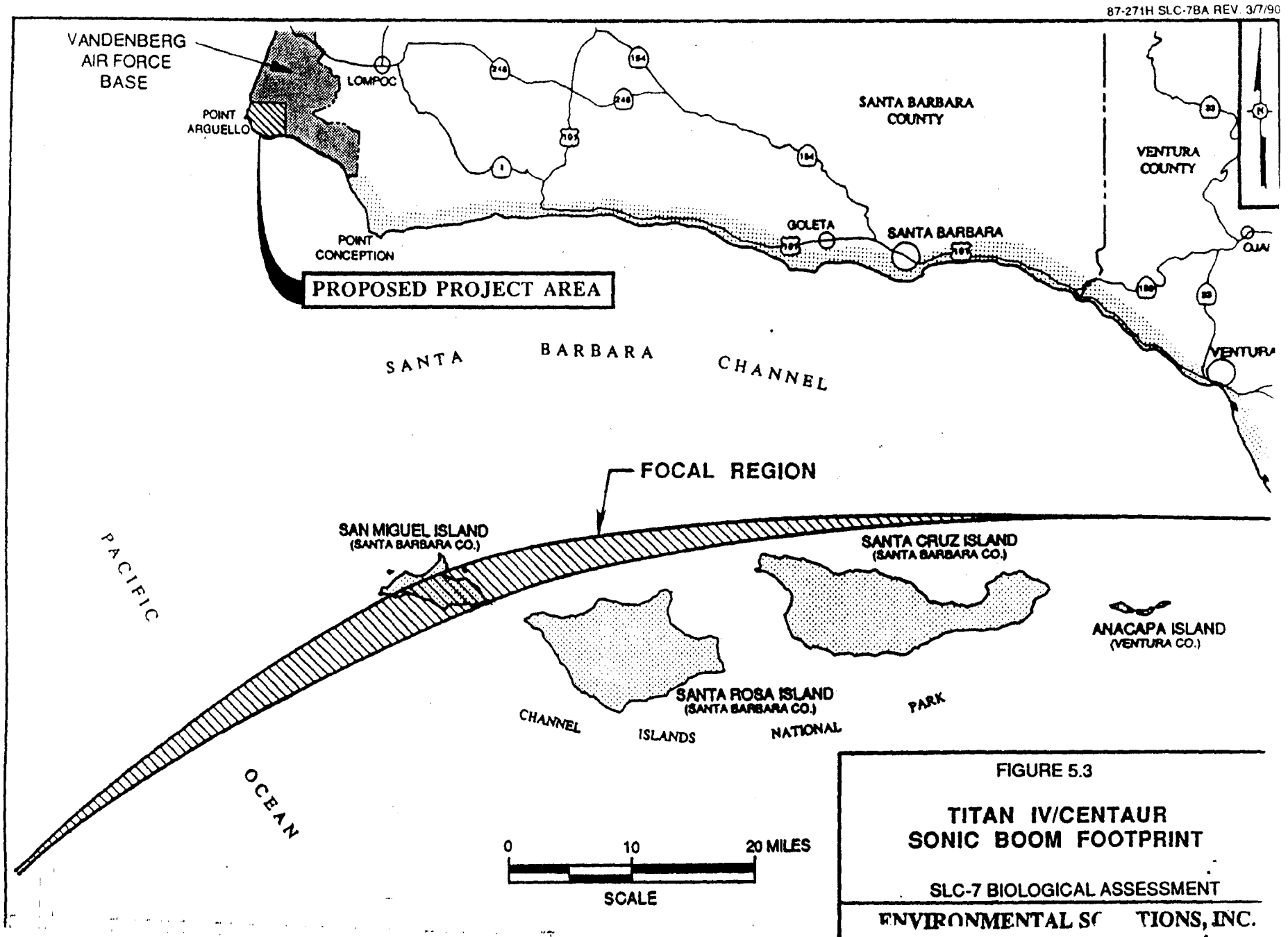

FIGURE 5.3

TITAN IV/CENTAUR SONIC BOOM FOOTPRINT

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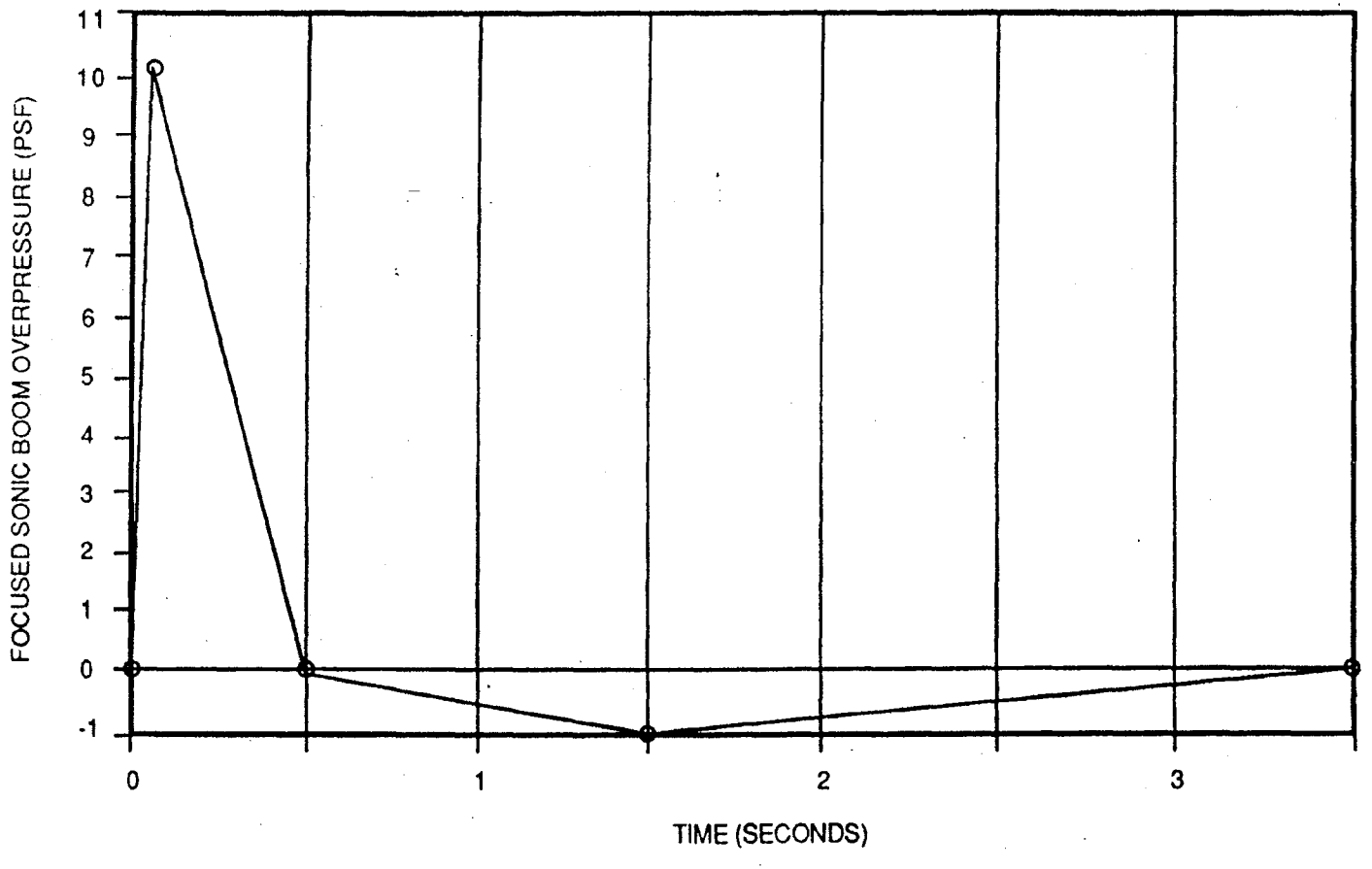

FIGURE 5.4

SIMPLIFIED FOCUS SIGNATURE

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5.2.3 LOCAL IMPACTS

1. In addition to regional impacts, the following sections provide an assessment of impacts to the local environment resulting from construction and operation of the proposed project. To reduce duplication, impacts are assessed in greatest detail for the Cypress Ridge site. Impacts at the SLC-6, Boathouse Flats, and Vina Terrace sites are discussed in detail if they differ appreciably from those assessed for Cypress Ridge. The importance of a potential impact was determined by assessing the significance of the resource affected, its sensitivity to disturbance, and the extent of the affected resource relative to its presence in the project area and study region. Impacts from construction, operations, noise, and launch-related sonic booms are discussed relative to their potential effects on terrestrial and aquatic wildlife, threatened and endangered species, and marine wildlife within the immediate project area.

5.2.4 TERRESTRIAL AND AQUATIC ANIMALS

5.2.4.1 Cypress Ridge

5.2.4.1.1 Construction

1. Potential impacts to wildlife from construction of the proposed action include: (1) removal of vegetation, which could lead to permanent or temporary loss of habitat and displacement or elimination of resident animals, and (2) degradation of the value of habitat adjacent to Cypress Ridge due to air pollution, noise or human activity. Clearing and grading would generate construction impacts through elimination of vegetation communities (habitats) and their associated faunas. There also could be some direct mortality to burrow-dwelling and less mobile animals that inhabit the project site. More mobile wildlife, such as birds and larger land mammals, would be expected to move temporarily into adjacent habitat. Some of the displaced species would be lost if adjacent communities are at carrying capacity.

2. Removal of southern coastal bluff and coastal dune scrub, chaparral, and grassland habitats would not result in significant impacts, since these habitats: (1) are widespread on VAFB, (2) support wildlife species that tend to be common and wide-ranging both locally and regionally, and (3) are not known to support resident populations of threatened or endangered species (see Chapter 3.0).

3. Noise, increased human activity, and exhaust emissions from heavy equipment and other construction vehicles during most phases of construction would render habitats adjacent to the construction area temporarily unattractive. Large and medium sized animals such as mule deer, coyote, skunk, hawk, and rabbit could temporarily stop using nearby areas, but at the end of construction would be expected to return to revegetated areas. An increase in road-

killed wildlife would be expected during the construction phase of the project due to increased vehicle traffic. These disturbances are expected to create impacts that are short-term and localized, and insignificant.

5.2.4.1.2 Operations

1. Potential impacts to wildlife and wildlife habitat may occur as a result of: (1) air pollutant emissions and wastewater resulting from launch, (2) vehicle failure, (3) launch-related noise and sonic booms, and (4) increases in human activity.

Air Pollutant Emissions and Acidic Deposition

1. It is expected that air pollutant emissions from vehicle launch may result in insignificant, short-term, and localized impacts to terrestrial fauna. During a normal Titan IV/Centaur launch, emissions of Al_2O_3 and HCl are generated. Previous studies have shown that actual operational emissions of these substances have not resulted in significant impacts to terrestrial fauna (Engineering Science 1987; ES and SWRI 1988).

2. During launch operations, there is an acidic mist formed by contact of the deluge water with the solid rocket motor exhaust during ignition that would be deposited regionally around the Cypress Ridge area (see Figure 5.1). Terrestrial animals in the vicinity of the launch site could come into contact with this acidic deposition for a short period of time. However, this contact is not expected to result in significant impacts since the exhaust cloud would be present for only a short time and mist, which settles, would evaporate quickly or be diluted in wet conditions.

3. There also is the possibility of acidic deposition into streams and nearby bodies of water, which would potentially lower the pH of the water and impact resident aquatic organisms. Within the potential area of acidic deposition, Honda Creek is the area of greatest concern due to its resident populations of unarmored three-spined stickleback and tidewater goby. Figure 5.5 (Acidic Deposition in Vicinity of Honda Creek) shows the extent of acidic deposition under worst-case meteorological conditions (wind speed of 25 mph). As shown, the greatest acidic deposition would occur within two to four miles of the Cypress Ridge site. Chemical analysis shows that the worst-case amount of acidic material deposited into Honda Creek would be neutralized by the cations present in the water, thereby reducing the possibility of a pH change that could affect the resident three-spined unarmored stickleback

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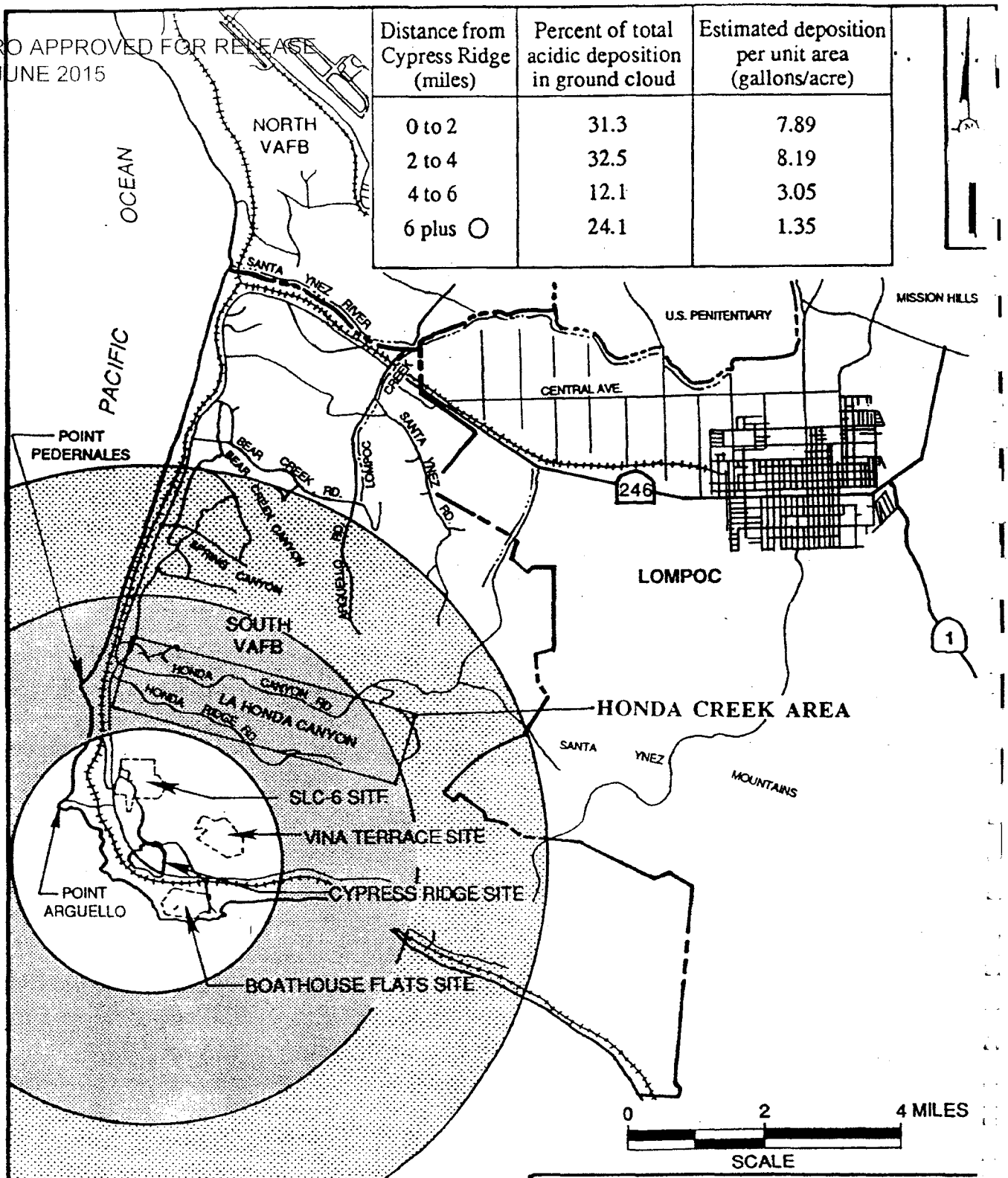
Distance from Cypress Ridge (miles)	Percent of total acidic deposition in ground cloud	Estimated deposition per unit area (gallons/acre)
0 to 2	31.3	7.89
2 to 4	32.5	8.19
4 to 6	12.1	3.05
6 plus ○	24.1	1.35



WIND SPEED = 25 MILES PER HOUR
COMPUTATION PERFORMED BY TRAJM (NASA 1983)
SOURCE: USAF 1986c

FIGURE 5.5

ACIDIC DEPOSITION IN VICINITY OF HONDA CREEK

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and tidewater goby populations. Further discussion on this subject is presented in Appendix E (Technical Memorandum, Acidic Deposition, Titan IV/Centaur Launch from the Cypress Ridge Site).

4. Air pollutants present in the Titan IV/Centaur exhaust plume could result in short-term, localized impacts to terrestrial biota exposed to initially high concentrations of pollutants (ES and SWRI 1988). Birds flying through the exhaust plume might be exposed to HCl, which could irritate eye and respiratory tract membranes. Since most birds would be frightened away by the noise, it is unlikely that many would come into contact with the exhaust plume. Exposure to Al_2O_3 would not be expected to impact resident wildlife populations. The Al_2O_3 would have a relatively short-term presence in the atmosphere. Further, it is known to have a low toxicity for humans and as a result is not expected to adversely affect animals.

5. The launch of a Titan IV/Centaur would generate about 126,000 gallons of wastewater. The exhaust duct serves as a retention basin to prevent the release of launch wastewater into surface and coastal waters. Launch wastewater generated at the Cypress Ridge site would be transported to the SLC-6 wastewater treatment plant for disposal. Therefore, there would be no significant impacts to aquatic biota as a result of deluge and washdown water discharges. In addition, containment areas within the launch complex boundary would control accidental release of spilled propellants preventing these types of spills from reaching aquatic areas.

6. The federal- or state-listed wildlife species known to be in the vicinity of the Cypress Ridge site that may be affected by project operations are transient and migrant, such as peregrine falcon, brown pelican, and California least tern, and would be subject to localized, short-term impacts from exposure to air emissions. The unarmored three-spine stickleback, a federal- and state-listed endangered species, and the tidewater goby and California red-legged frog, which are both Category 2 candidate species proposed for federal listing, occur in Honda Creek. However, as discussed above, project operations would not be expected to significantly impact the habitats of either species. There would be no significant impact to the habitat of other listed species of wildlife that are known to be present in the region as a result of project operations. Regionally rare and declining animals known to occur on the Cypress Ridge and alternative sites, such as northern harrier, prairie falcon, burrowing owl, least Bell's vireo, Wilson's warbler, and badger, are not expected to be exposed to significant impacts from project operations.

Launch Anomaly

1. There is small potential for a catastrophic accident during launch (launch anomaly). If the worst-case were to occur, where a Titan IV detonates while still on the launch pad, most animals within a few hundred feet of the blast would die, and a wildfire would probably ensue. Such a fire would have the potential to kill additional animals in habitats adjacent to the launch site. These impacts are judged to be insignificant based on past experience that: (1) there were no observable adverse impacts to biota in the vicinity of SLC-4 East following the Titan 34D explosion of April 1986, and (2) the habitats and their associated biota which are present in the vicinity of the launch site are adapted to, and thus tolerant of, naturally occurring wildlifes.

Launch Noise and Sonic Boom

1. Noise can impact terrestrial animals in a number of ways. In the short-term it can cause hearing damage and impairment and trigger traumatic startles (i.e., startles in which animals damage themselves or others). In the long-term, noise can cause changes in the distribution and abundance of affected species or alter predator-prey interactions which might lead to ecological changes (Janssen 1978). Since launches from the Cypress Ridge site would be limited, intensive events and their effects are expected to be short-term (ES and SWRI 1988). Thus, this analysis will be confined to potential short-term effects of noise on wildlife in the vicinity of the launch site.

2. Noise from Titan IV/Centaur launches could result in temporary physiological damage, such as short-term hearing impairment, to terrestrial biota near the Cypress Ridge site (ES and SWRI 1988). Temporary hearing impairment has been recorded for humans at 115 to 120 dBA (ES and SWRI 1988). The threshold for auditory damage from exposure to a single sonic boom has been found to occur in the range of 138 dB (mice) to 142 dB (chinchillas) (Chappell 1980). The maximum A-weighted sound level expected to be produced during a Titan IV/Centaur launch outside of the launch complex is 110 dBA. Thus, this level is not expected to result in temporary impairment or permanent auditory damage to animals in the vicinity (ES and SWRI 1988).

3. Terrestrial mammals, such as kangaroo rat, coyote, gray fox, bobcat, and mountain lion, which are known to have reasonably good low-frequency hearing, and which occur within a two- to three-mile radius of the launch site, may suffer temporary, short-term (10 to 48 hour) impacts following launches. Impacts may include hearing deficits and temporary hearing threshold shifts. Effects on animal behavior of these hearing impairments are not known, but

are not expected to be serious, since hearing impairment would be temporary (Hammernik et al. 1980). Thus, it is not expected that multiple launches would result in significant local impacts to terrestrial mammals.

4. Since most birds are relatively insensitive to sounds below 100 Hz, they are unlikely to experience auditory damage from sonic booms or launch noises (Collins 1988b). Based on studies of the American kestrel (Trainer 1946), it would appear that endangered and declining diurnal raptors, such as the peregrine falcon, bald eagle, black-shouldered kite, northern harrier, Cooper's hawk, merlin, and prairie falcon, probably would not be affected by noise from either a launch or subsequent focused sonic boom (ES and SWRI 1988). Ellis (1981) could find no evidence that frequent loud (82-114 dBA) helicopter overflights affected nesting success, adult mortality, or territory use of peregrine falcons and golden eagles, nor could he find evidence of opportunistic predation on their nests after they were startled off. Studies of other land birds have found no significant effect from occasional disturbances, such as sonic booms (Teer and Truett 1973; Higgins 1974). Based on the above information, it appears that there would be no significant local impact to land birds from launch noise and sonic booms generated from launches at the Cypress Ridge site.

Increase in Human Activity

1. An increase in human activity during project construction and operations, especially during periodic use of the external tank landing facility, could affect the clusters of monarch butterflies in the Monterey cypress near the Boathouse. This species is sensitive to disturbance resulting from human activity. Therefore, human intrusion into the area would be discouraged, and no significant impacts would be expected.

5.2.4.2 SLC-6

5.2.4.2.1 Construction

1. Additional loss of wildlife habitat is not anticipated as a result of construction at the SLC-6 site, since earth moving and excavation activities are not planned. Therefore, habitat-related impacts would not occur. Further, construction of the proposed project at SLC-6 would avoid the loss of habitat that would occur from project implementation at one of the undeveloped sites. Other impacts related to construction at SLC-6 would be similar to those described for the Cypress Ridge site.

5.2.4.2.2 Operations

1. On a daily basis, increased activity in the SLC-6 area would lead to increased noise, human activity, and decreased air quality. These changes may initially be disruptive, but wildlife in the area would be expected to adapt rapidly. As described above for the Cypress Ridge site, exposure to noise and air emissions during launch would produce short-term, insignificant impacts to species in the area. Impacts to the unarmored three-spined stickleback in Honda Creek would be similar to those for the Cypress Ridge site. Even though SLC-6 is closer to Honda Creek than Cypress Ridge, the buffering capacity of the water in the creek is sufficient to neutralize acidic deposition that might fall into the creek after a launch. Other operational impacts to terrestrial and aquatic animals in the area would be similar to those for the Cypress Ridge site and, therefore, insignificant (see Appendix E).

5.2.4.3 Boathouse Flats

5.2.4.3.1 Construction

1. Impacts to terrestrial and aquatic animals from construction of the project at the Boathouse Flats site are expected to be nearly the same as those described for the Cypress Ridge site. Disruption and loss of potential nesting habitats for American kestrel, mourning dove, rock dove, horned lark, cliff swallow, western meadowlark, house finch, and song sparrow would result from project construction. However, due to the present degraded condition of the grassland habitat at this site, and the widespread occurrence of this habitat and its associated species elsewhere in the VAFB region, the loss of this area to wildlife is not expected to be significant. Aside from an occasional transient peregrine falcon, there are no other threatened or endangered species of land birds expected to utilize the Boathouse Flats site.

5.2.4.3.2 Operations

1. Increase in noise, human activity, and decreased air quality would occur in the vicinity of the facility during normal day-to-day operations at Boathouse Flats. As described above, nearby wildlife would be expected to adapt to those changes. Although impacts would be long-term, they would be insignificant.

2. During launches, exposure to noise, air emissions or water discharges could create localized, short-term, insignificant impacts to resident, migrant, and transient listed species and regionally rare or declining species which are known or expected to occur in the vicinity. As previously discussed, no significant impacts to habitats of listed or candidate species are expected to result from operation of the proposed action at the Boathouse Flats site.

5.2.4.4 Vina Terrace

5.2.4.4.1 Construction

1. Impacts from construction of the proposed action at the Vina Terrace site are expected to be similar to those described for the Cypress Ridge site. Although the wildlife habitats present at the Vina Terrace site are of higher quality, the loss of these habitats for construction would be classed as insignificant for the same reasons as described for the Cypress Ridge site.

5.2.4.4.2 Operations

1. The Vina Terrace site is situated in proximity to two drainages, Oil Well Canyon to the west and Cañada Agua Viva to the east (see Figure 2.2). There exists the possibility that launch-related acidic deposition could impact the biota of these two drainages. Acidic deposition could result in a short-term, localized impact to terrestrial and aquatic biota, and to water quality of Cañada Agua Viva. This impact would be insignificant because: (1) this semi-perennial stream is not known to contain any resident, regionally rare, declining, or otherwise sensitive species of fish, amphibians, reptiles, or birds, and (2) the biota of this drainage is depauperate, due in part to disturbances resulting from cattle grazing.

2. There are no records of listed species within the vicinity of the Vina Terrace site, nor are any listed species expected to frequent this site on a regular basis. Thus, there would be no significant impact to the habitat of listed or candidate species from operation of the proposed action. Resident, migrant, or transient regionally rare and declining species, and listed species of birds and land mammals may be subject to insignificant, short-term, localized impacts from exposure to water discharges or air emissions from operation of the proposed action at the Vina Terrace site.

5.2.5 MARINE ANIMALS

5.2.5.1 Marine Turtles

1. As described in Section 3.3, the study region does not appear to be used by large numbers of marine turtles. The nearest breeding areas and nesting sites are along the coast of Mexico, so interruptions of the reproductive cycle from proposed project activities and launches would be inconsequential. In general, no impacts from the project are expected to marine turtles.

5.2.5.2 Marine Mammals

5.2.5.2.1 Regional Impacts

1. Launch noise and related sonic booms may have two effects on marine mammals (sea otters and pinnipeds) out of water. If the sound pressure levels are strong enough and within a certain frequency range, they could cause temporary or permanent hearing loss. Analyses done for the Space Shuttle predicted maximum focused sonic boom overpressures of 30 psf (156 dB) and indicated that permanent hearing loss was not likely, but that some temporary hearing threshold shift was possible for animals in the zone of sonic boom focus (Chappell 1980). Secondly, loud booms could create startle responses manifested by stampeding to the water. If this occurred during critical points in the reproductive cycle of breeding pinniped species, it could result in a potential impact to their populations, such as causing adults to abandon a breeding ground, nursing females to abandon their pups, or pups to be crushed by stampeding adults. However, the maximum predicted sonic overpressure for the Titan IV/Centaur is 10 psf (147 dB) (see Appendix D). Based on results of the Space Shuttle analysis, launches of the Titan IV/Centaur would be expected to result only in minor, short-term hearing losses.

2. The exact nature of startle response to loud sonic booms would probably differ among the four pinniped species currently breeding at San Miguel Island (California sea lions, harbor seals, northern fur seals, northern [steller] sea lion). Bowles and Stewart (1980) provide an account of potential reactions of these pinnipeds and indicate that California sea lions and harbor seals may be the most reactive. They also point out that, within the California sea lion population, individual responses to loud booms may vary as a function of seasonal or age-related sensitivity. The same may be true to varying degrees among the other species.

3. Based on the predicted worst-case focus signature, potential startle impacts are expected to be most prevalent at San Miguel Island. The responses of California sea lions, as well as northern fur seals, were observed during two breeding seasons (Bowles and Stewart 1980; Stewart 1981). Both species were reported as responding (running) in reaction to aircraft overflights and sonic booms. The observers, however, did not record evidence of crushed pups, panic leaping, overheating due to overexertion, or mother-pup separation. There were no other reports in literature which suggest that these findings are not consistent (Woodhouse 1988b).

4. The Guadalupe fur seal is only occasionally sited in the northern Channel Islands and are not expected to be impacted by launches of the proposed Titan IV/Centaur.

5. Harbor seals reportedly are more sensitive to disturbance than are other pinnipeds in the study region. However, they are not likely to permanently abandon favored haul-out sites, particularly not in response to noise stimuli unaccompanied by a visual stimulus (Stewart 1981; Speich et al. 1987). Mother-pup separations are subject to some controversy, but purely acoustic stimuli, such as sonic booms on San Miguel Island, would result in relatively controlled movements which would allow pups to follow their mothers (Bowles and Stewart 1980; Stewart et al. 1988).

6. The frequency of Titan IV/Centaur launches would be three per year. At the most, only one launch per year would occur during the harbor seal pupping season. Based on breeding statistics for San Miguel Island (Stewart et al. 1988), only pups less than two hours old could be separated from their mothers during a major startle. On San Miguel Island, 100 to 120 pups are born each year over a 75-day breeding period, with a maximum of two to three per day born during the peak period. Only one sonic boom from a Titan IV/Centaur would be possible during this period, so the probable risk and potential consequence of mother-pup separation is small.

7. Launch-related impacts to the one mustelid (sea otter) that occurs in the region are not anticipated. The sea otter occurs periodically rather than regularly, and sightings north of Santa Barbara area occasional. The closest breeding grounds, based on sightings north of VAFB, are north of Pismo Beach.

8. Gray whales are known to pass within 100 miles of the VAFB shoreline during the annual winter-spring migration, but adverse impacts are not expected due to the relatively infrequent launches and the sharp attenuation of noise-related effects below the air/water interface.

9. As discussed herein, no significant effect to marine mammals is anticipated. However, as there is the potential for some impact, Section 7 Consultation is required.

5.2.5.2.2 Local Impacts

Cypress Ridge

1. Potential impacts associated the construction phase at the Cypress Ridge site would be temporary. Construction support activities could impact nearshore marine mammal populations. If the ocean is utilized as a route for the delivery of construction supplies, adverse impacts could result from vessel movements and/or potential fuel spills. These events

could interfere with normal use of the area by marine mammals. Normal uses of the area may include harbor seals and, occasionally, California sea lions, which use the rocks immediately offshore of the breakwater, and sea otters and gray whales, which may pass through the immediate areas as seasonal and other parameters dictate.

2. The phases of operation may be delineated relative to potential impacts to marine mammal populations. Activities before or after launches may involve movements of materials and supplies by ship or barge via the external tank landing facility. This activity may prove disruptive to those marine mammal species using the nearshore (i.e., harbor seals, sea otters).

3. Activities during launches would have a wider impact, primarily noise generated by the launch vehicle. Noise would be of two types: (1) generated by the rockets at the launch pad during liftoff and ascent, and (2) created by sonic boom as the vehicle achieves supersonic speed down range. Noise of the first type may create a startle response and stampede to the water by pinnipeds hauled out along the shore in the Cypress Ridge area. Noise of the second type would be attenuated by distance and would not result in significant impacts to local pinniped populations.

4. The effect of exhaust gas emissions (carbon monoxide, nitrogen oxides, aluminum oxides, and hyrochloric acid) to pinnipeds or sea otters on or near the shoreline would depend in part on prevailing winds and rate of dissipation of exhaust gases. However, analyses of the effects of exhaust emissions done for the Titan IV program indicates no significant impacts to marine biota (ES and SWRI 1988). In addition, analyses undertaken for the SLC-7 Risk Assessment (Environmental Solutions, Inc. 1989) indicate that maximum exhaust gas dosages are below toxicity exposure limits for humans.

5. There is a small possibility for an early inflight termination and subsequent activation of the vehicle destruct system. Most of the propellant that would be released would ignite and burn before reaching the water. In the unlikely event of an inflight failure, coupled with a failure of the vehicle destruct system, the possibility exists that some liquid propellant might enter the ocean. The magnitude of the impact would depend on the amount of propellant released, the area of effective dispersion, and the biological significance of the impact area. Localized, short-term impacts to water quality and marine biota would likely result.

SLC-6

1. Impacts from project construction and operations would be the same as those described for the Cypress Ridge site.

Boathouse Flats

1. Implementation of the proposed project at the Boathouse Flats site may cause harbor seals using the shoreline immediately fronting the site to abandon the area either temporarily or permanently. These impacts would be related to construction and/or operations activities in proximity to the cliff. Generally, these pinnipeds are easily spooked by as little stimulus as a single person standing in full view on a bluff top. Previous construction activities in areas where harbor seals haul out have had a variety of effects. For example, the pier near Carpinteria, California (south of Santa Barbara), was built through a haulout used by the seals and currently supports continued activity by the oil industry. However, the animals have acclimated to these conditions and persist in using the shore. Alternatively, the entrance of the Goleta Slough, about 20 miles west of the project area, was used by numbers of harbor seals 50 years ago. Subsequently, a freeway was built over it, a beach park was developed around its entrance, and the animals essentially ceased using the area.

2. The potential effect of launch exhaust gas emissions at this site would also be below toxic threshold levels since the gases are hot and rise rapidly from ground level to a stabilization point some distance downwind.

3. The occurrence of a launch anomaly, while unlikely, could have some local impact to marine mammals in the path of falling debris or incompletely oxidized propellant. Such impact, although potentially significant to involved animals, would be short-term (ES and SWRI 1988).

Vina Terrace

1. Due to the relative distance of the Vina Terrace site from the shore, construction-related impacts to marine mammals are not anticipated. Operations impacts would be comparable to those described for the Cypress Ridge site.

5.2.5.3 Marine Birds

5.2.5.3.1 Regional Impacts

1. Noise generated during launch and sonic booms focused over the Channel Islands would result in short-term, localized, and insignificant impacts to marine birds. No long-term

auditory or physiological impacts are expected to occur as a result of sonic booms or noise generated during launches. Launch noise is expected to result in short-term impacts, such as temporary hearing impairment, to marine birds within a radius of about three to five miles of the project area. Marine birds which nest in the Rocky Point to Point Pedernales area (i.e., pelagic cormorant, pigeon guillemot, Western gull, rhinoceros auklet) could suffer temporary hearing impairment as a result of exposure to launch noise, but this impact is not expected to result in occurrences of colony abandonment (Collins 1988b). California brown pelicans would not be adversely affected by Titan IV/Centaur space vehicle launches from the project area. Due to distance from the launch site, impacts from launch noise are expected to be minimal and insignificant to the California least tern nesting colonies at the mouth of the Santa Ynez River and at Purisima Point (see Figure 3.6).

2. Focus sonic booms are not expected to produce significant, long-term impacts to marine bird colonies on San Miguel Island for the reasons stated above. Minor egg losses may occur in Western gull colonies on San Miguel Island, but these are not expected to significantly impact populations. Measurable egg loss is not expected to occur in cormorant nesting colonies on the island as a result of sonic booms (Schreiber and Schreiber 1980; HDR 1989; Jehl and Cooper 1980; Evans et al. 1979). The nearest California brown pelican nesting colony occurs on west Anacapa Island, which has a low probability of receiving focused sonic booms from these launches (see Figure 5.3).

5.2.5.3.2 Local Impacts

Cypress Ridge

1. Marine birds could be impacted during construction at the Cypress Ridge site by air pollution, noise, and human activity. Intrusion into offsite areas adjacent to known marine bird nesting or roosting sites could be particularly disturbing during the spring brooding season. Such disturbance could occur during barge deliveries of the MST, and equipment and supplies to the external tank landing facility. Due to the distance of the Cypress Ridge site from marine bird nesting or roosting sites, impacts from onsite construction activities are not anticipated.

2. Impacts to marine birds are not expected from deluge or washdown wastewater generated during operations since these are not released to grade. Launch- or accident-related ground clouds could result in the localized, short-term exposure of marine bird nesting and roosting colonies located between Point Arguello and the Boathouse to contaminants. Localized, short-term impacts to marine birds could occur as a result of a worst-case flight failure and failure of

the vehicle destruct system. The relative intensity of impacts to marine birds would depend on the amount of propellant to enter the water and on the biological sensitivity of the area of impact.

SLC-6

1. Significant impacts to marine birds are not expected from construction due to the developed nature of the site.

2. Impacts to marine birds from operations are expected to be substantially the same as those described for the Cypress Ridge site.

Boathouse Flats

1. Impacts to marine birds during project construction at the Boathouse Flats site are expected to be of the same type as those described for the Cypress Ridge site. However, due to the proximity of the Boathouse Flats site to the littoral zone, impacts to marine birds, which are known to forage and roost in the area, are expected to be greater during the construction phase than those described for the Cypress Ridge site. Noise, along with the visual presence of personnel and equipment less than 0.6 mile from a known brown pelican and cormorant roost (the Boathouse breakwater), could cause a temporary dispersal of pelicans and cormorants from the area, at least until the end of the construction phase. This displacement would be temporary, as these birds would be expected to return. Birds displaced from the Boathouse breakwater during construction would have to seek alternate roost sites on offshore rocks in the Point Pedernales and Rocky Point areas or on the sandy beach near the mouth of the Santa Ynez River. Temporary loss of the Boathouse area as a roosting area for brown pelicans would be a localized, short-term, and insignificant impact.

2. Propellant spilled during operations into the coastal environment could result in adverse impacts. Such spills are not expected to occur because of the presence of spill containment areas within the boundaries of the launch complex. A launch- or accident-related ground cloud may affect marine birds in the vicinity of the launch site. However, because this impact would be localized and short-term, it would be insignificant. Localized, short-term impacts to marine birds could occur in the unlikely event of a worst-case flight failure and failure of the vehicle destruct system. The extent of this impact would be dependent on the amount of propellant released, the effective dispersal area and on the biological significance of the area impact (ES and SWRI 1988).

Vina Terrace

1. Construction of the proposed action at Vina Terrace would result in fewer impacts to marine birds than described previously because the Vina Terrace site is located further from the nearshore littoral habitats which are utilized by marine birds for foraging and roosting. If the proposed action were built at the Vina Terrace site, increased noise and human intrusions during construction are expected to have an insignificant affect on marine biota in the Boathouse area.

2. Impacts to marine birds from operations are expected to be the same as those described for the Cypress Ridge site.

6.0 MITIGATION MEASURES

6.1 INTRODUCTION

1. Mitigation measures will be established to minimize impacts from project construction and operations. These measures include specific procedures related to preconstruction planning, project construction, and operations. USAF regulation 126-1, Conservation and Management of Natural Resources, Chapter 4, paragraph 12, March 20, 1984, states that species proposed for or under review for federal listing (candidate species) should be considered in environmental planning and be provided protection when feasible.

2. An Erosion Control and Restoration Plan (ECRP) also would be prepared, addressing measures to prevent erosion, where feasible, and to minimize the extent of erosion which would occur.

3. Finally, a monitoring program would be prepared and implemented in cooperation with USFWS and NMFS. The program would provide assessment and reporting procedures for tracking the long-term effects of project operations.

6.2 SPECIFIC MITIGATION MEASURES

6.2.1 VEGETATION

1. The extent of land disturbed for construction laydown and stockpile areas and utility corridors would be minimized through preplanning.

2. Prior to construction, an access corridor and turn-around area(s) would be staked. Construction vehicles and activities would be limited to the staked area(s). Other construction vehicle travel would be limited to designated roads. These areas would be shown on construction maps.

3. Areas of special interest plants and habitat that can be avoided would be flagged and, as appropriate, an environmental monitor would be present during clearing and grading to ensure these areas are protected. An example of this type of area is the proposed construction laydown area southwest of the SLC-6 External Tank Storage and Checkout Facility, near a large population of curly-leaved monardella.

4. During construction of the launch complex and utility corridors, the top six inches of topsoil would be stockpiled, to be respread at completion of construction. This would enable revegetation to occur by seeds present in the topsoil.

5. During construction of the electric power line, the power poles would be placed, as feasible, to avoid populations of Category 2 species *Monardella undulata* var. *frutescens*. Wetland areas at the Red Roof and Gray Canyon Crossing would be avoided by adjusting pole spacing to clear these areas.

6. Prior to construction, the opportunity would be provided for interested parties (representatives of herbaria and botanic gardens, universities, CNPS, etc.) to recover specimens of specific interest plants that would otherwise be taken by construction.

7. If erosion is likely disturbed areas would be revegetated with endemic plants, preferably with local seed or with approved, noninvasive, naturalized species.

8. Soil stabilization measures, such as erosion control fabric, soil cement, and/or gunite, would be utilized on areas of steep slopes or highly erodible soils.

6.2.2 WILDLIFE

1. Offsite activity by project-related construction and operations personnel would be controlled. During construction, workers would be restricted from unauthorized visits to areas of sensitive offsite wildlife resources such as harbor seal hauling grounds, the monarch butterfly roosting areas, and marine bird roost sites and nesting colonies.

2. Regulations prohibiting smoking in fire hazard areas would be established and strictly enforced.

3. At the External Tank Landing Facility, procedures would be utilized to minimize the opportunity for spills. Proper cleanup equipment would be at hand to contain and remove spilled substances. Containers from fuel storage and use would be required to be kept or constructed within suitable secondary containment structures.

4. A qualified biologist would be employed, as necessary, to periodically inspect construction activities.

5. Employees would be restricted from interfering with wildlife.

6.3 EROSION CONTROL AND RESTORATION PLAN

1. The approach to the development of the proposed action is to minimize impacts to the extent feasible. Environmental goals specific to the biological resources of the project area and larger project region are to minimize both the area and extent of disturbance to plant and animal resources.

2. In compliance with general USAF environmental regulations and specific environmental goals related to land use and terrestrial resources, the USAF will prepare an Erosion Control and Restoration Plan. The two primary goals of the ECRP are to:
   - Control erosion of disturbed areas during project construction and operations.
   - Restore areas disturbed during construction to natural habitat conditions.

3. These goals are to be achieved through a program which begins with preconstruction planning and continues with monitoring during project construction and operation.

4. The ECRP would specify measures for erosion control, revegetation and reclamation of disturbed areas, and treatment of sensitive species and wetland areas. These measures would include monitoring and control of exotic plants to mitigate impacts from weed invasion of disturbed construction areas, in accordance with AFR 126-1 and 19-7.

6.4 MONITORING PROGRAM

1. The monitoring program will include efforts related to both vegetation and wildlife species, in compliance with USAF Regulations 19-7 and 126-1. This program will be developed in accordance with the requirements of USAF environmental regulations and in consultation with USFWS and NMFS and will be ongoing during both the construction and operations phases of the project.

2. During construction, a qualified biologist would be employed, as necessary, to periodically monitor construction activities. Revegetation monitoring would be undertaken, and records would be kept of the seed sources and the revegetated locations. During project operations, the monitoring program will emphasize listed and, as applicable, other special interest species to assess impacts from noise and air emissions. For example, the program would assess the effect of acidic deposition on vegetation, with an emphasis on sensitive species.

3. Monitoring potential impacts to pinnipeds and sea birds from launch noise and sonic booms will be accomplished by utilizing the on-going Sea World Research Institute program. This program, funded by USAF, is a five-year effort to gather baseline animal behavior data prior to and after launches. These data will be used to monitor changes in populations and mortality trends that may result from space launches and to build a predictive model to forecast future animal abundance.

7.0 CONCLUSIONS

7.1 VEGETATION

1. Construction and operation of the proposed project at the Cypress Ridge site would not affect any federal- or state-listed threatened or endangered plants. USAF Regulation 126-1 (Conservation and Management of Natural Resources, Chapter 5, paragraph 12, March 20, 1984) states that species proposed for or under review for federal listing (candidate species) should be considered in environmental planning and be provided protection when feasible. Consistent with this regulation, the loss of 800 to 1,000 mature individuals and at least as many seedlings of the candidate plant *Monardella undulata* var. *frutescens* at the southern limit of its range due to construction at the Cypress Ridge site would constitute a locally significant impact to the present distribution of this species. As a mitigation measure, an opportunity would be provided for interested parties (representatives of herbaria and botanic gardens, universities, CNPS, etc.) to recover specimens of special interest plants that would otherwise be taken by construction.

2. An insignificant number of individuals of the federal candidate *Monardella undulata* var. *frutescens* would be lost if the Boathouse Flats site were chosen; no mitigation for its loss would be necessary.

3. Implementation of the proposed action at the SLC-6 site would not result in significant construction-related disturbance to vegetation since it is a fully developed space launch complex.

4. No known federal candidate species or special interest plants would be affected if the Vina Terrace site were selected.

7.2 WILDLIFE

1. Impacts to terrestrial, aquatic, and marine wildlife are expected to be minor and short-term. Terrestrial wildlife may experience temporary effects associated with construction of the launch complex, primarily related to clearing and grading activities. During operations, terrestrial wildlife may experience short-term effects from acidic deposition and launch noise. It is not expected that aquatic wildlife would be impacted by acidic deposition resulting from launches. These effects are not expected to be significant.

2. Marine mammals also may experience short-term effects associated with construction and operation of the proposed action. Pinnipeds hauled out on the shoreline in the vicinity of Rocky Point and the external tank landing facility may be disturbed by the proximity of humans and human activity, as well as by acidic deposition and launch noise. Marine mammals utilizing the northern Channel Islands, especially San Miguel Island, may experience intermittent exposure to launch-related sonic booms. Research indicates that these effects would not be significant.

3. Marine turtles and cetaceans are not expected to be affected by construction and operations activities associated with the proposed action, as their normal ranges are outside the region reasonably considered susceptible to project-related impacts.

4. There is the potential for ocean deposition of rocket fuels or falling debris resulting from a launch anomaly. Potential effects to marine species would depend upon the location and extent of such occurrence.

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9.0 LIST OF ABBREVIATIONS

1STRAD	First Strategic Aerospace Division
AFR	Air Force Regulations
Al_2O_3	Aluminum Oxide
APCD	Air Pollution Control District
CCAFS	Cape Canaveral Air Force Station
CDFG	California Department of Fish and Game
CNDDB	California Natural Diversity Data Base
CNPS	California Native Plant Society
CO	Carbon Monoxide
CY	Cubic Yards
dB	Decibels
dBA	Decibels (A-Weighted Sound Level)
DDT	Dichlorodiphenyltrychlaoethane
DOD	Department of Defense
ECRP	Erosion Control and Restoration Plan
EIS	Environmental Impact Statement
ESA	Endangered Species Act
ETR	Eastern Test Range
HCl	Hydrogen Chloride
H_2O	Oxygen
ICBM	Intercontinental Ballistic Missile
ILC	Initial Launch Capability
IOCN	International Union of the Conservation of Nature and Natural Resources
kV	Kilovolt
kVA	Kilovolt-ampere
LCC	Launch Control Center
LD	Launch Exhaust Ducts
LH_2	Liquid Hydrogen
LHe	Liquid Helium
LM	Launch Mount
LO_2	Liquid Oxygen
LSS	Launch Support Structure
MMPA	Marine Mammal Protection Act
MOL	Manned Orbital Laboratory

MST	Mobile Service Tower
N_2O_4	Nitrogen Tetroxide
NASA	National Aeronautics and Space Administration
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NUS	No Upper Stage
OSB	Operations Support Building
PCR	Payload Changeout Room
PLF	Payload Fairing
PPR	Payload Processing Room
psf	Pounds per square foot
psig	Pounds per square inch
REEDM	Rocket Exhaust Effluent Dispersion Model
RSV	Ready Storage Vessel
SAB	Shuttle Assembly Building
SAC	Strategic Air Command
SBMNH	Santa Barbara Museum of Natural History
SSD/DEV	Space Systems Division/Division of Environmental Planning
SLC-2, -3, -4, -5, -6, -7	Space Launch Complex 2, 3, 4, 5, 6, 7
SPL	Sound Pressure Level
SRMUs	Solid Rocket Motor Upgrades
STS	Space Transportation System
SV	Satellite Vehicle
TRAJM	Deposition Trajectory Model
UDMH	Unsymmetrical dimethyl hydrazine
USAF	United States Air Force
USFWS	United States Fish and Wildlife Service
UT	Umbilical Tower
UV	Ultraviolet
VAB/HTF	Vehicle Assembly Building/Horizontal Test Facility
VAFB	Vandenberg Air Force Base

APPENDIX A

PLANT SPECIES

A.1 Plant Species Observed in the Study Area

A.2 Candidate Plant Species on VAFB

A.3 Special Interest Plants at the Cypress Ridge Site

TABLE A.1

PLANT SPECIES OBSERVED IN THE STUDY AREA

SPECIES	COMMON NAME	Habitat Affinity[1] and Abundance[2]							Presence at Site[3]			
		C	S	G	W	D	N	B	CR	BH	VT	SLC-6
Acacia longifolia	golden wattle					o						
Achillea millefolium	yarrow	s	s	o			s	o	x	x	x	x
Adenostoma fasciculatum	chamise	c					o					x
Adiantum jordani	California maidenhair				o		o					
Agoseris apargioides				o								
Agoseris grandiflora	dandelion		s									
Agoseris heterophylla	mountain dandelion		s			o			x			
Agrostis diegoensis	thin grass	o	s	s			o		x			
Ambrosia chamissonis	beachbur							s				
Amsinckia intermedia	fiddleneck			c		o						
Amsinckia spectabilis var. *microcarpa*	fiddleneck		s	c				s	x	x		x
Anagallis arvensis	scarlet pimpernel	s	s	s	s	c			x	x	x	x
Anaphalis margaritacea	pearly everlasting						s					x
Anthemis cotula	mayweed			o		o						
Anthriscus scandicina	bur chervil						o					
Arctostaphylos purissima	Purisima manzanita	c					s					
Artemisia californica	coastal sagebrush	o	a	c		o		a	x	x	x	x
Artemisia douglasiana	mugwort		s		c		s					x
Artemisia dracunculus	tarragon		s			o		s	x			
Aster radulinus			o		o							
Astragalus nuttallii	locoweed		s	c				c		x	x	x
Atriplex californica								s				

(1) Habitats:
- C = Chaparral
- S = Central coastal scrub/Venturan coastal sage scrub
- G = Grassland
- W = Riparian and other wetlands
- D = Disturbed areas
- N = North-facing slopes (see text)
- B = Central dune and coastal bluff scrub

(2) Abundance:
- o = occasional
- s = scattered
- c = common
- a = abundant

(3) Presence at sites denoted by an "x"
- CR = Cypress Ridge Site
- BH = Boathouse Flats Site
- VT = Vina Terrace Site
- SLC-6 = Space Launch Complex 6 Site (within existing security fence)

Source: Hickson 1988.

TABLE A.1
(continued)

SPECIES	COMMON NAME	Habitat Affinity[1] and Abundance[2]							Presence at Site[3]			
		C	S	G	W	D	N	B	CR	BH	VT	SLC-6
*Atriplex lentiformis**	saltbush					s						
Atriplex semibaccata	Australian saltbush		o	o		a		c	x	x		x
Avena barbata	slender wild oat		s	a		a		c	x	x	x	x
Baccharis glutinosa	mulefat				s							
Baccharis pilularis ssp. *consanguinea*	coyote brush	c	a	c	a	c	o	c	x	x	x	x
Brassica geniculata	mustard		o	c		c			x	x	x	x
Brassica nigra	black mustard		s	c		s					x	x
Brassica tournefortii			s			c			x			
Bromus carinatus	California brome		s									
Bromus diandrus	ripgut brome	o	s	a		c			x	x	x	x
Bromus mollis	soft chess	o	o	a		c			x	x	x	x
Bromus rubens	red brome	o	s	a		a		s	x	x	x	x
Calandrinia ciliata var. *menziesii*	red maids		s	s		c			x			
Calyptridium monandrum		s	s									
Calystegia macrostegia ssp. *cyclostegia*	morning-glory	s	s	s			s	s	x	x	x	x
Camissonia cheiranthifolia ssp. *cheiranthifolia*	beach primrose							s				
Camissonia micrantha		o	s	s				s	x		x	x
Camissonia strigulosa		o	o						x			
Capsella bursa-pastoris	sheperd's purse		o	s		s						x
Cardionema ramosissimum	sand mat	s	s	s		s		s	x	x	x	x
Carex globosa	round-fruited sedge	s										x
Carex praegracilis	clustered field sedge				s							
Carpobrotus aequilaterus	sea fig							a				
Carpobrotus edulis	ice plant	o	s	s		a		a				x
Castilleja affinis	Indian paintbrush	s	s	s			s	s	x		x	x
Ceanothus cuneatus	buck brush	s										
Ceanothus impressus var. *impressus*	Santa Barbara ceanothus	a	s			s			x			x
Ceanothus thyrsiflorus	blue blossom	a										
Centaurea melitensis	tocalote	s	s	c		s		s	x	x	x	x
Cerastium glomeratum	mouse-ear chickweed				s							
Chenopodium californicum	goosefoot	s	s	s					x	x		x
Chenopodium murale	nettle-leaved goosefoot		s			s		s			x	x

ant used in revegetating areas around SLC-6, would not otherwise occur in the study area.

TABLE A.1
(continued)

SPECIES	COMMON NAME	Habitat Affinity[1] and Abundance[2]							Presence at Site[3]			
		C	S	G	W	D	N	B	CR	BH	VT	SLC-6
Chlorogalum pomeridianum	soap plant, amole	o	s						x			
Chorizanthe coriacea		s	s	s				s	x		x	
Chorizanthe diffusa var. *diffusa*		s	s	s				s	x		x	
Cirsium brevistylum	Indian thistle		o				o					x
Cirsium occidentale	Western thistle	s	s	s				s	x		x	x
Cirsium vulgare	bull thistle			s		s			x		x	
Claytonia perfoliata	miner's lettuce	s	s		s		s		x		x	
Collinsia heterophylla	chinese houses	o	s				s		x			
Conicosia pugioniformis (L.) N.E. Br.	thin-leaved ice plant	o	s			s		s				
Conium maculatum	poison hemlock				a	a					x	x
Convolvulus arvensis	bindweed		o			o						
Conyza sp.	horseweed	s	s	s		a			x	x	x	x
Coreopsis gigantea	giant coreopsis		s				c	c			x	x
Corethrogyne filaginifolia	cudweed aster		c	s			s	s	x	x	x	x
Cortaderia jubata	pampas grass					o						
Cotula australis					s							
Crassula erecta		s	s						x		x	x
Croton californicus var. *californicus*		s	c	s				s	x			x
Cryptantha leiocarpa		o	s	s		o		s	x			x
Cupressus macrocarpa	Monterey cypress		o			o			x			
Cuscuta sp.	dodder		o					o				
Daucus pusillus	rattlesnake weed	o	s	s		s		s	x			x
Delphinium parryi ssp. *blochmaniae*			s	s				o	x			
Descurainia pinnata ssp. *menziesii*	tansy mustard	o	s	s		s		s	x	x	x	x
Dichelostemma pulchellum	blue dicks	s	s	s			s	s	x		x	x
Dichondra occidentalis			s						x		x	
Dodecatheon clevelandii ssp. *insulare*	shooting star		o	o								x
Dudleya caespitosa	live-forever							s				x
Dudleya lanceolata	live-forever		s	o					x		x	
Ehrharta calycina	Veldt grass			s		c		s				x
Eleocharis sp.	spikerush				o							
Elymus condensatus	giant rye	s	a	o					x		x	x
Elymus glaucus	Western rye		s	s			o					
Emmenanthe penduliflora var. *penduliflora*	whispering bells		o									

TABLE A.1
(continued)

SPECIES	COMMON NAME	Habitat Affinity[1] and Abundance[2]							Presence at Site[3]			
		C	S	G	W	D	N	B	CR	BH	VT	SLC-6
Encelia californica	bush sunflower	o	a		c			s	x	x	x	x
Eremocarpus setigerus	turkey mullein			s						x	x	
Erigeron foliosus var. *foliosus*				o				o	x			
Erigeron sanctarum	saint's daisy	o										
Eriogonum elongatum				s							x	
*Eriogonum giganteum**	St. Catherine's lace					s						
Eriogonum parvifolium var. *parvifolium*	seaside buckwheat	s	c	s				c	x	x	x	x
Eriophyllum confertiflorum	golden yarrow	s	c	s					x		x	
Eriophyllum multicaule			s						x			
Eriophyllum staechadifolium var. *artemisiaefolium*			s				c	c				x
Erodium botrys	broad-leaved filaree		s	c		c			x	x		x
Erodium cicutarium	redstem filaree	o	s	s		c			x	x	x	x
Erodium moschatum	whitestem filaree			s		s						
Erysimum suffrutescens var. *grandifolium*	larged-leaved wallflower		s					s	x			
Eschscholzia californica	California poppy		s	a		c		a	x	x	x	x
Eucalyptus globulus	blue gum				s	s						x
Eucrypta chrysanthemifolia			s						x			
Euphorbia crenulata	Chinese caps		o									
Filago californica		s	c					s	x			
Filago gallica		s	s	s		s			x			
Fragaria vesca ssp. *californica*	wild strawberry		o				o					x
Frankenia grandifolia var. *grandifolia*	alkali heath							s				
Galium andrewsii		s										x
Galium aparine	bedstraw				s							x
Galium sp. *(nuttallii?)*	bedstraw	s	s		s		s		x		x	
Gaultheria shallon	salal						s					
Gilia capitata ssp. *abrotanifolia*		s			s		s	x				
Gnaphalium beneolens			s	s					x		x	x
Gnaphalium bicolor	bicolored cudweed	s	s					s	x		x	
Gnaphalium californicum	green everlasting	s	s	s				s	x		x	x
Gnaphalium chilense var. *chilense*		s	s									
Gnaphalium luteo-album			s			s						

[1] not used in revegetating areas around SLC-6, would not otherwise occur in the study area.

A-4

TABLE A.1
(continued)

SPECIES	COMMON NAME	Habitat Affinity[1] and Abundance[2]							Presence at Site[3]			
		C	S	G	W	D	N	B	CR	BH	VT	SLC-6
Gnaphalium purpureum		s	s	s				s	x	x	x	x
Gnaphalium ramosissimum	pink everlasting		o						x			
Grindelia robusta	gum plant		s			s			x	x	x	
Haplopappus ericoides	mock heather	s	a	s				c	x	x	x	x
Haplopappus squarrosus	sawtooth goldenbush		c	s				c	x	x	x	
Haplopappus venetus ssp. *sedoides*							s					
Haplopappus venetus ssp. *vernonoides*		o	c	s					x	x		
Hedypnois cretica		o	s	s		s		s	x	x	x	
Helenium puberulum	sneezeweed				o							
Helianthemum scoparium	rock rose	s	s				o				x	x
Hemizonia fasciculata	tarweed		s	c					x	x	x	
Hemizonia inscrescens (Hall ex Keck) *Tanowitz ssp. increscens*	tarweed		s	s					x	x	x	
Hemizonia sp.	tarweed			s				s				
Hesperocnide tenella		s	s		s		s					
Heteromeles arbutifolia	toyon	s	s									
Hordeum californicum	meadow barley							o		x		
Hordeum leporinum	foxtail		s	c		s			x	x	x	x
Horkelia cuneata		s	c	s					x			x
Hypochoeris glabra	smooth cat's ear	s	s	c		c		s	x	x	x	x
Iris douglasiana	Douglas iris	o										x
Juncus balticus	wire rush				s							
Juncus effusus var. *brunneus*	bog rush				s							
Juncus phaeocephalus (?)					s							
Koeleria macrantha	june grass		s	s				s	x			
Lamarckia aurea	goldentop		s	c		c		s	x	x	x	
Lasthenia chrysostoma	goldfields		s	a				a	x	x	x	x
Lathyrus laetiflorus ssp. *barbarae*	wild sweetpea	o		s			o	s	x			x
Lavatera cretica						s						
Layia platyglossa	tidy tips			a				c	x	x	x	x
Lepidium sp.		s	s	s				s	x			x
Linaria canadensis var. *texana*	toadflax		s			s			x			x
Lithophragma affine	woodland star				o							
Lobularia maritima	sweet alyssum					o						

TABLE A.1
(continued)

SPECIES	COMMON NAME	Habitat Affinity[1] and Abundance[2]							Presence at Site[3]			
		C	S	G	W	D	N	B	CR	BH	VT	SLC-6
Lolium perenne ssp. *multiflorum*	Italian ryegrass			c		c			x	x	x	x
Lotus junceus	deerweed	s	c	c		s		c	x	x	x	x
Lotus subpinnatus			o	o					x	x		
Lupinus albifrons var. *douglasii*	silver lupine		c	s							x	
Lupinus arboreus	coastal bush lupine		s	s		s		a	x			x
Lupinus chamissonis	dune lupine							c				
Lupinus nanus	sky lupine		s	c				c	x	x	x	x
Luzula subsessilis	common wood rush	s										x
Madia sativa	Chilean tarweed		o			s						x
Malva parviflora	cheeseweed			s		c				x		
Marah fabaceus	wild cucumber	c	s					s	x		x	x
Marrubium vulgare	horehound					s					x	
Matricaria matricarioides	pineapple weed	o		o		s			x	x		x
Medicago polymorpha	bur clover		s	c		c			x	x		x
Melica imperfecta	coast range melic	s	s	s	o			o	x		x	
Melilotus indicus	yellow sweet clover			s		s				x	x	x
Mesembryanthemum crystallinum	crystalline ice plant		s	s		s		s				
Microseris linearifolia			s						x			
Mimulus aurantiacus	bush monkey flower	c	c				c		x		x	x
Mimulus guttatus var. *guttatus*	monkey flower				o							
Mirabilis californica	wishbone bush		c					c	x		x	
Monardella undulata var. *frutescens*	curly-leaved monardella		o			o			x			
Monardella undulata frutescens x *M. crispa*	hybrid		o									
Monardella villosa var. *obispoensis*								o				
Mucronea californica (Benth.)			s					s	x		x	
Navarretia atractyloides		o										x
Nicotiana glauca	tree tobacco					o						
Orthocarpus purpurascens var. *pallidus*	owl's clover		s	s		s		s	x	x	x	x
Oryzopsis miliacea	rice grass			s	o							
Oxalis albicans ssp. *californica*	sorrel		o	o								
Oxalis pes-caprae	sour-grass			s		s		s			x	x
Parapholis incurva	sickle grass							o				
Parietaria hespera var. *californica*			o									
Pennisetum setaceum	fountain grass					o						

TABLE A.1
(continued)

SPECIES	COMMON NAME	Habitat Affinity[1] and Abundance[2]							Presence at Site[3]			
		C	S	G	W	D	N	B	CR	BH	VT	SLC-6
Pennisetum villosum	feather top					o						
Phacelia distans	wild heliotrope		s									
Phacelia douglasii			s	s		s			x			
Phacelia ramosissima var. *montereyensis*	branching phacelia		s	s				c	x			x
Phalaris stenoptera	Harding grass					o						x
Pholistoma auritum	fiesta flower		o		o							
Picris echioides	bristly ox tongue		o			s						x
Pityrogramma triangularis var. *triangularis*	goldback fern	o										
Plantago coronopus						c		s				x
Plantago erecta			s	s		s			x	x	x	x
Poa annua	annual bluegrass				s							
Poa scrabrella			s	s								
Polycarpon depressum		s	s						x			x
Polycarpon tetraphyllum	four-leaved all seed	o	s	s	s	c				x	x	
Polypodium californicum var. *californicum*	California polypody						s					
Polystichum munitum var. *munitum*	Western sword fern						o					
Potentilla glandulosa	sticky cinquefoil	o	o				s					x
Pteridium aquilinum var. *pubescens*	Western bracken	c	c		c	s	c					x
Pterostegia drymarioides	fairy mist	s	s		s		s		x			x
Quercus agrifolia	coast live oak	s	s						x			
Rafinesquia californica			s	s				s		x		
Ranunculus californicus var. *californicus*	California buttercup		s	s			s	s	x		x	x
Raphanus sativus	wild radish					c				x		x
Rhamnus californica ssp. *californica*	coffee berry	s	o		s		o	o				x
Rhamnus crocea	redberry	o										
Rhus integrifolia	lemonade berry		c					s				
Ribes malvaceum	chaparral currant	o										
Ribes speciosum	fuschia-flowered gooseberry	o	o									x
Rorippa nasturtium-aquaticum	watercress				s							
Rorippa palustris					c							
Rubus parviflorus var. *velutinus*	thimbleberry						o					
Rubus ursinus	wild blackberry		s		c		c				x	x
Rumex conglomeratus	green dock		s	s								x
Rumex crispus	curly dock			o								x

TABLE A.1
(continued)

SPECIES	COMMON NAME	Habitat Affinity[1] and Abundance[2]							Presence at Site[3]			
		C	S	G	W	D	N	B	CR	BH	VT	SLC-6
Rumex sp. *(angiocarpus?)*	sheep sorrel		s	s		c			x		x	x
Sagina occidentalis			s		s							
Salix lasiolepis var. *lasiolepis*	arroyo willow				a							x
Salsola iberica	Russian thistle					s						
*Salvia apiana**	white sage					o						
Salvia columbariae	chia		s	s					x			
Salvia leucophylla	purple sage		a	o					x		x	
Salvia mellifera	black sage	s	a	o				s	x		x	x
Salvia spathacea	hummingbird sage	s	s		s		s	s	x		x	x
Sambucus mexicanus	elderberry		s		c				x		x	x
Sanicula crassicaulis	snakeroot	s	s		s		s		x			x
Scrophularia californica	California figwort	s	s		s			s	x	x	x	x
Scrophularia californica x *atrata Hybrid*		s		s			s					x
Senecio californicus			o					s				
Silene gallica	windmill pink		s	s		c			x	x		x
Silene laciniata	Indian pink		s						x			
Silybum marianum	milk thistle		s	s	c	s					x	x
Sisyrinchium bellum	blue-eyed grass			s				c	x		x	x
Solanum douglasii	Douglas nightshade	s	s						x		x	x
Solanum xanti var. *xanti*	chaparral nightshade	s	s				s		x		x	x
Solidago californica	goldenrod	o	s					s	x		x	
Solidago sp.			s				s					x
Sonchus asper	prickly sow-thistle	o	o	s	s	s	s	s	x	x	x	x
Spergula arvensis	corn spurry		s	s	s	c			x	x	x	x
Spergularia macrotheca var. *macrotheca*								s				
Stachys bullata	wood mint	s	c	s	c		c		x		x	x
Stellaria media	chickweed	s	s		c	s			x			x
Stephanomeria elata			o						x		x	
Stipa lepida	small-flowered stipa		o	s	s				x			
Stipa pulchra	purple needlegrass		s	s				s	x	x	x	
Tauschia hartwegii			s	s								x

*Plants used in revegetating areas around SLC-6, would not otherwise occur in the study area.

TABLE A.1
(continued)

SPECIES	COMMON NAME	Habitat Affinity[1] and Abundance[2]							Presence at Site[3]			
		C	S	G	W	D	N	B	CR	BH	VT	SLC-6
Tetragonia tetragonioides	New Zealand spinach					s		s				
Thalictrum polycarpum	meadow rue				o							
Toxicodendron diversilobum	poison oak	s	c	s	c	o	s	s			x	x
*Trifolium hirtum**	rose clover					s			x			x
*Trifolium incarnatum**	crimson clover					s			x			x
Trifolium tridentatum	tomcat clover		s	s								
Urtica holosericea	giant creek nettle				c					x		x
Vaccinium ovatum	huckleberry						a					x
Verbena lasiostachys var. *lasiostachys*					s	s					x	
Veronica peregrina					o							
Vicia sp. *(benghalensis?)*	vetch			s		s			x	x		x
Viola pedunculata	Johnny jump-up		s	s				s	x		x	
Vulpia bromoides (L.) Gray	fescue			a		s		s	x	x	x	x
Vulpia myuros (L.) K.C.	rattail fescue	s	s	a		s			x			x
Vulpia octoflora (Walt.)Rydb.	six-weeks fescue	s	s	c		s		s	x	x	x	x
Zauschneria californica ssp. *californica*	California fuschia		o	o	s		s					

*Plants used in revegetating areas around SLC-6, would not otherwise occur in the study area.

TABLE A.2

CANDIDATE PLANT SPECIES ON VAFB

SPECIES	STATUS[1] Federal	State	CNPS[2]	Distribution on VAFB[3] and Distance of Closest Known Population from the Project Area
Aphanisma blitoides aphanisma	C2		3	Headlands near Lion's Head (Smith 1983), 21 miles north of Project Area. Also at Point Sal (Smith 1976), in coastal bluff scrub or dune scrub.
Arctostaphylos rudis shagbark manzanita	C2		4	In central maritime chaparral on San Antonio Terrace, Burton Mesa, and Lompoc Terrace (approximately five miles northwest of project area). Apparently found near SLC-6 in 1977 (Beauchamp and Oberbauer 1977), not relocated during this study.
Arenaria paludicola swamp sand wort	C2		1B	No records for VAFB. Occurs in coastal freshwater marshes near Oso Flaco Lake, San Luis Obispo County (Smith 1976).

(1) C1 = Federal Category 1 candidate (sufficient information exists to support listing as threatened or endangered)
C2 = Federal Category 2 candidate (possibly appropriate for listing, but information is insufficient at this time)
R = Rare
E = Endangered

(2) California Native Plant Society 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)
Ap.1 = (Appendix 1) plants considered for lists 1 through 4 but not included

(3) Several species included in this list have been suggested by the USFWS as possibly occurring on VAFB, although there are no records of the plants from the base.

TABLE A.2
(continued)

SPECIES	STATUS[1] Federal	State	CNPS[2]	Distribution on VAFB[3] and Distance of Closest Known Population from the Project Area
Baccharis plummerae ssp. *glabrata* Hoover's baccharis	C2			No records for VAFB. Occurs in northwestern San Luis Obispo County (D. Keil, pers. comm. 1988). Plummer's baccharis (*Baccharis plummerae*) occurs near Point Sal (Schmalzer and Hinkle 1987) and in the Santa Ynez Mountains.
Calystegia collina ssp. *venusta*	C2		3	No records for VAFB. Type locality is 35 miles northwest of project area. Not expected near the coast (S. Junak, pers. comm. 1988).
Castilleja mollis soft-leaved paintbrush	C2		1B	Back dunes from Casmalia Beach to Cypress Ridge, Santa Rosa Island (Smith 1983). All mainland plants will be considered *C. affinis* in new treatment of this taxon (L. Heckard, pers. comm. 1988).
Ceanothus impressus var. *nipomoensis*	C2		Ap.1	No records for VAFB. Occurs on Nipomo Mesa in San Luis Obispo County. Its varietal status is questionable (Hoover 1970). Var. *impressus* is found primarily in central maritime chaparral, from south slope of Cypress Ridge (this study), Lompoc Terrace, Burton Mesa, San Antonio Terrace to Point Sal (Smith 1976).
Chorizanthe pungens var. *pungens* Monterey spine flower	C2		1B	On Burton Mesa according to Smith (1976); however, the collection on which this was based has recently been determined by J. Reveal to be *C. diffusa* var. *diffusa*. The closest known locality for *C. pungens* is in dunes near Oso Flaco Lake in San Luis Obispo County (Smith 1976).
Cirsium loncholepis La Graciosa thistle	C2		1B	Smith (1983) reported populations in marsh areas near Santa Ynez River mouth, 7.5 miles north of project area. Efforts to relocate these in 1986 were unsuccessful; although the species may be present as seed in the soil, requiring some disturbance to establish (R. Nichols, pers. comm. 1988).

TABLE A.2 .
(continued)

SPECIES	STATUS[1] Federal	State	CNPS[2]	Distribution on VAFB[3] and Distance of Closest Known Population from the Project Area
Cirsium rhothophilum Surf thistle	C2		1B	In central foredune community from Rocky Point, one-quarter mile west of project area, to Shuman Canyon; a large population at Point Arguello (CNDDB).
Cordylanthus rigidus ssp. *littoralis* seaside bird's beak	C1	E	1B	Near Santa Lucia Canyon on VAFB (USAF 1987c) in disturbed central coastal scrub, approximately 12 miles northeast of project area.
Dithyrea maritima beach spectacle-pod	C2		1B	In central foredune community on VAFB (Smith 1983). Not observed in dunes at Rocky Point (this study). Possibly occurs at Point Arguello (one-half mile west of project area) and northward.
Eriodictyon capitatum Lompoc yerba santa	C1	R	1B	One colony northwest of intersection of 35th Street and California Avenue, 11 miles north of the project area; two colonies in Pine Canyon (Smith 1983). Also occurs northeast of Point Conception and on La Graciosa Ridge near Orcutt (Jacks et al. 1984).
Erysimum insulare island wallflower	C2		1B	At Surf (Smith 1976), six miles north of project area.
Fritillaria grayana	C2			USFWS has suggested that this plant may occur on VAFB, but apparently uses this name for *F. roderickii*, which occurs only in Mendocino County (Smith and York 1984). *F. grayana* has been used as a synonym for the more common *F. biflora*, which occurs from Santa Barbara to Point Sal and inland (Smith 1976).
Monardella crispa crisp monardella	C2		1B	Some confusion exists over this and the next taxon (see text). Together, they occur in dunes and disturbed sandy sites in central dune scrub and central coastal scrub from the Cypress Ridge proposed site to Point Sal and north to near Oceano in San Luis Obispo County.

TABLE A.2
(continued)

SPECIES	STATUS[1] Federal	State	CNPS[2]	Distribution on VAFB[3] and Distance of Closest Known Population from the Project Area
Monardella undulata var. *frutescens* curly-leaved monardella	C2		1B	See above.
Nasturtium gambellii Gambel's watercress	C2		3	One population in Barka Slough (Dial 1980), 16 miles northeast of study area.
Sanicula hoffmannii Hoffmann's sanicle	C2		4	At Point Sal (Smith 1976). Occurs in central coastal scrub. No record from VAFB, but could occur in the project area.
Scrophularia atrata black-flowered figwort	C2		3	Common over much of VAFB in many habitats, frequently hybridizing with California figwort (*S. californica*) (Smith 1983). Plants with intermediate traits are common in the study area.

TABLE A.3
SPECIAL INTEREST PLANTS AT THE CYPRESS RIDGE SITE

SCIENTIFIC NAME/ COMMON NAME	Federal[1] Status	CNPS[2] Status	Comments on significance and distribution within the site[3]
Amsinckia spectabilis var. *microcarpa* fiddleneck		Ap.1	Endemic to west Santa Barbara and San Luis Obispo Counties. Commonly scattered in grassland and burned area.
Ceanothus impressus var. *impressus* Santa Barbara ceanothus		Ap.1	On sandy mesas in west Santa Barbara and San Luis Obispo Counties. A few unburned individuals on north edge of burned scrub. Presumably will reseed in burned area.
Dichondra occidentalis Western dichondra		L4	Munz and Keck (1959) cite range as coastal Los Angeles to San Diego Counties and Santa Catalina, Santa Rosa, and Santa Cruz Islands. Common on upper slopes of site. Identified from flowering material according to Munz and Keck (1959).
Erysimum suffrutescens var. *grandifolium* large-leaved wallflower		L4	Endemic to west Santa Barbara and San Luis Obispo Counties. Approximately 75 to 100 individuals in unburned scrub east of Coast Road. Identified from flowering and fruiting material according to Munz and Keck (1968 supplement).
Monardella undulata var. *frutescens* curly-leaved monardella	C2	L1B	A population of 600 to 700 flowering plants and many more seedlings along fence east of Coast Road. Smaller populations of 10 to 60 flowering plants scattered throughout site. Approximately 800 to 1,000 plants total onsite. Flowering material identified by J. Jokerst (pers. comm. 1988).
Monardella undulata var. *frutescens* x *M. Crispa* crisp monardella			An unknown number of individuals of this hybrid between the two Federal Candidate plants, as identified by J. Jokerst.

(1) C2 = Category 2 Federal candidate (data is not sufficient to support listing).

(2) CNPS (California Native Plant Society):
Ap.1 = Plants considered but not listed. (Those here were considered too common for listing).
L4 = Of limited distribution.
L1B = Rare and endangered in California and elsewhere.

Sources: Munz and Keck (1959), Smith (1976), and field observations [illegible]ckson, project botanist.

APPENDIX B

TERRESTRIAL AND AQUATIC ANIMAL SPECIES

B.1 Key to Species Lists

B.2 Amphibians and Reptiles Observed or Expected To Occur Within the Study Region and Project Area.

B.3 Land Mammals Observed or Expected To Occur Within the Study Region and Project Area.

B.4 Birds Observed or Expected To Occur Within the Study Region and Project Area.

TABLE B.1

KEY TO SPECIES LISTS

1. HABITAT ABBREVIATIONS

TERRESTRIAL[1]

CI = Channel Islands (Northern Channel Islands only)
CBS = Southern Coastal Bluff Scrub and Central Dune Scrub
CSS = Venturan Coastal Sage Scrub and Central Coastal Scrub
C = Chaparral (northern mixed, central maritime, and blue brush)
G = Grassland (non-native and native perennial)
RW = Riparian Woodland (central coast arroyo willow and central coast riparian scrub)
AGR = Modified Habitats (planted eucalyptus and Monterey cypress windrows)

MARINE

OS = Offshore (oceanic)
SBC = Santa Barbara Channel
NS = Near Shore
CS = Coastal Strand (sandy beach)
RS = Rocky Shoreline (sea cliffs, ledges, shelves, rocky intertidal and off-lying rocks and islets)

2. RELATIVE ABUNDANCE DESIGNATIONS

The following ratings apply only to the occurrence of a species within the project area and do not represent its general abundance within similar habitats elsewhere in Santa Barbara County. These abundance designations are somewhat subjective but are helpful in determining the relative value or significance of a given habitat with respect to certain species.

ABBREVIATION	DESIGNATION	DESCRIPTION
A	Abundant	Species nearly always encountered in particular habitat type indicated, generally in moderate to large numbers.
C	Common	Species can usually be found in the designated habitat during the appropriate season, but usually not in large numbers (5 or more individuals/day).
U	Uncommon	Species occurs in small numbers (1-4 individuals/day) and is not always observed in the given habitat.
R	Rare	Species may occur within the designated habitat but only in very small numbers (1-5 sightings/season). Occurrence is irregular, seasonal, or unlikely.

(1) Habitat types follow Holland (1986).

TABLE B.1

KEY TO SPECIES LISTS
(Continued)

Ca	Casual	Within the range of the species, but not of regular occurrence. Generally fewer than five sightings from the Study Region adjacent to the alternative project sites.

3. SEASONAL STATUS OF BIRDS

ABBREVIATION	STATUS	EXPLANATION
SP	Spring Migrant (March 1 - May 31)	Species occurs within given habitat type as spring migrant.
SU	Summer Resident (June 1 - July 31)	Species occurs only as spring-summer breeder, but migrates out of region for the winter months.
WI	Winter Visitor (December 1 - February 28)	Species occurs only as winter visitor and is not known to breed in the study region.
AU	Fall Migrant (August 1 - November 30)	Species occurs within given habitat types as a fall migrant.
*	Known Breeding	Species nests within the project area.
?	Breeding Status Uncertain	Species may nest within the project area since suitable habitat exists. However, no definite evidence of nesting has been found.

4. SITE DESIGNATIONS

ABBREVIATION	LOCATION	DESCRIPTION
CR	Cypress Ridge	Includes vicinity of preferred site and Oil Well Canyon.
BHF	Boathouse Flats	Includes the flats south of the railroad tracks between Oil Well Canyon and the Boathouse. Also includes the shoreline and nearshore habitats adjacent to the site, including the Boathouse area.
VT	Vina Terrace	Includes vicinity of the Vina Terrace alternative site.
BS	Borrow Site	Includes vicinity of preferred borrow site.
PFA	Preferred Fill Area	Includes vicinity of preferred fill area at and adjacent to borrow pit at Point Pedernales. Also includes sandy and rocky beaches and off-lying and near-shore habitats adjacent to this site.

TABLE B.1

KEY TO SPECIES LISTS
(Continued)

ET	Electrical Transmission Line	Includes a corridor from the existing liquid nitrogen plant north of SLC-6 to the preferred Cypress Ridge site. Corridor includes area between the railroad tracks and an existing electrical transmission line corridor to SLC-6. Also included is existing buried liquid nitrogen pipeline from the LN Facility to SLC-6.
WP	Water Pipeline	Includes water pipeline corridor from existing water tank on ridge east of SLC-6 to the preferred Cypress Ridge site.
CI	Channel Islands/ Santa Barbara Channel	Includes the northern Channel Islands and the waters which surround them, including the waters of the Santa Barbara Channel.

NOMENCLATURE: Nomenclature follows Jennings (1987) and Collins et al. (1982) for amphibians and reptiles, Jones et al. (1986) for land mammals, and the "Thirty-Fourth Supplement to the American Ornithologists' Union Check-list of North American Birds" (A.O.U. 1982) and Banks et al. (1987) for birds.

5. SITE-SPECIFIC STATUS

ABBREVIATION	DESIGNATION	DESCRIPTION
O	Observed	Species was observed at indicated locality during field reconnaissance conducted 29 March, 5, 24 and 29 April, 7-8 and 20-21 May, and 17-18 June 1988.
E	Expected	Species expected to occur at given locality. Site is within limits of the species' distributional range, and suitable habitat is present. Records exist for the study region, but site-specific locality records are lacking.
P	Possible	Occurrence at the site is possible but not expected. Marginal habitat is present at the site. no records are available from the project site.
U	Unlikely	Occurrence at project site is unlikely due to absence of suitable habitat. Known distribution range for the species does not include the project area.

TABLE B.1

KEY TO SPECIES LISTS
(Continued)

?	Status Uncertain	Although suitable habitat is present, there are no recent records from the project site or the study region. Site is within the species' known historical range, but populations are now considered extirpated from the region.

TABLE B.2

AMPHIBIANS AND REPTILES OBSERVED OR EXPECTED TO OCCUR WITHIN THE STUDY REGION AND PROJECT AREA

SCIENTIFIC/COMMON NAME	RELATIVE ABUNDANCE AND HABITAT AFFINITIES[1]						SITE-SPECIFIC STATUS						
	CI	CBS	CSS	C	G	RW	CR	BHF	VT	BS	PFA	ET	WP
CAUDATA (Salamanders)													
Aneides lugubris arboreal salamander				R	C		P	P	P	U	U	E	P
Batrachoseps nigriventris blackbelly slender salamander		R	R	R	C		E	E	E	E	E	E	E
Batrachoseps pacificus Pacific slender salamander	C						Restricted to Channel Islands						
Ensatina eschscholtzii ensatina			C	R	U	C	E	U	E	P	U	E	E
ANURA (Frogs and Toads)													
Bufo boreas Western toad			U	U	U	C	P	P	U	P	U	E	U
Pseudacris (=Hyla) regilla Pacific tree frog	C		U	U	C	A	E	E	E	E	E	E	E
Rana aurora draytoni California red-legged frog						R						?	
TESTUDINES (Turtles)													
Clemmys marmorata pallida Southwestern pond turtle						U						?	
SAURIA (Lizards)													
Anniella pulchra California legless lizard		C	U	U	U	C	E	E	P	E	E	E	P
Eumeces skiltonianus Western skink		R	U	U	C	U	E	E	E	P	U	E	P

[1]See Key to Species Tables B.7, B.8, and B.9 for definitions of abbreviations.

TABLE B.2
(continued)

SCIENTIFIC/COMMON NAME	RELATIVE ABUNDANCE AND HABITAT AFFINITIES						SITE-SPECIFIC STATUS						
	CI	CBS	CSS	C	G	RW	CR	BHF	VT	BS	PFA	ET	WP
SAURIA (Lizards) (Continued)													
Elgaria multicarinatus Southern alligator lizard	C	U	U	U	A	C	E	O	O	E	E	O	O
Phrynosoma coronatum coast horned lizard			U	C	U	R	P	P	P	P	P	P	P
Sceloporus occidentalis Western fence lizard	C	C	A	A	A	C	O	O	O	O	O	O	O
Uta stansburiana side-blotched lizard	U	U	C	C	U	C	P	P	P	P	P	P	P
SERPENTES (Snakes)													
Coluber mormon Western yellow-bellied racer	U		U	U	U		E	P	E	P	U	E	E
Crotalus viridis Western rattlesnake		U	C	C	U	C	O	O	O	E	E	E	E
Diadophis punctatus ringneck snake			U	U	C	C	E	P	P	P	U	E	P
Hypsiglena torquata spotted nightsnake	R		R	R	Ca	R	U	U	?	U	U	P	P
Lampropeltis getulus common kingsnake		R	C	C	C	R	E	O	E	E	P	E	E
Masticophis lateralis striped racer		U	C	C	U	U	E	E	E	O	P	E	E
Nerodia (=Thamnophis) hammondii two-striped garter snake						U	U	U	U	U	U	?	U
Nerodia elegans Western terrestrial garter snake			C	C	U	C	E	E	E	E	P	E	E
Nerodia sirtalis common garter snake			R	R	R	C	P	P	P	P	U	P	P
Pituophis melanoleucus gopher snake	U	C	C	C	A	C	E	O	E	E	E	E	O

TABLE B.3

LAND MAMMALS OBSERVED OR EXPECTED TO OCCUR WITHIN THE STUDY REGION AND PROJECT AREA

SCIENTIFIC/COMMON NAME	RELATIVE ABUNDANCE AND HABITAT AFFINITIES[1] CI	CBS	CSS	C	G	RW	SITE-SPECIFIC STATUS CR	BHF	VT	BS	PFA	ET	WP
MARSUPIALIA (Marsupials)													
Didelphis virginiana Virginia opossum		U	C	U	C	C	E	E	P	E	P	E	E
INSECTIVORA (Shrews and Moles)													
Sorex ornatus ornate shrew		R	C	U	R	C	E	E	E	E	E	E	E
Sorex trowbridgii Towbridge's shrew		R	C	C		C	P	U	P	U	U	E	P
Scapanus latimanus broad-footed mole		U	C	C	A	C	E	E	E	E	E	E	O
CHIROPTERA (Bats)													
Myotis californicus California myotis *Myotis yumanensis* Yuma myotis *Pipistrellus hesperus* Western pipistrelle *Eptesicus fuscus* big brown bat *Lasiurus cinereus* hoary bat *Plecotus townsendi* Townsend's big-eared bat	Regional status and distribution of bats is poorly understood. Virtually nothing is known about their distribution and status on VAFB. Bats tend to be wide-ranging and show very weak habitat affinities. The species listed here are those which occur more commonly on the coastal plain and in foothill canyons of Santa Barbara County. Any or all of these species can be expected to occur within the project area.												

[1]See Key to Species Lists for definitions of abbreviations.

TABLE B.3
(continued)

SCIENTIFIC/COMMON NAME	RELATIVE ABUNDANCE AND HABITAT AFFINITIES						SITE-SPECIFIC STATUS						
	CI	CBS	CSS	C	G	RW	CR	BHF	VT	BS	PFA	ET	WP
CHIROPTERA (Bats) (Continued)													
Antrozous pallidus pallid bat													
Tadarida brasiliensis Brazilian free-tailed bat													
LAGOMORPHA (Lagomorphs)													
Sylvilagus audubonii desert cottontail		C	A	C	U	C	O	E	O	O	E	O	O
Sylvilagus bachmani brush rabbit			R	C		C	P	U	P	U	U	O	P
Lepus californicus black-tailed jackrabbit		U	U		C		E	E	E	E	P	E	P
RODENTIA (Rodents)													
SCIURIDAE (Squirrels)													
Tamias merriami Merriam's chipmunk			R	R			?	U	?	U	U	?	?
Spermophilus beecheyi California ground squirrel		A	C	U	A	R	O	O	O	E	O	O	E
Sciurus griseus Western gray squirrel						R	U	U	U	U	U	?	U
GEOMYIDAE (Gophers)													
Thomomys bottae Botta's pocket gopher		U	A	C	A	C	O	O	O	O	O	O	O

TABLE B.3
(continued)

SCIENTIFIC/COMMON NAME	RELATIVE ABUNDANCE AND HABITAT AFFINITIES						SITE-SPECIFIC STATUS						
	CI	CBS	CSS	C	G	RW	CR	BHF	VT	BS	PFA	ET	WP
HETEROMYIDAE (Kangaroo Rats)													
Perognathus californicus California pocket mouse			C	C	R	R	O	U	E	U	U	E	E
Dipodomys agilis fuscus agile kangaroo rat		R	C	C	C		?	?	?	?	U	?	?
Dipodomys heermanni arenae Hermann's kangaroo rat			C		C		O	P	O	O	E	O	O
CRICETIDAE (Mice and Rats)													
Reithrodontomys megalotis Western harvest mouse	R	R	U	R	A	U	E	E	O	E	P	O	E
Peromyscus californicus California mouse			C	C		C	O	U	O	U	U	O	E
Peromyscus boylii brush mouse			R	R		U	P	U	U	U	U	P	P
Peromyscus maniculatus deer mouse	A	C	A	C	R	C	O	E	O	O	E	O	E
Peromyscus truei piñon mouse			C	A		R	O	U	O	U	U	E	E
Neotoma lepida desert woodrat		U	C	C			O	O	O	E	O	E	E
Neotoma fuscipes dusky-footed woodrat			C	C		A	O	O	O	U	U	O	E
Microtus californicus California vole		U	C	U	A	U	O	E	E	E	U	O	O

TABLE B.3
(continued)

SCIENTIFIC/COMMON NAME	RELATIVE ABUNDANCE AND HABITAT AFFINITIES						SITE-SPECIFIC STATUS						
	CI	CBS	CSS	C	G	RW	CR	BHF	VT	BS	PFA	ET	WP
CANIDAE (Canids)													
Canis latrans coyote		C	C	C	C	C	O	O	O	O	O	O	O
Urocyon cinereoargenteus gray fox			U	C		R	E	U	E	U	O	E	O
Urocyon littoralis Channel Islands gray fox	A						Restricted to Channel Islands						
PROCYONIDAE (Raccoons)													
Procyon lotor raccoon		U	C	C	U	C	E	E	E	E	E	E	E
MUSTELIDAE (Weasels, Skunks)													
Mustela frenata long-tailed weasel		U	C	C	A	C	E	E	E	E	P	E	E
Taxidea taxus badger			U	U	C		O	O	O	P	P	E	E
Spilogale gracilis Western spotted skunk	U		C	C	U	C	E	E	E	P	P	E	E
Mephitis mephitis striped skunk		U	C	C	U	C	E	E	E	P	P	E	E
FELIDAE (Cats)													
Felis concolor mountain lion			R	U	R	R	P	U	P	U	U	P	P
Felis rufus bobcat		U	C	C	U	C	E	E	E	O	P	E	E

TABLE B.3
(continued)

SCIENTIFIC/COMMON NAME	RELATIVE ABUNDANCE AND HABITAT AFFINITIES						SITE-SPECIFIC STATUS						
	CI	CBS	CSS	C	G	RW	CR	BHF	VT	BS	PFA	ET	WP
ARTIODACTYLA (Hoofed Mammals)													
SUIDAE (Pigs)													
Sus scrofa wild pig					U	C	U	U	U	U	U	O	U
CERVIDAE (Deer)													
Odocoileus hemionus mule deer	U	U	C	C	C	C	O	O	O	O	E	O	O

TABLE B.4

BIRDS OBSERVED OR EXPECTED TO OCCUR WITHIN THE STUDY REGION AND PROJECT AREA

	RELATIVE ABUNDANCE & HABITAT AFFINITY																				
	SEASONAL STATUS(1)				MARINE					TERRESTRIAL						SITE-SPECIFIC STATUS							
SPECIES	SP	SU	AU	WI	OS	SBC	NS	CS	RS	CBS	CSS	C	G	RW	AGR	CR	BHF	VT	BS	PFA	ET	WP	CI
Gavidae																							
Arctic loon	A		C	C		C	A									U	O	U	U	O	U	U	E
common loon	C	Ca	U	C		C	C									U	O	U	U	E	U	U	E
red-throated loon	C	Ca	U	C		C	C									U	O	U	U	E	U	U	E
Podicipedidae																							
eared grebe	C	Ca	C	A		C	C									U	E	U	U	E	U	U	E
horned grebe	U		U	C		C	C									U	E	U	U	E	U	U	E
Western grebe	C	U	C	C		C	C									U	E	U	U	E	U	U	E
Procellariidae																							
black-footed albatross	R	R	Ca	Ca	R	Ca										U	U	U	U	U	U	U	P
Laysan albatross	Ca			Ca	Ca											U	U	U	U	U	U	U	P
Northern fulmar	R	Ca	C	C	C	U										U	U	U	U	U	U	U	E
Buller's shearwater			R		R	Ca										U	U	U	U	U	U	U	U
flesh-footed shearwater	R		R		R	Ca										U	U	U	U	U	U	U	P
pink-footed shearwater	U	C	U		C	U	Ca									U	U	U	U	U	U	U	E
sooty shearwater	A	A	C	U	A	A	A									U	P	U	U	P	U	U	E
black-vented shearwater			C	C		C	C									U	P	U	U	P	U	U	E
short-tailed shearwater			R	R	R	R									U	U	U	U	U	U	U	U	E
fork-tailed storm-petrel	Ca			R	R	R	Ca									U	U	U	U	U	U	U	P
ashy storm-petrel	R	C	R	Ca	U	C	U									U	U	U	U	U	U	U	E
Leach's storm-petrel	R	U	U	Ca	U	Ca										U	U	U	U	U	U	U	E
black storm-petrel	U	C	U	Ca		C	U									U	U	U	U	U	U	U	E
least storm-petrel		U	R			R	R									U	U	U	U	U	U	U	E
Phaethontidae																							
red-billed tropicbird		Ca	Ca			Ca	Ca									U	U	U	U	U	U	U	P
Pelecanidae																							
California brown pelican	C	U	C	A		C	C	U	U							U	O	U	U	O	U	U	E

(1) See Key to Species Lists for definitions of abbreviations.

SPECIES	SEASONAL STATUS(1)				RELATIVE ABUNDANCE & HABITAT AFFINITY: MARINE					TERRESTRIAL						SITE-SPECIFIC STATUS							
	SP	SU	AU	WI	OS	SBC	NS	CS	RS	CBS	CSS	C	G	RW	AGR	CR	BHF	VT	BS	PFA	ET	WP	CI
Phalacrocoracidae																							
double-crested cormorant	C	U	C	C		U	C		C							U	O	U	U	E	U	U	E
pelagic cormorant	C	C*	C	C		C	C		C							U	O	U	U	O	U	U	E
Brandt's cormorant	U	R	U	U		C	C		U							U	O	U	U	E	U	U	E
Fregatidae																							
magnificent frigatebird		Ca					Ca	Ca	Ca							U	P	U	U	P	U	U	P
Ardeidae																							
great blue heron	C	C?	C	C				U	C	U			U			U	O	U	U	O	U	U	E
cattle egret	R		R	R								U	R			U	P	P	U	U	P	U	P
green-backed heron	U	U	U	.U					U			U				U	U	U	U	U	P	U	P
great egret	U	R	U	U				R	U							U	P	U	U	P	U	U	P
snowy egret	C	U	C	C				U	C							U	P	U	U	P	U	U	E
black-crowned night heron	U	U							R					R		U	U	U	U	U	P	U	U
Threskiornithidae																							
white-faced ibis			Ca				Ca		Ca							U	P	U	U	P	U	U	U
Anatidae																							
lesser scaup	C	Ca	C	C		C	C									U	P	U	U	P	U	U	P
greater scaup	R	Ca	R	R		R	R									U	P	U	U	P	U	U	E
brant	C	R	U	R		C	C		R							U	E	U	U	E	U	U	E
white-winged scoter	C	Ca	U	U		U	U									U	E	U	U	E	U	U	E
black scoter		Ca	Ca			Ca	Ca									U	P	U	U	P	U	U	P
surf scoter	C	U	C	C		C	C									U	O	U	U	E	U	U	E
red-breasted merganser	U	U	C	C		U	C									U	E	U	U	E	U	U	E
Cathartidae																							
turkey vulture	C	C?	C	C				R	R	U	U	U	C	U		O	E	O	E	O	O	O	U
Accipitridae																							
osprey			R				Ca	Ca	Ca						Ca	P	E	U	U	P	U	U	P
black-shouldered kite	C	C?	C	C				U					C	U	U	E	E	P	P	U	P	P	?
Northern harrier	C	C*	C	C				C				U	C	C		O	O	O	E	E	O	O	E
sharp-shinned hawk	U		U	U							U	R	U	U	U	O	E	E	P	P	E	E	P
Cooper's hawk	U	U?	U	U							U	R	U	U	U	P	P	P	P	U	E	E	E
golden eagle		Ca	Ca	Ca							Ca	Ca	Ca			P	P	P	U	U	P	P	?
red-shouldered hawk	C	C?	C	C							C	U	U	C	U	E	P	P	P	U	E	E	U

TABLE B.4
(continued)

SPECIES	SEASONAL STATUS[1]				RELATIVE ABUNDANCE & HABITAT AFFINITY											SITE-SPECIFIC STATUS							
					MARINE					TERRESTRIAL												
	SP	SU	AU	WI	OS	SBC	NS	CS	RS	CBS	CSS	C	G	RW	AGR	CR	BHF	VT	BS	PFA	ET	WP	CI
red-tailed hawk	A	A*	A	A							C	C	A	U	C	O	O	O	E	O	O	O	E
rough-legged hawk			R	Ca							U	R	U		R	P	P	P	U	U	P	P	U
ferruginous hawk				R									R		R	P	P	P	U	U	P	P	?
bald eagle				Ca			Ca	Ca	Ca						Ca	U	P	U	U	U	U	U	E
Falconidae																							
Merlin	R		R	R				R	R		R		R	R	R	P	P	P	U	P	P	P	?
prairie falcon	R		R	R					R	R			R		R	P	P	P	U	U	P	P	U
American kestrel	C	C*	C	C						U	C	R	C	U	U	O	O	O	E	O	O	O	E
American peregrine falcon			Ca	Ca				Ca	Ca	Ca			Ca			P	E	P	U	P	P	P	E
Phasianidae																							
California quail	A	A*	A	A							A	A	U		C	O	O	O	O	E	O	O	E
Charadriidae																							
killdeer	C	C*	C	C				R	U					U		U	O	U	E	O	O	U	E
snowy plover	C	C*	C	C				C								U	P	U	U	P	U	U	E
mountain plover	Ca			R										Ca		P	P	P	U	U	U	U	P
semipalmated plover	C	C	C	C				U	R							U	P	U	U	P	U	U	P
lesser golden-plover		Ca	R					R						Ca		U	P	P	U	U	U	U	P
black-bellied plover	C	U	C	C				U	C					R		U	E	P	U	E	U	U	E
Haematopodidae																							
black oystercatcher	U	U*	U	U					U							U	E	U	U	E	U	U	E
Scolopacidae																							
willet	C	C	C	C				C	C							U	E	U	U	E	U	U	E
wandering tattler	U	R	U	U					U							U	O	U	U	E	U	U	E
spotted sandpiper	C	U*	C	C					U							U	E	U	U	E	U	U	E
whimbrel	C	U	C	U				C	U							U	E	U	U	E	U	U	E
long-billed curlew	C	C	C	C				C	U					C		U	E	P	U	P	U	U	E
marbled godwit	C	U	C	C				C	U							U	E	U	U	E	U	U	E
ruddy turnstone	U	R	U	R				R	U							U	E	U	U	E	U	U	E
black turnstone	C	R	C	C				R	C							U	E	U	U	E	U	U	E
surfbird	U	R	U	U					U							U	E	U	U	E	U	U	E
red knot	R	R	R					Ca	Ca							U	P	U	U	P	U	U	E
sanderling	C	U	C	A				A	C							U	E	U	U	E	U	U	E
Western sandpiper	C	C	C	C				U	R							U	E	U	U	E	U	U	E

TABLE B.4
(continued)

SPECIES	SEASONAL STATUS(1)				RELATIVE ABUNDANCE & HABITAT AFFINITY										SITE-SPECIFIC STATUS							
					MARINE					TERRESTRIAL												
	SP	SU	AU	WI	OS	SBC	NS	CS	RS	CBS	CSS	C	G	RW	AGR	CR	BHF	VT	BS	PFA	ET	WP	CI
least sandpiper	C	C	C	C				U	U							U	E	U	U	E	U	U	E
Baird's sandpiper			Ca	R				Ca	Ca							U	P	U	U	P	U	U	E
pectoral sandpiper			R						Ca							U	P	U	U	P	U	U	E
long-billed dowitcher	C	C	C	C				U	C							U	P	U	U	P	U	U	E
short-billed dowitcher	C	C	C	R				U	U							U	P	U	U	P	U	U	E
red phalarope	R		U	R	U	U	R									U	P	U	U	P	U	U	E
red-necked phalarope	U	U	C		U	C	R									U	P	U	U	P	U	U	E
Laridae																							
pomarine jaeger	R		U	U	U	Ca										U	P	U	U	U	U	U	E
parasitic jaeger	R	Ca	R	U	U	U	R	R								U	P	U	U	P	U	U	E
long-tailed jaeger	Ca		R		R	Ca										U	U	U	U	U	U	U	P
South Polar skua		U	R		U											U	U	U	U	U	U	U	P
Bonaparte's gull	C	R	U	U		C	C	C	U							U	E	U	U	E	U	U	E
Heermann's gull	U	C	C	C		C	C	C	U							U	E	U	U	E	U	U	E
mew gull	C		U	C		U	C	U	U							U	P	U	U	E	U	U	E
ring-billed gull	C	C	C	C		C	C	U	C							U	E	U	U	E	U	U	E
California gull	A	C	A	A		C	C	U	C							U	O	U	U	O	U	U	E
herring gull	U		U	U		U	U	U	U							U	E	U	U	E	U	U	E
Thayer's gull	U		U	U		U	U	U	U							U	P	U	U	P	U	U	P
Western gull	A	C*	A	A	R	A	A	C	C							U	O	U	U	O	U	U	E
glaucous-winged gull	C	R	C	C		U	C	C	C							U	O	U	U	O	U	U	E
black-legged kittiwake	R		R	U	U	U	R									U	P	U	U	P	U	U	E
Sabine's gull	C	Ca	U		C	R										U	U	U	U	U	U	U	P
Caspian tern	U	U	U	Ca		R	U	U	U							U	E	U	U	P	U	U	P
royal tern	R	R	U	U		U	U	U	U							U	E	U	U	P	U	U	P
elegant tern	U	C	C			U	C	C	C							U	E	U	U	P	U	U	P
common tern	U	R	U			U	U	U	U							U	E	U	U	P	U	U	P
Arctic tern	Ca		C		C	R										U	U	U	U	U	U	U	P
Forster's tern	U	U	U	U		U	U	U	U							U	E	U	U	E	U	U	E
least tern	C	C*	C				U	U	C							U	P	U	U	P	U	U	U
California black tern			Ca			Ca	Ca	Ca	Ca							U	P	U	U	P	U	U	P
black skimmer			Ca	Ca			Ca	Ca	Ca							U	P	U	U	P	U	U	P

TABLE B.4
(continued)

SPECIES	SEASONAL STATUS[1]				RELATIVE ABUNDANCE & HABITAT AFFINITY											SITE-SPECIFIC STATUS							
					MARINE					TERRESTRIAL												
	SP	SU	AU	WI	OS	SBC	NS	CS	RS	CBS	CSS	C	G	RW	AGR	CR	BHF	VT	BS	PFA	ET	WP	CI
Alcidae																							
common murre	U	R	U	A		C	C	U	R							U	E	U	U	E	U	U	E
pigeon guillemot	U	A*				C	A		A							U	O	U	U	O	U	U	E
Xantus' murrelet		C*				C	C		C							U	P	U	U	P	U	U	E
ancient murrelet				U		R	U		R							U	U	U	U	U	U	U	P
Cassin's auklet	U	A*	U	C	U	C	C		C							U	U	U	U	U	U	U	E
rhinoceros auklet	U	U*	U	C	U	C	C		U							U	P	U	U	E	U	U	E
tufted puffin	R				R	R										U	U	U	U	U	U	U	P
horned puffin	U				R	R										U	U	U	U	U	U	U	P
Columbidae																							
band-tailed pigeon	R	Ca	R	R										R		P	P	P	U	U	P	P	P
rock dove	C	C*	C	C					U				U		U	O	O	P	P	O	P	P	E
mourning dove	C	C*	C	C							U	U	C	C	C	O	O	O	O	E	O	O	E
Cuculidae																							
yellow-billed cuckoo		Ca												Ca		U	U	U	U	U	P	U	U
greater roadrunner	U	U*	U	U							U	R	U	U		O	O	E	E	P	O	E	U
Tytonidae																							
common barn-owl	U	U*	U	U						U	U	R	U	U	U	E	E	E	O	E	E	E	E
Strigidae																							
great horned owl	C	C*	C	C						U	C	U	C	C	C	P	E	P	P	O	P	P	U
burrowing owl	R	R?	R	R									R			E	E	E	E	P	E	P	E
long-eared owl		Ca												Ca	Ca	U	U	U	U	U	P	U	U
short-eared owl			R	R									R			U	P	P	U	U	P	U	U
Caprimulginae																							
common poorwill	U	U*	U	U							R	U				P	P	P	U	U	E	P	P
Apodidae																							
white-throated swift	U	U*	U	U						U	U	U	U			E	O	E	P	O	O	O	E
Vaux's swift	U		U							U	U	U	U			E	O	E	P	P	E	O	E
Trochilidae																							
black-chinned hummingbird	U	U*	R											U	R	P	P	P	U	U	O	E	E
Anna's hummingbird	C	C*	C							R	U	C	U	C	C	O	E	E	P	P	E	E	E
Costa's hummingbird	C	C*	U							U	C	C	U	R	R	O	O	O	O	P	O	O	E

TABLE B.4
(continued)

SPECIES	SEASONAL STATUS[1]				RELATIVE ABUNDANCE & HABITAT AFFINITY																	
					MARINE					TERRESTRIAL						SITE-SPECIFIC STATUS						
	SP	SU	AU	WI	OS	SBC	NS	CS	RS	CBS	CSS	C	G	RW	AGR	CR	BHF	VT	BS	PFA	ET	WP	CI
rufous hummingbird	U		U											U	U	E	E	E	E	E	E	E	E
Allen's hummingbird	C	C*	U								U	U	R	C	C	E	E	E	E	E	O	E	E
Alcedinidae																							
belted kingfisher	U	U*	U	U					U					R		U	P	U	U	P	U	U	P
Picidae																							
acorn woodpecker	C	C*	C	C										U	R	P	P	P	P	U	P	P	E
red-breased sapsucker	R		U	U										U	R	P	P	P	P	U	E	P	E
Nuttall's woodpecker	C	C*	C	C							U	U		C	U	P	E	P	P	U	E	P	U
downy woodpecker	C	C*	C	C										C	U	P	P	P	P	U	E	P	U
hairy woodpecker	U	U*	U	U										U	R	P	P	P	P	U	E	P	U
Northern flicker	C	U*	C	C							U	U	U	C	U	E	E	O	E	E	E	O	E
Tyrannidae																							
Western wood-pewee	U	R?	U											U	R	E	E	E	P	U	E	E	E
willow flycatcher	R		U											R	Ca	U	U	U	U	U	P	U	U
Hammond's Flycatcher	R													R	Ca	P	P	P	P	U	E	P	P
Western flycatcher	C	C*	C											C	U	P	P	P	P	U	O	P	E
black phoebe	C	C*	C	C							R	R	U	C	U	P	O	P	P	U	O	P	E
Say's phoebe	C	R?	C	C						R	C	U	A	U	U	E	E	E	E	P	E	E	E
ash-throated flycatcher	U	U?	U								U	U	U	C	U	P	P	P	U	U	E	P	P
Cassin's kingbird	U	U?	U	R							R	R	U	R	U	E	E	E	P	P	E	U	E
Western kingbird	U	R?	U								R	R	U	U	U	E	E	E	P	P	E	U	E
Alaudidae																							
horned lark	U	U*	C	C				U		R	U		C			E	E	E	E	P	E	O	E
Hirundinidae																							
tree swallow	C	C*	C	U							R		R	U		E	E	P	P	P	E	P	E
violet-green swallow	C	C*	C	R							R	U	R	C		E	E	P	P	P	O	E	E
rough-winged swallow	U	U*	U						R	R	R		R	U		E	E	E	P	P	O	P	E
northern cliff swallow	C	C*	C					U	U	U	C	U	C	C	C	O	O	E	O	O	O	P	P
barn swallow	U	U*	U					U	U	U	R	R	U	U	U	O	O	E	P	E	E	P	E
Corvidae																							
scrub jay	A	A*	A	A							U	U	R	U		E	E	E	E	P	O	O	E
American crow	C	C*	C	C						U	U	U	C	C	U	E	E	E	E	E	E	E	U

TABLE B.4
(continued)

SPECIES	SEASONAL STATUS[1]				RELATIVE ABUNDANCE & HABITAT AFFINITY										SITE-SPECIFIC STATUS							
					MARINE					TERRESTRIAL												
	SP	SU	AU	WI	OS	SBC	NS	CS	RS	CBS	CSS	C	G	RW	AGR	CR	BHF	VT	BS	PFA	ET	WP	CI
Paridae																						
plain titmouse	C	C*	C	C						U	C			U	U	E	E	E	P	U	E	E	U
Aegithalidae																						
bushtit	A	A*	A	A						C	C			A	U	O	O	O	O	U	O	O	E
Sittidae																						
red-breasted nuthatch	Ca		R	R										R	R	E	E	P	U	U	E	P	P
white-breasted nuthatch	U	U*	U	U										R	R	P	E	P	U	U	E	P	U
Certhiidae																						
brown creeper	Ca		R	R										R	R	P	E	P	U	U	E	P	E
Troglodytidae																						
rock wren	R	R*	R	R					R		R	R				U	O	P	U	E	E	P	E
Bewick's wren	C	C*	C	C							C	A		C	U	O	E	O	E	P	O	E	E
house wren	U	U*	U	R								R		U	R	E	E	E	P	P	O	E	E
winter wren			R	R										Ca		U	U	U	U	U	P	U	P
marsh wren	C	U?	C	C										R		U	U	U	U	U	E	U	P
Muscicapidae																						
golden-crowned kinglet	Ca		R	R										R	R	P	E	P	P	P	E	P	E
ruby-crowned kinglet	C		C	C							R	U		C	C	E	E	E	E	E	E	E	E
blue-gray gnatcatcher	U	R?	U								R	R	U	U	R	E	E	E	P	P	E	E	E
Swainson's thrush	C	C?	U									R		U		E	E	E	P	P	E	E	E
hermit thrush	C		C	C							U	U		C		E	E	E	P	P	E	E	E
varied thrush			R	R										R		U	U	U	U	U	E	U	P
mountain bluebird			R	R									R			U	E	E	U	U	U	P	E
Western bluebird	U	U?	U	U								R		U	R	U	E	U	U	U	E	P	P
American robin	C	U?	C	C							U	U		C	U	U	E	P	U	U	E	E	E
wrentit	A	A*	A	A							C	A		U		O	E	O	O	P	O	O	U
Mimidae																						
Northern mockingbird	U	U*	U	U										R	Ca	E	E	E	P	U	E	E	E
California thrasher	A	A*	A	A							A	A		U		O	O	O	E	P	O	O	U
Motacillidae																						
water pipit	U		C	C					U	U			U			P	E	P	U	U	P	P	E
Bombycillidae																						
cedar waxwing	U		U	U								U		U	U	U	E	U	U	U	E	U	E

TAI. B.4
(continued)

SPECIES	SEASONAL STATUS(1)				RELATIVE ABUNDANCE & HABITAT AFFINITY											SITE-SPECIFIC STATUS							
					MARINE					TERRESTRIAL												
	SP	SU	AU	WI	OS	SBC	NS	CS	RS	CBS	CSS	C	G	RW	AGR	CR	BHF	VT	BS	PFA	ET	WP	CI
Ptilogonatidae																						
phainopepla	R	R?	R									R		R	Ca	U	E	P	U	U	E	P	E
Laniidae																						
loggerhead shrike	C	U*	C	C							C	U	C	U	C	E	E	E	E	P	E	E	E
Sturnidae																						
European starling	A	A*	A	A						C	C	U	A	C	A	O	O	O	E	O	E	E	E
Vireonidae																						
Bell's vireo	Ca		Ca											Ca		U	U	U	U	U	P	U	U
solitary vireo	R		R											R	R	E	E	E	P	U	E	P	E
Hutton's vireo	C	C*	C	C										C	U	E	E	E	P	U	E	P	E
warbling vireo	C	C?	C											C	U	E	E	E	U	U	O	U	E
Emberizidae																						
Tennessee warbler			Ca											Ca	Ca	U	P	U	U	U	P	U	P
orange-crowned warbler	C	U*	C	C							R	R		C	C	E	E	E	E	U	O	E	E
yellow warbler	C	C*	C											C	U	E	E	E	E	U	E	E	E
yellow-rumped warbler	C		A	A				U	U	U	U	U		C	C	E	E	E	E	E	E	E	E
black-throated gray warb.	U		U	Ca										U	U	P	E	P	U	U	E	P	E
Townsend's warbler	C		C	U										U	U	E	E	E	E	E	E	E	E
hermit warbler	R		R	Ca										R	R	E	E	E	P	U	E	P	E
MacGillivray's warbler	R		U											R	R	U	P	U	U	U	E	U	P
common yellowthroat	C	C*	C	C							U	R	U	C	R	E	E	E	E	U	O	E	E
Wilson's warbler	C	C*	C	R							R			C	R	O	E	O	E	P	O	E	E
yellow-breasted chat	U	U?	U											U		U	U	U	U	U	E	U	P
Western tanager	C		U											C	U	E	E	E	E	U	E	E	E
black-headed grosbeak	C	C*	U											U	R	E	E	E	U	U	E	E	E
blue grosbeak	U	U?	U											U	R	P	P	P	U	U	E	P	P
lazuli bunting	U	U*	U									U		U	R	E	E	E	P	U	E	E	E
rufous-sided towhee	C	C*	C	C							C	C		C		O	E	O	O	P	O	O	E
brown towhee	C	C*	C	C							C	C		C		O	O	O	E	P	E	E	U
chipping sparrow	R			R									R	R		E	E	E	P	U	E	E	E
vesper sparrow	R		R										R			P	E	P	P	U	P	P	P
lark sparrow	C	U*	C	C									C	U	U	E	E	E	P	U	E	P	E
sage sparrow	R	R	R	R									R			P	E	E	U	U	E	P	U

TABLE B.4
(continued)

SPECIES	SEASONAL STATUS[1]				RELATIVE ABUNDANCE & HABITAT AFFINITY																	
					MARINE					TERRESTRIAL						SITE-SPECIFIC STATUS							
	SP	SU	AU	WI	OS	SBC	NS	CS	RS	CBS	CSS	C	G	RW	AGR	CR	BHF	VT	BS	PFA	ET	WP	CI
rufus-crowned sparrow	U	U*	U	U							U	U				E	E	E	U	U	U	U	P
savannah sparrow	C	C*	C	C						U	U		C	R	U	O	E	E	E	P	E	E	E
grasshopper sparrow	U	U*	R										U			P	P	E	U	U	P	P	U
fox sparrow	U		U	U								U		U		E	E	E	P	U	E	E	E
song sparrow	C	C*	C	C							U	U	R	C	R	O	E	P	P	P	O	E	E
Lincoln's sparrow	C		C	C							U	U	R	C	R	E	E	E	P	U	E	E	E
golden-crowned sparrow	C		C	A							C	C	U	C		E	E	E	E	P	E	E	E
white-crowned sparrow	A	A*	A	A							A	A	C	C	C	O	O	O	O	E	O	O	E
dark-eyed junco	C	U?	C	C							U	U		U	U	E	E	E	E	P	E	E	E
red-winged blackbird	C	C*	C	C							U		C	C	C	E	E	P	P	P	E	P	E
tricolored blackbird	U	U*	U	U									R	U	U	P	P	P	U	U	E	P	P
Western meadowlark	C	C*	C	C							U		A		C	O	O	O	E	E	E	E	E
Brewer's blackbird	C	C*	C	C							C	U	C	C	C	O	O	E	E	O	E	E	E
brown-headed cowbird	C	C*	C	C									U	C	R	E	E	E	P	P	E	E	E
hooded oriole	R	R?	R											R	R	E	E	E	P	U	E	P	E
Northern oriole	U	U?	U											U	U	E	O	E	P	U	E	P	E
Fringillidae																							
purple finch	U	U	U	U								R		C	U	P	P	P	U	U	E	P	E
house finch	A	C*	A	A						U	C	C	C	C	A	O	O	O	O	O	O	O	E
pine siskin	R		R	R										R	R	P	E	P	U	U	E	P	E
lesser goldfinch	C	C*	C	C							C	C	C	C	C	E	E	E	E	P	O	O	E
Lawrence's goldfinch	U	R	R	R								R		U	R	E	E	E	E	P	E	P	E
American goldfinch	C	C*	C	C							U	U	C	C	C	E	E	E	E	P	O	P	E
Passeridae																							
house sparrow	C	C*	C	C											C	E	E	P	P	P	E	P	U

APPENDIX C
MARINE ANIMALS

TABLE C.1

MARINE MAMMALS OF THE STUDY AREA*

MUSTELIDAE:	
Enhydra lutris	Southern sea otter
PINNIPEDIA:	
OTARIDAE	
Arctocephalus townsendi	Guadalupe fur seal
Callorhinus ursinus	Northern fur seal
Eumetopias jubatus	Steller (northern) sea lion
Zalophus californianus californianus	California sea lion
PHOCIDAE	
Mirounga angustirostris	Northern elephant seal
Phoca vitulina richardsi	harbor seal
CETACEA:	
MYSTICETI	
Eubalaena glacialis japonica	North Pacific right whale
Eschrichtius robustus	gray whale
Balaenoptera musculus	blue whale
B. physalus	fin whale
B. borealis	sei whale
B. edeni	Bryde's whale
B. acutorostrata	minke whale
Megaptera novaeangliae	humpback whale
ODONTOCETI	
Physeter catodon	sperm whale
Kogia breviceps	pygmy sperm whale
K. simus	dwarf sperm whale
Mesoplodon carlhubbsi	Carl Hubb's beaked whale
M. densirostris	Blainville's beaked whale
M. stejnegeri	Stejneger's beaked whale
Ziphius cavirostris	goose-beaked whale
Berardius bairdii	Baird's beaked whale
Globicephala macrorhynchus	short-finned pilot whale
Grampus griseus	Risso's dolphin
Orcinus orca	killer whale
Pseudorca crassidens	false killer whale
Delphinus delphis	common dolphin: Northern and Baja neritic forms
Lagenorhynchus obliquidens	Pacific white-sided dolphin
Lissodelphis borealis	Northern right-whale dolphin
Stenella coeruleoalba	striped dolphin
S. attenuatta?	spotted dolphin
Steno bredanensis	rough-toothed dolphin
Tursiops truncatus	bottlenose dolphin: coastal form
Phocoenoides dalli	Dall's porpoise
Phocoena phocoena	harbor porpoise

* Offshore of Point Arguello (including the Northern Channel Islands).

Source: Woodhouse 1988.

TABLE C.2

MARINE MAMMALS WITHIN FIVE NAUTICAL MILES OF POINT ARGUELLO

SPECIES EXPECTED TO OCCUR		SPECIES STATUS FEDERAL	CALIFORNIA
Southern sea otter	*Enhydra lutris*	Threatened	Rare, Protected
Harbor seal	*Phoca vitulina richardsi*	None	None
Northern elephant seal	*Mirounga angustirostris*	None	None
California sea lion	*Zalophus californianus*	Threatened	Protected
Northern fur seal	*Callorhinus ursinus*	Depleted	None
Pacific white-sided dolphin	*Lagenorhynchus obliquidens*	None	None
Pacific bottle-nose dolphin (coastal form)	*Tursiops truncatus*	None	None
Killer whale	*Orcinus orca*	None	None
California gray whale	*Eschrichtius robustus*	Endangered	None
Blue whale	*Balaenoptera musculus*	Endangered	None
Fin whale	*B. physalus*	Endangered	None
Minke whale	*B. acutorostrata*	None	None
Humpback whale	*Megaptera novaeangliae*	Endangered	None
Dall's porpoise	*Phcoenoides dalli*	None	None
Harbor porpoise	*Phocoena phocoena*	None	None
Risso's dolphin or gray grampus	*Grampus griseus*	None	None
SPECIES THAT COULD OCCUR			
Sperm whale	*Physeter catodon*	Endangered	None
Pygmy sperm whale	*Kogia breviceps*	None	None
Dwarf sperm whale	*K. simus*	None	None
Mesoplodonts	*Mesoplodon spp*	None	None
Baird's beaked whale	*Berardius bairdii*	None	None
Cuvier's beaked whale	*Ziphius cavirostris*	None	None
Steller sea lion	*Eumetopias jubatus*	None	None
Guadalupe fur seal	*Arctocephalus townsendi*	Threatened	Rare, Protected
North Pacific right whale	*Eubalaena glacialis*	Endangered	None
Sei whale	*B. borealis*	Endangered	None
Common dolphin	*Delphinus delphis*	None	None
Northern right whale dolphin	*Lissodelphis borealis*	None	None

TABLE C.3

RECORDED MARINE TURTLE SIGHTINGS, CENTRAL CALIFORNIA

SPECIES	DATE	LOCATION
Leatherback	July 1977	Ventura River Mouth, Ventura County
Leatherback	Fall 1980	Atascadero State Beach, San Luis Obispo County
Leatherback	July 1983	Emma Wood State Beach, Ventura County
Leatherback	June 1985	2 miles off Naples, Santa Barbara County
Leatherback	August 1985	Morro Bay Sand Spit, San Luis Obispo County
Leatherback	November 1985	Big Sur, Monterey County
Leatherback	May 1988	Santa Rosa Island, Santa Barbara County
Loggerhead	August 1983	Offshore Montecito, Santa Barbara County
Loggerhead	September 1983	8 miles SSW Anacapa Island, Santa Barbara County
Loggerhead	July 1987	Jalama Beach, Santa Barbara County

Source: Santa Barbara Museum of Natural History

APPENDIX D

CHANNEL ISLAND SONIC BOOM ANALYSIS FOR TITAN IV LAUNCHES FROM SLC-7

Technical Report No. 1653

CHANNEL ISLAND SONIC BOOM ANALYSIS FOR TITAN IV LAUNCHES FROM SLC 7

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November 1988

1653

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1. INTRODUCTION

This document has been prepared in support of the Biological Assessment for the SLC-7 Environmental Impact Analysis process. The document describes the assessment of the Titan IV ground level ascent sonic booms.

Potential sonic boom problems exist for the launch of large space boosters which have a ground track near sensitive regions. For Titan IV launches from Vandenberg Air Force Base, the ground track is near the Santa Barbara Channel Islands. Two of these islands, San Miguel and Anacapa, are rookeries or nesting areas for species which may be affected by the sonic boom. Consequently, it is necessary to assess the characteristics of the sonic boom which may affect the area.

The analysis performed in the course of this study was carefully targeted to the needs of the Biological Assessment. As such, the emphasis was on determining estimates of the maximum overpressures that might be generated by Titan IV ascent sonic booms, mapping of a typical area which might be subjected to the highest intensity booms and mapping of a typical region which might be affected by any ascent sonic boom. In contrast to earlier analyses no attempts were made to map overpressure isopleths nor to assess the sensitivity of results to model inputs. Rather, the project staff has drawn upon experience with previous studies to estimate these effects.

1.1 Sonic Booms

A body moving through the atmosphere generates pressure disturbances about it. These disturbances move at the speed of sound, although the air molecules through which the wave travels only move a small distance. The wave itself, rather than individual molecules, travels from the moving body to the ground.

At subsonic speeds this disturbance is normally too gentle to be noticed at ground level. However, at supersonic speeds a shock wave develops. The shock wave forms a continuous surface that travels along with the craft in supersonic flight.

The primary components of the sonic boom generated by an airplane are the compression shock formed at the bow of the aircraft and a collapse shock generated by the tail. Intermediate features of the aircraft generate secondary systems of shock waves.

Similarly, space boosters, such as the TITAN IV, generate sonic booms during the supersonic segment of their trajectories. The aircraft sonic boom is generated almost entirely by the aircraft itself. By contrast, a significant portion of the sonic boom generated by a space booster results from the plume of exhaust gases accompanying the rocket. Particularly at higher altitudes the overexpanded exhaust gases behave like a blunt body traveling at supersonic speeds. Under these conditions the exhaust plume sonic boom dominates that generated by the booster.

A maneuvering airplane causes distortions in shock wave patterns. Some maneuvers, (pushover, acceleration, turn entry) can cause an amplification effect. The trajectory of a space booster is analogous to a portion of an aircraft pushover maneuver. This produces a region of enhanced ground overpressures.

The following paragraphs describe the typical ground level sonic boom footprint generated by the launch of a space booster. Figure 1-1 shows a characterization of the sonic boom footprint presented in the environmental statement for Space Shuttle Program at Vandenberg Air Force Base (Reference 1). This figure identifies the regions represented by many of the terms used in the following discussion.

The greatest ground sonic boom overpressures generated by the launch of these vehicles occurs in the focal region (to be

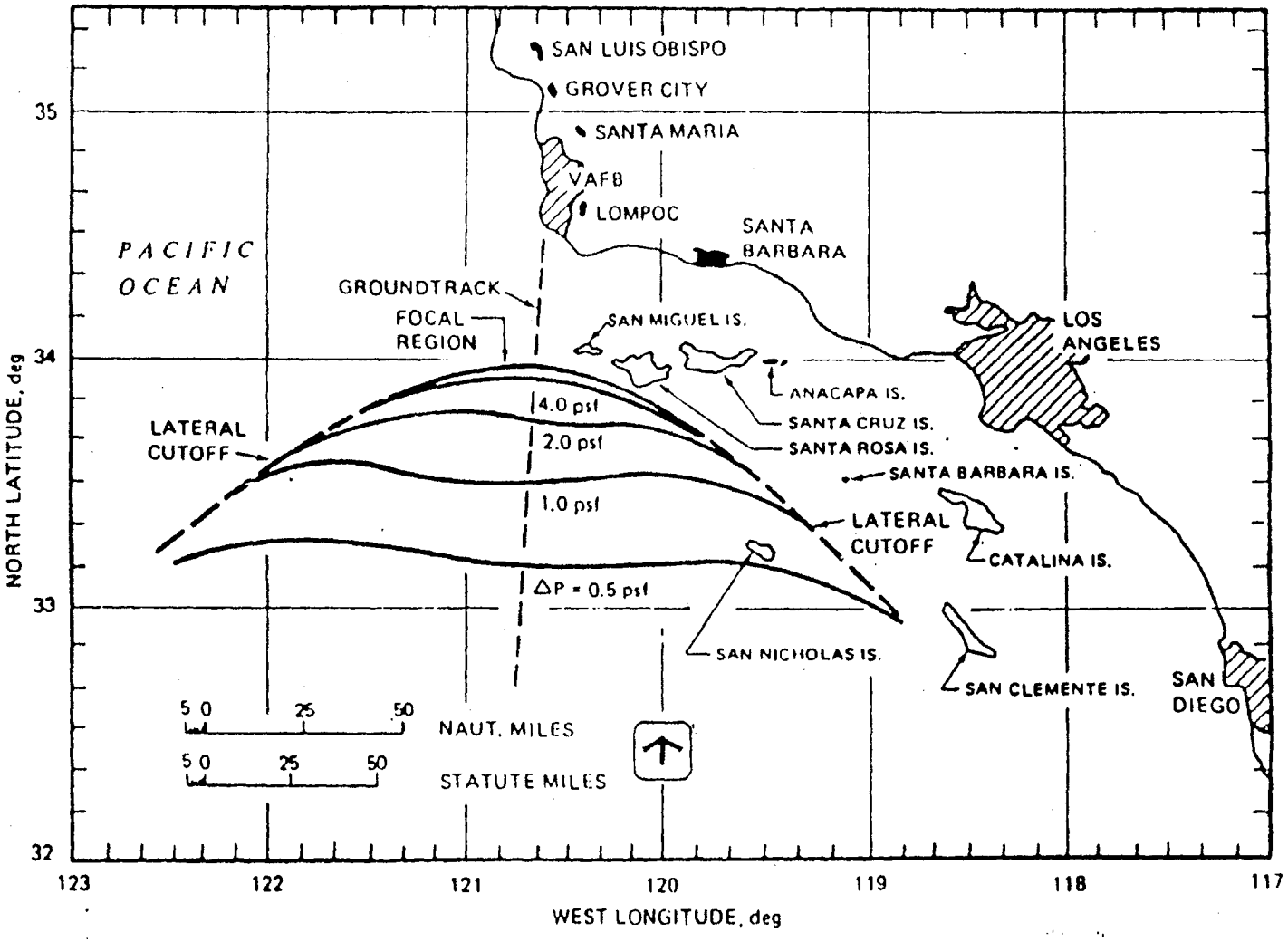


Figure 1-1. Footprint Reported in STS Environmental Statement

defined shortly). The rise time and the positive phase of the shock waves in this region are shorter than other sections of the footprint. Beyond the narrow confines of the focus the overpressures decrease rapidly. At the lateral cutoff, rays (paths of propagation) refract upward at ground level. Small amounts of energy "leak through" by diffraction beyond lateral cutoff to create a so-called rumble zone. The overpressures within a large portion of the sonic boom "footprint" are below levels of concern well within the lateral cutoff, making lateral cutoff a conservative boundary to the sonic boom footprint.

Typically, a space booster is launched in the vertical direction. The initial portion of its trajectory is characterized by acceleration along the trajectory and pitching over of the vehicle. The acceleration of the vehicle has the effect of reducing the apex angle of the Mach cone (reducing the angle between the shock front and the velocity vector). This geometry is illustrated in Figure 1-2. Since the direction of shock propagation is perpendicular to the shock waves, this increases the angle between the direction of propagation of the shock wave and the velocity vector. The effect of these maneuvers is thus to shift the initial direction of shock wave propagation from above the horizontal to progressively larger angles below the horizontal. The combination of acceleration and pitchover causes the footprints to arrive progressively further uprange with successive trajectory times (Figure 1-3).

At the same time that the vehicle has been accelerating and pitching over it has been climbing and moving downrange. Eventually, these positional effects overcome those associated with direction of propagation. When this occurs the footprints cease to advance uprange and begin moving downrange. The focal region is a region of overpressure intensification along the most uprange portion of the footprint. (Uprange of the direct sonic boom footprint is a lower overpressure region resulting from diffusion of energy beyond focal regions aloft.)

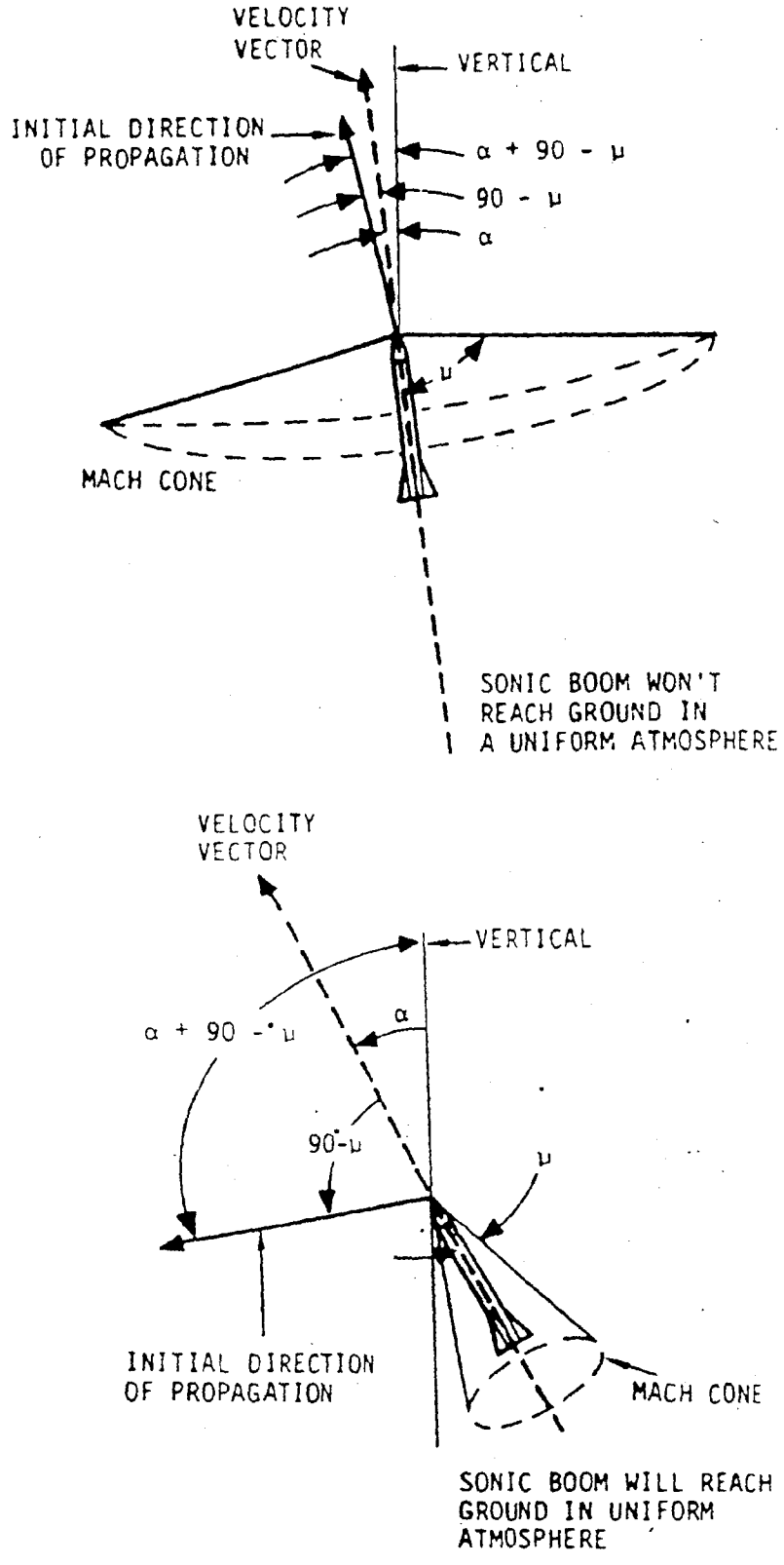


Figure 1-2. Initial Shockwave Geometry for Missiles

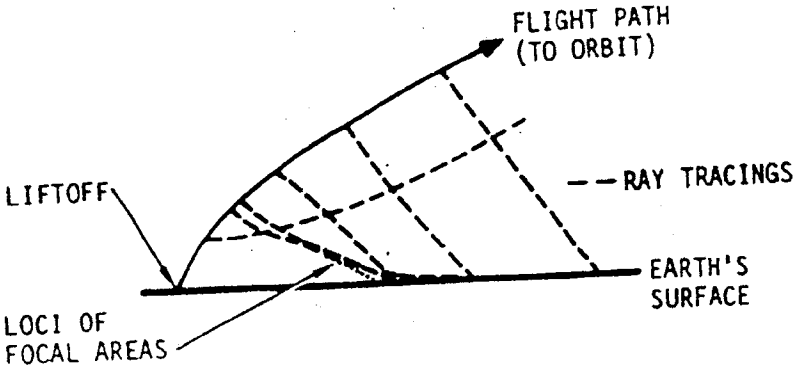


Figure 1-3. Shuttle Ascent Sonic Boom Propagation

The above description of the movement of the footprint is a simplification. The entire footprints do not reverse direction at the same trajectory time. This is a result of the evolution of the shape of the curve along which ground ray intersections occur and the differences in transit time as initial azimuthal angle of the rays increase. Transit time from the vehicle to the ground increases for increasingly shallow angles with respect to the horizontal; rays close to lateral cutoff take significantly longer to reach the earth's surface than rays immediately beneath the vehicle. As the vehicle altitude increases, in general, the footprint becomes broader.

1.2 Model Overview

Figure 1-4 outlines the relationship of the key elements of the model used to characterize the ascent sonic boom and propagate it to the ground. The pressure field generated by the booster is dominated by the exhaust plume contribution. Thus, the flow and associated pressure field for the exhaust plume must be developed. The model used for this draws upon theoretical and empirical studies over roughly the past twenty years.

At supersonic speeds, shock waves form upstream of all surfaces that are at a positive angle of attack, including the solid surfaces of the missile skin as well as the boundary surfaces of the rocket exhaust plume. The attached shock waves form a conical umbrella over the missile skin. The pressure jump across the shock depends upon the ambient static pressure and density at altitude, the geometry of the missile, and speed of the missile.

The shock waves attached to the exhaust plume boundary surface are more complex. The exhaust plume radial expansion at the lower ambient atmospheric pressures associated with higher altitudes is limited by the formation of a shock wave ahead of the plume. The shock increases the back pressure at the nozzle

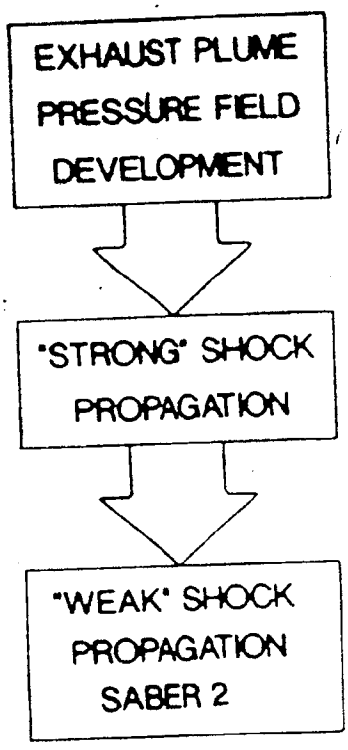


Figure 1-4. Primary Model Components

exit thus, limiting the radial expansion. The exhaust plume boundary, even though it is a gas interface, acts like a solid body that drives the upstream bow shock.

The appropriate technology for source characterization has been derived from several sources. JANNAF (Joint Army, Navy, NASA, Air Force) plume technology meetings occur every other year wherein computer programs (References 2, 3, and 4), laboratory tests (References 5 and 6), and field tests (Reference 7) are presented regarding rocket plume characteristics.

The numerical calculation methods and the gas dynamic models have progressed from those which treat the plume boundary interaction with the ambient air inviscidly to the inclusion of viscous effects. These changes result in different calculated plume shape and dimensions, thus modify the strength of the upstream shock. In order to better match observed results, the exhaust plume has been broken into different zones with specific assumptions for each zone. This calculational procedure permits the detailed properties of the exhaust plume to be established when needed (Reference 8). For this application, the exhaust plume boundary geometry and upstream shock wave geometry are important. This allows a number of simplifications.

Between the umbrella of shock waves attached to the front end of the missile, and shock wave attached upstream of the rocket plume; there are a series of supersonic, subsonic and air recirculation regimes (Reference 9). These were neglected because of the relative insensitivity of the results of this study to their effects.

A section of the pressure field taken parallel to the velocity vector near the booster is called a nearfield signature. Typically, the nearfield signatures associated with large boosters contain "strong" shocks, that is, pressure perturbations more than half the ambient pressure. The SABER 2 computer

program requires the input nearfield signatures to be weak. Weak nearfield signatures are generated by propagating the original strong nearfield signatures away from the source a sufficient distance.

Historically, characterization of booster nearfield signatures was accomplished by creating a scale model of the booster and its exhaust plume and performing wind tunnel measurements. Alternatively, complex computer codes have been exercised to numerically solve the systems of partial differential equation governing the propagation of strong shock waves. The procedure used for this study is an approximation developed by NASA investigators at the Ames wind tunnel facility (Reference 10). This procedure has been previously employed for the Apollo program and for the Space Shuttle program.

During the 1960's, extensive research was performed regarding the sonic boom phenomenon. By the early 1970's investigators at NASA and their supporting contractors had developed computer programs capable of propagating the weak shocks generated by maneuvering aircraft to the ground. Moreover, the theoretical basis had been developed for estimating the overpressures within the type of focal region generated by the flight of a space booster.

The SABER 2 program is based upon the Thomas Waveform Parameter method (Reference 11) and the Plotkin implementation (Reference 12) of Hayes theoretical characterization of overpressures in a focal region. During the application of this program to analysis of the sonic boom generated by the Space Shuttle for the STS Environmental assessment a number of program modifications were made to reduce the numerical noise in the shock propagation computations. The program was later successfully applied to support a sonic boom measurement test program for the launch of Space Shuttle mission STS 41D (References 13 and 14).

1.3 Document Organization

The remainder of this report is presented in two sections. Section 2 describes how the model operates and characterizes the effects of model inputs on sonic boom footprint calculations. Section 3 presents the results of the analysis including a brief discussion of sources of uncertainty in the calculations and a comparison with other programs in which ascent sonic booms for missiles and space boosters were investigated.

2. TECHNICAL ASPECTS OF MODEL

This section outlines the key features of the models. In order to provide a contextual framework for the discussion, we have reversed the order of presentation of the model comments over that provided in the first section. Figure 2-1 indicates an overview of the sonic boom model.

A body moving through the atmosphere at supersonic speeds will continuously generate a system of shock waves in its wake. Under appropriate atmospheric conditions these sonic boom shock waves will produce a disturbance at the ground. Computer programs for estimating the ground level sonic boom must include the following elements:

- A method for generating (describing) a trajectory for the supersonic craft.
- A method for characterizing the system of shock waves generated about the craft.
- A description of those atmospheric parameters that affect the propagation of the sonic boom shock waves.
- A method for characterizing the path of the shock wave propagation through the atmosphere.
- A method for evaluating the effect of the atmosphere on the magnitude and shape of the sonic boom waves.
- A method for accounting for the reflection/attenuation of the sonic boom at the ground.

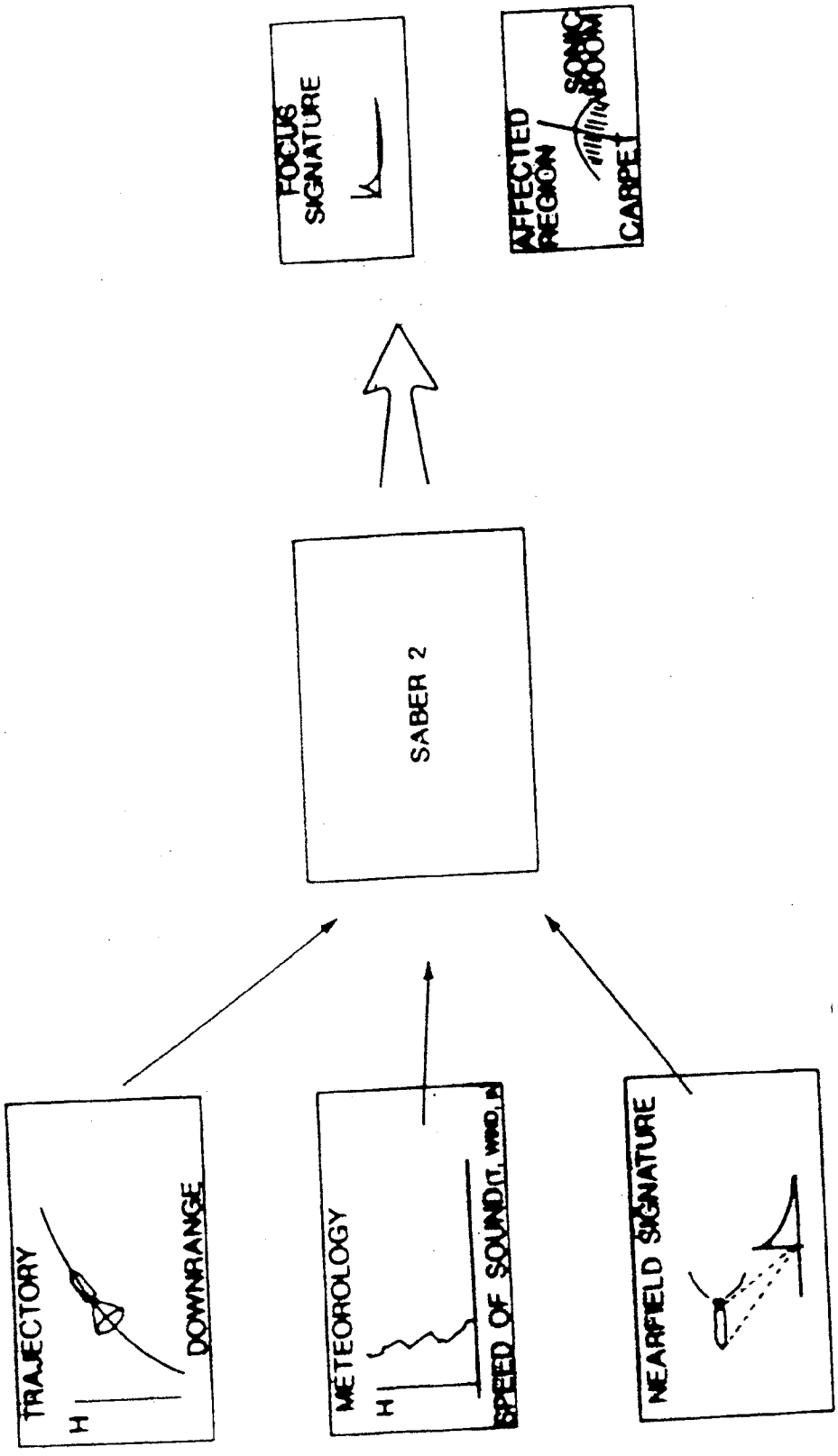


Figure 2-1. Overview

2.1 Trajectory

The trajectory information serves three functions in the sonic boom propagation analysis:

1. It provides an initial location from which the sonic boom shock wave is propagated. At each time point along the flight path the sonic boom shock wave system originates at the leading edge of the space booster; other features, notably the exhaust plume, generate the detail of the waveform at the location of these features. The combined length of the space booster and exhaust plume (and hence, the initial length of the system of shock waves) is much shorter than the distance from the aircraft to the ground. Thus, the path of the shock wave system may be characterized by tracing the path of the leading shock.

2. The leading shock wave (near the booster) will be a conical wave (called the Mach cone) with the axis of symmetry along the booster velocity vector, V_A (Figure 2-2). The booster Mach number, M ($M = V_A/c_A$, c_A is the speed of sound at the aircraft), is related to the apex half-angle, μ, by $1/M = \sin\mu$. The initial direction of propagation of the wave is at ninety degrees to the surface of the Mach cone; the collection of the initial directions of propagation forms a cone called the ray cone. Thus, the booster velocity vector determines the initial direction of propagation of the shock wave.

3. The ray cones generated by a booster accelerating along its velocity vector will have progressively larger apex angles. Thus, corresponding portions of the wave front generated at short time intervals from each other will tend to constructively interfere with each other at some distance from the booster. (The distance from the booster at which this occurs will depend on the rate of acceleration and the

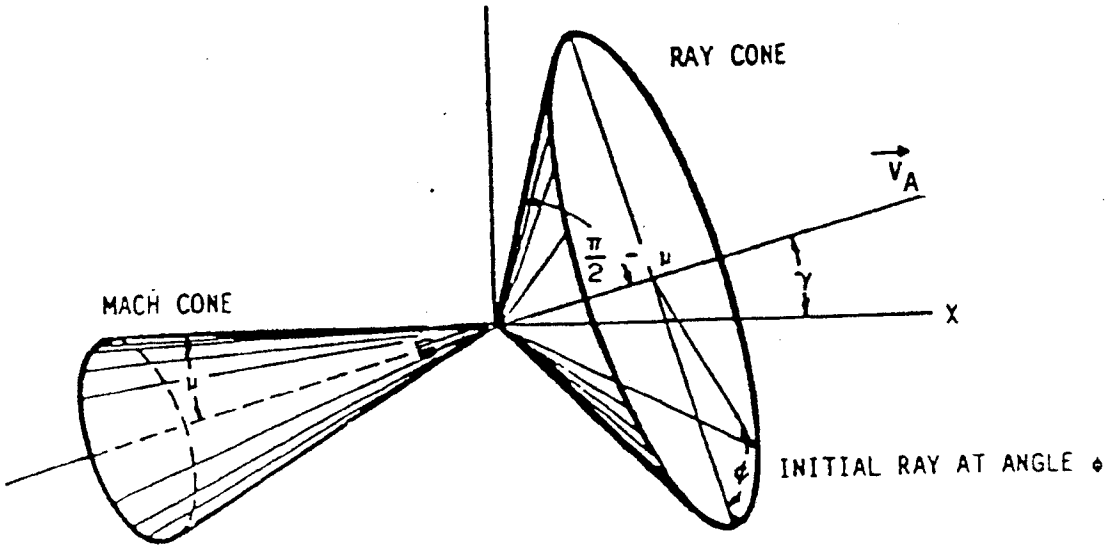


Figure 2-2. The Mach Cone and Ray

manner in which the atmosphere modified the propagation path from a straight line.) Analogously, space boosters engaged in constant speed turns will, over successive time periods, generate ray cones whose axes are misaligned (Figure 2-3). The misalignment of the ray cone axes causes the ray cones to be closer to each other on one side of the cone. This effect is maximal in the plane of the turn. On the side in which the ray cones are tilted toward each other there is an intensification of the signal, while on the opposite side the sonic boom levels are diminished. Since all maneuvers can be described as combinations of these basic maneuvers, the effect of a maneuver will be some local intensification (rarification) of the sonic boom. The magnitude of the aircraft acceleration and jerk will affect the location of this enhanced (subdued) sonic boom and the degree of amplification or diminishment.

The SABER 2 trajectory input is a planned or measured time history of a missile or space booster position, velocity and acceleration. Early in the planning phase of a program actual trajectories for specific payloads are commonly unavailable. Frequently, however, a trajectory envelope can be obtained. The only trajectory data for the TITAN IV which was available at the time of the analysis were generic trajectories from a different launch pad at Vandenberg AFB. The Western Space and Missile Center Range Safety group arranged for these trajectories to be translated to the SLC-7 launch pad and rotated to directly overfly San Miguel Island. Because this is one of the most environmentally sensitive areas, this launch azimuth represents a worst case condition. It was regarded as a credible worst case because it was within the range of planned launch azimuths.

2.2 The Nearfield Signature

In order to extrapolate the sonic boom overpressure signatures to the ground, a sonic boom propagation code must be provided a

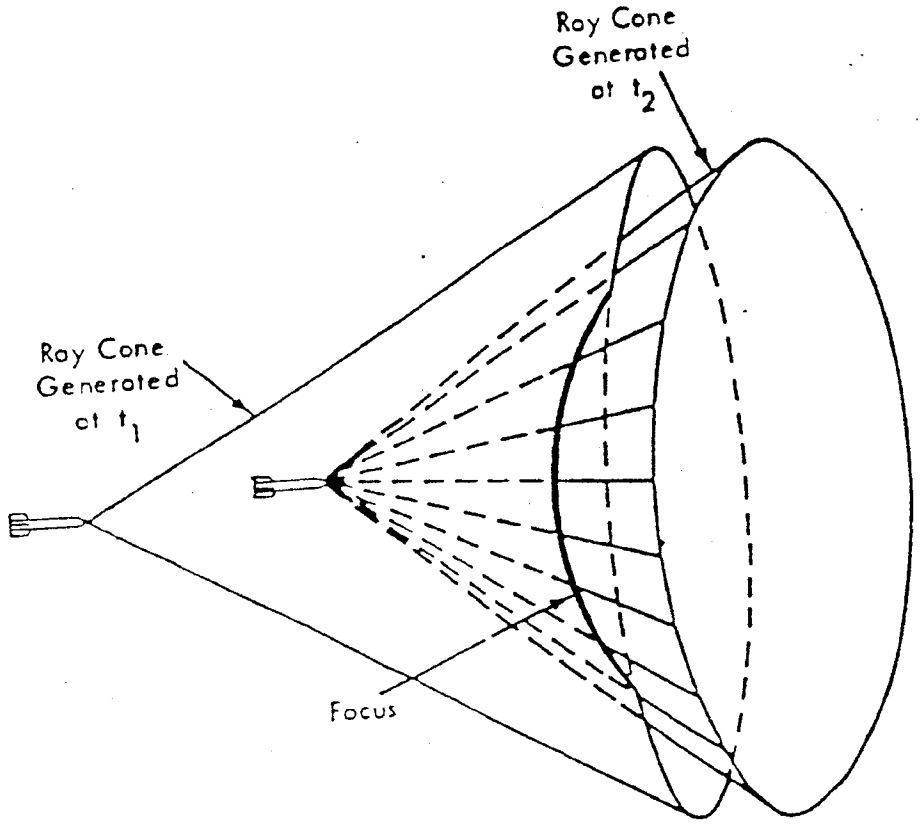


Figure 2-3. Turn Focus: Three Dimensions

description of the disturbance of the atmosphere generated by the supersonic body. This disturbance is described as an over-pressure waveform that an observer near the space booster would measure as it flies by. Figure 2-4 provides an overview of the procedure involved in developing the nearfield signature. For solid bodies, such as airplanes, nearfield signatures have been developed by testing or by evaluating theoretically the pressure perturbation field generated by the aircraft geometry and its lift distribution. The analysis for the Apollo and Space Shuttle programs had to address the additional disturbance generated by the exhaust plumes. For both of these programs extensive resources were expended to model the exhaust plume, to machine scale models of the boosters and exhaust plumes, to perform wind tunnel measurements and to extrapolate these measurements to a distance from the source at which strong shocks would be attenuated to weak shocks. (The standard sonic boom computer programs require a weak nearfield signature.) Numerous modeling and measurement problems were encountered in these two programs (see References 13, 14, 15 and 16). However, a significant result of these investigations is that during the flight regime of interest, the exhaust plume is the dominant contributor to the sonic boom generated by large space boosters.

2.2.1 The Close In Pressure Field and Plume Geometry

The description of the close-in pressure field of Titan IV during its powered supersonic flight, is presented in the following sequence:

- Actual Flow Field
- Key Parameters and Idealized Flow Field
- Relevant Non-dimensional Parameters and Universal Plume
- Pressure Distribution
- Multiple Exhaust Plumes
- Comparison to Wind Tunnel Data

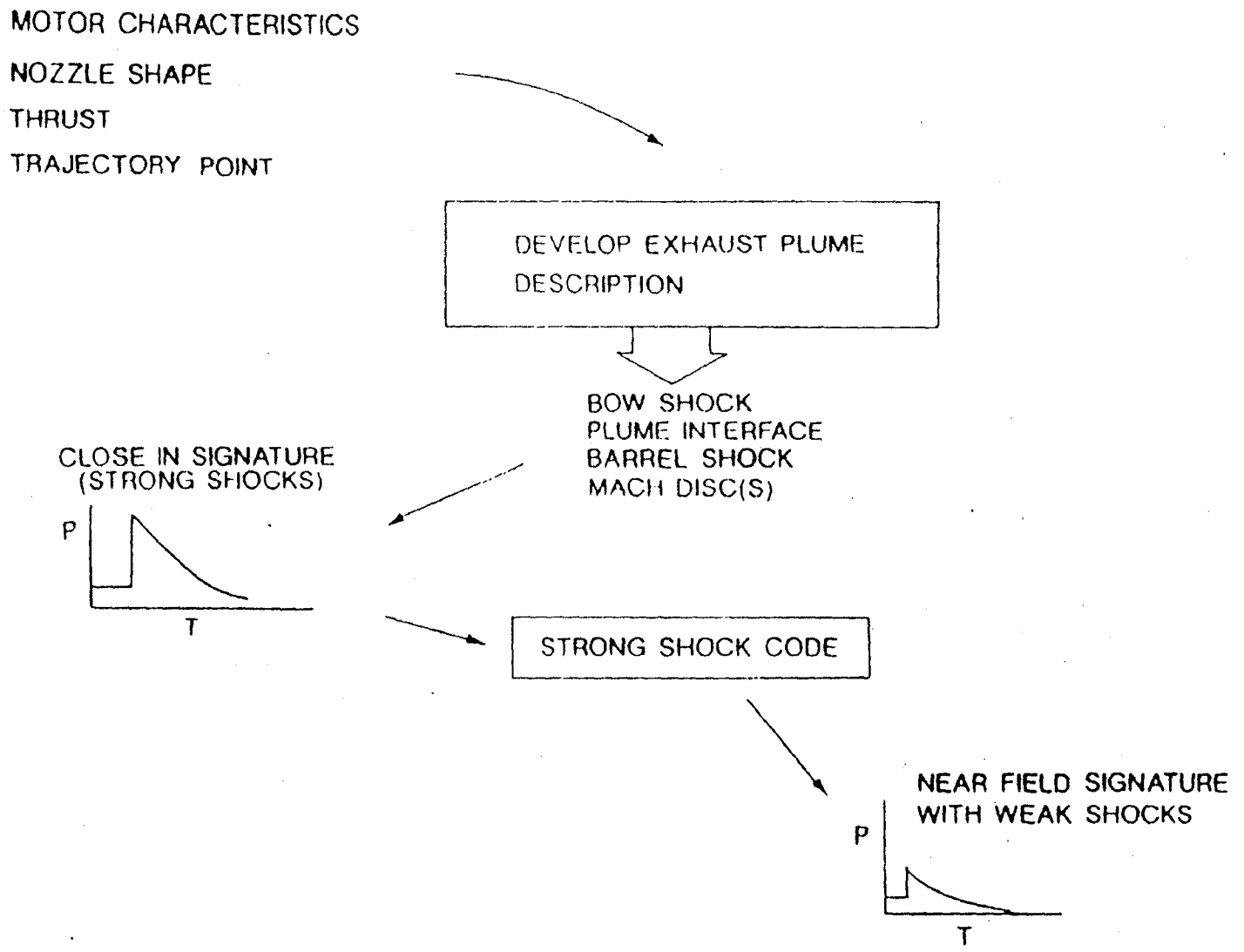


Figure 2-4. Near Field Signature Development

2.2.1.1 Actual Flow Field

During powered flight, a high-altitude rocket exhaust plume becomes greatly enlarged to resemble a hemisphere-cylinder afterbody attached to the rear of the rocket vehicle. This large afterbody creates a pressure gradient sufficiently strong to induce boundary layer separation on the vehicle surface. Two shocks are generated: a separation shock and a trailing shock (upstream of the plume boundary) (Reference 17). At several nozzle radii in the radial direction, these two shocks merge to form the shock upstream of the plume gases.

Figure 2-5 shows the plume afterbody, with the inviscid plume interface (plume mixing layer) (Reference 18). This afterbody, moving at slow supersonic speeds, supports an upstream low shock. Within the plume and close to the nozzle exit, there is a barrel shock and Mach disc that is formed when underexpanded supersonic flow from the nozzle exhaust into low ambient pressure.

It is the bow shock supported by the plume afterbody that is used in this report as a source for the sonic boom. The pressure field between the bow shock and plume interface prescribes the detailed sonic boom signature along a particular trace.

At higher supersonic speeds, the shock wave at the nose of the missile move to a smaller angle with respect to the missile skin. Eventually, the nose cone shock wave interacts with the plume shock wave as shown in Figure 2-6. Note that there is a complex recirculation flow field along the length of the missile between the regions defined by the dividing streamline and missile skin (Reference 19).

The figure also shows how the plume boundary streamline can just as well be represented by a solid body because no flow crosses normal to the plume boundary streamline. The supersonic flow,

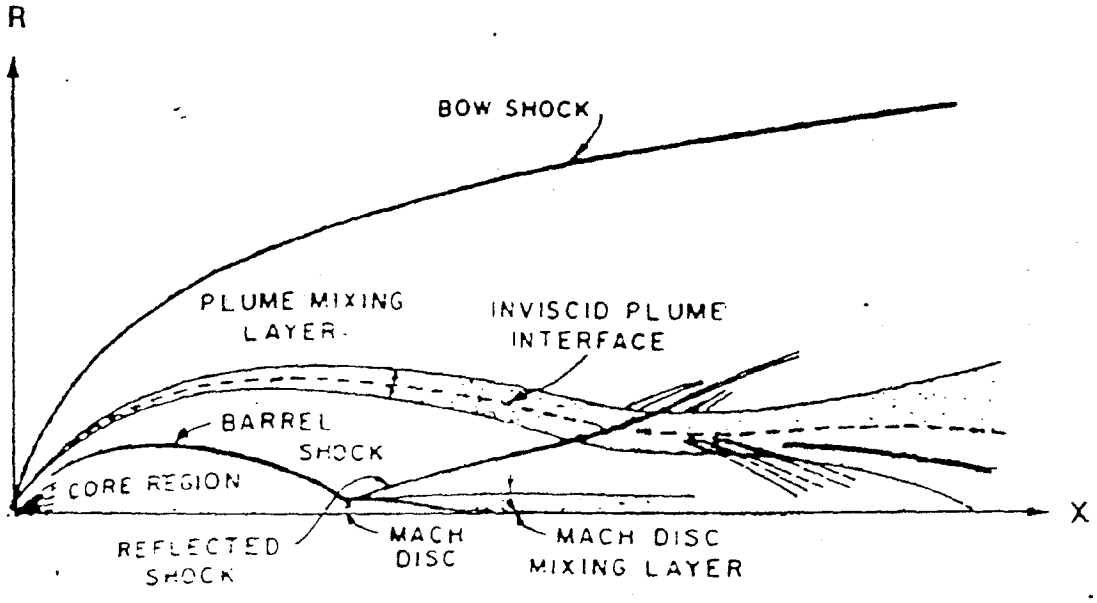
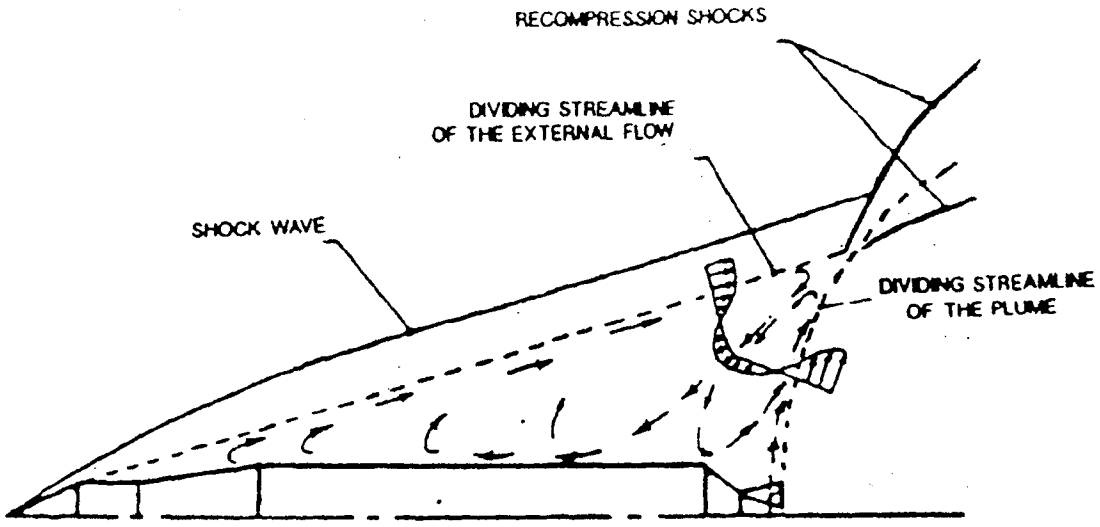
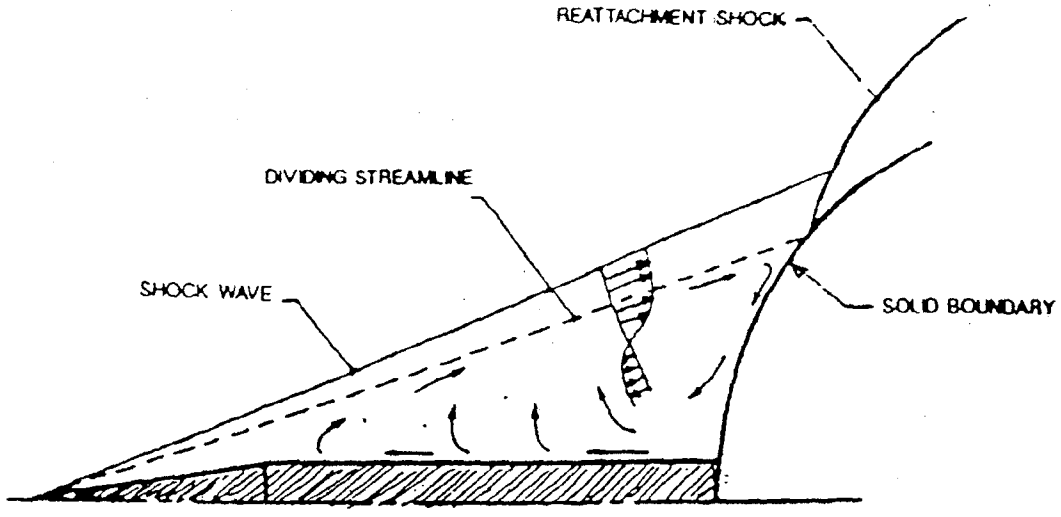


Figure 2-5. Schematic of Viscous/Inviscid Structure in Plume Nearfield



(A) ACTUAL SEPARATED FLOW FIELD



(B) SIMULATED FLOW FIELD

Figure 2-6. Comparison of Actual and Simulated Plume Induced Separation Region

between the dividing streamline and missile nose shock, interacts with the plume to form the reattachment shock.

2.2.1.2 Key Parameters and Idealized Flow Field

The key parameters that the sonic boom source model must carry are:

- Atmospheric (at altitude)
  - sound speed
  - specific heat ratio
  - temperature
  - static pressure
  - density
- Trajectory
  - rocket speed
- Rocket Motor/Engine
  - chamber pressure
  - throat area
  - nozzle exit plane area
  - exhaust gas specific heat ratio
  - nozzle exit plane angle
- Rocket Plume Configuration
  - number of plumes
  - plume centerline separations

For the purposes of this study, the first bow shock dominates the source strength of the sonic boom signature. The plume is nearly spherical and extends backward to the location of the first Mach disc (Figure 2-7). The bow shock is nearly parabolic and extends back to almost the same axial location.

2.2.1.3 Relevant Non-Dimensional Parameters and Universal Plume

The plume shape of an underexpanded supersonic nozzle has been extensively studied by the method of characteristics and in laboratory tests. From these studies (see, for example, References 20, 21 and 22) evolved descriptions of non-dimen-

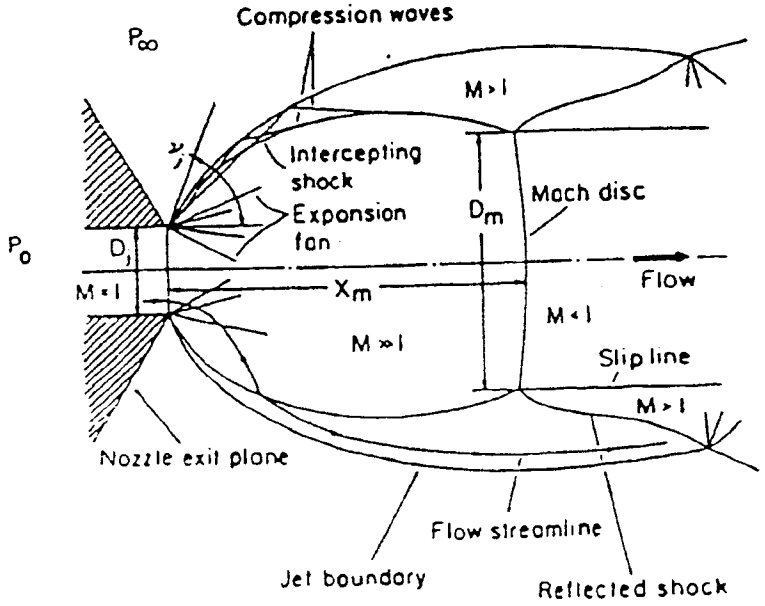


Figure 2-7. Schematic of Underexpanded Jet

sionalized universal plume and bow shock shapes. These curves are defined in terms of the following parameters:

- Dynamic Pressure
- Vacuum Thrust of the Rocket
- Weight Flow Rate of Rocket Gases
- Rocket Motor Chamber Pressure
- Throat Area of Nozzle
- Exhaust Velocity at Nozzle Exit Plane
- Ambient Pressure
- Nozzle Exit Plane Jet Pressure
- Nozzle Exit Area
- Rocket Motor Chamber Stagnation Pressure
- Rocket Motor Chamber Stagnation Temperature
- Specific Heat Ratio of Rocket Gases
- Molecular Weight of Rocket Gases

Thus, the universal bow shock curve and universal plume boundary curve are dependent on all the rocket motor/engine parameters, all the nozzle parameters, all the ambient altitude parameters and rocket trajectory parameters.

2.2.1.4 Pressure Distribution

The pressure jump across the bow shock can readily be calculated from the (1) local tangent angle of the bow shock in the universal plume curve as shown in Figure 2-8, (2) the specific heat ratio of the ambient air, and (3) the free stream Mach number. Curves are available relating the pressure jump to these parameters for wedge and conical bodies. By treating the exhaust plume as a solid, these curves can be applied.

For purposes of simplification, the pressure along the plume surface was considered constant. This introduces error when pressure values are selected within a few missile radii away from

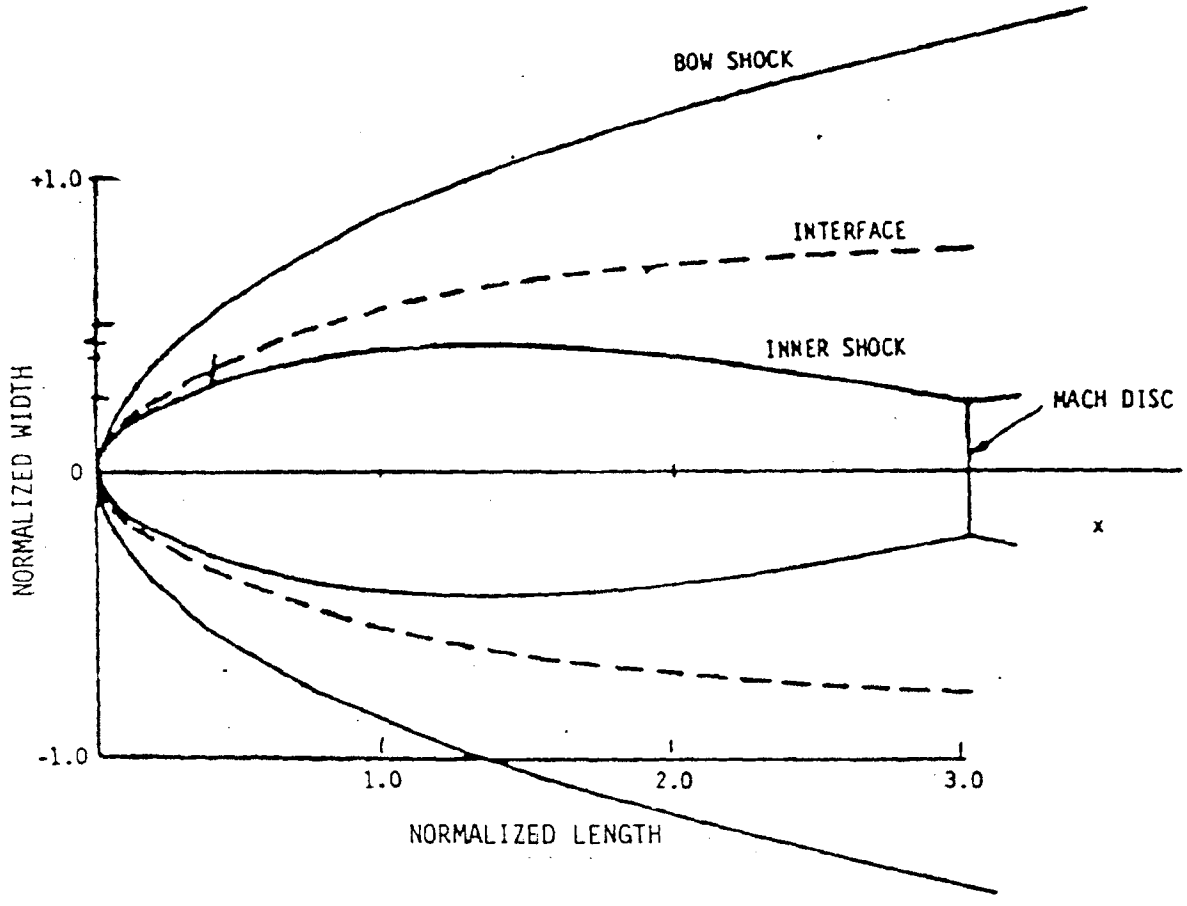


Figure 2-8. Universal Plume Shape

the missile centerline, but yields reasonable values at the more useful radial distances.

Based upon detailed calculations performed by other investigators, it has been determined that at close range, the radial pressure distribution is nearly linear. For these calculations it was assumed to be linear.

The earlier discussion specified the static pressure along the bow shock, the static pressure along the plume surface, and the linear static pressure distribution along a radial distance between the bow shock and plume surface. Figure 2-9 shows that it is a simple mathematical transformation to obtain the static pressure distribution versus axial distance for the observer at a fixed radial reference distance.

2.2.1.5 Multiple Exhaust Plumes

The effects of multiple exhaust plumes on the pressure distribution varies with distance. Figure 2-10 shows simplified views of the exhaust plumes or jets and the range of effects. At short distances from the nozzle exit plane and where the nozzle centerlines are distant from each other, the jets are decoupled. At medium axial distances, the jets begin to interact. At large distances, the jets may be considered as a single jet of double source strength. An illustration of these principles is seen in Figure 2-11 (Reference 23). In this figure, the locations of three exhaust nozzles of a large launch vehicle, and the pressure contours (decibels) of the overall system are depicted.

The model developed by NTS assumes that the multiple jets can be treated as a single jet in its universal plume model.

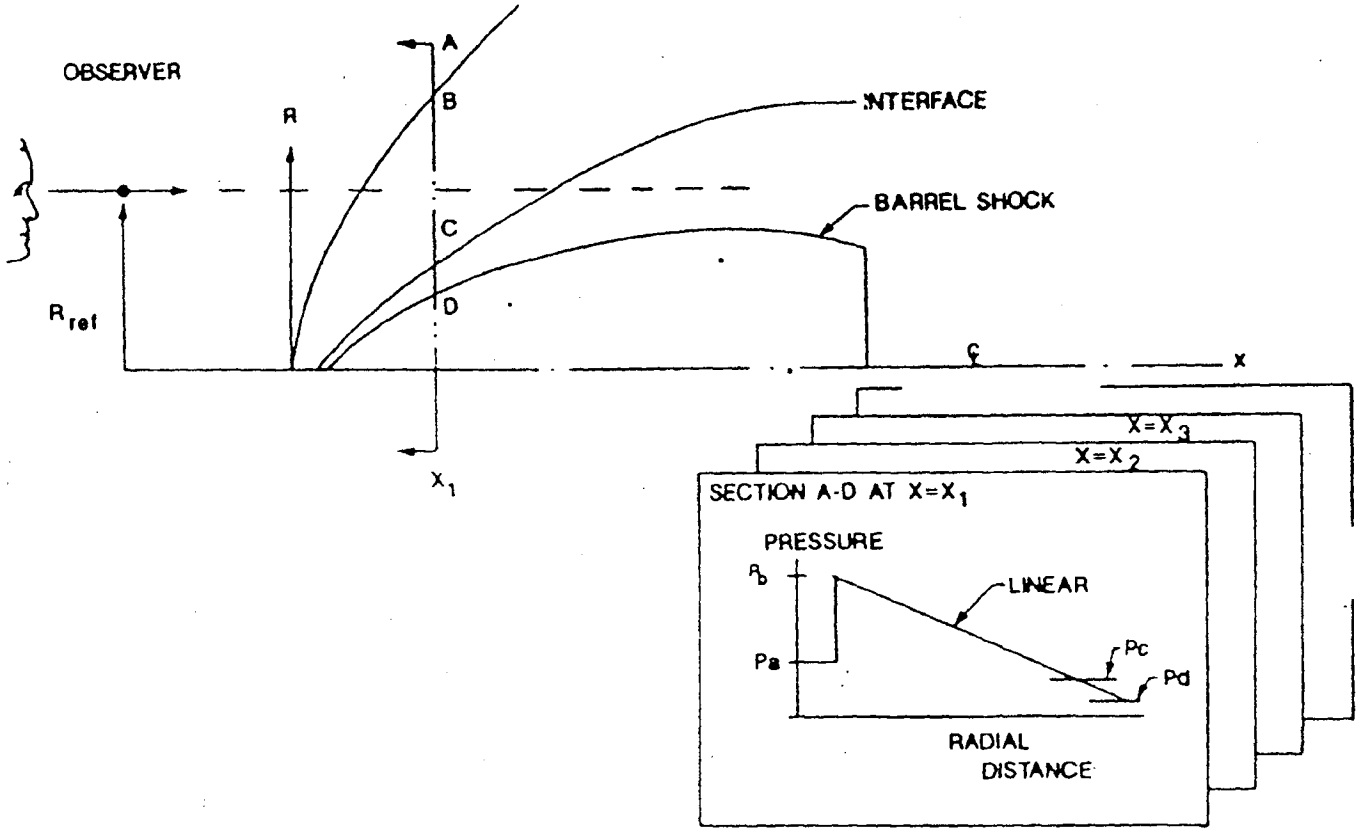
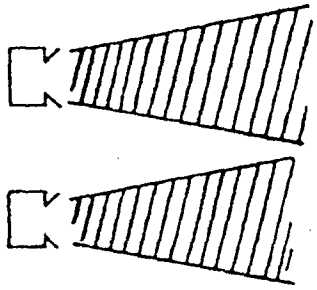
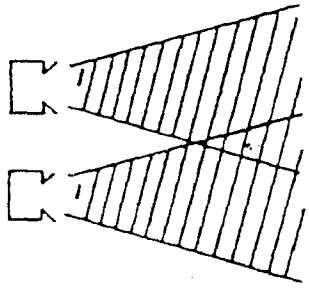


Figure 2-9. Methodology for Pressures in Field Between Boundaries

- CLOSE-IN
  JETS ARE DECOUPLED



- INTERMEDIATE
  JETS ARE PARTIALLY COUPLED



- FAR OUT
  JETS ARE A SINGLE JET WITH DOUBLE SURFACE STRENGTH

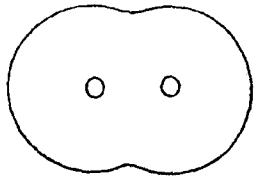


Figure 2-10. Multiple Jets

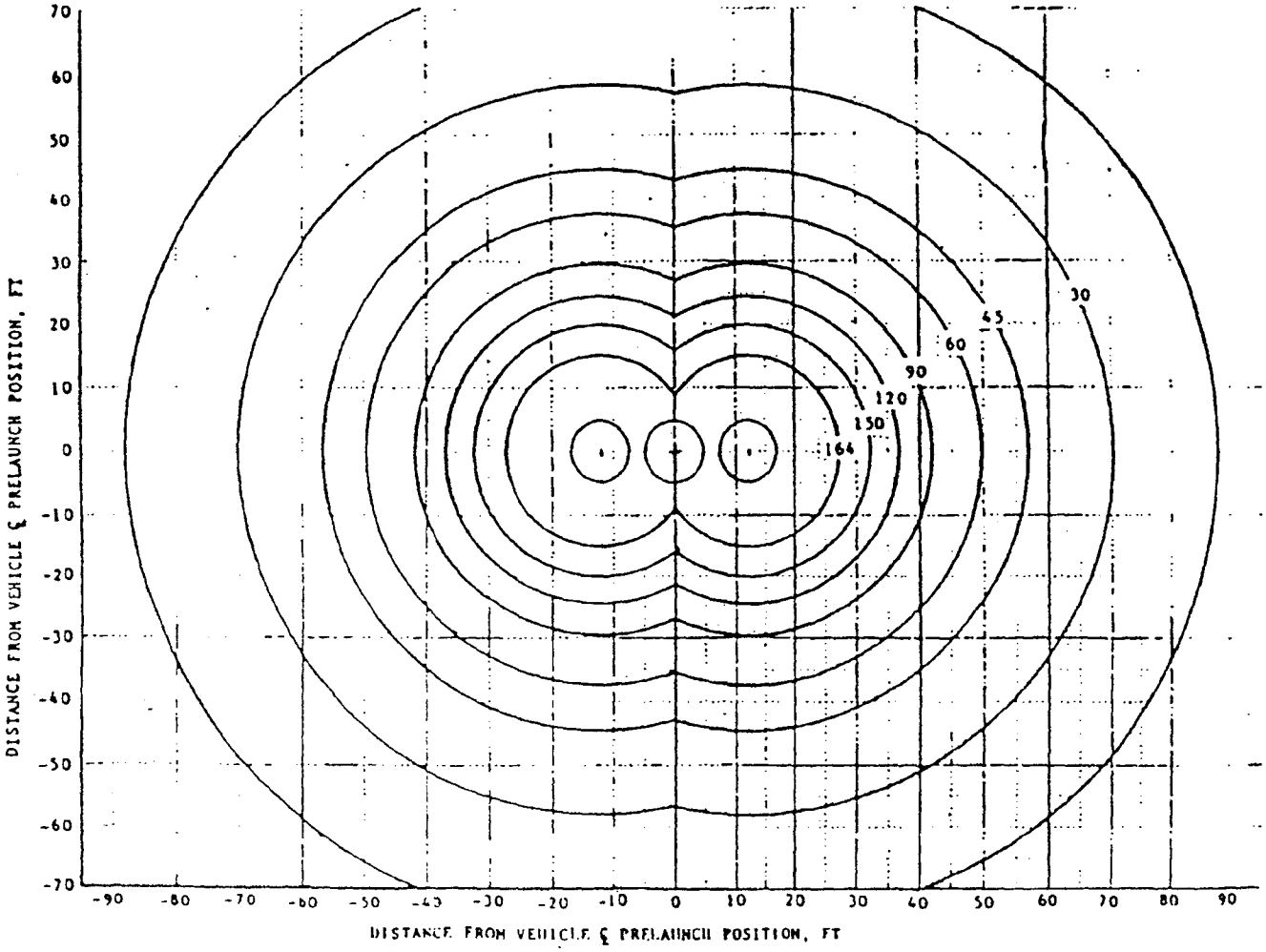


Figure 2-11. Dispersed Isobars of Max Splash Pressure

2.2.1.6 Comparison To Wind Tunnel Tests

In order to verify the reasonableness of the results of the exhaust plume nearfield model, a comparison was made with wind tunnel measurements. At NASA Ames facility, models of the Saturn V booster and plume were constructed and tested in a wind tunnel at Mach 3 and 5 (Reference 10). The schlieren photos showed the bow shock shape. Figure 2-12 shows the NTS model compared to the NASA wind tunnel tests. The comparison is favorable. The subtle differences between the NTS model and the NASA wind tunnel tests shown in the figure, are less than those NASA obtained between the model of the shock and plume configuration for the inviscid plume boundary versus the configuration for the viscid plume boundary.

2.2.2 Strong Shock Propagation

The strong shock propagation computer program is conceptually similar to the weak shock propagation programs. It employs correction terms based upon the higher relative pressures. Because a linearized version of isentropic theory cannot be used to calculate the propagation speed of each waveform point, relationships for normal shocks are used to calculate the change in propagation speed across each shock and the full isentropic expressions must be used to calculate the variation in propagation speed between shocks. Implicit in this analysis is the assumption that all propagation velocities are directed normal to the front shock. When the leading shock is strong, this assumption is questionable for aft portions of the signature. Consequently, only the front portion (positive phase) of the signature is extrapolated. An additional correction term is used to account for the modification of attenuation patterns by the density variation due to higher overpressures.

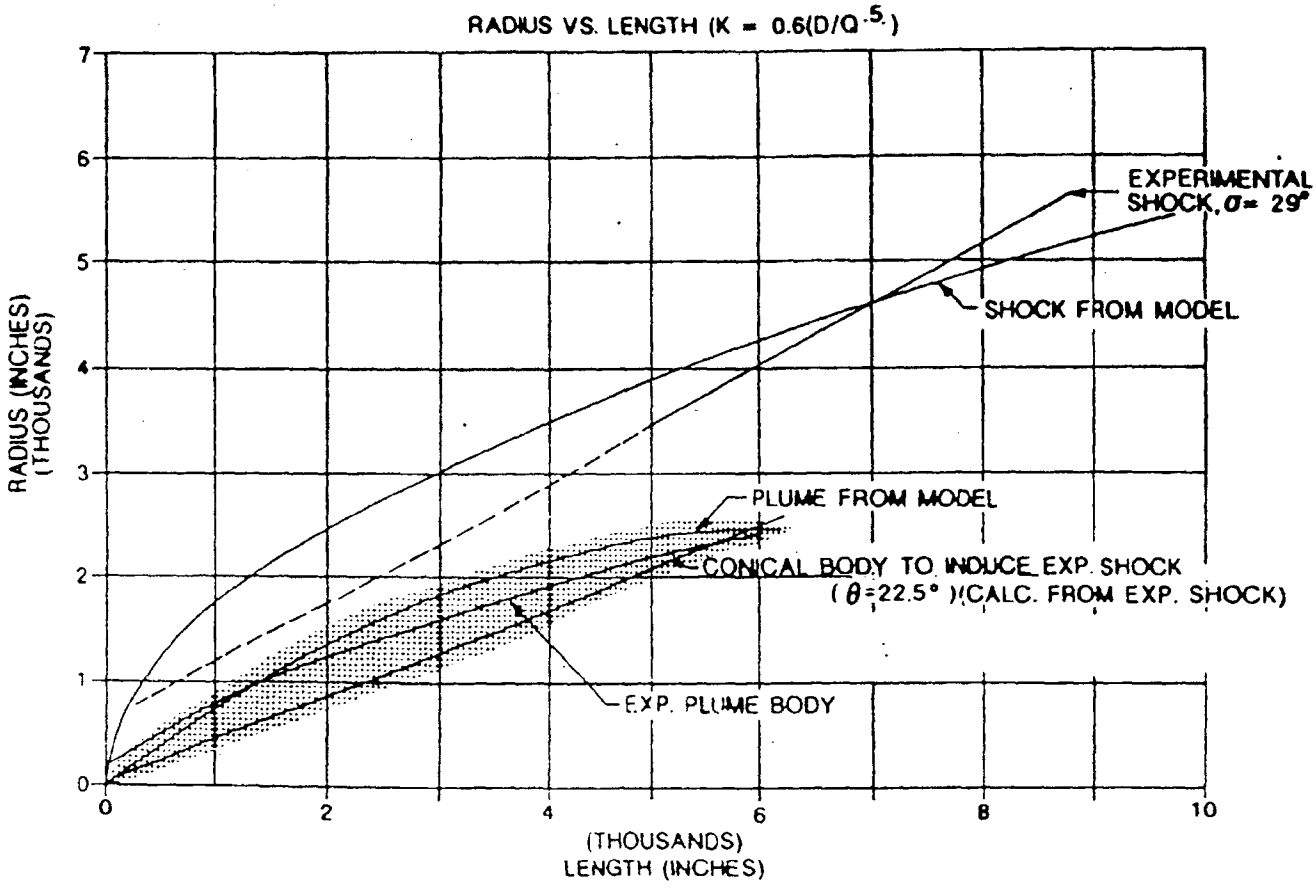


Figure 2-12. Outershock and Plume Boundaries

2.3 The Atmospheric Description

While the propagation of sonic boom through the atmosphere is affected by the detailed characterization of the atmosphere (temperature, pressure, winds, and chemical composition), as a practical matter useful results may be obtained by employing simplified descriptions. A common approach used is to describe these atmospheric properties as being horizontally stratified and temporally constant. This has the practical consequences of making the propagation analysis significantly more tractable and creating mathematical models consistent with the meteorological data available to use with them while sacrificing only the ability to model what are normally rather localized effects (focusing or attenuating sonic boom waveforms by small scale anomalies). This omission is likely to be important only for those atmospheric variations in the immediate vicinity of either the aircraft or the ground.

By altering the path of propagation of a sonic boom wavefront changes in meteorological profiles can shift the sonic boom footprint and alter the ground overpressure levels. Small scale variations (e.g., a cold spot) can cause localized focussing. Turbulence tends to create both spiked signatures (of normal amplitudes), as well as rounded signatures of reduced amplitudes. The primary effect of interest to this study is the changing of the curvature of the propagation path (ray) with respect to the surface along which focussing occurs. This type of an effect tends to result from medium scale meteorological variations.

The SABER2 program was designed to accept input pressure, temperature, dew point and wind profiles obtained from rawinsondes, rocketsondes or statistical analyses of such historical data. The meteorological parameters play three major roles in the models adopted: a) specification of the atmospheric pressure at the source and key altitudes, b) defining the "effective speed of sound" in the direction of propagation as a function of

altitude, and c) defining the effective speed of sound gradient seen by the advancing shock wave. The consequences of these are to displace the sonic boom footprint, affect the amplitude of the initial disturbance and to determine the extent of attenuation/ enhancement of the shock wave by the atmosphere.

The TITAN IV analysis was performed using the standard Vandenberg AFB reference atmosphere (Reference 24). This is a no wind atmosphere.

2.4 Propagation

The sonic boom propagation is based upon the theory of geometric acoustics with selected modifications to address its peculiar characteristics. The theory of geometric acoustics is valid when the wave length is small compared with characteristic macroscopic scales of the problem. Such scales include the radii of curvature of the wave fronts and the scale heights of the atmosphere. Geometric acoustics is invalid near the source, near a focus, and near the boundary of and within a shadow zone. In these areas, alternative models are required.

Standard acoustic theories are linear. For sonic boom propagation, the cumulative effect of non-linear effects over large distances are significant. The cumulative non-linear effects distort the signal and produce shock waves.

The basic concept of the geometric theory is the propagation of the sonic boom along rays, trajectories of points on the wave front. Because the wavelength is substantially smaller than the characteristic macroscopic scales of the problem, it suffices to trace only the rays originating from the leading edge of the shock wave. In addition, the analysis is based on the assumption that the cumulative non-linear effects do not affect the ray geometry. This is an accepted assumption for most sonic boom

problems of interest including characterization of a focal region.

An additionally important concept for the analysis is that of ray tube. A ray tube may be visualized as a collection of rays emitted from the booster initially displaced from each other by small times or distances. It is useful to define a quantity which provides a measure of the energy density since it is related to the amplitude of the signal. Such a quantity is the ray tube area. The ray tube area may be conceptualized as the area over which the original collection of rays is dispersed at any given time.

As a consequence of the foregoing assumptions and the horizontally stratified atmosphere, ray tracing may be performed using a form of Snell's law. Using this approach, ray-tube areas may be calculated employing a straightforward numerical integration. The amplitude of the signal and the amount of signal distortion may then be derived as a function of these quantities.

2.5 Reflection at the Ground

The measured magnitude of a weak shock wave normally incident to a perfect reflector will be twice the free field overpressures. As a consequence of energy absorption by the ground, the observed reflection factors are typically slightly less than two. As the angle of the incidence to the ground becomes more oblique, the reflection factor decreases, approaching one at cutoff (the location at which raypaths have been refracted to the horizontal direction at the earth's surface).

Although geometric acoustics would predict no sonic boom in the shadow zone beyond cutoff, as a consequence of diffraction effects, a low frequency rumble will be heard in this zone. A third phenomenon that occurs near the cutoff boundary is the

focusing of the rays which are turning up. As a consequence, observed reflection factors have the greatest spread near cutoff.

2.6 Ray Tracing

The program assumes the atmosphere (pressures, temperature, and winds) to be stratified in the vertical direction, but uniform in the horizontal direction and steady in time. These assumptions impose stringent conditions on the possible paths of motion (rays) of the wave. This motion is governed by a variant of Snell's law. By virtue of the stratification of the atmosphere, this requires the horizontal components of wave number to be constant with respect to the ground. This constant differs from one ray to another. When combined with the requirement that the net speed be that of sound relative to the air, it determines the size of the vertical component of motion, and thus, the motion itself. The result is that, for each ray, there are combinations of wind velocity and temperature at which it cannot exist. Where the ray can exist, its path curves toward regions more favorable to it; i.e., toward levels where the sound speed is lower and/or where the wind component in its direction is greater. For each ray there is a critical combination of temperature and wind velocity that will cause its vertical motion to slow, stop, and reverse (acoustical cutoff).

It should be noted that a downward moving ray which meets such a reversal layer and turns away from the ground will never, because of the stratification assumptions, reach the ground no matter what path it subsequently follows, but will always reverse again at the same height.

2.7 Signal Propagation

In the linearized acoustic theory, the wave form of the pressure travels along the ray unchanged except for amplitude changes. Pressure waves of this amplitude are governed by a non-linear

theory, and although the non-linear effects are small over any given region up to some tens of wavelengths in size, they do accumulate and are responsible for the typical N-wave profile of the direct sonic booms and the bulk of dissipation of acoustic energy between the source and the ground.

In terms of supersonic flow, the sonic boom is "weak," and the program applies a weak shock tube theory for the propagation of the sonic boom in ray tubes. In general, an overpressure at a given point in the wave form so increases the air speed and sound speed at its location that it seems to overtake a lesser overpressure located ahead of it. The amount of the overtaking is governed by a quantity termed the age, which increases along a ray at a rate proportional to the amplitude, and inversely proportional, among other terms, to the square root of the ambient air density.

When a section of the waveform actually overtakes one ahead of it, the choice among the three or more possible values of overpressures is resolved by fitting a shock (pressure jump), thereby cutting off the lobes of the overtaking and overtaken portions. To conserve mass, the shocks are so placed as to balance the area within the cutoff lobes using the so-called "equal area rule" (Figure 2-13).

When the ray tube area reverses sign along a ray the geometric theory implies that the overpressure is infinite at the point where the area is zero. This point is called a caustic point. Infinite pressures are, of course, contrary to reality and are a consequence of the failure of this theory.

The signature calculated for a caustic is based on the smooth caustic similitude solution developed by Seebass (Reference 25). This solution requires determining the relative curvature of the caustic surface in the direction of collapse with respect to the ray curvature.

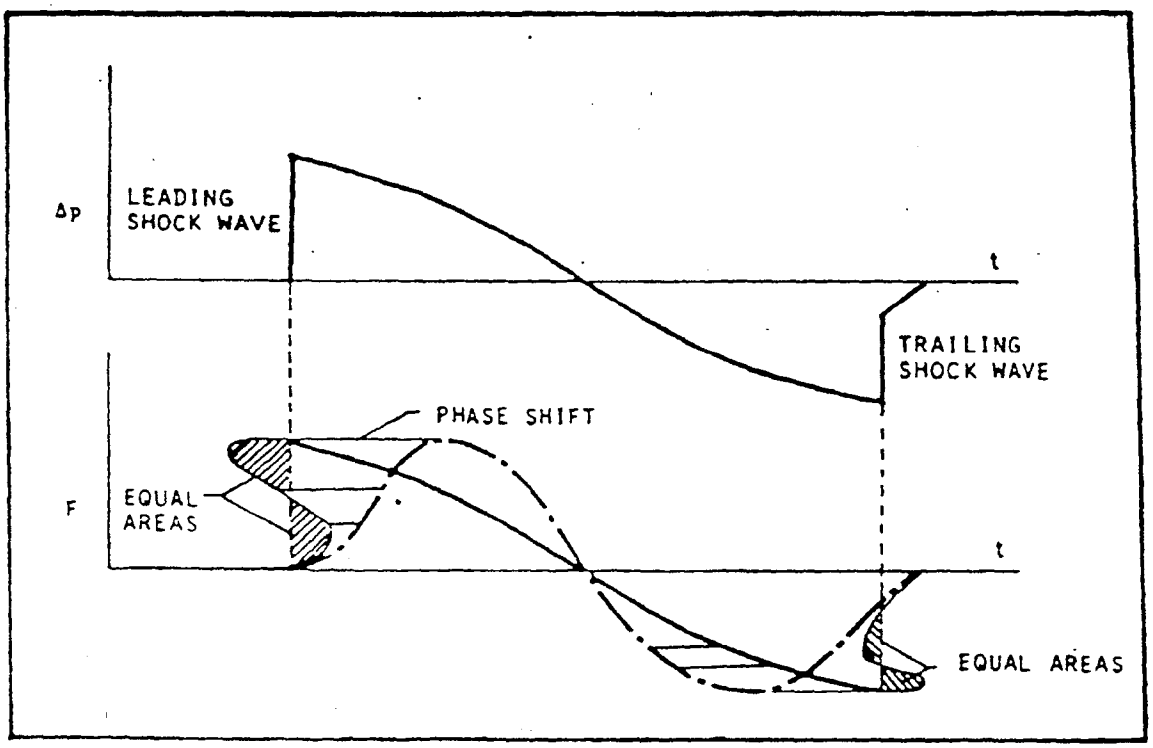


Figure 2-13. Signature Aging Process

3. RESULTS

The Titan IV ascent sonic boom analysis consisted of two phases. The first phase, accomplished under a previous contract, established that for appropriate combinations of trajectories and meteorological conditions Titan IV launches from Vandenberg Air Force Base can produce a focussed sonic boom at the Santa Barbara Channel Islands. The recommendations of the first phase were to assess the magnitude of the focus overpressures, to evaluate meteorological patterns and planned Titan launches to assess the frequency with which the Channel Islands might be subjected to focussed sonic booms (including the variation with season) and to assess the biological consequences of focussed sonic booms.

During the second phase, a simplified bounding analysis was performed to assess the extreme characteristics of the Titan IV ascent sonic booms which may affect the Channel Islands. The flight path employed in the analysis was a generic Titan IV trajectory translated to the SLC-7 launch pad and rotated to directly overfly San Miguel Island. A no-wind standard reference atmosphere for Vandenberg Air Force Base was used for the analysis. The nearfield signature for the Titan IV was calculated as described in the previous section based upon the approximation that the major contribution to the sonic boom during the period of interest was the exhaust plume generated by the solid rocket motors.

Figure 3-1 depicts an outline of the region affected by any sonic boom (the sonic boom footprint) and of the subregion affected by enhanced overpressures (the focal region). The focal region is relatively small and the region of "significant" consequences is yet still smaller. Peak overpressures occur along the uprange edge of the focal region and, within the focal region, decrease exponentially with distance in the downrange direction. Figure 3-2 shows a typical focus signature for the Titan IV launches. The positive phase of the waveform was calculated based upon the

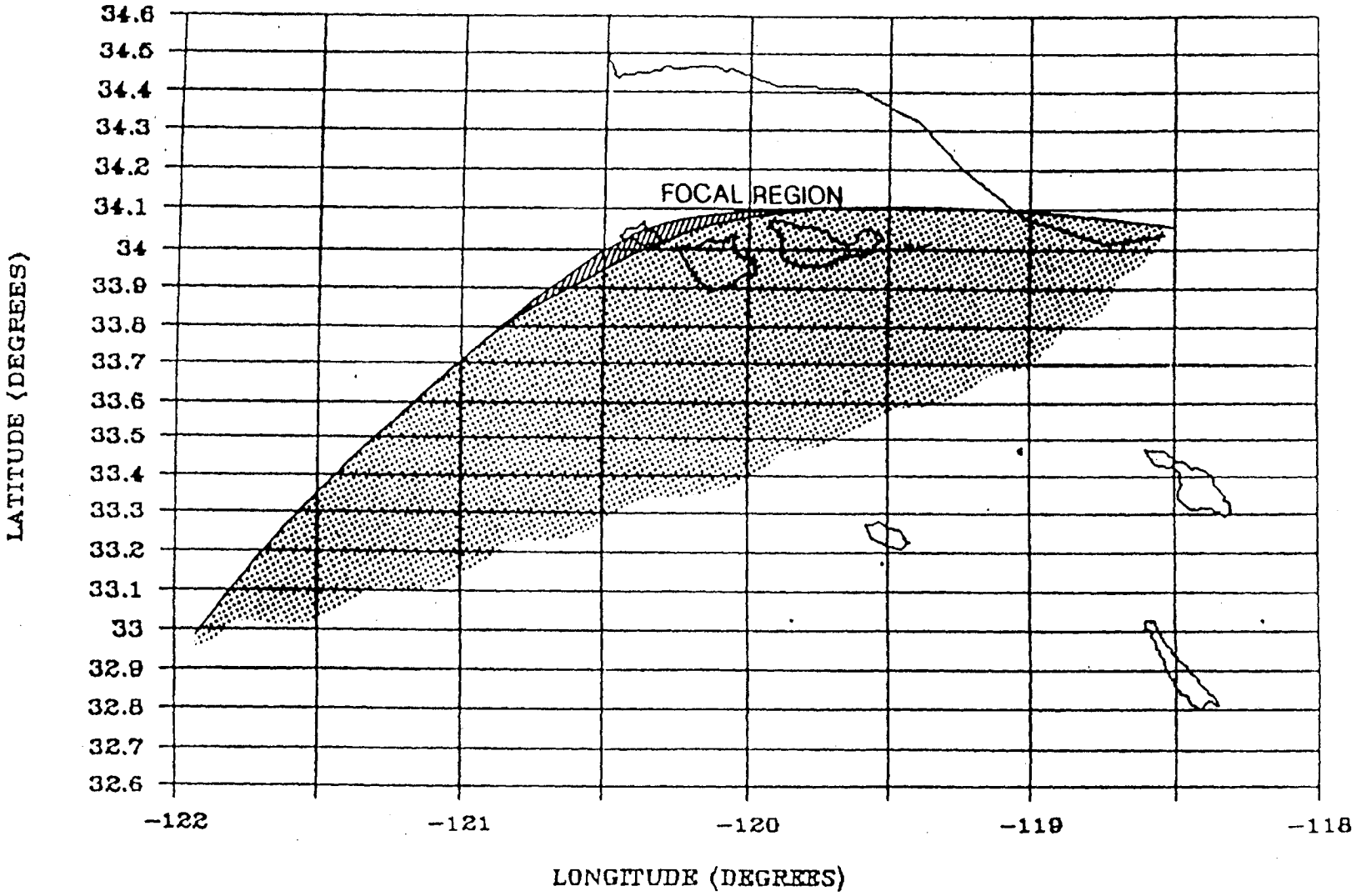


Figure 3-1. TITAN IV Sonic Boom Footprint

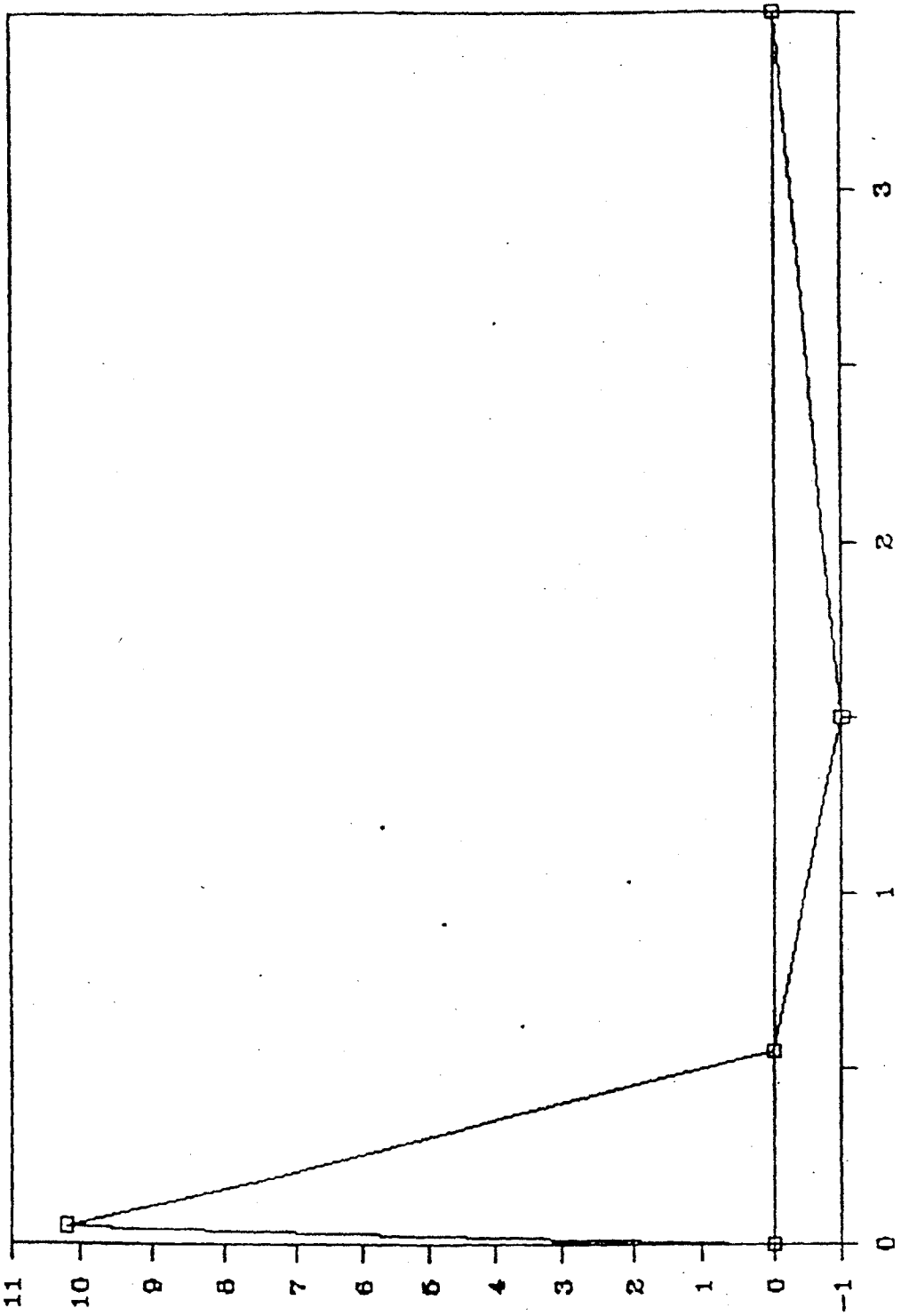


Figure 3-2. Typical (Simplified) Focus Signature

methodology described in the previous section; the amplitude and duration of the negative phase is based upon empirical results from the STS and Apollo programs.

A simple examination of the waveform indicates that most of the energy is at low frequencies -- a few Herz. (As the first order approximation, these frequencies are dictated by the duration of the positive phase of the waveform and the duration of the negative phase of the waveform.) Since the frequency band of maximum sensitivity of most species is in a frequency band in the range of 1-32 kilohertz, this mitigates the effect of these sonic booms on any affected species.

3.1 Uncertainty

There are a number of sources of uncertainty in the results which may be expected to cause observed Titan IV sonic booms to differ from the focus signature calculated. The following discussion presents each uncertainty source, the nature of its effect and an estimate of the magnitude of the uncertainty contribution.

The location of the sonic boom footprint will be affected by the particular trajectory exit azimuth and trajectory "shape" as well as the meteorological conditions through which the sonic boom must propagate. Changes in exit azimuth will cause the footprint to be rotated about the launch pad. Variations in trajectory shape translates the footprint uprange or downrange along the exit azimuth. (A secondary effect of variations in trajectory shape is to change the angle the footprint boundary makes with the exit azimuth.)

Meteorological effects on location are somewhat more complex. Changes in temperature, relative humidity and density profiles produce similar types of effects to changes in trajectory shape. Wind profile variations not only translate the location of the footprint, but also produce significant variations in footprint

shape. These location effects are important to a complete understanding of the sonic boom footprint, but are of secondary importance to the current bounding analysis. This is a consequence of the selection of conditions which place the focus directly on the Channel Island and of restricting the evaluation to a focus signature.

The calculated focus signature is sensitive to the input nearfield signature, trajectory and meteorological conditions.

The applicable nearfield signature at a given time in flight is a function of the booster speed and the atmospheric density at the booster elevation at the time of interest. The applicable atmospheric density depends on the trajectory shape (in particular, altitude versus time), and atmospheric density variability. In addition, a number of sources of uncertainty are present in the calculation of the nearfield signatures. These are a consequence of approximations in combining the flow fields from the two solid rocket motor exhaust nozzles, controversy in the literature as to the optimal method of setting the exhaust plume boundary (for example, use of mixing boundary versus some fraction of the inviscid boundary), uncertainty in the plume curvature characterization and omission of the vehicle contribution to the signature. A rigorous evaluation of the effect of these uncertainties was not undertaken in this study. It was, however, judged to result in an uncertainty range of -30% to +70% of the estimated peak ground overpressures. It is important to remember that the effect of the uncertainty in the nearfield signature does not affect the geometry of the focus region.

By contrast, the trajectory shape and the meteorological profile affect the ground level overpressures by altering the overall source to ground attenuation and by changing the geometry of the ray paths. This, in turn, alters the geometry of the caustic surface, and hence, the focus overpressure amplitudes.

An indication of the anticipated variability in peak focus overpressures which may be introduced by meteorological effects was obtained from the analyses performed for the space shuttle ascent sonic booms for launches from Vandenberg Air Force Base. Along the exit azimuth (in the region of highest overpressures), meteorological effects generated overpressure variations from -33% to +20% of the no-wind nominal calculations. Off-azimuth, in the lower overpressure regimes, calculated overpressure ranged from -50% to +100% of the no-wind levels.

No such sensitivity studies were available for estimating the effect of trajectory shape variations. Moreover, without a specification of the booster trajectory envelope, it would be dangerous to apply any past sensitivity analyses to the Titan IV.

3.2 Previous applications of the Methodology

Reference 26 describes the results of an analysis of sonic boom measurements from low altitude threshold Mach number flight of an F-104 fighter. Figure 3-3 presents a comparison between these measured signatures and theoretical focussed signatures developed by Seebass (Reference 26). Predicted peak overpressures vary from half those measured to one and one half times measured values.

Plotkin (Reference 12) describes two comparisons between measurements and theory. Sanai (Reference 27) conducted ballistic range experiments studying propagation of converging shocks. Plotkin determined that a direct application of the theory overpredicts the measured values by about 25 percent. Moreover, he notes that the finite actual rise times, rather than theoretical instantaneous ones, are not enough to totally account for this discrepancy. He comments that because of the rapid change in overpressure in the vicinity of a focus, the measured values may not have been the peak focussed pressures. Considering these two effects, he argues that there is good agreement between measure-

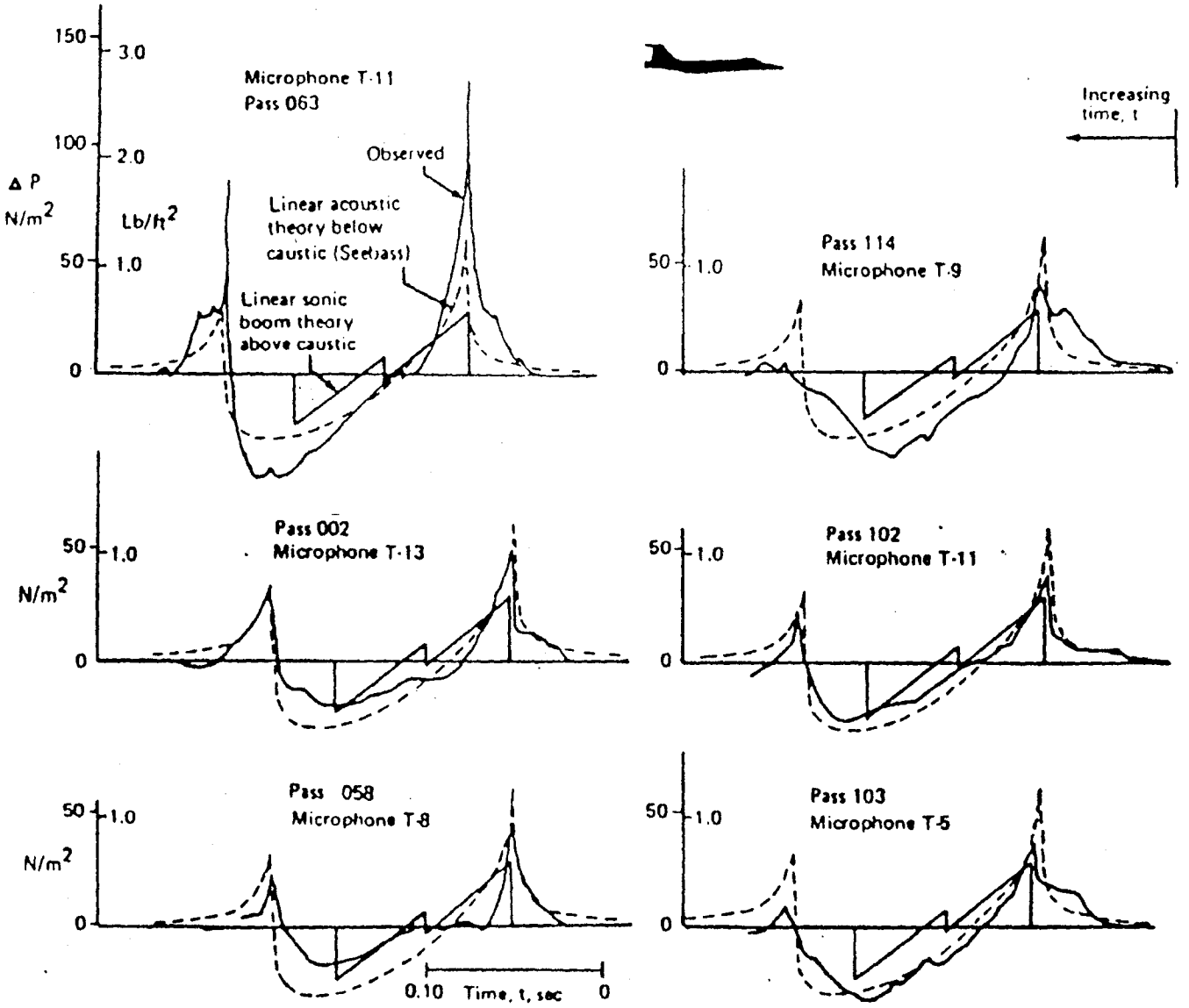


Figure 3-3. Comparison Between Theory and Experiment Near Caustics, Threshold Mach Number Flight

ment and theory. Wanner et al. (Reference 28) reports an extensive series of flight test sonic boom measurements. Plotkin has used Wanner's data on steady turns to compare with a theoretical estimate. After adjusting the theoretical calculation for shock thickness, he concludes that the theoretical prediction is about ten percent larger than the values measured.

The final example is the ascent sonic boom measurement program for space shuttle mission STS 41D (References 29 and 30). This measurement program was directed toward focus zone measurements extending from near the ground track to lateral cutoff. Seven boats and a string of sonabuoys was deployed. Figure 3-4 shows the locations of the boats relative to the booster groundtrack. Nearfield signatures for predictions were taken from wind tunnel data, the mission trajectory was taken from the STS guidance computer data, and the meteorological data was obtained from rawinsonde and rocketsonde measurement near launch time. As a consequence of extensive wind shears aloft the meteorological data had to be appropriately smoothed for the computer codes to function properly. Table 3-1 presents a comparison of the measured overpressures and arrival times with those calculated. Figure 3-5 provides a comparison of measured and calculated overpressures near the focal line.

3.3 Comparison with Other Programs

During the later Apollo flights, as a result of people reporting hearing sonic booms, interest in sonic booms generated by launch vehicles (space boosters and missiles) began to develop. Sonic boom measurements and development of estimation methodologies continued through the Air Force Operational Base Launch program for Minuteman II to the Space Shuttle program.

The types and sizes of rocket motors powering these vehicles varies significantly. The Space Shuttle is a hybrid vehicle with two strap-on solid rocket motors and liquid rocket motors on the

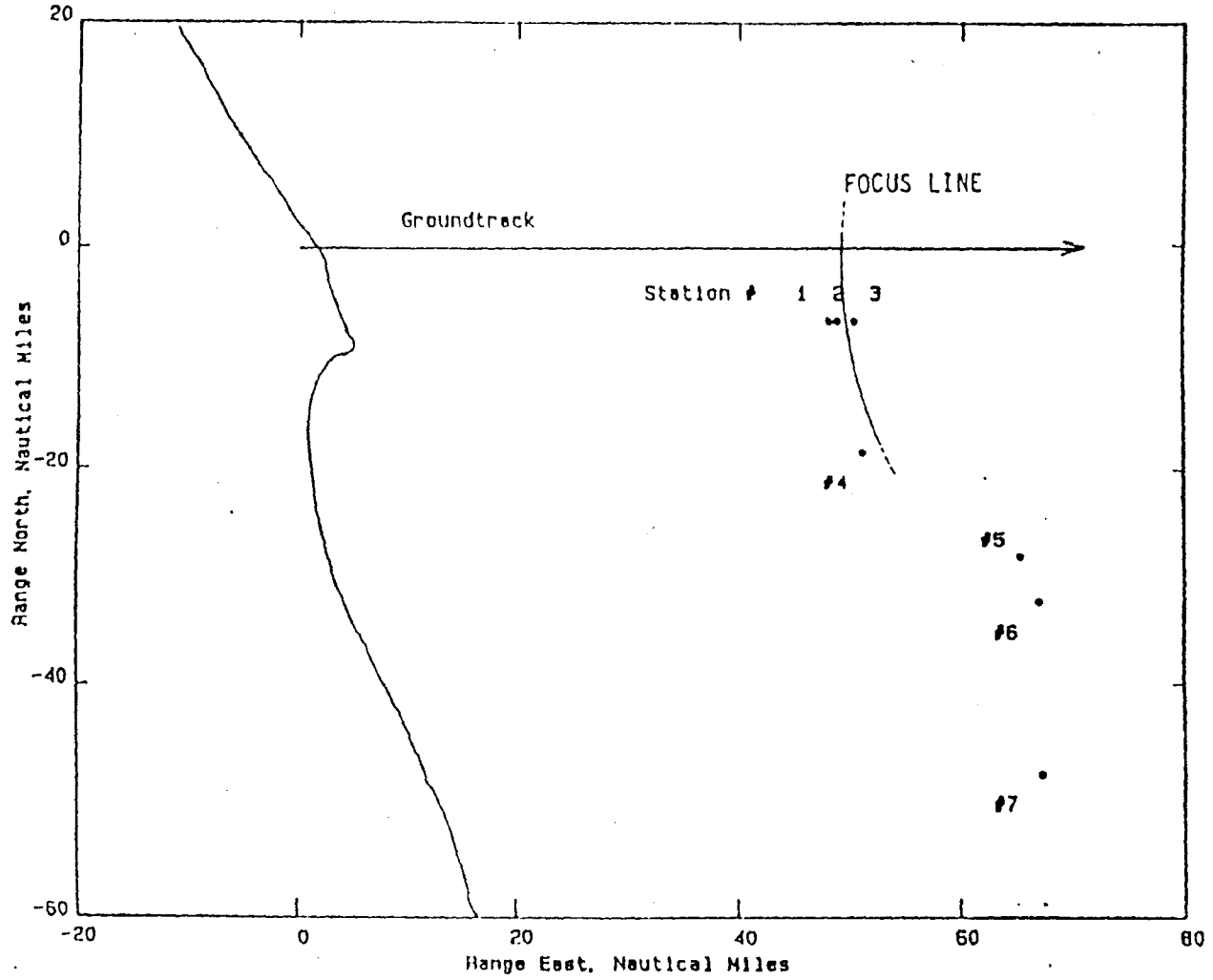


Figure 3-4. STS-41D Test Area Showing Groundtrack, Boat Locations, and Section of Focus Line

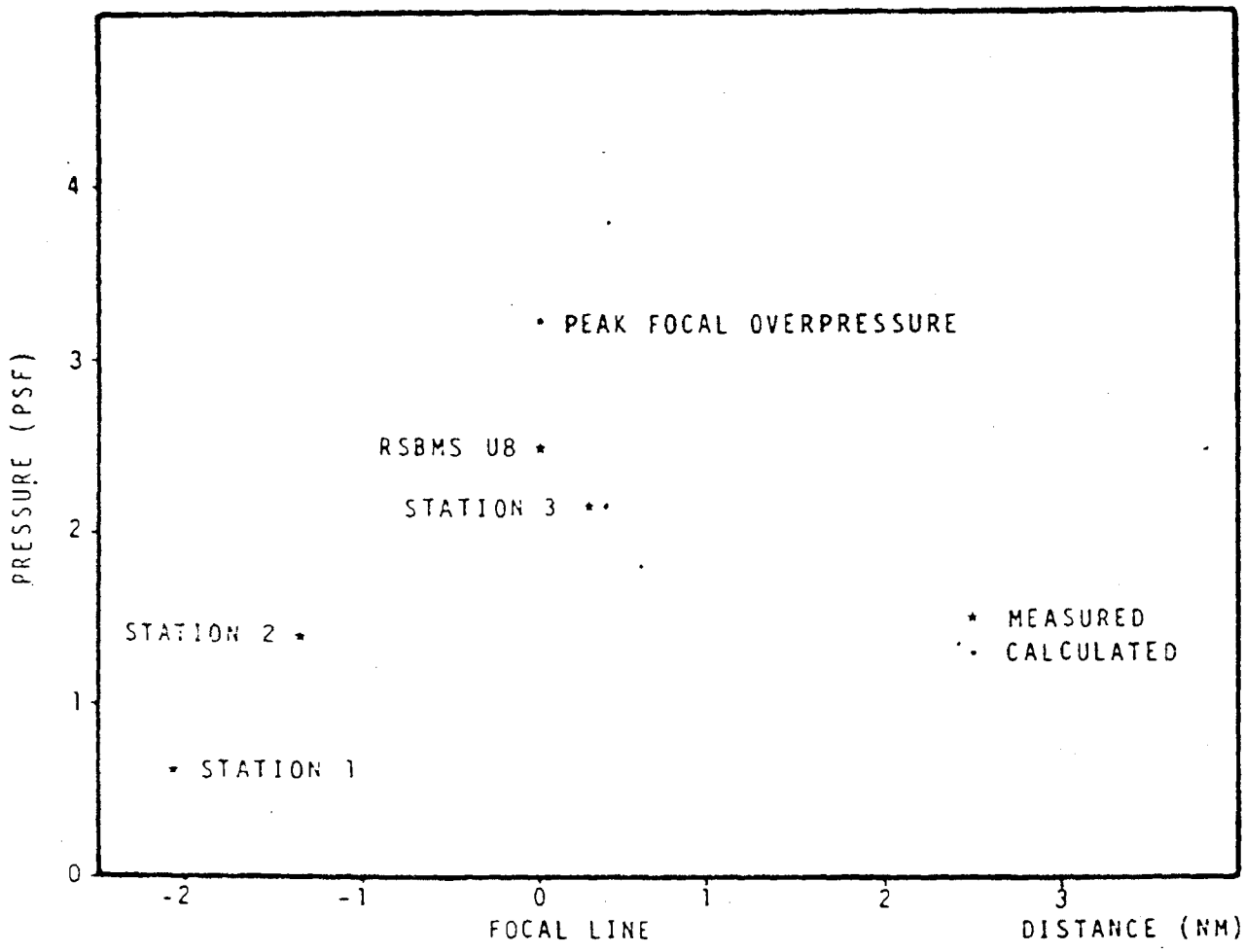


Figure 3-5. Sonic Boom Near Focus Line (Predicted vs Measured) STS-41D

Table 3-1. Comparison of Measured and Calculated Values Stations 1, 2, 3, and U8

STATION	PEAK OVERPRESSURE (PSF)		ARRIVAL TIME (SEC)	
	MEASURED	CALCULATED	MEASURED	CALCULATED
U8	2.5	3.26++	361.	361.8
3	2.17	2.0	363.2	363.46
2	1.42	*	348.9+	*
1	0.62	*	343.1+	*

* NOT CALCULATED, UPRANGE OF FOCAL LINE

+ NOTE: ARRIVAL TIME IS ABOUT 12 TO 18 SECONDS PRIOR TO ARRIVAL AT FOCUS

++ PRESSURE AT FOCUS NEAR U8

orbiter. All engines fire until the solids burn out. The Minuteman II is a three-stage missile; each stage is a single solid rocket motor. The Saturn V is a three-stage booster; each stage is propelled by a liquid rocket motor. The Titan IV consists of a liquid fueled rocket core and two solid rocket motor strap-ons. Various upper stages may be placed on the Titan IV. In contrast to the space shuttle, at the time that the sonic boom focus of interest is generated, only the solid rocket motors are thrusting.

Figure 3-6 indicates sonic boom measurements obtained during the ascent of Apollo 17 (Reference 31). The sonic boom signature shown for Station 2 indicates that this measurement was obtained very close to the focus. (For all measurement programs involving space booster, range safety regulations require a cross-range standoff from the flight track for the measurement stations. The magnitude of the standoff varies with the booster.) NASA estimated that although the maximum measured overpressure was 8.9 psf, that at the focus the overpressure was between 10 and 11 psf. In comparison to the Titan IV trajectory considered, the Apollo 17 booster was higher and faster at the time the focus sonic boom was generated. The orientation of velocity vector is not known. Increased altitude will tend to decrease the amplitude of a sonic boom. The effect of the vehicle speed cannot be interpreted without knowing the velocity vector orientation.

The Minuteman II measurement program (Reference 32) failed to capture any focus measurements as a result of major changes in meteorological conditions between the time at which the site locations for the boats were calculated and launch. The highest predicted overpressure for the Minuteman II launch was 18 psf. This prediction was based on a signal originating when the missile was travelling at Mach 4.3 and an altitude of 133 thousand feet.

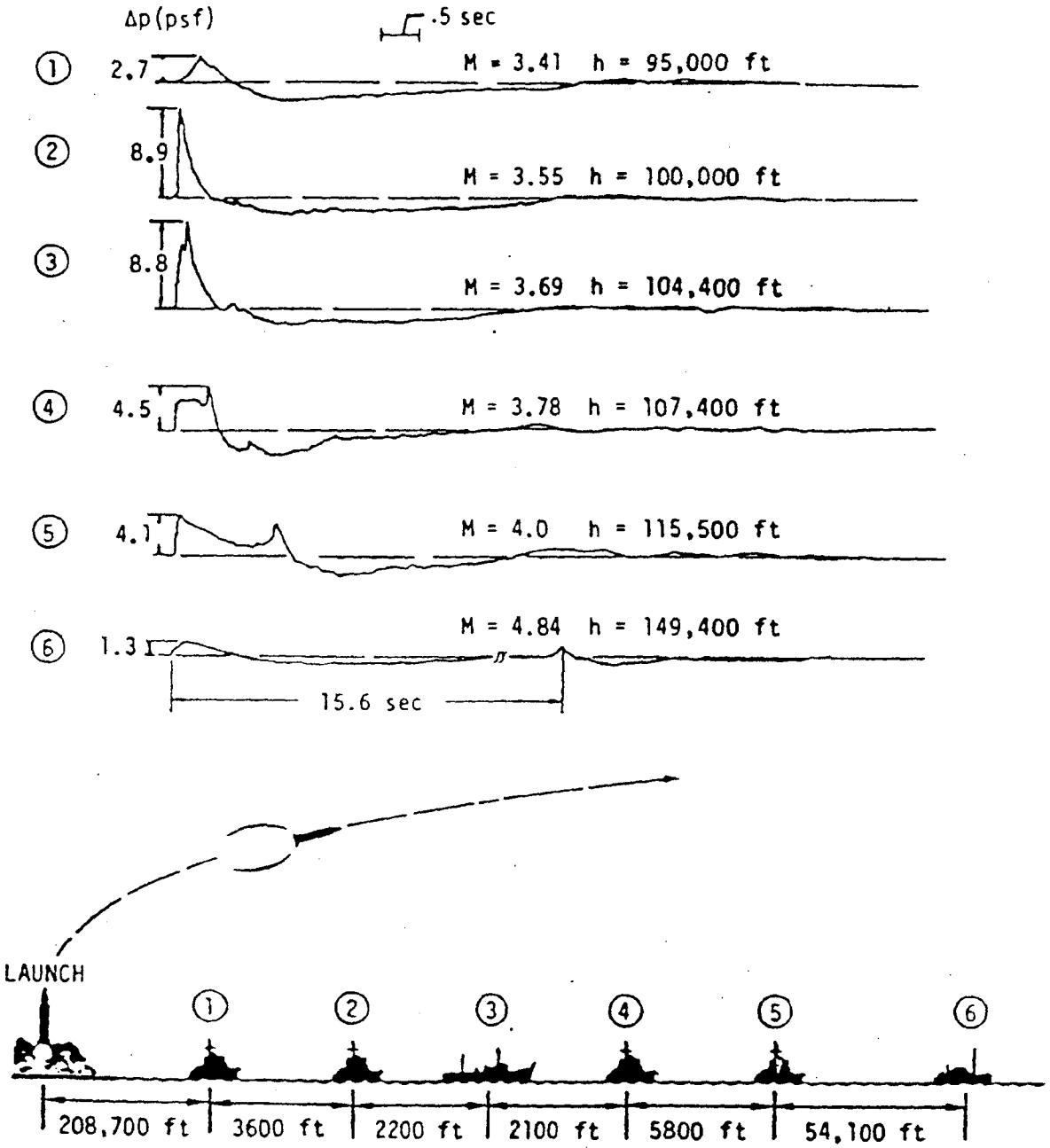


Figure 3-6. Apollo 17 Measured Ascent Sonic Boom Signatures

During the STS-7 Space Shuttle launch, sonic boom measurements were obtained (Reference 33). Figure 3-7 shows the peak overpressures measured and the location of the measured stations. Stations 2, 5, and 8 were very close to the focus. Recorded signatures for these stations are shown in Figures 3-8 through 3-10, respectively. Notice that the secondary peak is more prominent in these figures than that shown for Station 2 in Figure 3-4. This suggests that although these stations were close to the focus, they were more distant from the focus than Station 2 (Apollo 17 mission) was.

The final comparison to be presented is the calculations of peak focal overpressures for a Space Shuttle launch from Vandenberg Air Force Base (Reference 13). For the same meteorological conditions used for the Titan IV analysis, the maximum estimated focus overpressure calculated was approximately 16.5 psf. At the time that the sonic boom focus was generated, the Space Shuttle trajectory was not as steep as the Titan IV trajectory considered. The vehicle speed was slightly greater than that of the Titan IV.

Several patterns are noteworthy in the previous presentation. The highest predicted focus overpressures for launch vehicle sonic booms are significantly higher than the highest measured overpressures. Yet, when predictions are done with appropriate data, there seems to be good agreement of the locations where measurements are taken. This apparent contradiction has been attributed to the difficulty in "capturing" a focus measurement: The area affected by focal region overpressures is small. Overpressures decline rapidly with distance from the location of maximum overpressure. Finally, actual focal locations will depend upon the particular trajectory flown (as opposed to a planning trajectory) and the atmosphere through which the sonic boom wave travels which will differ from that through which a rawinsonde or rocketsonde will pass in collecting meteorological data.

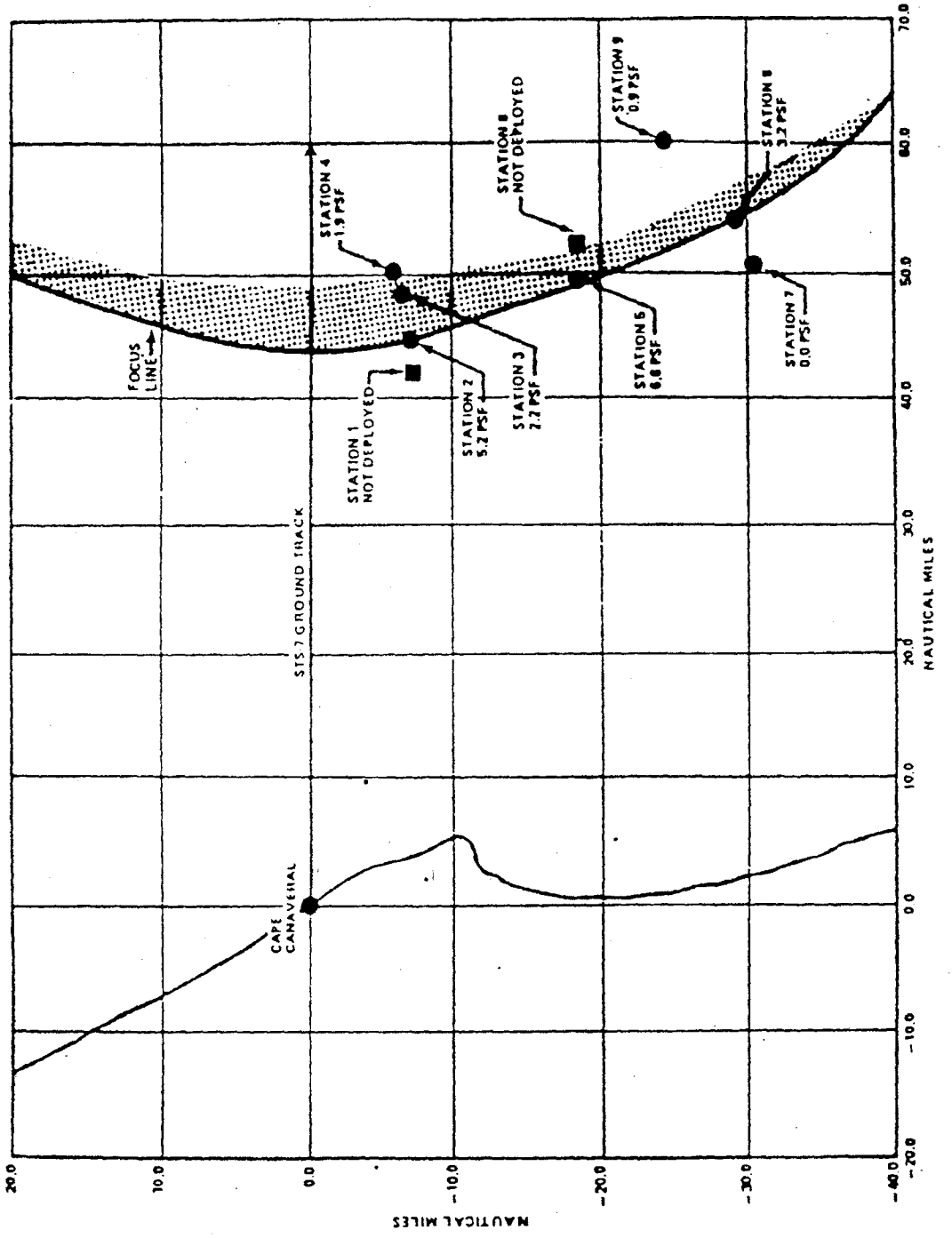


Figure 3-7. STS-7 Test Area Showing Boat Location and Peak Overpressure for each Station

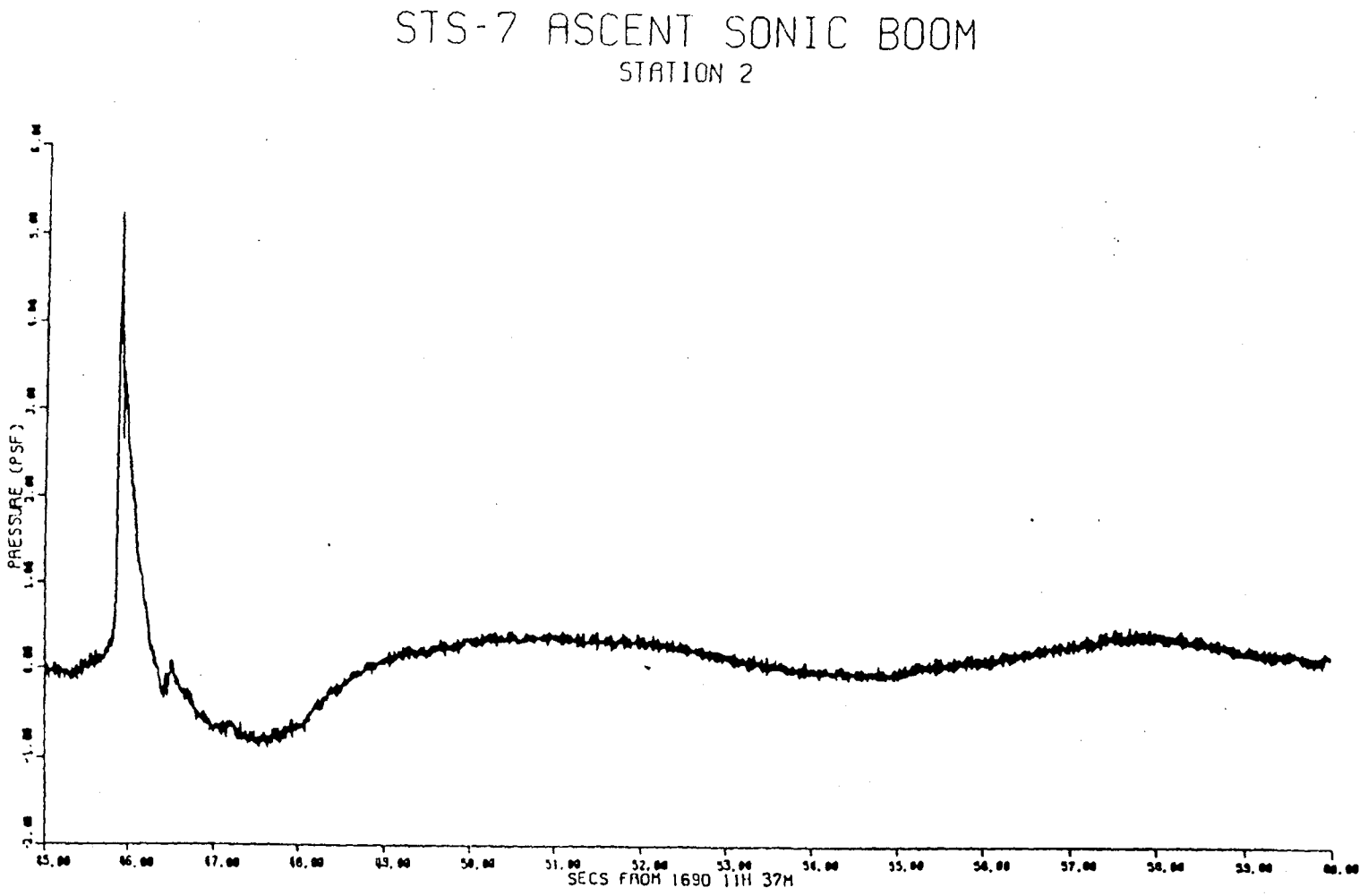


Figure 3-8. STS-7 Sonic Boom Signature Recorded at Station 2

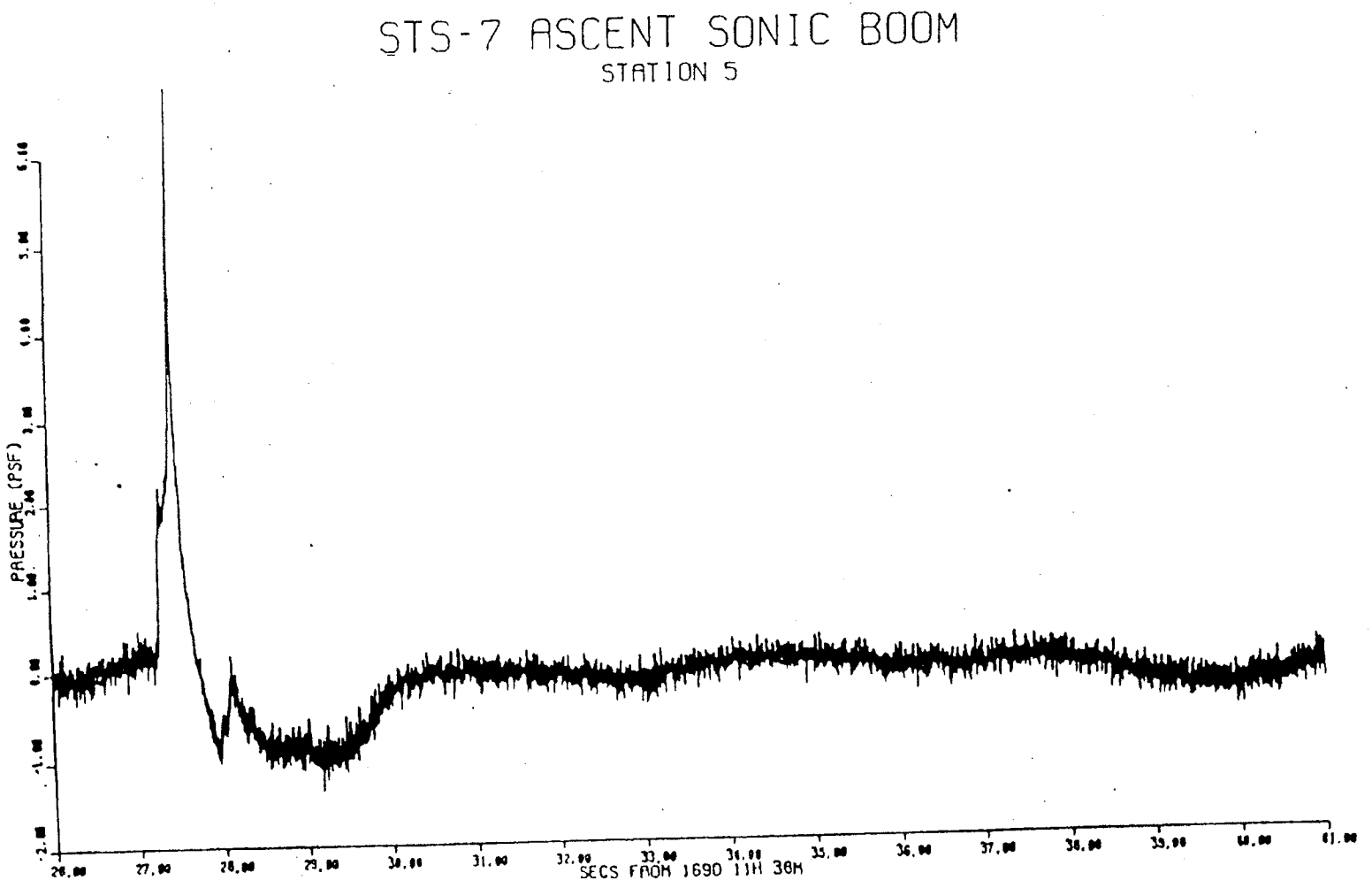


Figure 3-9. STS-7 Sonic Boom Signature Recorded at Station 5

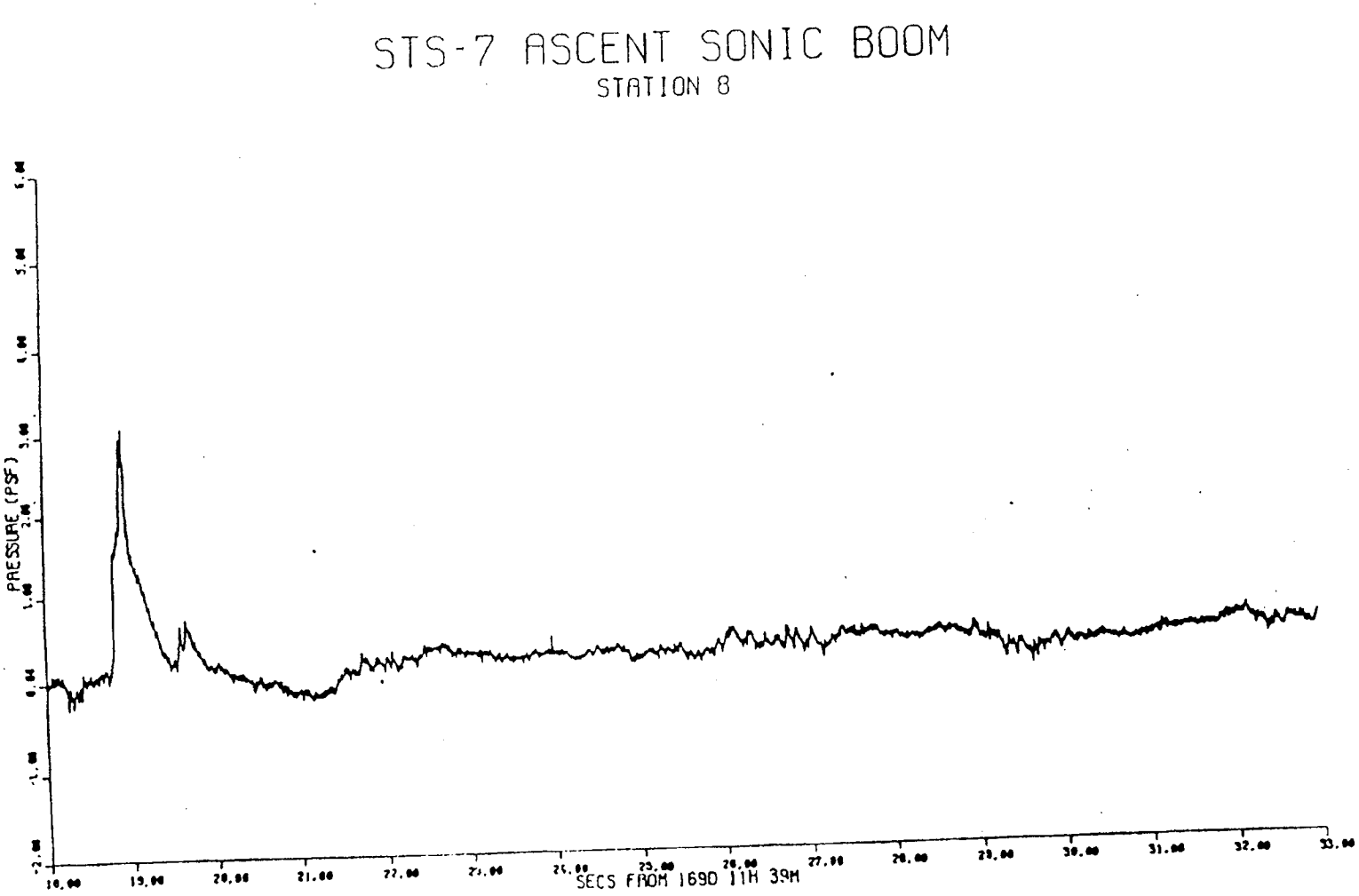


Figure 3-10. STS-7 Sonic Boom Signature Recorded at Station 8

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APPENDIX E

TECHNICAL MEMORANDUM
ACIDIC DEPOSITION
TITAN IV/CENTAUR LAUNCH
FROM THE CYPRESS RIDGE SITE

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ACIDIC DEPOSITION
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FROM THE CYPRESS RIDGE SITE

The launch of a Titan IV/Centaur would result in the formation of a ground cloud composed primarily of water, hydrochloric acid (HCl), and aluminum oxide (Al_2O_3). Twenty-six thousand gallons of deluge water would be utilized during launch, with approximately 75 percent, or about 20,000 gallons, evaporating into the ground cloud (USAF 1988b). Water vapor in the ground cloud would condense around Al_2O_3 particles to form droplets and, once condensed, readily absorb HCl from the cloud, thereby forming acidic droplets, which would fall to the ground. Based on measurements taken from Space Shuttle launches, the pH of these droplets would be between 0.1 and 1.0 (NASA 1983). Because of this high acidity, there is the potential for alteration of the pH of nearby streams or bodies of water where droplets might fall. One such stream, Honda Creek, which lies approximately three miles north of the proposed Cypress Ridge site, could be the recipient of acidic deposition. This deposition could have an adverse impact on the unarmored three-spined stickleback, a federal- and state-listed endangered species of fish, which is known to occur in Honda Creek.

In order to determine if the unarmored three-spined stickleback or other aquatic life could be harmed by acidic deposition, an analysis was performed to calculate the pH change of Honda Creek that would result from a Titan IV/Centaur launch. This analysis utilized a reasonable worst-case scenario, which assumed that acidic deposition from a launch would be most dense in the vicinity of Honda Creek. A computer trajectory deposition model, TRAJM, was used to calculate the amount of acidic deposition over a given area. TRAJM is a near-field model and can be used to predict the amount of acidic deposition close to a launch pad (NASA 1983). It was originally used by NASA to predict acidic deposition from Space Shuttle launches in Florida.

By using an iterative method, it was determined that the maximum amount of acidic deposition would fall into Honda Creek when the wind was blowing from the south at approximately 25 miles per hour. Under these conditions, the model calculated the acidic deposition rate in the area of Honda Creek to be about 8.2 gallons per acre. The deposition rates for annuli centered on the Cypress Ridge site in relation to the surrounding environment are shown in Figure E.1.