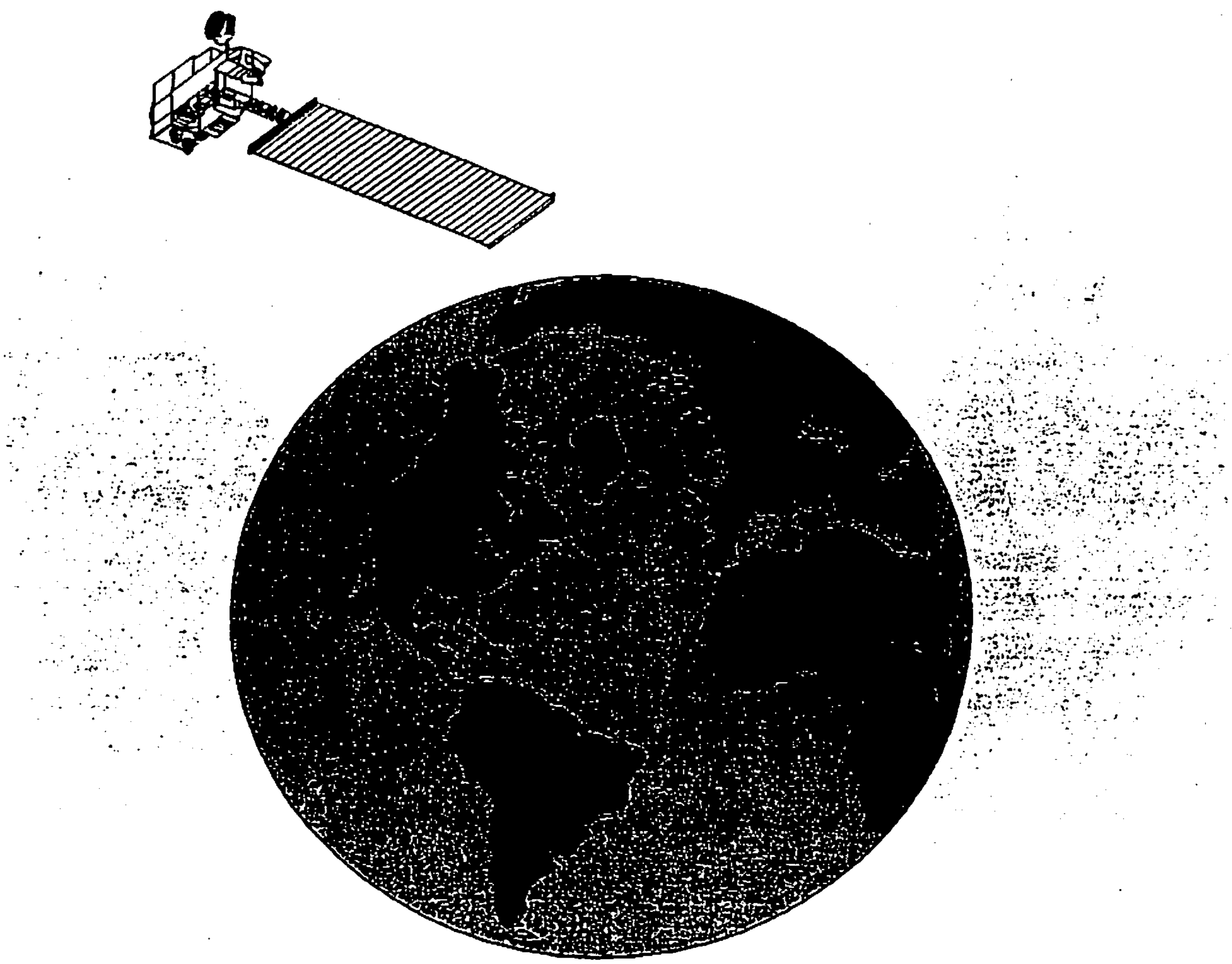
EOS

Earth Observing System

Final Programmatic Environmental Assessment



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Prepared for and in cooperation with:

National Aeronautics and Space Administration
Mission to Planet Earth Office
Goddard Space Flight Center
Greenbelt, MD 20771

JPL

Jet Propulsion Laboratory
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NASA

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

NOTICE (97-)

National Environmental Policy Act; Earth Observing System Program

AGENCY: National Aeronautics and Space Administration (NASA).

ACTION: Finding of no significant impact.

SUMMARY: Pursuant to the National Environmental Policy Act of 1969, as amended (NEPA) (42 U.S.C. 4321, et seq.), the Council on Environmental Quality (CEQ) Regulations for Implementing the Procedural Provisions of NEPA (40 CFR Parts 1500-1508), and NASA policy and procedures (14 CFR Part 1216 Subpart 1216.3), NASA has made a finding of no significant impact (FONSI) with respect to the proposed Earth Observing System (EOS) Program, which would involve a series of Earth orbiting spacecraft to be launched over the time period of 1998 through 2014 from Vandenberg Air Force Base (VAFB), California.

DATE: Comments on the FONSI must be provided in writing to NASA on or before (insert date 30 days from publication in the Federal Register).

ADDRESSES: Written comments should be addressed to Mr. Richard T. Beck, Deputy Director (Resources), Mission to Planet Earth Office, Code 170, NASA/Goddard Space Flight Center, Greenbelt, Maryland 20711. The Programmatic Environmental Assessment (PEA)

prepared for the Earth Observing System Program which supports this FONSI may be reviewed at the following locations:

(a) NASA Headquarters, Library, Room 1J20, 300 E Street, SW, Washington, DC 20546.

(b) VAFB, Technical Library, Building 7015, 806 13th Street, Vandenberg AFB, CA 93437.

(c) Jet Propulsion Laboratory, Visitors Lobby, Building 249, 4800 Oak Grove Drive, Pasadena, CA 91109 (818-354-5179).

(d) Spaceport USA, Room 2001, John F. Kennedy Space Center, Florida, 32899. Please call Lisa Fowler beforehand at 407-867-2497 so that arrangements can be made.

The PEA may also be examined at the following NASA locations by contacting the pertinent Freedom of Information Act Office:

(e) NASA, Ames Research Center, Moffett Field, CA 94035 (650-604-4190).

(f) NASA, Dryden Flight Research Center, Edwards, CA 93523 (805-258-3448).

(g) NASA, Goddard Space Flight Center, Greenbelt, MD 20771 (301-286-0730).

(h) NASA, Johnson Space Center, Houston, TX 77058 (281-483-8612).

(i) NASA, Langley Research Center, Hampton, VA 23665 (757-864-2497).

(j) NASA, Lewis Research Center, 21000 Brookpark Rd, Cleveland, OH 44135 (216-433-2222).

(k) NASA, Marshall Space Flight Center, Huntsville, AL 35812 (205-544-0031).

(l) NASA, Stennis Space Center, MS 39529 (601-688-2164).

A limited number of copies of the PEA are available by contacting Mr. Richard T. Beck at the address or telephone number indicated herein.

FOR FURTHER INFORMATION CONTACT: Mr. Richard T. Beck, 301-286-6613.

SUPPLEMENTARY INFORMATION: NASA has reviewed the PEA prepared for the EOS Program and has determined that it represents an accurate and adequate analysis of the scope and level of associated environmental impacts. The PEA is incorporated by reference in this FONSI.

NASA is proposing to develop, build and launch a series of investigative spacecraft designed to provide global science data from a low-altitude, Sun-synchronous orbit over the time period of 1998 through 2014 from VAFB, California. EOS investigations would study the atmosphere, oceans, biosphere, land surface, and solid Earth systems. Spacecraft final assembly, propellant loading and checkout of payload systems would be performed in Payload Processing Facilities at VAFB. The spacecraft would then be transported to a Space Launch Complex at VAFB where it would be integrated with the launch vehicle. Due to varying payload weights and orbital requirements, Earth Observing System (EOS) spacecraft would require different launch vehicles. The launch

vehicle selected as an environmental "bounding case" is the Delta II 7925.

The EOS Flight and Science projects focus on defining the state of the Earth system, understanding its basic processes, and developing and applying predictive models of those processes. All EOS instrument payloads are designed to measure physical Earth system phenomena from which specific data products can be derived. This effort would consist of both focused, disciplinary research centered around a specific data set and interdisciplinary research geared toward a broader exploration of systemic functions. Collecting data from the vantage point of space would provide information about Earth's land, atmosphere, oceans, ice and biota that is obtainable in no other way. In concert with the global research community, the EOS Program would spearhead the development of scientific knowledge required to support the complex national and international environmental policy decisions that lie ahead.

Alternatives to the proposed action that were considered included those that: (1) utilize an alternate launch vehicle, (2) utilize an alternate launch site, or (3) cancel the Earth Observing System Program (the "no action" alternative). Failure to undertake the EOS Program would impede scientific progress toward understanding the natural environment and its response to human activity and would cause more U.S. dependence on foreign acquisition of these data. The resultant loss of continuity in

Earth observation data acquisition could lead to not meeting national priorities with respect to management of the environmental global commons and may result in ineffective policy decisions with respect to managing the global commons. Of the launch vehicles evaluated, U.S. launch vehicles proposed for launch of EOS spacecraft (specifically the Atlas IIAS, Delta II 7925, Medium-Lite Expendable Launch Vehicles and the Pegasus) are best suited for the EOS Program for the following reasons: (1) the alternative launch vehicles examined are approximately equal in their potential impact to the environment, and these impacts are not substantial; (2) U.S. launch vehicles proposed closely match EOS performance requirements and allow for variations in payload size and weight; and (3) selected launch vehicles cost the same or less than the examined alternatives and are similar in terms of reliability. Of the launch sites evaluated, VAFB is best suited for the EOS Program for the following reasons: (1) the majority of EOS spacecraft would be launched to polar orbits, which require an orbital inclination greater than the maximum allowable inclination for Cape Canaveral Air Station launches; and (2) available information in the detail necessary to make a judgment as to environmental impact and differences in philosophy with regard to overflight of land for acceptable launch trajectory and debris risk is unavailable for foreign launch sites.

Expected impacts to the human environment associated with the program are bounded by and arise almost entirely from the normal launch of the Delta II 7925. Air emissions from the exhaust produced by the solid propellant graphite epoxy motors and liquid first stage primarily include carbon monoxide, hydrochloric acid, aluminum oxide in soluble and insoluble forms, carbon dioxide, and deluge water mixed with propellant by-products. Air impacts would be short-term and not substantial. Short-term water quality and noise impacts, as well as short-term effects on plants, and animals, would occur only in the vicinity of the launch complex. There would be no impact on threatened or endangered species or critical habitat, cultural resources, wetlands or floodplains. The EOS Program would follow the NASA guidelines regarding orbital debris and minimizing the risk of uncontrolled reentry into the Earth's atmosphere. Accident scenarios have also been addressed. None of the EOS Program missions will have radioactive materials aboard the spacecraft, except for the possibility of minute quantities on certain missions for instrumentation purposes. Consequently, no adverse impacts from radioactive substances are anticipated. No other individual or cumulative impacts of environmental concern have been identified.

The level and scope of environmental impacts associated with the launch of EOS spacecraft are well within the envelope of impacts that have been addressed in previous FONSI's concerning

other launch vehicles and spacecraft. EOS spacecraft would not increase launch rates nor utilize launch systems beyond the scope of approved programs at VAFB. No EOS-specific processing or launch activities have been identified that would require new permits and/or mitigation measures beyond those currently in place or in coordination at VAFB. No significant new circumstances or information relevant to environmental concerns associated with the launch vehicle have been identified which would affect the earlier findings. As specific spacecraft and missions are fully defined, they will be reviewed in light of the PEA. If any fall outside of the scope of the PEA, further NEPA review will be conducted, as necessary.

On the basis of the EOS PEA, NASA has determined that the environmental impacts associated with the program would not individually or cumulatively have a significant impact on the quality of the human environment. NASA will take no final action prior to the expiration of the 30-day comment period.

W. F. Townsend

William F. Townsend

Acting Associate Administrator for

Mission to Planet Earth

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EOS ACRONYMS, ABBREVIATIONS AND SYMBOLS

Acronym	Description
AAQS	Ambient Air Quality Standards
ACHP	Advisory Council on Historic Preservation
ACRIM	Active Cavity Radiometer
ADEOS	Advanced Earth Observing Satellite
AIRS	Atmospheric Infrared Sounder
Al	Aluminum
Al_yO_x	Oxides of Aluminum
AM	Morning (Spacecraft Series)
AMSU	Advanced Microwave Sounding Unit
APCD	Air Pollution Control District
ASF	Alaska Synthetic Aperture Radar (SAR) Facility
ASRM	Advanced Solid Rocket Motor
ASTER	Advanced Spaceborne Thermal Emission/Reflection Radiometer
BO	Biological Opinion
C	Celsius
CAA	Clean Air Act
CAAQS	California Ambient Air Quality Standard
$CaCO_3$	Calcium Carbonate
CAP	Consolidation and Accumulation Point
CARB	California Air Resources Board
CCAS	Cape Canaveral Air Station
CCR	California Code (of) Regulations
CCS	California Commercial Spaceport
CDFG	California Department of Fish and Game
CEC	Cation Exchange Capacity
CEQ	Council on Environmental Quality
CEQA	California Environmental Quality Act
CERCLA	Comprehensive Environmental Response Compensation Liability Act
CERES	Clouds and Earth's Radiant Energy System
CERL	Construction Engineering Research Laboratory
CES	Civil Engineering Squadron
CESA	California Endangered Species Act
CFCs	Chlorofluorocarbons
CHEM	Chemistry (Spacecraft Series)
CII	Chemistry International Instrument
CNELs	Community Noise Equivalent Levels
CNPS	California Native Plant Society
CO	Carbon Monoxide
CO_2	Carbon Dioxide
COLOR	EOS Ocean Color Instrument
CPHTS	Capillary-Pumped Heat Transport System
CSA	Canadian Space Agency
CSD	Command Safety Destruct
CSF	Chemistry and Special Flights Series
CSLC	California Space Launch Complex
CZMA	Coastal Zone Management Act
DAACs	Distributed Active Archive Centers
DARPA	Defense Advanced Research Projects Agency
DAS	Direct Access System
dB	decibel
dBA	A-weighted decibel
DDT	Dichlorodiphenyl Trichloroethane

DEIS	Draft Environmental Impact Statement
DEPs	Directed Energy Plans
DFA	Dual Frequency Altimeter
DOT	Department of Transportation
DRMO	Defense Reutilization and Marketing Office
DTSC	Department of Toxic Substances Control
EA	Environmental Assessment
ECS	Earth Observing System Data Information System Core System
EDC	EROS Data Center
EED	Electro-explosive Device
EIRP	Effective Isotropically Radiated Power
EIS	Environmental Impact Statement
ELVs	Expendable Launch Vehicles
EOS	Earth Observing System
EOSDIS	Earth Observing System Data Information System
EOSP	Earth Observing Scanning Polarimeter
EPA	Environmental Protection Agency
ERT	Emergency Response Team
ESA	European Space Agency
ESBM	Equipment Section Boost Motor
ESSB	Earth System Science Building
ESSC	Earth System Sciences Committee
ET	Environmental Technician
F	Fahrenheit
FFDP	Final Flight Data Packages
FIP	Federal Implementation Plan
FMEA	Failure Modes and Effects Analyses
FONSI	Finding of No Significant Impact
FOO	Flights of Opportunity
FOS	Flight Operations Segment
FSDP	Facility Safety Data Packages
g	gram
GCDIS	Global Change Data and Information System
GDSS	General Dynamics Space Systems Division
GEMs	Graphite Epoxy Motors
GHe	Gaseous Helium
GLAS	Geoscience Laser Altimeter System
GN_2	Gaseous Nitrogen
GOP	Ground Operations Plans
GSE	Ground Support Equipment
GSFC	NASA Goddard Space Flight Center
HAPS	Hazardous Air Pollutant Standards
HWCL	Hazardous Waste Control Law
H^+ and H_2	Hydrogen
H_2O	Water
HCl	Hydrogen Chloride
HCT	Mercury Cadmium Telluride Detectors
HFCs	Hydrofluorocarbons
HGA	High Gain Antenna
HgCdTe	Mercury Cadmium Telluride Detectors
HIRDLS	High-Resolution Dynamics Limb Sounder
HMCF	Hypergolic Maintenance and Checkout Facility
HSF	Hazardous Storage Facility
HTPB	Hydroxyl-Terminated Polybutadiene
Hz	Hertz
i	Orbital Inclination

IELV	Intermediate Expendable Launch Vehicle
IPA	Isopropyl Alcohol
IPF	Integrated Processing Facility
ISPs	Intended Support Plans
JPL	Jet Propulsion Laboratory
K	degrees Kelvin
kg	kilogram
km	kilometer
KSC	Kennedy Space Center
kton	kiloton
L	Liter
LALT	Laser Altimetry (Spacecraft Series)
LaRC	Langley Research Center
LATI	Landsat Advanced Technology Instrument
lbs	pounds
LE-7	Liquid Hydrogen/Liquid Oxygen Engine
LEL	Lower Explosive Limit
LH_2	Liquid Hydrogen
LIS	Lightning Imaging Sensor
LLV 3	Lockheed Launch Vehicle 3
LO_2	Liquid Oxygen
LOS	Level of Service
LOx	Liquid Oxygen
m	meter
MDA	McDonnell Douglas Aerospace
MELV	Medium Expendable Launch Vehicles
meq	milliequivalent
mg	milligram
mi	mile
MHS	Microwave Humidity Sounder
MIMR	Multifrequency Imaging Microwave Radiometer
MISR	Multi-angle Imaging Spectroradiometer
ml	milliliter
MLELV	Medium-Lite (Med-Lite) Expendable Launch Vehicles
MLS	Microwave Limb Sounder
MMH	Monomethyl Hydrazine
MMPA	Marine Mammal Protection Act
MODIS	Moderate-Resolution Imaging Spectroradiometer
MOL	Manned Orbital Laboratory
MOPITT	Measurements of Pollution in the Troposphere
MR	Microwave Radiometer
mrem	millirem (one-thousandth of a Roentgen equivalent man unit)
MSFC	NASA Marshal Space Flight Center
MSPSP	Missile System Prelaunch Safety Package
MT	Metric Ton
MTPE	Mission to Planet Earth
MTPEO	Mission to Planet Earth Office
N_2H_4	Hydrazine
N_2O_4	Nitrogen Tetroxide
NA	Not Applicable
NAAQS	National Ambient Air Quality Standards
NaOH	Sodium Hydroxide
NAS	National Academy of Sciences
NASA	National Aeronautics and Space Administration
NASDA	National Space Development Agency of Japan
NCS	Nutation Control System

NEPA	National Environmental Policy Act
NH_4CLO_4	Ammonium Perchlorate
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NO	Nitric Oxide
NOAA	National Oceanic and Atmospheric Administration
NO_2	Nitrogen Dioxide
NOx	Oxides of Nitrogen
NPDES	National Pollution Discharge Elimination System
NPPA	California Native Plant Protection Act
NSIDC	National Snow and Ice Data Center
NUS	No Upper Stage
O_2 and O^{-2}	Oxygen
O_3	Ozone
OCST	Office of Commercial Space Transportation
OH^-	Hydroxide Ion
OPLAN	Operations Plan
ORNL	Oak Ridge National Laboratory
OSHA	Occupational Health and Safety Administration
OSTP	Office of Science and Technology Policy
PAM-D	Payload Assist Module-Delta
PAR	Performance Assurance Requirements
PDR	Preliminary Design Review
PEL	Permissible Exposure Limit
PFDP	Preliminary Flight Data Packages
pH	hydrogen power
PIK	Precision Injection Kit
PLF	Payload Fairing
PM	Evening (Spacecraft Series)
PM_{10}	Particulate Matter < 10 Microns in Diameter
PPF	Payload Processing Facility
ppm	parts per million
PSD	Prevention of Significant Deterioration
psf	pounds per square foot
RALT	Radar Altimetry (Spacecraft Series)
RCRA	Resource Conservation and Recovery Act
REEDM	Rocket Exhaust Effluent Diffusion Model
rem	Roentgen equivalent man
ROC	Reactive Organic Compound
ROG	Reactive Organic Gas
ROI	Region Of Influence
RP-1	Kerosene
SAGE III	Stratospheric Aerosol and Gas Experiment III
SAR	Safety Assessment Report
SARA	Super Fund Amendment and Re-authorization Act
SBC	Santa Barbara County
SBCAPCD	Santa Barbara County Air Pollution Control District
SBRC	Santa Barbara Research Center
SBUV	Solar Backscatter Ultraviolet (Experiment)
SCCAB	South Central Coast Air Basin
sd	standard deviation
SeaWinds	SeaWinds Scatterometer
SEDAC	Socioeconomic Data and Applications Center
SELV	Small Expendable Launch Vehicle
SHPO	State Historic Preservation Officer
SIP	State Implementation Plan

SLAMS	State and Local Air Monitoring System
SLC	Space Launch Complex
SLF	Space Launch Facility
SLV	Standard Launch Vehicle
SO_2	Sulfur Dioxide
SOLSTICE	Solar Stellar Irradiance Comparison Experiment
SPW	Space Wing
SRM	Solid Rocket Motors
SRMU	Solid Rocket Motor Upgrade
SSI	Spaceport Systems International
SSPP	System Safety Program Plans
Std	Standard
STS	Space Transportation System
Sv	Sievert
SW	Space Wing
TBD	To Be Determined
TDRS	Tracking and Data Relay Satellite
TES	Tropospheric Emission Spectrometer
Th	Thorium
ThF_4	Thorium Fluoride
TOMS	Total Ozone Mapping Spectrometer
TPB	Terminated Polybutadiene
TRI	Toxic (Chemical) Release Inventory
TSCA	Toxic Substances Control Act
TSDF	Treatment, Storage, and Disposal Facility
UDMH	Unsymmetrical Dimethyl Hydrazine
UEL	Upper Explosive Limit
ug/m^3	micrograms per cubic meter
USAF	United States Air Force
USFWS	U.S. Fish and Wildlife Service
USGCRP	U.S. Global Change Research Program
VAB	Vehicle Assembly Building
VAFB	Vandenberg Air Force Base
VOC	Volatile Organic Compound
WQC	Water Quality Conservation Board
WCSC	Western Commercial Space Center
WR	Western Range
WRR	Western Range Regulations
Y_2O_3	Yttrium Oxide

EXECUTIVE SUMMARY

PROPOSED ACTION

This Environmental Assessment (EA) addresses the proposed action to develop, build and launch a series of investigative spacecraft over the time period of 1998 through 2014 from Vandenberg Air Force Base (VAFB), California. Spacecraft final assembly, propellant loading and checkout of payload systems would be performed in Payload Processing Facilities (PPFs) at VAFB. The spacecraft would then be transported to a Space Launch Complex (SLC) at VAFB where it would be integrated with the launch vehicle.

Due to varying payload weights and orbital requirements, Earth Observing System (EOS) spacecraft will require different launch vehicles. The launch vehicle selected as an environmental 'bounding case' is the Delta II 7925. The Delta II 7925 consists of a liquid bipropellant main engine, a liquid bipropellant second stage engine, and nine Graphite Epoxy Motor (GEM) strap-on solid rockets. Mating of the spacecraft with the launch vehicle, systems integration, liquid propellant servicing and ordnance installation would be completed at the launch complex.

Space Launch Complexes 2W and 3E at VAFB in California are considered the preferred launch sites for the EOS AM, PM, and CHEM projects, which plan on using an Atlas IIAS (AM-1 only) and Delta II launch vehicles prior to 2003. All other EOS projects (later AM, PM and CHEM projects, ALTs, and FOOs) call for the use of Med-Lite class launch vehicles or Small Expendable Launch Vehicles (SELVs), with the California Space Launch Complex (CSLC) and SLC-6 as the préferred launch site. The choice of VAFB SLCs and the CSLC is driven by payload size and the ability of specific sites to accommodate specific vehicles.

PURPOSE AND NEED FOR THE ACTION

EOS investigations would study the atmosphere, oceans, biosphere, land surface, and solid Earth systems. Of particular interest would be the flow of energy and cycling of water and other biogeochemicals through the Earth system. The EOS Flight and Science projects focus on defining the state of the Earth system, understanding its basic processes, and developing and applying predictive models of those processes. All EOS instrument payloads are designed to measure physical Earth system phenomena from which specific data products can be derived.

The overall need of the Mission to Planet Earth (MTPE) EOS Program is to understand the total Earth system and the effects of natural and human-induced changes on the global environment. To preserve and improve the Earth's environment for future generations, policies and decisions must be based on sound scientific understanding. Collecting data from the vantage point of space provides information about Earth's land, atmosphere, oceans, ice, and biota that is obtainable in no other way. In concert with the global research community, the EOS Program would lead the development of scientific knowledge required to support national and international environmental policy decisions.

The Earth Observing System (EOS) is the centerpiece of NASA's Mission to Planet Earth (MTPE) Program and is needed to establish the foundation for an innovative, comprehensive approach to global environmental monitoring and climate prediction. The need to monitor and manage Earth's large-scale biosystems is increasingly important as human activities have a widening impact on global change. EOS would better allow national environmental analysis and protection policy to be grounded in scientific fact.

ALTERNATIVES CONSIDERED

Alternatives to the proposed action that were considered included those that: 1) utilize an alternate launch site, 2) utilize an alternate launch vehicle, or 3) cancel the Earth Observing System Program (the "no-action" alternative).

Alternate Launch Sites

Cape Canaveral Air Station, a potential alternative launch site considered for launching EOS spacecraft on Delta II 7925 and Atlas IIAS rockets, has been eliminated from further study due to EOS orbital inclination requirements. The majority of EOS spacecraft would be launched to polar orbits, which require an orbital inclination greater than 51°, the maximum allowable inclination for CCAS launches. Orbital inclinations in excess of 90° are necessary for EOS spacecraft and introduce the potential for overflight of populated areas if launched from CCAS. This risk is expected to far exceed any cumulative effects expected at VAFB due to EOS launch impacts.

The potential use of foreign launch sites was considered by the EOS Program, since the program defines collaboration with several foreign counterparts. However, available information in the detail that would be necessary to make a judgment with respect to (1) environmental impact; and (2) differences in philosophy with regard to overflight of land for acceptable launch trajectory and debris risk are unavailable.

Alternate Launch Vehicles

Of the launch vehicles examined, U.S. Launch Vehicles proposed for launch of EOS spacecraft; the Atlas IIAS, Delta II 7925, Medium-Lite Expendable Launch Vehicles (MLELVs) and the Pegasus are best suited for the EOS Program, for the following reasons:

- Of the alternative launch vehicles examined, all were approximately equal in their potential impact to the environment.
- The U.S. launch vehicles proposed closely match EOS performance requirements and allow for variations in payload size and weight.
- Selected launch vehicles cost the same or less than the examined alternatives and are similar in terms of reliability.

No-Action Alternative

The No-Action alternative would mean the EOS Program would not be undertaken and the immediate local (*i.e.*, launch site) impacts would be minimized.

The No-Action alternative would impede scientific progress toward understanding the natural environment and its response to human activity, and would cause more U.S. dependence on foreign acquisition of these data. The resultant loss of continuity in Earth observation data acquisition would lead to not meeting national priorities with respect to management of the environmental global commons and may result in ineffective policy decisions with respect to managing the global commons.

SUMMARY OF ENVIRONMENTAL IMPACTS

Environmental Assessments (EAs) have been completed and Findings of No Significant Impact (FONSIs) issued for launch vehicles proposed for use by EOS at Vandenberg Air Force Base (VAFB).[1] The Earth Observing System Program would not increase launch

[1] [SLC2W 1991], [FONSIa 1991], [SLC6a 1995], [FONSI 1995], [ATLAS 1991] [FONSIc 1991] and [FONSIa 1993]

rates nor utilize launch systems beyond the scope of approved programs at VAFB. No EOS-specific processing or launch activities have been identified that would require permits and/or mitigation measures beyond those currently in place or in coordination at VAFB Payload Processing Facilities (PPFs) and Space Launch Complexes (SLCs). Any monitoring and/or mitigation would be provided for EOS by previously approved programs or programs in coordination at VAFB. [JO 1996]

Air Quality

Primary constituents of exhaust from solid-fueled rocket motors are hydrogen chloride (HCl), carbon dioxide (CO_2), carbon monoxide (CO), and oxides of aluminum (Al_2O_3). Exhaust products are expected to be dissipated before reaching sensitive human, flora or fauna receptors. Since launches would generally be directed southerly and since the predominant wind directions are from the north, there is expected to be no impact to communities and populated areas of western Santa Barbara County.

Operations at the payload processing facility, would include loading of propellants (hydrazine and nitrogen tetroxide). Emissions from loading processes would be controlled by means of scrubbers or closed loop propellant transfer operations. When compared to a National Academy of Sciences Committee on Toxicology Report, Occupational Safety and Health Administration (OSHA) Standards, and several state regulated acceptable ambient limits, the maximum predicted hydrazine emissions are below each standard or regulation. Maximum predicted nitrogen oxides emissions are below the State of California standard (for nitrogen dioxide) and OSHA standard (for nitrogen dioxide and nitrogen tetroxide).

Ground operations would temporarily increase emissions from electrical power generators and vehicle traffic. These increases are not expected to have adverse impacts to air quality. Previous estimates predicted that during operation of the Spaceport, approximately 10 personnel would work at the facility. Assuming all of these personnel drive their own vehicles, approximately 20 additional vehicle trips would be generated during operation of the facility. This represents approximately one percent of traffic using a single entrance to Vandenberg Air Force Base (VAFB) on a daily basis, which is not considered to be of concern [PPF 1993]. During EOS satellite processing, there would be a maximum of 80 to 100 vehicle trips, representing a four to five percent increase at a single gate on a daily basis. This increase would last approximately four months and is not expected to be of concern.

In summary, the total direct and indirect emissions from the Proposed Action do not exceed the Federal de minimis conformity threshold for the criteria nonattainment pollutants (ozone precursors). Additionally, total emissions for each nonattainment pollutant (ozone precursors) are less than 10 percent of the Santa Barbara County Air Pollution Control Districts (SBCAPCDs) 1990 Base Year Annual Emission Inventory. Therefore, this Proposed Action is considered de minimis and not regionally significant.

Water Quality

The nearest bodies of surface water are beyond the range of expected impacts. Moreover, the high acid neutralization characteristics of the local drainages would counteract any acidic deposition from the rocket launches [SLC6 1994]. In the event that rain water absorbs HCl which might then be deposited on the ground, this natural buffering capacity of the streams would result in negligible or no change in water quality [SLC6a 1995].

Local and regional water resources would not be affected since there would be no ground water withdrawals. Water utility piping would be used to meet miscellaneous onsite needs. As a result there would be no related impacts to the ground water, surface water or wastewater processing systems [SLC6 1994].

Ocean Environment [DELTA 1994]

In a normal launch, the first and second stages and the Solid Rocket Motors (SRMs) would impact the ocean. The trajectories of spent stages and SRMs would be programmed to impact a safe distance from any U.S. coastal area or other land mass. Toxic concentrations of metals would not be likely to occur due to the slow rate of corrosion in the deep ocean environment and the large quantity of water available for dilution.

Along with the spent stages would be relatively small amounts of propellant. Concentrations in excess of the maximum allowable concentration of these compounds for marine organisms would be limited to the immediate vicinity of the spent stage. No substantial impact would be expected from the reentry and ocean impact of spent stages, due to the small amount of residual propellants and the large volume of water available for dilution.

Hazardous Waste

Hazardous and solid waste management will comply with applicable Federal, State, and local base regulations. Hazardous waste routinely generated by the base include oils, paints, thinners, solvents, and other regulated materials, including radioactive wastes. A Hazardous Waste Management Plan has been developed and implemented to ensure compliance with Resource Conservation and Recovery Act (RCRA) requirements. In addition to the Hazardous Waste Management Plan, the base has also developed a Hazardous Waste Source Reduction Compliance Plan to provide information and procedures to reduce and minimize the generation of hazardous wastes on the base [PPF 1993]. The potential for an accidental release of liquid propellants will be minimized by strict adherence to all applicable safety procedures. All spills will be managed in accordance with the VAFB Spill Response Plan. First stage propellants, RP-1 and liquid oxygen, will be stored in tanks near the launch pad within cement containment basins designed to retain 110 percent of the storage tank volumes. Before each launch, a Toxic Hazard Corridor forecast is prepared by the United States Air Force (USAF) duty forecaster to assure safe launch conditions.

Noise Pollution

Peak launch noises for all potential EOS launch vehicles are experienced for a very brief time and are not expected to exceed Environmental Protection Agency (EPA) or OSHA requirements and recommendations.

VAFB has previously consulted with the National Marine Fisheries Service (NMFS) and is obtaining a permit addressing unavoidable disturbance to pinnipeds that may result from rocket launches. A program of monitoring and reporting noise levels and responses of the harbor seals at various haulout areas on VAFB would be conducted for each launch operation. If the results from the monitoring reveal that the effect of the launch noise on harbor seals is more than incidental harassment, NMFS would be immediately notified, and consultation would be requested. Currently no EOS-specific launch activities have been identified that would require permits beyond the baseline permits already necessary.

Ionizing and Nonionizing Radiation

Radioactive thorium fluoride is used in combination with yttrium oxide and germanium metal to provide an optical coating for the MODIS and MOPITT Instruments lens. The total amount of this material used is less than 0.2 grams (2.18×10^{-8} Curies) per each instrument. Although there is no anticipated mechanism for dispersion, a dose calculation was completed using very conservative (protective of resources) assumptions. This dose would be received over 50 years and amounts to 0.0072 mrem per year, a fraction of natural background radiation doses when populations in the proximity are considered. This dose is much less than that allowed for occupational exposures and within the range considered de minimis for radiation exposures. It is considered insignificant, and not a health concern.

The EOS AM-1 Spacecraft would carry three types of transmitters, a KU-Band High Gain for general data flow, an X-Band used for direct access by special user organizations and three S-Band transmitters for communication with the satellite (only two of the S-Band transmitters are used at any given time). With proper safeguard against electrical shock, there is no human health and safety hazard expected from radio frequency radiation by the launch vehicle/spacecraft.

Threatened and Endangered Species

Any action that may affect Federally listed species or their critical habitats requires consultation with the U.S. Fish and Wildlife Service (USFWS) and/or the National Marine Fisheries Service (NMFS) under Section 7 of the Endangered Species Act of 1973 (as amended). The USFWS and NMFS have previously reviewed those actions which would be associated with the launch of EOS proposed launch vehicles from VAFB and has determined that the continued existence of the covered species would not be in jeopardy provided mitigation measures were implemented. Currently no EOS-specific processing or launch activities have been identified that would require permits and/or mitigation measures beyond the baseline permits and mitigation measures already necessary or in coordination for Spaceport and SLC-2 operations. Any monitoring and/or mitigation would be provided for EOS by previously approved programs or programs in coordination at VAFB. Furthermore, the 1998 launch date would allow EOS to be covered by a base-wide, programmatic permit currently in coordination for all of VAFB. [JO 1996]

Biotic Resources

The EOS Program would not be expected to substantially impact VAFB terrestrial or aquatic biota. Launch noise is of short duration and is not expected to substantially affect wildlife. Wildlife could experience brief exposure to launch generated exhaust particles, but would not be expected to experience any substantial impact. Aquatic biota would not be expected to experience any adverse impact, because of the high buffering capacity of the surrounding surface waters.

Land Resources

The near-field effects of launches at VAFB are expected to be minimal or nonexistent. This is consistent with monitoring associated with Space Shuttle launches at Cape Canaveral, Florida. Although the Space Shuttle is much larger than the rockets currently considered for launch from VAFB, and uses deluge waters during its launch, the total near-field area of impact after 43 launches of the Space Shuttle was only 119 hectares (294 acres). Soils at Cape Canaveral are more susceptible to acidic deposition than those at VAFB [SLC6a 1995]. However, despite additions of significant amounts of acidic deposition from 43 wet launches over a ten year period, the affected soils showed no decrease in buffering capacity [SLC6a 1995].

Archeological and Historic Resources

Since no surface or subsurface areas will be disturbed, no significant archeological, historic, or cultural sites are expected to be affected by launching EOS spacecraft from VAFB.

Socioeconomics

The EOS Program is not expected to have a substantial impact on the local economy, since no additional permanent personnel would be expected beyond the current VAFB staff.

CONCLUSION

The AM-1 spacecraft is expected to be representative of all EOS spacecraft in terms of failure modes, hazardous materials and potential impacts. Specific designs are not available now for all instruments but the AM suite of instruments and those reviewed from other missions indicate that the materials used and therefore the hazards anticipated from them would be similar and benign. The components utilized in the instruments and spacecraft are materials normally encountered in the space industry and present no unique or unacceptable environmental impacts.

Potential impacts from construction of new facilities required by the EOS Program have been covered in separate environmental assessments and are referenced where appropriate throughout this EA. There do not appear to be any significant impacts associated with either planned Distributed Active Archive Centers (DAACs) modifications or new construction for EOS Program DAACs. All new facilities either have had an EA and FONSI issued or will have appropriate NEPA documentation in place prior to modification or construction.

The detailed analyses performed in this environmental assessment bound the anticipated potential impacts for the EOS Program. There is no indication that the expected impacts will be greater than those normally encountered in the general space program nor the specific launch programs at VAFB. In conclusion, the EOS Program environmental impacts fall well within the range of previously defined, but not judged significant, impacts for other authorized and approved programs.

1. CHAPTER ONE
PURPOSE AND NEED

GENERAL

The National Aeronautics and Space Administration (NASA) has prepared this Environmental Assessment (EA) for the proposed Earth Observing System (EOS) Program to comply with the National Environmental Policy Act of 1969, as amended (NEPA) (42 U.S.C. 4321 et seq.), the Council on Environmental Quality (CEQ) Regulations for Implementing the Procedural Provisions of NEPA (40 CFR Parts 1500-1508), and NASA policy and procedures (14 CFR Part 1216). The EA's objective is to provide decision makers with sufficient information and analysis to determine whether proceeding with the proposed action requires an Environmental Impact Statement (EIS) or a Finding of No Significant Impact (FONSI) to be prepared. Topics discussed include program objectives, potential environmental impacts, and alternatives to the proposed action.

The planned Earth Observing System is the centerpiece of NASA's Mission to Planet Earth (MTPE) Program. Mission to Planet Earth would consist of EOS, the EOS Data Information System (EOSDIS), Earthprobe satellites, additional payloads flown on the Space Shuttle, specialized aircraft and balloons, and a focused investigation program that provides the scientific understanding necessary to accomplish MTPE's goals and objectives. MTPE comprises NASA's contribution to the U.S. Global Change Research Program (USGCRP), whose goal is to establish a scientific basis and understanding for national and international policy making related to natural and human-induced changes in the global Earth system.

EOS investigations would study the atmosphere, oceans, biosphere, land surface, and solid Earth systems. Of particular interest will be the flow of energy and cycling of water and other biogeochemicals through the Earth system. The program is considering launching a series of investigative spacecraft on expendable launch vehicles over the time period of 1998 through 2014 (see Mission Profile, p. 2-6, Figure 2-3). Potential effects considered in this document include, but are not limited to impacts upon air quality, water quality, the local land area, health and safety, biotic resources, socioeconomics, wetlands, and historical sites. The EOS Program was proposed by the President of the United States and approved by Congress as a new start in 1990 for fiscal year 1994.

1.1 PURPOSE OF THE PROPOSED ACTION [PLAN 1995]

The Earth System Sciences Committee (ESSC), in its report issued in May 1986, stated that the purpose of Earth system science is "To obtain a scientific understanding of the entire Earth system on a global scale by describing how its component parts and their interactions have evolved, how they function, and how they may be expected to continue to evolve on all time scales." The report also identified the following challenge to Earth system science: "To develop the capability to predict those changes that will occur in the next 10 to 100 years, both naturally and in response to human activity." The scientific purpose of the program is to obtain an understanding of the Earth and how it may evolve, and to predict those evolutions; specifically:

- To launch a series of spacecraft which would orbit the Earth, thereby allowing the development and operation of an integrated, scientific, Earth Observing System emphasizing climate change;
- To acquire and assemble a global database of remote sensing measurements from space over a decade or more that would enable multidisciplinary study of the Earth's critical, life-

enabling, interrelated processes involving the atmosphere, oceans, land surface, and polar regions, and the dynamic and energetic interactions among them;

- To develop a comprehensive data and information system, including a data processing, storage, and retrieval system, that serves the needs of scientists performing definitive and conclusive studies of Earth system attributes, and to make MTPE data and information publicly available; and
- To advance our scientific understanding of the Earth and to provide a sound scientific basis for policy decision makers. [PLAN 1995]

The EOS Program's space-based network of advanced science platforms and ground-based network of data processing centers, designed to collect data for extended periods of time due to the long time constants associated with the changing Earth system, would allow scientists to fulfill these objectives. The result would be a comprehensive improvement in our knowledge of the components of the Earth system, the interactions between them, and how the system as a whole is changing.

1.2 NEED FOR THE PROPOSED ACTION [PLAN 1995]

The overall need of the Mission to Planet Earth (MTPE) EOS Program is to understand the total Earth system and the effects of natural and human-induced changes on the global environment. To preserve and improve the Earth's environment for future generations, policies and decisions must be based on strong scientific understanding. In concert with the global research community, the EOS Program would lead the development of scientific knowledge required to support the complex national and international environmental policy decisions that lie ahead. The MTPE Earth Observing System is needed to establish the foundation for an innovative, comprehensive approach to global environmental monitoring and climate prediction.

The need to monitor and manage Earth's large-scale biosystems is increasingly important as human activities have a widening impact on global change. The immediate future presents issues such as need for sustainable agriculture and fisheries and forestry management. Longer term considerations include air pollution impacts on Earth's regional forests, erosion, and watershed maintenance and, ultimately, the functioning of forests and phytoplankton in balancing atmospheric gases. Higher resolution, multi-spectral satellite data will place an enormous demand on information and communications systems and the related ability to store, access, and display the raw data. Interpretation of this data will place unprecedented demands on technologies for acquiring and integrating ground truth data. Coupling ground truth data and pattern recognition will be necessary for meaningful monitoring, science, and management. The EOS Program would uniquely integrate these concepts, while contributing to improved environmental quality by supporting the development of a scientific basis for ecosystem management. This scientific basis was identified by the Office of Science and Technology Policy (OSTP) in the National Critical Technologies Report of March 1995 as a priority for the national environmental research and development critical technologies list. [NCTR 1995]

The 1993 Climate Change Action Plan calls for measurements, policy analyses, and decisions to be made based on scientific data. EOS would allow national environmental analysis and protection policy to be better grounded in scientific fact. Without EOS, U.S. dependence on foreign acquisition of these data will increase. In many cases, the collaborations on an international basis have been fruitful and cost effective. However, those collaborations are dependent on each particular country having a significant contribution to make to the program.

EOS investigators and programs would represent a significant contribution to the emergence of Earth system science as a field of scientific endeavor. This relatively young discipline incorporates elements of the atmospheric, oceanic, hydrological, ecological, and solid Earth sciences, but integrates them in a way that addresses the full range of couplings in the Earth system.

Resulting data, information, and scientific understanding must be provided to all classes of users, including but not limited to the Earth science community. Policy makers, environmental decision-makers and resource managers, industrial planners, social scientists and the general academic community, educators, and interested individuals must have effective access to Earth science data and ideas so that difficult decisions about managing the global environment can be made on an informed basis. Training of future generations of Earth scientists, fully representing the diversity of the United States, could be inspired and facilitated by the data and ideas developed by the EOS. The program contributes directly to American economic growth and competitiveness through the scientific products delivered, as well as by developing and infusing spacecraft instrument and information system technologies to enable new scientific investigations. Methods used by EOS to obtain, interpret, and distribute Earth system data and information will be designed to be cost-effective and be at the cutting edge of science and technology.

2. CHAPTER TWO
PROPOSED ACTION AND ALTERNATIVES

GENERAL

This section describes the proposed action of developing flight projects and ground systems for the Earth Observing System Program. Topics covered include the morning (AM), afternoon (PM), Radar Altimetry (RALT), Laser Altimetry (LALT), and Chemistry (CHEM) spacecraft series and their subsequent launches, the construction of new (or modification of existing) Distributed Active Archive Centers (DAACs) to support the Data Information System activities of EOS (EOSDIS) and the use of Astrotech or a similar Payload Processing Facility (PPF). In addition, there are several instruments that would be flown, singularly, as Flights of Opportunity (FOO) on domestic or international spacecraft. Following the presentation of proposed EOS Flight and Science projects is a description of proposed vehicle (and other) alternatives considered, but eliminated, from further study. Figure 2-1 is a general schematic outline of EOS spacecraft, launch vehicles, and instrument payload configurations.

2.1 EOS FLIGHT AND SCIENCE PROJECTS: PROPOSED ACTION[2]

A series of Earth observing satellites is proposed for launch beginning in 1998 and continuing through 2014, with no more than four mission starts per year. Space Launch Complexes (SLCs) 2W and 3E at Vandenberg Air Force Base (VAFB) in Santa Barbara County, California are the proposed launch sites for the EOS AM, PM, and CHEM projects, which are planned using an Atlas IIAS (or Delta II) launch vehicle prior to 2003. All other EOS projects (later PM and CHEM missions, ALTs, and FOOs) call for the use of Med-Lite class launch vehicles or Small Expendable Launch Vehicles (SELVs), with the California Space Launch Complex (CSLC) and SLC-6 as the proposed launch site.

CSLC is currently under development on South Vandenberg by the California Spaceport Authority. The choice of VAFB SLCs and the CSLC is driven by payload size and the ability of specific sites to accommodate specific vehicles. Due to the proximity of the VAFB and CCS (California Commercial Spaceport) launch pads, they are considered together as a single launch location in this EA. (Where specific environmental differences are known to exist on and around a launch pad they are noted throughout the discussion.) The planned EOS spacecraft series, instrument complements, launch dates, and lifetimes are presented in Figure 2-1 and Table 2-1.

The EOS Flight and Science projects focus on defining the state of the Earth system, understanding its basic processes, and developing and applying predictive models of those processes. All EOS instrument payloads are designed to measure physical Earth system phenomena from which specific data products can be derived. A more complete description of the science objectives and individual instruments is contained in Appendix A.

[2] This section is summarized from the EOS Project Plan [PLAN 1995].

Figure 2-1. EOS Program Schematic

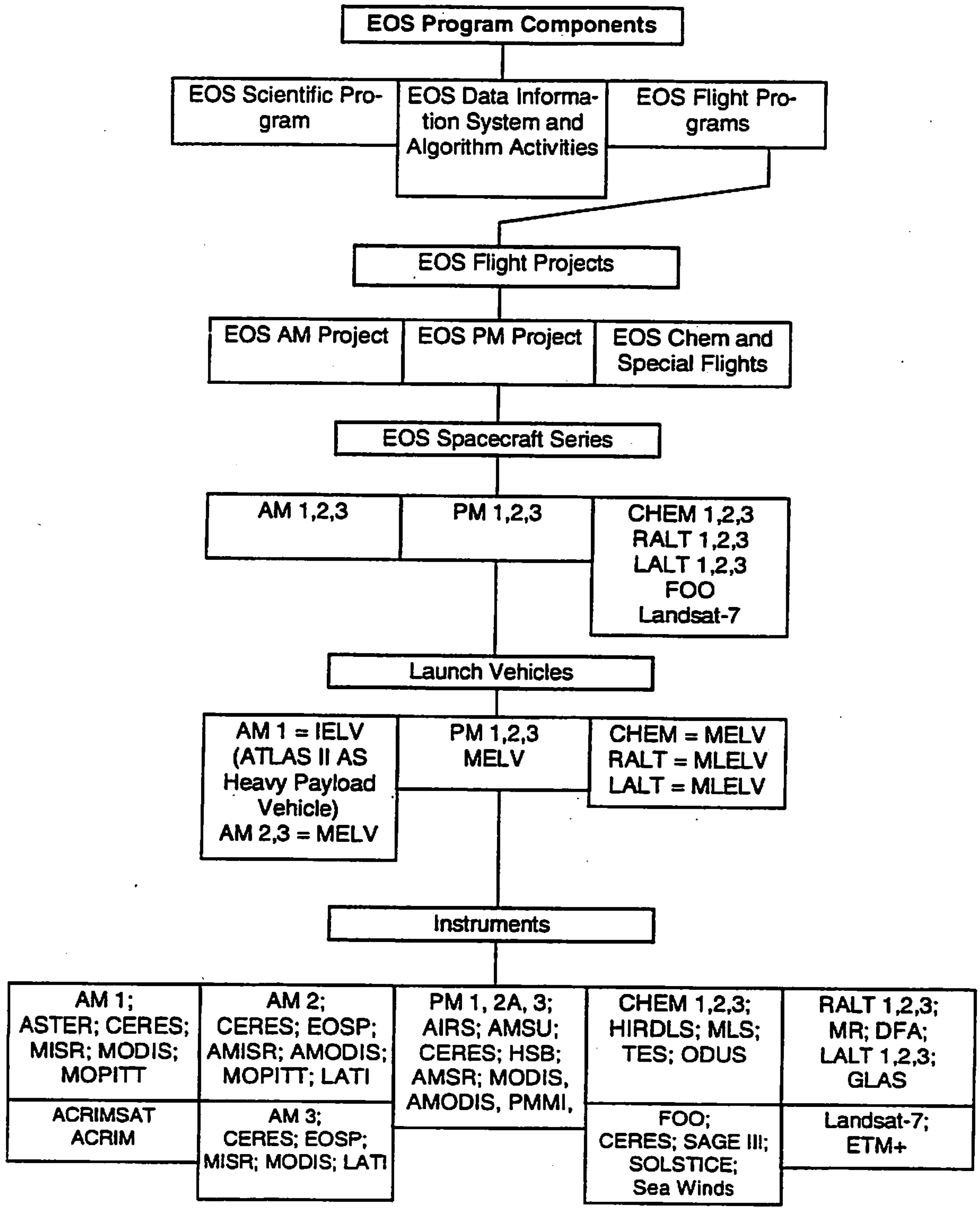


Table 2-1. EOS Mission Instrument Complements, Spacecraft, and Targeted Launch Dates [GRb 1995]

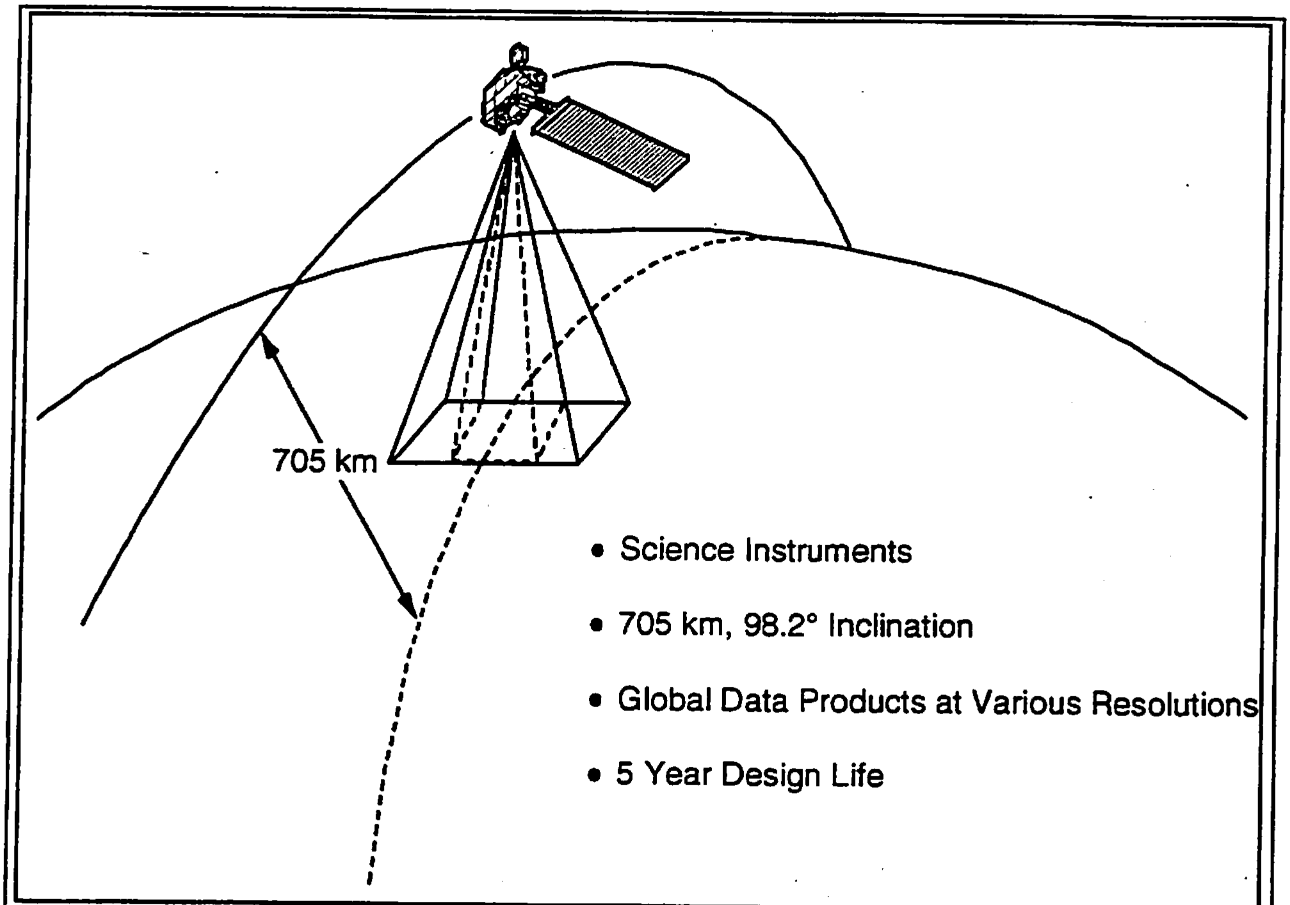
Spacecraft	Instrument	Center	Vendor	Mass (kg)	Pwr (W)	DR (Kbps)	Launch
AM SERIES							
AM-1	ASTER*	GSFC	JAPAN/MITI	450	525/761	8,300/89,200	06/98
	CERES (2)	LaRC	TRW	90	110/185	20	
	MISR	JPL	JPL	157	80/135	3,800/9,000	
	MODIS	GSFC	SBRC	274	230/285	6,200/10,800	
	MOPITT*	GSFC	CSA/COMDEV	184	250	25/40	
AM-2 & 3	CERES	LaRC	TRW	45	65/93	10	06/04
	EOSP	GSFC	TBD	26	19/19	44/88	06/10
	LATI	GSFC	TBD	104	84/84	70/185	
	AMISR	JPL	JPL	157	80/135	3,800/9,000	
	AMODIS	GSFC	SBRC	274	230/285	6,200/10,800	
PM SERIES							
PM-1	AIRS	JPL	LIRIS	156	256	1,440	12/00
	AMSU	GSFC	AEROJET	110	125	3	
	CERES (2)	LaRC	TRW	98 (2)	95 (2)	20	
	HSB	GSFC	TBD	60	80	4	
	AMSR	GSFC	NASA	385	465	130	
	MODIS	GSFC	SBRS	250	225	6,200/10,800	
PM-2 & 3	CERES (1)	LaRC	TRW	49	65/93	10	12/06
	AMODIS	GSFC	SBRS	274	230/285	6,200/10,800	12/12
	PMMI	GSFC	TBD	163	174	53	
CHEM SERIES							
CHEM	HIRDLS	OXFORD/NCAR	RAL/LORAL	169	169/230	50	12/02
	MLS	JPL	JPL	600	588	100	
	TES	JPL	JPL	300	300	3,240/19,500	
	ODUS	GSFC	NASDA	40	70	50	
CHEM 2A	AMLS	JPL	JPL	480	625	100	06/08
	SAGE III	LaRC	TBD	40	30/75	26/100	
CHEM 2B	ATES	JPL	JPL	300	300	3,240/19,500	12/08
	AHIRDLS	OXFORD/NCAR	RAD/LORAL	152	162/230	50	
RALT	MR	JPL	JPL	15	15	0.1	12/99
RALT-2	DFA	GSFC	CNES/ALCATEL	48	48	15	03/04
LALT	GLAS	GSFC	GSFC	300	300	200	07/02
LALT-2	GLAS	GSFC	GSFC	300	300	200	12/07
ACRIMSAT	ACRIM	JPL	JPL	15	25	1	06/98
SAVE	SOLSTICE	GSFC	NCAR	62	30	5/8	12/02
RUSSIAN 3M METEOR	SAGE III	LaRC	BASD	40	30/75	26/100	08/98
ISSA	SAGE III	LaRC	BASD	40	30/75	26/100	12/01
FOO	SAGE III	LaRC	BASD	40	30/75	26/100	12/05
	SOLSTICE	GSFC	NCAR	62	30	5/8	12/08
	CERES	LaRC	TRW	90 (2)	95 (2)	17 (2)	12/00
ADEOS	NSCAT	-	-	-	-	-	08/96
ADEOS-2	SeaWinds	JPL	JPL	270	290	5	02/99
TRMM	CERES	LaRC	TRW	85	81/138	17	08/97
	LIS	MSFC	MSFC	20	33	6	
LANDSAT-7	ETM+	GSFC	SBRC	418	600	150	09/98

* Algorithm activities only funded by EOS.

2.1.1 EOS AM Flight Project

First in the series of EOS flights, the AM project would develop and launch a succession of spacecraft designed to provide global science data from a low-altitude, Sun-synchronous orbit (Figure 2-2) on a long-term, sustained basis. Proposed investigations emphasize the study of cloud physics, atmospheric radiation properties, and terrestrial and oceanic surface characteristics.

Figure 2-2. EOS Sun-Synchronous Orbital Placement



Source: Adapted from [EOS 1995] and [PLAN 1995]

The AM project would consist of three spacecraft, designated AM-1, AM-2, and AM-3, scheduled for launch in 1998, 2004, and 2010, respectively. Instruments flown on AM science platforms would be designed to measure physical phenomena associated with clouds, aerosols, and radiative balance. The AM-1 is baselined to fly on an Atlas IIAS Intermediate Expendable Launch Vehicle (IELV) in June 1998 from the SLC-3E modified Atlas Launch Complex at the Air Force's Western Range (WR), which is located at Vandenberg Air Force Base. EOS AM-2 and AM-3 platforms would probably utilize Medium Expendable Launch Vehicles (MELVs). Each of the three AM spacecraft has a design lifetime of five years.

2.1.2 EOS PM Flight Project

The PM project would be the second EOS flight series to launch and, like EOS AM, is designed to provide global science data from a low-altitude, Sun-synchronous orbit on a long-term, sustained basis. Investigations proposed for this project would emphasize the study of atmospheric temperature and humidity profiles; cloud, precipitation, and radiative balance; terrestrial snow and sea ice properties; sea surface temperature and ocean productivity; soil moisture; and the improvement of numerical weather prediction.

This project would also consist of three spacecraft, PM-1, PM-2, and PM-3, each with a design lifetime of at least five years. The PM-1 spacecraft is baselined for launch in the year 2000 on a MELV-class launch vehicle from the SLC-2W site, which is located on the WR at VAFB. The EOS PM-2 and PM-3 platforms would launch on MELVs in the years 2006 and 2012, respectively.

2.1.3 EOS Chemistry (CHEM) and Special Flights (CSF) Projects

Third in the series, this project would focus on the acquisition of Earth science data specifically associated with atmospheric chemical species and transformations, aerosols, ocean circulation, biomass and productivity, ice sheet mass balance, atmospheric radiation properties, and lightning. The CHEM project would also develop and manage elements of the EOS FOO (See section 2.1.4). These investigations would include scientific instruments for which flights have not yet been assigned. [PLAN 1995]

The CHEM-1, CHEM-2, and CHEM-3 spacecraft are baselined for launch on MELV-class launch vehicles and have a design lifetime of five years each.

2.1.3.1 EOS Radar Altimetry (RALT) and Laser Altimetry (LALT) Spacecraft Series

The initial flights of the RALT and LALT series are baselined for launch on MLELVs in 1999 and 2003, respectively. Three spacecraft, RALT (or LALT) 1 through 3, would be flown in each series. The EOS Radar Altimetry spacecraft are designed to continue the measurements provided by the Topex/Poseidon mission.

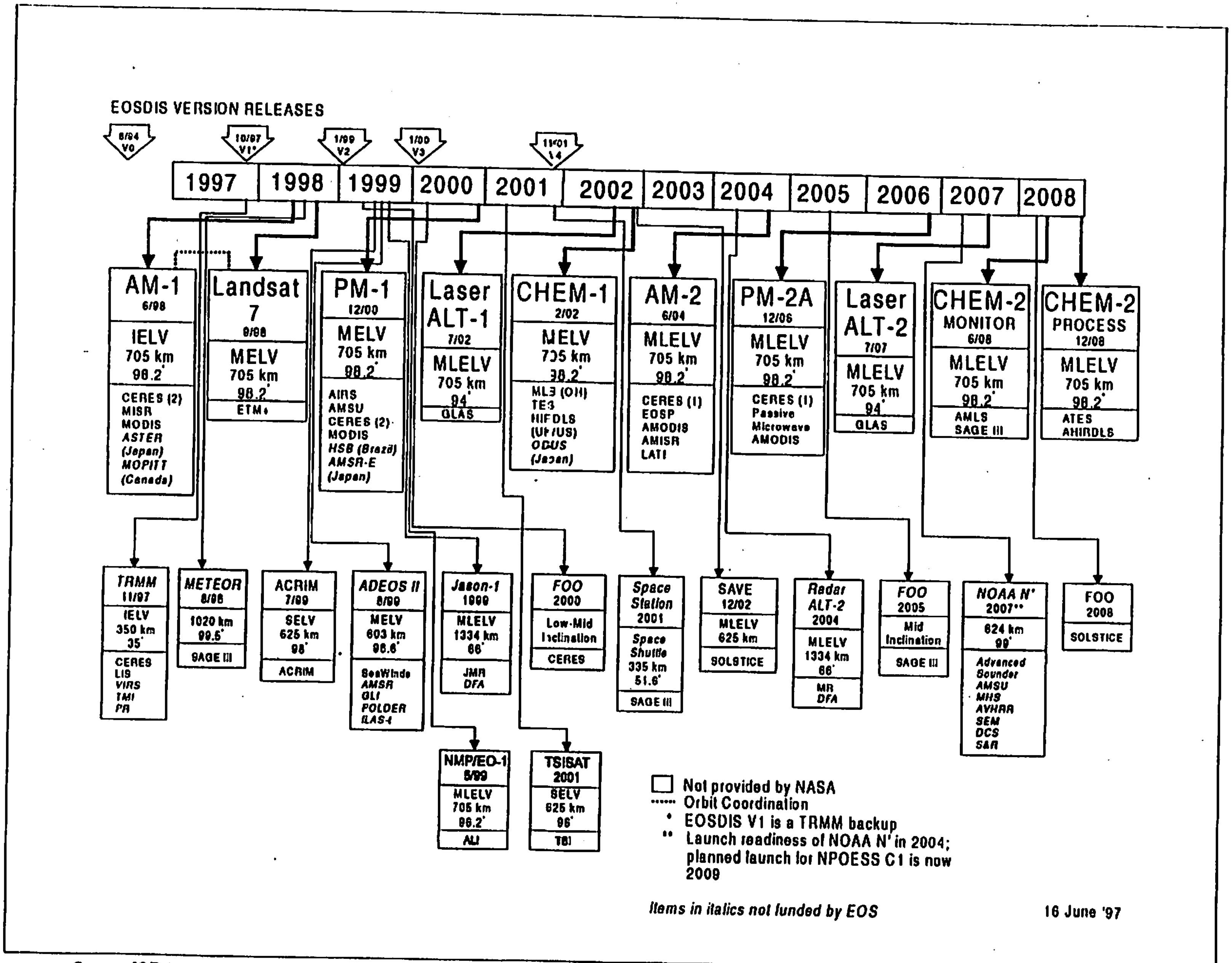
Specific investigations would include:

- Altimetry measurements focused on evaluating clouds, vegetation, and ocean circulation (EOS-RALT);
- Altimetry measurements focused on evaluating ice sheet mass (EOS-LALT).

2.1.4 Flights of Opportunity (FOO)

In addition to the projects described above, there would also be EOS-funded FOO instruments flown on other, to be determined, U.S. and international spacecraft. Selected FOOs, such as SeaWinds and SAGE III, are managed by the MTPE office, and include scientific instruments for which flights have not yet been assigned [PLAN 1995]. Other FOOs would be managed by the Implementing Center, which is under the programmatic oversight of the MTPE office. Although specific launch dates are not available, a general profile for this series is presented in Figure 2-3, Baseline EOS Program Profile.

Figure 2-3. Baseline EOS Program Profile



Source: [GR 1997]

2.2 EARTH OBSERVING SYSTEM DATA AND INFORMATION SYSTEM (EOSDIS)

An important part of the EOS Program is a ground-based network of data stations, known as Distributed Active Archive Centers (DAACs), located at sites across the United States (Figure 2-4). The EOSDIS is designed to process the data gathered by EOS spacecraft and instruments into scientifically useful products. Centers would also perform archival, information management, and distribution functions for all of NASA's Earth science data. As NASA's component of the interagency Global Change Data and Information System (GCDIS), this system would distribute Earth observation data to a broad user community.

Many EOSDIS locations have supported other programs and missions as data retrieval and archival facilities. While the EOS Program has attempted to utilize existing sites, it will be necessary to modify some of these facilities, or construct new ones, in order to handle the volumes of data anticipated. Proposed new facilities are discussed in the following subsections. Existing facilities which did not require major modifications are not covered in this EA, but for completeness are noted in Figure 2-4 and listed in Appendix B.

2.2.1 New Construction

New facilities required by the EOS Program are listed in Table 2-2 and will be discussed briefly in the following subsections. In-depth consideration of relevant new construction has been covered in separate documents and is referenced appropriately.

Table 2-2. EOSDIS Facility Requirements

Activity/Facility	Location	Required Modification & Duration (fiscal yrs)
Goddard Space Flight Center/ DAAC & ESSB	Greenbelt, MD	EOSDIS Facility (1994-2015)
Langley Research Center/DAAC	Hampton, VA	New two story building

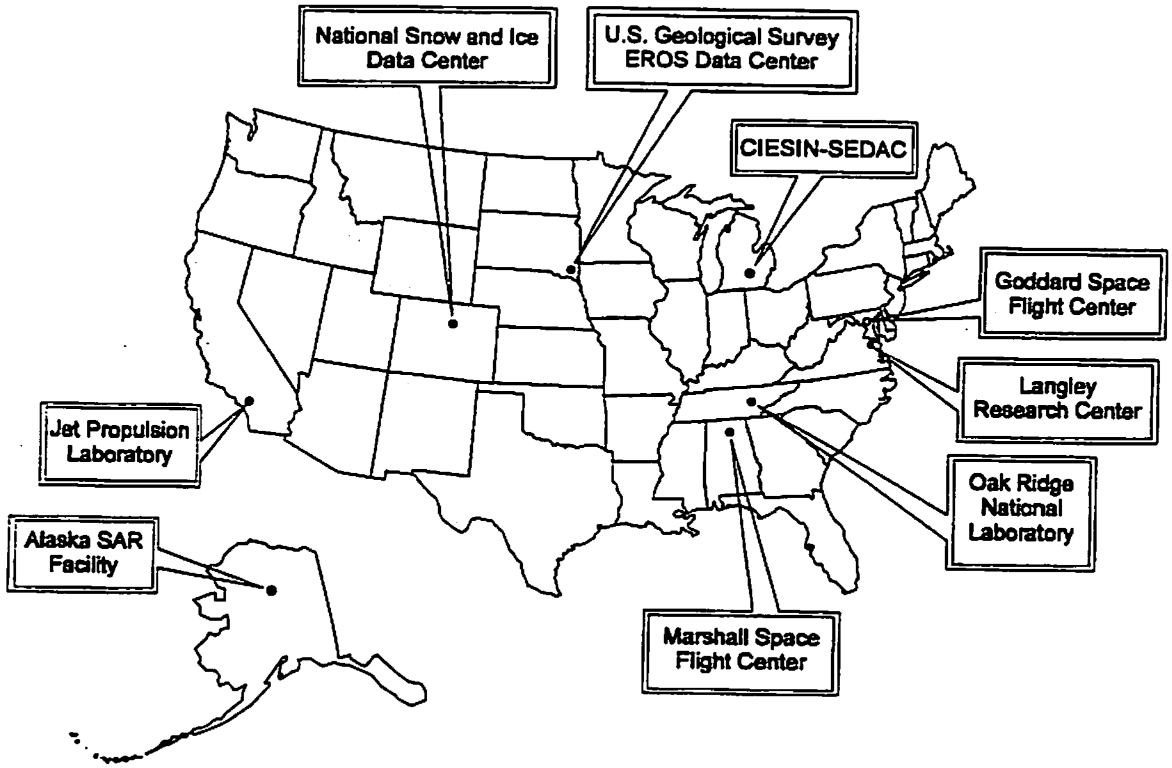
Source: [PLAN 1995]

2.2.1.1 Status of Environmental Documents

<u>EOSDIS Data Processing Facility GSFC/DAAC [EOSDIS 1991]</u>

Plans call for the construction of two buildings on a 42.5 hectare (105 acre) site situated within the Goddard Space Flight Center property. These facilities, the Earth Observation System Data and Information Storage Facility (EOSDIS) and the Earth System Science Building (ESSB), would consolidate the Earth System Science research program, creating a centralized environment for interdisciplinary scientific communication, collaboration, and efficiency in global change research. Construction for the EOSDIS building is complete and clearing has occurred for the ESSB building.

Figure 2-4. EOSDIS and DAAC Sites in the U.S.



As a result of the environmental analysis previously completed, no significant environmental impacts, adverse or beneficial, are anticipated as a result of EOSDIS and ESSB construction. The Environmental Assessment for EOSDIS and ESSB at Goddard Space Flight Center is complete and a Finding of No Significant Impact (FONSI) has been made and issued on August 15, 1991 [FONSIb 1991].

LaRC/DAAC [EOSDIS 1993]

A new two-story building for the Distributed Active Archive Center (DAAC) at the Langley Research Center (LaRC) in southeastern Virginia has been proposed to assist in archival of EOS data. The proposed DAAC facility will be located in the existing parking lot of the Langley Central Scientific Computing Complex. Based on the evaluations presented in the EA, the potential environmental impacts associated with the proposed construction and operation of a new DAAC building at LaRC, new/expanded parking lots, new sidewalk, and the widening of Langley Boulevard at LaRC, do not appear to individually or cumulatively have a significant effect on the quality of the environment. A Finding of No Significant Impact (FONSI) was issued on December 13, 1993 [FONSIb 1993].

2.2.2 Modification of Existing Facilities

Modifications to several existing DAAC facilities would be required for EOS data processing. The Earth Science Data and Information System Project Office (Building 16W), the EOS Data and Operations System Data Interface Facility and Building 28, all of which are at White Sands and the National Snow and Ice Data Center at the University of Colorado would all require minor modifications. The NEPA review process for these modifications will be covered in separate documents.

2.3 PAYLOAD PROCESSING AND GROUND OPERATIONS

2.3.1 Payload Processing Facility (PPF) Alternatives Considered

Four VAFB alternatives have been considered for providing payload processing support to the proposed EOS Program: (1) modification of Building 1610, (2) modification of the SLC-6 Integrated Processing Facility (IPF), (3) modification of the Hypergolic Maintenance and Checkout Facility (HMCF), and (4) use of the existing Astrotech commercial PPF. Although the alternatives described and summarized in this section discuss assessments for construction and or modification of specific buildings on VAFB, it is important to note that construction activity was already planned for Astrotech, HMCF, Building 1610 and SLC-6 IPF for potential non-EOS customers. No impacts of concern were encountered during the environmental assessment process for Building 1610, SLC-6 IPF, the Astrotech facility [PPF 1993], or the HMCF [HMCFa 1989].

2.3.1.1 Proposed Alternative: Astrotech PPF

Located at the deactivated magazine storage bunkers (all bunkers removed) adjacent to Tangair Road on North Vandenberg, the Astrotech facility consists of two processing buildings, an administrative office building, and an equipment storage building. Construction was completed in February of 1996, which enabled monopropellant fueling [CA 1996]. Should bipropellant fueling be required at a later date, Astrotech will obtain the necessary permits or exemptions from the Santa Barbara County Air Pollution Control District (SBAPCD), if necessary. Potential impacts for bipropellant fueling at this site are addressed in [ASTROTECH 1993].

The design and operation of the PPF is modeled after the Astrotech PPF in Titusville, Florida, which is located adjacent to Kennedy Space Center (KSC) and Cape Canaveral Air Station (CCAS). Since Astrotech began operation of the Titusville PPF in 1985, 58 payloads have been processed and delivered to their respective launch pads (or the Shuttle integration facility) without a single emergency or mishap. There have also been no appreciable spills at the Titusville PPF recorded during this period.

Air emissions at the Astrotech (VAFB) site will be minimized through use of closed loop propellant transfer operations. Propellant transfer operations will be analyzed on a case by case basis to insure emissions are well below de minimis levels. This procedure has been coordinated and approved by the Air Force's 30 SW Environmental Office and, as a result, a Santa Barbara County Permit to Operate is not required.

Using Astrotech facilities would position the EOS Program under the umbrella of Astrotech permits. The facility is capable of handling EOS payloads, and will require no new construction or modification of existing facilities.

2.3.1.2 Modification of Building 1610 (NASA Hazardous Propellant Processing Facility)

Building 1610 is located adjacent to Tangair Road, 3.2 kilometers (about 2 miles) east of SLC-2. The structure contains a spacecraft processing area (high-bay) with two 5.1 metric ton (5 ton) capacity trolleys and hoists on a single bridge. Building 1610 is currently inadequate to meet the processing requirement for EOS. A proposal to expand the building by the addition of a processing and combined encapsulation area and airlock is under consideration. [PPF 1993]

Approximately 1.2 hectares (3 acres) would be disturbed during construction of the PPF at Building 1610 [PPF 1993]. Construction activities have the potential to cause air pollution impacts due to combustion emissions from construction vehicles and dust from activities associated with land disturbance and grading operations. Modifications are also expected to be costly.

In July 1993, an Environmental Assessment (EA) was prepared for the modification of Building 1610 to accommodate EOS payload processing requirements. Although the environmental impacts were considered insignificant in the EA, no FONSI has been published. A site-specific NEPA process will be completed for payload processing before a site is selected.

2.3.1.3 Modification of the SLC-6 Integrated Processing Facility (IPF) [PPF 1993]

SLC-6 is located on South Vandenberg, near Point Arguello. The IPF, formerly known as the Payload Preparation Room (PPR), at SLC-6 was constructed to support the processing of Space Transportation System payloads. Construction was completed in 1985, but the facility has never been used for its intended purpose. Since the cancellation of the west coast STS Program, the facility has been used to process the Air Force STEP-0 payload launched in 1994, and the commercial GEMStar payload launched on the first Lockheed Launch Vehicle in August, 1995.

Only minor modifications are anticipated in the existing airlock and high bay to support the EOS Program. Some modifications would be made to cell three in order to accommodate EOS requirements and a new overhead bridge crane would be installed in the transfer tower to allow an encapsulated payload to be removed from the facility through the existing Transfer Tower doors. The IPF is currently operated by Spaceport Systems International on a commercial basis, and is included in a long term commercial lease with the Western Commercial Space Center (WCSC) the parent organization of Spaceport Systems International (SSI).

Based on an estimate of six months for completion of modifications to the SLC-6 IPF, and assuming five trips per day by construction-related vehicles, a total of 600 trips will take place during modification of the facility. Site-specific permits (construction and operation of air scrubbers) will be required from the Santa Barbara County Air Pollution Control District (SBCAPCD). The EA for the California Commercial Spaceport resulted in issuance of a FONSI on March 1, 1995 [FONSI 1995].

2.3.1.4 Modification of the Hypergolic Maintenance and Checkout Facility

The Air Force Hypergolic Maintenance and Checkout Facility (HMCF) is located in North Vandenberg on the Burton Mesa and consists of two separate buildings, the high-bay facility (Bldg. 2520) and the control facility (Bldg. 2500). Construction activities would involve internal and external modifications to both buildings, paving or resurfacing of about 0.8 hectares (about 2 acres), removal of vegetation from about 0.2 hectares (about 0.6 acres), a 325 square meter (3,500 square foot) addition to the high-bay facility, and improvements to systems for electrical service, heating, ventilation, and security. Construction would last about 10-12 months. [HMCFa 1989]

The only new permits that will be required for modifications to, and operations of, the HMCF will be air quality permits from the SBCAPCD. Hazardous wastes generated at the site will eventually be transferred to VAFB's Hazardous Waste Storage Facility, which was permitted under a State Hazardous Waste Facility Permit issued in November 1986. The high-bay facility (Bldg. 2520) and the control facility (Bldg. 2500) are equipped with three boilers for space heating and hot water. Permits for these boilers were issued as part of the Space Shuttle Transportation System and would be renewed. [HMCFa 1989]

The environmental assessment for the modification of the HMCF resulted in a Finding of No Significant Impact issued on January 23, 1989 [FONSI 1989]. An Air Force review of the necessary modifications to this facility to accommodate future use are pending policy determinations. It is not clear at this time if the review process will accommodate EOS Program timelines and budgetary constraints [SE 1995].

2.3.2 Ground Handling of Payloads

Ground operations are anticipated to be similar for all EOS payloads. The following discussion, based on EOS AM-1, presents a conservative (*i.e.*, largest) estimate of support requirements and activities.

2.3.2.1 Generic Payload Description [PPF 1993]

Although specific payloads are currently being developed, a "typical" payload has been assumed for the purposes of the EOS EA. The average mass for a typical payload is estimated to be approximately 6,272 kilograms (13,800 pounds) fully fueled, with a maximum of 454.5 kilograms (1,000 pounds) of hydrazine propellant. Instruments aboard the spacecraft may contain up to 0.2 grams (2.18×10^{-8} Curies) of radioactive thorium fluoride (ThF_4) used as a lens coating. The EOS AM-1 spacecraft would carry two such instruments. The spacecraft will also come loaded with 0.91 kilograms (2 pounds) of ammonia and be provided with a built-in leak detector. Payloads will measure 7.16 meters (23.5 feet) long and 3.66 meters (12 feet) in diameter.

Monopropellant fueled satellites will utilize hydrazine in a single fuel tank with a capacity of 454.5 kilograms (1,000 pounds), as described above. Bipropellant fueled satellites will utilize dual fuel tanks with capacities of up to 454.5 kilograms (1,000 pounds) each of hydrazine[3] and nitrogen tetroxide as an oxidizer. EOS fuel tanks will be of a bladder blowdown design, operating at a pressure of 2.1 megapascals (300 pounds per square inch).

2.3.3 Spacecraft Processing

The EOS AM-1 spacecraft is planned using monopropellant hydrazine, however bipropellant processing is discussed in this section to present a conservative (protective of resources) case.

Bipropellant processing operations at the selected PPF will include the loading of up to 454.5 kilograms (1,000 pounds) each of hydrazine (fuel) and nitrogen tetroxide (oxidizer), which is expected to last between 8 and 12 hours per satellite. Air emissions from the loading process will be controlled by means of scrubbers or closed loop transfer operations. [PPF 1993]

[3] Hydrazine can be utilized as a monopropellant, or as a fuel (to combine with an oxidizer) in bipropellant spacecraft.

Four truck trips, the first two for fuel and the second two for oxidizer, would also be associated with each bipropellant EOS payload. These trips would occur in the evening hours and would not impact peak-hour volume. Tangair Road is critical, being the ingress/egress point for Buildings 2520 and 1610 and all employees at the Astrotech PPF. For EOS AM-1, in 1998, the peak hour volume would increase by 16 trips per hour, which is considered negligible for the capacity of Tangair Road. If an EOS payload and a commercial payload were processed at the same time, the peak hour volume would increase by 26 trips per hour, which is also considered negligible in comparison to the road's capacity. Furthermore, the *payload* would travel between midnight and dawn at 8 kilometers per hour (5 miles per hour), which would decrease the concern for level-of-service degradation. [PPF 1993]

2.3.3.1 Personnel

Using operations at Astrotech's Titusville PPF as a guide, it is anticipated that the Vandenberg PPF would require roughly 10 individuals at the core site, an average of about 40 individuals per EOS satellite processing facility (50 for EOS AM-1) for about four months, and 25 individuals per commercial satellite processing facility. Assuming all employees drive separate vehicles, around 20 additional vehicle trips would be generated during operation of the facility. This amount represents approximately one percent of all traffic using the Pine Canyon Gate on a daily basis, which is not considered substantial [PPF 1993]. During EOS satellite processing, there would be a maximum of 80 to 100 vehicle trips, representing a four to five percent increase on a daily basis for a duration of approximately four months.

2.3.4 Transportation and Handling of Spacecraft [PLAN 1995]

Shipment of EOS spacecraft will require an environmentally controlled shipping container, a special lowboy trailer, and a C-5A aircraft. The spacecraft will be installed in the shipping container and lowboy trailer and moved via a planned highway route (selected for freedom from obstructions) from the spacecraft assembly facility (the Lockheed/Martin Facility for AM-1) to an Air force Base, where the spacecraft would be loaded onto a C-5A aircraft. The spacecraft would then be flown to VAFB and unloaded onto the same type of trailer for transport to the launch preparation facilities. Similar arrangements would be established for subsequent EOS spacecraft.

Transportation of EOS spacecraft from the VAFB airfield to PPFs and subsequent transport of spacecraft to SLCs will involve the use of cranes, trucks, small generators, and support vehicles.

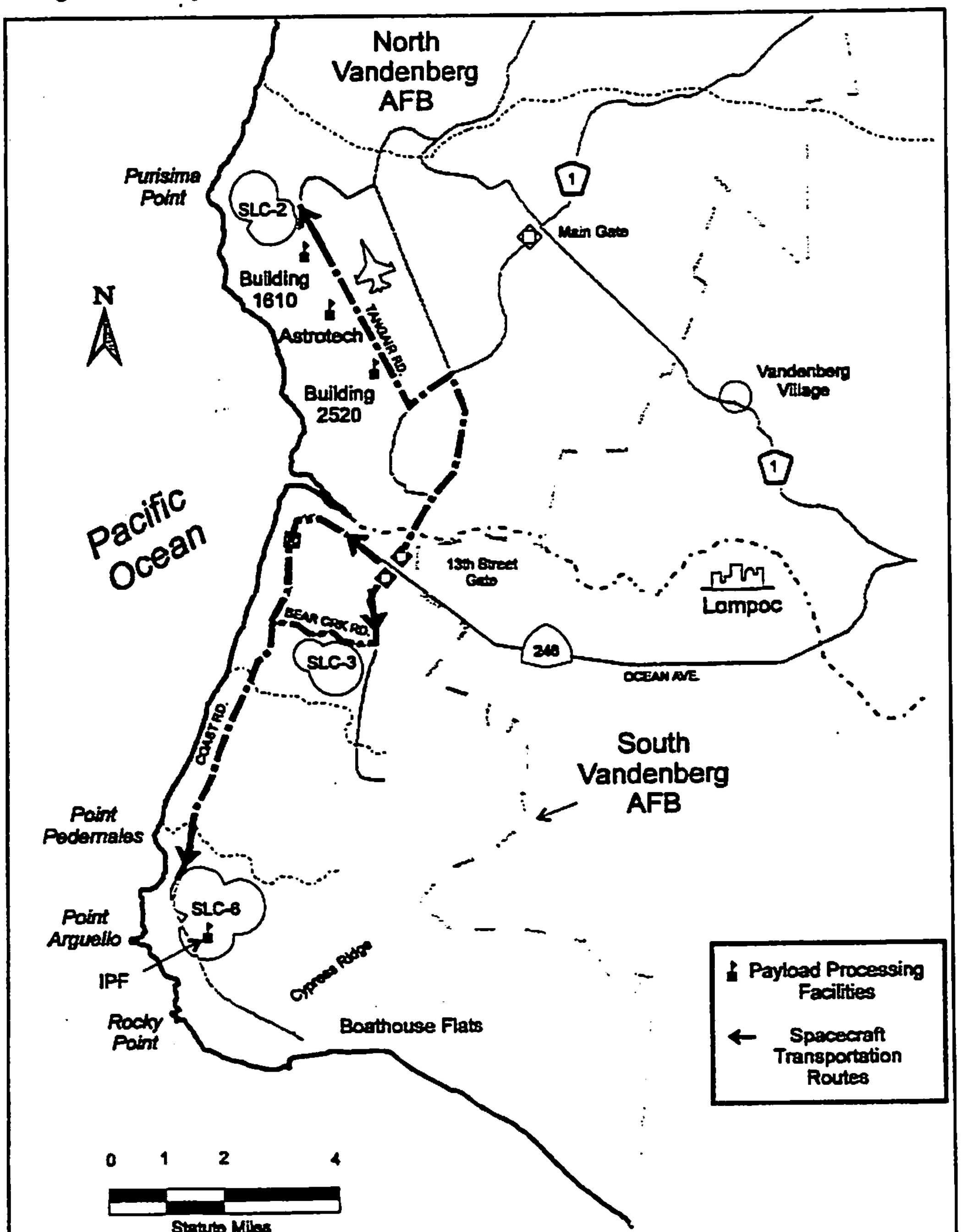
Transportation of fueled spacecraft will comply with the Joint Policy Statement by the Eastern and Western Ranges for Ground Transportation of Hazardous Materials and Pressurized Vessels Used on Missiles and Space Vehicles, dated March 12, 1990. This policy statement requires that the transport take place during off-duty hours, and all personnel be cleared a minimum of 381 meters (1,250 feet) from the transport convoy route or instructed to enter and remain inside a building for the duration of the transport. [PPF 1993] The transportation of fueled spacecraft on segments of public road requires Department of Transportation and/or California permits. However, current operating agreements between VAFB and the State of California negate any requirement to obtain permits for crossing State Highway 246 while transporting fueled spacecraft from north VAFB to launch sites on south VAFB.

Transportation routes from PPFs to SLCs will be similar for all alternative PPFs except for the SLC-6 IPF, which due to its proximity to SLC-6 and CSLC launch pads will not require transport beyond Coast Road. EOS spacecraft utilizing SLC-2 would be transported via Tangair (26th Street) and Aero Roads. EOS payloads for SLC-3 would travel on Tangair Road to the tow route, turn onto Bear Creek Road at the west end of Bear Creek, and then east to the SLC-3 entrance. SLC-6 would be accessed by taking Tangair Road to the tow route, turning onto Ocean Avenue, then traveling south along Coast Road to SLC-6. These routes

(Figure 2-5) are designed for Space Shuttle payload clearances and safety precautions and therefore exceed EOS requirements.

After the spacecraft is transported to the launch complex, the encapsulated payload would be positioned for hoisting onto the launch vehicle. This operation is controlled by established written procedures (USAF Joint Eastern/Western Space and Missile Center Policy for Ground Transportation/Handling of Hazardous Materials and Pressurized Vessels Used on Missiles and Space Vehicles). [PPF 1993]

Figure 2-5. Payload Processing Facilities and Spacecraft Transportation Routes



Source: Adapted from [SLC6a 1995]

2.3.5 PPF Environmental Management

General

As "small quantity generators" of hazardous waste, payload processing facilities must prepare and retain a written contingency plan and emergency procedures for dealing with emergencies (Article 20, Title 22, CCR). Each action plan elucidates required coordination with officials, applicable regulations and specific actions to be taken during an *emergency*. The site emergency coordinator is responsible for documenting any spill, calculating emissions including all actions taken and results, and corrective actions. This report shall be sent to 730 CES within one week of the spill incident and will be kept as part of the permanent site record. [SPILL 1995] It is expected that all PPFs at VAFB will have similar emergency response and environmental management plans.

Hazardous materials present at the PPFs include small quantities of isopropyl alcohol, spray paint and general purpose cleaner, as described in the Astrotech Spill Contingency Plan [SPILL 1995]. The hazardous materials housed at Astrotech and CCS are assumed to be exemplary of materials at all PPFs proposed for the EOS Program.

Recyclable solid waste produced by the EOS Program will be reused, or recycled through the base recycling plan, or processed through the Defense Reutilization and Marketing Office (DRMO) to meet Air Force solid waste reduction goals in accordance with Executive Order 12856.

2.3.5.1 Site Spill Contingency (Astrotech)

The Payload Processing Facility is used for all payload preparation operations, including liquid propellant transfer, solid rocket motor and ordnance installations, spacecraft/upper stage mating, and for certain expendable launch vehicles, payload fairing encapsulation. Hazardous operations are performed on a processing island surrounded by an emergency spill accumulation/containment system. In the event of a spill, the fuel will be contained in the containment trough until it is removed using contingency clean up operations. [ASTROTECH 1995]

The site emergency coordinator is responsible for documenting any spill, calculating emissions including all actions taken and results, and corrective actions. After the emergency response is complete, the emergency coordinator will ensure the spill materials are properly cleaned up, wastes disposed of in accordance with 30 SPW OPLAN 8550S-92 and site emergency response materials consumed during the emergency response are immediately replaced and serviceable. [SPILL 1995]

2.3.5.2 Site Spill Contingency (CCS)

SSI has secured the propellant team at Lockheed Martin Technical Operations Corporation to receive and store high purity hydrazine at the Hazardous Storage Facility (HSF) on VAFB. All hydrazine handling activities have oversight being performed throughout the operations by the subcontractor's control center and in-house management. In addition, the subcontractor coordinates with the Base Command Post and VAFB Operations, Safety, Environmental, Fire and Medical offices to coordinate base-wide notification of critical events and to assure comprehensive compliance to all applicable safety and environmental requirements concerning propellant operations. [REa 1995]

Throughout the fueling operations and until the point of payload departure from the IPF, a subcontractor provided Emergency Response Team (ERT) is on stand-by in the event of an inadvertent spill in the IPF. For propellant loading operations, secondary containment significantly reduces the potential impact of a spill. The 4 feet x 4 feet x 10 feet catch basin is made of materials that are compatible with all materials involved in the propellant operation and sized to safely contain the identified maximum spill quantity of hydrazine, plus a stabilizing 75 gallons of water. Specific spill operations, including emergency response, spill clean-up, and facility decontamination are outlined in SSI documents. [REa 1995]

2.3.5.3 Hazardous Waste Management

Wastes generated during nominal fueling operations includes: 1) unused propellant in the container used at the IPF/PPF, 2) decontamination water collected in the emergency shower basin during doffing wash-down, and 3) rinsate water used to clean the propellant loading cart and interconnection equipment. These wastes are containerized, then characterized by the propellant subcontractor. The containers are then routed from the HSF to the VAFB Consolidation and Accumulation Point (CAP) within 60 days to assure compliance with 90-day maximum storage requirements. It is acceptable for government-generated waste to be processed through the Defense Reutilization and Marketing Office (DRMO) system under the Air Force EPA Generator Number. [REa 1995]

Hazardous materials are controlled in accordance with federal, state, local and base regulations, and are allocated to the person responsible for the scheduled activities on a one-day supply basis. SSI assumes responsibility for compliance with environmental laws concerning hazardous materials control and requires strict adherence to environmental procedures as defined in the Environmental Management and Compliance program. Any required permits and approvals are secured by SSI on behalf of the customer and retained in archive storage as mandated by law [REa 1995].

For loading operations performed in the IPF, the propellant subcontractor provides an R-17 propellant trailer to capture vent emissions during payload propellant loading operations. The vent trailer is properly permitted for this portable use by the subcontractor and no special permitting or reporting requirements are imposed on the customer or SSI [REa 1995].

All of the equipment that was exposed to propellant liquid or vapors, or contaminated water is cleaned at the HSF by the subcontractor. At the HSF, the R-17 propellant trailer is vented through the facility scrubber. This venting operation fits within the scope of the HSF scrubber permit and does not require any specialized permit applications or modifications [REa 1995].

2.3.5.4 Customer Services

2.3.5.4.1 Material Handling (Astrotech)

According to the terms of the standard agreement between Astrotech and the customer, a Payload Processing Requirements Document (PPRD) will be prepared by the PPF user. The purpose of the PPRD is to outline all planned payload processing activities, and describe in detail all payload processing requirements to be supplied by Astrotech, including facilities, equipment, materials, and services.

Astrotech will provide transportation for spacecraft and Ground Support Equipment (GSE) if requested. Standard loading and unloading equipment, such as forklifts, mobile cranes, and aircraft loaders will normally be provided by Astrotech.

Upon arrival at Astrotech, the payload and its ground support equipment will be moved to the highbay by personnel under the supervision of the payload contractor. Payload contractor personnel will normally be responsible for all uncrating, receiving inspection, and installation of all test equipment and flight hardware. Once completed, the payload contractor will typically begin final assembly and test operations, as appropriate, including system level tests, propellant tank pressure demonstration, and ordnance installation. Payload fueling operations may be performed by the user or Astrotech personnel. Astrotech offers an option of procuring, handling and performing; all fueling operations.

2.3.5.4.2 Material Handling (CCS)

In response to a schedule prepared by SSI and the customer during early planning sessions, SSI prepares the facility, stages transportation equipment, tailors procedures, and prepares daily work schedules to support the various arrival dates. SSI informs Range Scheduling, Base Safety, Environmental and Operations personnel, Security Police, and the Command Post of the satellite arrival and support requirements. The roadway is inspected and any noted deficiencies identified to the customer prior to satellite loading for transportation. [REa 1995]

SSI provides assistance in unpacking, transporting, positioning, and cleaning all GSE. All material handling equipment is certified to meet design and performance requirements defined in EWR 127-1. [REa 1995]

The entire transport is monitored and managed by the SSI Move Director who coordinates over the cellular phone to ensure prompt clearances through Air Force security control points. All actions during the transport are the responsibility of the Move Director and any real-time decisions will be dictated by precoordinated procedure or discussed with customer representative prior to implementation, if circumstances allow.

Post-launch packaging and shipment handling assistance is provided by SSI, as requested by the customer. Packing and transportation will be provided during the normal process flow for GSE and support hardware. SSI personnel will crate, band, label, inventory, load, and deliver to a designated hauler all support equipment associated with the satellite launch activity.

2.3.5.5 Commodities/Supplies

<u>CCS</u>

All consumable material needs are defined by CCS customers on the Customer Requirements Checklist. This checklist identifies commodities supplied from SSI standard inventory, or commodities requested for issue to the customer. SSI provides common processing materials, first aid, and administrative supplies as part of the contracted services.

The supplies required to support processing of the identified payloads are as follows: spill prevention kits and materials including tube, mat and pellet absorbents; labels and signs; ear and eye protection; tapes; cotton and poly-blend wipes; gloves; and office materials. These supplies are procured, stored and provided by SSI. [REa 1995]

<u>Astrotech</u>

It is assumed that Astrotech will provide common processing materials, first aid, and administrative supplies as part of the contracted services. Astrotech can provide a wide range of personnel safety equipment, such as static dissipating devices, emergency eyewash, showers, and portable self contained breathing devices.

2.3.6 Environmental Approvals

<u>CCS</u>

Currently no EOS-specific processing or launch activities have been identified that would require permits beyond the baseline permits already necessary for Spaceport operations. Water usage for EOS payload processing fits within the current scope of the Spaceport water discharge permit definitions, and a pinniped harassment permit is being developed to accommodate impacts for vehicles with EOS launch capabilities.

<u>SLC-2</u>

Currently no EOS-specific processing or launch activities have been identified that would require permits beyond the baseline permits already necessary for SLC-2 operations.

2.4 LAUNCH VEHICLES

Launch vehicle selection for EOS missions is driven by spacecraft size and weight and desired orbital placement — characteristics which may differ significantly between the EOS flight series. Although specific launch vehicles are not yet designated for any project except AM-1, several are available and under consideration, including Delta II 7925, Atlas IIAS, Delta II 7326, Taurus, Pegasus and Pegasus XL. A new vehicle, the Delta-Lite, is under development. Early EOS launches (from 1998 through 2002) would utilize one of the existing launch vehicles; later missions would have the option of flying on the Delta-Lite. For ease of reference, proposed U.S. launch vehicles and their payload capabilities are listed in Table 2-3.

Table 2-3. Proposed Launch Vehicle Payload Capability

Launch System	Payload Capability
Atlas IIAS	5000 kg
Delta II-7925	3184 kg
Delta-Lite	Bound by Delta II 7925 and Taurus launch vehicles.
Taurus	800 kg
Pegasus	365 kg

Source: Data acquired from [ELVa 1991], [ELVb 1993], [ESA 1989], and [NASDA 1990] Maximum Payloads try to approximate the 705 kilometers (438 miles) 98.2 i EOS orbit requirement and assume a west coast launch. Values are approximate and conservative (*i.e.*, smaller).

For the purposes of this EA, the Delta II 7925 launch vehicle has been selected to represent an environmental case which is likely to bound the anticipated environmental impacts from launch activities. Anticipated environmental impacts from the launching of all other proposed U.S. launch vehicles are expected to be equal to or less than Delta II 7925 impacts. Emissions data, performance data, and propellant information is readily available for the Delta II. Preliminary information for the Delta-Lite launch vehicle indicates that it may use slightly larger quantities of solid propellants (about 10 percent more) than the Delta II; however, analyses associated with its emissions, performance, and design are not available. The Delta II 7925 will therefore serve as the basis for analysis of environmental impacts.

Potential alternative launch vehicles (illustrated in Figure 2-6) including Pegasus, MLELVs (*i.e.*, Delta-Lite), Delta II 7925, Atlas IIAS, and foreign launch vehicles are described briefly in the following subsections. Environmental Assessments (EAs) and Findings Of No Significant Impacts (FONSIs) have been published for all U.S. launch vehicles proposed for use by EOS, except for the Delta-Lite. The Delta-Lite contractor is expected to publish an environmental analysis, which will be reviewed and compared to the assumptions made in this EA when it becomes available to ensure that the scope of the EA has encompassed all potential launch vehicle environmental impacts. Individual launch vehicle impacts to air from normal launches and launch failures are described in Appendix C.

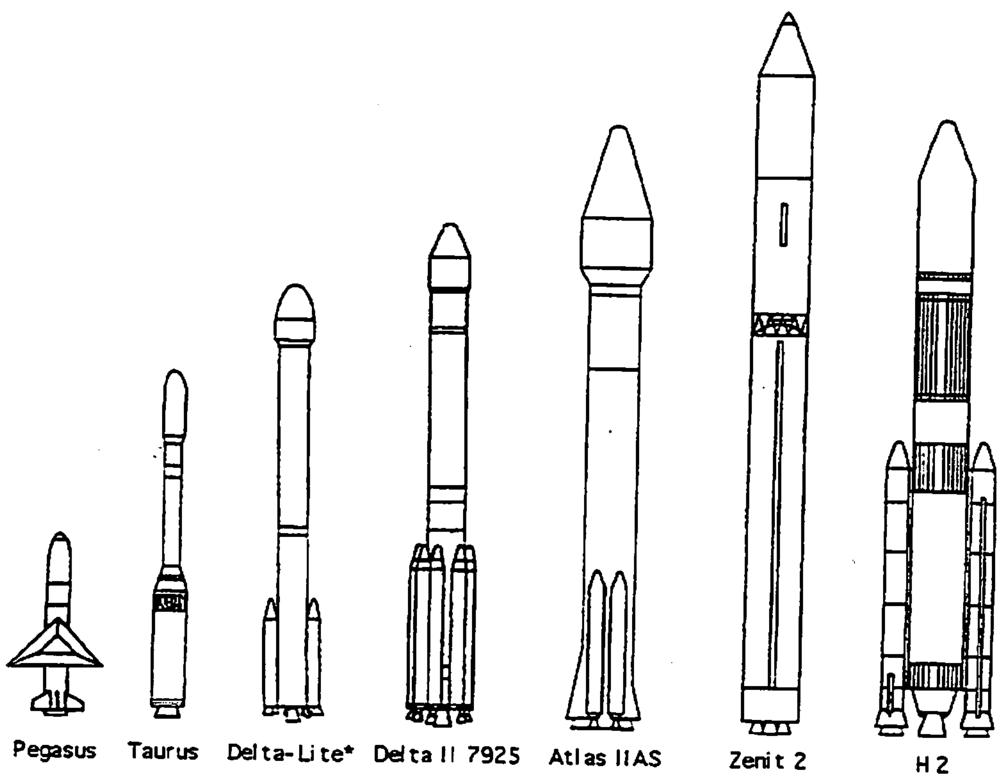
2.4.1 Delta II 7925 (MELV) and Delta 7326 (MLELV) Descriptions [DELTA 1994]

Each member of the Delta II family is identical in core vehicle height, configuration, and diameter. The core vehicle configuration includes:

- First stage: Liquid oxygen-kerosene main engine (RS-27A) and two vernier engines
- Second stage: Aerozine-50 and nitrogen tetroxide engine

The PM and CHEM series of spacecraft are proposed for launch on Delta II 7925s from SLC-2W at VAFB. This launch vehicle has a 96 percent success rate [ELVa 1991]. The Delta II 7925 consists of a payload fairing (PLF), first and second stage propulsion systems with nine graphite epoxy motors (GEMs) used as strap-on boosters to the first stage, and a Payload Assist Module-Delta (PAM-D) upper stage, which utilizes the Star 48B solid propellant motor.

Figure 2-6. Potential EOS Launch Vehicles



* Artist's rendering

The first stage of the Delta II is powered by a liquid bipropellant main engine and two vernier engines. The propellant load consists of 96,243 kilograms (211,735 pounds) of RP-1 fuel (thermally stable kerosene) and liquid oxygen (LOX) as an oxidizer. Thrust is augmented by nine GEMs, each fueled with 11,870 kilograms (26,114 pounds) of Hydroxyl-

Terminated Polybutadiene (HTPB) solid propellant (Table 2-4). The main engine, vernier engines, and six of the GEMs are ignited at liftoff; the remaining three GEMs are ignited in flight. The GEMs are jettisoned after burnout of the solid propellant.

Table 2-4. Delta II 7925 Propellant Quantities

Stage/Motor Type	Propellant Type	Propellant Quantity
Stage 0 (9 SRMs)	Solid (HTPB)	106,607 kg 235,026 lbs
Stage 1 (RS-27)	Liquid Oxygen Kerosene (RP-1)	66,842 kg 147,360 lbs 29,773 kg 65,639 lbs
Stage 2 (AJ10-118)	Aerozine-50 Nitrogen Tetroxide	2,064 kg 4,552 lbs 3,922 kg 8,648 lbs
Stage 3-PAM-D (Star-48B)	Solid (HTPB)	2,010 kg 4,422 lbs

Source: Adapted from [DELTA 1994]

The Delta II second stage propulsion system has a bipropellant engine that uses Aerozine-50 as fuel and nitrogen tetroxide as oxidizer. The second stage has a total propellant load of 6,019 kilograms (13,242 pounds).

The Delta Payload Assist Module (PAM-D) is the third stage of the launch vehicle and provides the final boost required to insert the spacecraft into the required orbit. This upper stage consists of: (1) a spin table to support, rotate, and stabilize the spacecraft before separating from the second stage; (2) a Star 48B solid rocket motor for propulsion; (3) an active Nutation Control System (NCS) to provide stability after spin-up of the spacecraft/PAM-D stack; and (4) a payload attach fitting to mount the Star 48B motor to the spacecraft. The Star 48B is fueled with 2,010 kilograms (4,422 pounds) of solid HTPB propellant.

Delta II 7326

The Delta II 7326 uses a smaller stage three motor (Star 37 FM) and only three of the GEM Strap-on Solid Rocket Motors (SSRM) compared to nine used on the Delta II 7925. Therefore, for the purposes of this EA, potential impacts associated with the Delta II 7326 will be considered encompassed by the Delta II 7925 discussion.

2.4.2 Atlas IIAS (IELV) Description [ATLAS 1991]

The Atlas IIAS is slated for launch of the AM-1 spacecraft from SLC-3E at VAFB in 1998. The Atlas is manufactured and assembled by Lockheed/Martin Aeronautics in Denver, Colorado and has a success rate of 86.9 percent (213/245) [ELVa 1991]. Each member of the Atlas II family is identical in core vehicle height, configuration, and diameter, including:

- Booster section: Two Rocketdyne liquid oxygen/kerosene booster engines
- Sustainer section: One Rocketdyne liquid oxygen/kerosene sustainer engine, one kerosene tank, and one liquid oxygen tank
- Upper stage: One Centaur module containing two Pratt & Whitney liquid oxygen/ liquid hydrogen engines, one liquid hydrogen tank, and one liquid oxygen tank.

The booster section of the Atlas IIAS consists of two Rocketdyne liquid oxygen/kerosene booster engines. These booster engines feed from the sustainer section propellant tanks, fire for approximately 166 seconds and are jettisoned approximately 169 seconds after liftoff. The sustainer section engine continues to fire until its propellant is depleted -- approximately 292 seconds after liftoff. This particular booster/sustainer combination is sometimes referred to as the "one and one-half Atlas booster."

The sustainer section fuel tank contains about 48,988 kilograms (108,000 pounds) of kerosene (RP-1); the sustainer section oxidizer tank contains approximately 106,595 kilograms (235,000 pounds) of liquid oxygen. The Centaur module fuel and oxidizer tanks contain approximately 2,676 kilograms (5,900 pounds) of liquid hydrogen and 14,220 kilograms (31,350 pounds) of liquid oxygen. The core vehicle also contains a small amount (less than 170 kilograms (375 pounds)) of hydrazine, which is used in small roll-control and reaction-control engines.

The Atlas IIAS consists of the Atlas IIA launch vehicle with four Thiokol Castor IVA™ solid rocket motors (SRMs) attached near the base of the vehicle. One pair of SRMs is ignited one-quarter second before liftoff. The first pair burns out roughly 54 seconds after liftoff, but jettison is delayed approximately 51 seconds following burnout to avoid impact of the spent SRM casings in the Santa Barbara Channel or on the northern Channel Islands. The second pair of SRMs is ignited approximately 65 seconds after liftoff, burns out in approximately 54 seconds, and is jettisoned about four seconds after burnout.

Atlas IIAS Heavy Payload Vehicle [PLAN 1995]

The standard Atlas IIAS vehicle would be modified to accommodate the AM-1 spacecraft, which is a heavier and larger payload than can be flown by the standard Atlas IIAS [PLAN 1995]. Significant modifications to be made to the Atlas IIAS are:

- Increase length of fairing by ~ 1 meter (3 feet)
- Design and build new spacecraft/ELV adapter and Separation System
- Strengthen the Centaur Equipment Module

The Atlas IIAS Heavy Payload Vehicle would launch the EOS AM-1 spacecraft from a modified Atlas Launch Complex, SLC-3E, at the Air Force's Western Test Range in California.

2.4.3 Medium-Lite Expendable Launch Vehicle Description (MLELV)

The Medium-Lite Expendable Launch Vehicles, which the RALT and LALT flight series could potentially use, would probably launch from the California Commercial Spaceport. Med-Lite refers to a launch system series that includes three vehicles: the Delta II 7326 (see Delta II 7925 description above), Delta-Lite, and Taurus. The vehicles proposed for low-Earth, Sun-synchronous orbits are the Delta-Lite with two Castor IVB™ solid motors and the Taurus. Most of the proposed EOS spacecraft require low-Earth, Sun-synchronous orbits. The Taurus and Delta-Lite would provide EOS spacecraft, which range in mass from 200 to 1850 kilograms (440 to 4,078 pounds), with a 200 to 1,200 kilometer (124 to 746 mile) circular orbit. Standard Med-Lite service will be the Delta-Lite configuration and will therefore be discussed in greater detail.

2.4.3.1 Delta-Lite (MLELV) Description

The Delta-Lite is a new launch vehicle being designed by McDonnell Douglas for NASA. The Delta-Lite vehicle will combine proven and reliable components to provide versatility in launching small spacecraft. Stages 0 and 1 are Castor 120™ SRMs, similar to the Lockheed Launch Vehicle (LLV 3). Stage 0 may include Castor IVB™ SSRMs for increased performance. Stage 2 is the 100 percent reliable (59 flights without failure) Delta second stage (AJ10-118). The AJ10-118 propellant system consists of an oxidizer tank and a fuel tank, separated by a common bulkhead. Propellants are nitrogen tetroxide (N_2O_4) and

Aerozine-50, a 50:50 blend of unsymmetrical dimethyl hydrazine (UDMH) and hydrazine (N_2H_4). Table 2-5 depicts propellant quantities and burn-out altitudes for each stage.

Table 2-5. Delta-Lite Propellant Quantities and Burn-out Altitudes

Stage/Motor Type	Propellant Type	Propellant Quantity		Burn-out Altitude	
Stage 0/Castor 120™	Solid (HTPB)	48,719 kg	107,408 lbs	19 km	11 mi
SSRMs/2 Castor IVB™	Solid (HTPB)	20,016 kg	44,128 lbs *	19 km	11 mi
Stage 1/Castor 120™	Solid (HTPB)	48,719 kg	107,408 lbs	78 km	48 mi
Stage 2/AJ10-118	Aerozine-50 and Nitrogen Tetroxide	2,064 kg 3,922 kg	4,552 lbs 8,648 lbs	185 km	115 mi

Source: [KR 1995]
*Propellant quantity for 2 Castor IVBs™
Burn-out altitude for the SSRMs assumed to be same as Stage 0

Through February of 1992, over 1,862 Castor motors of various types have flown, with a success rate of 99.95 percent [SLC6a 1995]. McDonnell Douglas predicts a reliability for the Delta-Lite of 97.7 percent [KR 1995]. An environmental assessment has not yet been prepared for this launch vehicle, but its proposed components would place it somewhere between the Delta II 7925 and the Taurus, with similarity to the LLV 3 in terms of emissions and potential impacts.

Emission quantities for the Delta-Lite are not yet available, but can be derived from a ratio of expected propellant quantities for the Delta-Lite and known propellant quantities for the LLV 3 (6). The LLV 3 (6) uses two Castor 120™ SRMs, an Orbus 21D™ Equipment Section Boost Motor (ESBM) and six Castor IVA/XL™ SSRMs,— a configuration which closely approximates the generic Delta-Lite proposed designs. Utilizing the total propellant quantity ratio of the first two stages (Delta-Lite/LLV 3) yields expected Delta-Lite emissions (Table 2-6) that are roughly 70 percent of LLV 3 emissions.

Table 2-6. Estimated Delta-Lite Emissions to 914 m (3,000 ft) Elevation

Launch Vehicle	Carbon Dioxide (CO_2)			Carbon Monoxide (CO)			Hydrogen Chloride (HCl)			Aluminum Oxide (Al_2O_3)		
	kg	lbs	tons	kg	lbs	tons	kg	lbs	tons	kg	lbs	tons
Delta-Lite	396	872	0.44	4,543	10,015	5.01	3,657	8,063	4.03	6,860	15,124	7.56

Source: Data derived from [SLC6a 1995]
Assumes Delta-Lite emissions are 70 percent of Lockheed Launch Vehicle 3 (LLV 3 (6)) emissions -- a total propellant quantity correlation of the first two stages.

A comparison of expected Delta-Lite emissions with the Delta II launch vehicle is presented in Table 2-7. Most constituents are below the Delta II emission values except for Al_2O_3, which is estimated to be 117 percent of the Delta II emissions.

Table 2-7. Delta II 7925 and Delta-Lite Emission Quantity Correlation

Constituent	Quantity in Metric Tons/(Tons)[4]		
	Delta-Lite	Correlation	Delta II 7925
HCl	21.05 MT (23.20)	94%	22.49 MT (24.78)
CO_2	2.28 MT (2.51)	7%	31.05 MT (34.22)
CO	26.15 MT (28.82)	40%	64.64 MT (71.24)
Al_2O_3	**44.90 MT (49.48)**	**117%**	38.25 MT (42.15)

Source: Data derived from [DELTA 1994] and [SLC6a 1995]
Represents total exhaust products produced by the first two Delta-Lite stages (2 Castor 120™ with 2 Castor IVB™ SSRMs)
Assumes Delta-Lite emissions are 70 percent of Lockheed Launch Vehicle 3 (LLV 3 (6)) emissions -- a total propellant quantity correlation.
Delta II emissions are for 9 GEMs and liquid first stage
Bold figures represent constituent where Delta-Lite exceeds Delta II emissions

2.4.3.2 Taurus Description (MLELV)

The Taurus is a four-stage, inertially guided system with a 0/1 interstage, designed to service small payloads in the range of 454 to 1,361 kilograms (1,000 to 3,000 pounds). The overall length of the vehicle is 20 meters (88.5 feet) and has a gross liftoff weight of 71,078 kilograms (156,700 pounds). A Castor 120™ engine and two Castor IVB™ SSRMs (optional) constitutes Taurus' first stage; a Pegasus launch vehicle provides three additional stages of boost. Pegasus is a three-stage, solid rocket booster with a total weight of approximately 16,000 kilograms (35,000 pounds). [SLC6a 1995]

The Taurus utilizes the same solid rocket propellant as that used for the Pegasus. The composition (by weight) of the solid propellant is approximately 95 percent fuel, oxidizer, and solid Hydroxyl-Terminated Polybutadiene (HTPB) fuel binder. The fuel and oxidizer portion is comprised of 19 percent aluminum and 69 percent ammonium perchlorate. The remaining twelve percent of the propellant mixture includes a wetting agent, a free radical initiator, plasticizers and other compounds [SELVa 1992]. First stage exhaust products from the Castor 120™ consist of hydrogen chloride, aluminum oxide, carbon monoxide, and oxides of nitrogen.

2.4.4 Pegasus and Pegasus XL Description

The standard Pegasus configuration is a Small Expendable Launch Vehicle (SELV) that requires the use of a B-52 aircraft (all previous West Coast Pegasus operations have involved B-52s). As a three-stage system that relies entirely on SRMs (Table 2-8), this vehicle is designed to orbit payloads in the 181 to 408 kilogram (400 to 900 pound) weight range [SELV 1993]. The ELV incorporates seven major elements: three solid rocket motors, a payload fairing, a lifting wing, an avionics assembly, and an aft skirt assembly (including three movable control fins). Proposed for service for EOS Flights of Opportunity, Pegasus can launch on various inclinations and has a success rate of 29 percent (2/7) [SH 1995]. This present low success rate is due to inadequate orbital placement, not catastrophic failure.

[4] A metric ton (MT) is equivalent to 1,000 kilograms (2,204.623 pounds). A ton refers to a short ton or 2,000 pounds (American Avoirdupois Weights).

Table 2-8. Composition of Pegasus ELV Rocket Fuel

CONSTITUENT	COMPOUND	Percent Composition (% weight)
Binder	Hydroxyl terminated polybutadiene (HTPB)	7.1
Fuel and Oxidizer	Aluminum (Al) Ammonium perchlorate (NH_4CLO_4)	19.0 69.0
Other	Compounds will vary due to motor manufacturing. Variations occur in, but are not limited to, stabilizers, oxidizers, binders, plasticizers, burn rate modifiers, curatives, catalysts, bonding agents, and processing aids	4.9

Source: Adapted from [SELV 1993]

Pegasus will conduct the majority of its contracted air launch operations from a drop point of 36° North Latitude, 123° West Longitude [OSC 1992]. A designated aircraft would deliver Pegasus to this location, approximately 185 kilometers (115 miles) off the Monterey, California, coastline. The launch system can achieve orbital inclinations between 65° and 120° from the specified drop point, a range of orbits which satisfies the Sun-synchronous mission requirements of EOS.

The Pegasus XL is a small design evolution from the original Pegasus ELV and is the baseline vehicle for all commercial Pegasus launches. The XL has a winged, three-stage solid rocket booster weighing roughly 22,680 kilograms (50,000 pounds), and measures 1.27 meters (50 inches) in diameter and 16.9 meters (55.4 feet) in length, six feet longer than the standard Pegasus. The primary modification on the XL is the incorporation of stretched Stages 1 and 2 to achieve greater payload-to-orbit performance [PEGASUS 1993]. Because the XL carries an additional 3,628 kilograms (8,000 pounds) of propellant, it will serve to define potential impacts associated with Pegasus launches in this EA.

Land-based Pegasus activities would include site preparation, payload preparation and checkout, assembly and payload mating, launch vehicle mating to the B-52 aircraft, and subsequent aircraft ground operations; takeoff, and departure. Necessary flight hardware would be delivered to a VAFB vehicle assembly building (VAB) for vehicle and payload integration. After processing, the Pegasus is mated to a B-52 for air launching.

Pegasus Precision Injection Kit [PEGASUS 1991]

Both Pegasus designs can be equipped with a fourth stage, called the Precision Injection Kit (PIK), that will allow greater accuracy and higher altitude in the placement of satellites into Earth orbit. As part of the advanced space technology program of the Defense Advanced Research Projects Agency (DARPA), the fourth stage is designed to be added to the existing three-stage solid propellant Pegasus booster, and can be fueled with up to 73 kilograms (160 pounds) of liquid hydrazine. The PIK has a 68 kilograms (150 pounds) capacity hydrazine tank, three 23 kilograms (50 pounds) force thrusters, and a new separation system that operates between the Pegasus Avionics structure and the third stage motor. Servicing of the hydrazine propellant is accomplished in the Pegasus VAB at VAFB.

2.4.5 Foreign Launch Vehicles

2.4.5.1 Zenit-2

The Russian Zenit-2 rocket is proposed for a 1998 launch of the EOS SAGE III instrument from the Plesetsk Cosmodrome, on board the Meteor 3M-1 spacecraft. Zenit-2 is a two-stage vehicle that utilizes liquid oxygen and kerosene for both stages (Table 2-9), and is capable of placing payloads in orbits up to 1,500 kilometers (932 miles) high. The first stage is comprised of the same type of strap-on boosters used for the Energia launch vehicle. The second stage has a sustainer engine with four vernier engines and a digital flight control system. The primary exhaust products (CO and H_2O) are similar to those produced by the Delta II 7925 first stage. However, emission quantities for Zenit would be roughly three times greater than the emissions for the Delta liquid boosters, due to three times the amount of liquid propellant. Zenit-2 was first launched in 1985 and has a success rate of 92.3 percent (12/13). [ELVa 1991]

Table 2-9. Zenit-2 Propellant Quantities

Vehicle Stages	Propellant Type	Propellant Quantity
Stage 1	LOx/Kerosene	318,800 kg (703,000 lbs)
Stage 2	LOx/Kerosene	318,800 kg (703,000 lbs)

Source: [ESA 1989]

2.4.5.2 H-II [NASDA 1990]

The H-II is a Japanese-built vehicle proposed to carry the EOS SeaWinds instrument aboard a Japanese spacecraft (ADEOS-II). Program plans propose a launch date of 1999 from the Yoshinobu Launch Complex in Japan. The H-II rocket was developed by NASDA, based on domestic technology, and should perform comparably to the European Space Agency's (ESA's) Ariane 4 and the U.S.'s Atlas and Titan rockets in launching 1.8 metric ton (2-ton) class satellites into geostationary Earth orbit. The overall system reliability of the H-II is designed to be 96 percent, about the same as for the Delta, Titan, and Atlas-Centaur expendable launch vehicles.

The H-II rocket is a two-stage vehicle, augmented by a pair of large solid rocket boosters. The core vehicle is 49 meters (161 feet) in overall length and 4 meters (13 feet) in diameter. It has a total liftoff weight of 236 metric tons (260 tons) and can place an unmanned payload of 9 metric tons (10 tons) into low Earth orbit, 3.6 metric tons (4 tons) into geostationary transfer orbit, or approximately 1.8 metric tons (2 tons) into geostationary Earth orbit.

The H-II first stage uses a newly developed, high-performance liquid hydrogen/ liquid oxygen engine, the LE-7, which is the most advanced and critical technology in the H-II vehicle system. The LE-7 is a pump-fed, staged-combustion-cycle engine, delivering 84 metric tons (93 tons) of thrust at sea level and 109 metric tons (120 tons) in a vacuum. Thrust will be augmented by two strap-on solid boosters that burn for a relatively short time in the boost phase, just after liftoff. Using a polybutadiene-based composite propellant, it is the largest (in thrust level and burn duration) solid rocket ever developed in Japan. Dimensions are 23.4 meters (77 feet) long and 1.8 meters (5.9 feet) across, delivering a thrust of 145 metric tons (160 tons) on liftoff.

An upgrade version of the second-stage cryogenic propulsion system of the H-I rocket is used in the H-II's second stage. On top of the second stage's propellant tank is the guidance section, where guidance and telemetry equipment, radar transponder, and electric power unit are housed. An inertial guidance system using ring laser gyroscopes is being developed for the vehicle guidance and control.

The aluminum payload fairing is also mounted on the second stage propellant tank. The fairing measures 4 meters (13 feet) across and can house a satellite up to 3.7 meters (12 feet) in diameter. NASDA is now developing a 5 meter (16 foot) fairing that will accommodate a larger spacecraft (up to 4.6 meters (15 feet) in diameter). H-II launch vehicle specifications are shown in Table 2-10.

Table 2-10. H-II Launch Vehicle Specifications

ITEM		Dimensions in Metric Tons (Tons) and Pounds		
		1st Stage	SRBs	2nd Stage
Propellant		LOx/LH$_2$	Polybutadiene Composite	LOx/LH$_2$
Propellant Mass		78 MT (86 tons) 172,000 lbs	107 MT (118 tons) 236,000 lbs	13 MT (14 tons) 28,000 lbs
Thrust		84 MT (93 tons) 186,000 lbs (Sea Level)	290 MT (320 tons) 640,000 lbs (Sea Level)	11 MT (12 tons) 24,000 lbs (In a Vacuum)
Fairing	Diameter	4.1 m (13 ft) (Outer Diameter)		
	Length	12 m (39 ft)		

Source: Adapted from [NASDA 1990]

2.5 ALTERNATIVES CONSIDERED BUT ELIMINATED FROM FURTHER STUDY

2.5.1 Domestic Alternative Launch Sites

2.5.1.1 Cape Canaveral Air Station (CCAS)

Cape Canaveral Air Station, a potential alternative launch site considered for launching EOS spacecraft on Delta II 7925 and Atlas IIAS rockets, has been eliminated from further study due to EOS orbital inclination requirements. The majority of EOS spacecraft would be launched to polar orbits, which require an orbital inclination greater than 51°, the maximum allowable inclination for CCAS launches. Orbital inclinations in excess of 90° are necessary for EOS spacecraft and introduce the potential for overflight of populated areas if launched from CCAS. This risk is expected to exceed any cumulative effects expected at VAFB due to EOS launch impacts. Although environmental impacts associated with EOS operations at CCAS are expected to be of little or no significance compared with other programs [DELTA 1994], CCAS has been eliminated from further study due to the potential for overflight of populated areas. Because of this overflight restriction, polar launches must be made from a West Coast location in the United States.

For a further discussion of CCAS's existing environment and the potential impacts associated with the launch of an EOS-type vehicle see the Mars Pathfinder Mission Environmental Assessment [DELTA 1994].

2.5.2 Foreign Alternative Launch Sites

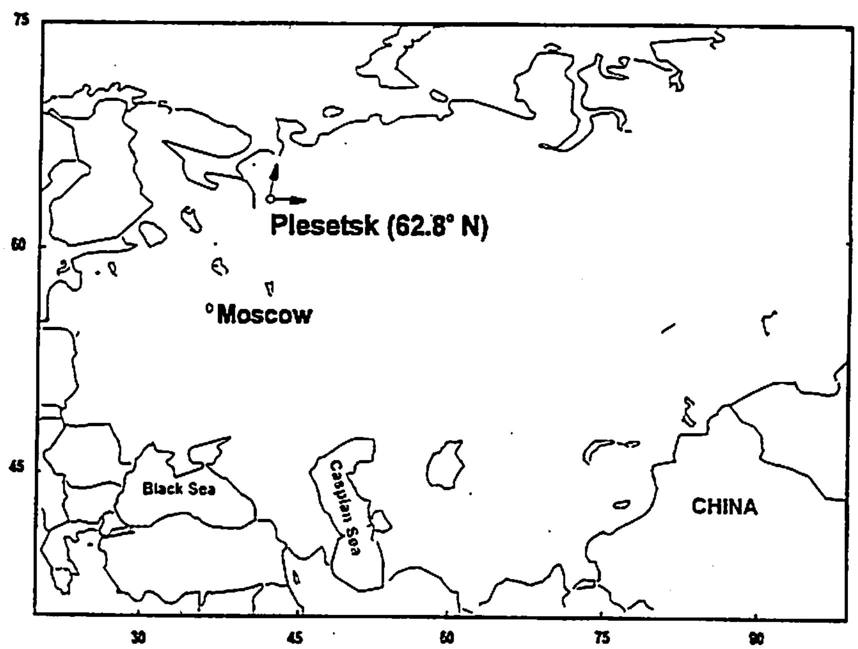
The potential use of foreign launch sites must be considered by the EOS Program, since the program defines collaboration with several foreign counterparts; adequate information exists to treat the Japanese and Russian collaborations in some detail. ADEOS II and

SeaWinds projects would utilize foreign launch vehicles and launch sites. The portions of U.S. contribution to these components of EOS is minimal, consisting only of instruments, which would ride on foreign spacecraft and launch vehicles. The inclusion of the discussion regarding these components is necessarily limited to the global impacts anticipated, addressed mainly as cumulative impacts based on assumptions where real world data was not available. Due to the limited involvement of the U.S. in such launches, a summary of what information is available and associated anticipated global impacts is described in the following sections.

2.5.2.1 Russian Cosmodrome at Plesetsk

One of three Russian launch sites, Plesetsk (Figure 2-7) is situated (62.8° N, 40.1° E) close to the Arctic Circle near the town of Plesetsk, on a railway line 800 kilometers (497 miles) north of Moscow. Direct orbital inclinations achieved from Plesetsk range from 62° to 83°. Plesetsk is often referred to as the Vandenberg equivalent. Given mission requirements and current collaborations, Plesetsk is a proposed launch site as identified in the Implementing Agreement between NASA and the Russian Space Agency for the TOMS and SAGE III EOS instruments (December 16, 1994) [MOA 1994].

Figure 2-7. Russian Cosmodrome at Plesetsk



Source: Adapted from [ELVa 1991]

Plesetsk is located in the Archangelsk region of Russia, which is a swampy, pine and birch forested, taiga[5] terrain. Temperatures in the region can be harsh, with heavy snowfall (up to 1.5 meters (5 feet) in winter) much of the year. November temperatures can routinely hover near minus 30° C. This launch site is capable of launching Soyuz, Cosmos, and Intercosmos carriers. The launching of space rockets from this location involves certain risks (falling debris from the rocket stages) to settlements up to hundreds of kilometers away, since the trajectories can be over population centers [PLESETSK 1991]. The closest settlement is the village of Mirnyy, 3.2 kilometers (2 miles) north of Plesetsk and about twice the size of Plesetsk, which houses the majority of the cosmodrome's staff.

[5] Taiga terrain refers to a swampy area of coniferous forest.

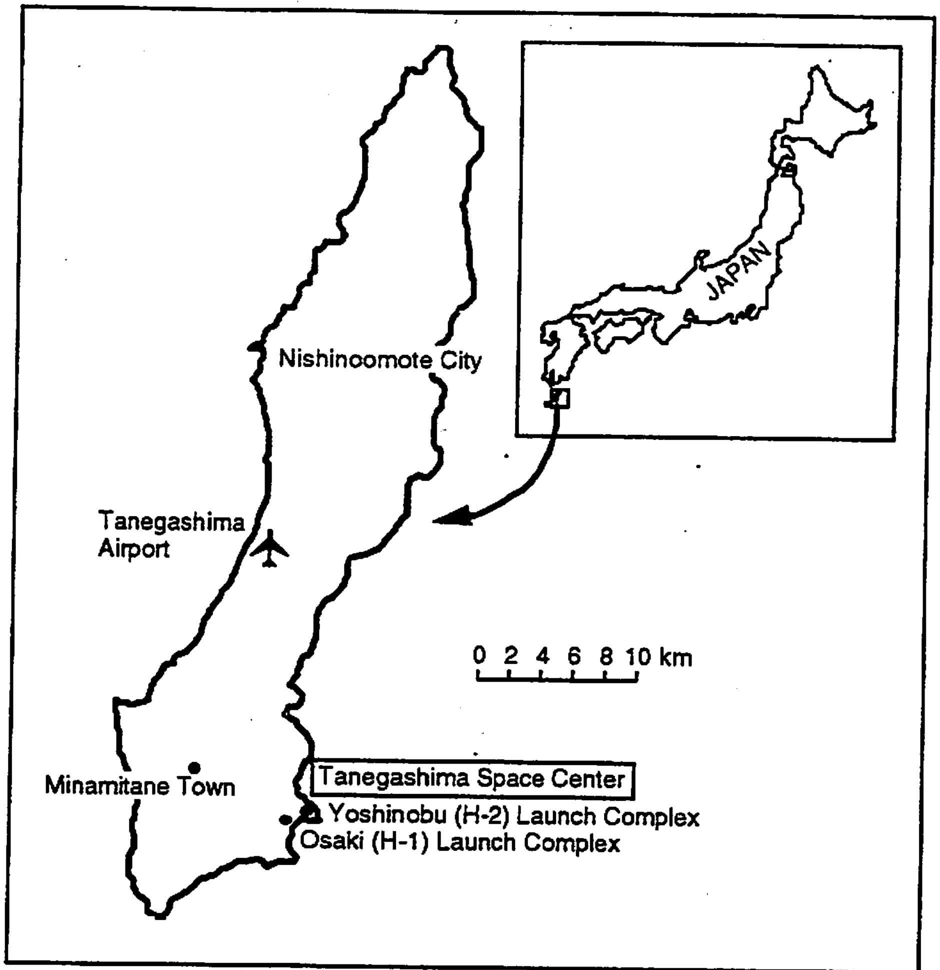
The Plesetsk site has historically supported the launch of large vehicles. Based on available information, as many as 70-80 launches per year may have occurred at this site in the past. Given these large numbers, the global impacts anticipated by the contribution of one to four launches per year is considered nominally not substantial. In recent years, the number of launches from Plesetsk has undoubtedly decreased from the level of the early 60's. The exact number of launches from this site is not known, since prior to 1983 the Soviets did not acknowledge its existence — Plesetsk was the major launch site for polar military missions. The directly attainable orbital inclinations of only 62° to 83° do not provide the best selection for most EOS requirements, which are for polar inclinations of 98° to 108°. Present day information on the environmental characteristics, and ground handling facilities at this site is extremely limited.

2.5.2.2 Tanegashima Space Center (Japan)

The Tanegashima Space Center (Figure 2-8) is located in the southeast region of Tanegashima island, Kagoshima (30° 24' N; 130° 58' E). Tanegashima island is located 80 kilometers (50 miles) off the southern coast of Kyushu, the southernmost island in the Japanese chain. The island is 58 kilometers (36 miles) in diameter and has a population of about 43,000. The climate is tropical. The Yoshinobu Launch Complex has been recently constructed to launch H-II launch vehicles. Launch trajectories are over unpopulated ocean areas, which makes the launch site a compatible location with regard to U.S. Range Safety philosophies. However, due to fisherman's objections to noise and falling rocket debris hazards over the fishing grounds, launches are restricted to two periods each year, — January 15-February 28 and August 1-September 15, which avoids the primary fishing seasons. If fishing restrictions remain in effect at the new H-II launch complex, four Japanese government launches per year can be allowed from this site. [JANES 1995]

As with the Russian launch site, little information is available with regard to launch site environmental characteristics. Less information is available with regard to the H-II launch vehicle exhaust products, emissions, and environmental impacts. Considering the government of Japan's domestic plans and needs for space launches and the allowable total number of launches from Tanegashima, it is highly unlikely that the Tanegashima launch complex can be considered a truly viable alternative to the U.S. domestic launch complexes for the majority of the EOS launches.

Figure 2-8. Tanegashima Space Center



Source: Adapted from [ELVa 1991]

2.5.3 Alternative Launch Vehicles

Selecting a launch vehicle for EOS projects depends on matching the payload mass and the energy required to achieve the desired orbit to the capabilities of the prospective launch system.

In general, each payload will weigh approximately 6,272 kilograms (13,800 pounds) fully fueled [PPF 1993] and will require sun-synchronous orbital placement. EOS spacecraft will be approximately 7.16 meters (23.5 feet) long and 3.66 meters (12 feet) in diameter [PPF 1993].

Other considerations which must be addressed in selection of the launch system include reliability, cost, and potential environmental impacts associated with use of the launch system (Table 2-11) [DELTA 1994].

Table 2-11. EOS Launch Vehicle Summary

LV Class & Spacecraft	Launch System - Cost	Propellant	Payload	Launch Sites	Success Rates
Intermediate AM-1 ADEOS	Atlas IIAS - $120M (FY 90 $) H-II (Japan) - $120M (FY 90 $) *Soyuz (Russia)* - $15M (FY 89 $) Zenit II (Russia) - $45M (FY 93 $)	2Liquid/4SRB 2Liquid/SRB 3Liquid	5000 kg 4000 kg 6900 kg	SLC3E/LC36AB Yoshinobu Baikonur	86.9% 96% 97.9%
Medium AM-2&3 PM-1,2&3 CHEM-1,2&3	Delta II-7925 - $50M (FY 90 $) *H-1 (Japan)* - $90M (FY 90 $) *Molniya (Russia)* - $15M (FY 89 $)	2Liquid1Solid/9SRB 2Liquid1Solid/SRB 4Liquid	3184 kg 1600 kg 1600 kg	SLC2W/LC17AB Tanegashima Baikonur	94% 100% 94.2%
Medium-Lite LALT-1,2&3 RALT-1,2&3	Delta-Lite - $25-30M (previsional - FY 95 $)	2Solid 1Liquid/2SRB	Bound by Delta II and Taurus launch vehicles.	Spaceport Back-up: SLC-2W/LC-17	97.7%
Small FOO	Pegasus - $7-12M (FY 90 $) Taurus - $15M (FY 90 $) *M-3SII (Japan)* - $30M (FY 90 $) *Kosmos (Russia)* - $10M	3Solids 4Solids 4Solids 2Liquid	365 kg 800 kg 780 kg 1200 kg	Air-launched VAFB (Mobile) Tanegashima Baikonur	29% 100% 100% 98%

Source: Data acquired from [ELVa 1991], [ELVb 1993], [ESA 1989], [KR 1995] and [NASDA 1990]
Maximum Payloads try to approximate the 705 kilometers (438 miles) 98.2 i EOS orbit requirement - assumes a west coast launch for U.S. launch vehicles
Italicized launch vehicles represent probable alternatives and are not definitive.
Values are approximate and conservative (*i.e.*, smaller)

2.5.3.1 Alternative Foreign Launch Vehicles

Foreign launch vehicles slated for EOS projects are the Zenit-2 and H-II, which are discussed in Subsections 2.4.5.1 and 2.4.5.2, respectively. Potential Intermediate Expendable Launch Vehicle (IELV) alternatives include the Russian Soyuz and European Ariane 40; potential alternative Medium Expendable Launch Vehicles (MELV) are the Japanese H-I and Russian Molniya; potential Small Expendable Launch Vehicle (SELV) alternatives include the Russian Kosmos and Japanese M-3S-II. A brief summary is presented below.

Foreign Alternative IELVs

- **Soyuz** performance and payload fairing size exceeds EOS project requirements by a wide margin.
- **Ariane 40** is very similar to the Atlas IIAS in terms of performance, payload fairing size and reliability, but will not provide a clear economic or environmental advantage.

Foreign Alternative MELVs

- **H-I** estimated launch price is approximately twice that of the Delta II 7925. The H-I offers no environmental advantage over the Delta, which uses essentially the same fuels and produces approximately 200,000 pounds more thrust at liftoff than the H-I.
- **Molniya** performance exceeds EOS project requirements. Molniya produces almost twice the thrust of a Delta vehicle at liftoff while using LOx/kerosene strap-ons, an environmental advantage. However, payload processing information and other launch related information (reliability, etc.) is not generally available.

Foreign Alternative SELVs

- **Kosmos and MU-3S-II** meet or exceed EOS requirements, but are clearly an environmental disadvantage when compared to Pegasus, which is air launched.

2.5.3.2 Alternative U.S. Launch Vehicles

Space Transportation System

At this time, the STS greatly exceeds EOS mission requirements and is not anticipated as a back-up launch system. Consequently, it is not considered to be a reasonable alternative launch system.

U.S. Expendable Launch Vehicles

U.S. Launch Vehicles slated for launch of EOS spacecraft are the Atlas IIAS (IELV), Delta II 7925 (MELV), Medium-Lite Expendable Launch Vehicles (MLELVs), and the Pegasus described in Section 2.4. Potential alternative vehicles in each class are:

Alternative IELVs

- **Titan IV**, which greatly exceeds EOS requirements.

Alternative MELVs

- **Atlas I** has a larger payload fairing and will produce less emission than a Delta II 7925 vehicle which uses SRMs. The Atlas I, however will produce approximately 150,000 pounds less thrust at liftoff and will cost an estimated $15 million more than the Delta.
- **Titan II** is very similar to the Delta II 7925 in terms of performance, payload fairing size, reliability, cost and environmental advantage.

Alternative SELVs

- **Scout I and Scout II** meet EOS FOO requirements. Unlike the Pegasus, these systems are ground launched, producing pollutants at and near the Earth's surface.

Summary

For EOS spacecraft, the Atlas IIAS, Delta II 7925, MLELVs and the Pegasus (U.S. launch vehicles) are best suited for the following reasons:

- They match EOS performance requirements and allow for variations in payload size and weight.
- They cost the same or less than the listed alternatives and are similar in terms of reliability.
- Alternate launch vehicles do not provide a clear environmental advantage with respect to environmental impacts.

2.6 NO-ACTION ALTERNATIVE

Though immediate local (*i.e.*, launch site) environmental impacts would be minimized by the No-Action alternative, No-Action would be an impediment to our understanding of natural and anthropogenic environmental impacts. EOS is an essential step toward understanding the natural environment and its response to human activity. The No-Action alternative would hinder scientific progress, and U.S. dependence on foreign acquisition of environmental data would increase. The resultant loss of continuity in Earth observation data would lead to not meeting national priorities (with respect to management of the environmental global commons) and may result in ineffective policy decisions, since they would be based on less than complete scientific information.

Collecting data from the vantage point of space provides information about Earth's land, atmosphere, oceans, ice, and biota that is obtainable in no other way. Data gathering and analysis accompanied by computer modeling efforts would provide the framework for interpretation of data and for quantitative testing of how Earth systems work. Future data would be integrated with previously obtained data to enable study of long-term Earth system evolution. Reliance upon non-space based systems (*i.e.*, measurements at ground level, science balloons, Space Shuttle missions, etc.) would not provide the long-term detailed measurements nor the volume of data required to model such dynamic Earth systems. With EOS, NASA would bring to the field of Earth system science the ability to observe the Earth globally from space.

People are benefiting today from MTPE products. This includes farmers, foresters, fishermen, land-use managers, etc., who currently utilize the weather prediction and remote sensing capabilities. In order to continue to lead the international effort on global environment management EOS is needed. The products delivered by the EOS Program could help ensure a level playing field for new global enterprises and effective global environmental policy decisions. EOS products could form the basis for public education, as well as provide training opportunities for future generations of scientists and engineers.

It is foreseeable that the lack of scientific information arising from the cancellation of the EOS Program could result in policies and actions that would adversely affect the quality of the human environment both in the United States and worldwide.

3. CHAPTER THREE
ENVIRONMENTAL CHARACTERISTICS OF VANDENBERG AIR FORCE BASE[6]

GENERAL

This discussion of the existing environment is limited to those resources, or related resources, that could be affected by the implementation of the EOS Program. Areas near SLCs proposed for use by EOS — SLC 2W, 3E, and 6 — are discussed in greater depth.

Sources of potential impacts to the environment include the use of hazardous materials, creation of exhaust plumes, emission of air pollutants, rocket motor noises, and sonic booms. Information provided in this chapter is summarized from the references cited in the text.

3.1 GEOGRAPHIC LOCATION

Vandenberg Air Force Base is located in Santa Barbara County, on the coast of South Central California (see Figure 3-1). It occupies 39,822 hectares (98,400 acres) of land and is bounded on the west by 56 kilometers (35 miles) of Pacific Ocean coastline. The nearest cities are Santa Maria, 10 kilometers (6.2 miles) to the northeast and Lompoc immediately to the east. The base is administratively divided into North Vandenberg and South Vandenberg. North Vandenberg contains SLC-2W (proposed launch pad for MELV-class EOS vehicles) and the following payload processing and integration facilities: Building 1610, the Astrotech facilities, and U.S. Air Force Facility 2520. South Vandenberg houses SLC-3E (the Atlas IIAS (IELV) launch pad) and SLC-6, which is part of the California Commercial Spaceport.

3.2 LAND USE AND DEMOGRAPHY [SLC6a 1995]

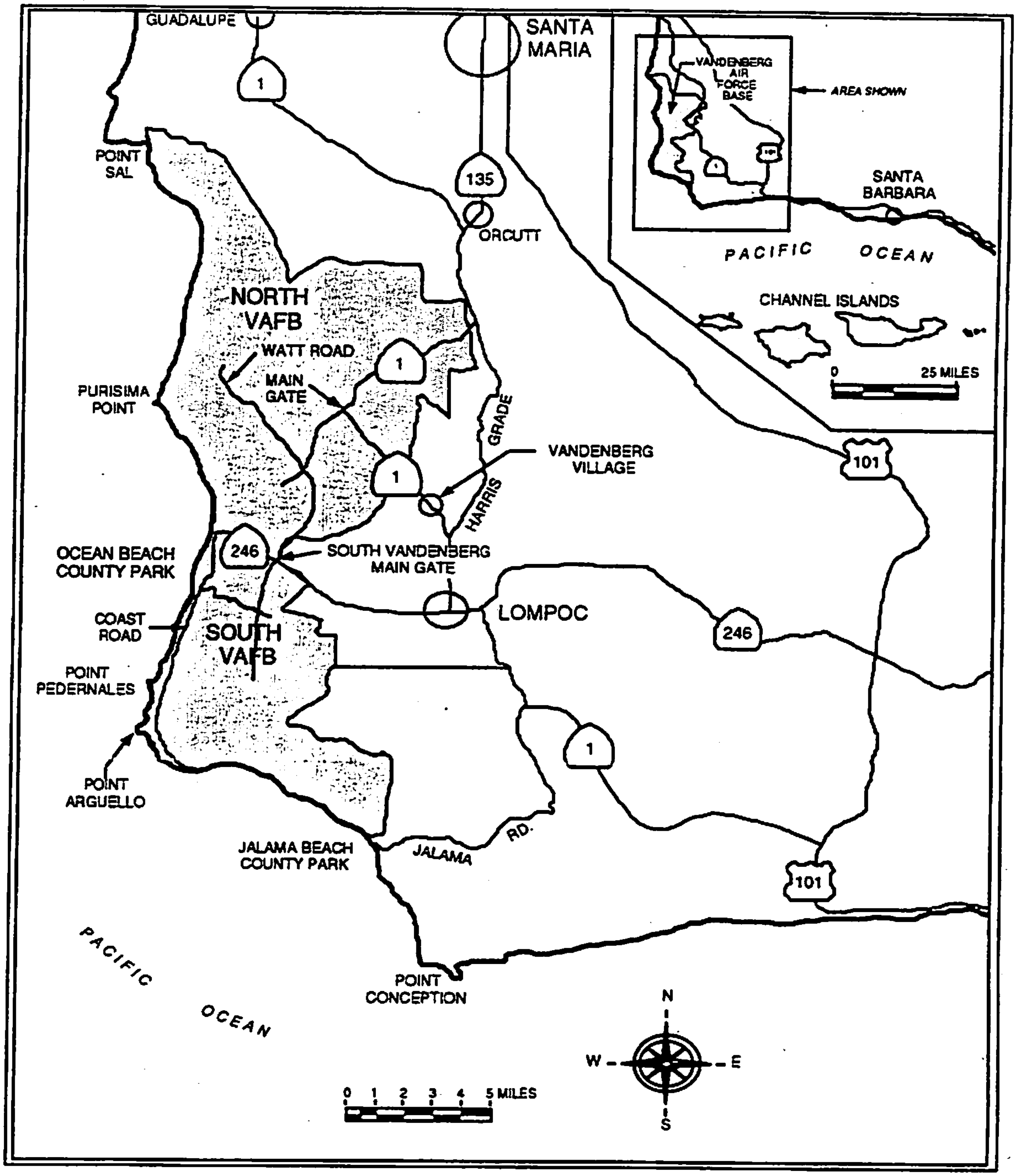
Vandenberg Air Force Base

Launch operations are the primary activity at VAFB, which is the headquarters of the 30th Space Wing, Air Force Space Command. Over 1,700 launches have been conducted since 1958. Among these, space boosters of all sizes have inserted more than 500 unmanned satellites into polar and high-inclination orbits.

Vandenberg AFB occupies roughly six percent of the total land area of Santa Barbara County. Sixty percent of the base is reserved for open space and recreation. An additional 30 percent is used for grazing and other forms of agriculture. The remaining 10 percent of the land is occupied by facilities and operations associated with U.S. Air Force activities. South Vandenberg is almost entirely devoted to open space and grazing uses; only one percent is occupied by Air Force-related activities. [SLC6 1994]

[6] This chapter is summarized from [ATLAS 1991], [SLC6 1994], [SLC6a 1995], [SLC2W 1993] and references cited throughout the text.

Figure 3-1. Regional Map



Source: Adapted from [SLC6a 1995]

Western Santa Barbara County

The western portions of Santa Barbara County are largely rural. According to the 1990 census, Santa Barbara County supports a population of 369,608 people, most of whom live near the Pacific Coast [U.S. Bureau of the Census 1993]. Lompoc, with a population of

37,649, is the nearest populated area to South Vandenberg. Farther to the north, Santa Maria, with a population of 61,284, is second in size only to Santa Barbara, with 85,571 people.

Recreation

The Pacific Coast in the vicinity of VAFB provide numerous opportunities for public recreation. Two of these recreation areas are adjacent to South Vandenberg. The first, Ocean Beach County Park, is located 12.1 kilometers (7.5 miles) to the north of the Cypress Ridge Area at the mouth of the Santa Ynez River. The second, Jalama Beach County Park, is situated at the mouth of the Jalama Creek, near the eastern boundary of VAFB. [SLC6 1994]

3.3 SOCIOECONOMICS

Agriculture is the region's primary industry, particularly in the Santa Maria area. Surface mining for diatomaceous earth is also a major regional industry [SLC6 1994]. The largest employers in the area of Santa Barbara county surrounding VAFB are services, retail trade, government, and manufacturing. In 1985, the area's employment levels was 101,600, an increase of approximately 50 percent in 10 years with most growth occurring in the manufacturing sector. Projections are for employment to increase to 145,800 by 2005, a 43 percent increase from employment levels in 1985. The unemployment rate is currently five percent and is projected to remain between five and five and one-half percent through the year 2005 [SLC6a 1995].

The number of persons employed at VAFB has declined from approximately 16,000 in 1985 to less than 10,000 currently. Of these, approximately 68 percent are civilian employees. The base generates about 4,300 jobs for the local economy, and has an overall monetary impact of more than $500 million on the surrounding region. VAFB employs approximately 40 percent of Lompoc's labor force and nine percent of Santa Maria's [SLC6a 1995].

3.3.1 Environmental Justice

Executive Order (EO) 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations," focuses Federal attention on the environmental and human health conditions in minority communities and low-income communities. The Executive Order, as amended, directs Federal agencies to develop an Environmental Justice Strategy that identifies and addresses disproportionately high and adverse human health or environmental effects of their programs, policies, and activities on minority populations and low-income populations.

3.3.1.1 Emergency Planning and Community Right-To-Know Act

NASA will comply with Toxic Release Inventory requirements, Emergency Planning and Community Right-to-Know responsibilities, and State and Local Right-to-Know and Pollution Prevention requirements. NASA will support the Local Emergency Planning Committee as requested and will make available all Pollution Prevention and Community Right-to-Know information to the public upon request. [NASA 1995]

3.4 ARCHEOLOGICAL AND HISTORIC RESOURCES [SLC6a 1995]

The National Historic Preservation Act (NHPA) of 1966, as amended, was established to protect significant historic and prehistoric resources. The NHPA: (1) establishes a National Register of Historic Places to be maintained by the Secretary of the Interior, (2) authorizes each state to establish the office of State Historical Preservation Officer (SHPO), and (3) establishes the Federal Advisory Council on Historic Preservation (ACHP). Section 106 of the act requires federal agencies to provide SHPO and ACHP an opportunity to comment on any federal undertaking within their state that would affect properties included in, or eligible for, inclusion in the National Register. [SLC2W 1991]

3.4.1 Archeological Resources

Paleoindian sites characterized by the presence of chipped stone tools and grinding stones at least 9,000 years old occupy areas along the coast from Point Conception to the Santa Maria River area. One of these rare Paleo-Coastal sites is a fluted projectile point fragment. It was found on a coastal plain east of Point Conception approximately 12.9 kilometers (8.0 miles) south of SLC-6. While claims have been made for earlier occupation of the area, the earliest well-documented remains are associated with Paleoindian peoples (12,000 to 9,000 years ago). After the lands were transferred to USAF ownership, their use related primarily to construction of missile launch and support facilities.

3.4.2 Historic Resources

Two historically valuable buildings remain in the Cypress Ridge area. The first of these is a Coast Guard Rescue Station, known as the Boathouse, built at Boathouse Flats between 1936 and 1938. Although deactivated in 1952, the station retains historical value as one of the few West Coast examples of the U.S. Colonial revival style of architecture. The second historical site is a complex of Coast Guard Station buildings located at Point Arguello. [SLC6 1994] A brief description of the cultural resources near SLCs proposed for use by EOS follows.

<u>SLC-2</u>

Cultural resources are present within and adjacent to SLC-2. Consultation with the State Historic Preservation Officer (SHPO) was conducted during the environmental assessment process for the modification of SLC-2W [SLC2W 1991] The SHPO recommended SLC-2W as a candidate for listing in the NRHP, therefore any proposed modifications to SLC-2W must first be reviewed by the SHPO [SO 1996].

<u>SLC-3</u>

Space Launch Complex - 3 (SLC-3) was the first spacecraft launch facility built at what was then referred to as Point Arguello Naval Missile Test Facility, now VAFB [ATLAS 1991]. This site has undergone several modifications since its construction and early use. During 1965 and 1966 it was converted to accommodate the Atlas Standard Launch Vehicle (SLV). Work was completed in 1966 and the pad was renamed SLC-3E. In 1968, SLC-3E was retired. In 1975 plans were begun to convert SLC-3E to accommodate the Atlas E and F series. In 1982 additional minor changes were made at SLC-3E to prepare for the Atlas H. An evaluation of the historical significance of SLC-3E was conducted to assess its potential eligibility for listing in the National Register of Historic Places (NRHP) during the environmental assessment process for the Atlas II Program at VAFB [ATLAS 1991]. The SHPO determined SLC-3E to be eligible for listing on the NRHP and the facility was preserved on paper prior to its modifications. The support building for SLC-3E is eligible for NRHP listing, therefore any proposed modifications must first be reviewed by the SHPO [SP 1996].

SLC-6

Space Launch Complex - 6 site was originally constructed in 1970 for the Titan IIIM space launch vehicle, which was designed to support the Manned Orbital Laboratory (MOL). In the 1980's, SLC-6 was modified in anticipation of Space Shuttle launches at VAFB. Neither the MOL nor the Space Shuttle programs were implemented, and SLC-6 has been in a care-taker status since the cancellation of the Space Shuttle Program. Although SLC-6 was not used for Cold War activities, it was evaluated for inclusion in the National Register of Historic Places (NRHP). The SLC-6 complex and the Payload Preparation Room have been evaluated and recommended as not eligible for inclusion on the NRHP [SLC6a 1995].

3.5 METEOROLOGY AND AIR QUALITY [SLC6a 1995]

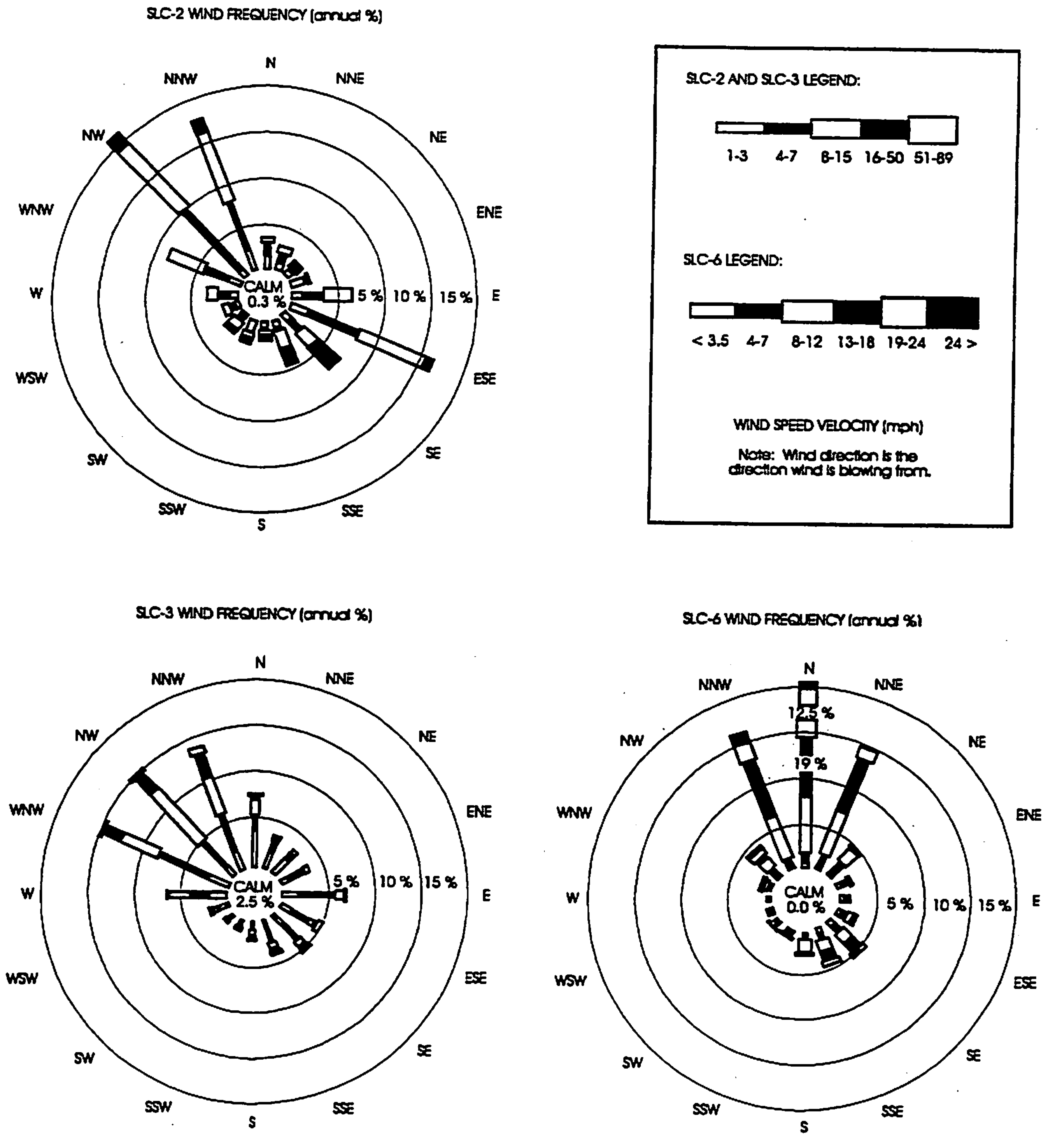
3.5.1 Regional Meteorology

The climate in the vicinity of VAFB is Mediterranean, which is characterized by warm, dry weather from May to November and cool, wet weather from December to April. The Pacific Ocean exerts a moderating influence on local weather patterns. [SLC6 1994]

At the VAFB airfield, the average annual temperature and the mean annual relative humidity are 12.8° C (55° F) and 77 percent, respectively. The average precipitation is 32.3 centimeters (12.7 inches) per year, ranging from 6.6 centimeters (2.6 inches) in February to less than 0.3 centimeters (0.1 inches) in July. More than 90 percent of annual precipitation falls between November and April. Coastal fog and low clouds are common in the morning hours, especially during the summer months, when inversion conditions intensify. [SLC6 1994]

Meteorological monitoring is conducted at two sites on VAFB. The first of these is on Watt Road, near the VAFB Airfield and SLC-2. The second air monitoring station is located adjacent to the SLC-6 power plant, about 1.6 kilometers (1.0 miles) north of the Spaceport. The airfield (near SLC-2) is on a flat plateau on North Vandenberg, where the wind blows predominantly from the north-northwest (NNW). The average monthly wind speed ranges from a low of approximately 5 knots (5.8 miles per hour) in August to a high of 7.8 knots (9 miles per hour) in March (see Figure 3-2). The Spaceport, located on South Vandenberg, is nearer to the ocean and on a terrace adjacent to a ridge, where the predominant wind flow is from the north (Figure 3-2). The monthly average wind speed measured at SLC-6 ranges from a low of 7.5 knots (8.6 miles per hour) in January to 10.5 knots (12 miles per hour) in July. Unlike the data from the airfield, the SLC-6 measured wind speed is higher in the summer than in the winter. Predominate wind flow at SLC-3E is from the northwest at 5 to 8 knots (5.8 to 9 miles per hour) (Figure 3-2).

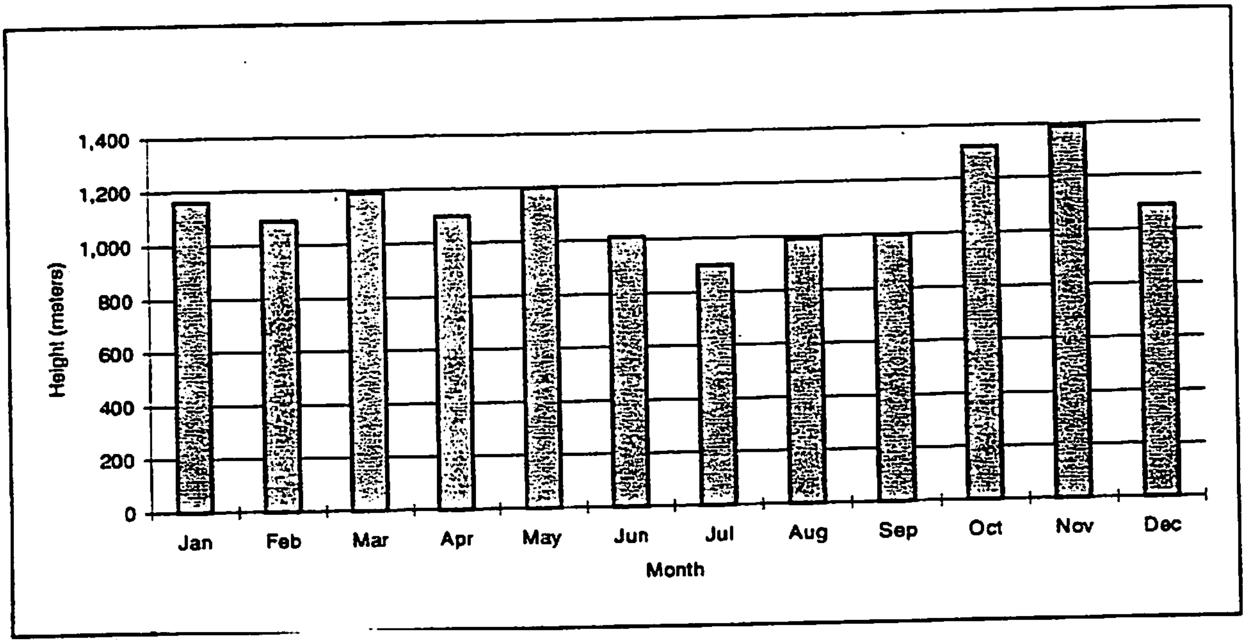
Figure 3-2. Annual Wind Frequency at SLCs 2, 3 and 6



Source: Data acquired from [ATLAS 1991], [PPF 1993] and [SELVa 1992]

The mixing height of the atmosphere represents the upper limit of the atmospheric region where pollutants and emissions generally remain. Higher mixing heights (inversion layers) will facilitate dispersion of any trapped air pollutants. The mixing height is controlled by the location in the atmosphere of the first layer of air that is warmer than the air below. At VAFB, the average maximum mixing height ranges from approximately 900 meters (2,950 feet) above sea level in July to 1,350 meters (4,430 feet) above sea level in November (Figure 3-3). Most frequently, the atmosphere at Vandenberg is nearly neutral in stability (Pasquill Stability Class D). [SLC6 1994]

Figure 3-3. Maximum Monthly Average Mixing Height Reported for Any Stability Class (meters)



Source: Adapted from [SLC6a 1995]

3.5.1.1 Air Quality [SLC6a 1995]

Vandenberg Air Force Base and Santa Barbara County are located within the South Central Coast Air Basin (SCCAB). With respect to air quality, Santa Barbara County is divided into North County and South County. South County includes the region south of the crest of the Santa Ynez Mountains and east of Jalama Beach. VAFB is situated entirely in North County.

Monitoring of ambient air pollution concentration is conducted by the California Air Resources Board (CARB), the Santa Barbara County Air Pollution Control District (SBCAPCD), and industry. Monitoring operated by CARB and SBCAPD are part of the State and Local Air Monitoring System (SLAMS). The SLAMS monitors are located to provide local and regional air quality information. Monitors operated by industry are called Prevention of Significant Deterioration (PSD) Stations. PSD stations are required to ensure that new and modified sources do not interfere with the County's ability to attain and maintain air quality standards.

Five criteria pollutants, as defined by the Clean Air Act (CAA), are monitored by VAFB: ozone (O_3), carbon monoxide (CO), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), and particulate matter under 10 microns in diameter (PM_{10}). In addition, the Air Force monitors for total hydrocarbons and meteorological data. Table 3-1 presents a summary of recent air quality measurements, as well as air quality standards defined by the CAA, the State of California, and Santa Barbara County. Many sections of Santa Barbara County are not in attainment of the National Ambient Air Quality (NAAQ) standards. Both the primary national and California health standards for ozone have been exceeded in recent years (1994). For all monitoring stations, Santa Barbara County experiences between 30 and 45 days per year on which the state ozone standard is violated and two to eight days per year on which the national standard is violated.

Table 3-1. Vandenberg Air Force Base Air Quality Data and Applicable Standards

Pollutant	Highest Measured Concentration: SLC 2: Watt Road VAFB Mar - Sep '93	Highest Measured Concentration: SLCs 3/6: South VAFB Power Plant Oct '92-Nov '93	CA Ambient Air Quality Standard BNA 321:0101, Article 15	Nat'l. Ambient Air Quality Standard 40 CFR 50.6	Santa Barbara County Air Pollution Control District
Ozone(O^3) 1-hour average (ppm)	0.085	0.087[c]	0.09	0.12	Ozone precursor (Nox, VOC) de minimis threshold =100 tons/yr[a]
Carbon Monoxide (CO) 1-hour average (ppm) 8-hour average (ppm)	1.2 1.0	1.0 0.8	20.0 9.0	35.0 9.0	"cannot be classified or better than national standards"
Nitrogen Dioxide (NO_2) 1-hour average (ppm)	0.015	0.046	0.25	No Std	"cannot be classified or better than national standards"
Sulfur Dioxide (SO_2) 1-hour average (ppm) 3-hour average (ppm) 24-hour average (ppm)	0.005 0.003 0.001	0.008 0.007 0.004	0.25 No Std 0.05	No Std 0.5[b] 0.14	"cannot be classified"
Suspended Particulate with aerodynamic diameter less than (PM_{10}) 24-hour average (µg/m³) Annual geometric mean (µg/m³) Annual arithmetic mean (µg/m³)	42.0 NA NA	48.9 NA NA	50.0 30.0 No Std	150.0 No Std 50.0	"cannot be classified"

(a) Santa Barbara County is classified as "moderate" nonattainment for O_3. The proposed action must also be <10% of the regional baseline inventory for the priority pollutants.
(b) National Secondary Standard
(c) Levels violated the Federal Ozone Standard in July, 1992

Source: Adapted from [SLC6a 1995]

The Air Force and the Santa Barbara County Air Pollution Control District (APCD) have agreed to cooperate in the air quality program managed by Santa Barbara County. Under this agreement, changes in activities at VAFB are coordinated with and permitted through the Santa Barbara County APCD. Any new emissions on VAFB from regulated sources (*i.e.*, that are caused by EOS activities) will have to be considered within the context of the agreement. Currently permitted air pollution sources at SLCs 2 and 3 are depicted in Table 3-2.

Table 3-2. Currently Permitted Air Pollution Sources at SLCs 2W and 3

SLC-2W (Delta Operations)		SLC-3 (Atlas Operations)	
Source Description	Permit Number	Source Description	Permit Number
Scrubber Tank	8658	RP-1 Tanks (2)	Applied
Storage Vessel Vapor Scrubber	8658		
Spray Booth	8914	Trichlorethylene Flush	5246
Storage Vessel	8305	North VAFB Sources	
Lubricating and Purging Unit Tank Cart Waste Container	8306	Spray Paint Booth (2)	8468 & 8930

Source: Adapted from [ATLAS 1991], [JA 1996] and [SLC2W 1991]
Trichlorethylene will be utilized until the formerly purchased reserve is depleted [RO 1995].

3.6 LAND RESOURCES

3.6.1 Geology [SLC6a 1995]

The recent geologic history of the Vandenberg region is characterized by alternating periods of deposition and uplift. The bedrock underlying the Cypress Ridge area consists of the Upper Monterey Formation, a diatomaceous shale. The hills to the northeast of SLC-6 are comprised of middle Miocene Tranquillon volcanics. Marine terrace deposits consisting of beds and lenses of sand, silt, and gravel underlie nearly all of VAFB.

All of the south central coast of California is considered to be a seismically active region. In Santa Barbara County, major earthquakes have been recorded as early as 1769. In 1927, an earthquake with a Richter magnitude of 7.3 occurred approximately 32 kilometers (20 miles) west of Point Arguello. Of the 90 additional earthquakes that have occurred within a 32 kilometer (20 mile) radius of VAFB since 1900, their Richter magnitudes have been 7.1 or less. The Santa Ynez fault, about 64 kilometers (40 miles) to the east of the Cypress Ridge area, is the nearest seismically active, onshore, geologic feature.

3.6.2 Soils

The characteristics and development of soils are related to the underlying bedrock, topographic conditions, organisms, and time. The soils immediately to the southeast of SLC-6 were sampled in 1986 in anticipation of the Space Shuttle Program. Fifty soil samples were obtained and analyzed in March 1986, and ten of those sample points were resampled in September of the same year. The acidity of these soils, measured from a 1:1 soil/water mixture, typically ranged from 5.0 to 6.0 pH units (mean pH = 5.5). The cation exchange capacities ranged from about 5.0 to 35.0 meq/100 g (mean = 9.6). The mean percent organic matter and percent base saturation were 8.6 (sd = 4.94) and 74.2 (sd = 16.03), respectively. These values are expected to be similar and representative of the soils near other SLCs proposed for use by EOS. [SLC6a 1995]

Soils containing little or no calcium or magnesium carbonates have low buffering capacity. Acidic deposition poses a threat to ecosystems for which, because of local or regional geology (crystalline/metamorphic rock), soils and surface waters cannot neutralize acidified rain, snow, or dry-deposited materials. Vandenberg AFB soils have a high buffering capacity and do not originate from crystalline or metamorphic rock.

3.6.3 Wetlands and Floodplains

Two areas in the vicinity of the Spaceport scored positive for the three Corps of Engineers criteria for wetland determination: hydrology, dominant vegetation, and soils characteristics. These areas are a ditch near the former storage facility asphalt pad , and a pool of water in a trench south of the retention pond. The pool area is off-site and would not be disturbed during operations. The ditch area meets the Corps criteria for a wetland not normally considered jurisdictional, that is, "Non-tidal drainage and irrigation ditches excavated on dry land" (Federal Register Vol. 51, No. 219, p. 41217, Nov. 13, 1986). The overall project site location of the Spaceport is concluded to be a non-wetland as defined by the Army Corps of Engineers Delineation Manual. Since there are no jurisdictional wetlands affected by operation of the Spaceport, mitigation measures for wetlands are not required [SLC6a 1995] [SLC6b 1995].

No wetlands or floodplains were identified in environmental assessment documents for SLCs 2W [SLC2W 1991] and 3E [ATLAS 1991].

3.7 HAZARDOUS AND TOXIC MATERIAL USAGE

The hazardous and toxic materials that would be used on the launch complex are similar for each alternative SLC proposed for use by EOS. The primary liquid rocket motor fuels include hydrazine (N_2H_4), nitrogen tetroxide (N_2O_4), kerosene (RP-1), and liquid oxygen (LO_2). High pressure helium (GHe), gaseous nitrogen (GN_2), and other materials would also be on the complex. Fueling of the launch vehicles would be from service trucks or carts, which would make deliveries from existing permitted facilities on base. Fueling carts will meet all existing Air Force, DOT, and other applicable regulatory agency requirements. [SLC6a 1995]

None of the EOS Program missions will have radioactive materials onboard the spacecraft, except for minute quantities that may be used on certain mission in conjunction with instrumentation

3.8 HAZARDOUS WASTE GENERATION

General

The implementation of the EOS Program would result in the generation of small amounts of domestic, industrial, and hazardous waste. These wastes will be managed in compliance with environmental laws and regulations. In particular, launch operation contractors will use VAFB's hazardous waste management system and EPA identification numbers [SLC6a 1995]. Hazardous wastes and spills will be managed in accordance with the VAFB Hazardous Waste Management Plan and Spill Response Plan [ATLAS 1991].

<u>SLC-2W [SLC2W 1991]</u>

SLC-2 has removed hypergolic propellants from the site. Propellants are routinely recycled from overflow lines, and waste hypergol propellants are not routinely generated by SLC-2 launches. The Aerozine-50 system was improved by the addition of a scrubber water catch tank to replace the open pond of wastewater produced.

Deluge water captured during a launch operation may be considered either industrial waste or hazardous waste, depending upon its level of contamination. SLC-2 is currently implementing procedures to minimize the amount of contaminants in the deluge water and various other wastewaters in order to produce industrial waste rather than hazardous waste.

Waste minimization efforts are on-going, due to SLC-2's participation in VAFB efforts associated with Hazardous Waste Source Reduction and Management Review Act of 1989 [USAF 1995].

SLC-3E [ATLAS 1991]

Principal hazardous wastes that may be generated at SLC-3 prior to each launch of an Atlas II-family rocket include engine flush liquid contaminated with rocket fuel, scrubber water contaminated with hydrazine or nitrogen tetroxide, aerosol cans, spent solvents, spent freon, waste oils and hydraulic fluids, and oil- or solvent-contaminated waste rags. The principal hazardous waste that may be generated following a launch is the residue at the bottom of the SLC-3E retention basin. Insignificant amounts of hazardous wastes will be generated at the building where the Atlas IIAS solid rocket motors are received and checked out (Building 960 or 1670).

SLC-6 [SLC6a 1995]

Users of SLC-6 or the CSLC will be provided direction on the storage, use, and disposal of hazardous materials. The wastes from operations will be handled and disposed of in accordance with VAFB treatment, storage, and disposal permits. It is expected that no more than 22 kilograms (10 pounds) of solid hazardous waste (contaminated rags, clothing, etc.) and minimal amounts of liquid hazardous waste (waste oils, lubricants, greases, hydraulic fluid, and anti-freeze) would be generated as a result of customer operations. While the Spaceport operates as a commercially leased facility, all management of hazardous waste at the spaceport will be done in accordance with the VAFB Hazardous Waste Management Plan. This plan outlines standardized procedures for hazardous waste operations involving the identification, accumulation, labeling, storage, record keeping, transfer, disposal, and personnel protective equipment and safety training. Compliance with these procedures will be required of all Spaceport customers to effectively and legally manage any amount of hazardous waste generated.

3.9 HYDROLOGY AND WATER QUALITY

3.9.1 Surface Waters

Surface water resources near VAFB are characterized by three major stream drainage areas or watersheds[7]. Shuman Creek drains the northern portion of VAFB. The southern boundary of VAFB is located near Jalama Creek and the Jalama Creek drainage system. The Santa Ynez River bisects North and South VAFB and comprises the core of the Santa Ynez drainage system. In addition, one minor drainage area, the San Antonio drainage system, is present on North VAFB and is drained by San Antonio Creek. [SLC2W 1991]

Prominent drainages to the north of SLC-6 include Cañada Honda Creek, Spring Canyon, Bear Creek, and the Santa Ynez River. The Santa Ynez River is the only major drainage on South Vandenberg. The distances of these and other drainages from the proposed SLCs are listed in (Table 3-3). Drainages nearest SLC-3 are the Santa Ynez River and Bear Creek. SLC-2 is the furthest removed from local drainages. San Antonio Creek and the Santa Ynez River are about 4.8 and 6.4 kilometers (3 and 4 miles) from SLC-2, respectively.

[7] A watershed or drainage area is defined as the region surrounding a body of water from which precipitation discharges to join that body.

Table 3-3. Distances from Local Drainages to SLCs

Drainage	Distance to SLC-2	Distance to SLC-3	Distance to SLC-6
Cañada Honda Creek	Well beyond region of influence	5.0 km (3.1 miles)	3.7 km (2.3 miles)
Bear Creek	Well beyond region of influence	1.0 km (0.6 miles)	8.9 km (5.5 miles)
San Antonio Creek	5.3 km (3.3 miles)	Well beyond region of influence	Well beyond region of influence
Santa Ynez River	6.8 km (4.2 miles)	3.9 km (2.4 miles)	13.2 km (8.2 miles)

South VAFB has no permanent lakes, impoundments, rivers, or flood plains; however, several local drainages discharge directly into the Pacific Ocean. The flow rates associated with these drainages can be highly variable. Many of them flow only during storm events. Intense episodes would be expected to give high intermittent yields due to the relatively steep topography of the area. Some of the drainages are spring-fed, although ground percolation frequently traps the water flow before it reaches the ocean. [SLC6 1994]

3.9.1.1 Surface Water Quality

In general, the streams near SLC-6 are high in hardness, alkalinity, and specific conductance, but low in chemical oxidation demand, and total organic carbon. These streams also have high levels of certain elements such as calcium, iron, magnesium, and sodium. [SLC6 1994]

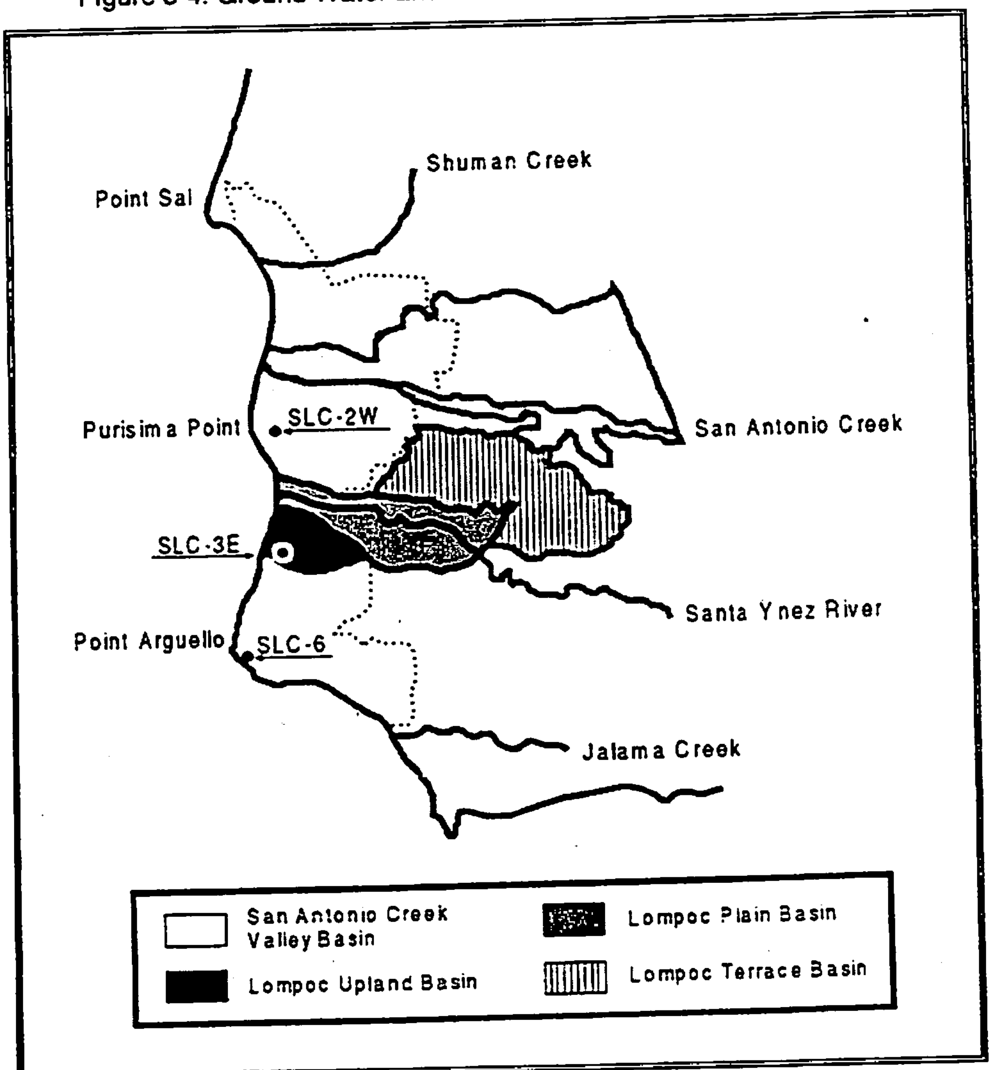
Surface flows have been sampled near SLC-2W and other space launch complexes on both North and South Vandenberg. Dissolved oxygen and pH values of not less than 5.0 mg/L and 6.5-8.5 pH units, respectively, are within the EPA's criteria for aquatic life. High levels of total dissolved solids, chloride, lead, and zinc in the surface water have resulted in the water generally being recognized as of poor to medium quality. [SLC2W 1991]

3.9.2 Ground Waters

The Monterey shale underlying the region supports a minimal amount of ground water in fracture zones. The lower member of this formation contains greater amounts of water than the upper member. The depths to the water table vary from 42 meters (138 feet) to 40 meters (131 feet). [SLC6 1994]

Ground water in the vicinity of VAFB is present in four ground water basins (Figure 3-4): the Lompoc Upland Basin, the Lompoc Plain Basin, the Lompoc Terrace Basin, and the San Antonio Creek Valley Basin. A ground water basin is a hydrogeologic unit containing one large aquifer or several connected and interrelated aquifers. In general, in a valley between mountain ranges, the ground water basin may occupy only the central portion of the stream drainage area. The three Lompoc basins are concentrated along the Santa Ynez River, while the San Antonio Creek Valley Basin is present along a part of the San Antonio Creek. Ground water is the sole potable water source on VAFB; ten wells are used to draw water from the first three basins for domestic and operational use. Ground water pumped by VAFB is also consumed at the adjacent U.S. Penitentiary and Federal Correctional Institute. Increased withdrawals from the area's ground water basins has created an overdraft condition that is affecting the availability and quality of water in these basins. Continued overdraft of the ground water basins could lead to a decrease in the water table levels, a compaction of the basins, and subsidence of the surface land; EOS is not expected to exacerbate the situation.

Figure 3-4. Ground Water and Surface Water in the Vicinity of VAFB



Source: Adapted from [SLC2W 1991]

The city of Lompoc and the surrounding incorporated communities receive their water from wells drilled in the Lompoc Plain and Lompoc Upland ground water basins. North VAFB receives about 30 percent of its water from the Lompoc Plain ground water basin, and South VAFB derives all of its water from the Lompoc Terrace ground water basin. North VAFB takes approximately 70 percent, or 2,850 acre-feet per year, of its water supply from the San Antonio Creek Valley Basin, which is overdrafted by 12,000 acre-feet per year. Total VAFB ground water usage is approximately 4,300 acre-feet per year.

3.9.2.1 Ground Water Quality

Samples taken at four of the wells near SLC-6 indicate that the quality of the ground water is low (Table 3-4). Three parameters, dissolved solids, hardness, and chloride were measured at high levels. These averaged 1,150 mg/L, 617 mg/L, and 343 mg/L, respectively. These compare with the respective State of California and EPA standards, which are as follows: 500 mg/L, 400 mg/L, and 250 mg/L. [SLC6a 1995]

Table 3-4. Vandenberg AFB Selected Ground Water Parameters (State of California and EPA standards)

Parameter	Concentrations Measured Near SLC-6 (mg/L)	Standard (mg/L)
Dissolved Solids	1,150	500
Hardness	617	400
Chlorides	343	250

Source: Adapted from [SLC6a 1995]

Ground water quality in the region meets all national Interim Primary Drinking Water Regulation standards. A slight decrease in water quality has occurred in the region due to the use of water for irrigation. As irrigation water flows through the soil and back to the basin, it entrains salt which increases the salinity of the ground water. [SLC2W 1991]

3.10 REGIONAL OVERVIEW OF BIOTIC RESOURCES

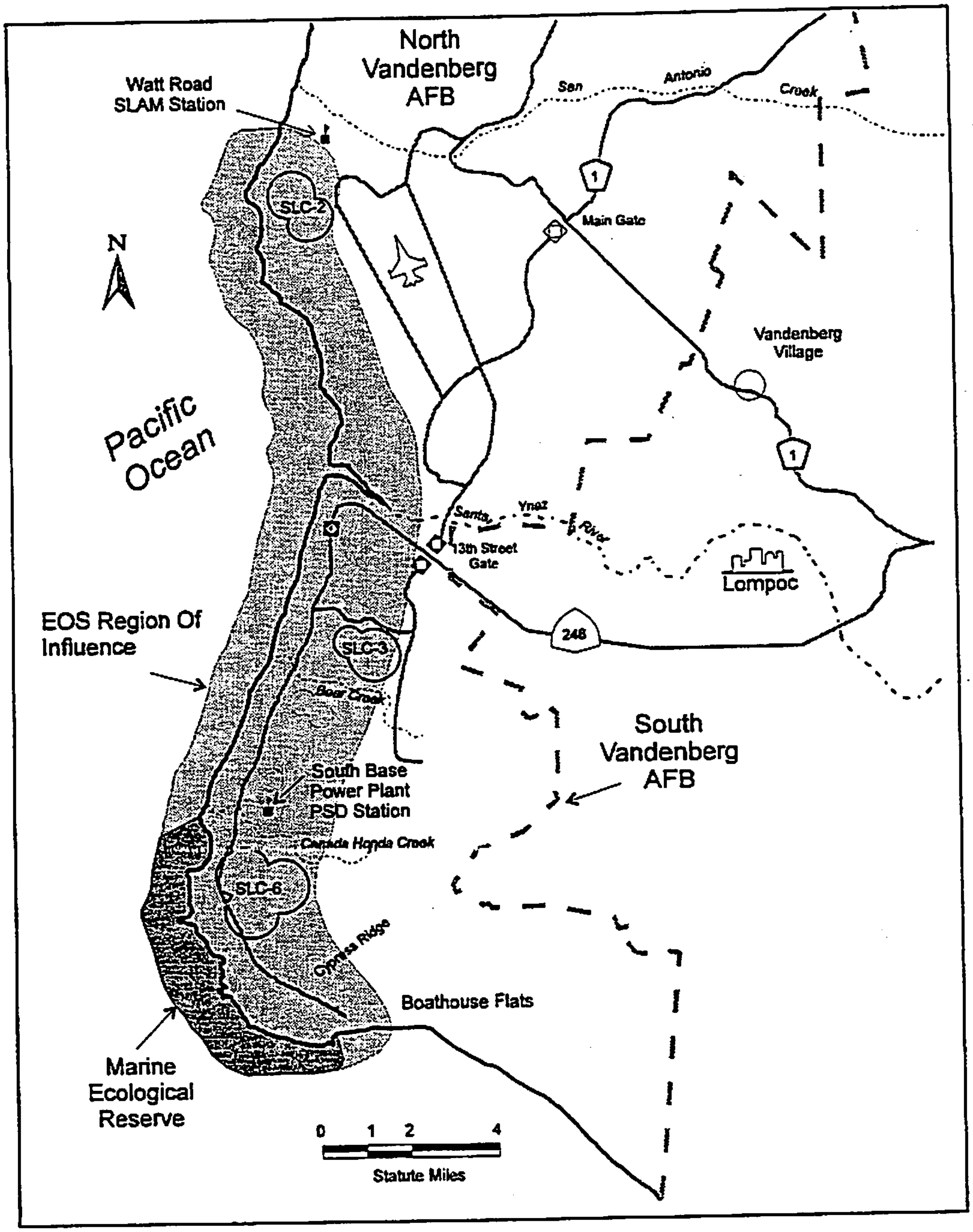
General

Vandenberg Air Force Base is recognized as a biologically important area, occupying a transitional zone between the cool, moist conditions of northern California and the semi-desert conditions of southern California. Consequently, many plant species, as well as plant communities, reach their northern or southern limits in this area. Plant communities of particular interest include tanbark oak forest, bishop pine forest, Burton Mesa chaparral, coastal dune scrub, and a variety of wetland types. [SLC6a 1995]

The portion of Vandenberg's coastline that lies within the EOS Region Of Influence (ROI), depicted in Figure 3-5, is occupied by several species of seabirds, marine mammals, and other species of interest (*i.e.*, threatened and endangered species) (Table 3-5). Harbor seals, protected under the Marine Mammal Protection Act, use the beaches south of Rocky Point as haulout[8] and pupping areas (breeding activities). Southern sea otters also feed in the offshore kelp beds and occasionally come onshore. Peregrine falcons nest on the rocky cliffs. Western gulls, brown pelicans, pigeon guillemots, pelagic[9] cormorants, rhinoceros auklets, black oystercatchers, and Brandt's cormorants use the rocky outcrops for roosting or nesting purposes. Three miles of Vandenberg's coastline are protected under agreement with the State of California as a marine ecological reserve. This area extends from Lookout Rock to Point Pedernales. [SLC6a 1995] Figure 3-5 depicts this area graphically. Vandenberg AFB has a memorandum of agreement with the California Department of Fish and Game for access to these areas for military operations and scientific research only [REb 1995].

[8] A haulout is an area where marine mammals haul themselves from oceans to congregate, breed, etc.
[9] marine

Figure 3-5. EOS Region of Influence and the California Marine Ecological Reserve



Source: Adapted from [SLCa 1995]

Table 3-5. VAFB Species of Concern

SPECIES	Potential Occurrence* SLC-6	SLC-3	SLC-2	STATUS[a] Federal	State	Other
Threatened/Endangered Species						
FISH						
Unarmored threespine stickleback (*Gasterosteus aculeatus williamsoni*)	X			FE	E	
Tidewater goby (*Eucyclogobius newberryi*)	X			FE		
REPTILES/AMPHIBIANS						
California red-legged frog (*Rana aurora draytonii*)	X	X		FT	SC	
Leatherback sea turtle (*Dermochelys coricea*)	O	O	O	FE		
Loggerhead sea turtle (*Caretta caretta*)	O	O	O	FT		
Green sea turtle (*Chelonia mydas*)	O	O	O	FT		
Pacific Ridley sea turtle	O	O	O	FT		
BIRDS						
American peregrine falcon (*Falco peregrinus anatum*)	X	X	X	FE	E	
California brown pelican (*Pelecanus occidentalis californianus*) (a transient species)[10]	X	X	X	FE	E	
Western snowy plover (*Charadrius alexandrinus nivosus*)	X	X	X	FT	SC	
California least tern (*Sterna antillarum browni*)			X	FE	E	
Bald eagle (*Haliaeetus leucocephalus*)				FE		
Southwestern willow flycatcher (*Empidonax traillii extimus*)		X		FE		
PLANTS						
Seaside bird's beak (*Cordylanthus rigidus*)					E	1B
Beach Layia (*Layia Carnosa*)		X		C	E	1B
Surf thistle (*Cirsium rhothophilum*)	X		X	C	T	1B
Spectacle pod (*Dithyrea maritima*)	X		X		T	
MAMMALS						
Southern sea otter (*Enhydra lutris nereis*)	X	X	O	FT	R	
Candidate Species						
INVERTEBRATES						
White sand dune scarab beetle (*Lichnanthe albopilosa*)			X	F		
Morro Bay blue butterfly (*Icaricia icaroides moroensis*)			X	F		
REPTILES/AMPHIBIANS						
Southwestern pond turtle (*Clemmys marmorata pallida*)	X	X		F	SC	
Two-striped garter snake (*Thamnophis hammondii*)	X			F		
California tiger salamander (*Ambystoma californiense*)				C	SC	
South coast garter snake (*Thamnophis sirtalis ssp.*)				F		
Silvery legless lizard (*Anniella pulchra pulchra*)	X	X	X	F		
California horned lizard (*Phrynosoma coronatum frontale*)	X	X	X	F		
Arroyo chub (*Gila orcutti*)				F		
Western spadefoot toad (*Scaphiopus hammondii*)				F		

[10] California brown pelicans are a common year-round visitor to VAFB, however they frequent many diverse sites.

SPECIES	Potential Occurrence*			STATUS[a]		
	SLC-6	SLC-3	SLC-2	Federal	State	Other
BIRDS						
Bell's sage sparrow (*Amphispiza belli belli*)	X			F		
Southern California rufous-crowned sparrow (*Aimophila ruficeps canescens*)				F		
Western burrowing owl (*Speotyto cunicularia hypugea*)	X	X	X	F	SC	
California black rail		X		C	SC	
White-faced ibis	O		O	F	SC	
Ferruginous hawk (*Buteo regalis*) (<u>a transient species</u>)	X	X		F	SC	
Long-billed curlew	O		X	F		
White-tailed kite (*Elanus leucurus*)	X		X		P	
Northern harrier (*Circus syaneus*)	X		X		SC	
Cooper's hawk	X		X		SC	
Prairie falcon	X		X		SC	
Long-eared owl					SC	
Short-eared owl	X				SC	
Belding's savannah sparrow (*Passerculus sandwichensis belding*)				F		
Large-billed savannah sparrow (*Passerculus sandwichensis rostratus*)				F		
Olive-sided flycatcher (*Contopus borealis*)				F		
Little willow flycatcher (*Empidonax traillii brewsteri*)		X		F		
Saltmarsh common yellowthroat (*Geothlypis trichas sinuosa*)				F		
Elegant tern (*Starna elegans*)				F		
Mountain plover (*Charadrius montanus*)				C		
Tricolored blackbird (*Agelaius tricolor*)			X	F		
White-faced ibis (*Plegadis chihi*)				F		
PLANTS						
Shagbark manzanita			X	F		1B
Lompoc Yerba Santa			X	C	R	1B
Aphanisma			X	F		3
Crisp monardella (*Monardella crispa*)	X		X	F		1B
San Luis Obispo Monardella (*Monardella frutescens*)	X		X	F		1B
Black flowered figwort (*Scrophularia atrata*)	X		X	F		3
La Graciosa thistle			X	C		1B
MAMMALS						
Sand Diego desert woodrat (*Neotoma lepida intermedia*)	X	X		F		
Townsend's Western big-eared bat (*Plecotus townsendii townsendii*)	X	X	X	F	SC	
Badger (*Taxidea taxus*)	X		X		SC	
Mountain Lion (*Felis concolor*)	X				P	
Greater western mastiff-bat (*Eumops perotis californicus*)				F		
Small-footed myotis (*Myotis ciliolabrum*)				F		
Long-eared myotis (*Myotis evotis*)				F		
Fringed myotis (*Myotis thysanodes*)				F		
Long-legged myotis (*Myotis volans*)				F		
Yuma myotis (*Myotis yumanensis*)				F		

SPECIES	Potential Occurrence*			STATUS[a]		
	SLC-6	SLC-3	SLC-2	Federal	State	Other
Other species of interest						
Right whale	O	O	O	FE		
Sperm whale	O	O	O	FE		
Humpback whale	O	O	O	FE		
Blue whale	O	O	O	FE		
Finback whale	O	O	O	FE		
Sei whale	O	O	O	FE		
Gray whale (*Eschrichtius robustus*)	O	O	O	FE		
California sea lion (*Zalophus californicus*)	O	O	O	P		
Northern fur seal (*Callorhinus ursinus*)	O	O	O	P		
Northern elephant seal (*Mirounga angustirostris*)	O	O	O	P		
Harbor seal (*Phoca vitulina richardsi*)	O	O	O	P		
Guadalupe fur seal (*Arctocephalus townsendii*)	O	O	O	FT		
Steller sea lion (*Eumetopias jubata*)	O	O	O	FT		
Golden eagle (*Aquila chrysaetos*)						
Habitats of interest						
Pinniped haulout and breeding areas						
Seabird nest and roost sites						
Wetland and riparian habitats						

Source: Data acquired from [SLC6a 1995], [SELVa 1992], [ATLAS 1991], [SLC2W 1993], [Federal register Vol. 61 No. 40, 2/28/96]
[a] FE = Federally listed as Endangered, FT = Federally listed as Threatened, C = Candidate for federal listing (USFWS has sufficient information on biological vulnerability and threat(s) to support proposals to list them as endangered or threatened species), F = federal species of concern (former Category 2 Candidate species) - Such species are the pool from which future candidates for listing will be drawn [Federal register Vol. 61 No. 40, 2/28/96]. E = State listed as Endangered, T = State listed as Threatened, R = Rare, P = Protected by State or Federal law, SC = CDFG Species of Special Concern, 1B = Candidate plants considered by the California Native Plant Society (CNPS) to be of highest priority, rare and endangered in California and elsewhere, 3 = Candidate plants considered by the CNPS to be possibly appropriate for candidate listing but for which more information is needed. * X = Possibly suitable habitat available on site or within the EOS region of influence, O = Offshore Species in the vicinity of Boathouse Flats are noted as potentially occurring near SLC-6. Correspondence with NMFS elicited concern for the threatened Guadalupe fur seal and the threatened Steller sea lion.
No other Federally listed species under the jurisdiction of the National Marine Fisheries Service (NMFS) are likely to be affected.

Terrestrial animal life consists of species common to coastal sage scrub, grassland, and chaparral communities. Common mammalian species occurring at VAFB include mule deer, coyote, bobcat, jackrabbit, cottontail, skunk, ground squirrel, and numerous nocturnal rodents. The larger, contiguous, relatively undisturbed tracts of native vegetation on South VAFB provide high-quality foraging habitat for wide-ranging carnivores like mountain lion, bobcat, black bear, badger, gray fox, and coyote, in addition to several regionally rare or declining hawks and owls. Reptiles and amphibians are represented by several snakes, the Pacific treefrog, western toad, and the California legless lizard, among others. The region contains a diversity of bird species, such as redtailed hawks, American kestrels, white-tailed kites, and numerous common land birds. Shore birds are abundant on all sandy beaches. California brown pelicans and the California least tern occur at several locations along the coast. The western snowy plover is considered a year-round resident of VAFB. A harbor seal population haulout site occurs at Purisima Point, which is identified in the National Marine Fisheries Service census as a breeding rookery in their annual harbor seal census. The southern sea otter is found at various rocky areas along the VAFB coastline. A small colony of sea otters was found near Purisima Point in 1990 and was still intact in 1992. Brown pelicans do not breed on VAFB, but are transient visitors to the coast. [SLC2W 1993]

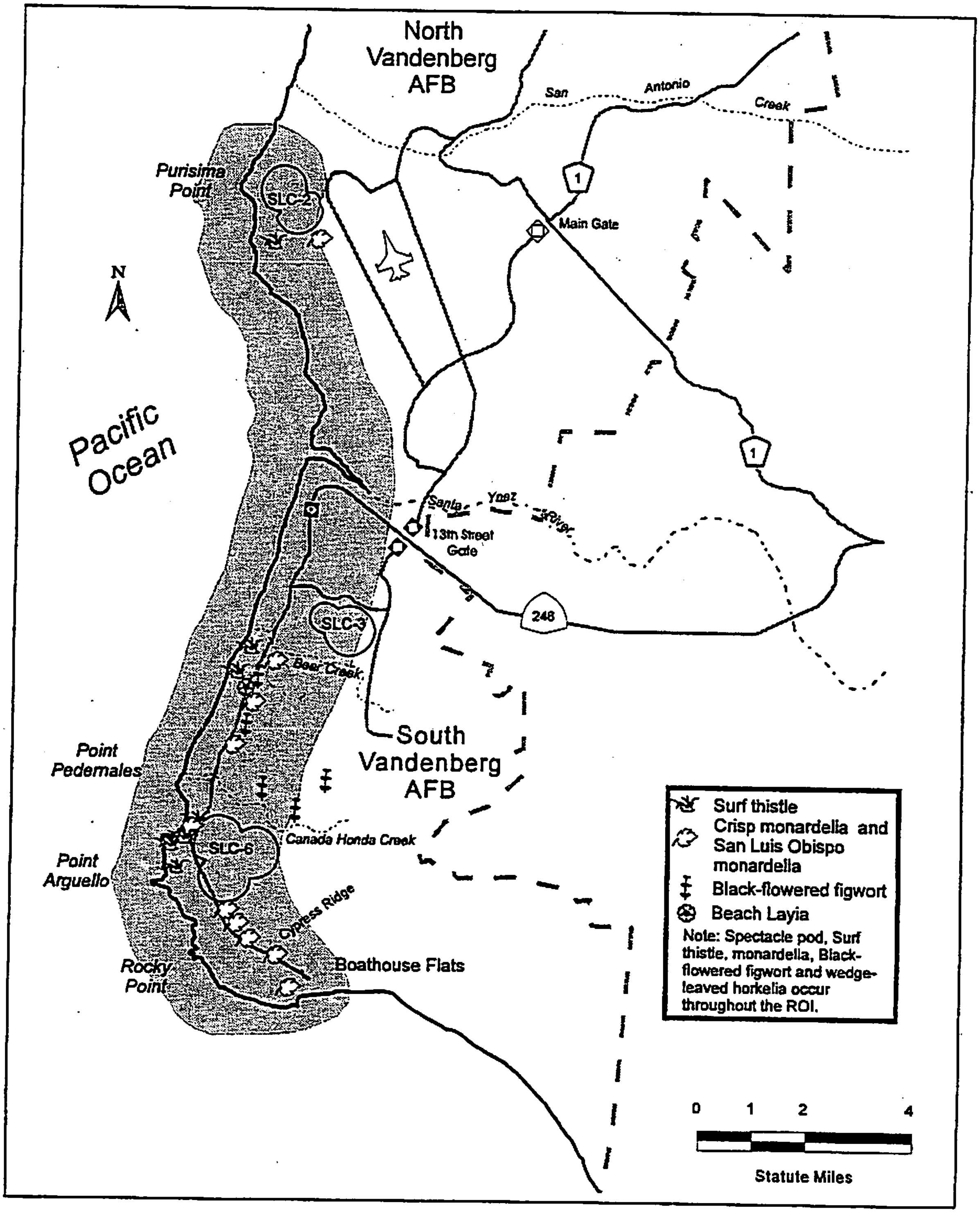
Due to the predominance of southerly and westerly exposures, the region's vegetation is primarily central coastal scrub or coastal sage scrub, grassland, and chaparral community types. The riparian vegetation of drainages in the area provide important habitat for wildlife. Plant communities of particular interest include tanbark oak forest, bishop pine forest, Burton Mesa chaparral, coastal dune scrub, and a variety of wetland types. [SLC6a 1995]

Approximately 30 vegetative assemblages, representing more than 15 distinct plant communities, have been identified within VAFB boundaries. Plant communities include coastal saltmarsh, coastal sage scrub, central dune scrub, riparian woodland, a variety of chaparral types, and diverse upland woodland communities. This diversity results from variation in topography, elevation, geology, and proximity to the coast. Approximately 85 percent of VAFB supports a "natural" vegetation; the remaining 15 percent supports a ruderal, or disturbed, vegetation or is developed for human use. [ATLAS 1991]

The flora of VAFB comprises approximately 624 species and subspecies, approximately 21 percent of which are alien to California; the remaining 79 percent are native. Local flora includes a number of sensitive plant taxa, including several species recognized as rare, threatened, or endangered by the state or federal government. [ATLAS 1991]

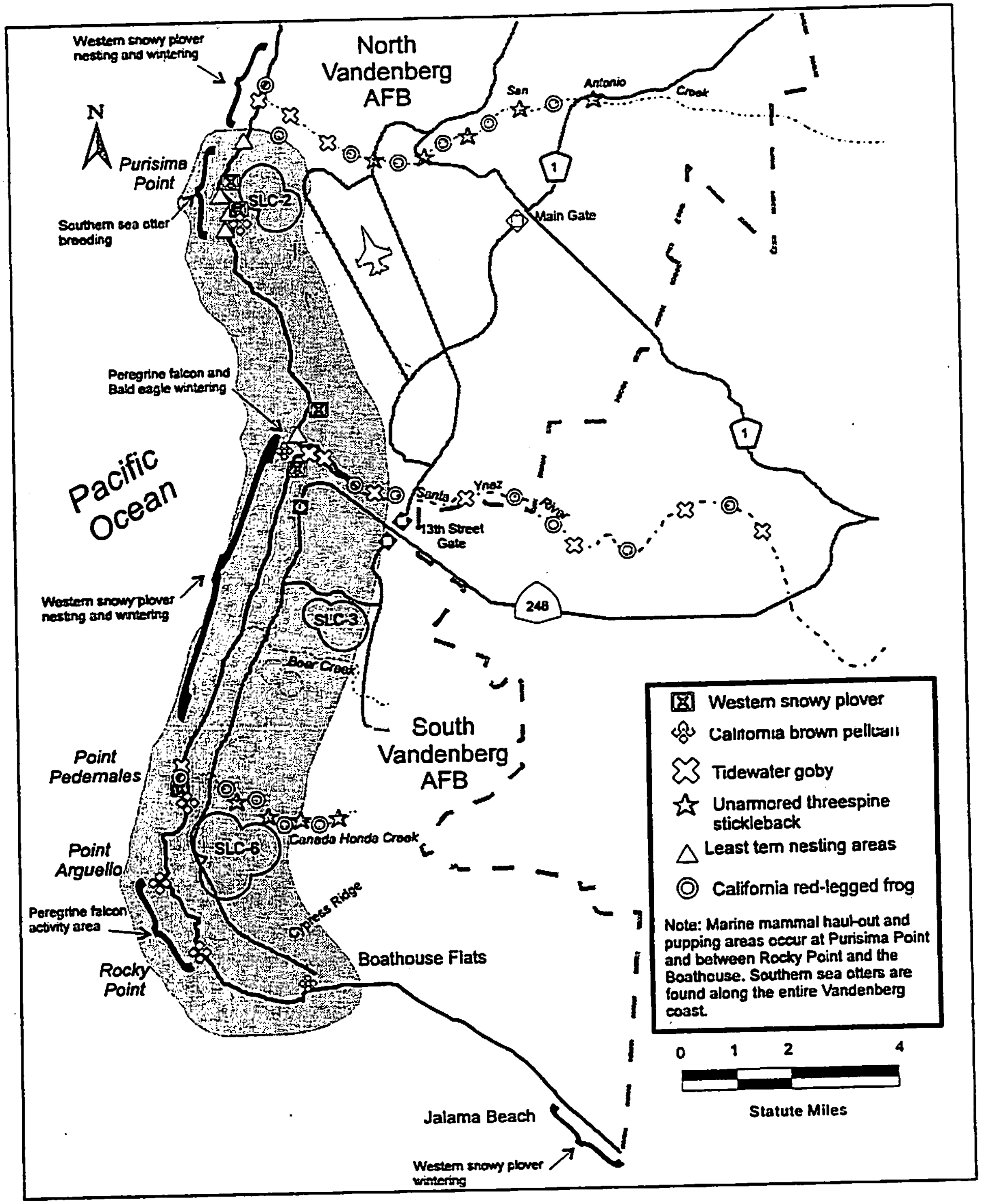
Some species of concern, and their approximate locations relative to SLCs proposed for use by EOS are depicted in Figures 3-6 and 3-7.

Figure 3-6. Threatened/Endangered Flora Within the Region of Influence



Source: Adapted from [SLC6a 1995]

Figure 3-7. Threatened/Endangered Fauna Within the Region of Influence



Source: Adapted from [SLC6a 1995]

3.10.1 Overview of Marine Bird Biota [ATLAS 1991]

The marine bird fauna of the waters offshore of VAFB and the northern Channel Islands is large and complex. Many of the 101 species of seabirds recorded for California could occur in this area. The abundance and diversity of the marine avifauna in the project region is due to proximity of the Channel Islands, the location of the Santa Barbara Channel along the Pacific Flyway, and the location of the project at a biogeographical boundary between warm southern and cold northern/offshore water masses.

The open ocean water of the continental shelf, a 20 kilometer-wide (12.4 mile-wide) zone in the vicinity of VAFB, is highly productive and thus an important seabird habitat. Ten to thirty species of seabirds are known to frequent these waters. Seabird numbers are highest over the shelf during the summer; when sooty shearwaters predominate. Large numbers of arctic loons, sooty shearwaters, red and red-necked phalaropes, and Bonaparte's gulls pass across the shelf waters of the ROI during their annual spring and fall migrations. This area is especially important as a feeding area for seabirds during the fall. Seabird abundance in the shelf waters of the project region are lowest in winter; Cassin's auklet, common murre, and western gull are the most abundant at that time.

Nearshore waters (within one kilometer (0.6 miles) of shore) are used as resting and foraging habitat by loons, grebes, cormorants, scoters, phalaropes, gulls, terns, and some alcids during all seasons of the year. Highest abundances occur during the spring and summer. During the fall (October to mid-December) and spring (March to May) migration periods, many of the loons, brants, scoters, gulls, and terns that winter south of Point Conception pass through nearshore waters adjacent to SLC-3E, often within one kilometer (0.6 miles) of the shoreline. Gulls, cormorants, and brown pelicans predominate in nearshore waters of the region during the summer and fall. During the winter, large flocks of gulls and terns can be found on beaches in the region.

Rocky shorelines are used by pelicans, cormorants, gulls, and terns for roosting and nesting, and by a variety of shorebirds, such as black oystercatcher, wandering tattler, black and ruddy turnstones, willet, and surfbird for foraging. Significant rocky shoreline habitat occurs around the northern Channel Islands and, in a somewhat disjunct form, in the Point Conception and Rocky Point to Point Pedernales vicinities near the southern boundary of VAFB. These areas are approximately six to nine kilometers (9.7 to 14.5 miles) from SLC-3, three to four kilometers (4.8 to 6.4 miles) from SLC-6, and well beyond the ROI of SLC-2. The closest Channel Island (San Miguel) is approximately 65 kilometers (105 miles) from SLC-3, 60 kilometers (96.6 miles) from SLC-6, and 75 kilometers (121 miles) from SLC-2. Documented nesting sites between Point Conception and Point Arguello include Point Pedernales and Destroyer Rock (pigeon guillemot), Point Arguello (pelagic cormorant, black oystercatcher, western gull, pigeon guillemot, and rhinoceros auklet), Rocky Point (black oystercatcher and pigeon guillemot), and Point conception (pelagic cormorant and pigeon guillemot). About 1,000 breeding pairs have been observed using these areas. Cormorants, brown pelicans, and a variety of gulls also use the breakwater at the boathouse on South VAFB for roosting during the fall and winter.

The Channel Islands (Figure 3-8) are inhabited by breeding colonies of 11 species of marine birds, composed of about 24,000 pairs. By far the largest and most important colonies occur on San Miguel Island and its two associated islets, Prince Island and Castle Rock. 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 (*i.e.*, Leach's and ashy storm-petrels, Brandt's, double-crested and pelagic cormorants, pigeon guillemot, and Cassin's auklet). Brown pelicans breed regularly on western Anacapa and Santa Barbara Islands and occasionally on Scorpion Rock, off Santa Cruz Island.

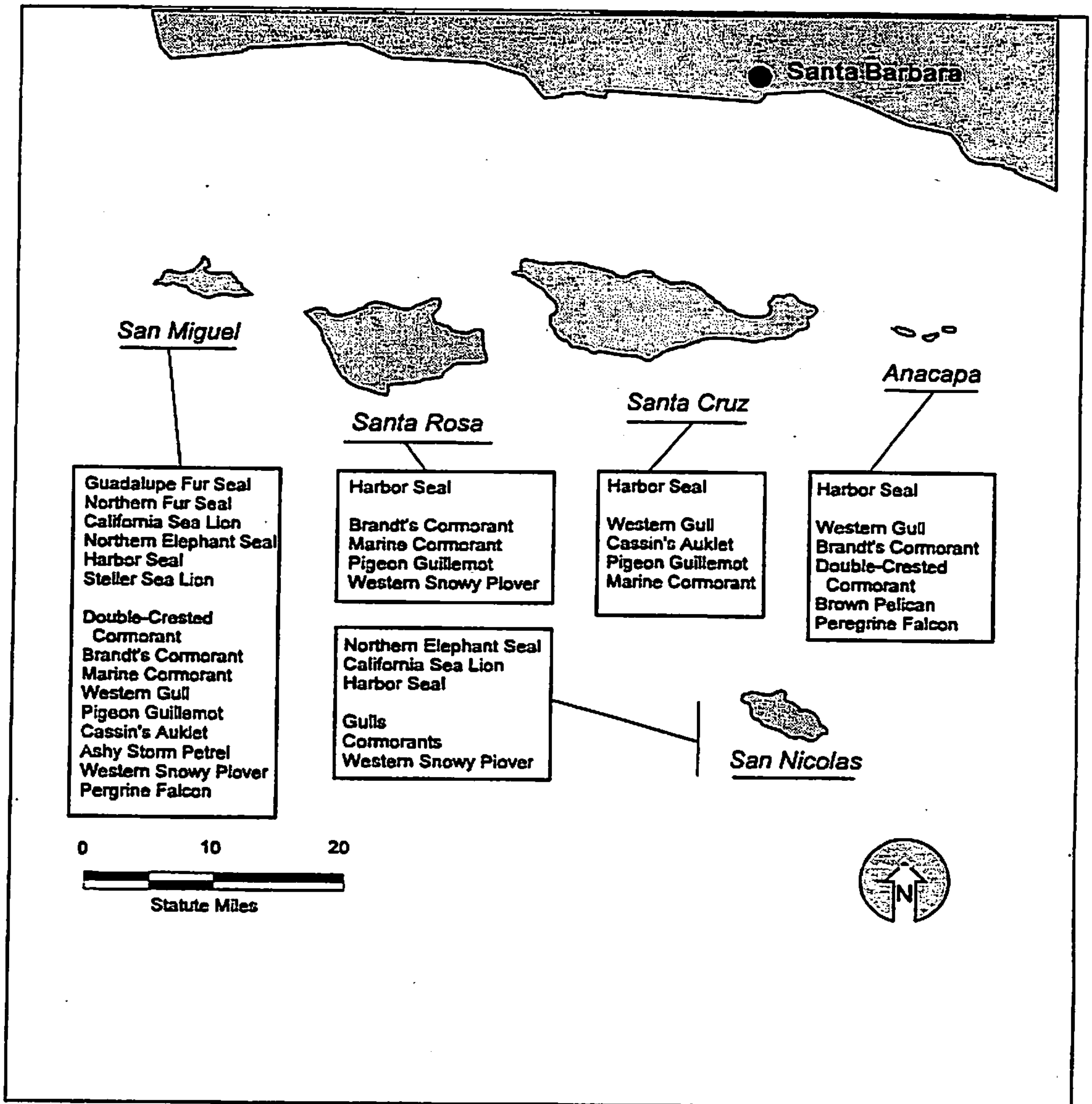
A sandy beach habitat is widespread along the southern coast of Santa Barbara County, on the northern Channel Islands, and in the Point Conception to Point Sal area. Much of this habitat has been disturbed by human use. Moderately sized, relatively undisturbed coastal dunes and associated sandy beaches occur on North VAFB from Shuman Creek south to the mouth of the Santa Ynez River. Shorebirds, such as black-bellied plover, snowy plover, willet, whimbrel, long-billed curlew, marbled godwit, sanderling, and several species of gulls and terns frequent sandy beaches in the region for foraging and roosting. Water pipit, yellow-rumped warbler, black turnstone, and short- and long-billed dowitchers forage along the upper portions of beaches, where rotting kelp attracts invertebrate prey. Species known to breed in the sandy beach and backdune habitats of the region include horned lark, Brewer's blackbird, and house finch. In addition, the state and federally listed endangered least tern and the federally threatened snowy plover are known to use this habitat for nesting. Least terns 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. Snowy plovers nest on San Nicolas, Santa Rosa, and San Miguel islands, on VAFB near the mouth of the Santa Ynez River, and on Purisima Point Beach.

3.10.2 Overview of Marine Mammal Biota [ATLAS 1991]

The coastal waters encompassing south VAFB and the northern Channel Islands (Figure 3-8) support diverse marine mammal assemblages. The sea otter, six species of pinniped (seals), and more than 25 species of cetacean (whales) inhabit the regions either as residents or transients. The Marine Mammal Protection Act of 1972 protects all marine mammals inhabiting the study region. The Santa Barbara County Local Coastal Plan identifies marine mammal haulout and pupping grounds as environmentally sensitive habitat and delineates policies designed to help protect these areas.

The California sea lion, northern fur seal, northern elephant seal, and the harbor seal use the northern Channel Islands as haulout, mating, and pupping grounds (breeding activities). The pupping season on the Channel Islands extends from December through August (Table 3-8). The largest concentration of marine mammals occurs on San Miguel Island, the only Channel Island that supports colonies of northern fur seal. The Guadalupe fur seal, which historically occurred in great abundance on the Channel Islands, is now a rare visitor to the western shores of San Miguel. San Miguel presently is the northern limit of Guadalupe fur seal range. The Steller sea lion once used San Miguel Island as a rookery, but pupping has not been known to occur there since the late 1970's, and no Steller sea lions have been observed on San Miguel since 1985. Approximately 75 percent of the estimated 135,000 seals and sea lions that inhabit the Southern California Channel spend at least some portion of the year in the northern Channel Islands. The range of the southern sea otter, once abundant along the entire coast of California, generally does not extend south of San Luis Obispo. Isolated individuals, however, are sighted frequently along the coast of VAFB. Sea otters have been the focus of recent reintroduction efforts in the southern Channel Islands.

Figure 3-8. Occurrence of Breeding Populations of Marine Mammals and Sea Birds on Northern Channel Islands



Source: Adapted from [SELVa 1992]

Table 3-6. Pupping Season for Marine Pinnipeds in the Region of VAFB and the Northern Channel Islands

Marine Pinnipeds	Pupping Season
Northern elephant seal	December-February
Harbor seal	February-April
California sea lion	May-July
Northern fur seal	June-July
Guadalupe fur seal	Pupping Not Known to Occur in ROI
Steller sea lion	Pupping Not Known to Occur in ROI

Source: Adapted from [ATLAS 1991]

The Rocky Point area of South VAFB contains 12 haulout sites used by harbor seals and, to a lesser extent, by California sea lions, elephant seals, and northern fur seals. During a 1988 survey, 533 harbor seals were counted at these sites. Harbor seal breeding activity has been observed in the Vandenberg area.

Eleven marine animals on the federal list of threatened or endangered species are present in the Channel Islands/VAFB region and surrounding ocean. The distribution of seven of these are not close enough to the EOS ROI area and related activities to be impacted. Four species — the southern sea otter, Guadalupe fur seal, Steller sea lion (all three federally-listed threatened species), and gray whale (federally-listed endangered species) — may be impacted. The gray whale is a transient species in the study region, known to pass close to Point Conception on fall and spring migrations between summer habitats off Alaska and Canada and winter habitats in the lagoons off Baja California. Species proposed for federal listing in the vicinity of EOS proposed SLCs are discussed in the following section and Appendix D.

3.10.3 Overview of Threatened/Endangered Species in the Vicinity of SLC 2, 3 & 6

General

Numerous plant and animal species of special interest live in or around the VAFB region. The following subsections provide a brief description of the sensitive wildlife resources found within the vicinity of those SLCs proposed for use by EOS — 2W, 3E, and 6. Species include those listed by state and federal agencies as either threatened or endangered, as well as those under review by the federal government for listing. Candidate and former Category 2 candidate species in the vicinity of EOS SLCs are discussed where information on their occurrence is available. Former Category 2 candidate species are included, because such species are the pool from which future candidates for listing will be drawn [Federal register Vol. 61 No. 40, 2/28/96]. See Appendix D for further discussion of the threatened and endangered species, as well as regionally occurring candidate species.

3.10.3.1 SLC-2W Species of Concern

There are no threatened or endangered amphibians, reptiles, or land mammals known to occur in the vicinity of SLC-2. However, two federally endangered bird species (the California brown pelican and California least tern) are known to occur in the SLC-2 area. One, the California brown pelican, is a transient species and does not nest or breed on VAFB. One federally threatened mammal (the southern sea otter), one federally threatened bird (the western snowy plover), and two state threatened plant species (the surf thistle and spectacle pod), have been reported or are expected to occur near SLC-2. There are also eight former Category 2 candidate species that could occur in the SLC-2 area (Table 3-7).

Table 3-7. SLC-2 Species of Concern

SPECIES*	STATUS		
Threatened/Endangered Species	Federal	State	Other
BIRDS			
California brown pelican (*Pelecanus occidentalis californianus*) (a transient species)	FE	E	
Western snowy plover (*Charadrius alexandrinus nivosus*)	FT	SC	
California least tern (*Sterna antillarum browni*)	FE	E	
MAMMALS			
Southern sea otter (*Enhydra lutris nereis*)	FT	R	
PLANTS			
Surf thistle (*Cirsium rhothophilum*)	C	T	1B
Spectacle pod (*Dithyrea maritima*)		T	
Candidate Species			
INVERTEBRATES			
White sand dune scarab beetle (*Lichnanthe albopilosa*)	F		
Morro Bay blue butterfly (*Icaricia icaroides moroensis*)	F		
REPTILES/AMPHIBIANS			
Silvery legless lizard (*Anniella pulchra pulchra*)	F		
BIRDS			
Mountain plover (*Charadrius montanus*)	C		
PLANTS			
Crisp monardella (*Monardella crispa*)	F		1B
San Luis Obispo Monardella (*Monardella frutescens*)	F		1B
MAMMALS			
Townsend's Western big-eared bat (*Plecotus townsendii townsendii*)	F	SC	
Habitats of interest			
Pinniped haulout and breeding areas			
Seabird nest and roost sites			

Source: Data acquired from [SLC6a 1995], [SELVa1992], [ATLAS 1991], [SLC2W 1993], [Federal register Vol. 61 No. 40, 2/28/96] and [REb 1995] Please see Table 3-5 for an explanation of status designations.

3.10.3.1.1 Threatened/Endangered Species: Birds

California Brown Pelican [SLC2W 1993]

The California brown pelican does not nest or breed on VAFB, but is a transient visitor to the area. No impact to breeding brown pelicans on the Northern Channel Islands is predicted to occur from sonic booms as a result of launching the Delta II from SLC-2W. Based on actual recorded data on sonic boom levels and observations of wildlife, the Air Force determined that the Space Shuttle sonic boom would not have a significant impact on wildlife species inhabiting the Channel Islands. Since the magnitude of the sonic boom is directly associated with the size of the vehicle and the size of its exhaust plume, the magnitude of the sonic booms associated with the Delta II is estimated to be far less than that of the Shuttle.

California Least Tern [SLC2W 1993]

Although the least tern is a fairly common 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, it is a rare but regular transient and post-breeding visitor to near shore habitats in the SLC-2 area.

The least tern has historically established nesting colonies on VAFB in the coastal foredunes at the mouths of the Santa Ynez and San Antonio Lagoons and at the dunes near Purisima Point. Two sites were observed on VAFB during the 1992 breeding season, one at Purisima Point and one located one to two kilometers (0.6 to 1.2 miles) north of Purisima Point. The terns also congregate at the mouth of the Santa Ynez River before migrating south. In northern Santa Barbara county and southern San Luis Obispo County, least terns have been recorded breeding at six localities during the 1980s: Pismo Beach, Oso Flaco Lake, Guadalupe Dunes near the mouth of the Santa Maria River, the mouth of the San Antonio Creek, Purisima Point, and the mouth of the Santa Ynez River. In general, the nesting success at these six colonies near SLC-2W has been low due to cold windy conditions prevalent at several of the dune locations (*i.e.*, Guadalupe Dunes and Purisima Point), high water levels in the Santa Ynez river estuary, fluctuations in the availability of suitable prey, and presence of predators (coyotes, etc.) at some of the colony sites.

Although the nesting colonies in Santa Barbara and San Luis Obispo counties are small (1 to 30 nesting pairs) and contain only approximately 5.8 to 12.3 percent of the species' total estimated state-wide population, they are, nevertheless, significant in that they represent the only active areas between Ventura County and the San Francisco Bay. These colonies are important to the geographic breeding range of the species.

Despite the fact that the least tern nesting colony at the mouth of the Santa Ynez River is intermittent and quite small, large numbers of least terns have been recorded using this area following the nesting season. The Santa Ynez River apparently is a key area for feeding, roosting, and for post-fledgling congregation of adults and juveniles. Preliminary observations from banding studies of least terns recorded northward movements of post-breeding birds from Venice Beach in Southern California to the mouth of the Santa Ynez River. In most years, this area is used by 20 to 25 adults and fledglings for foraging and roosting following the breeding season.

The VAFB colony at Purisima Point had mixed success in 1992. With a total of 26 nests, 41 total eggs and a final count of 26 chicks, the fledgling count was only four. The 1992 breeding season was greatly affected by a high rate of natural predation. A total of six nests were lost due to confirmed predation, and five others were abandoned. The abandonment may have been due to such reasons as El Niño having a detrimental affect on the colonies in producing a lack of food. High winds of early June also were detrimental; covering nests with sand, possibly leading to the abandonment of nests by adult terns.

The closest observed nesting area is located at least 731 meters (2,400 feet) away from the launch point at SLC-2W.

<u>Western Snowy Plover</u>

Snowy plovers have been systematically surveyed by observers on foot at VAFB from Minuteman Beach (adjacent to Point Sal) to Purisima Point (about 1.6 kilometers (1 mile) NW of SLC-2) since 1980. Point Reyes Bird Observatory have also conducted extensive studies throughout California and the project area near Purisima Point which is between Point Sal and Point Conception. The western snowy plovers have been surveyed on a monthly basis for most years through 1992. [SLC2W 1993]

3.10.3.1.2 Threatened/Endangered Species: Mammals

Southern Sea Otter [SLC2W 1993]

The California sea otter, once abundant along the entire coast of California, is not now generally found south of San Luis Obispo in large populations. Isolated individuals, however, are sighted frequently along the coast of VAFB. Sea otters have been the focus of recent reintroduction efforts in the southern Channel Islands. In 1990, a small breeding colony was discovered in the vicinity of Purisima Point (about 1.6 kilometers (1 mile) NW of SLC-2) and was still intact in 1992. Some of the colony may have immigrated from San Nicolas Island.

3.10.3.1.3 Threatened/Endangered Species: Plants

Surf Thistle and Spectacle Pod

Vegetation within the facility boundary of SLC-2W is very sparse, with some dune mint present [SLC2W 1993]. Surf thistle and coast spectacle pod are known to occur near SLC-2W. Studies during June of 1991 found that in both species, the populations as a whole appear to be stable, although the status of mini-populations on individual dunes are variable because of the active nature of dune habitat.

3.10.3.2 SLC-3 Species of Concern [ATLAS 1991]

Wildlife in the vicinity of this launch center are less diverse than elsewhere on VAFB due to: (1) the absence of habitats known to support higher species diversities, (2) the high level of past and present anthropogenic disturbance, and (3) the predominance of habitats known to contain relatively low wildlife species diversities (*i.e.*, chaparral, central dune and coastal sage scrub, ruderal/disturbed habitats).

There are no endangered amphibian, reptile, or land mammals known to occur near SLC-3; however, the California red-legged frog has been recently listed (May 24, 1996) as threatened (61 FR 25813) and may be found there. One federally endangered species, the tidewater goby has resident populations on South Vandenberg, but is not expected to turn up in the immediate vicinity of SLC-3 because the habitat and environmental conditions there are not suitable. Three bird (the California brown pelican, western snowy plover and American peregrine falcon) and one mammal species (the southern sea otter) that are either federally or state listed as endangered or threatened have been reported or are expected to be seen near SLC-3. An additional bird species, the Southwestern willow flycatcher, has recently been listed as endangered on February 27, 1995 (60 FR 10694) and may occur in the vicinity.

There are seven former Category 2 candidate species that could occur in the SLC-3 area. Of these, the southwestern pond turtle has resident populations on South VAFB, but this species is not expected to occur at or in the immediate vicinity of the SLC-3 site because of unsuitable habitat and environmental conditions. Of the six other candidate species, there are two birds, two land mammals, one reptile and one plant species. These species and their status are listed in Table 3-8.

Table 3-8. SLC-3 Species of Concern

SPECIES	STATUS		
	Federal	State	Other
Threatened/Endangered Species			
REPTILES/AMPHIBIANS			
California red-legged frog (*Rana aurora draytonii*)	FT	SC	
BIRDS			
California brown pelican (*Pelecanus occidentalis californianus*) (a transient species)	FE	E	
Western snowy plover (*Charadrius alexandrinus nivosus*)	FT	SC	
Southwestern willow flycatcher (*Empidonax traillii extimus*)	FE		
American peregrine falcon (*Falco peregrinus*)	FE	E	
MAMMALS			
Southern sea otter (*Enhydra lutris nereis*)	FT	R	
Candidate Species			
REPTILES/AMPHIBIANS			
Southwestern pond turtle (*Clemmys marmorata pallida*)	F	SC	
Silvery legless lizard (*Anniella pulchra pulchra*)	F		
BIRDS			
Western burrowing owl (*Speotyto cunicularia hypugea*)	F	SC	
Little willow flycatcher (*Empidonax traillii brewsteri*)	F		
PLANTS			
Black-flowered figwort (*Scropularia atrata*)	F		3
Beach Layia (*Layia Carnosa*)	C	E	1B
MAMMALS			
Sand Diego desert woodrat (*Neotoma lepida intermedia*)	F		
Townsend's Western big-eared bat (*Plecotus townsendii townsendii*)	F	SC	
Habitats of interest			
Pinniped haulout and breeding areas			
Seabird nest and roost sites			

Source: Data acquired from [SLC6a 1995], [SELVa 1992], [ATLAS 1991], [SLC2W 1993], [Federal register Vol. 61 No. 40, 2/28/96] and [REb 1995] Please see Table 3-5 for an explanation of status designations.

3.10.3.2.1 Threatened/Endangered Species: Reptiles and Amphibians

California Red-Legged Frog

The California red-legged frog has been recently listed (May 24, 1996) as threatened (61 FR 25813). However, there are no records of red-legged frogs from riparian habitats within the area near SLC-3E. Although the riparian and in-stream habitats in Bear Creek appear to be suitable for sustaining a small population of red-legged frogs, the species has yet to be recorded there. The closest red-legged frog populations to SLC-3 are in Honda and Jalama creeks and along the Santa Ynez River at the 13th Street bridge. [ATLAS 1991]

Consultation with the USFWS for the California red-legged frog will be completed by VAFB officials prior to launch of EOS spacecraft [JO 1996].

3.10.3.2.2 Threatened/Endangered Species: Birds

California Brown Pelican

The California brown pelican does not nest or breed on VAFB, but is a transient visitor to the area [SLC2W 1993]. No impact to breeding brown pelicans on the Northern Channel Islands is predicted to occur from sonic booms as a result of launching the Atlas from SLC-3E. Preliminary analyses indicate that Atlas focused sonic booms would occur north of San Miguel Island, not overhead [ATLAS 1991].

Western Snowy Plover

The western snowy plover has resident populations on south VAFB, but this species is not expected to occur at, or in the immediate vicinity of, SLC-3 because the habitat and environmental conditions there are not suitable. [ATLAS 1991]

Consultation with the USFWS for the western snowy plover for launches from SLC-3 will be completed by VAFB officials prior to launch of EOS spacecraft [JO 1996].

Southwestern Willow Flycatcher

Several canyons on South VAFB contain willow riparian habitats of sufficient size and quality to be used by willow flycatchers during migration (*i.e.*, Bear, Spring and Honda creeks). This species is expected to frequent the willow woodlands along Bear Creek near SLC-3E as an uncommon fall and rare spring transient. [ATLAS 1991]

The southwestern willow flycatcher was listed as endangered on February 27, 1995. Consultation with the USFWS for the southwestern willow flycatcher for launches from SLC-3 will be completed by VAFB officials prior to launch of EOS spacecraft [JO 1996].

American Peregrine Falcon

Habitats found at the SLC-3 are not expected to support any resident state or federally listed threatened or endangered species of birds. Although the peregrine falcon can be expected to fly over the project site occasionally and is regularly found roosting and foraging at the Santa Ynez estuary during winter, there is no suitable nesting or foraging habitat available for this species at SLC-3. The ferruginous hawk, a former Category 2 candidate species for federal listing, was observed foraging and roosting within the SLC-3E area during the December 1990 field surveys for the Atlas II Program. This species can be expected to visit the area infrequently during the winter months. Other regionally rare or declining species expected to frequent habitats found on the SLC-3 site include wide-ranging raptors and owls and several perching birds. None of these species is expected to nest at SLC-3E. [ATLAS 1991]

Southern Bald Eagle

Eagles are not known or expected to occur along the immediate coast near SLC-3E [ATLAS 1991]. However, Bald eagles have been observed wintering at the Santa Ynez estuary.

3.10.3.2.3 Threatened/Endangered Species: Mammals

Southern Sea Otter

Southern sea otters frequent the coastal and offshore habitats adjacent to VAFB. In addition, a breeding colony is established near Purisima Point on North Vandenberg. In the South Vandenberg area, southern sea otters feed offshore in kelp beds near the Boathouse, Cañada Aqua Viva, Water Canyon, Cañada del Morida, and Jalama Creek. However, there are no permanent populations of southern sea otters along the coast of South Vandenberg at this time. [SLC6a 1995]

3.10.3.2.4 Candidate Species: Reptiles/Amphibians

Southwestern Pond Turtle and Silvery Legless Lizard

The southwestern pond turtle and silvery legless lizard have resident populations on South VAFB; however, these species are not expected to occur at or in the immediate vicinity of SLC-3 because of unsuitable habitat and environmental conditions [ATLAS 1991].

3.10.3.2.5 Candidate Species: Plants

Beach Layia

Beach Layia is an annual plant that lives for a single season between March and June. It was discovered along Coast Road in 1994 approximately 0.40 kilometers (0.25 miles) north of Kelp Road and SLC-4. Biological monitoring of Beach Layia was performed for a Titan IV launch from SLC-4 on May 12, 1996. There were no observable impacts to the plants and no changes to the pH paper laid out to record acidic deposition [GI 1996]. Considering SLC-3 is approximately 3 kilometers (2 miles) from the nearest occurrence of Beach Layia and the HCl emitted by the Atlas IIAS at launch is approximately four percent of that emitted by Titan IV, there is almost no chance that Atlas IIAS launches would substantially impact Beach Layia.

Consultation with the USFWS for beach layia will be completed by VAFB officials prior to launch of EOS spacecraft [JO 1996].

Black-flowered Figwort

The historic range of black-flowered figwort extends into to the Vandenberg region, although its genetic integrity is decreasing along the central coast due to hybridization with the more common species, California figwort. The hybrid form occurs along the canyon slopes of Bear Creek, and a few pure black-flowered figwort occur within the SLC-3 area. [ATLAS 1991]

3.10.3.3 SLC-6 Species of Concern [SLC6a 1995]

There are no threatened or endangered reptiles, amphibians, or land mammals in the vicinity of SLC-6 (Table 3-9). Four federally endangered bird and fish species (the unarmored three-spine stickleback, tidewater goby, American peregrine falcon and the California brown pelican) and one federally threatened bird species (the western snowy plover) have been reported or are expected to occur at or in the immediate vicinity. Seven former Category 2 candidate reptile/amphibian, bird, plant and mammal species are expected to occur at or near this launch site.

Table 3-9. SLC-6 Species of Concern

SPECIES	STATUS		
Threatened/Endangered Species	Federal	State	Other
FISH			
Unarmored threespine stickleback (*Gasterosteus aculeatus williamsoni*)	FE	E	
Tidewater goby (*Eucyclogobius newberryi*)	FE		
BIRDS			
American peregrine falcon (*Falco peregrinus anatum*)	FE	E	
California brown pelican (*Pelecanus occidentalis californianus*) (a transient species)	FE	E	
Western snowy plover (*Charadrius alexandrinus nivosus*)	FT	SC	
MAMMALS			
Southern sea otter (*Enhydra lutris nereis*)	FT	R	
PLANTS			
Surf thistle (*Cirsium rhothophilum*)	C	T	1B
REPTILES/AMPHIBIANS			
California red-legged frog (*Rana aurora draytonii*)	FT	SC	
Candidate Species			
REPTILES/AMPHIBIANS			
Southwestern pond turtle (*Clemmys marmorata pallida*)	F	SC	
Two-striped garter snake (*Thamnophis hammondii*)	F		
BIRDS			
Western burrowing owl (*Speotyto cunicularia hypugea*)	F	SC	
PLANTS			
Crisp monardella (*Monardella crispa*)	F		1B
San Luis Obispo Monardella (*Monardella frutescens*)	F		1B
MAMMALS			
Sand Diego desert woodrat (*Neotoma lepida intermedia*)	F		
Townsend's Western big-eared bat (*Plecotus townsendii townsendii*)	F		SC
Habitats of interest			
Pinniped haulout and breeding areas			
Seabird nest and roost sites			

Source: Data acquired from [SLC6a 1995], [SELVa 1992], [ATLAS 1991], [SLC2W 1993], [Federal register Vol. 61 No. 40, 2/28/96] and [REb 1995] Please see Table 3-5 for an explanation of status designations.

3.10.3.3.1 Threatened/Endangered Species: Fish

Unarmored Threespine Stickleback

Cañada Honda Creek is the nearest unarmored threespine stickleback habitat to SLC-6; the rest are on North VAFB.

Tidewater Goby

Near SLC-6, the tidewater goby currently inhabits the coastal lagoons and portions of the river channels of the Santa Ynez River and Jalama Creek. It has also been observed in Honda Creek. The tidewater goby is adversely affected by road widening and bridge construction, water diversion projects, commercial and residential developments, ground water overdrafts, agricultural and sewage effluents, river channelization and cattle grazing.

3.10.3.3.2 Threatened/Endangered Species: Birds

California Brown Pelican

This species is known to roost in the region of influence of SLC-6, and the Cypress Ridge area. Within the vicinity of the SLC-6, they roost at Point Sal, Purisima Point, the mouth of the Santa Ynez River, and the Boathouse Breakwater. They also roost on Point Pedernales, Destroyer rock, Point Arguello, and Rocky Point. No impact to breeding brown pelicans on the Northern Channel Islands is predicted to occur from sonic booms as a result of launching EOS launch vehicles from the Spaceport. The LLV 3's sonic boom, which would be most representative of EOS proposed launch vehicle sonic booms was determined to not intercept any portion of the Channel Islands when launched from SLC-6 (CCS).

American Peregrine Falcon

Within the vicinity of the Spaceport, a pair of peregrine falcons presently utilize the nearby rocky cliffs and coastal habitats for nesting and foraging purposes.

Western Snowy Plover

The nearest western snowy plover nesting area is outside the ROI for SLC-6.

California Least Tern

The nearest least tern nesting areas to SLC-6 include the mouth of the San Antonio Creek, Purisima Point, and the Santa Ynez River. None of these sites are in the region of influence of the California Spaceport [SLC6a 1995].

3.10.3.3.3 Threatened/Endangered Species: Reptiles and Amphibians

California Red-legged Frog

In the vicinity of South Vandenberg, the red-legged frog (federally listed as threatened) has been found in the Santa Ynez River, Cañada Honda Creek, and Jalama Creek. The red-legged frog has not been observed in Red Roof Canyon, Oil Well Canyon, or Cañada Agua Viva and it appears that these riparian habitats are not suitable for this species. Consultation with the USFWS for the California red-legged frog will be completed by VAFB officials prior to launch of EOS spacecraft [JO 1996].

3.10.3.3.4 Threatened/Endangered Species: Mammals

Southern Sea Otter

Southern sea otters frequent the coastal and offshore habitats adjacent to Vandenberg, and a breeding colony is established near Purisima Point. In the South Vandenberg area, these otters feed offshore in kelp beds near the Boathouse, Cañada Aqua Viva, Water Canyon, Cañada del Morida, and Jalama Creek. There are currently no permanent southern sea otter populations along the coast of South Vandenberg.

Harbor Seals

On the coastline of South Vandenberg, harbor seals have been noted near Point Arguello, at the mouth of Oil Well Canyon, in the area surrounding Rocky Point, and near the Boathouse Breakwater. Distances of these haulout areas from the Spaceport range from 0.8 to 2.5 kilometers (0.5 to 1.6 miles).

3.10.3.3.5 Candidate Species: Animals

Burrowing Owl

Several burrowing owls were recently observed in the east-central portions of the Cypress Ridge area. Evidence for the burrowing owl was noted in the grassland to the south-east of SLC-6.

Southwestern Pond Turtle

Within the vicinity of the Spaceport, pond turtles have been found in Jalama Creek, at the Hollister Ranch, and at the Bixby Ranch. The habitat at Cañada Honda Creek is also suitable for pond turtles.

3.10.3.3.6 Candidate Species: Plants

Surf Thistle and Spectacle Pod

These plant species have not been observed on the terraces in the vicinity of SLC-6 nor on the slopes of Cypress Ridge.

Black-flowered Figwort

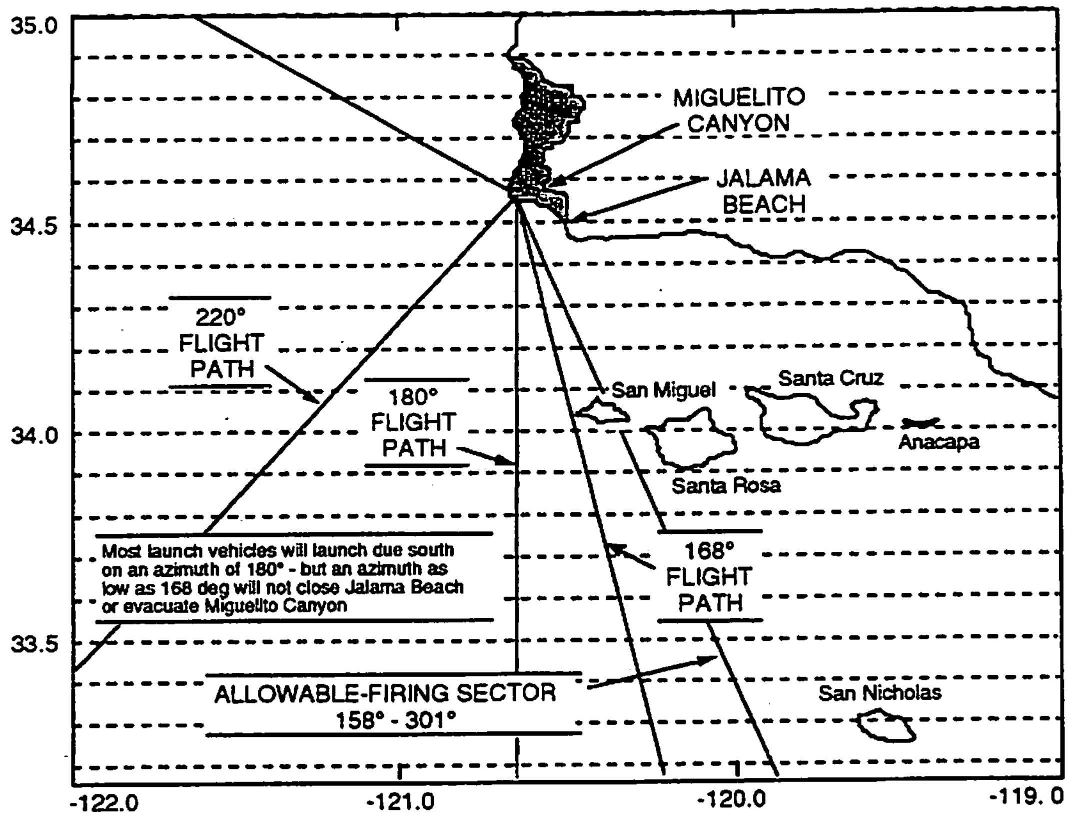
Among the verified occurrences of black-flowered figwort, those in the Cañada Honda Creek and Cañada Agua Viva are the closest to the Spaceport. Small populations of figwort were also found along Coast road near Point Arguello. It was not clear, however, if these plants represented black-flowered figwort or the more common California figwort. Most populations of figwort show evidence of hybridization. Moreover, sampling to the south of SLC-6 catalogued the presence of California figwort, but not black-flowered figwort. During recent surveys (September 1994) black-flowered figwort was not observed in the SLC-6 or Cypress Ridge areas.

3.11 RANGE SAFETY AND LAUNCH AZIMUTHS

A Range Safety Program is implemented for each launch to ensure that the launch and flight of launch vehicles and payloads present no greater risk to the general public than that imposed by the overflight of conventional aircraft. In addition to public protection, range safety on a national range includes launch area safety, launch complex safety, and the protection of national resources. [WR 1995]

Nearly all EOS spacecraft would be inserted into polar orbits, which require a southerly launch from the Western Range (WR). WR is the launch head at VAFB and extends along the West Coast of the continental United States westward through the Pacific and Indian Oceans. The allowable firing sector from the WR is from headings of 158° from true north to 301° from true north. Normal space launches range from 158° from true north to 201° (Figure 3-9). [SLC6a 1995]

Figure 3-9. Launch Azimuths Available from the Western Range



Source: Adapted from [SLC6a 1995] and [WR 1995]

SLC-6 or CSLC launch azimuths will be available from headings of 168° to 220° from true north. The basis for the launch azimuths are prescribed by agreement between the Air Force (30 SW/SEY) and the Western Commercial Space Center (WCSC). This agreement is based on Air Force analyses of hazards and risks to nearby populations and recreational areas. The resulting limits to launch azimuths, 168° and 220°, are based on the impact limit lines, identified during the risk analyses. These boundaries are considered maxima. Recreational areas to the south of VAFB would not be affected by launches from the Spaceport. Of all existing launch sites on Vandenberg, the Spaceport would have the least potential for causing closures of public beach areas. This is due to its geographic location to the south and west of all existing Air Force launch sites. A launch azimuth as low as 168° from the Spaceport will not cause closure of Jalama Beach or evacuation of Miguelito Canyon [SLC6a 1995].

EOS proposed launch vehicle impacts have previously been approved for launch of spacecraft from SLC-2, SLC-3 and SLC-6. The EOS Program would not increase launch rates nor utilize launch systems beyond the scope of approved programs at VAFB, therefore EOS would not produce increased closure of County-owned parks, other public use areas and private properties [JO 1996].

3.12 NOISE

Noise levels for most of the region surrounding VAFB are normally low. Higher levels appear in industrial areas and along transportation corridors. The rural areas near Lompoc and Santa Maria are expected to have low overall community noise equivalent levels (CNELs). Noise levels temporarily increase due to aircraft flyovers, railroad traffic, and missile launches. Noise monitoring conducted at VAFB and surrounding areas during 1984 and 1985 showed 24-hour average noise levels of 48 to 67 dBA, with higher levels along transportation corridors. These levels are typical of rural areas. [ATLAS 1991]

Peak launch noises (Table 3-10) are experienced for a very brief time and are therefore not expected to exceed EPA or OSHA requirements and recommendations. Comparatively, peak noise levels created by industrial and construction activities — mechanical equipment such as diesel locomotives, cranes, and rail cars — could range from about 90 to 111 dBA. Vehicular traffic noise ranges from around 85 dBA for a passenger auto to about 100 dBA for a motorcycle. [DELTA 1994]

In recent years, there have been no recorded complaints concerning noise produced by missile launches, which can be attributed to the infrequency of launches and the low annoyance level of rocket motor firings. [SLC2W 1991]

Table 3-10. Launch Vehicle Noise Levels at 1.6 km in A-weighted Decibels[11]

Launch Vehicle	Noise Level	Standards
Space Shuttle	135.7	OSHA Requirements
Titan IIIC	124.2	Not to exceed 115 dBA for >15 min.
Saturn V	121.5	Not to exceed 90 dBA for an 8-hr day
Saturn I	119.1	
Delta II	110.0	EPA Recommendation
Delta-Lite	107.0	Not to exceed 70 dBA for the general
Taurus	96.0	public as a 24-hr average
Atlas IIAS	90.0	

Source: Data acquired from [SLC6a 1995], [KSC 1986] and [KR 1995]
Sound levels were calculated using the sound pressure equation described in section 4.2.4.
For rocket motors firing, at distances of less than 1.6 km (1.0 mi) overall dBA measurements will be approximately 20 dB less than corresponding overall dB measurements [SLC6a 1995].

[11] A-weighted decibels (dBA) are applied to emphasize the mid-range of human hearing.

4. CHAPTER FOUR
ENVIRONMENTAL IMPACTS

GENERAL

Preparations for completing the EOS Program include refining the design of flight projects, fabrication and assembly of spacecraft, testing of components, modification and/or construction of existing or new facilities, final instrument design and fabrication, launch and on orbit activities. While fabrication processes may generate small quantities of effluents generally associated with tooling or cleaning operations, these are well within the scope of normal activities at fabrication/testing facilities, are covered in applicable environmental permits, and will produce no substantial adverse environmental consequences. Pre-launch activities (*i.e.*, at the launch site) will involve integration and testing of the payload with the launch vehicle and final launch preparations, such as spacecraft and launch vehicle fueling operations, and would culminate in a successful launch as an element of the EOS spacecraft series. The NEPA process (for space launches from VAFB) has been previously completed for launch activities in the range expected for EOS[12] [JO 1996]. Currently no EOS-specific processing or launch activities have been identified that would require permits and/or mitigation measures beyond the baseline permits and mitigation measures already necessary.

The potential environmental impacts of both normal launches and launch failures are described in the sections below.

4.1 MULTIPLE LAUNCH SITES

EOS may use several launch sites at the VAFB location. The EOS proposal is to use one to three launch pads at VAFB. These include: SLC -2W, for launching Delta II's or the new Med-Lite (Delta-Lite) launch vehicles, the Commercial Spaceport (CCS or SLC-6) for the new Med-Lite ELVs, and SLC-3E for launching the Atlas IIAS. The environmental impacts associated with any particular launch site are similar in effect with respect to noise, emissions from expendable launch vehicles, and payload processing. The site specific environment characteristics such as flora and fauna, endangered species habitat, transportation routes and access, existing land use and proximity of population centers can be unique to a site. The flights of opportunity may use the Pegasus and the VAFB mobile launch station. The following discussion presents the impact discussion as if it were a single location, but with specific notations of environmental impacts based on differences in the three launch sites.

4.2 SINGLE LAUNCH SITE

4.2.1 Environmental Impacts- Normal Launch VAFB

General

The greatest source of uncontrollable emissions to the atmosphere will be vehicle launch. Primary constituents of exhaust from solid-fueled rocket motors are HCl, CO_2, CO, and Al_2O_3. Since launches will generally be directed southerly and since the predominant wind directions are from the north, no impacts to communities and populated areas of western Santa Barbara County are expected. Exhaust products are expected to dissipate before reaching sensitive human, flora or fauna receptors. [SLC6 1994]

[12] [SLC2W 1991], [FONSIa 1991], [SLC6a 1995], [FONSI 1995], [ATLAS 1991] [FONSIc 1991] and [FONSIá 1993]

The near-field effects of launches at VAFB are also expected to be small and local or nonexistent. This is consistent with monitoring associated with Space Shuttle launches at Cape Canaveral, Florida [ELVa 1993]. Although the Space Shuttle is much larger than the rockets currently considered for launch from VAFB and uses deluge waters during its launch, the total near-field area of impact after 43 launches of the Space Shuttle was only 119 hectares (294 acres). The recorded impacts were primarily attributed to interactions of the exhaust with the deluge water. By not using deluge water for certain launches (*i.e.*, Pegasus, Taurus and Delta-Lite), the exhaust plumes are expected to have little, if any, impact on the local flora or fauna [SLC6 1994].

4.2.2 Air Quality Impacts

Many sections of Santa Barbara County are not in attainment of the National Ambient Air Quality Standards (NAAQS). Both the primary national and California health standards for ozone have been exceeded in recent years (1994). For all monitoring stations, Santa Barbara County experiences between 30 and 45 days per year on which the state ozone standard is violated and two to eight days per year on which the national standard is violated. The Air Force and the Santa Barbara County Air Pollution Control District (APCD) have agreed to cooperate in the air quality program managed by Santa Barbara County. Under this agreement, changes in activities at VAFB are coordinated with and permitted through the Santa Barbara County APCD [MOA 1991]. Any new emissions on VAFB from regulated sources which are caused by the EOS Program will have to be considered within the context of the Air Force/APCD agreement. For this purpose a complete conformity analysis is presented in Appendix E.

4.2.2.1 EOS Launch Vehicle Impact Summary: Preferred Launch Vehicles

For convenience and ease of reference, the solid propellant quantities and predicted impacts of launch vehicles proposed for use by the EOS Program are summarized in Table 4-1 and 4-2, and displayed graphically in Figure 4-1.

Table 4-1. EOS Launch Vehicle Solid Propellant Quantity Comparison

Launch Vehicle	Solid Propellant Weight
Pegasus	12,152 kg (26,790 lbs) (Stage 1) 3,025 kg (6,670 lbs) (Stage 2) 782 kg (1,725 lbs) (Stage 3) 15,960 kg (35,185 lbs) (Total)
Atlas IIAS	41,731 kg (92,000 lbs) (4 Castor IVA™ SSRMs)
Taurus	48,988 kg (108,000 lbs) (Castor 120™: Stage 1) 20,016 kg (44,128 lbs) (2 Castor IVB™ SSRMs - Optional) 15,960 kg (35,185 lbs)(Pegasus: Stages 2-4) 84,965 kg (187,313 lbs) (Total)
Delta II 7925	106,607 kg (235,026 lbs) (9 GEMs)
Delta-Lite	97,977 kg (216,000 lbs) (2 Castor 120™: Stage 0 & 1) 20,016 kg (44,128 lbs) (2 Castor IVB™ SSRMs) 118,034 kg (260,128 lbs) (Total)

Source: Adapted from [SLC6a 1995] and [DELTA 1994]

Predicted peak impacts on VAFB property due to emissions from launch-related activities are below adverse health limits. The closest public access location to any of the three SLC sites will be West Ocean Avenue. Peak impacts at this location (approximately 4.8 kilometers (2.8 miles) from SLC 3) will be even less than those on VAFB; these impacts will be of short duration and launch activities will be controlled to limit impacts even further. The ambient air quality impacts due to launch-related activities are expected to be insignificant.

A study of Space Shuttle launches from KSC indicates that 28 percent of the HCl produced in the first ten seconds of launch is entrained in deluge water and/or deposited on the ground. These values strongly suggest that input values for ground cloud composition be reduced by at least 20 to 30 percent. [HCI 1985] The values tabulated below do not reflect this reduction and are conservative (protective of resources) estimates.

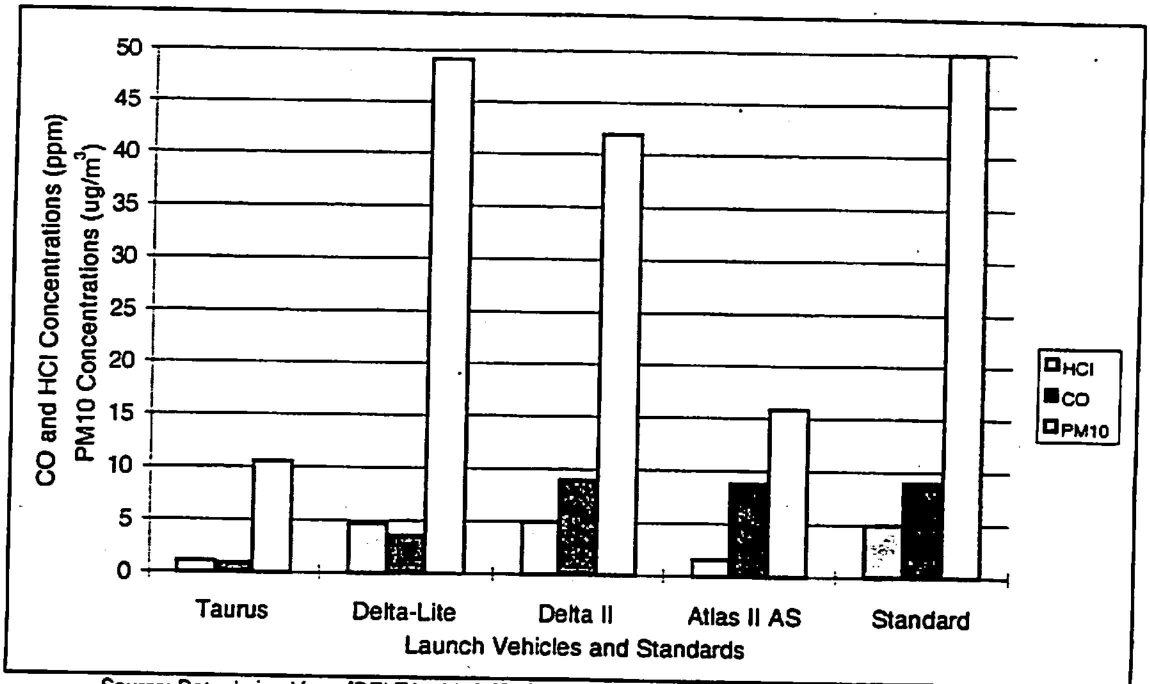
Table 4-2. Launch Vehicle Emission Concentrations

Launch Vehicle / Pollutant	Taurus* Concentration/ Distance	Delta-Lite Concentration/ Distance	Delta II 7925* Concentration/ Distance	Atlas IIAS Concentration/ Distance	Standard Concentration Allowed
HCl	1.1 ppm @ 4.8 km	< 5 ppm @ 4.3 km	< 5 ppm @ 4.3 km	2 ppm @ 4.3 km	5 ppm(2)
CO	0.9 ppm @ 4.8 km	< 4 ppm @ 4.8 km	< 9 ppm @ 4.8 km(1)	< 9 ppm @ 4.8 km	9 ppm(3)
Al_2O_3 (PM_{10})	11 ug/m³ @ 4.8 km	49 ug/m³ @ 4.8 km	42 ug/m³ @ 4.8 km	15.8 ug/m³ @ 4.8 km	50 ug/m³(4)

Source: Adapted from [DELTA 1994], [SLC6a 1995], [TITAN 1990] and [SELVa1992]
[1] Delta launches are not expected to exceed NAAQS beyond the launch complex boundaries. CO concentrations due to a Titan launch were predicted to be below 9 ppm. Carbon monoxide concentrations are not expected to exceed the NAAQS of 35 ppm (1 hr average) beyond the immediate vicinity of the launch complex and are expected to rapidly oxidize to carbon dioxide (CO_2) in the atmosphere. [DELTA 1994]
[2] The OSHA PEL for HCl is 5 ppm for an 8-hour time-weighted average.
[3] NAAQS for CO is 9 ppm for an 8-hour time-weighted average.
[4] 24 Hour California Ambient Air Quality Standard in micrograms per cubic meter.
* Figures for the Taurus and Delta II are based on 40 and 10 percent of Titan emissions, respectively.
Pegasus is an air-launched vehicle and therefore not considered here.
Delta-Lite ascent speed is not considered in this analysis – protective of resources.
Delta-Lite emissions are based on a solid propellant quantity correlation with the LLV-3 (6).

A comparison of launch vehicle emissions at 4.8 kilometers (3 miles) represents the approximate location of the closest populations of interest. All potential EOS launch vehicles have emissions which fall well within an acceptable level when compared with standards for human exposures (Figure 4-1).

Figure 4-1. Vehicle Emission Concentrations Beyond 4.8 km and Applicable Standards



Source: Data derived from [DELTA 1994], [SLC6a 1995], [ATLAS 1991], [TITAN 1990] and [SELVa 1992] Emissions shown are normalized at a 4.8 kilometer distance from the launch pad. Delta II and Taurus vehicle emissions are extrapolated from the Titan launch vehicle (40 percent and 10 percent, respectively).Delta-Lite emissions are based on a solid propellant quantity correlation with the LLV-3 (6). Atlas IIAS emissions are based on a total effluent quantity correlation with the Delta II. PM_{10} values (in micrograms per cubic meter) are derived from Titan IV/SRMU REEDM values [TITAN 1990]. All plume Al_2O_3 was assumed to be in the PM_{10} size range - protective of resources. Pegasus is an air-launched vehicle and therefore not considered here.

4.2.2.2 Ground Handling - Air impacts [PPF 1993]

In terms of payload processing, there are no anticipated releases of fluorocarbons to the atmosphere. Ozone-depleting chlorofluorocarbons (CFCs) and hydrofluorocarbons (HFCs) are commonly used for both cooling systems and fire suppression systems. Support services for payloads may require provision of a cooling system for the period immediately before launch. An electromechanical compressor/condenser unit would be used. Any ozone-depleting chemicals would be properly contained, reused, or disposed of in accordance with applicable federal, state, and local laws, regulations, rules, and the VAFB Hazardous Waste Management Plan. There is no planned free venting of the system to the atmosphere. The WCSC will comply with all U.S. Air Force regulations that apply to the use of ozone-depleting chemicals [SLC6 1994]. NASA has an active program in place to eliminate uses of CFC's to the maximum extent possible consistent with flight safety.

Approximately 15.1 liters (4 gallons) of isopropyl alcohol (IPA) will be used prior to satellite processing to wipe the interior of the facility free of dust. The IPA would evaporate inside the building and it is unlikely that any amount of IPA would escape into the environment [PPF 1993]. Usage rate of IPA wipe cleaner will be well within the prescribed SBCAPCD Rules and Regulations.

Operations at the payload processing facility, will include loading of fuel propellants (hydrazine and nitrogen tetroxide) from existing loading carts. Up to 454.5 kilograms (1,000 pounds) of hydrazine and as much as 454.5 kilograms (1,000 pounds) of nitrogen tetroxide (oxidizer) will be loaded into the spacecraft at the PPF. The fuel handling activity is expected to last between 8 and 12 hours per satellite fueling operation. Emissions from the loading process will be controlled by means of scrubbers or closed loop propellant transfer operations. Estimates of scrubber emission rate from hydrazine and nitrogen oxides (oxidizer) vapors are estimated to be less than 0.0009 kilograms per hour (0.0020 pounds per hour) and 0.026 kilograms per hour (0.057 pounds per hour), respectively, based on fuel handling from a similar type facility located in Titusville, Florida and on pilot studies conducted, which indicated a control efficiency of 98 percent.

To further investigate the potential impact on the VAFB environment as a result of this proposed action, the U.S. EPA SCREEN atmospheric dispersion model was employed. Results from the SCREEN model show a maximum concentration of 0.2 micrograms per cubic meter (adjusted 8-hour concentration) at a distance of 77 meters (252.6 feet) for hydrazine emissions (Table 4-3) and 5.1 micrograms per cubic meter (adjusted 8-hour concentration at a distance of 77 meters (252.6 feet) for nitrogen oxides emissions (Table 4-4).

Table 4-3. Modeling Results For Hydrazine Compared to Acceptable Ambient Levels

AGENCY/SCREEN MODEL RESULTS	ACCEPTABLE AMBIENT LEVEL
National Academy of Sciences	19.6 micrograms/m^3/8-hour
OSHA (PEL)	130 micrograms/m^3/8-hour
SCREEN Model Results	0.2 micrograms/m^3/8-hour

Source: [PPF 1993]

Table 4-4. Modeling Results For Nitrogen Oxides Compared to Acceptable Ambient Levels

AGENCY/SCREEN MODEL RESULTS	ACCEPTABLE AMBIENT LEVEL
State of California (nitrogen dioxide)	470 micrograms/m^3/8-hour
OSHA (PEL)	900 micrograms/m^3/8-hour
ACGIH (nitrogen dioxide)	600 micrograms/m^3/8-hour
SCREEN Model Results	5.1 micrograms/m^3/8-hour

Source: [PPF 1993]

When compared to a National Academy of Sciences, Committee on Toxicology Report, OSHA Standards, and several state regulated acceptable ambient limits, the maximum predicted hydrazine concentration is below each standard or regulation. When compared to the State of California standard (for nitrogen dioxide) and OSHA Standard (nitrogen dioxide and nitrogen tetroxide) the maximum predicted nitrogen oxides concentration is below each standard.

Some of the spacecraft will also come loaded with 0.91 kilograms (2 pounds) of ammonia and a built in leak detector. There will be no loading or transfer of ammonia planned within the facility. Therefore, no emissions to the atmosphere are anticipated.

Ground operations would temporarily increase the emissions slightly from electrical power generators and vehicle traffic. Tables 4-5 & 4-6 represent a comparative expectation for the Taurus program involving four launches per year. The anticipated increases for EOS would be within the range predicted here. These increases are not expected to have substantial adverse impacts to air quality. The EOS contribution to the atmospheric load of carbon products is insignificant when compared to the world release estimates of 12.7 million metric tons (14 million tons per year).

Table 4-5. Emissions from Generators for Launch Vehicle Power and Lighting

Pollutant	Tons/Launch		Tons/Year	
CO	0.21 MT	0.23 tons	0.83 MT	0.92 tons
HC	0.08 MT	0.09 tons	0.33 MT	0.36 tons
NOx	0.97 MT	1.07 tons	3.88 MT	4.28 tons
SOx	0.06 MT	0.07 tons	0.25 MT	0.28 tons
PM	0.07 MT	0.08 tons	0.29 MT	0.32 tons

Source: Adapted from [SELVa 1992]
Figures are for the Taurus launch program
Assumes four Taurus launches per year

Table 4-6. Emissions from Support Vehicles and Equipment

	Emissions, tons/launch (tons/year)				
Equipment	CO	HC	NOx	SOx	PM
Cranes (2)	0.12 (0.48)	0.03 (0.12)	0.33 (1.32)	0.03 (0.12)	0.03 (0.12)
Trucks (15)	0.003 (0.012)	0.012 (0.048)	0.012 (0.048)	0.003 (0.012)	0.003 (0.012)
Total	0.112 MT 0.123 (0.446 MT) (0.491)	0.038 MT 0.042 (0.153 MT) (0.169)	0.310 MT 0.342 (1.270 MT) (1.399)	0.030 MT 0.033 (0.120 MT) (0.132)	0.030 MT 0.033 (0.120 MT) (0.132)

Source: Adapted from [SELVa 1992]
Figures are for the Taurus launch program
Assumes four Taurus launches per year

4.2.2.3 Launch - Air Impacts to Wildlife [PPF 1993]

Individual launch vehicle impacts to air from normal launches and launch failures are described in Appendix C. A summary of potential impacts to air from proposed launch vehicles at their corresponding SLCs follows.

SLC-2

Permits and mitigation measures exist for launching two rockets per year from SLC-2. An additional EA is currently in coordination and preparation for up to 10 launches per year. McDonnell Douglas Corporation has considered launching two Delta II's per year for EOS, and expects no substantial impacts beyond the scope of current approvals/permits. For further discussion see [SLC2W 1991] and [SLC2W 1993].

SLC-3

Air emissions from Atlas IIAS launches from SC-3E may result in insubstantial, short-term, and localized impacts to the terrestrial fauna found in the immediate vicinity of the launch site. Due to the relatively innocuous nature of the major Atlas IIAS propellants (RP-1 and LOX) and their combustion products (H_2, CO, and CO_2), air quality impacts to wildlife are not expected to be substantial. During a normal Atlas IIAS launch, there will be emission of carbon monoxide (CO), carbon dioxide (CO_2), water (H_2O), hydrogen (H^+ and H_2) oxygen (O_2 and O^{-2}), hydroxide ion (OH^-), hydrochloric acid (HCl), aluminum oxide (Al_2O_3), and unburned hydrocarbons. HCl and AL_2O_3 are emitted by the SRMs. Since most of the CO will be converted to CO_2 within a few seconds after combustion, no substantial impacts to wildlife are expected to result from CO emissions. Previous studies have shown that actual operational emission of CO has been below levels that could result in any substantial impacts to terrestrial biota. [ATLAS 1991]

The emissions produced by the combustion of hydrazine are not expected to generate any impacts to terrestrial wildlife. Since only about 18 kilograms (40 pounds) of hydrazine will be burned in the lower atmosphere, there will be only a trace amount of unburned hydrazine emissions generated in the lower atmosphere during an Atlas IIAS launch. [ATLAS 1991]

SLC-6 (CCS)

The CCS environmental assessment accounts for a total of 25 launches per year from the new commercial site. Although at the time of the EA potential customers were not confirmed, the analysis accounted for at least two potential EOS launches per year from the site. The general impacts and conformity analysis has been completed for the previous licensing of this site. For clarity and ease of reference, however, a detailed discussion of EOS conformity analysis is included in this document in Appendix E and summarized briefly below.

4.2.3 Conformity Analysis [SLC6a 1995]

The Air Force is required to make a formal determination as to whether VAFB operations comply with the General Conformity Rule of the Clean Air Act, as amended (42 U.S.C. 7401 et seq.). Section 176(c) of the Clean Air Act, as amended in 1990, requires all Federal agencies or agency supported activities to comply with an approved or promulgated state implementation plan (SIP) or Federal implementation plan (FIP). Conformity means compliance with a SIP/FIP's purpose of attaining or maintaining the national ambient air quality standards (NAAQS). Specifically, this means ensuring the activity will not: 1) cause a new violation of the NAAQS; 2) contribute to an increase in the frequency or severity of existing NAAQS violations; or 3) delay the timely attainment of any NAAQS, interim milestones, or other milestones to achieve attainment.

For the EOS conformity analysis, emissions have been derived from scaling by one-eighth the predicted Spaceport emissions of twenty-four launches per year (Table 4-7 and Appendix E). The original analysis included Castor 120™ solid rocket boosters; gasoline and diesel fueled vehicles transporting Spaceport and customer launch support personnel and rocket motors, payloads, and miscellaneous launch support equipment; and diesel fueled standby power generators for emergency backup power to maintain critical Spaceport systems, which can be assumed to be representative of EOS activities. Emissions will result from both solid and liquid fueled rocket launches. Proposed solid rocket boosters will use the same basic fuel formulation (aluminum powder, ammonium perchlorate, hydroxyl terminated polybutadiene). Liquid fueled booster will primarily emit CO_2 and H_2O.

Table 4-7. Total Emissions (Tons/Year)

Source (per year)	NO_x		VOC	
EOS *	0.196 MT	0.216 tons	0.086 MT	0.095 tons
CCS Launch Activities (year)**	1.565 MT	1.725 tons	0.686 MT	0.756 tons

* Maximum EOS contribution assumes a maximum of three flights per year, which scales all other launch and launch support activities by 1/8.

** Total Spaceport contribution includes 24 launches of the LLV 3 with 6 Castor IV/XL™ SSRMs used in describing Delta-Lite impacts, gasoline vehicles (80 twenty-mile round trips/day x 260 days), diesel vehicles (110 forty-mile round trips/year, 60 two-mile tow tug trips), diesel standby generators (300 hp-hr generator x 12 hr/year), alcohol wipedown (48 gallons per year), and hydrazine transfer (99% efficiency).

Source: Adapted from [SLC6a 1995]

The creation of thermal NO_x resulting from afterburning (heated exhaust decomposing the atmosphere) is not expected. [SLC6a 1995]

The total direct and indirect emissions from the Proposed Action, do not exceed the Federal de minimis conformity threshold for the criteria nonattainment pollutants (ozone precursors). Additionally, total emissions for each nonattainment pollutant (ozone precursors) are less than 10 percent of SBCAPCD's 1990 Base Year Annual Emission Inventory (Table 4-8). Therefore, the Proposed Action is considered de minimis and not regionally significant. This determination is in accordance with EPA Conformity Rule 40 CFR Part 93.153 (b) and (c), in accordance with Section 176 (c) of the Clean Air Act, as amended in 1990, 42 USC 7506 (c).

Table 4-8. Comparative EOS Emissions (Tons/Year)

Quantity/Standard Ozone Precursor	Total EOS Contribution	Total Spaceport Contribution	De Minimis Thresholds	10% of SBC 1994 Forecast Planning Emission Inventory
VOCs	0.095	0.756	100	1,456
NOx	0.216	1.725	100	1,263

Source: Data acquired from [SBCAPCD 1994], [JA 1996] and [SLC6a 1995]
Total Spaceport contribution includes 24 launches of the LLV 3 with 6 Castor IV/XL™ SSRMs used in describing Delta-Lite impacts, gasoline vehicles (80 twenty-mile round trips/day x 260 days), diesel vehicles (110 forty-mile round trips/year, 60 two-mile tow tug trips), diesel standby generators (300 hp-hr generator x 12 hr/year), alcohol wipedown (48 gallons per year), and hydrazine transfer (99% efficiency). Maximum EOS contribution assumes maximum of three flights per year, which scales all other launch and launch support activities by 1/8.

4.2.4 Noise

Federal and state governments have established noise guidelines and regulations for the purpose of protecting citizens from potential hearing damage and various other adverse physiological, psychological, and social effects associated with noise. The California Division of Aeronautics sets standards to control the noise in communities located in the vicinity of airports. A community noise equivalent level (CNEL) of 65 dBA is the state airport noise standard. Noise limits also have been established by the Occupational Safety and Health Administration (OSHA) to protect people at their work places (29 CFR Part 1910.95). For an eight-hour work day, people should not be exposed to a continuous noise level greater than 90 dBA. In addition personnel should not be exposed to noise levels higher than 115 dBA for periods longer than 15 minutes. For the general public, the EPA recommends a 24-hour average noise level of 70 dBA. This noise exposure limit will prevent hearing damage from exposure to routine noise daily, over a period of months or years. Noise monitoring conducted at VAFB and surrounding areas during 1984 and 1985 showed 24-hour average noise levels of 48 dBA to 67 dBA, with higher levels along transportation corridors. These levels are typical of rural areas. [ATLAS 1991]

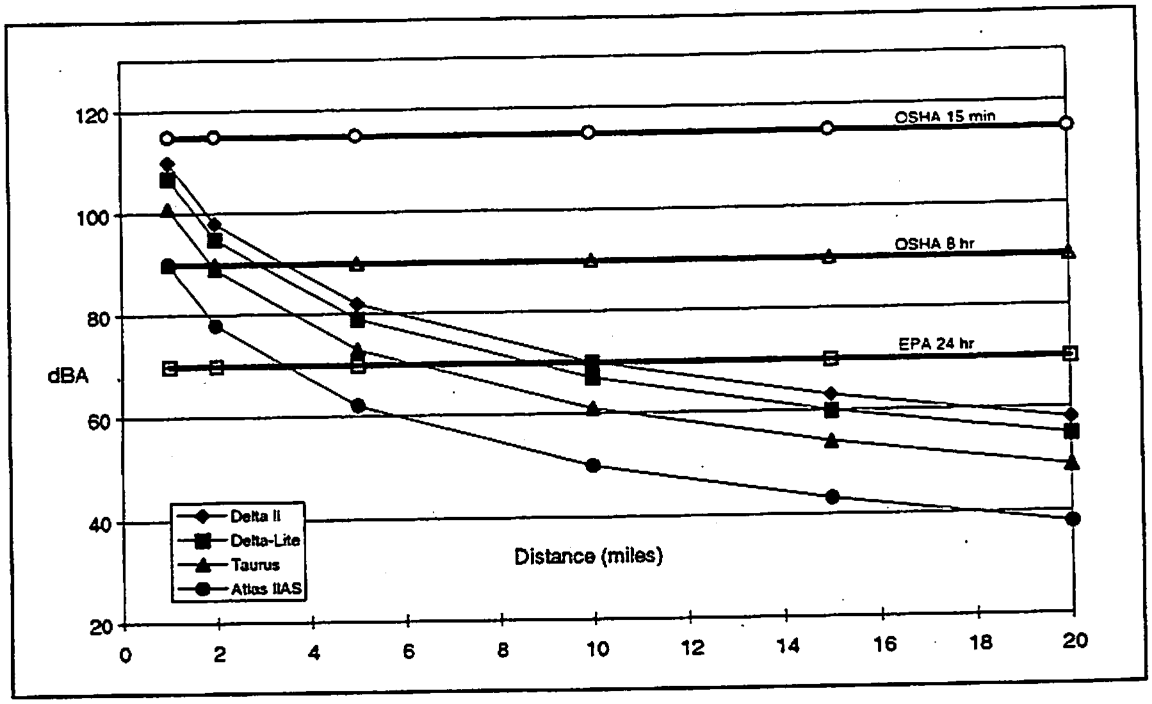
Predicted launch noise levels were calculated using the following sound pressure equation:

$$SPL_1 = SPL_o - 20 \log D_1^2/D_o^2,$$

where SPL_1 is the sound pressure level at distance D_1 from the source, and SPL_o is the known sound pressure level at distance D_o from the source. Estimation of the sound levels in Figure 4-2 assumed that noise attenuates only from the inverse square law. The estimations do not consider absorption by surface topography or the atmosphere and assumes a linear relationship between A-weighted decibels and decibels, and will therefore be a conservative (over predicting) estimate.

Peak launch noises for all potential EOS launch vehicles are experienced for a very brief time period (approximately 5 seconds), and therefore, are not expected to exceed EPA or OSHA requirements and recommendations (Figure 4-2). Moreover, any personnel at the launch site exposed to high noise levels would wear hearing protective gear.

Figure 4-2. Launch Noise vs. Distance from the Launch Site



Source: Data acquired from [SLC6a 1995], [KR 1995] and [ATLAS 1991]
Sound levels were calculated using the sound pressure equation described in section 4.2.4. Actual dBA values would decrease more rapidly with distance (protective of resources). -OSHA requirements state: 1.) Personnel should not be exposed to noise levels higher than 115 dBA for greater than 15 minutes. 2.) People should not be exposed to a continuous noise level greater than 90 dBA for an eight-hour day. -EPA recommends, for the general public a 24-hr average noise level of 70 dBA. Sound pressure levels at the launch site were estimated to be 139.0 dB for the Delta-Lite (without SRMs) and 142.6 dB for the Delta II [KR 1995]. For rocket motors firing at distances of less than 1.6 km (1.0 mi), overall dBA measurements will be approximately 20 units less than corresponding overall dB measurements [SLC6a 1995].

4.2.4.1 Noise - Impacts to Wildlife

Under the Marine Mammal Protection Act (MMPA), it is unlawful to "take" any marine mammal, wherein take means to harass, pursue, capture, hunt, or kill. The 1994 amendments to the MMPA defined "harassment" as any act of pursuit, torment, or annoyance which has the potential to injure a marine mammal or marine mammal stock in the wild, or has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns (*i.e.*, breeding, sheltering, migration). The requirement for 'Take Permits' has been raised by the SW Region of the National Marine Fisheries Service (NMFS). Due to the predicted sound levels produced from space vehicle launches, it is likely that the only type of "take" of harbor seals on VAFB may be by incidental harassment (*i.e.*, alert response or moving into the water) [SLC6b 1995]. Previous documents and studies (Appendix F) have suggested that harmful effects to threatened and endangered species have not occurred as a result of rocket launches at VAFB [SLC6a 1995].

Pinniped harassment permits are either in place or are being developed to accommodate impacts for vehicles with EOS launch capabilities. Monitoring and mitigation plans developed by Spaceport Systems International (SSI) and McDonnell Douglas Aerospace identify comprehensive monitoring and mitigation activities that would be performed on behalf of all users (Appendix G). Individual users would not be expected to perform natural resource monitoring for their missions, instead this is provided as a service. Currently no EOS-specific processing or launch activities have been identified that would require permits beyond the baseline permits already necessary for Spaceport and SLC-2 operations [REa 1995 and SO 1995]. Furthermore, the 1998 launch date would allow EOS to be covered by a base-wide, programmatic permit currently in coordination for all of VAFB [JO 1996].

It is encouraging to note that the pinniped monitoring report thus far indicates that the levels of noise associated with Titan IV and Taurus launches were not observed to cause mortality or long-term behavioral effects to harbor seals [SLC6b 1995]. It is also unlikely that launch noises in the range expected for EOS selected vehicles launched from VAFB would have a substantial impact. Based on analyses presented in section 4.2.4 the launch noises expected from the Delta II, Atlas IIAS or the Med-Lite vehicles are less than and not substantially different than those measured for the Titan program. However, due to the frequency of launches planned for the Spaceport and a previous commitment by VAFB and the CCS the impacts will be evaluated by startle response monitoring of launch noise effects to wildlife [SLC6a 1995].

Terrestrial mammals in the project area are not expected to suffer any long-term impacts, such as a permanent hearing loss, from the noise generated during EOS launches from VAFB. Sensitive terrestrial mammals, such as kangaroo rats, coyote, gray fox, bobcat, and mountain lion, known to have reasonably good low-frequency hearing and occurring near the launch sites, may suffer temporary, short-term (10-48 hour) impacts, such as hearing deficits and temporary hearing threshold shifts. Small and medium sized animals that experience hearing impairments as a result of launch noise could suffer a small decrease in population density due to increased susceptibility to predators. However, actual adverse effects of these hearing impairments have not been documented and are not likely to be serious, since the effects of temporary hearing impairment probably will disappear within 10 to 48 hours [ATLAS 1991].

Since most terrestrial birds are relatively insensitive to sounds below 100 Hz, they are unlikely to experience any auditory damage from launch noise and sonic booms generated during the launch of EOS proposed vehicles. Based on studies of the American kestrel, it appears that endangered and declining diurnal raptors, such as the peregrine falcon, bald eagle, white-tailed kite, northern harrier, Cooper's hawk, merline, and prairie falcon probably would not be affected by noise from either a launch or subsequent focused sonic boom. Studies found no evidence that frequent loud (82-114 dBA) helicopter overflights affected nesting success, adult mortality, or territory use of peregrine falcons and golden eagles [ATLAS 1991]. Nor any evidence of opportunistic predation on their nest when they were startled off by helicopter overflights. Studies of other birds have found no substantial effects from occasional disturbances, such as sonic booms. Based on the above information, it appears that there would be no substantial impact to birds from launch noise and sonic booms generated during the launch of EOS vehicles from VAFB.

Hearing of marine birds is very similar to other birds in that they are less sensitive to low frequency sounds than humans. However, it has been suggested that marine birds could suffer a number of impacts as a result of sonic booms, such as abandonment of breeding sites, egg breakage by "panicked" adults, physical damage of eggs due to noise, crushing of eggs, adults or young due to collapse of burrows, and heating and cooling of eggs due to exposure. Most of these suggested impacts are unfounded. Brandt's cormorants and western gulls were reluctant to leave their nest unprotected, even when repeatedly exposed to simulated booms higher (130-140 dBA) than the sonic booms anticipated from EOS launches [ATLAS 1991]. Sound levels from sonic booms and launch noise generated during EOS launches at VAFB are not expected to result in any permanent hearing loss or auditory damage in marine birds.

4.2.5 Sonic Booms

Previous monitoring of harbor seals indicates that pinnipeds tend to flee temporarily into the water when noises associated with rocket launches equal or exceed 145 dB.[13] Although noises from rocket launching and sonic booms may not be directly comparable, the results provided are useful threshold values. [SLC6a 1995]

Preliminary analyses indicate that Atlas focused sonic booms would occur north of San Miguel Island, not overhead; nonetheless, since the Atlas vehicle is smaller than the Titan IV vehicle, any focused sonic booms that may occur over the northern Channel Islands from the Atlas IIAS are expected to be of lesser intensity than those for the Titan. [ATLAS 1991] No animals appeared to be injured and most animals were returning to shore within two hours of the Titan IV launch on 2 August 1993 [NOISE 1993].

The LLV 2, which is representative of the Taurus launch vehicle, would produce the most intense sonic boom of any Spaceport launch vehicle analyzed, about 120 dB (over the Channel Islands) [SLC6a 1995]. This would be well within the threshold value of 145 dB. The LLV 3's sonic boom, which would be most representative of EOS proposed launch vehicle sonic booms (especially the Delta-Lite), was determined to not intercept any portion of the Channel Islands when launched from SLC-6 (CCS). The sonic boom created by the LLV 3 would begin farther to the south due to a slower rate of acceleration than the smaller vehicles [SLC6a 1995]. Therefore, it is concluded that sonic booms from EOS rocket launches at the Spaceport (SLC-6) would not adversely affect any species that utilize San Miguel or Santa Rosa Islands.

Consistent with current practice, ships, and recreational boaters will be warned of impending launches [ATLAS 1991].

4.2.5.1 Sonic Boom Summary

The effects of sonic booms on birds and pinnipeds of northern Channel Islands are expected to be well within the range of other rocket launching programs that have been considered previously at VAFB. Monitoring for the Titan IV/Centaur Program did not document any significant impacts to pinnipeds from noise effects. The intensity of these sonic booms would be largely indistinguishable from normal, background noise from the surf and the wind. Thus, launches of EOS launch vehicles are not expected to substantially impact wildlife on the Channel Islands.

Despite rather intensive, long-term studies, no evidence has been found to confirm that dangerous leaping, self-damage, crushing, or breeding colony responses are brought on by sonic booms or loud overflights. Furthermore, breeding of Guadalupe fur seals and Steller sea lions (both listed as Federally threatened) is not known to occur in the northern Channel Islands. Therefore, it is concluded that launches from any of the SLC locations would not produce a substantial impact to pinnipeds on the Channel Islands from sonic booms.

4.2.6 Noise - Catastrophic Failures

Noise levels of about 200 dBA (equivalent to an overpressure wave of 4,000 psf) were predicted within a radius of 30.5 meters (100 feet) in the event of explosion of a Titan IV/Centaur launch vehicle during liftoff. The sound levels at Lompoc were predicted to be about 90 dBA as a result of a Titan IV/Centaur explosion [ATLAS 1991]. The smaller EOS launch vehicles contain less explosive material than the Titan IV/Centaur; therefore, sound levels at

[13] Many animals, including the harbor seal, respond to a higher range of frequencies than humans, therefore flat-weighted (all frequencies weighted equally) decibels are utilized for this discussion.

(CCS EA) validates this proportionality assumption. The CCS EA indicated that plants are expected to be directly affected by deposition of exhaust products within 300 feet (approximately 100 meters) of the launch pad. The LLV 3 ground lit solid propellant quantity is 119,750 kilograms (264,000 pounds). Using a direct relationship between propellant quantities and vegetation impacts, described above, the LLV 3 would be expected to impact vegetation within 100 meters (328 feet) of the launch site, which is consistent with the CCS EA analysis. The observation of plant communities at other active South Vandenberg AFB launch sites, such as the Titan IV pad at SLC-4, indicate that plants are able to thrive in the extreme near-field of launch events [SLC6a 1995]. All impact distances are within the respective fragment exclusion zone identified at each launch pad on VAFB.

4.2.9 Acidic Deposition

The Atlas IIAS and Delta II 7925 utilize deluge water for sound suppression. During a normal Atlas IIAS or Delta II 7925 launch, much of the deluge water evaporates; a fraction of this subsequently condenses on AL_2O_3 exhaust particles from the SRMs. The droplets absorb HCl gas, forming an acidic cloud. The pH of the cloud droplets ranges from 0.1 to 3.0 for the Space Shuttle [ATLAS 1991]. The pH of cloud droplets for the Atlas IIAS and Delta II 7925 should be no more acidic than for the Space Shuttle. Terrestrial animals in the immediate vicinity of the launch site could come into contact with this acidic mist for a short period. However, this contact is not expected to have a substantial impact on wildlife, since the exhaust cloud will be present only briefly, and any mist that settles out of the cloud will evaporate quickly.

4.2.9.1 Soil Chemistry Impacts

A study of Space Transportation System (STS) launches at Kennedy Space Center (KSC) demonstrated that a substantial amount of chlorides (HCl) and particulates are deposited in the near-field area outside the pad perimeter fence during launches of the STS. It is estimated that under certain wind conditions 3,400 kilograms (7,755 pounds) of HCl and 7,100 kilograms (16,193 pounds) of particulates are deposited across the 12.6 hectare study site. Estimates of maximum HCl deposition in the study area represented 17 percent of the total produced during the first 10 seconds of the launch event. In addition, measurements of chlorides in the deluge water holding ponds represented another 11 percent of the HCl produced. [HCl 1985]

Assuming 17 percent of the HCl produced in the first 10 seconds of launch will be deposited on the launch site, terrestrial loading of HCl was calculated for potential EOS launch vehicles (Appendix H). Knowing the cation exchange capacity[14] for VAFB soils, the quantity of soil required for buffering HCl deposition was determined assuming the availability of a sufficient quantity of $CaCO_3$ (meq 9.6/100 g) for buffering and/or the availability of sufficient cations with electrical charges greater than that of hydrogen and a soil moisture pH of 7 (Table 4-11).

[14] The cation exchange capacity is defined as the ability of a particular rock or soil to absorb cations. The amount of exchangeable ions, in milliequivalents, per 100 grams of solid material at a pH of 7.

Table 4-11. Quantity of Soil Required to Buffer HCl Deposition From EOS Launch Vehicles

Launch Vehicle	Ground Lit Solid Propellant		HCl Deposition/Launch		Soil Required	
Space Shuttle	1,008,582 kg	2,223,520 lb	3,400 kg	7,755 lb	971 kg	2,215 lb
Delta II 7925	71,071 kg	156,684 lb	385 kg	878 lb	110 kg	251 lb
Delta-Lite	69,005 kg	152,128 lb	364 kg	831 lb	104 kg	237 lb
Taurus	48,988 kg	108,000 lb	347 kg	791 lb	99 kg	226 lb
Atlas IIAS	20,275 kg	44,700 lb	265 kg	605 lb	76 kg	173 lb

Source: Data derived from [HCl 1985], [SLC6a 1995], [DELTA 1993] and [DELTA 1994]
Proposed EOS launch vehicles have much larger ascent rates than the Space Shuttle, therefore the linear extrapolation above is conservative (protective of resources).
These calculations assume a soil moisture pH of 7 and that a sufficient quantity of $CaCO_3$ (meq 9.6/100 g) is available for buffering the HCl deposited.

VAFB soils near SLC-6 have a cation exchange capacity from 5-35meq/100 g (mean 9.6meq/100 g) [SLC6a 1995]. These values are expected to be representative of soils at alternative EOS SLCs, therefore the mean value of 9.6meq/100 g has been utilized for the purpose of determining HCl terrestrial loading.

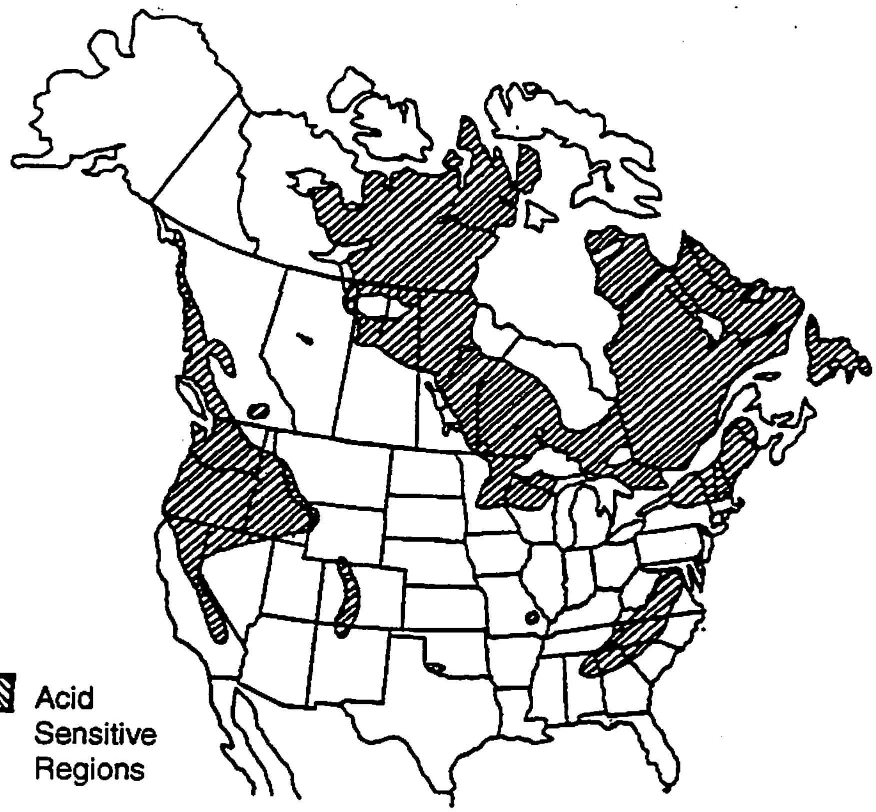
The equivalent weight[15] of a compound is the formula weight divided by the electrical charge or unit weight per electric charge. One equivalent of any substance in nature reacts actually or theoretically with one equivalent of every other substance to produce one equivalent of each of the products. The cation exchange capacity is determined by dividing a compounds concentration by the compounds equivalent weight, eliciting the number of cations that can be absorbed per unit weight. A cation exchange capacity of 9.6meq/100 g means 100 grams of VAFB soil has the potential to absorb 9.6 hydrogen ions (assuming sufficient quantities of $CaCO_3$ are available).

The ratio of the soil's capacity to absorb cations (9.6meq/100 g) and HCl cation production (2.7meq/100 g) is three and one-half to one. This means that a vehicle launch depositing 100 kilograms of HCl on VAFB would require the buffering capacity of approximately 28 kilograms of VAFB soil. Assuming an average density of 1,440 kilograms per cubic meter for VAFB soil (a sandy loam) a launch depositing 100 kilograms of HCl would require 0.02 cubic meters of VAFB soil, to be buffered.

VAFB occupies an area of approximately 40,000 hectares (98,840 acres) or 400,000,000 square meters. Assuming a depth of penetration for mobilized HCl to be 0.5 centimeters, VAFB represents 2,000,000 cubic meters of soil capable of buffering HCl. This represents an HCl buffering capacity (for all of VAFB) equivalent to approximately three million Space Shuttle launches. Furthermore, VAFB is <u>not</u> in an acid sensitive region of the United States (Figure 4-3).

[15] Equivalent weight of an element may be defined as that weight of it which has combined with or displaced one atomic weights worth of hydrogen.

Figure 4-3. Acid Sensitive Regions of the United States



Source: Adapted from [GODISH 1991]

Using the simplistic relationships described above (and in Appendix H) and assuming the worse possible case of 3,400 kilograms of HCl dispersed evenly across 12.6 hectares (31.2 acres) of VAFB, as was measured for the Space Shuttle during studies at KSC [HCl 1985], elicited a potential buffering capacity of 78,624 kilograms of HCl. This is equivalent to 23 Space Shuttle launches. EOS proposed launch vehicles utilize approximately 15 times less solid propellant than the Space Shuttle and are therefore expected to produce no substantial soil impacts. However, as the annual rate of deposition increases with increasing launch rates, the capacity of the terrestrial and aquatic subsystems to act as a "buffer" for these inputs will decrease [HCl 1985]. While greater launch rates have been experienced at VAFB, information concerning the environmental consequences of such rates is incomplete [SLC6a 1995].

4.2.10 Water Impacts

The nearest bodies of surface water are beyond the range of expected impacts. Moreover, the high acid neutralization characteristics of the local drainages would counteract any acidic deposition from the rocket launches [SLC6 1994]. In the event that rain water absorbs HCl which might then be deposited on the ground, this natural buffering capacity of the streams would result in negligible or no change in water quality [SLC6a 1995].

Water usage for EOS payload processing fits within the current scope of water discharge permit definitions [REa 1995]. Local and regional water resources would not be affected since there would be no ground water withdrawals. Water utility piping would be used to meet miscellaneous onsite needs. As a result there would be no related impacts to the ground water, surface water or wastewater processing systems [SLC6 1994].

SLC-2

SLC-2W is equipped with a recently resealed flame duct and retention basin to retain all deluge water and any contaminants. Base policy is that discharge release valves must be kept closed during daily operations in order to catch and hold any accidental spills. VAFB requires that deluge water currently be tested before disposal either to base treatment plants as industrial wastewater or to a hazardous waste facility. The proposed action would not require more deluge water per launch than has been used historically. No substantial impact to surface water is expected from the discharge of deluge water as discharge would not occur at the site. System analysis and procedural changes are ongoing to attempt to reduce water use at SLC-2W.

Launch failure impacts on water quality would stem from unburned liquid propellant being released into VAFB surface waters. For most launch failures, propellant release into surface waters will be substantially less than the full fuel load, primarily due to the reliability of the vehicle destruct system. [DELTA 1994]

SLC-3

Wastewater will be managed so that no water of unacceptable quality is discharged from SLC-3. Thus, there would be no substantial impacts to terrestrial or Bear Creek biota as a result of deluge and washdown water discharges. Containment areas within the SLC-3E launch complex will prevent the accidental release of any spilled propellants or chemicals to Bear Creek. [ATLAS 1991]

Groundwater in Bear Creek Canyon is hard and well buffered; average calcium carbonate hardness of groundwater is 300 mg/L, or an alkalinity of 6 meq/L. Assuming a depth of one centimeter (0.39 inches) for Bear Creek, alkalinity per unit area would be 60 meq/m^2. Maximum acidic deposition from Titan IV/Centaur launches was estimated to be 8.2 gallons/acre at pH 0.1, or 7.7 ml/m^2 of liquid with an acid deposition of 6.1 meq/m^2. Thus, buffering capacity of the Bear Creek water would be at least ten times that required to neutralize acid from a Titan IV launch. Total HCl emitted by the Atlas IIAS at launch is approximately four percent of that emitted by Titan IV; hence, there is almost no chance that Atlas IIAS launches could acidify Bear Creek. [ATLAS 1991]

There is also the possibility for an early inflight termination and subsequent activation of the Atlas IIAS vehicle destruct system. There is little potential of any significant impacts to terrestrial wildlife from such a launch anomaly [ATLAS 1991].

SLC-6

At SLC-6, rain and wash water are collected into catchments that are tested before release. If the water in the catchment requires treatment, the water would be pumped to the industrial wastewater treatment facility for processing before release [SLC6a 1995].

There are no jurisdictional wetlands in the immediate vicinity of SLC-6. The nearest bodies of surface water are normally beyond the range of expected impacts due to prevailing winds from the NW to the SE. Moreover, the high acid neutralization characteristics of the local drainages, such as Honda Creek, would counteract any acidic deposition from SLC-6 launches [SLC6a 1995]. Initial and annual monitoring of the Honda Creek habitat and species will be performed to first provide a baseline, then to determine if any changes have occurred [LAR 1995].

Pegasus Impacts to Water

The introduction of the PIK to the Pegasus program will result in the generation of hydrazine contaminated liquid and solid waste from the propellant transfer process. The waste water will be disposed of by VAFB personnel using approved procedures. VAFB has a permit for the storage of hazardous wastes generated at the base until transported offsite by a registered hauler to an approved disposal site. As long as the payloads which are to be orbited by the Pegasus/PIK are sponsored by the U.S. government the storage and disposal of hazardous wastes fall under the existing permits.

4.2.11 Ocean Environment [DELTA 1994]

In a normal launch, the first and second stages and the SRMs would impact the ocean. The trajectories of spent stages and SRMs would be programmed to impact a safe distance from any U.S. coastal area or other land mass. Toxic concentrations of metals would not be likely to occur due to the slow rate of corrosion in the deep ocean environment and the large quantity of water available for dilution.

Along with the spent stages would be relatively small amounts of propellant. Concentrations in excess of the maximum allowable concentration of these compounds for marine organisms would be limited to the immediate vicinity of the spent stage. No substantial impacts would be expected from the reentry and ocean impact of spent stages, due to the small amount of residual propellants and the large volume of water available for dilution.

Delta II 7925

If there was an early flight termination and failure of the Delta II 7925 vehicle destruct system, it is remotely possible that the entire stage 2 propellant quantity could be released to the ocean. Shallow or confined surface water systems would receive most of the impact. The release of the entire RP-1 fuel load in this near-pad intact vehicle impact scenario would form a very thin film (less than 0.003 centimeters, or 0.001 inches) covering a water surface area less than 4.4 square kilometers (1.7 square miles). This film would be expected to dissipate within a few hours. In this hypothesized worst case, which has never occurred for the Delta II, Aerozine-50 and N_2O_4 contaminants could exceed allowable concentrations for an approximate radius of 241 meters (800 feet) in water depths exceeding 3 meters (9 feet) deep. However, even given this worst case scenario, the impacts to ocean systems would be localized and/or transient in nature, and expected to recover rapidly. [DELTA 1994]

Atlas IIAS

In the unlikely event that there was an inflight failure coupled with a failure of the Atlas IIAS vehicle destruct system, it is possible that some of the liquid propellants from the launch vehicle might enter the ocean. Localized short-term impacts to water quality and marine biota would result from such an unlikely launch anomaly [ATLAS 1991].

4.2.12 Coastal Zone Management

The Coastal Zone Management Act (CZMA), as amended, establishes as a national policy the preservation, protection from development, and, where possible, the restoration and enhancement of the nation's coastal zone. Section 305 of the Act requires Federal agencies that conduct activities which directly affect the state's coastal zone, to make sure that these activities are consistent, to the maximum extent practicable, with approved state Coastal Zone Management Programs [SLC6a 1995]. The California Coastal Commission has reviewed those actions which would be associated with the launch of EOS proposed launch vehicles from

VAFB and found those actions to be consistent with the California Coastal Management Program.

4.2.13 Archeological and Historic Resources

SLC-6 is located within an area thought to have been a part of the historic Juan Bautista de Anza National Historic Trail. Possible impacts to the original corridor could include restriction of access during launches and alteration of the area's visual character. These impacts have been previously identified by CCS and are under review as part of the commercial use of that complex. Determination and final disposition of this review will determine EOS impact significance.

Since no surface or subsurface areas will be disturbed, no significant archeological, historic, or cultural sites are expected to be affected by launching EOS spacecraft from VAFB. Other than the above National Historic Trail, the processing and launch of EOS spacecraft will not affect any property listed or eligible for listing in the National Register of Historic Places.

4.2.14 Transportation Impacts

Existing daily traffic volumes were previously compared to level of service (LOS) E roadway capacities to arrive at a volume-to-capacity ratio and corresponding LOS operation for the CCS. Projected traffic volumes were based on an estimated 1.5 to 2 percent increase in traffic annually. All road segments in the vicinity of the base currently operate at LOS C or better. However, the California Boulevard/Lompoc-Casmalia road intersection near the Santa Maria Gate generally operates at LOS D or E during peak hours when traffic entering the base backs up through the intersection [PPF 1993].

Previous estimates predicted that during operation of the Spaceport, approximately 10 personnel would work at the facility. Assuming all of these personnel drive their own vehicle, approximately 20 additional vehicle trips would be generated during operation of the facility. This represents approximately one percent of traffic using Pine Canyon Gate on a daily basis, which is not considered to be of concern. [PPF 1993]. Maximum EOS support personnel are anticipated to be 40-50. Scaling from previous studies, increased traffic flow would be between four to five percent however the increase would only be for three to four months, not year round. Previous policy and analysis indicate that impacts to the transportation system were considered to be of concern if LOS or system capacity ratios were degraded [PPF 1993]. A temporary increase of four to five percent is not considered a significant degradation of capacity ratios. EOS AM-1 is projected to be the largest payload to process. Subsequent payloads estimated to require 20 percent less support activities due to smaller payloads, will probably require fewer support personnel and therefore have even lower impacts on transportation capacity ratios.

Transporting of the fueled spacecraft will comply with the Joint Policy Statement by the Eastern and Western Ranges for Ground Transportation of Hazardous Materials and Pressurized Vessels used on Missiles and Space Vehicles, dated 12 March 1990. This Policy Statement requires that the transport take place during off-duty hours, and all personnel be cleared a minimum of 381 meters (1,250 feet) from the transport convoy route or instructed to enter and remain inside a building for the duration of the transport.

The EOS Program would conduct transportation in accordance with existing use and guidelines. The transportation routes used will not unduly burden the existing roadways, or require any significant changes to them since they have all been cleared for use by the Shuttle, a larger vehicle than any of the proposed EOS launch configurations.

4.2.15 Hazardous Materials and Solid Waste Management

Hazardous and solid waste management will comply with all existing Federal, applicable State and local base environmental regulations. The hazardous materials anticipated are the usual materials normally encountered in the space industry. Vandenberg AFB operates as a generator of hazardous waste and as a Treatment, Storage, and Disposal Facility (TSDF). The transportation and disposal activities for EOS-generated waste can be performed by VAFB host base services [REa 1995]. Hazardous waste routinely generated by the base include oils, paints, thinners, solvents, and other regulated materials, including radioactive wastes. A Hazardous Waste Management Plan has been developed and implemented to ensure compliance with Resource Conservation and Recovery Act (RCRA) requirements. The base has a RCRA Part A permit, and the Part B permit is presently under review. In addition to the Hazardous Waste Management Plan, the base has also developed a Hazardous Waste Source Reduction Compliance Plan to provide information and procedures to reduce and minimize the generation of hazardous wastes on the base. [PPF 1993]

The handling and use of hazardous and toxic materials would be limited. Solid rocket propellants would be contained in the launch vehicles themselves. These would be fueled at the factory and would arrive at VAFB as completely assembled, painted, encapsulated units.

Hazardous materials used by Spaceport/Astrotech customers during operations would normally consist of various solvents and cleaners, paints and primers, adhesives, alcohol, lubricants, hydrazine, and contaminated clothing and rags. It is expected that no more than a gallon of each of the listed types of materials would be used for each EOS payload.

Hazardous and toxic materials would be used on the launch complex. The primary liquid rocket motor propellants include hydrazine (N_2H_4), nitrogen tetroxide (N_2O_4), kerosene (RP-1), and liquid oxygen (LOx). Liquid hydrogen (LH_2), gaseous helium (GHe), gaseous nitrogen (GN_2), and other materials would also be on the complex.

Fueling of Spaceport launch vehicles would be from user-supplied service trucks or carts, which would make deliveries from existing permitted facilities on VAFB. Fueling carts for use at the Spaceport would meet all existing Air Force, DOT, and other applicable regulatory agency requirements [SLC6a 1995]. There would be no permanently installed rocket fueling systems at the PPFs/IPF.

<u>SLC-3</u>

After pumping out the SLC-3E retention basin following a launch, there is approximately one drum of sediment remaining. The sediment often tests hazardous due to the presence of certain heavy metals, particularly lead and zinc. It is postulated that the source of the heavy metals is microscopic flakes of old Umbilical Mast coatings washed into the retention basin by the deluge water. Care will be taken to assure that coatings used on the new Umbilical Tower do not contain toxic heavy metals. Thus, it is conceivable that the post-1995 retention basin sediment will not be hazardous. [ATLAS 1991]

SLC-6

It is expected that no more than 4.5 kilograms (10 pounds) of solid hazardous waste (contaminated rags, clothing, etc.) and minimal amounts of liquid hazardous waste (waste oils, lubricants, greases, hydraulic fluid, antifreeze) would be generated as a result of each EOS payload processed at the Spaceport. While the Spaceport operates as a commercially leased facility, all management of hazardous waste at the Spaceport would be done in accordance with the VAFB Hazardous Waste Management Plan. Compliance with these procedures would be required of all Spaceport customers. Individual users of the Spaceport would be required to quantify the amounts of hazardous materials to be used and waste to be produced in separate environmental analysis documents. Hazardous materials not used by the user would be removed and disposed of by qualified personnel. [SLC6a 1995]

Summary

It is expected that SLC-2W, SLC-3E and SLC-6 launches would cause no substantial adverse environmental impacts with respect to hazardous wastes, because the amounts of hazardous wastes generated would be small and because all hazardous wastes generated would be managed in accordance with the VAFB Hazardous Waste Management Plan which has been previously approved and utilized on VAFB with no adverse effects. [ATLAS 1991]

The only radioactive material that might be used on a specific mission would be minute in quantity and associated with scientific instrumentation. Consequently, no adverse environmental impact is anticipated from radioactive substances.

4.3 ACCIDENTS AND LAUNCH FAILURES

4.3.1 Liquid Propellant Spill

The potential for an accidental release of liquid propellants would be minimized by strict adherence to established safety procedures. All spills would be managed in accordance with the VAFB Spill Response Plan. First stage propellants, RP-1 and liquid oxygen, will be stored in tanks near the launch pad within cement containment basins designed to retain 110 percent of the storage tank volumes. Post-fueling spills from the launch vehicle would be channeled into a sealed concrete catchment basin and disposed of according to the appropriate state and federal regulations. Second stage propellants, Aerozine-50 and N_2O_4, are not stored at the SLCs and would be transported to the launch site by specialized vehicles.

The most severe propellant spill accident scenario would be releasing the entire launch vehicle load of N_2O_4 at the launch pad while conducting propellant transfer operations. This scenario would have the greatest potential impact on local air quality. Using again the Titan predictive models and scaling for the Delta propellant loading, incremental airborne NO_x levels from this scenario should be reduced to 5 ppm within about 150 meters (500 feet) and to 1 ppm within 300 meters (about 1,000 feet). Activating the launch pad water deluge system would substantially reduce the evaporation rate, limiting exposure concentrations in the vicinity of the spill that are above federally established standards. Propellant transfer personnel will be outfitted with protective clothing and breathing equipment. Personnel not involved in transfer operations will be excluded from the area during such operations. [DELTA 1994]

4.3.2 Accident Scenarios During Processing at the PPF [PPF 1993]

The accident scenarios posing potential risk from hydrazine and nitrogen tetroxide occur during transfer operations and moving the fueled spacecraft. Effects of these accidents would be limited to the PPF and workers in the building. The most likely outcome of an accident is a spill that is contained with no damage to life or property. The most likely consequences of a severe accident are some level of damage to the spacecraft and the immediate liquid propellant transfer area. Facility design will limit further damage to the facility. For example, the facility is designed so as to contain explosive damage due to the use of heavily reinforced concrete and substantial cross members. No injuries are anticipated if facility workers follow emergency procedures. Although improbable, a violent fire or an explosion could produce severe injuries or even death.

As a result of the minor amount of handling required, and the straight path from the PPF to the transporter, the chance of dropping a spacecraft is small. Moreover, the consequence would be limited to minor damage to the spacecraft. Rupture of either the fuel tank or the oxidizer tank is unlikely because of the low height that the payload must be lifted. Tank rupture may expose unprotected personnel to toxic fumes.

During the transport of the EOS spacecraft from the processing facility to the launch site there could be a traffic accident. Several factors will minimize the consequence of any accident. The forces imparted to the encapsulated spacecraft during an accident will be small because of the low speeds involved during transportation. The spacecraft is protected from damage by the capsule and a protective blanket. Thus, the most likely consequences of an accident are either no effect or toppling and damage to the capsule without affecting the spacecraft. Should the spacecraft be damaged, it is unlikely that the hydrazine tank or the oxidizer tank will be damaged. If a tank is damaged, any spill would be small. [PPF 1993]

In the unlikely event of a leak, personnel involved in moving the spacecraft and providing security would be protected by following emergency procedures including the wearing of appropriate protective clothing. Risk during mating operations arise from the possibility of dropping the spacecraft or its impact with the service tower. The vast majority of such accidents of this type would do little more than damage the spacecraft or its encapsulation. There are, however, scenarios that could result in dropping the spacecraft from a height so that the hydrazine tank and, possibly, the oxidizer tank rupture on impact, causing an explosion that damages the launch vehicle and produces severe injuries or fatalities among operational personnel.

4.3.3 Launch Failures

The environmental impacts of any of the proposed launch vehicles (Atlas IIAS, Delta II 7925, Delta-Lite, Taurus, and Pegasus) during launch failures have been previously described in environmental assessments for each launch vehicle and are summarized in Appendix C [ATLAS 1991, DELTA 1994, SELVa 1992 and SELV 1993]. Accidents either on the launch pads or within a few seconds of launch present the most threat to people, mainly the launch complex work force. Due to Range Safety requirements and operational requirements all personnel, including workers are sufficiently far away from the launch site so as not to be affected by debris and other direct impacts of such accidents. There are potential short term effects including: localized effects of a fireball, fragments from the explosion, and release of some propellants and combustion products.

Range Safety Requirements mandate command safety destruct (CSD) systems on liquid propellant tanks and solid rocket motors. In the event of a CSD action, combustion products will include: Al_2O_3 particulates, HCL, CO, NO_x from the solids and CO_2 & N_2 from the hypergols. The amount of dilution would be dependent on existing meteorological conditions at the time of launch, but the products are not expected to be higher concentrations than those during a nominal launch since the SRM's would probably extinguish under a CSD scenario. [FEIS 1995] The flight of the vehicle would be monitored by Air Force personnel who have authority to destroy the launch vehicle in the event of abnormal operations or a departure from the approved limits of flight. The 30 SW Commander has the ultimate responsibility for safety of all space, missile, and aeronautical flights within the Western Range [SLC6a 1995].

Some uncombusted propellants could enter nearby surface waters or the Pacific Ocean. Depending on the amount of fuel reaching the water bodies, aquatic biota could be subject to short term impacts including death to biota in the immediate area due to hydrazine or nitrogen tetroxide releases. Immediate on pad effects to terrestrial plants and animals due to a fireball are possible. These effects although severe are transient and occur only one time if there is an accident on the pad.

SLC-2W Delta launches utilize a water deluge under the main engine and essentially no heat reaches any vegetation upon ignition. Solid Rocket Motors utilize side deflectors to divert exhaust from six solids and the heat intensity is localized to the immediate concrete pad area. After ignition any hot materials are confined to an asphalt covered area within 100 feet. Because these areas are already disturbed, these impacts are not considered substantial. [SLC2W 1991]

If an explosion occurred at SLC-3 while the launch vehicle was still on the pad, then most animals within a few hundred feet of the blast would be killed, and a fire could ensue. Such a fire could kill additional animals in habitats adjacent to the launch site. This impact would not be substantial over the long-term because; (1) there were no observable long-term adverse impacts on biota in the vicinity of SLC-4 following the Titan 34D explosion of April 1986; and (2) the habitats and their associated biota present in the vicinity of the launch site are adapted to naturally occurring fires. [ATLAS 1991]

Fires could begin near the Spaceport and burn off special habitat unless immediately contained. Subsequent natural growth would occur, but regrowth could take over 5 years depending upon the extent of the fire damage. Existing fire control measures such as plowed firebreaks would reduce the extent. [SLC6a 1995]

If it is assumed that the environmental impacts during an on pad launch accident are roughly scaled to the amount of solid propellants used in the launch vehicle and bound by successful launch exhaust products then one can conclude that impacts from the EOS launch vehicles are roughly scaled from least to most impacting as Pegasus< Atlas IIAS<Delta-Lite<Delta II (Table 4-12).

Table 4-12. EOS Launch Vehicle Emissions in Pounds for a Complete Burn

Launch Vehicles Combustion Product	Delta II 7925[1]	Delta-Lite[2]	Taurus[3]	Atlas IIAS[4]	Pegasus[5]
AlCl	47				
$AlCl_2$	47				
$AlCl_3$	24				
AlClO	24				
Al_2O_3 (soluble)	69,544	98,960	52,800	31,800	13,000
Al_2O_3 (insoluble)	14,760				
CO	142,474	57,640	30,000	139,000	7,400
CO_2	68,451	5,020		109,800	
Cl	635				
H	68				
HCl	49,567	46,400	26,400	15,800	6,400
H_2	8,302				
H_2O	73,410				
N_2	19,343				
OH	89				
NO_x			12,400		3,000

Source: Data acquired from [DELTA 1994], [SLC6a 1995] and [SELVa 1992]
[1] Includes products from 9 GEMs and the Delta II 1st stage [DELTA 1994]. [2] Delta-Lite emissions are assumed to be 70 percent of the LLV 3 (6) [SLC6a 1995]. [3] Knowing the quantity of pollutants created from the burning of 16,275 pounds of fuel [SELVa 1992] total Taurus emissions were calculated using the ratio of total propellant quantity to the propellant quantity with known pollutant values (143,185 pounds/16,275 pounds). [4] Atlas IIAS values include SRM, booster and sustainer phase emissions [ATLAS 1991]. [5] Pegasus emission values were obtained by using total propellant quantity for the Pegasus. Assumes HTPB propellants will emit the same quantity and proportions of pollutants. Represents a complete burn of all vehicle propellants.

SAMPLE CALCULATION FOR THE TAURUS: If 1.5 tons of HCl are created from the burning of 16,275 pounds of HTPB fuel, then the burning of the full load of propellant (143,185 pounds) is assumed to elicit 13.2 tons of HCl:

$$X = 1.5 \times 143{,}185/16{,}275$$

4.4 EOS SPACECRAFT AND INSTRUMENT HAZARDS

4.4.1 EOS (AM-1) Hazardous Materials [MODIS 1995]

Total inventories and descriptions are not available for later missions, but AM project materials are expected to be representative of future materials in later projects. The following hazardous materials have been identified with the EOS AM-1 payload:

- **Beryllium** is used as a structural element in the MODIS and CERES Instruments. In it's solid metallic state, Beryllium presents no health hazard; Beryllium as a dust, usually associated with machining of the material, presents a problem. No machining is planned at the WR. Beryllium is also used in electronic connector pins, beryllium-copper. The quantity of beryllium present has been determined by Martin Marietta Environmental Health and Safety to present no health hazard to personnel. [MODIS 1995]
- **Hydrazine** is a propellant that is highly toxic and volatile. It is planned that the EOS AM-1 Spacecraft will contain 259 kilograms (570 pounds) of hydrazine at launch. Special precautions and personnel protective equipment is required when handling hydrazine and when hydrazine is present in the system.
- **Anhydrous Ammonia** is the working fluid in the heat pipes and the Capillary-Pumped Heat Transport System (CPHTS). Each CPHTS contains approximately 1 kilogram (2 pounds or 0.4 gallons) of ammonia for a total quantity of 5.4 kilograms (12 pounds) of am-

monia plus the individual heat pipes. Charging of the systems will take place at Martin Marietta Aerospace.

Instruments

Early in the spacecraft design phase, a hazard analysis is required to be completed on all system components and instruments. Hazard analyses are not yet available for many of the PM, CHEM, ALT & RALT and FOO's instruments or spacecraft. Therefore, the AM payload (Table 4-13) will be assumed to be generally representative of the types of instruments and materials which will be used on other projects.

Table 4-13. AM-1 Instrument Hazardous Materials

Instrument	Hazard	Quantity/Usage	Regulations/Control Measures
ASTER	No Hazardous Material[1]	N/A	N/A
CERES	Thorium Fluoride (ThF_4) Beryllium	0.2 g/Optical coating Structural element	< 15 lbs exempt[2] Solid state - no hazard
MISR	TBD	TBD	TBD
MODIS[3]	Thorium Fluoride (ThF_4) Beryllium HgCdTe (HCT) detectors	0.2 g/Optical coating Structural element	< 15 lbs exempt Solid state - no hazard No safety hazard[4]
MOPITT	Thorium Fluoride (ThF_4)	0.2 g/Optical coating	< 15 lbs exempt

Source: Data acquired from [MO 1995], [PLAN 1995] and [HgCdTe 1995]
[1] ASTER is believed to contain no hazardous materials [MO 1995]
[2] The Nuclear Regulatory Commission states in 10 CFR Part 40.22 (Small quantities of source material) that ThF_4 in quantities of less than 15 pounds usually do not require special handling procedures or a special radiation safety monitoring program
[3] No failure modes of Criticality 1 were described for the MODIS instrument in the final Failure Modes (and) Effects Analysis report [PLAN 1995].
[4] With the exception of processing the basic photoconductive, and photovoltaic detector materials, HCTs produce no intrinsic safety hazard as the mercury is bound into the crystal lattice of the compound [HgCdTe 1995].

Where specific Failure Mode and Effect Analyses (FMEA's) have been completed for instruments they have been reviewed. No failure modes of criticality one[16] were described for the MODIS instrument in the final FMEA report [PLAN 1995].

The CERES instrument is a low hazard level benign thermal radiation measuring device, which does not contain any large energy source such as flammable fuels or pressurized vessels. It contains no radioactive material, one toxic material, no large fast moving parts, and performs no energetic or hazardous functions. As with other EOS instrument reviewed no significant hazards are expected from the materials used in the CERES instrument [CERES 1994].

EOS instruments, AIRS and MODIS, require detector spectral response in the range of 14 to 17 micrometers and operation in the range of temperatures between 65 to 95 K. Currently, a prime candidate detector for these instruments is trapping-mode photoconductive mercury cadmium telluride (HgCdTe) infrared devices. These devices would be in the form of a crystalline solid, which eliminates exposure and would not produce an intrinsic hazard during payload processing or launch. HgCdTe (HCT) Detectors, with the exception of processing the basic photoconductive, and photovoltaic detector materials, produce no intrinsic safety hazard

[16] A failure mode of criticality one is a single failure that could result in loss of human life, serious injury to personnel, loss of mission, or loss of spacecraft and instrument [FMEA 1994].

as the mercury is bound into the crystal lattice as a constituent of the compound, HgCdTe. Therefore, once the detectors are machined and produced they present no significant hazard. [HgCdTe 1995]

Methane gas and carbon monoxide (CO) are used in the MOPITT to serve as a filter when examining atmospheric gases. Methane's Lower Explosive Limit (LEL) is 5.3 percent and Upper Explosive Limit (UEL) is 14 percent. Carbon monoxide can cause oxygen deprivation in enclosed spaces and thus becomes a personnel hazard. Safety analyses have been performed [SAR 1995] to assess the likelihood of leaking methane, leaking CO, and the possible ignition source that may be present. The Safety Assessment Report (SAR) indicated that neither of these conditions are highly likely. The volume of CO in the MOPITT instrument (28 mg/m^3) is well below the Short Term Exposure Value (STEV=460 mg/m^3) for CO and the Time Weighted Average Exposure Value (TWAEV= 40 mg/m^3) for CO. The analyses also indicated that the amount of methane in MOPITT was not enough to reduce the oxygen to a level below 18 percent, which would be the level of concern during operations. Also, there will not be an ignition source available during operations and testing, and the amount of methane available should there be a leak, would not exceed the lower inflammability level (5 percent) at any time. These materials, while in certain quantities can be hazardous, are not hazardous in the quantities anticipated for EOS.

Ionizing Radiation

Radioactive Thorium Fluoride (ThF_4) is used in combination with Yttrium Oxide (Y_2O_3) and germanium metal to provide an optical coating for the MODIS and MOPITT Instruments lens. The total amount of this material used is less than 0.2 grams (0.007 ounces) or 2.18 x 10^{-8} Curies per each instrument. Thorium Fluoride is an alpha emitter and is hazardous only if ingested or inhaled. For this to occur, the lens coating would have to be scraped off or the lens damaged to create a thorium fluoride powder. Also, it is possible to create a radioactive fume with this material if it is heated >1,100° C which is not an expected temperature. Martin Marietta is presently obtaining the forms necessary to present this material and it's usage to the 30th SPW/SES for approval on the range. The Nuclear Regulatory Commission states in 10 CFR Part 40.22 (Small quantities of source material) that ThF_4 in quantities of less than 6.8 kilograms (15 pounds) usually do not require special handling procedures or a special radiation safety monitoring program. As a bounding case for radiation hazard it was assumed that the thorium utilized in the instrument would be natural Th-232. Although there is no anticipated mechanism for dispersion, a dose calculation was completed utilizing very conservative assumptions. The resultant potential effective dose equivalent (assumed that 0.40 grams is thorium) would be 0.36 Sv[17] (36 rem[18]). This dose would be received over 50 years and amounts to 0.0072 Sv (0.72 rem) per year. If the anticipated affected population was considered to potentially be 100,000 persons (population of Santa Maria and Lompoc) the theoretical dose per person would be 0.006 mrem per year. This dose is much less than that allowed for occupational exposures and much much lower than doses allowed for public exposures. It is also significantly below the range considered de minimis for radiation exposures and subsequently it is not considered significant, nor of a health concern.

Other instruments reviewed did not identify other hazardous materials for PM, CHEM, ALT RALT and FOO's. The AM instrument suite is considered to be representative of other instrument complements and therefore is expected to bound the hazards impact analysis for EOS instruments. If future EOS projects include hazardous materials outside the scope of this EA, updated safety and hazards analyses will be made available, and additional NEPA documentation will be prepared, if appropriate.

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[17] A Sievert (Sv) is a radiation dose equivalent to one-hundred rem.

[18] A Roentgen equivalent man (rem) is a unit of radiation exposure.

Nonionizing Radiation

The EOS AM-1 Spacecraft would carry three types of transmitters, a KU-Band High Gain for general data flow, an X-Band used for direct access by special user organizations and three S-Band transmitters for communication with the satellite (only two of the S-Band transmitters are used at any given time). With proper safeguard against electrical shock, there is no human health and safety hazard expected from radio frequency radiation by the launch vehicle/spacecraft.

4.4.2 EOS (AM-1) Subsystem Hazard Analysis [MODIS 1995]

4.4.2.1 Analysis Process

The EOS AM-1 subsystems were individually evaluated for hazards and their contributing factors. The identified hazards from each subsystem were then evaluated for hazard severity, probability of occurrence and operational constraints using the guidelines of the Performance Assurance Requirements (PAR). This information was entered on the Hazard Report worksheet along with applicable safety requirements. Design features already incorporated into the bus design were identified along with procedural safety requirements.

4.4.2.2 Analysis Results

The subsystem hazard analysis identified 80 hazards associated with the spacecraft design and launch preparation. None of the identified hazards fall into the unacceptable area of the matrix. The identified hazards that fall into the undesirable area fall into three main categories:

- electrical energy; high voltage and high current sources on the spacecraft and the electrical ground support equipment
- handling of fully charged nickel-hydrogen batteries
- personnel making contact with elevated temperature surfaces during integration and testing

4.4.3 EOS Safety Program

All pertinent safety requirements will be adhered to in compliance with applicable instructions or addressed in appropriate safety plans. The EOS Project will establish a comprehensive System Safety Program for the entire mission in accordance with System Safety for Orbital Flight Projects, GMI 1700.3A; System Safety Program Requirements, MIL-STD-882C; and WRR 127-1. The program will cover ground support personnel, test and integration personnel and facilities, hardware and software, and launch operations.

4.5 ORBITAL SPACE DEBRIS

NASA Management Instruction (NMI) 1700.8 states "NASA's policy is to employ design and operations practices that limit the generation of orbital debris, consistent with mission requirements and cost-effectiveness." The NMI requires that each program or project conduct a formal assessment for the potential to generate orbital debris. General methods to accomplish this policy include:

- Depleting on-board energy sources after completion of mission

- Limiting orbit lifetime after mission completion to 25 years or maneuvering to a disposal orbit
- Limiting the generation of debris associated with normal space operations
- Limiting the consequences of impact with existing orbital debris or meteoroids
- Limiting the risk from space system components surviving reentry as a result of postmission disposal

The EOS Program performed such an assessment, considering the general methods above to limit debris generation.

4.5.1 EOS Disposal Plan

EOS-AM orbital disposal plans will not be typical of those for subsequent EOS spacecraft. The EOS-AM Spacecraft Safe Disposal Plan [OPD-999 1993] was completed prior to the issuance of NASA's Management Instruction (NMI) 1700.8, "Policy to Limit Orbital Debris Generation". The mission was well developed at the time the specific orbital disposal requirements were published in NSS 1740.14. The EOS-AM Spacecraft Safe Disposal Plan calls for AM-1 to utilize any existing resources at end of mission to shorten the decay lifetime [OPD-999 1993]. However, AM-1 may exceed the 25 year lifetime limit in the current orbital disposal guidelines, depending on how much fuel remains after compensation for injection errors and other dispersions. All other spacecraft (PM, CHEM, LALT, RALT, etc.) would comply with NMI 1700.8 [LE 1997].

The AM project has completed an orbital debris analysis for the AM-1 spacecraft [GRa 1995]. The results of the analysis assumes that AM-1 debris would be allowed to fall back to Earth without propulsion system assist. This will take between 10-30 years, will have a predicted debris impact area of 350 square kilometers (135 square miles) and a calculated casualty expectation (hazard to the world population) of 3.9×10^{-4}. [EOSDN 1993]

The risks presented here represent unassisted orbital decay. If resources are available at end of mission they will be used to shorten the decay orbit and therefore lower the hazard and risk to the population. Given the risk calculated there are several other factors useful in determining acceptability of the proposed mission:

1) The values calculated for AM-1 are consistent with other orbital debris disposal options used for other satellites.

2) The decay lifetimes calculated for AM-1 polar orbit are consistent with existing low earth orbiting satellites and would therefore affect the same population base. However, the actual casualty expectation is probably lower than predicted because people are generally protected by buildings and shelter, which the models do not take into account.

3) The conservative prediction of 350 square kilometers (135 square miles) for the debris footprint is consistent with typical re-entering satellite estimates of 250 square kilometers (97 square miles).

The AM project has preliminarily determined that the best solution for limiting the environmental impacts of reentry of any of its components is by allowing the spacecraft to naturally fall back to earth. Environmental impacts as defined by the mathematical model described above are anticipated as minimal.

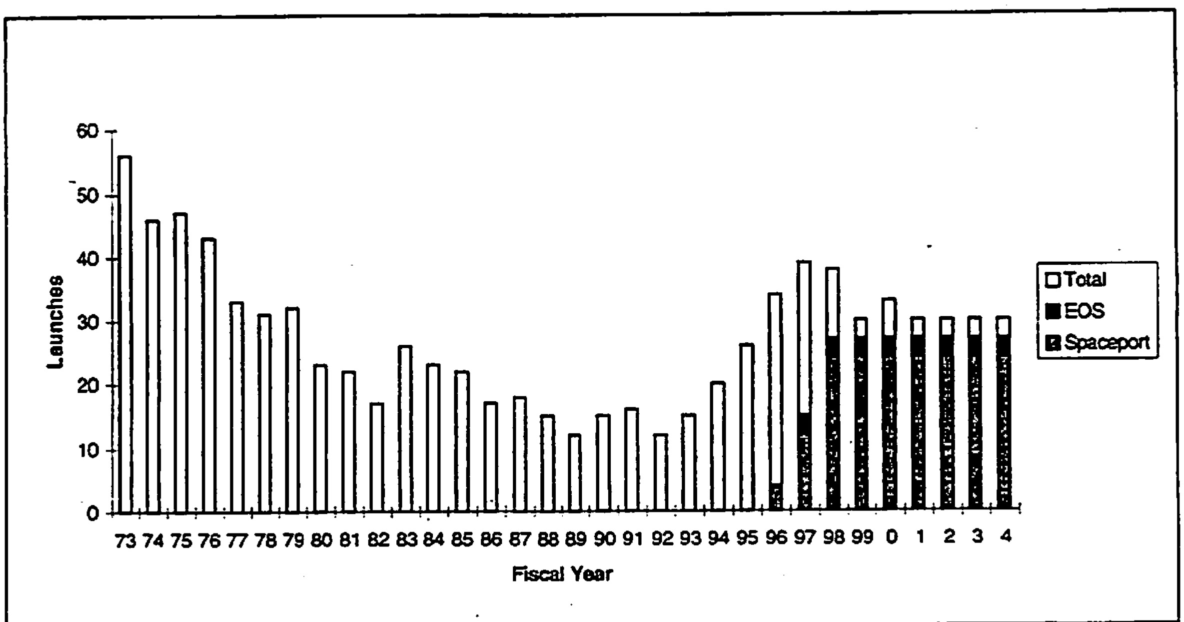
4.6 CUMULATIVE EFFECTS

4.6.1 Cumulative Impacts

General

The long-term, cumulative effects to the local and regional biota would be expected to be not substantial. This is indicated by Figure 4-4 which shows that the EOS Program would not represent an overall increase to the rocket launching activities at Vandenberg AFB. The use of VAFB SLC facilities is consistent with existing uses and poses no new impacts. The total number of launches at individual launch sites proposed by the EOS Program per year is small when compared to ongoing programs at VAFB and is included within the previously approved launch rate. The Earth Observing System Program would not increase launch rates nor utilize launch systems beyond the scope of approved programs at VAFB. When the proposed program of approximately 25 launches (11 of which would be FOO launched at alternative launch sites) is considered over the life of the program (approximately 15 years) it amounts to only two launches per year at VAFB. The EOS Project Plan shows a maximum of four launches in any one year, but this includes several FOO flights. Even a conservative estimate of four additional launches per year at VAFB does not pose significantly adverse environmental impacts. A comparison of potential number of launches at VAFB indicate that even if proposed missions do launch at any of the SLC facilities (including the CCS) the total expected launches do not approach previous years (1973-1979) in which no cumulative or adverse impacts have been observed. Furthermore, when compared to National emission estimates of over 62 million metric tons (68 million tons) of carbon products produced each year EOS Program emissions are insignificant (Table 4-14).

Figure 4-4. Vandenberg AFB Workload (launches per year)



Source: Adapted from [SLC6a 1995]
Assumes an increase due to three EOS launches (maximum) per year

Table 4-14. National and EOS Program Emission Estimates

	Emissions (Tons/Year)		
Source*	CO	PM_{10}	NOx
Transportation	44,900,000	1,500,000	9,300,000
Stationary source fuel combustion	7,900,000	2,000,000	11,400,000
Industrial processes	5,200,000	2,800,000	700,000
Solid waste disposal	1,900,000	300,000	100,000
Miscellaneous	7,800,000	1,100,000	100,000
EOS Program	22.86	32.85	0.216**

Source: Data acquired from [GODISH 1991]
*National emission estimates are for 1987
**1/8 of total Spaceport emissions (Table 4-2)
CO and PM_{10} values for the EOS Program assume emissions up to 914 meters (3,000 feet) for 3 launches of the LLV 3 with six Castor IV/XL™ SSRMs used in describing Delta-Lite impacts with the addition of ground operations (Table 4-5 & 4-6 (emissions from generators and support vehicles)) described for the Taurus launch vehicle.

Honda Creek riparian areas, near SLC-6 are not expected to be impacted by cumulative effects from rocket launches. Input of HCl at this distance is projected to be at extremely low levels and only under the most adverse atmospheric conditions. Under the infrequent south wind conditions, when exhaust products could reach Honda Canyon, peak concentration from different launches would be expected at different places, minimizing the potential for cumulative exposure, even when considering the total number of launches over many years [SLC6b 1995].

Monitoring and any trigger for corrective action should target the most susceptible sensitive species, which would be the California red-legged frog (federally listed as threatened). This species is capable of absorbing chemicals and water directly through the skin. In the unlikely case that monitoring reveals project-related input of HCl at levels having potential biological significance, it would be possible to avoid launching during the infrequent conditions that create this possibility. [SLC6b 1995]

4.6.2 Impacts on Stratospheric Ozone

During the last 20 years there has been an increased concern about human activities affecting the upper atmosphere. Substantial decreases of total ozone in the middle and high latitudes of both hemispheres have been documented [WMO 1994]. The links between ozone losses in the Antarctic spring and Arctic winter stratosphere and human-made chlorine and bromine increases have been established. Although losses of total ozone and midlatitudes are difficult to simulate with atmospheric models, the observed losses are best explained by the halogen increases. Furthermore, the link between a decrease in stratospheric ozone and an increase in surface ultraviolet (UV) radiation has been measured [WMO 1994].

Space vehicles that use SRMs have been studied concerning potential contribution to ozone depletion due to exhaust products. Primary constituents of exhaust from solid-fueled rocket motors are HCl, CO_2, CO, and Al_2O_3. To date, most attention in previous studies has focused on the chlorine emissions of rockets as the largest threat to stratospheric ozone (*i.e.*, [HCl 1996] and references therein). Through reaction with OH ($OH + HCl \rightarrow Cl + H_2O$), the chlorine atom from HCl is released to play a role in ozone loss. One such catalytic loss cycle is:

$$Cl + O_3 \rightarrow ClO + O_2$$
$$\underline{ClO + O \rightarrow Cl + O_2}$$
$$\text{Net: } O_3 + O \rightarrow O_2 + O_2$$

The Cl is not consumed in this loss process, thus one Cl atom can be responsible for the loss of many hundreds of thousands of ozone molecules before reacting with another atmospheric constituent and ending the catalytic loss cycle [HCl 1975].

Extrapolating from estimates made for Space Shuttle and Titan IV solid rocket motor launches, EOS proposed launch vehicle effects on ozone would be negligible and probably indistinguishable from effects caused by other human-made causes.

4.6.2.1 EOS Launch Vehicle Atmospheric Impacts

Since the planned EOS launch vehicles will result in emissions of exhaust products into the stratosphere, their effect on stratospheric ozone depletion was evaluated. The evaluation of the effect of an Atlas IIAS launch on the stratosphere was performed using model simulations available for Space Shuttle and Titan IV launches [HCl 1996]. Peak column ozone depletion resulting from a steady-state launch rate of nine Space Shuttles and three Titan IV per year is predicted to be approximately 0.05 percent due to chlorine (as HCl) emissions from the SRMs.

An Atlas IIAS launch will emit approximately 7.2 metric tons (7.9 tons) of HCl, compared to 725 metric tons (799 tons) emitted in the stratosphere by nine Space Shuttles and three Titan IV launches. Thus, by simple ratio, the estimate of peak column ozone depletion due to six Atlas IIAS launches per year would be 0.003 percent, which is considered insignificant [ATLAS 1991].

Using the same relationship described above for the Atlas IIAS vehicle estimates of peak ozone depletion due to six launches of the Delta II 7925, Delta-Lite, Taurus, and Pegasus launch vehicles were also calculated (Table 4-15). The tabulated values are conservative, in that they represent ozone depletion for launch rates (six per year) double of that required by EOS and the values were calculated assuming all HCl will migrate to the stratosphere. Also, a study of Space Shuttle launches from KSC indicates that 28 percent of the HCl produced in the first ten seconds of launch is entrained in deluge water and/or deposited on the ground, which strongly suggests that input values for stratospheric ozone calculations and ground cloud composition be reduced by at least 20 to 30 percent. [HCl 1985] Ozone depletion estimates below do not include this reduction.

Table 4-15. Stratospheric Ozone Depletion per Year

Launch Vehicles	HCl/Launch (tons)	Ozone Depletion
Delta II 7925	24.8	0.009%
Delta-Lite	23.2	0.009%
Atlas IIAS	7.9	0.003%
Taurus	5.6	0.002%
Pegasus	2.1	0.0008%

HCl quantities are for the complete burn of all solids
Assumes all HCl emissions migrate to the stratosphere
Assumes a total of six launches per vehicle per year
Assumes a linear relationship

Rockets contribute very minor amounts of HCl to the atmosphere when compared with other human-made sources. The launch scenario of nine Space Shuttles and three Titan IVs each year would release 725 metric tons into the atmosphere. Existing analyses show extremely small, if any, long-term impacts on stratospheric ozone due to Space Shuttle and Titan operations. An assumed launch rate of six Delta II 7925 rockets per year would introduce a maximum of 135 metric tons (149 tons) of HCl into the atmosphere, some of which would be released at too low an altitude to have any potential impact on stratospheric ozone.

Extensive analyses have been performed and concluded that "the effects of rocket propulsion on stratospheric ozone depletion, acid rain, toxicity, air quality, and global warming were extremely small compared to other anthropogenic impacts, and therefore that there is no pressing need to change propellants of current launch systems." [ELVb 1991]

4.6.3 Pollution Prevention

NASA

In compliance with Executive Order 12856, "Pollution Prevention and Community Right-to-Know," NASA has developed a comprehensive agency program to prevent adverse environmental impacts by: 1) Moving ahead of environmental compliance; 2) Emphasizing pollution source elimination and waste reduction; and, 3) Involving communities in NASA decision processes. [NASA 1995]

By December 31, 1999, NASA will have achieved a 50 percent reduction (1994 baseline) in releases of toxic chemicals to the environment and off site transfers of such chemicals for treatment and disposal as reported on Toxic Chemical Release Inventory (TRI), Form R. NASA will have a system in place to transfer Pollution Prevention technologies both in and out of its operations. Specifications and Standards used by NASA will no longer require the use of extremely hazardous substances and toxic chemicals, within safety and reliability constraints. Each NASA Center will submit annual Pollution Prevention progress reports to NASA Headquarters, describing the progress the Center has made in complying with Executive Order 12856. [NASA 1995]

USAF

By December 31, 1999, the USAF will have achieved a 50 percent reduction (1994 baseline) in total releases and off-site transfers of TRI Chemicals. Purchases of Environmental Protection Agency (EPA) 17 Industrial Toxic Pollutants[19], and hazardous waste disposal will be reduced 50 percent (1992 baseline) by December 31, 1996, and 1999, respectively. Environmentally preferable products will be purchased, so that one-hundred percent of all products purchased each year in each of EPA's "Guideline Item" categories shall contain recycled materials. [USAF 1995]

4.6.4 Environmental Justice

EO 12898 directs Federal agencies to identify and address disproportionately high and adverse human health or environmental effects of their programs, policies and activities on low-income populations and minority populations in the United States. Given the launch direction and trajectories of the EOS missions, analysis indicates little or no potential of substantial environmental effects on any human populations outside VAFB boundaries.

[19] Established in 1991 as EPA's first voluntary initiative under the Pollution Prevention Act of 1990. The program (33/50 program) targets 17 priority pollutants: Benzene, Cadmium, Carbon tetrachloride, Chloroform, Chromium, Cyanide, Dichloromethane, Lead, Mercury, Methyl ethyl ketone, Methyl isobutyl ketone, Nickel, Tetrachloroethylene, Toluene, 1,1,1-Trichloroethane, Trichloroethylene and Xylenes.

4.7 NO-ACTION ALTERNATIVE

The No-Action alternative would mean the EOS Program would not be undertaken and the immediate local (*i.e.*, launch site) impacts would be minimized.

The No-Action alternative would impede scientific progress toward understanding the natural environment and its response to human activity, and would cause more U.S. dependence on foreign acquisition of these data. The resultant loss of continuity in Earth observation data acquisition would lead to not meeting national priorities with respect to management of the environmental global commons and may result in ineffective policy decision with respect to managing the global commons.

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7. APPENDIX A
EOS INSTRUMENT SCIENCE OBJECTIVES AND DESCRIPTION[20]

GENERAL

A brief description of each instrument is offered to illustrate the breadth and importance of EOS science objectives. Spacecraft upon which specific instruments would fly are included after instrument acronyms for ease of reference. Italicized instruments and/or spacecraft are not funded by EOS. Detailed information on each instrument can be found in the EOS Reference Handbook [EOS 1995].

Active Cavity Radiometer (ACRIM-*FOO*)

To be flown as a Flight of Opportunity (FOO) the ACRIMs primary objective is to monitor the variability of total solar irradiance, thereby extending the high-precision database compiled by NASA since 1980. ACRIM data products would provide measurements of the total solar irradiance above the atmosphere, with absolute accuracy of 0.1 percent and long-term precision of 0.0005 percent per year for use in climate and solar physics investigations.

Atmospheric Infrared Sounder (AIRS-PM1-3)

To be flown on PM 1-3 the AIRS is a high-resolution sounder which measures the Earth's outgoing radiation. In combination with AMSU and MHS instruments AIRS would improve the global modeling efforts, numerical weather prediction, study of the global energy and water cycles, detection of the effects of greenhouse gases, investigation of atmosphere-surface interactions, and monitoring of climate variations and trends. Simultaneous observations of the atmosphere and clouds from AIRS would allow characterization of the spectral properties of clouds for enhanced understanding of their role in modulating the greenhouse effect, and the increased resolution and number of infrared sounding channels (an increase of two orders of magnitude beyond current operational sounders) will improve the accuracy of weather forecasting.

Advanced Microwave Sounding Unit (AMSU-PM1-3)

The AMSU instrument would be flown on PM 1-3 and is designed primarily to obtain profiles of stratospheric temperature and to provide a cloud-filtering capability for tropospheric observations of total column water vapor in the atmosphere and to indicate the presence of rain. In combination with AIRS and MHS instruments AMSU would improve the global modeling efforts, numerical weather prediction, study of the global energy and water cycles, detection of the effects of greenhouse gases, investigation of atmosphere-surface interactions, and monitoring of climate variations and trends by providing atmospheric temperature measurements from the surface up to 40 kilometers (25 miles).

Advanced Spaceborne Thermal Emission and Reflection Radiometer (*ASTER*-AM1)

ASTER is an agency instrument provided for the EOS AM-1 platform by the Japanese Ministry of International Trade and Industry (MITI) to provide high spatial resolution images of the land surface, water, ice, and clouds. ASTER data would be used for long-term monitoring of local and regional changes on the Earth surface, which either lead to or are in

[20] This appendix is summarized from the EOS Reference Handbook [EOS 1995].

response to global climate change. ASTER data products would include cloud studies, surface mapping, soil and geologic studies, volcano monitoring, and surface temperature, emissivity, reflectivity determination, land use patterns and vegetation, study of coral reefs and glaciers, digital elevation models (of local topography, cloud structure, volcanic plumes, and glacial changes), evapotranspiration, and land and ocean temperature. ASTER would provide data to bridge the gap between field observations and data acquired by MODIS and MISR instruments.

Clouds and Earth's Radiant Energy System (CERES- AM1-3, PM1-3, *TRMM,FOO*)

The CERES instrument would provide EOS with an accurate and self-consistent cloud and radiation database by measuring Earth's radiation budget and atmospheric radiation from the top of the atmosphere to the surface. Clouds are one of the largest sources of uncertainty in understanding climate. CERES would permit retrieval of cloud parameters in terms of measured areal coverage, altitude, liquid water content, and shortwave and longwave optical depths. Cloud and radiation flux measurements are fundamental inputs to models of oceanic and atmospheric energetics, and would also contribute to extended range weather forecasting.

Ozone Dynamics Ultraviolet Spectrometer (*ODUS-* CHEM1-3)

This international investigation is currently undefined but is expected to be provided by NASDA in reciprocation for SeaWinds flying on Advanced Earth Observing Satellite (ADEOS II) [PLAN 1995].

EOS Ocean Color Instrument (COLOR-*FOO)*

To be flown as a Flight of Opportunity (FOO) COLOR is a second generation sensor, based on the Coastal Zone Color Scanner on Nimbus-7 and SeaStar and has been approved to maintain continuity of the data set. COLOR would further our understanding of the role of oceans in the global carbon cycle, fluxes of trace gases at the air-sea interface, and ocean primary productivity.

Dual Frequency Altimeter (DFA-RALT1-3, *TPFO or GFO)*

TBD based upon mission selection [PLAN 1995]

Earth Observing Scanning Polarimeter (EOSP-AM2&3)

EOSP would provide global maps of cloud and aerosol properties, global aerosol distribution and optical thickness in the troposphere and stratosphere. These data would provide atmospheric corrections for clear-sky ocean and land observations, and would also be applied to the study of vegetation and land surface characteristics. EOSP data products would include cloud-top pressure, cloud particle phase and size at cloud top, and cloud optical thickness.

Geoscience Laser Altimeter System (GLAS-LALT1-3)

GLAS is a laser altimeter designed to measure ice-sheet topography and associated temporal changes, as well as cloud and atmospheric properties. In addition, operation of GLAS over land and water would provide along-track topography.

High-Resolution Dynamics Limb Sounder (HIRDLS-CHEM1-3)

To be flown on the CHEM series of spacecraft HIRDLS would observe global distribution of temperature and concentrations of O_3, H_2O, CH_4, N_2O, NO_2, HNO_3, N_2O_5, CFC_{11}, CFC_{12}, $ClONO_2$, and aerosols in the upper troposphere, stratosphere, and mesosphere. Overall science goals of HIRDLS are to observe the global distributions of temperature and several trace species in the stratosphere and upper troposphere at high vertical and horizontal resolution.

Landsat Advanced Technology Instrument (LATI-AM2&3)

TBD [PLAN 1995]

Lightning Imaging Sensor (LIS-*TRMM)*

LIS would acquire and investigate the distribution and variability of lightning over the Earth, its correlation with rainfall, and its relationship with the global electric circuit. LIS investigations would further understanding of processes related to and underlying, lightning phenomena in the Earth/atmosphere system. Lightning activity is closely coupled to storm convection, dynamics, and microphysics, and can be correlated to the global rates, amounts, and distribution of precipitation, to the release and transport of latent heat, and to the chemical cycles of carbon, sulfur, and nitrogen. The investigations would contribute to several important EOS mission objectives, including cloud characterization and hydrologic cycle studies. LIS standard products would be intensities, times of occurrence, and locations of lightning events.

Microwave Humidity Sounder (MHS/NOAA-PM1-3)

The Microwave Humidity Sounder (MHS) Instrument is a microwave radiometer. It is a facility instrument, to be provided by another organization. The MHS science objective is to provide global humidity data for weather forecasting [PLAN 1995].

Multifrequency Imaging Microwave Radiometer (MIMR-PM1-3)

MIMR is a passive microwave radiometer provided under a Memorandum of Understanding with the European Space Agency (ESA). Slated for the EOS-PM satellite series, the instrument would observe numerous atmospheric and oceanic parameters, including precipitation, soil moisture, global ice and snow cover, sea surface temperature and wind speed, atmospheric cloud water, and water vapor. In conjunction with data from other EOS instruments MIMR data would assist in evaporation and transpiration studies, moisture equivalence determinations and studies of heat exchange across the air-sea surface.

Multi-angle Imaging SpectroRadiometer (MISR-AM1-3)

MISR would be used to monitor global and regional trends in radiatively important optical properties of natural and anthropogenic aerosols, including those arising from industrial and volcanic emissions, slash-and-burn agriculture, and desertification, and to determine their effect on solar radiation budget. MISR would yield estimates of albedo, provide improved vegetation cover classifications, would be used to investigate how spatial and seasonal variations of different cloud types affect the planetary solar radiation budget and would supplement EOS studies of the biogeochemical cycle within the Earth's aquatic systems.

Microwave Limb Sounder (MLS-CHEM1-3)

MLS would study and monitor the chemistry of the lower stratosphere and upper troposphere measuring concentrations and temperature of H_2O, O_3, ClO, HCl, OH, HNO_3, NO, N_2O, HF, and CO for their effects on transformations of greenhouse gases, radiative forcing of climate change, and ozone depletion. MLS would monitor ozone chemistry and variables important in determining effects of volcanic injections into the atmosphere.

Moderate-Resolution Imaging Spectroradiometer (MODIS-AM1-3, PM1-3)

MODIS is an EOS facility instrument designed to measure biological and physical processes on a global basis every one to two days. Slated for both the EOS-AM and EOS-PM satellite series, the instrument would provide long-term observations from which to derive an enhanced knowledge of global dynamics and processes occurring on the surface of the Earth and in the lower atmosphere. The instrument is expected to make major contributions to understanding of the global Earth system, including interactions between land, ocean, and atmospheric processes.

Measurements of Pollution in the Troposphere (MOPITT-AM1)

The MOPITT experiment is provided under a Memorandum of Understanding with the Canadian Space Agency (CSA). MOPITT would measure emitted and reflected infrared radiance in the atmospheric column, which, when analyzed, permits retrieval of tropospheric CO profiles and total column CH_4. A better understanding of the role of these constituents is essential in understanding anthropogenic effects on the environment. MOPITT measurements would also permit studies of the global and temporal distributions that drive budget and source/sink studies.

Microwave Radiometer (MR-RALT1-3*(TPFO or GFO))*

TBD based upon mission selection [PLAN 1995]

Stratospheric Aerosol and Gas Experiment III (SAGE III-*Meteor(3M-1) Space Station, FOO)*

SAGE III is a natural and improved extension of the successful Stratospheric Aerosol Measurement II (SAM II), SAGE I, and SAGE II experiments and would extend the data sets (begun in 1978), enabling the detection of long-term trends. The instrument would retrieve global profiles of atmospheric aerosols, ozone, water vapor, NO_2, NO_3 , OClO, temperature, and pressure in the mesosphere, stratosphere and troposphere.

SeaWinds Scatterometer (SeaWinds-*ADEOS II)*

SeaWinds, a principle investigator instrument, is a rotating, dual spot beam, Ku-band scatterometer scheduled for flight on the ADEOS II spacecraft. SeaWinds science objectives are to acquire all-weather measurements of global backscatter cross-section and near-surface wind velocity (both speed and direction) over the ice-free oceans. These measurements provide critical atmospheric forcing inputs to ocean circulation and air-sea interaction models, and serve as stringent boundary conditions when assimilated into atmospheric circulation models [PLAN 1995].

Solar Stellar Irradiance Comparison Experiment (SOLSTICE-*FOO)*

SOLSTICE would provide precise daily measurements of solar ultraviolet (UV) irradiance between 5 and 440 nanometers (2.0 x 10^{-7} inches and 1.7 x 10^{-5} inches). Measuring small changes in solar UV irradiance will improve understanding of corresponding changes in the photochemistry, dynamics, and energy balance of the middle atmosphere. The investigation would also model the penetration of solar radiation down into the Earth's atmosphere and establish the radiation field at all locations and altitudes, including the Earth's surface.

Tropospheric Emission Spectrometer (TES-CHEM1-3)

TES would generate three-dimensional profiles on a global scale of virtually all infrared active species from Earth's surface to the lower stratosphere. Observations from TES would further understanding of long-term variations in the quantity, distribution, and mixing of minor gases in the troposphere, including sources, sinks, troposphere-stratosphere exchange, and the resulting effects on climate and the biosphere. TES would provide global maps of tropospheric ozone and its photochemical precursors. TES measurements would help determine local atmospheric temperature and humidity profiles, local surface temperatures, and local surface reflectance and emittance. TES observations would also be used to study volcanic emissions for hazard mitigation, indication of the chemical state of magma, eruption prediction, and quantification of the role of volcanoes as sources of atmospheric aerosols.

8. APPENDIX B
DAAC LOCATIONS, PHONE/FAX NUMBERS AND E-MAIL ADDRESSES

Alaska SAR Facility (ASF) Geophysical Institute, University of Alaska, Fairbanks, AK 9975-7320 (907) 474-7848 (907) 474-5567-Fax cwales@iias.images.alaska.edu

U.S. Geological Survey, EROS Data Center (EDC), Mundt Federal Building, Sioux Falls, SD 57198 (605) 594-6164 (605) 594-6567-Fax ole-son@edcserver1.cr.usgs.gov

NASA Goddard Space Flight Center (GSFC), Code 902.2 Greenbelt, MD 20771 (301) 286-0828 (301) 286-1775-Fax, chan@eosdata.gsfc.nasa.gov

Jet Propulsion Laboratory (JPL), Mail Stop 300-323, 4800 Oak Grove Drive Pasadena, CA 91109 (818) 354-3473 (818) 393-6720-Fax djc@seaanchor.jpl.nasa.gov

NASA Langley Research Center (LaRC) Mail Stop 157D, Hampton, VA 23681-0001, (804) 864-6589 (804) 864-7635-Fax, r.c.dunkum@larc.nasa.gov

NASA Marshall Space Flight Center (MSFC) Global Hydrology and Climate Center 977 Explorer Blvd.Huntsville, AL 35806 (205) 922-5805 (205) 922-5801-Fax cathy.lapenta@msfc.nasa.gov

National Snow and Ice Data Center (NSIDC) CIRES, Campus Box 449 University of Colorado Boulder, CO 80309-0449, (303) 492-7624 (303) 492-2468-Fax, weaver@kryos.colorado.edu

Oak Ridge National Laboratory (ORNL) PO Box 2008, Mail Stop 6407, Oak Ridge, TN 37831-6407, (615) 574-7309 (615) 574-4665-Fax, ldv@ornl.gov

Socioeconomic Data and Applications Center (SEDAC), Consortium for International Earth Science Information Network (CIESIN), 2250 Pierce Road University Center, MI 48710 (517) 797-2611 (517) 797-2622-Fax bob.chen@ciesin.org

9. APPENDIX C
EOS LAUNCH VEHICLE IMPACTS TO AIR FROM NORMAL LAUNCHES AND CATASTROPHIC FAILURES[21]

GENERAL

This appendix contains a descriptive summary of impacts to air from proposed EOS launch vehicles and is summarized from the references cited in the text.

9.1 ATLAS IIAS IMPACTS TO AIR

Pre-launch and post-launch processing activities for the Atlas IIAS rocket and payload will result in emissions of criteria air pollutants such as CO, SO_x, NO_x, PM, and Reactive Organic Compounds (ROCs). In addition, under normal operating conditions, propellant-loading activities may result in minimal emissions of RP-1 (kerosene), hydrazine, Monomethyl Hydrazine (MMH), and N_2O_4. [ATLAS 1991]

Propellant-loading operations for the Atlas IIAS rocket and payload will result in minimal emissions of RP-1, hydrazine, MMH, and N_2O_4. RP-1, the Atlas booster/sustainer fuel, will be vented from the storage tanks during loading operations. Because RP-1 (kerosene vapor) has a very low vapor pressure, operational emissions to the atmosphere will be very small. Hydrazine, the fuel used for the roll control module and reaction control system of the Centaur upper stage, will be delivered to the launch pad in a 189 liter (55 gallon) stainless steel drum and loaded into the rocket. Because hydrazine has a low vapor pressure and because only a small amount of hydrazine (no more than 170 kilograms (375 pounds)) will be used for a launch, emissions to the atmosphere will be minimal. The minimal emissions of hydrazine, MMH, and N_2O_4 will be controlled by scrubbers. [ATLAS 1991]

The greatest source of uncontrollable emissions to the atmosphere will be vehicle launch. Atlas IIAS launch emissions will be generated by oxidation of propellants during various stages of the launch cycle from liftoff through termination of the sustainer phase. The primary sources of pollutants during launch will be the four Thiokol Castor IVA™ SRMs, the two Rocketdyne MA-5A booster liquid rocket engines, and the one sustainer liquid rocket engine. [ATLAS 1991]

The primary pollutant products of propellant combustion for the SRMs will be CO, aluminum oxide (Al_2O_3), and hydrogen chloride (HCl). Two SRMs will be ignited on the ground and will burn out at an approximate altitude of 6,096 meters (20,000 feet). A second pair of SRMs will be ignited near an altitude of 8,230 meters (27,000 feet) and will burn out at an approximate altitude of 38,710 meters (127,000 feet). The total SRM emission from ignition to complete burn will be 14.4 metric tons (15.9 tons) of Al_2O_3, 9.2 metric tons (10.1 tons) of CO, and 7.2 metric tons (7.9 tons) of HCl. [ATLAS 1991]

The primary pollutant products of combustion for the booster and sustainer engines will be CO and CO_2. Upon release to the atmosphere, nearly all of the CO will oxidize to CO_2. The liquid-fueled booster and sustainer engines will operate throughout the booster phase of the trajectory. The booster phase will end at an approximate altitude of 83,820 meters (275,000 feet). Only the sustainer engine will operate during the sustainer phase of the trajectory. The sustainer phase begins at 83,820 meters (275,000 feet) and concludes at an

[21] This appendix is summarized from [ATLAS 1991], [DELTA 1994], [SLC6a 1995], [SELVa 1992] and [PEGASUS 1991].

approximate altitude of 150,572 meters (494,000 feet). The total emission of CO and CO_2 from the booster and sustainer engines are shown in Table C-1. [ATLAS 1991]

Table C-1. CO and CO_2 Emissions from the Atlas IIAS Liquid Rocket Engine Booster and Sustainer Phases for Complete Burn

Emissions (tons)	CO	CO_2
Booster Phase	41.5 MT (45.7)	35.7 MT (39.3)
Sustainer Phase	12.4 MT (13.7)	14.2 MT (15.6)
Total	53.9 MT (59.4)	49.8 MT (54.9)

Source: [ATLAS 1991]

This air quality impact assessment focuses on public access areas. The closest public access areas to SLC-3E include West Ocean Avenue (Route 246), approximately 3.8 kilometers (2.4 miles) north-northeast of SLC-3, and the east fenceline (*i.e.*, property boundary) of VAFB, approximately 3.4 kilometers (2.1 miles) east of SLC-3. The closest communities to SLC-3 are Lompoc, approximately 10 kilometers (6.2 miles) east of SLC-3E; Vandenberg Village and Mission Hills, about 12 kilometers (7.5 miles) northeast of SLC-3E; and residential areas on VAFB, approximately 8 kilometers (5 miles) north-northeast of SLC-3E. [ATLAS 1991]

Pre- and post-launch processing activities for the Atlas IIAS rocket at SLC-3E will result in emissions of criteria pollutants such as CO, SO_x, NO_x, PM and ROC, primarily from two natural gas-fired boilers and the H_2 flare. Past studies performed for the larger Titan IV/NUS rocket at SLC-4 indicate that the short duration and intermittent nature of launch-related activities do not result in significant effects on regional air quality [ATLAS 1991]. The Titan IV/NUS does not utilize an upper stage, therefore the flaring of hydrogen is not a source of pollution for the Titan IV/NUS. Based on this information, it is projected qualitatively that launch-related activities associated with the smaller Atlas IIAS rocket also will not result in significant effects on regional air quality [ATLAS 1991].

Hydrazine, MMH, and N_2O_4 are of special concern because these chemicals are considered toxic; however, the quantities of these chemicals to be used during launch activities at SLC-3E are small. Also, there will be minimal storage of these chemicals at SLC-3E between launches. The toxicity of these chemicals requires tight control of their emissions. Scrubbers will be employed to eliminate the escape of vapors to the atmosphere during handling. Thus, under normal conditions, the quantities of these chemicals that could escape to the atmosphere during launch activities will be very small, resulting in insignificant effects on air quality. [ATLAS 1991]

The pollutants of concern present in the Atlas IIAS vehicle exhaust in the lower atmosphere are CO, Al_2O_3, and HCl. The quantity of Al_2O_3 and HCl emitted along the vehicle's trajectory will be small. To quantify CO, Al_2O_3, and HCl ground-level impacts in the downwind region from rocket launch emissions, the USAF's Rocket Exhaust Effluent Diffusion Model (REEDM) was implemented. REEDM is designed to calculate peak concentration and surface deposition resulting from both gravitational settling and precipitation scavenging of ground-cloud constituents downwind from normal launches and launch failures. The peak ground-level concentrations of HCl, CO and Al_2O_3 for both a normal launch scenario and launch failure (*i.e.*, on-pad explosion) scenario are shown in Table C-2. Numerous representative meteorological scenarios for each season of the year (using 1987-1988 data) were analyzed by REEDM to calculate these peak impacts. [ATLAS 1991]

Table C-2. Peak REEDM-predicted CO, HCl, and AL_2O_3 Impacts due to Emissions from a Normal Launch and a Launch Failure for the Atlas IIAS Rocket

	Pollutant	Averaging Period	Applicable Standard	Peak Ground-level Concentration (mg/m³)[a]	Location	
					Direction	Distance (km)
Normal Launch Scenario	CO	1-hr	23.0[b]	0.1	NNE	2
	HCl	8-hr	7.5[c]	0.1	NNE	2
	AL_2O_3	8-hr	10.0[c]	0.4	E	3
Launch Failure Scenario	CO	1-hr	23.0[b]	0.5	NNE	2
	HCl	8-hr	7.5[c]	0.5	NNE	2
	AL_2O_3	8-hr	10.0[c]	1.2	NNW	6

Notes: NNE = North-northeast
E = East
NNW = West
[a] Based on a model-predicted 30-min. concentration. Concentrations for time periods greater than. 30 minutes will be lower.
[b] California Ambient Air Quality Standard.
[c] Threshold Limit Value-Time Weighted Average.

Source: [ATLAS 1991]

The REEDM-predicted peak 1-hr average CO impacts for a normal launch (0.1 ppm) and a launch failure (0.5 ppm) are well below the Federal (9.0 ppm; 8-hr time-weighted average) and state AAQS for CO. AAQS do not exist for HCl; however, model-predicted impacts can be compared against and are well below OSHA requirements (5.0 ppm; 8-hr time-weighted average for HCl). Al_2O_3 concentrations are also well below the CAAQS (30 ppm; annual geometric mean). HCl and Al_2O_3 model-predicted concentrations are also well below the Threshold Limit Values defined by the American Conference of Governmental Industrial Hygienists (7.5 ppm and 10.0 ppm, respectively; 8-hr time-weighted average)

In summary, predicted peak impacts on VAFB property due to emissions from Atlas IIAS activities are well below adverse health limits. Peak impacts outside VAFB will be even less than those on VAFB. The impacts will be of short duration and launch activities will be controlled to limit impacts even further. As a result, the ambient air quality impacts due to launch-related activities will be insignificant, and further mitigation is unnecessary [ATLAS 1991].

9.1.1 Atlas IIAS Failure Impacts to Air [ATLAS 1991]

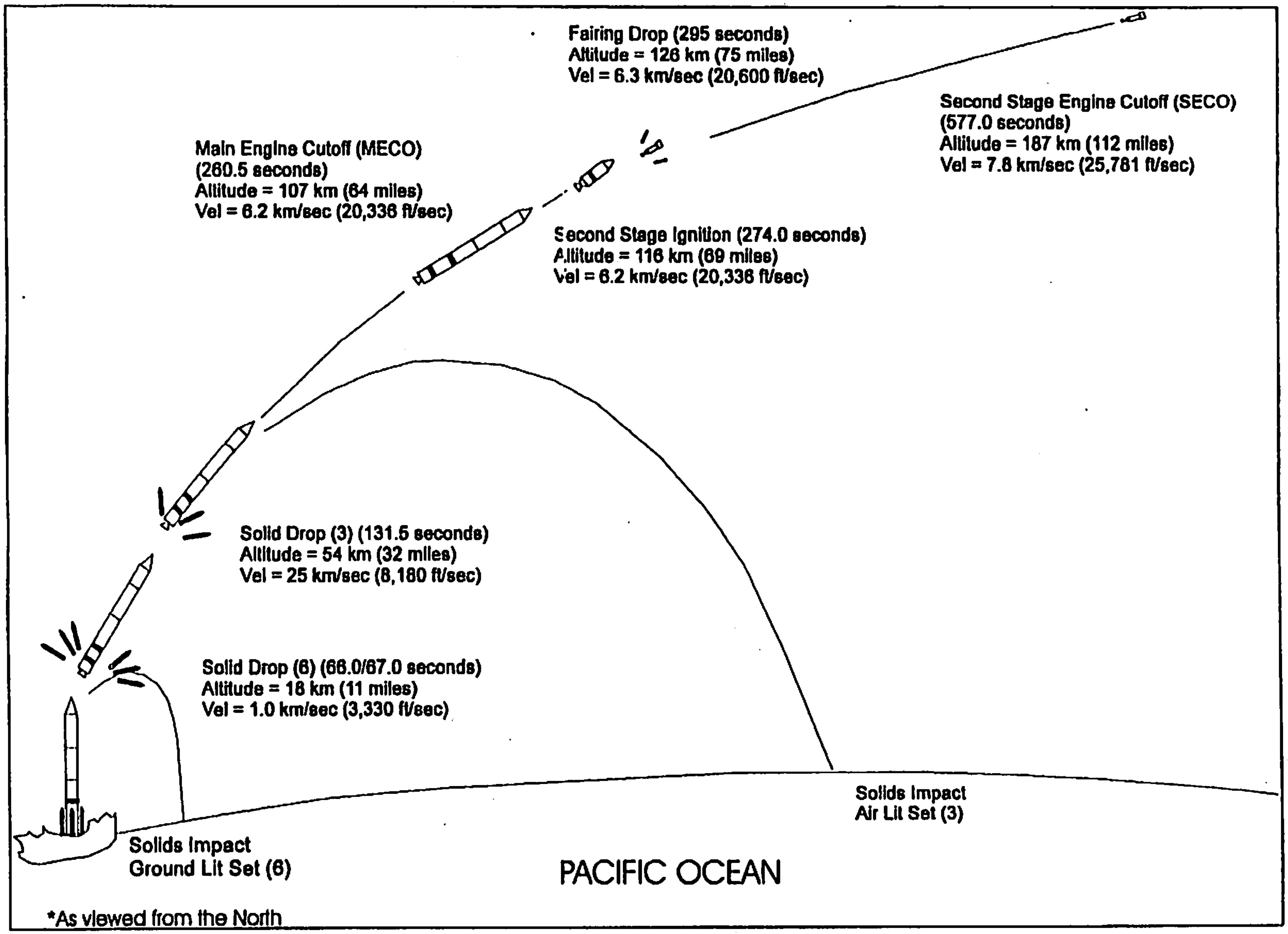
There is the slight possibility of a catastrophic accident during launch. The launch vehicle could explode accidentally or could be detonated intentionally. Most of the RP-1, liquid oxygen, liquid hydrogen, and hypergolic propellants would probably be consumed in the explosion and fireball. Only small amounts of these liquid propellants may not be burned during the explosion. The fireball generated by an explosion would cause the cloud containing any uncombusted propellants to rise, minimizing any potential ground-level impacts to terrestrial wildlife. The primary combustion products expected to result from explosion of an Atlas IIAS launch vehicle would be the same as for a normal launch, with additional particulates and hydrocarbons from combustion of paint and plastics. The cloud would be considerably more concentrated, because all combustion would occur at once, instead of in phases along the rocket's normal trajectory.

If an explosion occurred while the launch vehicle was still on the launch pad, then most animals within a few hundred feet of the blast would be killed, and a fire could ensue. Such a fire could kill additional animals in habitats adjacent to the launch site. This impact would be insignificant because: (1) there were no observable long-term adverse impacts on biota in the vicinity of SLC-4 following the Titan 34D explosion of April 1986; and (2) the habitats and their associated biota present in the vicinity of the launch site are adapted to naturally occurring fires.

9.2 DELTA II 7925 IMPACTS TO AIR [DELTA 1994]

In a normal launch, exhaust products from the Delta II 7925 are distributed along the launch vehicle's path (Figure C-1: Delta Boost Profile). Primary products of Graphite Epoxy Motor (GEM) combustion will be carbon monoxide (CO), carbon dioxide (CO_2), hydrochloric acid (HCl), aluminum oxide (Al_2O_3) in soluble and insoluble forms, nitrogen oxides (NO_x), and water.

Figure C-1. Delta II 7925 Boost Profile (Up to Orbit Injection)



Source: [DELTA 1994]

Combustion products of the GEM Strap-on Solid Rocket Motors are listed in Table C-3. Major exhaust products of the Delta II first stage will be CO, CO_2, and water. Exhaust products from the Delta II first stage are given in Table C-4.

Table C-3. Combustion Products for the GEM Solid Rocket.

Combustion Product	Product Mass Fraction	Product Mass per GEM		Product Mass for 6 Ground-Lit GEMs		Product Mass for 3 Air-Lit GEMs		Total Product Mass for 9 GEMs	
		kg	lbs	kg	lbs	kg	lbs	kg	lbs
AlCl	0.0002	2	5	14	31	7	16	21	47
$AlCl_2$	0.0002	2	5	14	31	7	16	21	47
$AlCl_3$	0.0001	1	3	7	16	4	8	11	24
AlClO	0.0001	1	3	7	16	4	8	11	24
Al_2O_3 (soluble)	0.2959	3,512	7,727	21,074	46,363	10,537	23,181	31,611	69,544
Al_2O_3 (insoluble)	0.0628	745	1,640	4,473	9,840	2,236	4,920	6,709	14,760
CO	0.2208	2,621	5,766	15,725	34,596	7,863	17,298	23,588	51,894
CO_2	0.0235	279	614	1,674	3,682	837	1,841	2,511	5,523
Cl	0.0027	32	71	192	423	96	212	288	635
H	0.0002	2	5	14	31	7	16	21	47
HCl	0.2109	2,503	5,507	15,020	33,045	7,510	16,522	22,530	49,567
H_2	0.0228	271	595	1,624	3,572	812	1,786	2,436	5,359
H_2O	0.0773	918	2,019	5,505	12,112	2,753	6,056	8,258	18,168
N_2	0.0823	977	2,149	5,861	12,895	2,931	6,448	8,792	19,343
OH	0.0002	2	5	14	31	7	16	21	47

Source: Adapted from [DELTA 1994]

Table C-4. Exhaust Products for the Delta II 7925 First Stage

Combustion Product	Mass Fraction	Product Mass	
		kilograms	pounds
CO	0.4278	41,173	90,580
CO_2	0.2972	28,603	62,928
H	0.0001	10	21
H_2	0.0139	1,338	2,943
H_2O	0.2609	25,110	55,242
OH	0.0002	19	42

Source: Adapted from [DELTA 1994]

Table C-5. Estimated Rocket Exhaust per Launch of a Delta II 7925 (9 GEMs and 1st Stage Emissions)

Constituent	Quantity	
	Metric Tons	Tons
HCl	22.48	24.78
CO_2	31.05	34.22
CO	64.63	71.24
Al_2O_3	38.24	42.15

Source: Adapted from [DELTA 1994]

To estimate the peak ground level concentrations of ground cloud pollutants, the U.S. Air Force has extrapolated Delta II exhaust plume diffusion data from models developed for the Titan launch vehicle program. These Titan models are used to calculate peak ground level concentrations of various pollutants in ground clouds. Due to the similarity of propellant types, the Delta vehicle ground cloud will be similar in composition to that produced by the Titan. However, the size of the Delta ground cloud should be considerably smaller than that of the Titan because the Delta vehicle and solid rocket GEMs contain less propellant, produce less vapor, and accelerate off the launch pad more quickly than the Titan. The ground cloud resulting from a normal Delta II launch is predicted to have a radius of about 20 meters (about 67 feet).

From these estimates, HCl concentrations from a Delta II ground cloud should not exceed 5 ppm beyond about 4.3 kilometers (2.7 miles) downwind. The Occupational Health and Safety Administration (OSHA) permissible exposure limit (PEL) for HCl is 5 ppm for an 8-hour time-weighted average. Although National Ambient Air Quality Standards (NAAQS) have not been adopted for HCl, the National Academy of Sciences (NAS) developed recommended short-term exposure limits for HCl of 20 ppm for a 60-minute exposure, 50 ppm for a 30-minute exposure, and 100 ppm for a 10-minute exposure. Since the nearest uncontrolled area (*i.e.*, general public) is approximately three miles away, HCl concentrations are not expected to be high enough to be harmful to the general population. The maximum level of HCl expected to reach uncontrolled areas during preparation and launch of the Delta II would be well below the NAS recommended limits. Appropriate safety measures will also be taken to ensure that the permissible exposure limits defined by the Occupational Safety and Health Administration are not exceeded for personnel in the launch area.

The same predictive modeling techniques used for HCl were also applied to CO and Al_2O_3. Carbon monoxide concentrations are not expected to exceed the NAAQS of 35 ppm (1 hr average) beyond the immediate vicinity of the launch complex and are expected to rapidly oxidize to carbon dioxide (CO_2) in the atmosphere. For Titan launches, CO concentration were predicted to be less than 9 ppm except for brief periods during actual liftoff. Concentrations resulting from a Delta launch should be considerably lower.

Aluminum oxide exist as a crystalline dust in solid rocket motor (SRM) exhaust clouds, but is inert chemically and is not toxic. However, since many of the dust particles are small enough to be retained by lungs, it is appropriate to abide by NAAQS for suspended particulates smaller than 10 microns. For particles smaller than 10 microns, peak concentrations of aluminum oxide should not exceed 11 ppm at a distance of approximately 4.8 kilometers (3 miles) from the launch site.

Nitrogen oxides may enter the atmosphere through propellant system venting, a procedure used to maintain proper operating pressures. Air emission control devices will be used to mitigate this small and infrequent pollutant source. First stage propellants will be carefully loaded using a system with redundant spill-prevention safeguards. Aerozine-50 vapors from second stage fuel loading will be processed to a level below analytical detection by a citric acid scrubber. Likewise, N_2O_4 vapors from second stage oxidizer loading will be passed through a sodium hydroxide (NaOH) scrubber. These scrubber wastes will be disposed by a certified hazardous waste contractor.

9.2.1 Delta II 7925 Failure Impacts to Air [DELTA 1994]

In the unlikely event of a launch vehicle destruction, either on the pad or in flight, the liquid propellant tanks and SRM cases would be ruptured. Due to the hypergolic (ignite on contact) nature of the second stage propellants, a launch failure would result in a spontaneous burning of most of the liquid propellants, and a somewhat slower burning of SRM propellant fragments. Tables C-6 and C-7 define the combustion products of a GEM SRM failure and a catastrophic launch pad failure. This release of pollutants would have only a short-term impact on the environment [DELTA 1994].

Table C-6. Combustion Products for Delta II 7925 GEM Failure Scenario.

Combustion Product	Product Mass Fraction	Total Propellant Mass of 105,872 kg	
		kg	lbs
Al_2O_3	0.1759	18,623	40,971
Ar	0.0064	678	1,492
C	0.0143	1,514	3,331
CH_4	0.0000	0	0
CO_2	0.1329	14,070	30,954
Cl_2	0.0000	0	0
HCl	0.1071	11,339	24,946
H_2O (liquid)	0.1274	13,488	29,674
H_2O (gaseous)	0.0136	1,440	3,168
N_2	0.4188	44,339	97,546
O_2	0.0000	0	0

Source: Adapted from [DELTA 1994]
Combustion products represent the catastrophic failure of 9 GEMs.

Table C-7. Combustion Products for Delta II 7925 Catastrophic Failure Scenario.

Combustion Product	Product Mass Fraction	Total Propellant Mass of 209,433 kg	
		kg	lbs
Al_2O_3	0.0926	19,393	42,666
Ar	0.0064	1,340	2,949
C	0.0191	4,000	8,800
CO_2	0.2514	52,651	115,833
Cl_2	0.0000	0	0
HCl	0.0551	11,540	25,387
H_2O (liquid)	0.1556	32,588	71,693
H_2O (gaseous)	0.0141	2,953	6,497
N_2	0.4051	84,841	186,651

Combustion Product	Product Mass Fraction	Total Propellant Mass of 209,433 kg	
		kg	lbs
O_2	0.0000	0	0

Source: Adapted from [DELTA 1994]
Values reflect combustion products for the catastrophic failure of all Delta II 7925 stages and 9 GEMs.

9.3 DELTA-LITE (MLELV) IMPACTS TO AIR

Emission quantities for the Delta-Lite were derived from a ratio of expected propellant quantities for the Delta-Lite and known propellant quantities for the LLV 3 (6). The LLV 3 (6) uses 2 Castor 120™ SRMs, an Orbus 21D™ Equipment Section Boost Motor (ESBM) and 6 Castor IVA/XL™ SSRMs, a configuration which most closely approximates the generic Delta-Lite proposed designs. Utilizing the total propellant quantity ratio of the first two stages (Delta-Lite/LLV 3) yields expected Delta-Lite emissions (Table C-8) that are approximately 70 percent of LLV 3 emissions.

Table C-8. Estimated Delta-Lite Emissions to 914 meters (3,000 feet) Elevation

Launch Vehicle	Carbon Dioxide (CO_2)			Carbon Monoxide (CO)			Hydrogen Chloride (HCl)			Aluminum Oxide (Al_2O_3)		
	kg	lbs	tons	kg	lbs	tons	kg	lbs	tons	kg	lbs	tons
Delta-Lite	396	872	(0.44)	4,543	10,015	(5.01)	3,657	8,063	(4.03)	6,860	15,124	(7.56)

Source: Adapted from [SLC6a 1995]
Assumes Delta-Lite emissions are 70 percent of Lockheed Launch Vehicle 3 (LLV 3) emissions

Aerozine-50 vapors from second stage fuel loading will be processed to a level below analytical detection by a citric acid scrubber. Likewise, N_2O_4 vapors from second stage oxidizer loading will be passed through a sodium hydroxide (NaOH) scrubber. These scrubber wastes will be disposed by a certified hazardous waste contractor. [DELTA 1994]

9.3.1 Impacts From Accidental Open Burn of a Castor 120™

If one complete solid rocket booster, Castor 120™, burns in the atmosphere at standard atmospheric pressure, the primary products would include carbon monoxide (CO), carbon dioxide (CO_2), nitric oxide (NO) and hydrogen chloride (HCl). Under the assumption of a 10-minute fire that consumes an entire booster motor containing 49,033 kilograms (108,100 pounds) of fuel, 550 kilograms (1212 pounds) of nitric oxide (NO) would be released (Table C-9). Open burning of all fuel in the Castor 120 ™ booster would release 6,434 kilograms or 14,185 pounds of Aluminum Oxide (Al_2O_3). However, this would primarily occur in a slag-like form that would not affect the atmosphere. [SLC6a 1995]

Table C-9. Predicted Products from Open Burn of a Castor 120™

Combustion Products	Quantity	
	Kilograms	Pounds
CO_2	3,523	7,768
HCl	3,205	7,065
CO	2,720	5,997
NO	550	1,212

Source: [SLC6a 1995]

The release of pollutants would be at much lower levels if the rocket were operating normally. All potential impacts associated with the Delta-Lite launch vehicle are expected to be less than impacts produced by a Delta II 7925 and slightly more than a Taurus launch vehicle.

9.4 TAURUS IMPACTS TO AIR (MLELV) [SELVa 1992]

For the Taurus launch only a portion of the Stage 0 SRM would be combusted at a level below 1,524 meters (5,000 feet). The launch vehicle reaches 1,524 meters (5,000 feet) within 9.3 seconds of ignition. At a burn rate of 794 kilograms per second (1,750 pounds per second) of solid propellant, the amount of solid propellant burned is 7,382 kilograms (16,275 pounds) at 1,524 meters (5,000 feet) (Table C-10). These emission were calculated by proportioning the amount of propellant burned to the combustion products generated for a Pegasus launch [SELVa 1992]. The annual emissions are based on a maximum of three Taurus launches per year.

Table C-10. Taurus Launch Emissions

Pollutant	Metric Tons (Tons)/Launch	Metric Tons (Tons)/Year
HCl	1.4 MT (1.5)	4.0 MT (4.4)
Al_2O_3	2.7 MT (3.0)	8.1 MT (8.9)
CO	1.5 MT (1.7)	4.7 MT (5.2)
NOx	0.6 MT (0.7)	1.8 MT (2.0)

Source: [SELVa 1992]
Based on a maximum of three launches per year

At VAFB, liftoff emissions have the potential for migration to uncontrolled populated areas since the separation distance is only about 6.4 kilometers (about four miles). Previous studies on the exhaust plume during ignition and liftoff using SRMs have indicated that the emissions only have a short-term impact, even for large vehicles such as the Titan IV. The amount of HCl and Al_2O_3 formed during liftoff of a Taurus launch is less than one-tenth of those from a Titan IV launch.

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

Overall, the impacts to ambient air quality from the Taurus program are considered insignificant because the emissions are generated intermittently (maximum of three launches per year) at low quantities.

9.4.1 Taurus Failure Impacts to Air [SELVa 1992]

Another factor that could contribute to launch emissions would be a vehicle failure on or near the launch pad through either vehicle overpressure failure or vehicle command (or inadvertent) destruct. Regarding an inadvertent or deliberate destruct on or near the launch pad, the Flight Termination System is designed such that it fragments the booster case and grain in such a way that no detonation is possible, and in fact most of the propellant would not even burn. Hence, emission would be less than a normal launch. Therefore, impacts from launch failures are not considered a credible event nor are they significantly different from a normal launch. [SELVa 1992]

9.5 PEGASUS IMPACTS TO AIR [PEGASUS 1991]

Impacts from normal Pegasus operations are not expected to have a significant impact on the natural environment. Carrier aircraft impacts from ground operations, takeoff and departure associated with Pegasus launches are expected to be insignificant when compared to routine VAFB aircraft traffic. At most EOS Pegasus operations would increase aircraft traffic at VAFB by three departures and arrivals per year.

The only component of the natural environment that has a potential impact from the routine operations of the Pegasus/PIK is the air quality at VAFB. During the loading of the hydrazine propellant in the Vehicle Assembly Building (VAB) a minute amount of hydrazine vapor will be released into the air. The predicted values of 0.005 ppm for public exposure will be contained well within the VAB perimeter fence and no significant environmental impacts are expected. A hydrazine spill would require short-term mitigative actions and is not expected to create a health hazard.

10. APPENDIX D
THREATENED, ENDANGERED AND CANDIDATE BIOLOGICAL SPECIES OF INTEREST AT VAFB

THREATENED AND ENDANGERED SPECIES

10.1 FISH

10.1.1 Unarmored Threespine Stickleback

The endangered, unarmored threespine stickleback occurs in several local drainages. Although sticklebacks are adaptable in their temperature and food requirements, they have suffered from habitat loss due to urban and agricultural developments [SLC6 1994]. Originally, this species was widely distributed throughout southern California. It was found in the Santa Clara, Los Angeles, San Gabriel, and Santa Ana Rivers, along with a couple of locations in Santa Barbara County. The unarmored threespine sticklebacks prefer clear flowing freshwater, in densely vegetated small stream pools or backwaters. Much of the preferred habitat for this subspecies has been destroyed as a result of urban and agricultural developments. Today natural populations only occur in the headwaters of the Santa Clara River and its tributaries in Los Angeles County, and in San Antonio Creek on north VAFB. [ATLAS 1991]

In an effort to increase its range and 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, and from a tributary on the upper Santa Clara River into San Felipe Creek in Imperial County. A small number of sticklebacks were also inadvertently introduced into El Rancho Pond on VAFB.

10.1.2 Tidewater Goby

Historically, the tidewater goby occurred in at least 87 coastal lagoons of California. In Southern California, this range extends from Morro Bay to San Diego. Near SLC-6 the tidewater goby currently inhabits the coastal lagoons and portions of the river channels of the Santa Ynez River and Jalama Creek [SLC6a 1995].

10.2 REPTILES AND AMPHIBIANS

10.2.1 California Red-legged Frog

California red-legged frogs were federally listed as threatened in May 1996. This species is found in freshwater pools and ponds associated with arroyo willow, cattails, and other thickets of emergent aquatic vegetation. However, this species has significantly declined during the past century because of degradation and loss of critical habitat, predation from introduced freshwater fish, and competition from introduced bullfrogs. [SLC6a 1995]

In the past, this species could be found along the lengths of most of the creeks and rivers in Santa Barbara County. Along the north coast, red-legged frogs have been found at Barka Slough on San Antonio Creek, in Cañada Honda Creek on south VAFB, near the mouth of Jalama Creek, 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, 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. [ATLAS 1991]

10.3 BIRDS

10.3.1 Peregrine Falcon

Peregrine falcon is thought to be a year-round resident of VAFB. Peregrine falcons frequently nest on seaward-facing coastal cliffs and forage on nearby terraces and flats. Regionally, the numbers of peregrine were severely depleted in the 1970s. However, since the banning of DDT, they have become more numerous. In addition to the mainland, peregrine falcons also visit San Miguel Island and other Northern Channel Islands during winter months and migration periods. Breeding peregrines were once reduced in numbers on the Channel Islands, but are now present on San Miguel Island, Santa Cruz Island and West Anacapa Island. [SLC6a 1995]

The American peregrine falcon is considered an endangered species by both state and federal governments. Intensive management efforts through captive-breeding and reintroduction programs have enhanced the wild peregrine population in California. The USFWS estimated that there were 50 to 60 breeding pairs in California in 1979. This number rose to 64 breeding pairs by 1984 and 80 pairs by 1985; at least ten of these pairs were located along the coast. There have been no recent confirmed nesting attempts recorded for coastal areas along the mainland of Santa Barbara County. 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. [ATLAS 1991]

10.3.2 California Brown Pelican

Brown pelicans are common year-round visitors to open beaches, nearshore waters, and protected bays and harbors in Santa Barbara County. 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 from July through December when birds from Mexico migrate north. Between July and October, 25,000 to 35,000 pelicans occupy the nearshore and coastal waters of the Santa Barbara County region. Large numbers of pelicans congregate regularly during the fall and winter at several roost sites in northern Santa Barbara County, including the mouth of the Santa Maria River, Point Sal, Purisima Point, and more rarely, the mouth of the Santa Ynez River. Other important roosting and loafing sites for brown pelicans in northwestern Santa Barbara County include the mouths of Shuman and San Antonio creeks on north VAFB, and on the boathouse breakwater on south VAFB. Pelicans are also known to frequent roosts on the northern Channel Islands, at the Santa Barbara Harbor, at the mouth of Goleta Slough, at Point Mugu, and at the mouth of the Santa Clara River. [ATLAS 1991].

This species is designated as an endangered species by both the state of California and the federal government. During the late 1960s and early 1970s the brown pelican population in southern California suffered significant reproductive failures. Eggshell thinning caused by pesticide contamination, in particular DDE and DDT, is believed to be the primary factor responsible for the reproductive failures and subsequent declines observed in the brown pelican population in southern California. Although the California brown pelican has increased in numbers during the past 10 years, it has retained its endangered status because of its low reproductive success and relatively low breeding population. [ATLAS 1991]

10.3.3 Southern Bald Eagle [ATLAS 1991]

The bald eagle is federally designated as an endangered species. Historically, bald eagles were a common visitor and permanent resident along the coast of Santa Barbara County and on the Channel Islands. Habitat loss, egg collecting, shooting, and eggshell thinning from pesticide accumulation are factors thought to be responsible for the disappearance of bald eagles in southern California. By the 1930's the species was common only on the Channel Islands and was rare on the mainland. Until the early 1950's, bald eagles nested at a few sites along the south coast and on the northern Channel Islands. More recently, bald eagles were recorded nesting in the vicinity of Lake Cachuma in 1989 and 1990. This represents the first confirmed nesting of this species in Santa Barbara County since the early 1950's.

Today, bald eagles occur regularly during the winter in small numbers at Lake Cachuma, and casually in very small numbers on the northern Channel Islands. The species typically arrives in November and departs by late March. A total of 15 bald eagles have been observed on Santa Rosa Island since 1975, and there have been only 11 sightings away from the known wintering site at Lake Cachuma since 1971. The wintering bald eagle population at Lake Cachuma has ranged from 13 in 1978-1979, to four in 1980, to 12-18 during the winters of 1987-1989.

Only one bald eagle has been sighted at VAFB - in 1976. This species is likely to continue to occur in the project region as a very rare fall and winter transient. The most likely site for migrant and wintering bald eagles to occur in northwestern Santa Barbara County would be along the Santa Ynez River from Lompoc to its mouth. This area provides a suitable prey base and roost trees adequate for attracting an occasional transient eagle.

10.3.4 Western Snowy Plover

The Pacific coast population of the Western snowy plover was federally listed as a threatened species on March 5, 1993. The breeding season of the coastal population extends from mid March through mid September. The Western snowy plover is defined as those individuals that nest adjacent to or near tidal waters, and includes all nesting colonies on the mainland coast, peninsulas, off shore islands, adjacent bays and estuaries. The Pacific coast population is genetically isolated from western snowy plovers. The Pacific population breeds primarily on coastal beaches from Washington to southern Baja California, Mexico. A total of 20 plover breeding areas occur in coastal California and eight of the areas, including Point Sal to Point Conception, which includes VAFB and Purisima Point, support 78 percent of the California coastal population. State wide surveys between 1977 and 1980 indicated up to 10,200 breeding plovers in Washington, Oregon, California and Nevada. Recent surveys of these states (and also Utah) in 1988 and 1989 provided further information on the species distribution and abundance and showed a possible decline in numbers. In 1988 and 1989 the breeding population size in Washington, Oregon, California and Nevada was estimated to be about 7,900 birds and in Utah about 1,700. Most plovers (about 7,700) were at interior sites, some (about 1,900) were coastal. Although adult snowy plovers on the California coast experienced a decline from 1,565 total adults in 1977-1980 to 1,386 adults in 1989, the Vandenberg population from Point Sal to Point Conception was relatively unchanged with 119 adults in 1977-1980 and 116 adults in 1989. [SLC2W 1993]

The threatened western snowy plovers have declined as nesting species throughout Southern California, due in part to human disturbance of their sandy beach nesting habitat. On and near VAFB, the western snowy plovers nest on all sandy beaches with suitable habitat with the exception of Jalama Beach. They have been extirpated as a breeding species in southern Santa Barbara County, but continue to breed and winter along undisturbed sandy beaches on VAFB between Point Sal and Point Conception, and surrounding areas. In Santa Barbara County, populations of snowy plover are larger in winter than in summer because of an influx of birds from other breeding areas. Western snowy plovers also nest on San Miguel Island and Santa Rosa Island. [SLC6a 1995]

Snowy plovers forage on invertebrates in the wet sand and amongst surf-cast kelp within the intertidal zone; in dry, sandy areas above the high tide; or in salt pans, spoil sites, and along the edges of salt marshes. The central coast provides suitable habitat for the snowy plover and surveys have been conducted at the Morro Bay area, Callendar-Mussel Rock Dunes, Point Sal to Point Conception (VAFB) and the Oxnard Lowlands. The latest survey for these four areas for the 1989 season accounted for 533 adults. [SLC2W 1993]

10.3.5 California Least Tern

The California least tern, is a migratory bird species that breeds and resides in Southern California from late April to August. Following breeding, they depart, and by late August and early September the species is virtually gone from the region [SLC2W 1993]. The localities usually selected by the least tern for nesting are broad, flat, open sandy beaches, entirely devoid of vegetation. Development and recreational use of the California coast has led to the loss of nesting habitat. Foraging and roosting habitats have been destroyed by the dredging and filling of coastal wetlands. The historical breeding range for the least tern was from the San Francisco Bay Area, California, south to southern Baja California, Mexico. The current breeding range along the California coast is similar to the historical one but with far fewer birds [SLC2W 1993]. This species has declined in numbers because of recreational, industrial, and residential developments, as well as the introduction of non-native predators [SLC6a 1995].

The California least tern was classified as endangered by the USFWS in 1970. During the last five years, the California least tern population has ranged from 954 breeding pairs in 1987 down from 1,046 pairs in 1984. The estimate for 1987 places the Santa Barbara County least tern population at 40 to 45 nesting pairs. The Central California Coast breeding colonies located from the Guadalupe/Mussel Rock Dunes south to VAFB Surf location produced a total of 40 nests in 1989, 42 nests in 1990, 50 nests in 1991 and 55 nests in 1992.

10.4 MARINE MAMMALS

10.4.1 Southern Sea Otter

The southern sea otter is a nonmigratory species which was originally distributed from central Baja California to the strait of Juan de Fuca. Along the coast of California, the southern sea otter is mostly associated with kelp beds, where it feeds on sea urchins, abalone, and shallow-water fish. Because of unrestricted fur hunting throughout the 1800's it has been severely depleted in numbers and distribution. Subsequent protection and reintroductions have allowed the southern sea otter to reoccupy portions of its original range. [SLC6a 1995]

10.4.2 Harbor Seals

The State of California has designated a three-mile area of South Vandenberg AFB as a marine ecological reserve affording additional protection for marine mammals and other wildlife. Establishment of the reserve was not intended to restrict operations from launch complexes on South Vandenberg AFB. Vandenberg AFB has initiated a memorandum of agreement with the California Department of Fish and Game to have access into the marine ecological reserve for military operations and scientific research. [SLC6a 1995]

Harbor seals are protected under the Marine Mammal Protection Act. They utilize rocky coastlines and beaches on the Channel Islands and at mainland sites near the Spaceport for pupping, as well as year-round haulout activities. They forage close to shore where they take a wide variety of medium-sized fish, including herring, flounders and cod. In addition, harbor seals feed on bivalves, crabs, squid and octopus.

10.4.3 Guadalupe Fur Seal [ATLAS 1991]

The Guadalupe fur seal is federally-listed as a threatened species and is listed as rare and protected by the state of California. Current populations of Guadalupe fur seal are concentrated on Isla de Guadalupe and surrounding waters off Baja California, although there are occasional sightings of juveniles on San Miguel, Santa Barbara, San Clemente, and San Nicolas islands. The Guadalupe fur seal seldom, if ever, inhabits open sandy beaches, preferring the caves and recesses along narrow shorelines at the bases of towering cliffs. The species currently breeds only on Isla de Guadalupe, from May to July.

Historically, the Guadalupe fur seal may have numbered 200,000, but by the end of the 19th century the species was near extinction due to commercial exploitation. Their remains are the most abundant pinniped found at archeological sites on Point Bennett, San Miguel Island. The current population is estimated to be 1,600 animals. As population levels increase, the Guadalupe fur seal may reoccupy its former breeding range, which included the Point Arguello area. The success of this recolonization, however, may be influenced by competition with the northern fur seal and the California sea lion for habitat and food.

10.4.4 Steller Sea Lion [ATLAS 1991]

The Steller sea lion is federally-listed as a threatened species. This species ranges from Japan through the Aleutian Islands, central Bering Sea, Gulf of Alaska, and south to central California. The centers of abundance and distribution are the Gulf of Alaska and Aleutian Islands, respectively. San Miguel Island has been used by small numbers of Steller sea lions for breeding, but no territorial bulls have been seen since 1985. Currently, the southernmost breeding colony is located on Año Nuevo Island, but the largest rookeries occur in the Gulf of Alaska and Aleutian Islands. Point Sal Rock may be used as a haulout site.

Severe population declines have been documented for the Steller sea lion in both Alaska and California. Surveys conducted during 1989 in Alaska indicate that numbers observed on rookeries from Kenai Peninsula to Kiska Island have decreased 82 percent since the late 1950s. Similarly, California surveys on Año Nuevo and Farallon islands show a 90 to 93 percent decline since the 1930s. The causes of the declines have not been determined. Possible factors affecting the species include: reduction in availability of pollock, the most important prey species in western and central Alaska; over-use for commercial, recreational, scientific, or education purposes; disease and predation; and incidental mortality associated with commercial fishing operations.

10.4.5 Gray Whale [ATLAS 1991]

The gray whale is federally-listed as an endangered species. The species ranges from the Beaufort, Chukchi, and eastern Siberian seas to western Baja and the Gulf of California. Annual migrations between the summer feeding grounds in the subarctic seas and the winter calving grounds of the Gulf of California bring gray whales within five miles of the shoreline between December and May.

Commercial whaling drove the gray whale nearly to extinction, but with protection the population has rebounded to approximately 21,000, which is believed to be equal to or greater than its size prior to commercial whaling.

CANDIDATE SPECIES [SLC6a 1995]

Candidate species are those which are under consideration by the USFWS as candidates for listing as threatened or endangered species. As such their status is under current review by the USFWS. Former Category 2 candidate species in the vicinity of VAFB are also covered in this section, because such species are the pool from which future candidates for listing will be drawn [Federal register Vol. 61 No. 40, 2/28/96].

10.4.6 Townsend's Western Big-eared Bat [ATLAS 1991]

Townsend's western big-eared bat is a former Category 2 candidate for federal listing and is given a second priority listing in the CDFG "Species of Special Concern" list. Townsend's big-eared bats occur throughout California. In California, Townsend's big-eared bats frequent 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. The species roosts in limestone caves, lava tubes, mine tunnels, buildings, and other human-made structures. Habitat for this species must contain suitable wintering sites that are both free from disturbance and close to fresh water. Townsend's big-eared bat roosts are extremely sensitive to disturbance. Studies suggest that the decline of this species in California is primarily the result of human disturbance to their roost sites.

10.4.7 Ferruginous Hawk [ATLAS 1991]

The ferruginous hawk is a former Category 2 candidate for federal listing and appears on the Audubon Society's Blue List as a "Species of Special Concern". This species is an uncommon fall transient and winter visitor to grasslands and agricultural fields in Santa Barbara County. It is most numerous in agricultural areas in the Cuyama Valley and occurs regularly but in small numbers in the Santa Maria, Los Alamos, and Santa Ynez valleys. Along the immediate coast, this species is a casual fall transient and winter visitor. Ferruginous hawks have been observed during the fall and winter near the mouth of the Santa Ynez River, at Jalama Beach, and on an infrequent but regular basis on the Hollister and Bixby Ranches. The sighting of a ferruginous hawk was observed at the SLC-3E launch site on December 7, 1990.

10.4.8 White-faced Ibis [ATLAS 1991]

The white-faced ibis is a former Category 2 candidate for federal listing and has been assigned the highest priority of "Species of Special Concern" by the CDFG. Due to loss of much of its preferred freshwater marsh habitat, the species has declined during the past 50 years throughout southern California. Its preferred nesting habitat is extensive marshes; its foraging habitat includes marshes, flooded fields, ditches, and occasionally estuaries.

In the past this species was more numerous in Santa Barbara County. Today, white-faced ibis are rare transients to coastal areas of Santa Barbara County and are casual visitors in winter, spring, and summer. Seven birds were observed in September 1978 in the vicinity of the Boathouse on south VAFB. Although the species can be expected to frequent habitats adjacent to the project area, its status there would be as a casual fall transient. The nearest suitable foraging habitat for this species occurs at the mouth of the Santa Ynez River.

10.4.9 Burrowing Owl

The burrowing owl nests in rodent burrows throughout much of the southwestern United States where it lives in open grasslands, prairies, dikes, deserts, and farmlands. In recent years, this species suffered substantial reductions in population sizes, including a sharp decline in California. Several burrowing owls were recently observed on the east-central portions of the Cypress Ridge area.

10.4.10 Bell's Sage Sparrow

The distribution of the sage sparrow extends from the Great Basin and the Snake River Plain to the southern deserts of the United States, and southern California. From the San Francisco Bay area to San Diego, the Bell's sage sparrow occurs within 113 kilometers (70 miles) of the Pacific coast. The preferred habitat of this subspecies includes dense chaparral and brush sand dunes. In South Vandenberg, it would be expected to occur sparingly in the coastal sage scrub. The Bell's sage sparrow has been observed within the area of SLC-6.

10.4.11 Rufous-crowned Sparrow

The rufous-crowned sparrow is a resident of central and southern California, as well as Arizona and southern New Mexico. The distribution of the southern California (ashy) rufous-crowned sparrow extends from the Santa Maria area to the border with Mexico. This coincides with the range of its preferred habitat, coastal sage vegetation. It is most abundant in open plant communities with sparse coverage. Furthermore, the SLC-6 habitat suggest strong potential for occurrences of the southern California rufous-crowned sparrow. These upland songbird species could potentially nest, and occur as year-round residents, on the terraces surrounding SLC-6, and on the slopes of Cypress Ridge.

10.4.12 Tricolored Blackbird [ATLAS 1991]

Tricolored blackbirds are a former Category 2 candidate species for federal listing. They are resident throughout coastal areas of southern California and can be found in large congregations at breeding and wintering localities. In Santa Barbara County, this species nests in large colonies that tend to be associated with dense stands of bulrushes and cattails. Tricolored blackbird nesting colonies have been found in the vicinity of Buellton and Goleta, and in the Santa Maria and Cuyama Valleys. A moderate size nesting colony was observed in 1987 along the Santa Ynez River about 0.8 kilometers (about 0.5 miles) upstream from Santa Rosa Creek. During the nesting season this species is rarely found away from its breeding locales. Summer foraging occurs in agricultural areas, fields, pastures, and short grass habitats adjacent to nesting colonies.

During the fall and winter this species forages in habitats similar to those used in the summer. The largest concentrations of wintering tricolored blackbirds in the Santa Barbara region have been found in the Santa Maria Valley and near the mouth of the Santa Ynez River. This species is expected to occur in small numbers as a transient during the fall and winter, foraging in grasslands and open coastal scrub habitats.

10.4.13 Southwestern Pond Turtle

In Southern California, the southwestern pond turtle is found in unpolluted rivers and streams, as well as other freshwater habitats, particularly pools lined with aquatic vegetation. However, habitat degradation and collecting for the pet trade have decreased the population levels in many areas.

The southwestern pond turtle is a former Category 2 candidate species for possible federal listing and is a CDFG "Species of Special Concern". Southwestern pond turtles occur throughout southern California, including parts of the Mojave Desert. Their preferred habitat includes unpolluted rivers, streams, reservoirs, ponds, marshes, canals, and floodplain backwaters where water is present year-round. This species frequents quiet water and generally selects deeper pools lined with aquatic vegetation, such as cattails. [ATLAS 1991]

Southwestern pond turtles have been recorded from the Campbell Road vernal ponds along Highway 246 (West Ocean Avenue), along the Santa Ynez River from the Floradale Avenue Bridge to its mouth, from San Antonio Creek at Barka Slough, from Jalama Creek, and from 12 sites on the Bixby and Hollister ranches. Based on the available sighting and specimen records, this species does not appear to be in any real danger of extirpation in northwestern Santa Barbara County. However, it is subject to local extinction as a result of agricultural and stock pond developments and ground water pumping. [ATLAS 1991]

10.4.14 California Horned Lizard

The California horned lizard inhabits a variety of upland habitats in central California; on Vandenberg it is found in open scrub and grassland habitats, typically in sandy areas, and is often found near anthills. Ants are its preferred food. It is a former Category 2 candidate species and is expected to occur in the ROI of one or more of the alternative SLCs proposed for use by EOS.

10.4.15 Silvery Legless Lizard

The silvery legless lizard is a secretive burrowing species, typically found in leaf litter under shrubs, where it feeds on insects, insect larvae, and spiders. It requires sandy or loose organic soils. It is relatively widespread in coastal and valley habitats of central and southern California. On Vandenberg it is common but seldom observed in coastal dune scrub vegetation, typically under dune lupine. Its distribution on South Vandenberg is not well understood. It is expected to occur in the ROI of one or more of the proposed EOS alternative launch pads.

CANDIDATE PLANT SPECIES [SLC6a 1995]

10.4.16 Surf Thistle and Spectacle Pod

Surf thistle and spectacle pod are found on active dune systems along the Pacific coastline of VAFB. In South Vandenberg, they have been found between Point Arguello and Point Pedernales. They are both candidate species for federal listing.

10.4.17 Monardella

Two closely-related species of *Monardella* occur on active dunes, stabilized dunes, and in disturbed habitats. Although, hybrids are common where these two species coexist, a recent taxonomic treatment separates them according to their morphological characteristics and exacting soil requirements. Crisp monardella prefers unstabilized dunes and disturbed habitats, whereas San Luis Obispo monardella is most common on inactive dunes and in coastal sage scrub vegetation. Both species of *Monardella* are former Category 2 candidates for federal listing.

A recent survey for *Monardella spp.* was conducted on South Vandenberg. San Luis Obispo monardella is a prominent component of the coastal sage scrub vegetation in the Cypress Ridge area. Crisp monardella was not observed in the Cypress Ridge area.

10.4.18 Black-flowered Figwort

Black-flowered figwort is an endemic plant species that maintains a patchy distribution in moist depressions, with willows and coyote brush. This former Category 2 candidate species is found on the diatomaceous and calcareous hills around Lompoc, as well as in coastal sage scrub and similar types of vegetation.

11. APPENDIX E
CONFORMITY ANALYSIS [SLC6a 1995]

The U.S. Air Force is required to make a formal determination as to whether any VAFB operation complies with the General Conformity Rule of the Amended Clean Air Act. Section 176(c) of the Clean Air Act, as amended in 1990, requires all Federal agencies or agency supported activities to comply with an approved or promulgated state implementation plan (SIP) or Federal implementation plan (FIP). Conformity means compliance with a SIP/FIP's purpose of attaining or maintaining the national ambient air quality standards (NAAQS). Specifically, this means ensuring the activity will not: 1) cause a new violation of the NAAQS; 2) contribute to an increase in the frequency or severity of existing NAAQS violations; or 3) delay the timely attainment of any NAAQS, interim milestones, or other milestones to achieve attainment.

Air quality management in Santa Barbara County is under the jurisdiction of the Santa Barbara County Air Pollution Control District (SBCAPCD). Santa Barbara County is primarily following locally approved rules and regulations as the framework for air quality management.

According to consultation with VAFB ET air quality personnel and previous reports, the area of Santa Barbara County containing VAFB is designated "cannot be classified" for SO_2 and PM_{10}, and "cannot be classified or better than national standards" for NO_2 and CO. The entire Santa Barbara County is classified as "moderate" nonattainment for O_3. Therefore, this conformity determination will evaluate only ozone precursors (oxides of nitrogen (NO_x) and volatile organic compounds (VOCs)); other pollutants (SO_2, PM_{10}, and CO) are exempted from conformity analysis, in this instance.

The conformity rule requires that total direct and indirect emissions of criteria pollutants, including ozone precursors (*i.e.*, volatile organic compounds and nitrogen oxides) be considered in determining conformity. The rule does not apply to actions where the total direct and indirect emission of criteria pollutants do not exceed Federal de minimis conformity threshold values for ozone precursors. The de minimis threshold levels in nonattainment areas are shown on Table E-1. The proposed action must also be less than 10 percent of the regional baseline inventory for the priority pollutants.

Table E-1. De Minimis Thresholds in Nonattainment Areas

Criteria Pollutant	Degree of Nonattainment	Tons/Year
Ozone (VOCs or NOx)	Serious	50
	Severe	25
	Extreme	10
	Other ozone nonattainment areas outside of ozone transport region	100
VOCs	Marginal/moderate nonattainment within ozone transport region	50
NOx	Marginal/moderate nonattainment within ozone transport region	100
Carbon monoxide (CO)	All	100
Particulate matter (PM_{10})	Moderate	100
	Serious	70
Sulfur/nitrogen dioxide SO_2/NO_2	All	100
Lead (Pb)	All	25

Source: 40 CFR Part 93.153 (b)

For the EOS conformity analysis, emissions have been derived from scaling by one-eighth the predicted Spaceport emissions from 24 launches per year (Table E-2). The original analyses included the Castor 120™ solid rocket boosters; gasoline and diesel fueled vehicles transporting Spaceport and customer launch support personnel and rocket motors, payloads, and miscellaneous launch support equipment; and diesel fueled standby power generators for emergency backup power to maintain critical Spaceport systems, which can be assumed to be representative of EOS activities. Principal emissions will result from both solid and liquid fueled rocket launches. Proposed solid rocket boosters will use the same basic fuel formulation (aluminum powder, ammonium perchlorate, hydroxyl terminated polybutadiene). Liquid fuel booster will emit primarily CO_2 and H_2O. [SLC6a 1995]

Table E-2. Total Emissions (Tons/Year)

Source (per year)	NOx		VOC	
EOS *	0.196 MT	0.216 tons	0.086 MT	0.095 tons
CCS Launch Activities (year)**	1.565 MT	1.725 tons	0.686 MT	0.756 tons

* Maximum EOS contribution assumes maximum of three flights per year, which scales all other launch and launch support activities by 1/8.
** Total Spaceport contribution includes 24 launches of the LLV 3 with 6 Castor IV/XL™ SSRMs used in describing Delta-Lite impacts, gasoline vehicles (80 twenty-mile round trips/day x 260 days), diesel vehicles (110 forty-mile round trips/year, 60 two-mile tow tug trips), diesel standby generators (300 hp-hr generator x 12 hr/year), alcohol wipedown (48 gallons per year), and hydrazine transfer (99% efficiency).

Source: Adapted from [SLC6a 1995]

The creation of thermal NO_x resulting from afterburning (heated exhaust decomposing the atmosphere) is not expected. [SLC6a 1995]

The total direct and indirect emissions from the Proposed Action do not exceed the Federal de minimis conformity threshold for the criteria nonattainment pollutant (ozone precursors). Additionally, total emissions for each nonattainment pollutant (ozone precursors) are less than 10 percent of SBCAPCD's 1994 Forecast Planning Emission Inventory (Table E-3). Therefore, this Proposed Action is considered de minimis and not regionally significant. This determination is in accordance with EPA Conformity Rule 40 CFR Sections 93.153 (b) and (c), in accordance with Section 176 (c) of the Clean Air Act, as amended.

Table E-3. Comparative EOS Emissions (Tons/Year)

Quantity/Standard Ozone Precursor	Total EOS Contribution	Total Spaceport Contribution	De Minimis Thresholds	10% of SBC 1994 Forecast Planning Emission Inventory
VOCs	0.095	0.756	100	1,456
NOx	0.216	1.725	100	1,263

Source: Data acquired from [SBCAPCD 1994], [JA 1996] and [SLC6a 1995]

Total Spaceport contribution includes 24 launches of the LLV 3 with 6 Castor IV/XL™ SSRMs used in describing Delta-Lite impacts, gasoline vehicles (80 twenty-mile round trips/day x 260 days), diesel vehicles (110 forty-mile round trips/year, 60 two-mile tow tug trips), diesel standby generators (300 hp-hr generator x 12 hr/year), alcohol wipedown (48 gallons per year), and hydrazine transfer (99% efficiency). Maximum EOS contribution assumes maximum of three flights per year, which scales all other launch and launch support activities by 1/8.

12. APPENDIX F
BEHAVIORAL RESPONSE STUDIES OF HARBOR SEALS

SLC-2

Sound levels and behavioral responses of harbor seals at Purisima Point and Rocky Point were documented during launch of a Taurus Small Launch Vehicle from SLC-576E (which is expected to be representative of SLC-2W launches) on 13 March 1994. The A-weighted sound exposure level of noise recorded at Purisima Pt. (40 second duration; 2.24 kilometers from the launch pad) was 108.1 dB. Twenty of the 23 harbor seals that were hauled out at Purisima Point before the launch fled immediately into the water within a few seconds after launch; only three of those seals, at most, returned to land within two and one-half hours of the disturbance. The A-weighted sound exposure level of noise recorded at Rocky Point (130 second duration; 20.4 kilometers from the launch pad) was 80.0 dB. That noise included launch noise and perhaps a sonic boom. Twenty of 74 harbor seals of the harbor seals that were monitored at Rocky Point fled into the water within several seconds of the sound arriving there. None of the four young pups that were ashore left the beach nor were they separated from their mothers. Virtually all of the seals that left the beach returned ashore within 30 minutes of the launch-noise disturbance. Harbor seals that were exposed to the greater sound levels at Purisima Point reacted more intensely to the sound and evidently remained at sea longer than harbor seals that were disturbed at Rocky Point. Seals did not appear to suffer mortality or injury as a result of exposure to the launch-noise at either site. Any long-term effects of launches of Taurus and other Space Launch Vehicles on the use of local haulout sites by harbor seals will likely be primarily determined by the annual frequency and timing of all launches at VAFB. [NOISE 1994]

Although the sound level at Purisima Point during the launch does not appear to have the potential to cause permanent or temporary hearing damage, it did evidently frighten most seals sufficiently to discourage them from returning to land for at least two and one-half hours. [NOISE 1994]

At 1430 hours (PST) on 13 March, 134 harbor seals were hauled out at Rocky Point (20.4 kilometers from SLC 576E), including four pups. At 1431:19 hours (PST) all of those seals alerted and began moving towards the surf. Within three seconds of alerting 14 seals entered the water whereas most of the rest had stopped moving. Six more seals entered the water by 1432:30 but all remaining seals returned to normal activities within one minute after alert. None of the pups or mothers fled into the water or were separated from each other. By 1510 hours, approximately 40 minutes after the initial disturbance at least 8 of the 25 seals that left the beach in response to the two sound disturbances had not returned to the spots where they had been previously hauled out. However, direct observations and counts of seals on the entire beach suggests that most, or perhaps all, of those seals hauled out farther down the beach by 1500 hours. There was no evidence that the sound experienced by harbor seals at Rocky Point disrupted the relationships between females and their young pups. [NOISE 1994]

SLC-3

For Atlas II vehicles to attain a polar or near-polar orbit, their launch azimuths must be generally southerly. The Atlas II vehicles may pass between San Miguel and Santa Rosa and are expected to generate sound pressure levels of between 88.4 and 91.6 dB near these islands. For a modeled flight path directly over San Miguel Island, focused sonic booms would become three distinct sonic booms, beginning 3.7 to 8.4 kilometers (2.3 to 5.2 miles) north of San Miguel Island, and ranging from approximately 121 to 134 dB (0.5 to 2 psf). [ATLAS 1991]

Due to the proximity of SLCs 4E and 3W, noise impacts from rocket launches at SLC-3W are expected to be similar to those produced by rocket launches at SLC-4E. A Titan IV rocket was launched from SLC-4E, at approximately 1300 hrs on 2 August 1993. The noise from the launch was measured at a harbor seal haulout at SVAFB, and near pinniped haulout and breeding areas at San Miguel Island. Near the harbor seal haulout at SVAFB, the maximum sound level was 101.8 dBA. These noise levels are similar to a jet overflight, although lower in frequency. An F-16 passing overhead at an altitude of 100 meters, flying at 255 knots, produces a maximum sound level of 93.5 dBA [NOISE 1993].

All harbor seals (41) that were ashore at Rocky Point (SVAFB) fled into the water in response to the launch noise on 2 August. About 75 percent of those seals returned to shore later that day, most within 90 minutes of the disturbance. Haul-out patterns appeared to be normal during the next several days but evaluation of longer-term effects were complicated by additional disturbances (of unknown source) on eight days between 7 and 24 August. [NOISE 1993]

A transient sound overpressure was recorded at San Miguel Island at approximately 1304 hrs that had a maximum sound level of 108.3 dB. This is comparable to thunder at a distance of around one to two kilometers. [NOISE 1993]

Five of 33 radio-tagged harbor seals were hauled out at Otter Harbor, San Miguel Island, prior to the Titan IV launch. All fled into the water in response to the noise that impacted San Miguel Island. Three returned to shore within 30 minutes and one returned within seven hours; another remained at sea for 68 hours before hauling out again. [NOISE 1993]

Virtually all sea lions (25,000 including 14-15,000 one-month-old pups), northern fur seals (1,100 including 650-700 one-month-old pups), and northern elephant seals (800) at Pt. Bennett alerted to the initial sound overpressure but few moved toward the surf. The noise that followed that initial disturbance caused about 95 percent of the California sea lions, but few northern fur seals and no elephant seals, to rush towards the surf. About 45 percent of the California sea lions and 2 percent of the northern fur seals at Point Bennett entered the surf in response to the popping and rumbling sound that followed the initial overpressure and that continued for about 104 seconds. No animals appeared to be injured during these movements but approximately 15 percent of sea lion pups were temporarily abandoned when their mothers fled into the surf. Most animals were returning to shore within two hours of the disturbance. No unusual pinniped mortalities or behavior were observed during the follow-up surveys between 3-5 August or between 28 August and 3 September. [NOISE 1993]

13. APPENDIX G
MONITORING AND MITIGATION AT THE CALIFORNIA SPACE LAUNCH COMPLEX AND SLC-2

13.1 MONITORING AND MITIGATION (CSLC)

Monitoring and mitigation plans developed by Spaceport Systems International (SSI) identify comprehensive monitoring and mitigation activities that will be performed by SSI on behalf of all Spaceport users. Individual users will not be expected to perform natural resource monitoring for their missions, instead this is provided as a Spaceport service. SSI believes that the scope of this program encompasses the EOS Program, if it were to launch from the Spaceport. [LAR 1995]

The current mitigation programs that have already been established and in some instances implemented are as follows:

- Peregrine Falcon: Five captive breed peregrine chicks will be released on South VAFB each year for three consecutive years. The fledgling chicks will be provided food and monitored for approximately six weeks thereafter or until it is determined that they are self-sufficient and no longer require assistance. It is felt that this release program can result in significant stabilization of the peregrine falcon in California.
- Brown Pelican and Nesting Seabirds: SSI is negotiating with the Channel Islands Park Service to provide SSI funding for the development and implementation of a black rat eradication program planned for Anacapa and San Miguel Islands. These rats prey on eggs and young of brown pelican and a variety of nesting seabirds. Any level of eradication will have direct benefit for these species. In addition, SSI funding has been allocated for the installation of a viewing blind and the development of interpretive materials, both of which will be installed on Santa Barbara Island. This blind will minimize the impact of the presence of human observers on the second largest brown pelican breeding colony in California.

Monitoring plans were developed to determine if launch noise or launch exhaust dispersion has a significant effect on harbor seals, sea otters, western snow plovers, near-field wildlife and vegetation, or Honda Creek endangered and threatened species. The scope of the monitoring plans are outlined below:

- Harbor Seal and Sea Otter: Currently monitoring activities are performed for all VAFB launches to determine the effect of launch noises on the local population of pinnipeds (seals). Specific monitoring requirements are defined on a program-by-program basis by the NMFS during their review of incidental harassment or small take permits that are required for any activity that results in the "harassment" of the species. SSI is currently applying for a permit with the NMFS. As a result of the NMFS review process, specific monitoring requirements will be identified for Spaceport launches. Currently, SSI is attempting to identify an acceptable mitigation program, it is hoped that the monitoring requirements will be reduced to observations during the pupping season only or eliminated. The NMFS discussions are about to commence, and at the worst case if SSI is unsuccessful, the monitoring requirements will be virtually identical to the visual and sound observations currently made for all VAFB launches.
- Western Snow Plover: The USFWS Biological Opinion identified the need for launch noise monitoring of the western snowy plover located at the southerly end of the Surf Beach area. Monitoring will be by direct observation, one hour before, during and after a launch. The monitoring frequency has been proposed to be once during the breeding season for each class of Spaceport vehicles. Monitoring will not be conducted during non-breeding season. After each class of vehicles from the Spaceport has been monitored or determined to be within the boundaries of another class, monitoring can be suspended until a new class outside the boundaries is introduced.

- Near-Field Vegetation and Wildlife: Deposition monitoring will be performed using a variety of techniques to detect and determine the spatial distribution of acidic exhaust products at ground level. The pattern and degree of acidic products measured will be used to interpret whether observed changes in vegetation or soils are associated with the launches or caused by other non-launch induced effects. Vegetation, habitat and wildlife sampling will be performed on an annual, pre-launch and post-launch basis to detect changes. Monitoring frequency will be once per year for the first two years when launch frequencies are low, and twice per year thereafter.
- Honda Creek Species: Initial and annual monitoring of the Honda Creek habitat and species will be performed to first provide a baseline, then to determine if any changes have occurred. Water quality sampling techniques will be employed to determine if the launch exhaust products adversely affect the Honda Creek habitat. Monitoring will occur once per year for the first two years when launch frequencies are low and only for launches during December through February (when winds have the highest probability of coming from the South). For the third year and thereafter, monitoring will occur twice per year, also only during the December through February time period. [LAR 1995]

13.1.1 Spaceport Monitoring and Mitigation Requirements [BO 1995]

In order to avoid the prohibitions of Section 9 of the Endangered Species Act, the Air Force is responsible for compliance with the following terms and conditions. Terms and conditions were contained in the U.S. Air Force's description of the proposed action and are modified herein by the Service.

1. American peregrine falcon hacking, cross-fostering or other mitigation approved by Vandenberg and the Service shall be conducted for a minimum of three consecutive years. Sites on Vandenberg are preferred for American peregrine falcon mitigation, however, off-base sites may be considered if on-base mitigation proves infeasible. If American peregrine falcon hacking, cross-fostering or other approved mitigation is not implemented prior to the first launch, a monitoring program shall be implemented. American peregrine falcon hacking, cross-fostering or other approved mitigation shall be initiated as soon as practicable, though no more than two years following commencement of Spaceport construction activities. If monitoring indicates that take attributed to the Spaceport has occurred to American peregrine falcons, mitigation shall be initiated within one year of the take incident pending the availability of American peregrine falcons for hacking or cross-fostering.

2. Monitoring of dB and dBA noise levels shall be recorded near brown pelican roost sites from Point Pedernales (Destroyer Rock area) to the Boathouse breakwater for all Spaceport launches. Data shall be collected until sufficient information exists to determine if significant impacts from Spaceport launches occur, or a commitment to implement mitigating measures is made.

   a. Brown pelican behavioral response shall be monitored for all Spaceport launches using pre- and post-launch counts (counts), and video recordings. Counts shall be conducted from Point Pedernales (Destroyer Rock area) to the Boathouse, including the coastline and offshore rocks. Counts shall be conducted no more than 48 hours prior to a launch, and within 24 hours following a launch. To the extent practicable, counts shall be conducted at the same time of day and shall commence with the gathering of baseline data as developed in the monitoring and Mitigation Plan by Vandenberg and the Service. Data shall be collected until sufficient information exists to determine if significant impacts from Spaceport launches occur, or a commitment to implement mitigating measures is made. Development of a Mitigation Plan for the brown pelican shall require coordination between Vandenberg, the Service, and other affected entities (*i.e.*, Channel Islands National Park) depending on mitigation measures and locations.

b. Pre- and post-launch counts for southern sea otters shall be completed within 48 hours before and after all Spaceport launches. Monitoring counts shall commence with compilation of existing baseline data or collection of baseline data, as specified in the Monitoring and Mitigation Plan developed by Vandenberg and the Service. Data shall be collected until sufficient information exists to determine if significant impacts from Spaceport launches occur, or a commitment to implement mitigating measures is made. Mitigation for southern sea otters shall be developed in coordination between Vandenberg and the Service.

c. Personnel conducting surveys, monitoring activities or implementing mitigation measures must be approved by Vandenberg, and the Service, as appropriate. Launch monitoring plans and a list of personnel conducting the monitoring shall be submitted to Vandenberg for review and approval no later than 60 days prior to the first launch. Any subsequent changes to monitoring protocols or personnel shall be reviewed and approved by Vandenberg and the Service.

d. A draft report on Spaceport monitoring and mitigation activities shall be submitted to Vandenberg and the Service in March of each year. Each agency shall review and approve the final report prior to public release. Quarterly progress reports produced by the proponent on monitoring and mitigation efforts and results shall be provided to Vandenberg.

3. If predictive modeling approved by Vandenberg and the Service indicates Canada Honda Creek may be affected by Spaceport launches, water quality monitoring shall be conducted for launches likely to affect the creek. Sampling, or monitoring, shall be completed no more than 24 hours before and after Spaceport launches. Water quality monitoring shall include pH and dissolved oxygen at a minimum. If monitoring data indicates that Spaceport launches result in a detrimental impact to species found in Canada Honda Creek, the Spaceport proponent shall immediately develop measures to restrict the number and timing of impacting launches in consultation with Vandenberg and the Service.

4. Sample populations of western snowy plovers shall be monitored to determine the degree to which Spaceport operations disturb them. Western snowy plover monitoring shall be part of the Monitoring and Mitigation Plan. If monitoring indicates that Spaceport operations do not unduly disturb western snowy plovers, monitoring of future spaceport operations may be discounted after discussions with and concurrence of the Service.

a. A Monitoring and Mitigation Plan shall be completed within 90 days following the signing of the Finding of NO Significant Impact (FONSI) for the Spaceport EA. The plan shall be developed by the project proponent in coordination with Vandenberg environmental personnel and the Service.

b. Personnel conducting surveys, monitoring activities or implementing mitigation measures shall be approved by Vandenberg, and the Service, as appropriate. Launch monitoring plans and a list of personnel conducting the monitoring shall be submitted to Vandenberg for review and approval no later than 60 days prior to the first launch. Any subsequent changes to monitoring protocols or personnel shall be reviewed and approved by Vandenberg and the Service.

c. A draft report on Spaceport monitoring and mitigation activities shall be submitted to Vandenberg and the Service in March of each year. Each agency shall review and approve the final report prior to public release. Quarterly progress reports produced by the proponent on monitoring and mitigation effort and results shall be provided to Vandenberg.

13.2 MONITORING AND MITIGATION (SLC-2)

Monitoring and mitigation plans developed by USAF/NASA/McDonnell Douglas Aerospace (MDA) and agency consultation for SLC-2W launches identify comprehensive monitoring and mitigation activities that will be performed pending launch type (*i.e.*, NASA-USAF-commercial). Individual spacecraft users are not expected to perform natural resource monitoring for their spacecraft missions. This is provided as part of the launch service contract with the appropriate agency. MDA believes the scope of the present program encompasses the EOS Program, if it were to launch from SLC-2.

The current mitigation programs that have already been established and in some instances implemented are as follows:

- Near-Field Vegetation and Wildlife: Acid deposition measurements were conducted on November 4, 1995, for the RADARSAT launch to monitor for indications of pH changes in the surrounding air caused by hydrogen chloride (HCl) vapors or deposition. Forty-seven sampling stations (pH paper 6 inches by 1 inch) were set up in a grid pattern south and west of the launch point. A grid was established to forecast of winds from 350 degrees and allowance for direction changes of 40 degrees to capture the ground cloud. No pH changes occurred on any of the test strips and there was no indication of acid deposition. The launch releases were confined to the launch pad and the lofted plume which rose because of heating. Repetition of measurements may not be required for future launches. Presently, based on the data collected and forwarded to the USFWS, no additional measurements of this type are contemplated for future launches.
- California Least Tern, Western Snow Plover, and California Brown Pelican: A Supplemental Environmental Assessment for year round launches of two MELVs per year from SLC-2 was completed in June of 1993. A Finding of No Significant Impact (FONSI) was rendered. The USFWS prepared a Biological Opinion (BO) that included mitigation measures to reduce the impacts to these species from launches. Launches shall not occur when wind is blowing toward the La Purisima Point and nesting area (March 15 - September 15 only). The BO concluded that the continued existence of the covered species would not be in jeopardy provided the mitigation measures were implemented. The USFWS determined the proposed projects are not likely to jeopardize the continued existence of the California least tern or the western snowy plover. An additional EA is in coordination for up to ten launches per year.
- Harbor Seal and Sea Otter: An annual permit dated September 19, 1995, requires notification to Marine Fisheries Service 48 hours prior to each launch, observation by a biologically trained observer of harbor seals in the vicinity of SLC-2 and Purisima point and noise level measurements. Mitigation also includes avoiding, when possible, launches between February 1 thru May 31. The preference is for launches after June 1 and prior to Dec 1, as well as night launches. Repetition of monitoring is required for future launches.
- Acoustic noise measurements: Presently, based on the data collected and forwarded to the USFWS, no additional measurements of this type for avian noise are required or contemplated for future launches.

13.2.1 SLC-2W Monitoring and Mitigation Requirements [BO 1993]

1. The Air Force shall ensure that the following mitigation measures are implemented. These measures were developed by the Air Force and submitted to the Service with the request for formal consultation, in a letter dated August 31, 1992, and during telephone conversations with VAFB Environmental Management staff and have been slightly modified herein by the Service. Due to the extensive informal consultation that has occurred between the Air Force and the Service, many of these measures have begun to be implemented.

   a. Acoustic measurements shall be performed on the first available launches from SLC-2W and 576E. The data from these measurements shall be made available to the Service. The Air Force shall provide funds to the service in the amount of $5,000 to fund scientific research on the impacts of noise to avian species.
   b. Exhaust plume deposition shall be monitored on the first available launch from SLC-2W and 576E. The information shall be made available to the Service.

c. Launches from SLC-2W and 576E shall not occur during the California least tern and western snowy plover nesting season when the wind is blowing toward the La Purisima Point and south nesting area. This time period is from March 15 through September 15.

d. The Air Force shall manage the California least tern and western snowy plover populations in a manner that will increase stability and enhance reproductive success of these two species at VAFB. These measures shall include, but not be limited to:

1) The California least tern monitoring program shall be increased from past levels of effort to three days a week at all sites. The western snowy plover monitoring program shall also be increased from past levels of effort to two days a week.

2) Habitat shelters (roof tiles) for California least terns shall be placed in the colony prior to the start of the 1993 nesting season.

3) The wooden pole near the La Purisima Point least tern colony which could be used as a perch by avian predators shall be removed.

4) California least tern decoys shall be installed at the La Purisima Point nesting area and other appropriate areas at VAFB prior to the start of the 1993 nesting season. The Air Force shall provide funds to the Service in the amount of $1,800 to purchase 125 California least tern decoys for placement at VAFB.

5) The Air Force shall provide funds to U.S. Department of Agriculture Animal Damage Control in the amount of $20,000 to provide the following for the La Purisima Point, San Antonio Creek and Santa Ynez River mouth nesting areas: monitoring and a report regarding the extent of predation; an evaluation of the effectiveness of non-lethal protection measures; and recommendations for predator control techniques.

a) The Air Force shall erect and maintain a new portable electric fence at the La Purisima Point nesting site prior to the 1993 nesting season to protect the colony from predators. The portable fence shall be constructed by placing brace posts in the ground as necessary. Round fiberglass rods shall serve as stays between the posts to keep the electric wires spaced properly no more than five or six inches apart. The wires shall be made of braided nylon wire that can be reused every year.

b) The Air Force shall install gates in the existing chain link fences prior to the 1993 nesting season to allow access to personnel from the Service, The Nature Conservancy, and Animal Damage Control for observations, monitoring, and investigations of the California least tern and western snowy plovers at La Purisima Point.

c) The Air Force shall repair existing fences where necessary near the La Purisima Point nesting site prior to the 1993 nesting season.

d) The existing electric fence near the La Purisima Point nesting site shall be cleared of vegetation and sand and repaired prior to the 1993 nesting season. The bottom wire shall not be over eight inches above the ground at any location.

2. The Air Force shall provide the Ventura Field Office with copies of all reports generated from the studies and monitoring requirements generated from these terms and conditions.

14. APPENDIX H
CALCULATIONS FOR THE DETERMINATION OF POTENTIAL IMPACTS TO TERRESTRIAL RESOURCES FROM HYDROGEN CHLORIDE DEPOSITION

GENERAL

A study of Space Transportation System (STS) launches at Kennedy Space Center (KSC) demonstrated that under certain wind conditions an estimated 3,400 kilograms (7,755 pounds) of HCl and 7,100 kilograms (16,193 pounds) of particulates are deposited across the 12.6 hectare (1,260 acre) site during a nominal launch. Estimates of maximum HCl deposition in the study area represented 17 percent of the total produced during the first 10 seconds of the launch event [HCl 1985]. In addition, measurement of chlorides in the deluge water holding ponds represented another 11 percent of the HCl produced during the first 10 seconds of the launch event [HCl 1985].

14.1 CALCULATIONS OF HCL DEPOSITION FROM EOS LAUNCH VEHICLES

Given the relationship above, HCl deposition quantities were determined for each of the proposed EOS launch vehicles:

14.1.1 Delta-Lite

For the purposes of this EA the Delta-Lite has been determined to produce 70 percent of the pollutants created by the LLV 3. HCl deposition per launch of the Delta-Lite is calculated to be 364 kilograms (831 pounds).

- The LLV 3 creates 11,519 pounds of HCl in the first 16.5 seconds [SLC6a 1995], therefore 6,981 pounds of HCl will be created in the first 10 seconds.
- Seventeen percent of 6,981 pounds equates to 1,187 pounds of HCl deposition per launch of LLV-3
- Seventy percent of 1,187 pounds equals 831 pounds of HCl deposition per launch of the Delta-Lite

14.1.2 Delta II 7925

The Delta II 7925 produces HCl from the SSRMs (GEMs) it utilizes, exclusively. Therefore, the quantity of HCl deposited per launch was calculated using the burn rates associated with GEM SSRMs. HCl deposition per launch of the Delta II 7925 is calculated to be 385 kilograms (878 pounds).

- One GEM contains 25,882 pounds of propellant which burns in 63.2 seconds [DELTA 1993].
- This equates to a burn rate of 410 pounds per second or 4,100 pounds in 10 seconds.
- The Delta II 7925 product mass fraction for HCl is approximately 21 percent [DELTA 1994], therefore 861 pounds of HCl is created in the first 10 seconds of GEM ignition.
- Six GEMs are ground lit, therefore the 861 pounds created by one GEM in the first 10 seconds must be increased by a factor of six. This equates to 5,166 pounds of HCl created in the first 10 seconds of a Delta II 7925 launch.
- Seventeen percent of 5,166 pounds equals 878 pounds of HCl deposition per launch of the Delta II 7925.
- Eleven percent of 5,166 pounds equals 568 pounds of HCl entrained in deluge water.

14.1.3 Taurus

The Taurus launch vehicle utilizes a Castor 120™ solid rocket booster and two Castor IVBs™ (optional) as the first stage. These SRMs utilize a fuel similar to the Delta II 7925, therefore the HCl mass fraction of 21 percent was utilized for Taurus calculations. The Taurus launch vehicle is calculated to deposit 347 kilograms (791 pounds) of HCl per launch.

- The two optional Castor IVBs™ contain 44,128 pounds of propellant total. Assuming a burn rate equal to that of the Castor IVA™ (424 pounds per second) the two Castor IVBs™ will burn 8,480 pounds of fuel in 10 seconds.
- The Castor 120™ burns at a rate of 1,367 pounds of fuel per second [SLC6a 1995]. This equates to 13,670 pounds in 10 seconds.
- Assuming a mass fraction of approximately 21 percent [DELTA 1994], the HCl produced from the burning of 22,150 lb of fuel = 4,651 pounds.
- Seventeen percent of 4,651 pounds equals 791 pounds of HCl deposited per launch of the Taurus with two Castor IVB™ SSRMs.

14.1.4 Atlas IIAS

The Atlas IIAS produces HCl from the four Castor IVA™ SSRMs exclusively, therefore the burn rates and propellant quantities of the Castor IVAs™ were utilized to determine the HCl deposited from an Atlas IIAS launch. The Atlas IIAS is calculated to deposit 265 kilograms (605 pounds) of HCl per launch.

- Castor IVA™ SSRMs burn at a rate of 174 kilograms (424 pounds) of fuel per second [SLC6a 1995], or 4,240 lb in 10 seconds.
- Four Castor IVAs™ burning simultaneously would burn 16,960 pounds of fuel in 10 seconds.
- Assuming a mass fraction of approximately 21 percent [DELTA 1994] HCl, the HCl produced from the burning of 16,960 pounds of fuel equals 3,561 pounds of HCl.
- Seventeen percent of 3,651 pounds equates to 605 pounds of HCl deposition per launch of the Atlas IIAS.
- Eleven percent of 3,651 pounds equals 391 pounds of HCl entrained in deluge water.

14.2 VAFB SOIL BUFFERING CAPACITY CALCULATIONS

General

In this section calculations appear under specific excerpts from this EA to illustrate the equations and assumptions used in determination of the values presented in these excerpts:

1) The ratio of VAFB soils capacity to absorb cations (9.6meq/100 g) and HCl cation production (2.7meq/100 g) is three and one-half to one. This means that a vehicle launch depositing 100 kilograms of HCl on VAFB would require the buffering capacity of approximately 28 kilograms of VAFB soil. Assuming an average density of 1,440 kilograms per cubic meter for VAFB soil (a sandy loam) a launch depositing 100 kilograms of HCl would require 0.02 cubic meters of VAFB soil, to be buffered.

- The Cation Exchange Capacity (CEC) equals the concentration divided by the equivalent weight or grams/(grams/hydrogen) per a volume or mass, which equates to a number of hydrogen ions per volume or mass.
- VAFB soils have a mean CEC of 9.6 meq/100 g [SLC6a 1995], therefore 9.6 hydrogen ions can be absorbed by 100 grams of VAFB soil.

- CEC is defined as the ability of a particular rock or soil to absorb cations.
- The equivalent weight of HCl is 36.46097 grams per hydrogen ion, therefore the 100 grams of HCl will produce 2.7 hydrogen ions.
- 9.6/2.7 equals a ratio of 3.5:1, therefore 100 kilograms of HCl will require 28 kilograms of VAFB soil for buffering. VAFB soils weigh approximately 1,440 kilograms per cubic meter, therefore 28 kilograms of VAFB soil would occupy 0.02 cubic meters.

2) VAFB occupies an area of approximately 40,000 hectares or 4,000,000 acres or 400,000,000 square meters. Assuming a depth of penetration for mobilized HCl to be 0.5 centimeters, VAFB represents 2,000,000 cubic meters of soil capable of buffering HCl. This represents the buffering capacity to accommodate approximately three million Space Shuttle launches.

- 400,000,000 square meters x 0.5 centimeters (0.005 meters) = 2,000,000 cubic meters.
- If VAFB soils weigh approximately 1,440 kilograms per cubic meter, then 2,000,000 cubic meters of VAFB soils is equivalent to 2,880,000,000 kg of soil.
- Using the ratio of 3.5:1 elicits 1.008×10^{-10} kilograms of HCl as the buffering capacity of VAFB.
- 10,080,000,000 kilograms of HCl divided by 3,400 kilograms (HCl deposited by one launch of the Space Shuttle) equals 2,964,706 launches.

3) Assuming the worse case of 3,400 kilograms of HCl dispersed throughout 12.6 hectares (31.2 acres) of VAFB, as was measured during studies at KSC [HCl 1985], has the potential to buffer 78,624 kilograms of HCl. This is equivalent to 23 Space Shuttle launches.

- 31.2 acres or 3,120 square meters x 0.005 meters equates to 15.6 cubic meters.
- 15.6 cubic meters times 1,440 kilograms per cubic meter equals 22,464 kilograms of soil capable of buffering 78,624 kilograms of HCl, which is equivalent to the HCl produced by 23 Space Shuttle launches.

15. APPENDIX I
RESPONSES TO THE EOS LETTER TO REGULATORS/ENVIRONMENTAL ASSESSMENT

Version	Comment Submitted	Name/Organization of Respondent	Section Eliciting Comment	Section/Rationale Addressing Comment
PRELIMINARY March 1996	1) Please submit an AF Form 813 for each payload and launch anticipated. 2) Evaluation of the "No-Action" alternative must be sustained throughout the document. 3) Much of what is being described in this second paragraph under "Environmental Justice" would be more appropriately discussed under a separate section: Superfund Amendments and Reauthorization Act Title III. 4) The California Red-legged frog was listed as "threatened" by the USFWS on 26 May 96. 5) Please add a new section titled "List of Preparers".	Karl E. Kneeling, P.E./ Chief, Planning Environmental Management, Vandenberg Air Force Base	1) General 2) Section 2.5.4 p. 2-32 3) Section 3.3.1 p. 3-3 4) Section 9.2.1 p. 9-1	1) Subsequent AF 813 forms will not be required [SA 1996]. 2) A No-Action alternative discussion was added to Chapter 4. 3) Section 3.3.1.1/A separate section was added: Emergency Planning and Community Right-To -Know Act. 4) This correction was made here and elsewhere in the text. 5) A "List of Preparers" section was added.
PRELIMINARY March 1996	1) Surf thistle is known from the vicinity of SLC-2. 2) Western snowy plovers are found all year at SLC-2 and Wall Beach north of the Santa Ynez river. American peregrine falcons, and to a lesser extent bald eagles, use the Santa Ynez river mouth during the winter. Southern sea otters are found along the entire Vandenberg coast, but breed at Purisima Point. 3) Not addressed in [ATLAS 1991], was the listed western snowy plover, California red-legged frog, beach layia, and southwestern willow flycatcher, all of which are within the vicinity of SLC-3. 4) American peregrine falcons are regularly found roosting and foraging at the Santa Ynez estuary during winter. Bald eagles have spent the entire winter at the Santa Ynez estuary. 5) Tables should be updated to include listed and candidate species status. 6) The last sentence under brown pelicans is unclear. If this statement refers to conditions placed on the Spaceport, those details have not been finalized. 7) The last sentence under SLC-6 does not state what constitutes an impact and what unfavorable conditions might be. Additionally, impacts to red-legged frogs have not been addressed. 8) This section does not adequately address the impacts of wildfire possibly resulting from a failed launch. 9) Appendix G does not adequately address monitoring and mitigation requirements.	Jim Watkins/U.S. Fish and Wildlife Service, Vandenberg Air Force Base	1) Figure 3-6 2) Figure 3-7 3) Section 3.10.3.2 4) Section 3.10.3.2.1 5) Tables 3-7,3-8,3-9 6) Section 3.10.3.3.2 7) Section 4.2.10 8) Section 4.3.3 9) App. G	1) Figure 3-6 was modified to reflect this comment. 2) Figure 3-7 was modified to reflect this comment. 3) Section 7 consultation for these species will be completed by VAFB officials prior to launch of EOS spacecraft. [JO 1996] 4) Section 3.10.3.2.1/These statements were added for completeness. 5) The tables were updated to reflect recent changes in listed and candidate species status. 6) Section 3.10.3.3.2/The unclear sentence has been removed for clarity. 7) A statement regarding monitoring plans was added. 8) A sub-section was added describing potential wildfire impacts. 9) Monitoring and Mitigation requirements were added to Appendix G.
PRELIMINARY March 1996	1) (a) Will the 1-hour NAAQS for CO be exceeded at the launch complex? (b) What percentage of Al_2O_3 is assumed to be PM_{10}? (c) The document states chemical rockets represent less than 0.00004 percent of the total anthropogenic sources of CO_2. How many chemical rockets were assumed and what are the total amounts used to derive the percentage? 2) VAFB has recently released an Environmental Assessment for Launch Rate Increase for the Delta II Program. Were EOS Program launches included in the additional eight launches described in the VAFB EA? 3) The carrying capacity and VAFB growth allowance determination must be made using the 1996 inventory shown in the 1994 Clean Air Plan. 4) Santa Barbara County is a moderate nonattainment area for ozone and is in attainment for all other pollutants. The conformity analysis *de minimis* thresholds are 100 tons per year each for NO_x and ROG.	Vijaya Jammalamadaka, Air Quality Specialist/Santa Barbara County Air Pollution Control District	1) Table 4-2 p. 4-3 2) Table 4-8 p. 4-8 3) App. E p. 10-2 4) Table E-3 p. 10-3	1) (a) Carbon monoxide concentrations are not expected to exceed the NAAQS of 35 ppm (1 hr average) beyond the immediate vicinity of the launch complex and are expected to rapidly oxidize to carbon dioxide (CO_2) in the atmosphere. [DELTA 1994] (b) All Al_2O_3 is assumed to be in the PM_{10} size range. (c) The original text did not specify how these numbers were contrived, therefore this statement was removed. 2) Yes, EOS launches were included as part of the 8 additional Delta II launches [SO 1996]. 3) App. E was changed to reflect this comment. 4) Table E-3 was changed to reflect this comment.
PRELIMINARY March 1996	1) The subject document should address potential closures of County-owned parks at Ocean Beach and Jalama, as well as closures and evacuations of other public use areas and private properties. The subject document should address such potential impacts, particularly the cumulative effects of this and other anticipated VAFB programs.	Daniel Gira, Acting Deputy Director Comprehensive Planning Division/County of Santa Barbara Planning and Development		1) Section 3.11/The EOS Program would not increase launch rates nor utilize launch systems beyond the scope of approved programs at VAFB, therefore EOS would not produce increased closure of County-owned parks, other public use areas and private properties.
PRELIMINARY	1) Please note that most of the Permit Numbers listed in Table 3-2 on Page 3-9 are no longer valid. Permits numbered 3727, 3728, 5041 and 8304 have been canceled. Permit	Vijaya Jammalamadaka, Air Quality Special-	1) Section 3.5.1.1	1) Table 3-2 was changed to reflect this comment.

Version	Comment Submitted	Name/Organization of Respondent	Section Eliciting Comment	Section/Rationale Addressing Comment
March 1996	number 5042 and 5043 have been consolidated into one: 8658. Permits numbered 5089, 5090, 6228, 5229 have been changed to 8914, 8305, 8468 and 8930, respectively.	ist/Santa Barbara County Air Pollution Control District		
DRAFT August 1995	1) Why use the LLV-3 as a comparison to the pre-production Delta-Lite proposed for use by EOS? 2) It was not mentioned that the Taurus can utilize the Castor IVB SSRMs. 3) The Titan IV/NUS does not utilize an upper stage, therefore the flaring of hydrogen is not a source of pollution for the Titan IV/NUS. 4) Delta II first stage propellants are RP-1 and LOx like the Atlas, yet you are using the Titan for a comparison. APP C p. C-4	Tom Shaw, Flight Systems Section Manager/Jet Propulsion Laboratory	1) Section 2.5.3.1 2) Section 2.5.3.2 3) App. C p. C-2 4) App. C p. C-4	1) Section 2.5.3.1/Using the LLV-3 elicited a conservative (protective of resources) result. Data was available for the LLV-3 and it most closely approximated the Delta-Lite configuration. 2) Section 2.5.3.1/Language was changed to reflect this comment. 3) App. C p. C-2/ Language was added to reflect this comment. 4) App. C p. C-4/ To reduce errors introduced by further extrapolation of data the Delta II was compared to the Titan.
DRAFT August 1995	1) Air emissions at the Astrotech VAFB site will be minimized through use of closed loop propellant transfer operations, not scrubbers. 2) Nitrogen tetroxide is probably not a reasonable "generic" propellant for payloads launched from VAFB. 3) Current operating agreements between VAFB and the State of California negate any requirement to obtain permits for crossing State Highway 246 while transporting fueled spacecraft from north VAFB to south VAFB.	Astrotech Space Operations, L.P.	1) Section 2.4.1.1 2) Section 2.4.2.2 3) Section 2.4.4	1) Section 2.4.1.1/Language was changed to reflect this comment. 2) Section 2.4.2.2/Bipropellant processing may occur and was discussed for conservatism (protective of resources). 3) Section 2.4.4/Language was changed to reflect this comment
DRAFT August 1995	1) Fugitive emissions produced by the modifications to the SLC-6 PPR should be based on about six months for completion not 10. This equates to approximately 800 construction-related vehicle trips, and 475 kg of fugitive emissions.	California Commercial Spaceport Inc.	1) Section 2.4.1.3	1) Section 2.4.1.3/ Language was changed to reflect this comment
Letter to Regulators December 1994	1) The emissions resulting from the proposed project must be regulated in accordance with the Memorandum of Agreement between Vandenberg AFB and the SBAPCD. 2) The programmatic EA should include discussion of the existing air quality in the region, cumulative and growth-inducing impacts, and feasible mitigation measures.	Vijaya Jammalamadaka, Air Quality Specialist/Santa Barbara County Air Pollution Control District		1) A Conformity Analysis is included in Appendix F. 2) A discussion of the existing air quality can be found in Chapter 3. Cumulative impacts and mitigation measures are included in Chapter 4.
Letter to Regulators December 1994	1) Available information indicates that the threatened Guadalupe fur seal and the threatened Steller sea lion may be affected by your program. No other Federally listed species under the jurisdiction of the National Marine Fisheries Service are likely to be affected. However, the U.S. Fish and Wildlife Service should be contacted. 2) Recommendation: EA should include information related to the potential impacts on Northern elephant seals, California sea lions, Pacific harbor seals, and Northern fur seals. (NASA may be required to obtain authorization to incidentally "take" marine mammals under the MMPA.)	Hilda Diaz-Soltero, Regional Director/United States Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service		1) Descriptions of the potentially impacted pinnipeds occur in Chapter 3. 2) Information related to the potential impacts to pinnipeds is provided in Chapter 4 and Appendix D.

MAR 2 RECD

Santa Barbara County
Air Pollution Control District

February 27, 1995

Mr. Mark R. Fontaine
Deputy Director for Resources
Mission to Planet Earth Office
Code 170
NASA/ Goddard Space Flight Center
Greenbelt, MD 20771

RE: NASA: Earth Observing System Program Environmental Assessment

Dear Mr. Fontaine:

The Santa Barbara County Air Pollution Control District (SBCAPCD), as the local agency with jurisdiction over the air resources of Santa Barbara County appreciates the opportunity to comment on the proposed EA for the above mentioned project.

Santa Barbara County, California is classified a moderate nonattainment area for the National Ambient Air Quality Standard for ozone. The County also continues to violate the more stringent California standard for ozone and particulate matter (PM_{10}).

Flight preparation and flight support activities may require equipment that will need permits from the SBCAPCD as well as require the application of Best Available Control Technology (BACT) and offsets. Such equipment might include, but is not limited to, fuel storage tanks and transfer systems, propellant storage tanks and transfer systems, diesel-fired engines and generators, paint spray booths, boilers, and use of solvents. The emissions resulting from the proposed project must be regulated in accordance with the Memorandum of Agreement (July 19, 1991) between Vandenberg AFB and the SBCAPCD.

In addition to analyses of the air quality impacts of the proposed EOS project activities and alternatives, the programmatic EA should include discussion of the existing air quality in the region, cumulative and growth-inducing impacts, and feasible mitigation measures. We look forward to reviewing the draft EA. If the SBCAPCD can be of assistance in conducting the required analyses for this very important project, please contact me at (805) 961-8893.

Sincerely,

Vijaya Jammalamadaka

Vijaya Jammalamadaka
Air Quality Specialist
Interagency Review Section
Technology and Environmental Assessment Division

cc: Dave Romano, APCD
Project File (VAFB: NASA Earth Observing System)
TEA Caron File

LARIWPLIACCGERVUASAEOS.NOP

Douglas W. Allard Air Pollution Control Officer
26 Castilian Drive B-23, Goleta, CA 93117 Fax: 805-961-8801 Phone: 805-961-8800
A Division of the Department of Agriculture and Environmental Management

CITY OF
LOMPOC

VALLEY OF FLOWERS

MAR 13 REC'D

March 7, 1995

Mr. Mark Fontaine
Deputy Director for Resources
Mission to Planet Earth Office, Code 170
NASA/Goddard Space Flight Center
Greenbelt, MD 20771

Dear Mr. Fontaine,

The City of Lompoc has received your letter introducing the Earth Observing System (EOS) Program and NASA's intentions to prepare an Environmental Assessment.

The City of Lompoc appreciates the opportunity to review and comment on environmental documents for proposed projects which may potentially impact Lompoc or the surrounding natural resources. We have no comments to offer regarding the proposed project, at this time. However, we look forward to reviewing the Environmental Assessment once it has been released for public review.

If you have any questions or comments, please contact me at (805) 736-1261, Extension 275.

Sincerely,

Sharon K. Reifer

Sharon K. Reifer
Environmental Coordinator

CITY OF
LOMPOC
VALLEY OF FLOWERS

April 11, 1996

Ms. Dawn J. Skinner
JPL/MS 301-472H
4800 Oak Grove Drive
Pasadena, CA 91109-8099

Dear Ms. Skinner,

The City of Lompoc has received the Preliminary Environmental Assessment (EA) for the Earth Observing System. The City of Lompoc generally appreciates the opportunity to review and comment on environmental documents for proposed projects which may potentially impact Lompoc or the surrounding natural resources. At this time, City Planning and Environmental Management staff are occupied with the preparation of comments for the City of Lompoc General Plan ADEIR and the Lompoc Airport Master Plan EIR/EA. Given the short public review period (we received the EA today) and limited staff, we will be unable to fully read and prepare comments for the document provided by April 22, 1996. I will however review the document as soon as possible and respond with our comments.

Thank you again for the opportunity to review this environmental document. If you have any questions or comments, please contact me at (805) 736-1261, Extension 275.

Sincerely,

Sharon K Reifer

Sharon K. Reifer
Environmental Coordinator

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southwest Region
501 West Ocean Boulevard, Suite 4200
Long Beach, California 90802-4213
TEL (310) 980-4000; FAX (310) 980-4018

F/SWO31:IVL

APR 4 1995

APR 12 REC'D

Mr. Mark R. Fontaine
Deputy Director for Resources
Mission to Planet Earth Office
Code 170
NASA/Goddard Space Flight Center
Greenbelt, Maryland 20711

Dear Mr. Fontaine:

Thank you for requesting information regarding the presence of Federally listed species that may be affected by activities associated with the Earth Observing System (EOS) at the U.S. Air Force Western Space and Missile Center (WSMC).

Available information indicates that the threatened Guadalupe fur seal and the threatened Steller sea lion may be affected by your program. No other Federally listed species under the jurisdiction of the National Marine Fisheries Service (NMFS) are likely to be affected. However, the U.S. Fish and Wildlife Service should be contacted regarding the presence of listed species that may be under its jurisdiction.

All marine mammals in the United States are protected under the U.S. Marine Mammal Protection Act (MMPA). Under the MMPA, it is unlawful to take marine mammals wherein "take" means to harass, hunt, capture, or kill. The term "harassment" means any act of pursuit, torment, or annoyance which has the potential to injure a marine mammal or disturb a marine mammal in the wild by causing disruption of behavioral patterns. Northern elephant seals, California sea lions, Pacific harbor seals, and Northern fur seals inhabit sandy beaches and rocky intertidal areas on the Channel Islands for pupping, breeding, molting, and resting. San Miguel Island supports the largest breeding colonies of Northern elephant seals and California sea lions in the United States. Furthermore, harbor seals and northern elephant seals inhabit several areas on the WSMC. For these reasons, I recommend that your Environmental Assessment also include information related to the impacts of your program on these species.

Depending on the intensity and location of sonic booms and launch noise produced by launches from WSMC, the National Aeronautics and Space Administration may be required to obtain authorization to incidentally "take" marine mammals under the MMPA. This is a cumbersome regulatory process which usually takes several months to a year to complete. Early application will ensure the necessary authorization is obtained without project delay.

If you have questions concerning these comments please contact Ms. Irma Lagomarsino at (310) 980-4016.

Sincerely,

for Hilda Diaz-Soltero
Regional Director

County of Santa Barbara
Planning and Development
John Patton, Director

15 April 1996

Ms. Dawn J. Skinner
JPL/MS 301-472H
4800 Oak Grove Drive
Pasadena, California 91109-8099

RE: Draft Programmatic Environmental Assessment for Earth Observing System

Dear Ms. Skinner:

Thank you for the chance to comment on this draft environmental document. Santa Barbara County generally appreciates and supports the various space programs at Vandenberg Air Force Base, including the job opportunities and overall economic stimulus they provide to the County. However, it also is important that any potentially adverse effects of such programs be anticipated. In this spirit, we have noted in comments on prior environmental documents for other projects that the County's primary concerns over potentially adverse impacts are related to public health and safety, esp. fuels transportation and the direct and indirect effects of potential debris from launch mishaps. The latter encompasses concerns over potential closures of County-owned parks at Ocean Beach and Jalama, as well as closures and evacuations of other public use areas and private properties. The subject document should address such potential impacts, particularly the cumulative effects of this and other anticipated Vandenberg AFB programs such as the McDonnell-Douglas Aerospace "Launch Rate Increase for Delta II Program," for which a draft Environmental Assessment recently has been released for public review and comment.

Again, thank you for the chance to comment. Please contact Greg Mohr at (805) 568-2080 if you should have any questions.

Sincerely,

DANIEL H. GIRA, Acting Deputy Director
Comprehensive Planning Division

xc: Claude Garciacelay, County Park Dept.
Jim Raives, CA Coastal Commission

Santa Barbara County
Air Pollution Control District

April 18, 1996

Rec'd @ JPL
Apr. 23/96

Ms. Dawn J. Skinner
JPL/ MS 301 - 472H
4800 Oak Grove Drive
Pasadena, CA 91109 - 8099

RE: Earth Observing System (EOS) Program: Programmatic Environmental Assessment (PEA), March, 1996.

Dear Ms. Skinner:

The Santa Barbara County Air Pollution Control District (APCD) appreciates the opportunity to comment on the above mentioned document.

GENERAL COMMENTS

It is not clear from the PEA if the NAAQS or CAAQS for CO and PM_{10} will be exceeded at the launch site due to launch emissions. From the information in the PEA, tropospheric air quality impacts of the project do not appear to be significant. However, we would like to correct the conformity analysis methodology used in Appendix E (see below).

SPECIFIC COMMENTS

1. Page 4-3. Table 4-2. The document states that launch vehicle emission concentrations for Delta launches are not expected to exceed NAAQS [for CO] beyond the launch complex. Will the 1-hour NAAQS for CO be exceeded at the launch complex? What percentage of Al_2O_3 is assumed to be PM_{10} ? The document states that that the amount of CO_2 produced by all chemical rockets is extremely minute, representing less than 0.00004 percent of the total anthropogenic sources of CO_2. How many chemical rockets were assumed and what are the total amounts used to derive the percentage? Please ensure that the launch vehicle emission factors and PM_{10} fraction of Al_2O_3 used in this document are consistent with the final CIR[1] for VAFB.

2. Page 4-8. Table 4-8. VAFB has recently released an Environmental Assessment for Launch Rate Increase for the Delta II Program. Were EOS

[1] CH2M Hill, March, 1996. *Draft Air Emissions Comprehensive Inventory Report for Vandenberg Air Force Base.*

Douglas W. Allard
Air Pollution Control Officer
... Fax: 805-961-8801 Phone: 805-961-8800

Program launches included in the additional eight launches described in the VAFB EA?

3. Appendix E, Conformity Analysis.

- Page 10-2, 1st paragraph. The 1994 Clean Air Plan (CAP) for Santa Barbara County referenced in this paragraph contained three different plans. The VAFB growth allowance was included only for the Maintenance Plan described in Chapter 10 of the CAP. The USEPA suspended consideration of the Maintenance Plan due to violations of the federal ozone standard in 1994 (USEPA letter to the California Air Resources Board dated June 7, 1995). Consequently, the carrying capacity and VAFB growth allowance listed in the document are not valid. The determination that the project emissions are not regionally significant (40 CFR 51.853[i]) must be made by showing that they are less than 10 percent of the latest emission inventory (currently the 1996 inventory shown in the 1994 CAP).

- Table E-3. Please note that in terms of the NAAQS, Santa Barbara County is a moderate nonattainment area for ozone and is in attainment for all other pollutants. The County is also considered outside the ozone transport region. Therefore, the conformity analysis *de minimis* thresholds are 100 tons per year each for NO_x and ROG.

Again, thank you for the opportunity to review the EA for this important project. We look forward to receiving the final EA with responses to our comments. Please call me at (805) 961-8893 if you would like clarification on the above comments.

Sincerely,

Vijaya Jammalamadaka

Vijaya Jammalamadaka
Air Quality Specialist
Technology and Environmental Assessment Division

cc: Project File (NASA EOS Program)
TEA Chron File

H:\GROUP\PCA\WP\ARCORR\NASAEOS.PEA

Santa Barbara County
Air Pollution Control District

Rec'd @JPL 4/26/96

April 25, 1996

Ms. Dawn J. Skinner
JPL/ MS 301 - 472H
4800 Oak Grove Drive
Pasadena, CA 91109 - 8099

RE: **Earth Observing System (EOS) Program:** Programmatic Environmental Assessment (PEA), March, 1996 -- Additional Comments.

Dear Ms. Skinner:

This letter is a supplement to the Santa Barbara County Air Pollution Control District (APCD) letter dated April 18, 1996 commenting on the above mentioned document.

Page 3-9, Table 3-2 Currently Permitted Air Pollution Sources at SLCs 2W & 3. Please note that most of the Permit Numbers listed in this table are no longer valid. Please update the final PEA and your records as listed below:

APCD Permit Number	Current Status
# 3727	Cancelled 11/21/91
# 3728	Cancelled 11/21/91
# 5041	Superseded by PTO 8653 (1/8/92) and cancelled 6/10/94
# 5042	Superseded by PTO 8658 (10/3/91); consolidated into one modified permit #8658 on 4/14/94
#5043	Superseded by PTO 8657 (10/3/91); consolidated into one modified permit #8658 on 4/14/94
# 5089	Superseded by PTO 8914 (10/21/92)
# 5090	Superseded by PTO 8305 (11/22/91)
# 6228	Superseded by PTO 8468 (12/11/91)
# 6229	Superseded by PTO 8930 (3/9/93)
# 8304	Cancelled 8/9/94
# 8306	Currently valid.

Again, thank you for the opportunity to review the EA for this important project. We look forward to receiving the final EA with responses to our comments. Please call Dave Romano at (805) 961-8815 if you have questions on the above table.

Sincerely,

Vijaya Jammalamadaka
Vijaya Jammalamadaka
Air Quality Specialist
Technology and Environmental Assessment Division

cc: Project File (VAFB: NASA EOS Program)
TEA Chron File

H:\GROUP\PCA\WP\ARCORR\NASAEO2.PEA

Douglas W. Allard
Air Pollution Control Officer
26 Castilian Drive B-23, Goleta, CA 93117 Fax: 805-961-8801 Phone: 805-961-8800

MARYLAND Office of Planning

Parris N. Glendening
Governor

Ronald M. Kreitner
Director

May 2, 1996

MAY 9 REC'D

Mr. Mark Fontaine
Deputy Director for Resources
National Aeronautics and Space Administration
Goddard Space Flight Center
Greenbelt, MD 20771

STATE CLEARINGHOUSE REVIEW

State Application Identifier:	MD960423-0284
Project Description:	Earth Observing System Programmatic Environmental Assessment
State Clearinghouse Contact:	Bob Rosenbush

Dear Mr. Fontaine:

This is to acknowledge receipt of the referenced project. By copy of this letter we are providing copies of the project to appropriate agencies, inviting them to contact your agency directly with any comments or concerns by May 30, 1996. Also, a copy of any related correspondence should be forwarded to the Clearinghouse.

The applicant is requested to complete the enclosed form and return it to the State Clearinghouse upon receipt of notification that the project has been approved or not approved.

Please be assured that after May 30, 1996 all intergovernmental review requirements have been met in accordance with the Maryland Intergovernmental Review and Coordination Process (COMAR 14.24.04).

Sincerely,

William G. Carroll
Manager, Plan and Project Review

WGC:BR:mds
Enclosure
(* indicates with attachments)
cc: DBED - Roger Drechsler*
City of Greenbelt- Wilson*
DNR - Ray Dintaman*
MDE - Steve Bieber*
MDOT - Henry Kay*
PGEO - Beverly Warfield*
DHCD - Sue Hartman*
OPC - Mary Abrams*
OPL - Bill Carroll*

CITY OF
LOMPOC

VALLEY OF FLOWERS

May 10, 1996

Ms. Dawn J. Skinner
JPL/MS 301-472H
4800 Oak Grove Drive
Pasadena, CA 91109-8099

Dear Ms. Skinner,

The City of Lompoc has received the Programmatic Environmental Assessment (PEA) for the Earth Observing System. The City of Lompoc appreciates the opportunity to review and comment on environmental documents for proposed projects which may potentially impact Lompoc or the surrounding natural resources. We wish to commend your agency for such a well prepared environmental document. At this time, we have no comments to offer regarding the above mentioned proposed project.

Thank you again for the opportunity to review this environmental document. If you have any questions or comments, please contact me at (805) 736-1261, Extension 275.

Sincerely,

Sharon K. Reifer

Sharon K. Reifer
Environmental Coordinator

May 24, 1996

To : Ms. Dawn J. Skinner
JPL/MS 301-472H
4800 Oak Grove Drive
Pasadena, CA 91109-8099

From : Jim H. Watkins
U.S. Fish and Wildlife Service
2493 Portola Road, Suite B
Ventura, CA 93003

Subject: Comments to EOS Programmatic Environmental Assessment

The Ventura Field Office received the EA on May 9, 1996. The following are bullet comments provided by me to support our May 24, 1996 telephone conversation.

General Comments

- The U.S. Fish and Wildlife Service (Service) revised the federal candidate list February 28, 1996 in the Federal Register (61 FR 7596);
  -There are no longer categories for candidate species; and
  -Many previous candidate species have been removed from candidate status.

- The California red-legged frog (*Rana aurora draytonii*) has been recently listed (May 24, 1996) as threatened (61 FR 25813). Consequently, no programs that may affect the California red-legged frog on Vandenberg Air Force Base (Vandenberg) have gone through the formal section 7 consultation process provided for under provisions of the Endangered Species Act of 1973, as amended (Act). Therefore, to state that no additional monitoring or mitigation will be required beyond those provided for existing programs (top of pages xiv and xvi) may not be accurate.

- The southwestern willow flycatcher (*Empidonax traillii extimus*) was listed as endangered on February 27, 1995 (60 FR 10694). Previous SLC-3 launch programs that may affect the southwestern willow flycatcher did not address this listed species. Therefore, to state that no additional monitoring or mitigation will be required beyond those provided for existing programs may not be accurate.

- *Layia carnosa* was discovered along Coast Road in 1994, and was not considered in previous launch programs in locations considered by the EOS project. Therefore, to state that no additional monitoring or mitigation will be required beyond those provided for existing programs may not be accurate.

- Marine cormorant should be pelagic cormorant (*Phalacrocorax pelagicus*).

- Black-shouldered kite should be white-tailed kite (*Elanus leucurus*).

- Species names in tables and text should be consistently provided.

- Vandenberg has updated (1995) data on listed species within its boundaries which more accurately reflects the existing environment.

- Brown pelicans (*Pelecanus occidentalis californianus*) are found on Vandenberg all year, therefore the term transient used throughout the EA should be defined or removed

- Impacts to wildlife should be extended to sensitive receptors down-range from the proposed launch site as well as those within close proximity of the launch site. This is particularly important for species like the western snowy plover (*Charadrius alexandrinus nivosus*) who appear to respond primarily to visual impacts of a launch. For that reason, analysis should be given to night launches where the sudden and prolonged light associated with a launch may be more impacting than during a diurnal launch, or launch noise.

- Of particular interest to the Service are the predicted launch rates from each launch site, and the analysis of cumulative impacts due to those launches combined with all Vandenberg launches (i.e. cumulative impact section needs to be beefed up).

- The Titan program recently experienced a focused sonic boom over the Channel Islands. Therefore, the sonic boom section in analysis of impacts should address this issue at greater length in relation to EOS launch vehicles and azimuths.

- Additional information will be needed to justify the use of SLC-2 instead of an alternate site. Because of breeding and wintering southern sea otters (*Enhydra lutris nereis*), California least terns (*Sterna antillarum browni*), and western snowy plovers, candidate plants, and year around use by brown pelicans, the Service is working with Vandenberg to eliminate or reduce launches from SLC-2 and pad 576E.

- Wildfires resulting from launch exhaust products or stochastic events should be addressed in more detail, particularly for SLC-3 launches that could impact beach layia (*Layia carnosa*).

- Additional reference citations should be provided throughout the EA (e.g. paragraph 3 on page 3-27).

- The treatment of brown pelicans should be expanded to include potential impacts to breeding birds on the Channel Islands from focused sonic booms relative to launch vehicles and azimuths for each section dealing with specific launch sites (e.g. sec. 3.10.3.1.1). Additionally, night roosts are important features to brown pelican distribution. Night roosts likely include Purisima Point, Pedernales Point, and Point Arguello.

Specific Comments

Fig 3-6 Surf thistle is known from the vicinity of SLC-2.

Fig 3-7 Western snowy plovers are found all year at SLC-2 and Wall Beach north of the Santa Ynez river. American peregrine falcons (*Falco peregrimus anatum*), and to a lesser extent bald eagles (*Haliaeetus leucocephalus*), use the Santa Ynez river mouth during the winter. Southern sea otters are found along the entire Vandenberg coast, but breed at Purisima Point, important because this is the southernmost breeding population of the listed subspecies.

Sec. 3 10.3.2 Not addressed in Atlas (1991), was the listed western snowy plover, California red-legged frog, beach layia, and southwestern willow flycatcher, all of which are within the vicinity of SLC-3.

Sec. 3 10.3.2.1 American peregrine falcons are regularly found roosting and foraging at the Santa Ynez estuary during winter. Bald eagles have spent the entire winter at the Santa Ynez estuary.

Tables 3-7, 3-8, and 3-9 should be updated to include listed and candidate species status.

Sec. 3.10.3.3.2 The last sentence in the paragraph under brown pelicans is unclear. A reference is made to monitoring or mitigation, but is not explained why it is required or in what manner it will be completed.. If this statement refers to conditions placed on the Spaceport, those details have not been finalized.

Sec. 4 2.10 The last sentence in the paragraph under SLC-6 states that the EOS launch schedule will be adjusted to avoid unfavorable wind conditions if impact were to occur due to EOS launches. Not stated is what constitutes an impact and what unfavorable conditions might be. Additionally, California red-legged frogs may exist in the treatment ponds near SLC-6 and the Spaceport, or in water collected in the exhaust ports on SLC-6. Impacts to these potential habitats have not been addressed.

Sec. 4.3 3 This section does not adequately address the impacts of wildfire possibly resulting from a failed launch. Fire suppression measures (e.g. bulldozed fire lines) and habitat loss should be analyzed, and impacts to beach layia near SLC-3 should be addressed.

Appendix G Monitoring and Mitigation represented here is incomplete relative to existing launch program requirements addressed through the NEPA or Act processes for the Spaceport and SLC-2. Paragraph 1 on page xiv and paragraph 3 on page xvi state that no additional mitigation would be needed beyond those measures already necessary for Spaceport and SLC-2 operations. Therefore, a clear statement needs to be made regarding Vandenberg requirements and EOS program commitments towards monitoring and mitigation. NEPA is a public disclosure process. To accurately assess the project, any mitigation needs to be clearly stated as part of the proposed project description.

CC:

DEPARTMENT OF THE AIR FORCE

30TH SPACE WING (AFSPC)

JU! ! _ REC'D

28 JUN 1996

MEMORANDUM FOR NASA/GODDARD SPACE FLIGHT CENTER
MISSION TO PLANET EARTH OFFICE, CODE 170
DEPUTY DIRECTOR FOR RESOURCES
ATTN: MR MARK FONTAINE
GREENBELT MD 20771

FROM: 30 CES/CEVP
806 13th Street, Suite 116
Vandenberg AFB CA 93437-5242

SUBJECT: Preliminary Programmatic Environmental Assessment (EA), and Draft Conformity Analysis (Inound), for Earth Observing System Program at Vandenberg Air Force Base (VAFB), California

1. The subject draft EA, dated March 1996, which proposes launch of a series of spacecraft by an assortment of launch vehicles from different sites at VAFB, has been reviewed by the Environmental Impact Analysis Process (EIAP) Subcommittee. We are forwarding the following comments:

a. Environmental Assessment. General. The majority of the subject EA's content, presented for environmental impact analysis, consists of impacts and effects associated with various launch vehicle programs previously evaluated by this office and already approved for operation at VAFB. This "tierred" information could have been incorporated by reference, and the environmental analysis presented could have been substantially narrowed in scope (and size) to include just those specific effects associated with the EOS program (i.e., transportation of components to PPFs, spacecraft assembly, fueling & preparation, waste management, payload mating, etc). This would also help to eliminate much of the redundancy throughout the document.

b. Environmental Assessment. General. Please submit an AF Form 813 for each payload and launch anticipated. The AF Form 813 must be submitted prior to transport of components for assembly and fueling. Allow approximately 45 days for review and authorization.

c. Executive Summary, pg xvii, para 1, ln 1. Remove "-" from word "archeo-logical".

d. Sec 2.5.4, pg 2-32. No-Action Alternative. General. Pursuant to CEQ Regulations at 40 CFR 1502.14(a)(d), the relative impact of alternatives to the proposed action (including "no action") must be evaluated for comparison of the anticipated impacts of all reasonable alternatives. Therefore, evaluation of the "no action" alternative must be sustained throughout the document (i.e., impacts with project v without project). The EA discontinues any comparison of impacts of the proposed action v no action, after Sec 2.5.4.

e. Sec 3.2, pg 3-3, para 1, ln 5. Correct term to read "Jalama *Creek*".

f. Sec 3.3.1, pg 3-3, para 5. General. Much of what is being described in this second para under "Environmental Justice" would be more appropriately discussed under a separate section dedicated to Superfund Amendments and Reauthorization Act Title III (Emergency Planning & Community Right-To-Know Act). The issues identified here are *statutory requirements*, rather than executive directives.

g. Sec 3.10.2, pg 3-24. Figure 3-8. Santa Rosa Island (inset). Add word "plover" to term "Western Snowy ..."

h. Sec 9.2.1, pg 9-1, para 4. General. The California Red-legged frog was listed as "threatened" by the U.S. Fish and Wildlife Service on 26 May 96. Please make this correction here and elsewhere in the EA and appendices.

i. Document. General. Please add a new section titled "List of Preparers" so that the qualifications of the document preparers may also be evaluated.

2. This concludes our comments. Should you have any questions, please contact Mr Garry E. Sanchez at (805)734-8232, extension 6-2814.

Karl E. Kneeling

KARL E. KNEELING, P.E.
Chief, Planning
Environmental Management

cc: Dawn Skim

MARYLAND DEPARTMENT OF THE ENVIRONMENT
2500 Broening Highway ● Baltimore, Maryland 21224
(410) 631-3000

Parris N. Glendening
Governor

Jane T. Nishida
Secretary

Rec'd
JPL
7-26-9

JUl 3 - REC'D

June 24, 1996

Mr. Mark Fontaine
Deputy Director for Resources
National Aeronautics and Space Administration
Goddard Space Flight Center
Greenbelt MD 20771

State Application Identifier: MD960423-0284
Project Description: Earth Observing System

Dear Mr. Fontaine:

Thank you for providing the Maryland Department of the Environment (MDE) with the opportunity to comment on the above-referenced project. Copies of the documents were circulated throughout MDE for review, and it has been determined that this project is consistent with MDE's plans, programs and objectives.

Again, thank you for giving MDE the opportunity to review this project. If you have any questions or need additional information, please feel free to call me at (410) 631-3656.

Sincerely,

Steven Bieber

Steven Bieber
MDE Clearinghouse Coordinator
Technical and Regulatory Services Administration

cc: Bob Rosenbush, State Clearinghouse