RECORD OF DECISION
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Final Supplemental Environmental Impact Statement for Sounding Rockets Program

A. BACKGROUND

The purpose and need for this action is to update the Final Environmental Impact Statement (FEIS) which was prepared for the NASA Sounding Rockets Program (SRP) in July 1973. The NASA SRP supports space and Earth sciences research sponsored by NASA and other users by providing suborbital vehicles for deployment of scientific payloads. The Proposed Action presented in the Final Supplemental Environmental Impact Statement (FSEIS) is to continue SRP activity in the present form and at the current level of effort. The Proposed Action does not contemplate any significant change in programmatic scope, or site-specific elements of the program. Consequently, no change in current environmental or interrelated socioeconomic impacts is anticipated from the continuation of the SRP.

The FSEIS reflects programmatic and site-specific changes in the NASA SRP that have taken place since 1973. This includes deleting launch vehicles that are no longer used; adding new launch vehicles and systems currently being used; reflecting changes in Federal and State environmental statutes and regulations; and updating changes in launch sites and ground support activities.

The NASA SRP is a suborbital spaceflight program primarily in support of space and Earth sciences research activities sponsored by NASA. This program also provides applicable support to other government agencies, as well as international sounding rocket groups and scientists. The program is a relatively low-cost, quick response effort. These experiments provide a variety of information, including high-altitude wind shear and velocity, density and temperature of particles in the upper atmosphere, and changes in the ionosphere. Sounding rocket payloads also yield valuable data on the natural conditions surrounding the Earth, Sun, stars, galaxies, nebulas, planets, and other phenomena. The environmental studies dealing with ozone depletion and global warming are only a few examples of scientific programs carried out by the NASA SRP for the protection of planet Earth.

NASA uses sounding rockets to allow scientists to conduct investigations at specified times and altitudes. Sounding rockets fly vertical flight trajectories from 48 kilometers (30 miles) to over 1,290 kilometers (800 miles) in altitude. Sounding rockets provide the only means for in-situ measurements at altitudes between the maximum altitude of balloons (about 48 kilometers or 30 miles) and the minimum altitude for satellites (about 160 kilometers or 100 miles). The flight normally lasts less than 30 minutes. All of the motors used in the program use solid fuel and are relatively small.

B. INTRODUCTION TO THE ENVIRONMENTAL IMPACT STATEMENT (EIS)

This FSEIS was developed to address: (1) the programmatic environmental impact of the SRP; and (2) the site-specific environmental impacts at, and in the area of, the three principal domestic sounding rocket sites: Wallops Flight Facility (WFF), Wallops Island, Virginia; Poker Flat Research Range (PFRR) near Fairbanks, Alaska; and White Sands Missile Range (WSMR), White Sands, New Mexico.

Some sounding rocket campaigns are conducted at other U.S. sites and at foreign locations. Prior to deciding whether to conduct sounding rocket campaigns at sites other than the three specifically addressed in the FSEIS, NASA will undertake additional site-specific environmental review and documentation, as appropriate.

Comments on the Draft Supplemental EIS (DSEIS) were solicited from federal, state and local agencies, organizations, and the general public through notices published in the Federal Register: NASA notice on June 12, 1995 (60 FR 30901), and U.S. Environmental Protection Agency notice on June 16, 1995 (60 FR 31716). Newspaper advertisements ran in the Virginia Eastern Shore News, the Fairbanks (Alaska) Daily News, and the Alamogordo (New Mexico) Daily News. There was also a concurrent mailing of the document to 194 federal, state, and local agencies, organizations, and members of the general public. Twenty-three written comment letters were received from the public comment period. These comments dealt with a range of issues, including: concern over the endangered White Sands Pupfish; concern about interruption of radio telescope signals; request for additional detail regarding spent rocket recovery procedures and site maps; lack of Environmental Justice data; upgraded WSMR data; and the need to follow erosion and sediment control and storm water management plans.

On May 1, 1996, the DSEIS was re-mailed to 35 Alaska addressees via certified mail after NASA was notified that they had not received their comment copies. As a result of this mailing, two comments were received from Alaska: (1) PFRR thanked NASA for the review opportunity and had no recommendations; (2) the U. S. Department of Agriculture, Natural Resources Conservation Service indicated no impact.

The FSEIS was made available on February 18, 2000, and the waiting period expired on March 20, 2000. Nine comment letters were received. These letters identified two typographical errors, and recommended additional mitigation measures concerning archaeological resources. NASA has responded directly to these comments. Mitigation measure commitments are presented in this Record of Decision (ROD).

Alternatives Considered

The alternatives addressed in the FSEIS were:

(1) Continue the SRP in its present form and at the current level of effort. This Proposed Action does not contemplate any significant change in programmatic scope, or site-specific elements of the program. Consequently, no change in current environmental or interrelated socioeconomic impacts is anticipated from the continuation of the SRP; and (2) The No-Action alternative, termination of the NASA SRP, consists of the cessation of the launching of the various vehicles with their payloads from the three principal launch sites or from any other launch site. This alternative will result in overall negative scientific and economical consequences, and reduce progress in our understanding of the Earth's environment. However, minor environmental impacts associated with rocket launches associated with SRP would be avoided.

Programmatic alternatives to the Proposed Action and site-specific alternatives:

Programmatic: Include alternatives to sounding rockets that could accomplish the aims of the Space Science Exploration Program and launching sounding rockets with alternative propellants. Major issues regarding alternatives to sounding rockets include the area of plasma physics where all alternatives considered are unsuitable or produce data of lower quality. It can be deduced from the nature of scientific inquiry in other disciplines that observations from the ground, aircraft, and balloons result in a reduced quality of the scientific data collected in some instances, and total inability to conduct experiments in other instances. The use of the Space Transportation System (STS), satellites, and space probes meet the program objectives in some instances; however, such high technology vehicles are not always available or cost effective for the low-cost science projects, such as those being supported by the SRP. Also, some of the SRP payloads are not allowed to be flown on STS. Furthermore, the propulsion systems used to lift the STS, satellites, and space probes are considerably larger and more complex than required by the missions flown on sounding rockets. Most of the alternatives do not provide a practical and satisfactory means for conducting scientific research in the indicated disciplines. No alternative to the sounding rocket could provide the same quality of scientific data.

The use of alternative solid propellants was also considered under this FSEIS. The propellant systems currently used by the NASA SRP are based either on an ammonium perchlorate (AP)/aluminum (Al) combination, or a nitrocellulose (NC)/nitroglycerin (NG) combination. The emissions from the AP/Al propellant combination include hydrogen chloride and aluminum oxide, and are generally considered to be more environmentally damaging than emissions from the NC/NG propellant combinations. NASA has carried out an extensive operational and environmental evaluation of the replacement propellants for the AP/Al propellant combination. Several alternatives were considered and evaluated, including ammonium nitrate (AN). It was determined that AN propellant is low in performance and would generate emissions of other pollutants, such as nitrogen oxides and nitric acid. Other propellants considered by NASA included cyclotetramethylene tetranitramine (HMX). This alternative was also rejected as impractical, because HMX is highly explosive and is rated as a detonating compound. Alternative propellants are impractical since they would result in decreased performance, generate other pollutants, or present other physical dangers.

Site-Specific: Sounding rocket vehicles consist of small rockets that move in suborbital trajectories. They require launchers (e.g., of the rail or tube type) and present some environmental risks at takeoff. Therefore, rocket launch sites and associated support facilities of some complexity are needed. These sites are permanent where repeated launches take place year after year. Currently, NASA uses the three fully equipped permanent sounding rocket launch sites at WFF, PFRR, and WSMR. There are no proposals at this time for construction of additional permanent launch facilities for the NASA SRP. Building of new and different permanent facilities would increase environmental stress due to construction activities without providing any known operational or environmental advantages.

Key Environmental Issues Evaluated

The most important and relevant programmatic environmental issues with respect to continuation of the SRP are upper and lower atmosphere emissions; noise; landing and recovery operations; and risk to human life and property. Depending on the specific launch site involved, other issues, such as impacts to wildlife and threatened and endangered species, wetlands, and water quality, may be important. All potential environmental effects were evaluated in accordance with the National Environmental Policy Act of 1969, as amended (42 U.S. C. 4321 et seq.), the Council on Environmental Quality regulations for implementing the procedural provisions of the National Environmental Policy Act (40 CFR Parts1500-1508), and NASA policy and procedures (14 CFR Part 1216, Subpart 1216.3).

Environmental Consequences of the Alternatives

Programmatic impacts of the NASA SRP include environmental impacts on the Earth's upper and lower atmosphere, as well as impacts due to noise and landing and recovery operations. The highest altitudes for SRP emissions are in the hundreds of kilometers where chemical releases from some payloads take place. At lower levels, there are emissions from the exhausts of SRP upper stage rockets and attitude control systems. The releases of chemicals and attitude control systems fluid/gases in the upper atmosphere are associated with scientific missions. The emissions of rocket exhaust products are associated with the operation of the launch vehicles.

Analysis of a 10-year SRP activity indicates 31 flights each year with mass of chemical release varying from 5 to 272.2 kilograms (11.24 to 600.2 pounds) per flight, with an average of 43.4 kilograms (95.7 pounds) per flight. The 10-year total mass of released chemicals was 1344.6 kilograms (2,964.8 pounds), for an annual average of 134.5 kilograms (296.6 pounds). The release of a given chemical in the upper atmosphere is usually made to enhance a specific scientific observation. Some of these chemicals are classified as hazardous; however, the quantities of chemicals released and the negative impacts of such releases are small and can be best addressed in an operational sense.

Typical upper stage rocket exhaust emissions from the NASA SRP vehicles include hydrogen chloride, aluminum oxide, carbon monoxide, carbon dioxide, hydrogen, water, trace metals, and small quantities of other chemicals. The emissions of 13 of the 15 launch vehicles are essentially confined to the stratosphere. Only Black Brant X and XII vehicles emit in the ionosphere. The emissions occur as line sources along trajectory arcs.

Noise generated by the suborbital SRP flights can be grouped into launch noise, flight noise, and landing noise. The SRP flights follow ballistic trajectories modified by air resistance. The landing speeds of these objects are supersonic, similar to those of artillery shells and missiles, which enter the atmosphere at directions not far from the vertical. Therefore, the sonic booms associated with supersonic flight of aerodynamic bodies flying horizontally or at small angles to the horizontal are absent in the SRP.

All metallic and other solid, heavier-than-air objects, which are propelled into the atmosphere by the launch vehicles return to Earth in more or less ballistic trajectories. The objects include spent rockets, payloads, nose cone doors, and despin weights. In multistage SRP launch vehicles, the first stage or launch rocket invariably flies a very short trajectory following a burn time of only a few seconds. The impact ranges for the first stage of all multistage vehicles are shown to be less than 1.5 kilometers (1 mile), with some as small as 0.3 kilometer (0.2 miles). Spent rocket impact weights are in the 270- to 800-kilogram (595.4 to 1,764 pounds) range.

The spent second stage in a three-stage launch vehicle has an impact range from 5 to 25 kilometers (3 to 15 miles). The impact range varies with selected payload weight and launch angle. The impact ranges for the spent weather, ozone, and 70-millimeter test rockets are from 2.8 to 5.5 kilometers (2 to 3 miles). Rocket motors that impact hundreds of kilometers or more down range are limited to vast uninhabited areas. Normally, no recovery is attempted. Without additional disturbance, natural processes eventually obliterate the location of the impact.

While spent rockets are usually not recovered, most payloads are recovered for data extraction, inspection, refurbishing and prospective reuse. This is normally done by separating the payload from the final stage and then deploying a parachute at about a 6 kilometers (3.7 miles) altitude. As a result, the payload decelerates and floats down in a direction determined by local wind conditions. The payload is located by aircraft. At WSMR, a good-faith attempt is made to recover all rocket debris.

All NASA SRP missions are required to contain both Ground and Flight Safety Plans to minimize risk to human life, property, and natural resources. Impact and overflight criteria are considered in the Flight Safety Plans and, while risk cannot be entirely eliminated, it is reduced to a very small and acceptable level.

Impacts to land, wetlands, and floodplains of the WSMR stem from the actual impact of launch vehicles and payloads, and may result from recovery efforts. The first stage of the launch vehicle impact occurs relatively close to the launch facilities. This is evidenced by several launch vehicles found partially buried, nose down, a few hundred meters from the launch facility. Such impacts do not appear to materially affect the surrounding habitat.

Endangered and threatened species are present at WFF, PFRR, and WSMR. Consultations with the U.S. Fish and Wildlife Service, and state, as well as site operators, revealed a number of concerns regarding protection of these species. Appropriate corrective actions were taken by NASA WFF at Wallops Island in cooperation with the Fish and Wildlife Service. Restrictions on activities on the southern and northern parts of Wallops Island during the piping plover nesting season have been implemented. In order to protect pupfish habitat at WSMR, the U.S. Navy, which is responsible for NASA SRP operations at WSMR, has instituted mitigation procedures that are described under Section E (Mitigation) of this document.

Based on an environmental justice evaluation, it was determined that federal actions conducted at WFF, WSMR, and PFRR do not disproportionately or adversely affect minority or low-income populations. In addition, no impacts to identified cultural resources are predicted as a result of the SRP.

Termination of SRP activity would result in the elimination of minor and transient environmental impacts of the sounding rocket launches. The reduction in emissions of carbon dioxide, carbon monoxide, aluminum oxide, hydrogen chloride, metals, and other chemical will be approximately 39 metric tons annually. The overall reduction in use of materials and energy due to termination of the SRP is small.

Termination of the sounding rocket launches would result in a reduction or elimination of a number of atmospheric environmental research studies. Some of these studies deal with ozone depletion and green house atmospheric effects, as well as research in plasma physics, ultraviolet and X-ray astrophysics, solar physics, and Earth's upper atmosphere. The termination of the SRP will have an adverse impact on local economies, especially in the area of the Eastern Shore of Virginia, where WFF makes a substantial contribution to the local economy.

C. ASSESSMENT OF THE ANALYSIS

While the introduction of any chemical, including water and carbon dioxide, has some impact on the chemistry of the upper atmosphere, those that are introduced by the SRP are in relatively small quantities in the stratosphere, and even smaller in the ionosphere and can be considered to be not substantial. The program uses relatively minute amounts of fuel in the form of propellants. Consequently, little if any contribution to global climate change occurs as a result of emissions from this program. The quantity of chlorine released in the upper atmosphere is very small and produces little, if any, impact on stratospheric ozone. The SRP generates relatively small amounts of air emissions, and no substantial pollution effects in the lower atmosphere are expected from this program.

Launch noise persists for a few seconds. The unprotected public at 11 kilometers (6.8 miles) would be exposed to a noise lower than a diesel truck that generates 85 dBA from 15 meters (50 feet) distance when travelling at 64 kilometers per hour (40 miles per hour). Unless humans or animals are in the immediate vicinity of a landing ballistic, spent rocket, or payload, noise is not a problem.

Based on worldwide experience to date, the landing impacts due to SRP launches have been safely minimized without incident. From 1959 to the present time, over 2,600 launch vehicles have been flown in the SRP. As evidence of the effectiveness of the precautions observed, no casualties, injuries, or property damage are known to have resulted from the landing impacts of the spent rockets, payloads, or fragments. Impact and overflight criteria are considered in the Flight Safety Plans. While risks cannot be entirely eliminated, they are reduced to a very small likelihood and are acceptable.

The SRP adheres to all special considerations for minimizing and/or preventing impacts on endangered and threatened species.

The programmatic environmental impacts of the SRP are not significant. The cumulative programmatic and site-specific environmental impacts associated with conducting the SRP at WFF, PFRR, and WSMR are not significant. However, it is conceivable that the combination of programmatic and site-specific impacts at another site could result in significant effects to the quality of the human environment. Therefore, additional environmental documentation, as appropriate, will be completed before final action is taken on SRP activities at sites other than WFF, PFRR, and WSMR.

Choice of Alternatives

In view of the small risks associated with continuation of the SRP in its present form and at the current level of effort, it is my intention to choose the Proposed Action, Alternative 1, based on the following:

The NASA SRP is a scientific endeavor designed to increase the depth of knowledge of near-space, the Earth's atmosphere, and outer space. The results of the scientific experiments are making substantial contributions to the protection of the environment without having a significant negative effect on the environment. The launch and recovery processes represent relatively minor transient effects.

Practical and cost-effective means for protecting the environment can be developed only on the basis of knowledge and understanding of the physical, chemical, and biological processes affecting such an environment. Scientifically, more has been learned about the immediate environment and that of the solar system in the last 2 decades than in all the previous decades combined. The NASA SRP makes unique contributions to the total effort to provide an operational capability to measure and monitor environmental conditions and natural resources from a local to global scale.

The application of sounding rocket technology in studies dealing with ozone depletion in the upper atmosphere is one of the examples of the critical role the NASA SRP is playing in protecting our environment. In fulfilling its responsibility, the program has followed a philosophy that has emphasized safety and economy in conducting these experiments.

The continuation of the NASA SRP would result in irreversible and irretrievable commitment of small quantities of structural materials and propellants. Use of military surplus solid propellant rockets, such as Nike, Orion, Taurus, Terrier, and Aries, in the NASA SRP activities further reduces the commitment of new raw materials and provides for the beneficial use of already expended resources that might become hazardous waste. The quantities of physical resources used by the SRP are small. Consequently, the continuation of the NASA SRP will not commit expenditure of natural resources in substantial quantities.

Termination of the SRP would eliminate the small direct adverse environmental impacts of its implementation. Therefore, in one sense this alternative would be environmentally preferable. However, termination of the SRP would not satisfy the need and purpose of this program, which includes a better understanding of the Earth's environment.

D. ADDITIONAL INFORMATION

The regulations for implementing the procedural provisions of the National Environmental Policy Act (40 CFR 1502.25) state that, to the fullest extent possible, draft EIS's shall be prepared concurrently with, and integrated with, surveys and studies required by the Fish and Wildlife Coordination Act (16 U.S.C. 661 et seq.), the National Historic Preservation Act 1966 (16 U.S.C. 470 et seq.), the Endangered Species Act of 1973 (16 U.S.C. 1531 et seq.), and other environmental review laws and executive orders.

Examination of available literature (existing site-specific EIS, environmental assessment, environmental resources document, biological, and archaeological/historical reports), face-to-face and telephone consultations, and correspondence with responsible regulatory agencies generated the information required for compliance with these requirements.

Extensive safety and technical reviews will continue to be conducted for all NASA SRP missions.

E. MITIGATION

Mitigation procedures committed to the NASA SRP are specified in Chapter 4.0 of the FSEIS and shall be implemented. In the normal launch of a sounding rocket, one or more spent rocket stages and often the payload will follow a ballistic trajectory and land, intact, in the ocean or an unpopulated land area. To avoid endangering, to any appreciable extent, any person, property, or any living plant or animal species, the landing locations are carefully planned. Because the flightpath of sounding rockets is influenced by atmospheric winds, careful consideration is given to wind velocities before any launch. The impact areas are carefully selected. If it is an ocean area, ship traffic is advised so that there will be a minimal hazard to people or property aboard such vessels. Aircraft and radar surveillance is exercised over these areas when sounding rocket launches are planned. When payloads impact in the ocean, sometimes recovery is attempted. Spent rocket stages are usually not recovered. In the case of land areas, exclusion is practiced, and the areas are under surveillance during periods of activity. When spent stages or unrecovered payloads would impact on land, unoccupied areas are planned as landing sites.

In the WSMR desert area, only rangeland surface is disturbed. In northern areas such as PFRR, launches over land will cause impacts on tundra and subarctic evergreen forest. Because most rockets are fin stabilized, they impact nose down, and the surface disturbance will be minimal.

Current environmental protection policies at WSMR for the NASA SRP fully recognize the sensitivity of the White Sands pupfish habitat and have built-in mitigation to ensure no impact. After the launch is completed, the recovery team is transported via helicopters to locate the sustainer and payload. The sustainer is recovered by ground vehicles entering the desert single file from the nearest point of an existing road. The payload is recovered by helicopter; no ground vehicles are required for payload recovery. The worst case scenario, a direct hit on the species habitat of Salt Creek, would not harm the pupfish population unless it directly hit a pupfish. Of the more than 1,100 recorded rocket motor stage impacts since 1967, there have been no landings on Salt Creek. The probability of harming a pupfish is very low.

The FSEIS also states that in the event that previously undiscovered cultural resources are identified during the course of the SRP, NASA will take no action affecting the resources until the requirements of 36 CFR Part 800 (Protection of Historic Properties) are satisfied.

Based on worldwide experience to date, the landing impacts due to SRP launches have been safely minimized without incident. In my judgment, all practicable means to avoid or minimize harm from the selected alternative have been adopted and will be implemented.

Decision

Based upon all of the foregoing, it is my decision to programmatically continue the NASA SRP activity in its present form and at the current level of effort. Furthermore, it is my decision to continue NASA SRP activity at WFF, PFRR, and WSMR in its present form and current level of effort. This proposed action does not contemplate any significant change in programmatic scope, or site-specific elements of the program. I am confident that no change in current environmental or interrelated socioeconomic impacts will occur from the continuation of the NASA SRP.

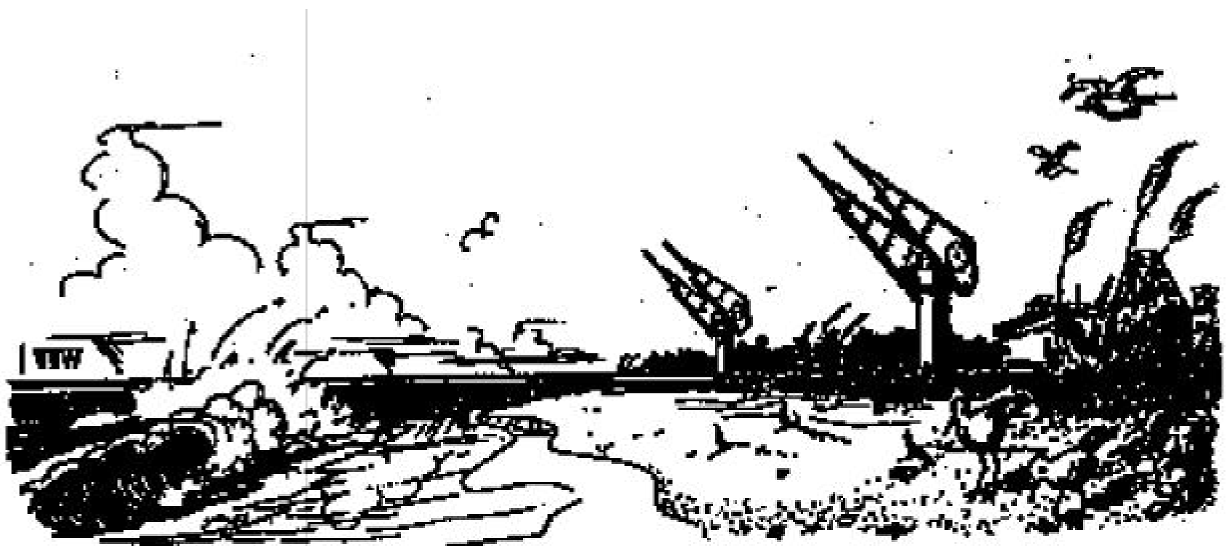
Alan Bunner for
Edward J. Weiler
Associate Administrator for Space Science

6/30/00
Date

NASA

Final

SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT
for
SOUNDING ROCKET PROGRAM



National Aeronautics and Space Administration
Goddard Space Flight Center
Wallops Flight Facility
Wallops Island, Virginia 23337 **1998**

ERRATA SHEET
June 26, 2000

Chapter/Page	Changes
3.2.2.2.7/Page 3-36	The last sentence of the first paragraph is changed to read: "The Lower Range of this facility is located within the 500-year flood plain of the Chatanika River, but lies outside the 100-year floodplain."
Appendix D/Page D-13	Under "Response to Comment 3.9," change "110 impacts On Salt Creek" to read: "no impacts on Salt Creek."
Front Cover and pages	Change "1998" to "2000" where it appears on the cover of this document and page footers throughout the document.*

*The Record of Decision for this Final Supplemental Environmental Impact Statement for Sounding Rockets Program was signed on June 30, 2000.

NASA Wallops Flight Facility
Goddard Space Flight Center
Final Supplemental Environmental Impact Statement

ADDENDUM
February 1, 2000

Since the printing of the document entitled NASA Final Supplemental Environmental Impact Statement for Sounding Rocket Program - 1998, the Sounding Rocket Program Handbook dated June 1, 1999 has been issued electronically and has replaced the Sounding Rocket User's Handbook (Bibliography #86).

All other information and analysis presented in the 1998 Final Supplemental Environmental Impact Statement for Sounding Rocket Program remains current and accurate as of this date.

SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT FOR THE SOUNDING ROCKET PROGRAM

( ) Draft Supplemental Environmental Impact Statement
(X) Final Supplemental Environmental Impact Statement

RESPONSIBLE FEDERAL AGENCY:

National Aeronautics and Space Administration, Washington, DC 20546

THE TITLE OF PROPOSED ACTION:

Supplemental Environmental Impact Statement for the Sounding Rocket Program

FOR ADDITIONAL INFORMATION, CONTACT:

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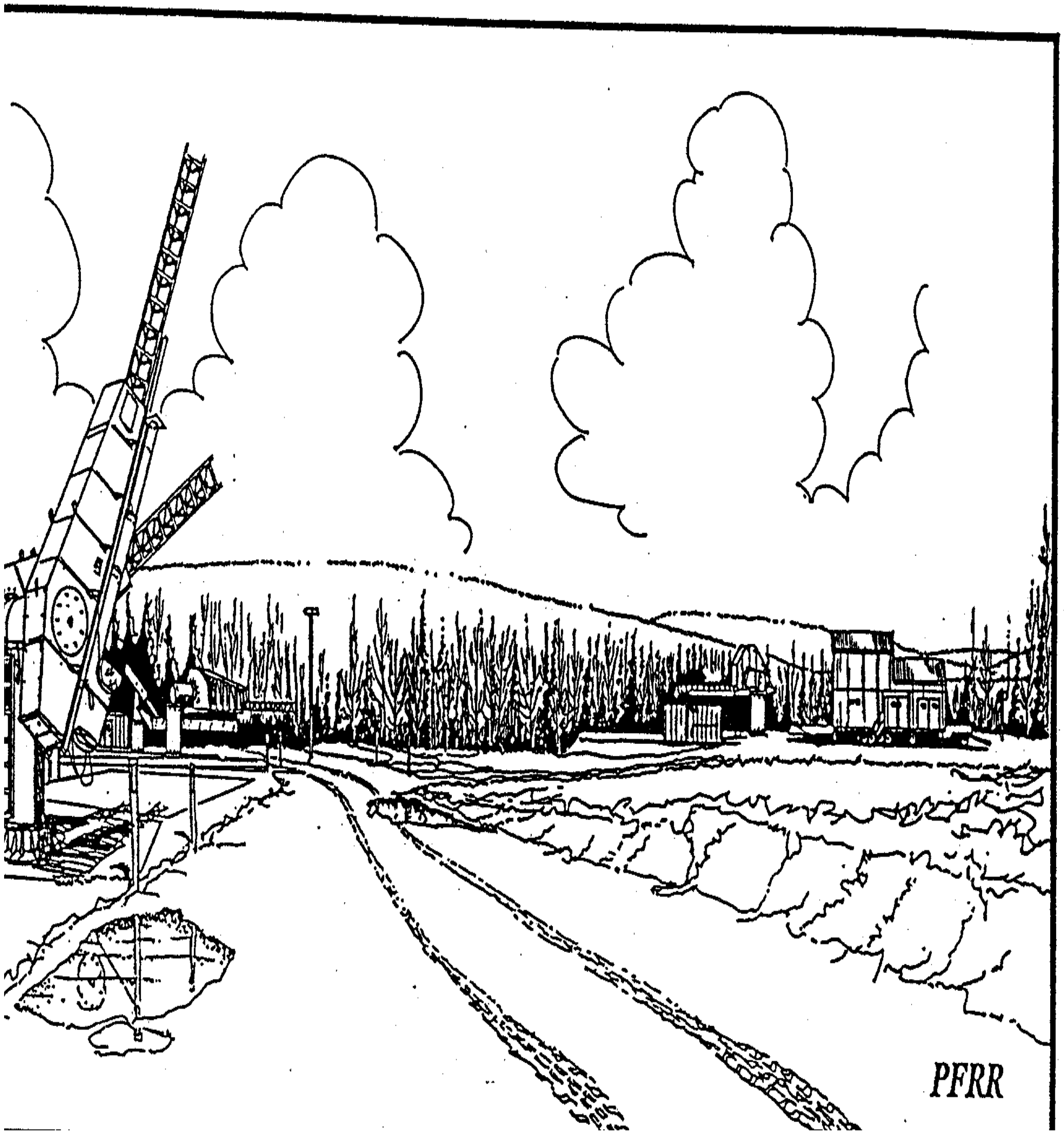
ABSTRACT:

This Supplemental Environmental Impact Statement (SEIS) was prepared for the National Aeronautics and Space Administration (NASA) Sounding Rocket Program (SRP) to update the Final Environmental Impact Statement (FEIS) for the SRP published by NASA in July 1973. The NASA SRP supports space and Earth sciences research sponsored by NASA and other users by providing suborbital vehicles for deployment of scientific payloads. The Proposed Action of this SEIS is to continue SRP activity in the present form and at the current level of effort. The Proposed Action does not contemplate any significant change in programmatic scope, or site-specific elements of the program. Consequently, no change in current environmental, economical, or social impacts are anticipated from the continuation of the Sounding Rocket Program.

The SEIS presented here reflects programmatic changes in the NASA SRP that took place since 1973 by deleting launch vehicles that are no longer used, adding new launch vehicles and systems currently being used, and ensuring that the statement reflects changes in statutes and regulations pertaining to environmental issues. The programmatic impacts of the SRP are addressed on a global scale, while the current environmental issues at three principal domestic sounding rocket launch sites: Wallops Flight Facility (WFF) in Wallops Island, Virginia; Poker Flat Research Range (PFRR) in Fairbanks, Alaska; and White Sands Missile Range (WSMR) in White Sands, New Mexico are addressed in a site-specific manner.



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LIST OF ABBREVIATIONS AND ACRONYMS

Abbreviation

A	angstrom(s), astrophysics
AAP	aurora acceleration phenomena
ACS	attitude control system
AK	Alaska
Al	aluminum
Am	americium
AML	Astro Met Laboratories
AN	ammonium nitrate
ANFO	ammonium nitrate/fuel oil explosion
AP	ammonium perchlorate
ARAB	Rocket Assembly Building A
ARC	Atlantic Research Corporation
ASSI	airglow solar spectrometer instrument
B	boron
Ba	barium
BBVB	Black Brant VB
BBVC	Black Brant VC
BLM	Bureau of Land Management
C	carbon
Ca	calcium
CAA	Clean Air Act
CAAA	Clean Air Act and its Amendments
CAL	calibration
Cd	cadmium
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CF_3Br	bromo-trifluoro-methane (fluid)
CFC	chlorofluoro-carbons
CFR	Code of Federal Regulations
Cl	chlorine
Cm	curium
Co	cobalt
CO_2	carbon dioxide
CPIA	Chemical Propulsion Information Agency
Cu	copper
CuO	copper oxide
D	distance(s)
dBA	decibels (a weighted sound level)
DOD	Department of Defense
E	Earth sciences, endangered
EA	Environmental Assessment(s)
EIS	Environmental Impact Statement(s)
EM	electromagnetic
EOS	Earth orbiting satellite
EPA	Environmental Protection Agency
ERD	Environmental Resources Document(s)
ES	electrostatic shocks
ESA	European Space Agency
estd.	estimated
EUV	extreme ultraviolet

LIST OF ABBREVIATIONS AND ACRONYMS (Continued)

Abbreviation

FB	Fairbanks, Alaska
Fe	iron
FEIS	Final Environmental Impact Statement
FR	Federal Register
Ft	Fort
FY	fiscal year
GRN	Sondre Stromfjord, Greenland
GSFC	Goddard Space Flight Center
H	hydrogen
HANLC	high altitude noctilucent clouds
HFEF	high frequency electron flux
HMTA	Hazardous Material Transportation Act
HMX	cyclotetramethylene tetranitramine
HSWA	Hazardous and Solid Waste Act
IR	infrared
ISCST	Industrial Source Complex - Short Term
kg	kilogram(s)
km	kilometer(s)
kNm	kilo-Newton-meters
kPa	kilopascal(s)
KWAJ	Kwajalein, Marshall Islands
LC	launch complex(es)
Li	lithium
LVI	launch vehicle impact
Mg	magnesium
MISTI	mesospheric ionization structure and turbulence investigation
mm	millimeter(s)
MRP	Meteorological Rocket Program
MS	mass spectrometer
msl	mean sea level
N	nitrogen
NACA	National Advisory Committee for Aeronautics
NASA	National Aeronautics and Space Administration
NC	nitrocellulose
Nd	neodymium
NEPA	National Environmental Policy Act
NG	nitroglycerine
$Ni(CO)_4$	nickel carbonyl
No.	number
NO_x	oxides of nitrogen
NWR	National Wildlife Refuge
ORSA	Ogive recovery system assembly
OSHA	Occupational Safety and Health Administration
OSSA	Office of Space Science and Applications
P-T	pressure-temperature
Pb	lead
PCAD	Products of Combustion/Atmospheric Dispersion
PFRR	Poker Flat Research Range
PGI CAL	Penning Gas Imager proportional counter calibration

LIST OF ABBREVIATIONS AND ACRONYMS (Concluded)

Abbreviation

pH	the negative logarithm of the effective hydrogen ion concentration in gram equivalents per liter, used in expressing both acidity and alkalinity
PE	payload effect
PMSE	polar mesospheric summer echoes
PR	Camp Tortuguero, Puerto Rico
psi	pounds per square inch
QE	quadrant elevation or launch angle
RCRA	Resource Conservation and Recovery Act
REDAIR	release experiments to derive airglow inducing reactions
RS	radioactive source
S	sulfur
S-T	stratosphere - troposphere
S*	startle of nesting species
Sa	samarium
SDIO	Strategic Defense Initiative Organization
SEC, sec	second(s)
SEIS	Supplemental Environmental Impact Statement
SF_6	sulfur hexafluoride (gas)
SO	stratospheric ozone
SP	Space Physics
SPH	-sphere
Sr	strontium
SRP	Sounding Rocket Program
SS	Solar System Exploration
STS	Space Transportation System (Space Shuttle)
T	threatened
TAD	throwaway detector
TEA	triethyl aluminum
Ti	titanium
TiB_2	titanium diboride
TLV	threshold limit values
TMA	trimethyl aluminum
TR	test rocket
TSCA	Toxic Substances Control Act
T_m	maximum thrust
U.S.	United States
UAF	University of Alaska at Fairbanks
UAR	upper atmosphere research
UARS	upper atmosphere research satellite
USC	United States Code
USFWS	United States Fish and Wildlife Service
UV	ultraviolet
UV-B	ultraviolet-B
VA	Virginia
Ve	exit plane velocity
WFF	Wallops Flight Facility
WI	Wallops Island, Virginia
WPC	wave-particle correlations
WSMR	White Sands Missile Range
w/	with
σ	sigma, absolute dispersion

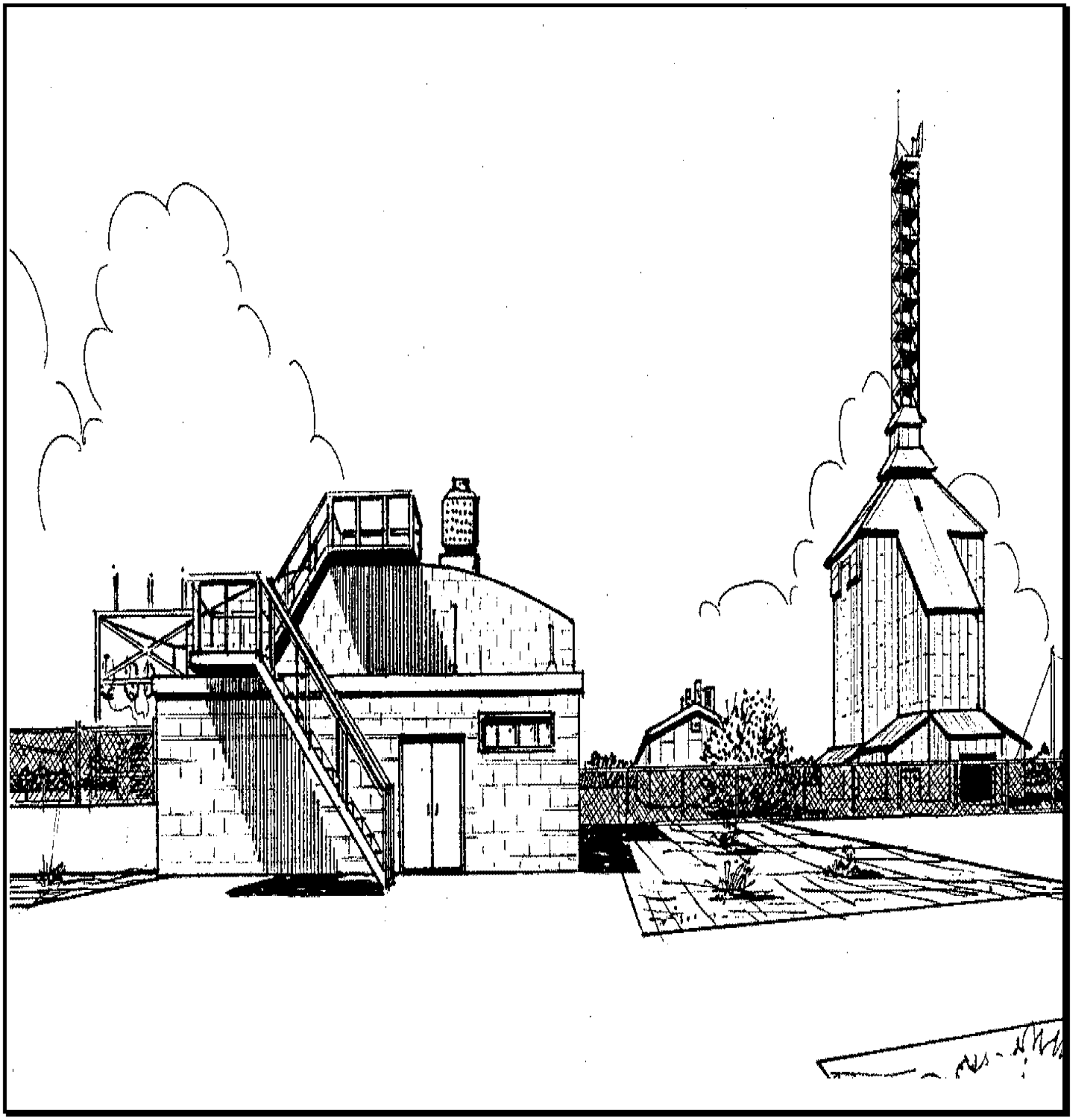
GLOSSARY OF TECHNICAL TERMS

Term	Definition
APOGEE	highest point or apex in a suborbital trajectory followed by a launch vehicle before reversing direction and returning to Earth.
ATTITUDE CONTROL SYSTEM	an arrangement of controlled jets of compressed fluids or gases attached to space objects, such as optical instruments, to align them accurately on celestial bodies by use of reactive forces.
BALLISTIC	path of an aerial projectile with an initial velocity under the action of gravity and air resistance, with no on-board propulsion; e.g., path of a spent rocket after burnout.
CRITICAL HABITAT	(1) specific areas within the geographical area occupied by a species at the time it is listed (as endangered or threatened) on which are found those physical or biological features (a) essential to the conservation of the species and (b) which may require special management considerations or protection; and (2) specific areas outside the geographical area occupied by a species at the time it is listed, upon a determination that such areas are essential for the conservation of the species.
DIFFUSION	spreading of emitted matter into the atmosphere from a stationary or moving source, determined by physical and chemical properties of the emission and by site specific conditions, such as altitude, wind, and weather.
DIFFUSION MODEL	a method of calculating parameters of diffusion, such as concentrations of emitted substances, over geographical areas of interest with time, for comparison with allowable exposure limits.
DISPERSION	deviation of actual impact range of a spent rocket from the predicted location, usually broken down into downrange and crossrange components.
EMISSION	addition to the atmosphere of foreign matter from stationary or moving sources, e.g. rocket exhaust from a sounding rocket in its trajectory, or from a stationary rocket firing.
ENDANGERED	any species that is in danger of extinction throughout all or a significant portion of its range.
GLOBAL WARMING, GREENHOUSE EFFECT	the effect of an increase of carbon dioxide and other gases in the atmosphere which act like glass in a greenhouse which is penetrated by sunlight but traps some of the solar heat which otherwise would be radiated back to space.

Term	Definition
IMPACT RANGE	horizontal distance along the Earth's surface from the launch point of a launch vehicle to the landing point of the payload or a spent rocket. Usually used to denote the maximum horizontal distance traveled by a launch vehicle, i.e., the distance to the landing point of the payload or spent final rocket stage.
IONOSPHERE	atmospheric layer from about 80 km to beyond 1000 km (see p. 3-3).
LAUNCH VEHICLE	a stacked assembly of one or more cylindrical rockets in series, topped by a cylindrical payload and a nose cone. In the sounding rocket application the payload consists of scientific instruments either gathering in situ samples or making optical observations of terrestrial (atmospheric), planetary, solar system or galactic targets.
MESOSPHERE	atmospheric layer from about 50 km to about 80 km (see p. 3-3).
METEOROLOGICAL	dealing with the Earth's atmosphere and its phenomena, and especially with weather and weather forecasting.
MITIGATION	in relation to environmental impacts this includes (1)avoiding the impact altogether by not taking an action; (2)minimizing impacts by limiting an action; (3) rectifying the impact by repairing or restoring the affected environment; (4) reducing or eliminating the impact over time by preservation/maintenance operations during the life of the action; (5) compensating for the impact by replacing or providing substitute resources or environments.
PROGRAMMATIC	relating to the Sounding Rocket Program as a whole, uninfluenced by the launch site, e.g., upper atmosphere impacts.
ROCKET EXHAUST	the combustion or burning of a rocket converts the chemical constituents of the propellant at ambient temperature to high-temperature gaseous (and some solid) compounds, collectively called the rocket exhaust or exhaust gases, which flow out of the rocket exit nozzle at supersonic speeds into the surrounding atmosphere.
SITE-SPECIFIC	relating to a particular launch site, e.g., impacts affected by geographical location and local climate, fauna and flora.

GLOSSARY OF TECHNICAL TERMS (Concluded)

Term	Definition
SOLID PROPELLANT	a cured mixture of powdered chemicals, including fuel and oxidizer compounds, and an electrical igniter, formed into cylindrical shape and inserted into the rocket casing. The proportions of the ingredients are selected to provide a given thrust and burning time, but once ignition takes place, the solid propellant combustion cannot be further controlled.
SOUNDING ROCKET	a rocket-propelled suborbital launch vehicle equipped with a scientific payload for making observations from the Earth's atmosphere. The propulsion may be by a single rocket for low apogees or by multiple rockets staged in series to attain higher apogees.
SPENT ROCKET	residual casing or shell of a solid propellant rocket after burnout when the propellant has been exhausted and expelled as exhaust gases; follows a ballistic path to ground.
STRATOSPHERE	atmospheric layer from about 10 km to about 50 km (see p. 3-1).
SUB-ORBITAL TRAJECTORY	flight path of typical sounding rocket, from surface launch up to apogee and down to surface landing, along an arc of close to parabolic shape.
THREATENED	any species that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.
TROPOSPHERE	atmospheric layer from surface to about 10 km (see p. 3-1).
WETLANDS	land or areas, such as tidal flats and swamps, which contain large amounts of soil moisture.



SUMMARY

SUMMARY

THE PURPOSE

This Supplemental Environmental Impact Statement (SEIS) was prepared for the National Aeronautics and Space Administration (NASA) Sounding Rocket Program (SRP) in compliance with the National Environmental Policy Act (NEPA) as amended (42 USC 4321 et seq.), CEQ regulations at 1502.9(c), and NASA policy and regulations at 14 CFR 1216.3.

> ***The purpose of this SEIS is to update the Final Environmental Impact Statement (FEIS) which was prepared for the NASA SRP in July 1973.***

The SEIS presented here reflects programmatic and site-specific changes in the NASA SRP that have taken place since 1973 by deleting launch vehicles that are no longer used, adding new launch vehicles and systems currently being used, updating changes in launch sites and ground support activities.

THE NEED

The NASA SRP supports space and Earth sciences research by providing approximately 30 to 40 flight opportunities per year to space scientists in the disciplines of upper atmosphere, plasma physics, solar physics, planetary atmospheres, galactic astronomy, and high energy astrophysics. The environmental studies dealing with ozone depletion and global warming are only a few examples of scientific programs carried out by NASA for the protection of planet Earth. Sounding rockets provide the only means for in situ measurements at altitudes between the maximum altitude of

> ***The NASA SRP is needed for support of space and Earth sciences research by providing suborbital vehicles for deployment of scientific payloads.***

balloons (about 50 kilometers or 30 miles) and the minimum altitude for satellites (about 160 kilometers or 100 miles). The launch vehicles used by the NASA SRP for deployment of scientific payloads have:

1. high reliability (96.9-percent vehicle and 85.5-percent mission success rate in the last 10 years),
2. short mission lead time,
3. low cost,
4. mobility, and
5. payload recovery and reuse.

THE SCOPE

The scope of this SEIS covers the programmatic and site-specific aspects of the NASA SRP and the following related activities: special agreements for NASA SRP support, i.e., reimbursable and other Memorandum of Agreement Programs; flight and static rocket testing; test rockets; and standard NASA meteorological and ozonesonde rockets i.e., Super Loki and Viper IIIA Darts, that utilize the same rocket launch sites as those used by the NASA SRP.

The programmatic elements of this SEIS apply to the launching of NASA sounding rockets on a worldwide basis, including from launch sites in the United States; from foreign sites in Norway, Sweden, and elsewhere; and from mobile launch sites anywhere in the world. The site-specific aspects of this SEIS apply to the environmental impact issues at three principal domestic sounding rocket launch sites: Wallops Flight Facility (WFF), Eastern Shore of Virginia; Poker Flat Research Range (PFRR), Alaska; and White Sands Missile Range (WSMR), New Mexico.

All SRP launches by NASA outside the United States are conducted under terms and conditions of a specific agreement with the appropriate governmental counterpart agency of the host country. Thus, all NASA SRP launches outside the United States are conducted with the prior knowledge and approval of the host country.

The SRP activities at each NASA facility are conducted in accordance with laws, regulations, and policies protecting environmental quality.

ALTERNATIVES

The mandate of NEPA calls for the environmental impact of alternatives to be considered, including the Proposed Action and the No Action Alternative. Within the scope of this SEIS, two types of alternatives are possible: programmatic and site-specific. Both were considered.

Programmatic Alternatives

Three types of programmatic alternatives to the Proposed Action were considered in this SEIS:

1. Alternatives to sounding rockets that could accomplish the aims of Space Science Exploration Program,
2. Sounding rockets with alternative propellants,
3. No Action alternative, e.g., termination of the SRP.

Alternatives to Sounding Rockets

Alternatives to sounding rockets consist of other ways in which scientists can make observations and accomplish the aims of their Space Science Exploration Program. These may involve making observations from:

1. the ground,
2. aircraft,
3. scientific balloons,
4. the Space Transportation System (STS),
5. satellites orbiting the Earth, and
6. deep space probes.

In the area of plasma physics, all alternatives considered are unsuitable or produce data of lower quality as demonstrated in Table 2-1.

The analysis carried out under this SEIS disclosed that the SRP occupies a unique position in a battery of tools available for scientific studies in the near space.

It can be deduced from the nature of scientific inquiry in other disciplines that observations from the ground, aircraft, and balloons result in a reduced quality of the scientific data collected in some instances, and total inability to conduct experiments in other instances.

The use of the STS, satellites, and space probes meet the program objectives in some instances; however, such high technology vehicles are not always available to the low-cost science projects, such as those being supported by the SRP. Also some of the SRP payloads are not allowed to be flown on manned STSs. Furthermore, the propulsion systems used to lift the STS, satellites, and space probes are considerably larger and more complex than required by the missions flown on sounding rockets.

Most of the alternatives to sounding rockets that were considered in this SEIS do not provide a practical and satisfactory means for conducting scientific research in the indicated disciplines.

Alternative Propellants

The use of alternative solid propellants was also considered under this SEIS. The propellant systems currently used by the NASA SRP are based either on an ammonium perchlorate (AP)/aluminum (Al) combination, or a nitrocellulose (NC)/nitroglycerin (NG) combination. The emissions from the AP/Al propellant combination include hydrogen chloride and aluminum oxide, and are generally considered to be more environmentally damaging than emissions from the NC/NG propellant combinations. Recently (1989), NASA carried out an extensive operational and environmental evaluation of the replacement propellants for the AP/Al propellant combination. Several alternatives were considered and evaluated, including ammonium nitrate (AN). It was determined that AN propellant is low in performance and would generate emissions of other pollutants, such as nitrogen oxides and nitric acid.Other propellants considered by NASA included cyclotetramethylene tetranitramine (HMX). This alternative was also rejected as impractical, because HMX is highly explosive and is rated as a detonating compound. The United States Air Force is currently conducting research on innovative clean-burning propellants, such as aluminum hydrate, but such concepts in clean propellants will not be available until the next century.

Based on the considerations described here, it appears that the alternative of a less polluting propellant substitution is not a practical option at this time.

Site-Specific Alternatives

Currently NASA uses three fully equipped permanent sounding rocket launch sites: WFF, PFRR, and WSMR. There are no proposals at this time for construction of additional permanent launch facilities for the NASA SRP. Building of new and different facilities would increase environmental stress due to construction activities without providing any known operational or environmental advantages.

The site-specific alternatives are limited to the three existing launch facilities (WFF, PFRR, and WSMR), with only two options available: to continue operations, or to terminate operations.

No Action Alternative: Termination of SRP

This alternative consists of the cessation of the launching of the various vehicles with their payloads from the three principal launch sites or from any other launch site. The impacts of SRP termination on NASA's scientific programs and the three principal launch sites would be negative.

PROPOSED ACTION

The Proposed Action of this SEIS is to continue the SRP, a suborbital space flight program supporting space and Earth science activities sponsored by NASA. The NASA SRP is a low-cost, quick response activity employing 15 launch vehicle systems, plus test and meteorological rockets, as well as vehicles for supporting studies on atmospheric ozone (ozonesonde rockets).

The Proposed Action is to continue SRP activity in the present form, and at the current level of effort. The Proposed Action does not contemplate any significant change from the current level of activity either in programmatic scope, or in the site-specific elements of the program. Consequently, no changes in current environmental, economical, or social impacts are anticipated from the Proposed Action.

The NASA SRP makes a unique contribution to the total research effort in the Earth upper atmosphere and near-space by providing an operational capability to measure, monitor, and manage environmental conditions and natural resources from local to global scale. The NASA SRP provides a relatively inexpensive approach to the partial satisfaction of the fundamental need to better understand, utilize, predict, and control the life sustaining, and sometimes hostile, environment. These activities are being carried out by NASA successfully, without any mishaps, or known substantial adverse environmental impacts. During the past 10 years, the level of NASA SRP activity was fairly constant as illustrated in Figure S-1. A similar level of activity is projected for the future.

ENVIRONMENTAL CONSEQUENCES

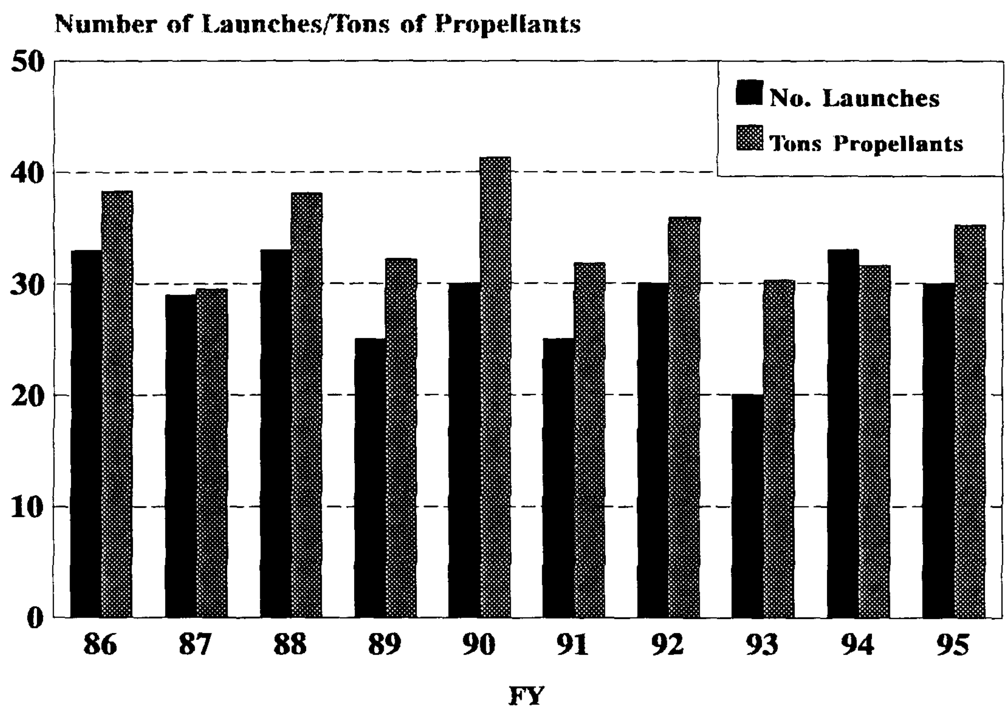
Programmatic Impacts

Programmatic impacts of the NASA SRP include environmental impacts on the Earth upper and lower atmosphere, as well as impacts due to noise and landing and recovery operations.

Upper Atmosphere

The highest altitudes for SRP emissions are in the hundreds of kilometers where chemical releases from some payloads take place. At lower levels, there are emissions from the exhausts of SRP upper stage rockets and attitude control systems (ACS). The releases of chemicals and ACS fluid/gases in the upper atmosphere are associated with scientific missions. The emissions of rocket exhaust products are associated with the operation of the launch vehicles.

FIGURE S-1
NASA SRP ACTIVITIES OVER PAST 10 YEARS



SRP Payload Chemical Releases

Analysis of the 10-year SRP activity indicates that there were 31 flights with mass of release varying from 5 to 272.2 kilograms per flight, with an average of 43.4 kilograms per flight. The 10-year total mass of released chemicals was 1344.6 kilograms, for an annual average of 134.5 kilograms. The release of a given chemical in the upper atmosphere is usually made to enhance a specific scientific observation.

The quantities of chemicals released and the negative impacts of such releases are small and can be best addressed in an operational sense so as to preclude adverse effects on the environment.

SRP Rocket Exhaust Emissions

Typical upper stage rocket exhaust emissions from the NASA SRP vehicles include hydrogen chloride, aluminum oxide, carbon monoxide, carbon dioxide, hydrogen, water, trace metals, and small quantities of other chemicals. The emissions of 13 of the 15 launch vehicles are essentially confined to the stratosphere. Only Black Brant X and XII vehicles emit in the ionosphere. The emissions occur as line sources along trajectory arcs.

The emission data, generated under this SEIS, indicate that the SRP discharges an average annual total of 19.1 metric tons of emissions into the upper atmosphere based on the 10-year total. Typically, the average annual total hydrogen chloride emission from the SRP into the stratosphere is 3.7 metric tons, compared to stratospheric per launch amounts of chlorine of 57 metric tons for a single European Space Agency (ESA) Ariane-5, or 32 metric tons for a single Titan IV.

While the introduction of any chemical, including water and carbon dioxide, has some impact on the chemistry of the upper atmosphere, those that are introduced by the SRP are in relatively small quantities in the stratosphere, and even smaller in the ionosphere and can be considered to be not substantial.

SRP Attitude Control Systems Emissions

For certain observations of deep space phenomena, such as in galactic astronomy, it is necessary to align optical instruments accurately with celestial bodies. For this reason, an ACS using directed jets of fluids (freons) or compressed gases (nitrogen, neon) to provide the needed reactive forces is included in payloads making such observations. All substances used for this purpose, except the freons, are permanent gases found naturally in the Earth's atmosphere. The freons contain chlorine which is known to contribute to ozone depletion in the stratosphere below 50 kilometers.

Since the ACS application is usually at 50 kilometers or higher, and above the ozone formation layer, releases of freons do not create adverse environmental impacts.

Effects on Stratospheric Ozone and Global Warming

The effects of rocket exhausts on the stratospheric ozone (SO) have been investigated in terms of local, regional, and global effects.

The SRP uses relatively small amounts of energy in the form of propellants. Consequently, no substantial global warming takes place as a result of this program. The quantity of chlorine released by the SRP in the upper atmosphere is very small and does not produce a substantial impact on stratospheric ozone.

For the Titan III, actual measurements of ozone loss were made in the exhaust trail. At an 18-kilometer altitude, only 13 minutes after launch, SO was reduced by more than 40 percent below background. However, after a few hours, recovery to near background levels occurred. Similarly, there was no ozone reduction at Kennedy Space Center a few hours after a Space Shuttle launch (see Section 4.1.1.1.4). Currently annual carbon dioxide emissions from Earth are in excess of 24 billion tons (see Section 4.1.1.1.4). The annual carbon dioxide emissions from the SRP total less than 0.54 metric tons and can be considered to be not substantial.

Lower Atmosphere

The lower atmosphere (below 10 kilometers) receives SRP launch vehicle rocket exhaust emissions from all first stages, plus many second stages, including those in three- and four-stage launch vehicles. The first, or launch, stage usually contains more propellant than the second stage, the second stage more than the third, and so on. Thus, the lower atmosphere receives most of the rocket exhaust emissions from a given launch vehicle. The emission data indicates that the SRP launch vehicles discharge an average annual total of 18.9 metric tons, including hydrogen chloride, aluminum oxide, carbon monoxide, and lead into the lower atmosphere. On a global scale, this amount in quantitative terms is very small, and is not substantial (see Section 4.1.1.2.4).

Weather and ozone rockets and 70-millimeter test rockets all emit small amounts of exhaust gasses into the lower atmosphere, typically at altitudes less than 2 kilometers, e.g., into the atmospheric boundary layer.

The SRP generates relatively small amounts of air emissions and no substantial pollution effects in the lower atmosphere

Impacts of Payloads with Radioactive Sources

A small fraction of all launches includes sealed radioactive sources as part of instruments in the payloads. The amounts of radioactive materials used are minute and they are used under close control of internal NASA safety with approvals from a Radiation Safety Committee. These safeguards were proven effective during the entire SRP program.

Noise Impacts

Noise generated by the suborbital SRP flights can be grouped into launch noise, flight noise, and landing noise. The SRP flights follow ballistic trajectories modified by air resistance and, in particular, by reentry into the denser lower atmosphere which decelerates and heats the reentering spent rockets and nonrecovered payloads.

Unless humans or animals are in the immediate vicinity of a landing ballistic, spent rocket, or payload, noise is not a problem.

Even so, the landing speeds of these objects are supersonic, similar to those of artillery shells and missiles which enter at directions not far from the vertical. This means that the sonic booms associated with supersonic flight of aerodynamic bodies flying horizontally or at small angles to the horizontal are absent in the SRP, including the weather, ozone, and test rocket flights. The highest sound levels for sounding rockets (Taurus/Talos) are 113 dBA at 1 kilometer (0.6 miles), 97 dBA at 3 kilometers (2 miles), and 75 dBA at 11 kilometers (7 miles). The launch noise persists for few seconds. The unprotected public at 11 kilometers (6.8 miles) will be exposed to a noise lower than a diesel truck which generates 85 dBA from 15 meters (50 feet) distance when travelling at 64 kilometers per hour (40 miles per hour).

Landing and Recovery Impacts

All metallic and other solid heavier-than-air objects, which are propelled into the atmosphere by the launch vehicles, land back on Earth in more or less ballistic trajectories. The objects include spent rockets, payloads, nose cone doors, and despin weights. In multistage SRP launch vehicles, the first stage or launch rocket invariably flies a very short trajectory following a burn time of only a few seconds. The impact ranges for the first stage of all multistage vehicles are shown to be less than 1.5 kilometers (1 mile), with some as small as 0.3 kilometer (0.2 miles). Spent rocket impact weights are in the 270- to 800-kilogram range.

The spent second stage in a three-stage launch vehicle has an impact range from 5 to 25 kilometers (3 to 15 miles), varying with selected payload weight, launch angle, and apogee. The spent rocket impact weights are in the 270- to 800-kilogram range. The impact ranges for the spent weather, ozone, and 70-millimeter test rockets, are from 2.8 to 5.5 kilometers (2 to 3 miles). These spent rocket impact weights vary from 7 to 9 kilograms. The final stages are usually lighter than the preceding stages, so that impact weights are 140 kilograms or less, except for the Black Brant (268 kilograms) and Aries (739 kilograms). When impact ranges in the hundreds of kilometers or more are expected, terrestrial ranges are limited to vast uninhabited areas. Normally, no recovery is attempted so, without additional disturbance, the location of the impact is eventually obliterated by natural processes.

While spent rockets are usually not recovered, most payloads are recovered for data extraction, inspection, refurbishing and prospective re-use. This is normally done by first separating the payload from the final stage and then deploying a parachute at about a 6-kilometer altitude. As a result, the payload decelerates and floats down at a rate and in a direction determined by local wind conditions. The payload is located by its proximity to the final stage rocket and often by radio signals emanating from the payload. At WSMR an attempt is made to recover all rocket debris.

Based on worldwide experience to date, the landing impacts due to SRP launches have been safely minimized without incident.

From 1959 to the present time, over 2,600 launch vehicles have been flown in the SRP. As evidence of the effectiveness of the precautions observed, no casualties, injuries, or property damage are known to have resulted from the landing impacts of the spent rockets, payloads, or fragments.

Site-Specific Impacts

During the past 10 years, launch sites used by the NASA SRP included WFF, Virginia; WSMR, New Mexico; PFRR, Alaska; Churchill Research Range, Manitoba, Canada; Kiruna, Sweden; Andoya, Norway; Kwajalein, Marshall Islands; Woomera, Australia; Alcantara, Brazil; Sondre Stromfjord, Greenland; Camp Tortuguero, Puerto Rico; and other locations. This SEIS addresses site-specific impactsonly at three permanent installations in the U.S.: WFF, WSMR, and PFRR.

Air Quality Impacts

Ground level concentrations of the air pollutants resulting from the sounding rocket launches have been estimated in the 1973 programmatic EIS. The calculations were performed for the two critical air pollutants: carbon monoxide and hydrogen chloride under three atmospheric stability criteria: slightly unstable, stable, and slightly stable. The results indicate that estimated peak concentrations for hydrogen chloride and carbon monoxide are well below threshold limit values (TLV) within 100 meters downwind from the launch site.

No substantial atmospheric effects were observed at ground level from the firing of sounding rockets because such firings are infrequent and very short in duration.

More recently, supporting evidence for earlier air emission modelling studies was reported by the Ballistic Missile Defense Organization (BMDO), formally the Strategic Defense Initiative Organization (SDIO) in 1993 by modelling static firing of the Minuteman II Stage 1 and Stage 3 rocket motors. The first stage of Minuteman II produces four times as much emissions as the largest rocket motor in the SRP arsenal - the Aries. According to SDIO reporting for the Minuteman II Stage 1 and 3, the maximum predicted concentrations of air contaminants from static testing are well below suggested criteria for aluminum oxide, hydrogen chloride, carbon monoxide, and nitrogen oxide. The stationary static testing of a rocket motor used as a basis for these calculations is the worst case scenario in respect to ground level air emissions.

Payload Recovery and Reentry Safety

All NASA SRP missions are required to contain both Ground and Flight Safety Plans to minimize risk to human life, property, and natural resources. All flights are designed such that the impact or reentry of any part of the launch vehicle over any landmass, sea, or airspace will not produce a casualty expectancy of greater than 10^{-6} unless a Safety Analysis Report is prepared. For details of landing and recovery impacts and mitigation see Section 4.1.4.

Both impact and overflight criteria are considered in the Flight Safety Plans and, while risks cannot be entirely eliminated, they are reduced to an acceptable margin.

Waste Disposal

Hazardous waste disposal at WFF is managed by NASA, at PFRR by the University of Alaska, and at WSMR by the U.S. Navy in accordance with regulations.

Aquatic and Terrestrial Ecology

Impacts to land, wetlands, and floodplains of the WSMR stem from the actual impact of launch vehicles and payloads, and may result from recovery efforts. Launch vehicle impacts occur relatively close to the launch facilities. This is evidenced by several launch vehicles found partially buried, nose down, a few hundred meters from the launch facility. Such impacts do not appear to affect the surrounding habitat.

No impacts to identified cultural resources are predicted as a result of the SRP.

Based on historical record, the impacts to the terrestrial and aquatic ecology from SRP operations are not substantial.

Noise associated with launch activities may have a startle effect upon the local fauna. Such noise, however, is of infrequent occurrence, short duration (few seconds), and moderate intensity. No adverse effects on local resident fauna were reported in the past.

Endangered and Threatened Species

Endangered and threatened species are present at three principal SRP launching sites in United States, WFF, PFRR, and WSMR. Consultations with Federal and State Fish and Wildlife Services, as well as site operators revealed a number of concerns regarding protection of these species. These concerns are described in the Appendix A and public comments to this SEIS. Appropriate corrective actions were taken by NASA WFF at Wallops Island in cooperation with the U.S. Fish and Wildlife Service (USFWS). Restrictions on activities on the southern and northern parts of Wallops Island during the piping plover nesting season were implemented. In order to protect the pupfish habitat at WSMR, the U.S. Navy, who is responsible for NASA SRP operations at WSMR, instituted a series of mitigation procedures. These mitigation procedures are described in Appendix B.

Cultural Resources

In the event that previously undiscovered cultural resources are identified during the course of the SRP, no further action that might effect the resources will be taken until the requirements of 36 CFR Part 800 are satisfied.

Socioeconomic Effects

The NASA SRP activity contributes approximately $87 million to the budget at WFF, $8 million at WSMR, and an estimated $1.5 million at PFRR.

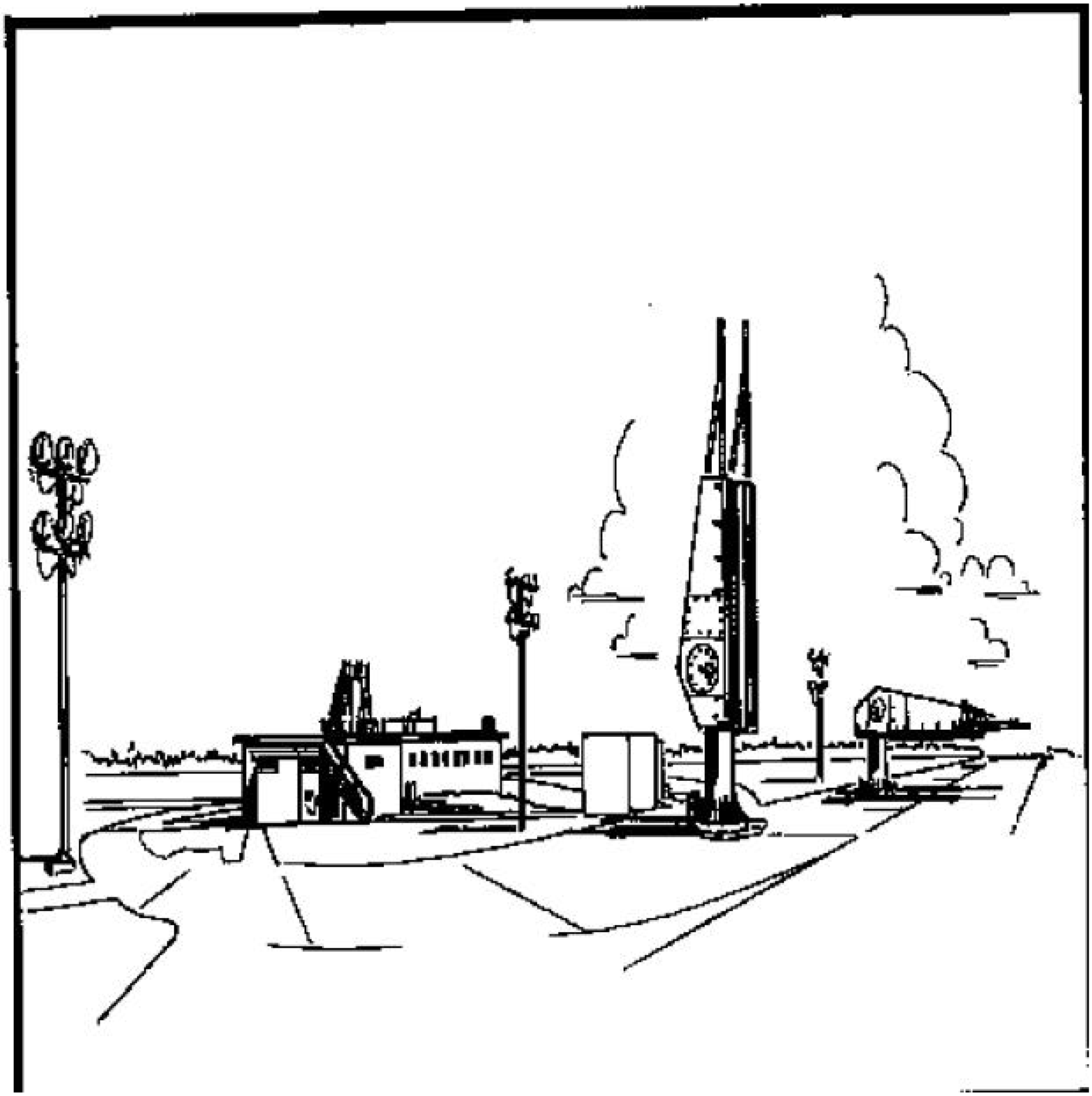
The continuation of the SRP activity will assure a future beneficial contribution to the local economy.

Impacts of Program Termination

Termination of SRP activity will result in the elimination of minor and transient environmental impacts of the sounding rocket launches. The reduction in emissions of carbon dioxide, carbon monoxide, aluminum oxide, hydrogen chloride, metals, and other chemicals will be approximately 39 metric tons annually on a worldwide basis. The overall reduction in use of materials and energy due to termination of SRP activity will be proportional to the materials and energy used in the production and operation of 20 to 30 automobiles (see Section 4.5).

The overall programmatic and site-specific effects of termination of the SRP will be negative.

Termination of the sounding rocket launches will also result in a reduction or elimination of a number of atmospheric environmental research studies, including some that are dealing with ozone depletion, and greenhouse atmospheric effects, as well as studies in plasma physics, ultraviolet and X-ray astrophysics, solar physics, and Earth's upper atmosphere. The termination of the SRP will have an adverse impact on local economies, especially in the area of the Eastern Shore of Virginia, where WFF makes a substantial contribution to the local economy.



SEIS

1.0 PURPOSE AND NEED

This Supplemental Environmental Impact Statement (SEIS) was prepared for the National Aeronautics and Space Administration (NASA) Sounding Rocket Program (SRP) in compliance with the National Environmental Policy Act (NEPA) as amended (42 USC 4321 et seq.), CEQ regulations at 1502.9(c), and NASA policy and procedures (14 CFR 1216.3.)

The purpose of this SEIS is to update the Final Environmental Impact Statement (FEIS) which was prepared for the NASA SRP in July 1973.

1.1 INTRODUCTION

The NASA SRP is a low-cost, quick-response activity employing a total of 18 launch vehicles, including test, meteorological, and ozonesonde (systems used to study atmospheric and ozone phenomena) rockets in support of scientific exploration of the upper atmosphere and near space. The program provides sounding rockets which carry research payloads with scientific instruments to altitudes ranging from 50 kilometers (30 miles) to approximately 1,500 kilometers (1,000 miles). The scientific payloads carried by sounding rockets reach altitudes three to four times higher than the Space Shuttle. The experiment time ranges up to 20 minutes.

Scientific data are collected and usually returned to Earth by telemetry links. Payloads are recoverable by parachute. Sounding rockets provide the only means for in situ measurements at altitudes between the maximum altitude of balloons (about 50 kilometers or 30 miles) and the minimum altitude for satellites (about 160 kilometers or 100 miles). The launch vehicles used by the NASA SRP for deployment of scientific payloads have:

1. high reliability (96.9-percent vehicle and 85.5-percent mission success rate in the last 10 years),
2. short mission lead time,
3. low cost,
4. mobility, and
5. payload recovery and reuse.

The NASA SRP supports space and Earth sciences research sponsored by NASA and other government agencies by providing suborbital vehicles for deployment of scientific payloads.

Currently, the program provides approximately 30 flight opportunities per year to space scientists in the disciplines of upper atmosphere, plasma physics, solar physics, planetary atmospheres, galactic astronomy, and high energy astrophysics.

Typical examples of science studies supported by SRP are:

<u>Upper atmosphere:</u> Cryogenic whole-air sampler measurements in support of upper atmospheric research satellite;

<u>Plasma physics:</u> Development of numerical model of the dip equator electrodynamic process and study of the electromagnetic pulse from lightning and its interaction with ionosphere;

Solar physics: Study of solar activity and the structure and plasma properties of coronal loops and study of high spatial and spectral resolution of ultra violet emissions of the Sun;

Planetary atmospheres: Observation of the Jupiter/Shoemaker Levy comet impact and study of hydrogen in the interplanetary medium;

Galactic astronomy: Study in ultra-violet astronomy with the primary goal of obtaining spatially resolved spectra of faint extended emission line objects and hot stars;

High energy astrophysics: High resolution X-ray spectroscopy of a bright mass transfer binary (Cygnus X-1) and high resolution x-ray spectroscopy in the vicinity of the north polar spur and SCO-X-1.

The contributions of SRP to this scientific endeavor include:

1. scientific instrument development for future space flight missions,
2. payload development for space missions,
3. proven testing ground for future space instruments.
4. graduate student education, and
5. international involvement and cooperation in space.

The programmatic elements of this SEIS apply to the launching of NASA sounding rockets on a worldwide basis, including launch sites in the United States; at foreign sites from Norway, Sweden, and elsewhere; and from mobile launch sites anywhere in the world. The site-specific aspects of this SEIS apply to the environmental impact issues at three principal domestic sounding rocket launch sites: Wallops Flight Facility (WFF), Eastern Shore of Virginia; Poker Flat Research Range (PFRR), Alaska; and White Sands Missile Range (WSMR), New Mexico. The site-specific aspects of this SEIS do not apply to the mobile launch sites, nor to the permanent launch sites abroad.

1.2 THE PURPOSE

The purpose of this SEIS is to update the Environmental Impact Statement (EIS) which was prepared for the NASA SRP in July 1973 [57][1]. The SEIS presented here reflects programmatic and site-specific changes in the NASA SRP that have taken place since 1973 by deleting launch vehicles that are no longer used, adding new launch vehicles and systems currently being used, updating changes in launch sites and ground support activities.

1.3 THE NEED

The need for information about near and far space is as old as the human race. Astronomical studies were conducted in antiquity, as they are today, in part to satisfy curiosity about the physical environment, and in part to meet the very needs of existence. In the second half of the 20th century, the use of aerospace vehicles

These studies enlarge our pool of general knowledge and are needed for generation of data and information on the nature and dynamics of the gragile environment so as to assure its preservation today and for generations as yet unborn.

[11] Numbers in brackets correspond with document numbers contained in the Bibliography.

ranging from aircraft to space probes became prevalent for observing properties and phenomena of the Earth's atmosphere, the solar system, and deep space.

The environmental studies dealing with ozone depletion and global warming are only a few examples of scientific programs carried out by NASA for the betterment of the Earth.

Presently, studies of near and far space are being carried out in the United States by NASA in space physics, astrophysics, solar system exploration, and Earth science and applications.

1.3.1 SPACE PHYSICS

Space physics are concerned with cosmic and heliospheric plasma physics, solar physics, mesospheric physics, and thermospheric physics. Its goals are to understand:

1. The Sun, as a star, and as the dominant source of energy, plasma, and energetic particles in the solar system.
2. The interactions between the solar wind and the solar system bodies, including studies of the ionosphere, mesosphere, thermosphere, and magnetosphere.
3. The nature of the heliosphere in its steady state as well as dynamic configuration.
4. The origin, acceleration, and propagation of solar and galactic cosmic rays.

To achieve these goals certain requirements must be met. These requirements include:

1. access to unique altitude regimes, such as the mesosphere (50 to 90 kilometers);
2. observation of highly structured and time-variable phenomena, such as auroras in the ionosphere (above 90 kilometers);
3. specific geographical locations, e.g., where noctilucent clouds are present or where unique ground- based facilities are needed for experiments; and
4. observation of suddenly occurring, short-lived or transient phenomena, such as solar flares, supernovas, or magnetic storms.

1.3.2 ASTROPHYSICS

Astrophysics specializes in contemporaneous observations across the entire electromagnetic spectrum, collection and analysis of world scientific community data, and a continuing series of short-time scale flight opportunities. This includes the fields of galactic astronomy and high-energy phenomena, including x-rays. The goals are in cosmology, astronomy, and physics and assist in providing answers to the following questions:

1. What was the origin of the universe? What is its large-scale structure? What will be its fate?
2. What is the origin of the galaxies, stars, planets and life, and how do they evolve?
3. What is the physics of matter under the extreme conditions found in astrophysical objects?

In galactic astronomy, various ultraviolet related observations are made, such as the study of ultraviolet spectra of stars and ultraviolet cosmic background radiation. At the same time, the field of spectroscopic instruments has been advanced to improve the quality of these observations. Diffuse x-ray background as determined by sounding rocket payloads is used for comparison with satellite observations.

1.3.3 SOLAR SYSTEM EXPLORATION

Solar system exploration is devoted to a better understanding of the solar system, expressed through the following goals:

1. Origin and Evolution. To determine the present nature of the solar system and to search for other planetary systems in various stages of formation, to understand how the solar system and its objects formed, evolved and, in one case, produced an environment that could sustain life.
2. Comparative Planetology. To better understand the planet Earth by studying the processes governing planetary development and understanding why the "terrestrial" planets of the solar system are so different from each other.
3. Pathfinders to Space. To establish the scientific and technical data base required for undertaking major human endeavors in space, including near-Earth resources in near-Earth and planetary surfaces.

Recent efforts have included a variety of observations in support of Halley's Comet research. Also, deep space missions have been supported by making baseline measurements of planetary or solar parameters at the time of planetary spacecraft encounters. In this category were measurements of sulfur dioxide in the atmosphere of Venus to compare with Pioneer-Venus data, and of solar extreme ultraviolet flux to compare with Voyager data at the time of the Neptune encounter. Also, spectrometer development was carried out for ultraviolet airglow observations.

1.3.4 EARTH SCIENCE AND APPLICATIONS

Earth science and applications deals with the study of phenomena in the Earth's atmosphere, oceans, on land, and within the biosphere. Its stated goal 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 scales. This involves the physical, chemical, and biological processes that operate to unify the Earth environment as a whole system. Global models will be tested against long-term data sets for validation.

1.4 THE SCOPE AND ORGANIZATION

This SEIS is organized into three principal parts: programmatic, site-specific, and analytic.

The programmatic part (Chapter 2.0) describes the propulsion systems used to support science research in the atmosphere and near-space and their alternatives. The site-specific part (Chapter 3.0) of this SEIS provides a description of the rocket launch sites and support facilities at WFF, PFRR, and WSMR. This part of the SEIS also addresses the environmental, cultural, and socioeconomical character of each site, as well as the atmospheric aspects of the environment impacted by this program. Chapter 4.0 of this SEIS addresses the environmental impacts of the programmatic aspects of the NASA SRP and its alternatives on a global scale and the site-specific environmental impacts at each major rocket launch site in the United States. Commitment of resources in support of this activity, effects on minority and low-income communities, and appropriate mitigation measures are also discussed in this part.

This SEIS presents new SRP programmatic and site-specific information and a review, analysis, and summary of all available pertinent and applicable data.

1.5 SOURCES OF INFORMATION

The information and data related to the site-specific environmental issues at WFF, PFRR, and WSMR comprise documents which were developed in support of NASA, Army, Navy, Air Force, range user's handbooks and a number of site-specific EA's and EIS's, commercial launch vehicles and missions. A number of additional general references related to this SEIS were also considered in preparation of this document (See Section 6.0, Bibliography).

The information used in preparation of the Draft SEIS for NASA SRP was enhanced in the Final SEIS by additional data which recently became available.

Programmatic information and data were provided by Mr. William B. Johnson, NASA GSFC\WFF for NASA SRP operations in FY's 93, 94, and 95. This information was used in updating the programmatic part of the report [34].

Site-specific information for Wallops Flight Facility (WFF) was updated and enhanced using the latest site-specific information from the ***Environmental Resources Document***, NASA Goddard Space Flight Center, Wallops Flight Facility, Wallops Island, Virginia 23337, published in August 1994 [54] and correspondence from the Department of Environmental Quality, Commonwealth of Virginia dated June 12, 1995.

Site-specific information for White Sands Missile Range (WSMR) was re-written using information from the draft ***White Sands Missile Range Range-wide Environmental Impact Statement*** published by the White Sands Missile Range, New Mexico, Directorate of Environment and Safety, Environmental Services Division, WSMR, New Mexico 88002 in June 1994 [144].

Site-specific information for Poker Flat Research Range is based largely on information contained in the ***Environmental Assessment, Improvement and Modernization Program, Poker Flat Research Range,*** Fairbanks, Alaska 99775 published by Geophysical Institute, University of Alaska, in April 1993 [25].

Specific details that form the basis of this analysis can be found in the referenced reports, and in a library of supporting documents to this SEIS maintained at the NASA Programs and Mission Management Division, Code 830, WFF, Wallops Island, Virginia 23337.

2.0 ALTERNATIVES INCLUDING THE PROPOSED ACTION

This chapter describes the actions which can implement the need for scientific observations of space as set forth in Section 1.2. First, proven Alternatives (2.1) are given. One of these is selected as the Proposed Action (2.2), and its omission becomes the No Action Alternative (2.3).

2.1 ALTERNATIVES

The location of space observing instrumentation falls into two classes. The Programmatic Alternatives (2.1.1) consist of global locations on and above the Earth's surface on various aerospace vehicles each having a unique altitude duration envelope. The Site-Specific Alternatives (2.1.2) are locations on the Earth's surface underlying the programmatic ("vertical") locations, or the sites from which observational aerospace vehicles are launched.

2.1.1 PROGRAMMATIC ALTERNATIVES

This subsection contains paragraphs which describe the usefulness of eight programmatic alternatives in obtaining data for science disciplines. These paragraphs are condensed into Table 2-1, which is a matrix of seven alternatives by six scientific disciplines. Information in this subsection was obtained from interviews with NASA Discipline Scientists:

1. Ultraviolet Astrophysics [142] [1];
2. Galactic Astronomy (X-Ray Astrophysics) [39];
3. Solar Physics [141];
4. Plasma Physics [21];
5. Planetary Atmospheres [12]; and
6. Earth Upper Atmosphere [40].

2.1.1.1 Ground Observations

Here the duration is of any desired length. In plasma physics, ground radar observations have been made, but spatial resolution is poor. However, the Earth's upper atmosphere has been observed remotely from a global network of ground stations for many years. Environmental impacts are confined to ground level and are minimal.

2.1.1.2 Aircraft Observations

These are typically limited to altitudes of 20 kilometers, with a duration of hours, which can be extended by refueling. Such observations are not useful in astrophysics. They are of limited use for solar physics, plasma physics, and planetary atmospheres. However, in situ observations in the Earth's lower atmosphere may be made in any location at any season for long durations, which has many advantages. Environmental impacts are principally due to operation of aircraft propulsion systems, such as exhaust emissions and noise.

2.1.1.3 Balloon Observations

Scientific unmanned balloons can ascend up to 40 kilometers for durations of days to months. Balloon observations are of limited use in solar physics and plasma physics. Planetary atmospheres can be observed in the high ultraviolet and in the infrared.

[1] 1Numbers in brackets correspond with document numbers contained in the Bibliography.

Table 2-1

MATRIX OF ALTERNATIVES FOR NASA SCIENCE MISSIONS[1]

	Space Science Disciplines		
Alternative (Altitude) - Duration -	*Ultraviolet Astrophysics (100A - 2000A Range)* [3]	*X-Ray Astrophysics*	*Solar Physics (Solar Atmosphere Telescopy)*
Ground (0km) - indefinite -	No observations possible in desired range.	No x-rays; no observations possible.	Limited observations possible; unsteady images.
Aircraft (to 10 km) - hours -	No observations possible in desired range.	No x-rays; no observations possible.	Limited observations possible; turbulence problems affect visibility.
Balloon (to 40 km) - days/months -	Marginal observations possible.	No x-rays; no observations possible.	Improved but still limited observations possible.
Suborbital Sounding Rocket (to 1,500 km) - minutes -	Observations in desired range.	X-rays above 160 km; observations in 160 km plus range.	Above 80 km good observation for short-term events.
STS[2] (250 km/400 km) - days/months -	Observations in desired range.	Observations in orbit.	Everything is visible with human attention; but, limited time for long-term events.
Satellite (500 km/ 15,000 km) - months/years -	Observations in desired range.	Observations in orbit.	Everything is visible for long-term; but, no human attention.
Space Probe (Planets/Galaxy) - years -	Closest observations possible.	Closest observations possible.	Closest observations possible.

1 km = kilometers
2 STS = Space Transportation System (Space Shuttle)
5 A = Angstroms

Table 2-1 (Concluded)

MATRIX OF ALTERNATIVES FOR NASA SCIENCE MISSIONS

	Space Science Disciplines		
Alternatives (Altitude) - Duration -	*Plasma Physics (Multiple Targets)*	*Planetary Atmospheres (Whole EM Spectrum)* [3]	*Earth Upper Atmosphere (Stratosperic Ozone)* [4]
Ground (0km) - indefinite -	Observations by radar; but, poor spatial resolution.	UV - Limited IR - Limited	Remote observations from global station network over many years.
Aircraft (to 10 km) - hours -	Mobile radar observations; but, power limited.	UV - Limited IR - Limited	*In situ* observations up to 20 km in any location at any time; many advantages.
Balloon (to 40 km) - days/months -	Limited to low altitude; poor resolution.	UV - Only above 2700A IR - good (ozone)	*In situ* observations by multiple instruments; limited locations and seasons.
Suborbital Sounding Rocket (to 1,500 km) - minutes -	Good *in situ* observations over 60 to 1,000 km; good coordination with ground.[5]	Good spectral range.	*In situ* NO_x and P-T observations, but limited locations and flight time.
STS[2] (250 km/400 km) - days/months -	Limited to high altitude; poor coordiation with ground.	Good spectral range.	Remote data from space for limited time; instruments recoverable.
Satellite (500 km/ 15,000 km) - months/years -	Limited to high altitude; poor coordination with ground.	Spectral range better at higher altitude.	Long-term remote data from space global sampling; no instrument recovery.
Space Probe (Planets/Galaxy) - years -	Not useful for earth atmosphere.	*In situ* planetary sampling.	Not useful for earth atmosphere.

[3] EM = electromagnetic
UV = ultraviolet
IR = infrared

[4] No_x = oxides of nitrogen
P-T = pressure-temperature

[5] Over half of the NASA SRP experiments are plasma physics (10-year data).

Multiple instruments can make in situ observations in the Earth's atmosphere (such as ozone), though locations and seasons are limited. Environmental impacts are minimal, associated with non-recovery of balloons after use.

2.1.1.4 Observations from Suborbital Sounding Rockets with State-of-the-Art Solid Propellants

Sounding rockets carry an instrument payload in the nose and, after ground launch follow a parabolic trajectory, returning to Earth some distance from the launch point. By staging three or four rockets in series, altitudes up to 1,500 kilometers can be reached with associated flight durations up to 20 minutes. Lower altitudes (and durations) can be explored with single- and two-stage rockets. Continuous observations can be made over the range of altitudes from ground to apogee during the upleg and downleg portions of the trajectory. The instrument payload is usually recoverable by parachute.

Sounding rockets can make astrophysical ultraviolet observations in the desired wavelength range. Above a 160-kilometer altitude, they can make X-ray astronomical observations. Above a 80-kilometer altitude, they can observe short-term solar physics events. Sounding rockets are highly useful for in situ plasma physics observations over the 60- to 1,000-kilometer altitude range. A good spectral range can be observed in planetary atmospheres. In the Earth's upper atmosphere, in situ observations of oxides of nitrogen and density variation can be made, though in limited locations and over short durations.

Environmental impacts of sounding rocket operation are associated with launch, flight trajectory, and landing. At launch, there are ground effects due to the first stage rocket takeoff, from exhaust emissions and noise. During the flight trajectory at the higher altitudes, there are exhaust emissions from the upper rocket stages, as well as releases into the atmosphere of launch vehicle hardware components, payload chemicals, and attitude control fluids. Landing impacts include dispersion of spent rockets, unrecovered payloads, and noise. The solid propellant systems currently used by the NASA SRP are based either on an ammonium perchlorate (AP)/ aluminum (Al) combination, or a nitrocellulose (NC)/nitroglycerin (NG) combination. Super Arcas; Orion; Black Brant V, VC, and VB; Tomahawk; Malemute; Aries; Nihka; Super Loki; and Viper IIIA are based on the AP/Al propellant combination, while the Nike, Taurus, Terrier, Talos, and 70-Millimeter Test Rocket are based on the NC/NG propellant combination.

2.1.1.5 Observations from Suborbital Sounding Rockets with Alternative Solid Propellants

The use of alternative solid propellants was also considered under this SEIS. The propellants currently used by the NASA SRP are either of the variety that contains an ammonium perchlorate (AP) oxidizer with an aluminum (Al) fuel in a binder matrix (usually referred as composite propellant), or a nitrocellulose (NC)/nitroglycerine (NG) combination (usually referred to as a double-base propellant). There are, of course, some variations in the actual constituents of these propellant types. The most significant variation usually occurs in the Al content.

Composite propellants may contain anywhere from 0% to 20% Al content. Similarly, double-base propellants may sometimes contain Al (the primary example is the Terrier Mk 12).

Emissions from composite propellants include hydrochloric acid and aluminum oxide, and are considered to be more harmful to the environment than emissions from double-base propellants. In 1989, NASA conducted an extensive operational and environmental evaluation of possible replacements for the composite propellants [55]. The alternatives considered and evaluated were propellants based on ammonium nitrate (AN) and cyclotetramethylene tetranitramine (HMX). This study determined that AN propellants are low in performance and would generate harmful emissions. The NASA study also rejected HMX propellants because HMX is a detonable substance, and therefore poses a safety concern.

HMX is also a constituent of composite-modified double-base (CMDB) propellants -- this formulation is most often represented as: AP-HMX/NC-NG/Al. CMDB propellants are currently employed on both Air Force (Minuteman) and Navy (Trident and Poseidon) strategic missile rocket motors. As these CMDB rocket become surplused by the Services, it is feasible that these motors may be acquired and utilized by the NASA SRP.

The Air Force is currently conducting research on innovative clean-burning propellants, such as aluminum hydrate, but propellant formulations based upon this research are not likely to be available until the next century [125].

2.1.1.6 Space Shuttle (STS) Observations

Here observations may be made during ascent to orbit, in Earth's orbit at altitudes in the 250- to 400-kilometer range for days or weeks, and during descent to Earth. For most of the time, human attention can be devoted to any experiments as needed, and the instruments are recoverable. The observations are confined to a particular orbit for a given flight.

From the Space Shuttle, both ultraviolet and X-ray astrophysical observations can be made. Solar atmosphere telescopy can be performed with human guidance, but the duration may not accommodate long-term events. Plasma physics observations are limited to high altitudes and coordination with the ground is limited. A good range of planetary atmosphere spectra is observable. Remote observation of the Earth's upper atmosphere is possible, and instruments are recoverable. Environmental impacts are mainly due to emissions from propulsion and attitude/orbit control rockets and from the human presence.

2.1.1.7 Satellite Observations

Unmanned satellites may be kept in Earth's orbit at altitudes from 500 to over 15,000 kilometers for months or years. Here, too, observations are confined to a particular orbit, but without human attention or instrument recovery. Astrophysical spectra can be observed, as with the STS. Long-term observations of the solar atmosphere are possible. Plasma physics observations are limited to the orbit altitude, and coordination with the ground is limited. The spectral range for planetary atmosphere observation is good and improves as orbit altitude increases. Remote data on the Earth's upper atmosphere can be recorded for long periods of time, but without instrument recovery. Environmental impacts are due to emissions from propulsion and attitude/orbit control rockets, plus out-gassing from solid surfaces at the high vacua encountered.

2.1.1.8 Space Probe Observations

Space probes usually target a planet in the solar system or even regions in the vicinity of the Sun, and are programmed to be on their way for years. This means that they are best suited for observations of the most remote objects, such as the stars (astrophysical spectra) and the Sun (solar atmosphere telescopy). They can sample planetary atmospheres in situ while approaching their target planet. Space probes are not suitable for upper atmosphere observations during most of their trajectory because of their increasing distance from Earth. Environmental impacts are due to emissions from propulsion and attitude/orbit control rockets, and outgassing from solid surfaces, as before.

2.1.2 SITE-SPECIFIC ALTERNATIVES

The first five Programmatic Alternatives listed above are tied to specific ground sites, for ground observations (2.1.1.1), aircraft takeoff (2.1.1.2), balloon launching (2.1.1.3), and rocket launching (2.1.1.4 and 2.1.1.5). In contrast, the Space Shuttle (2.1.1.6) and satellites (2.1.1.7) are basically Earth orbiting instrument platforms which can be launched from various sites and still achieve the same orbit. The Space Probe (2.1.1.8) can be launched from various sites and also reach its distant destination.

In all cases, the location in space, date, and diurnal time of the desired scientific observations determine the ground site and date, time, and direction of launch of the aerospace vehicle of the particular Programmatic Alternative. For example, observations of aurora are made at high latitudes in winter, whereas observations of terrestrial magnetism have been made near the equator. Aircraft and balloons may be launched from a multiplicity of airports and launch pads close to the desired location of the scientific observations.

Sounding rocket vehicles consist of small rockets which move in suborbital trajectories. They require launchers (e.g., of the rail or tube type) and present some environmental risks at takeoff. Therefore, rocket launch sites and associated support facilities of some complexity are needed. These sites are permanent where repeated launches take place year after year, but temporary (and removable) for special or limited use.

The orbital or escape vehicles (Space Shuttle, satellites, space probes) are very large and require extensive permanent launch facilities, especially if a human crew is involved. Only a few such facilities exist globally.

2.2 PROPOSED ACTION

In this SEIS, the Proposed Action is the continuation of current observations from suborbital sounding rockets with state-of-the-art propellants, as outlined above in 2.1.1.4 and paragraph 3 of 2.1.2.

Included in the Proposed Action are these three current NASA programmatic components:

1. The SRP which employs 15 launch vehicles for various space scientific missions (2.2.1);
2. The Meteorological Rocket Program (MRP) which employs two launch vehicles for weather and ozone observations (2.2.2); and
3. The Test Rocket Program which supports each SRP and meteorological rocket flight by preflight launches of one or two 70-millimeter test rockets to act as targets for checkout of ground radar (2.2.3).

Also included in the Proposed Action are three site-specific components in the form of these permanent SRP launch facilities in the United States: WFF at Wallops Island, Virginia; PFRR at Fairbanks, Alaska; and WSMR at White Sands, New Mexico (2.2.4).

Since individual Sounding Rocket campaigns occur at a variety of other worldwide locations with little frequency at each one, and no long-term schedule, NASA will prepare appropriate environmental documentation for individual campaigns on a case-by-case basis.

2.2.1 SRP WITH STATE-OF-THE-ART PROPELLANTS

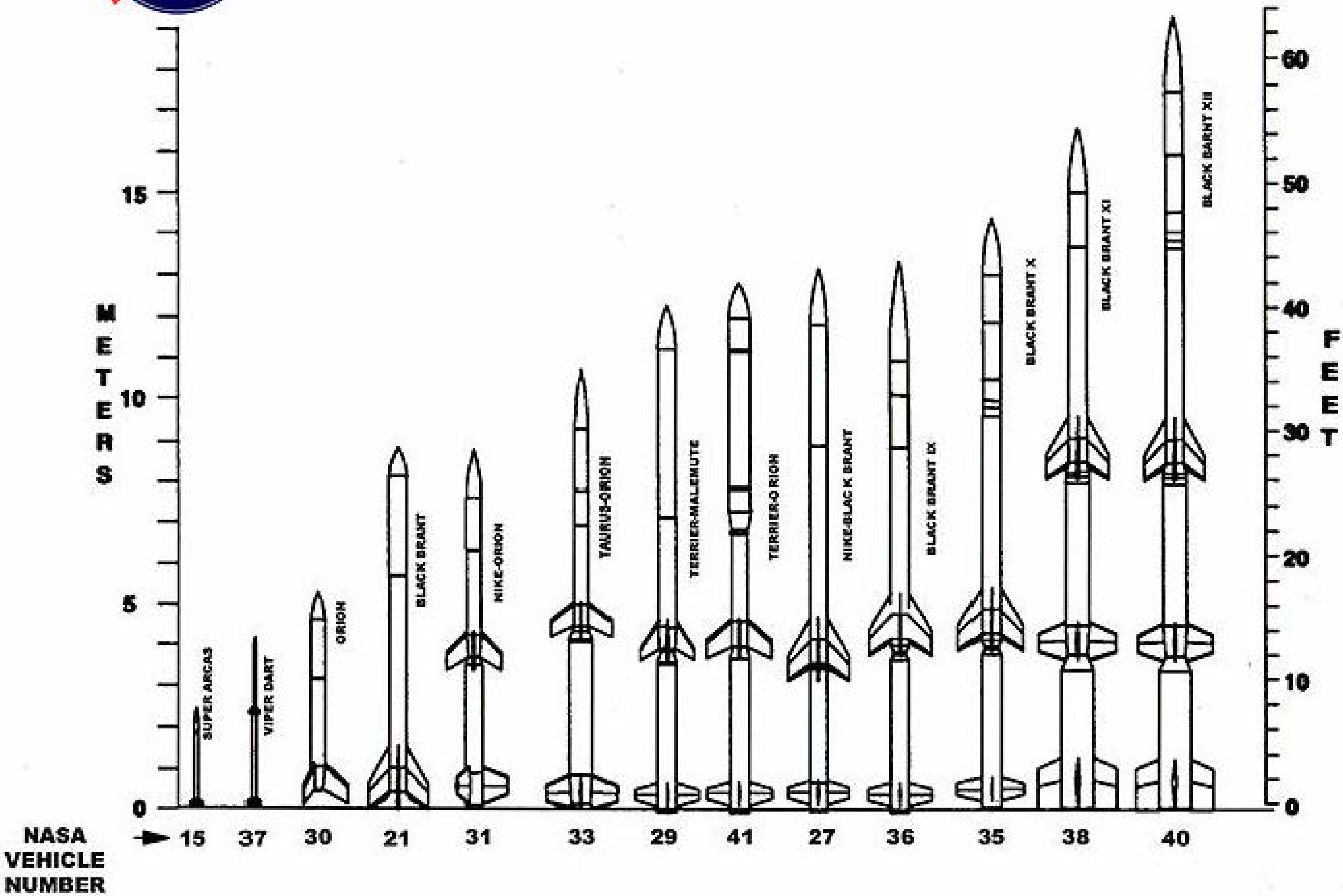
Sounding rockets take their name from the nautical term "to sound" which means to take measurements. A sounding rocket consists of a solid propellant rocket motor and a scientific payload mounted forward of it. The SRP sounding rockets come in a variety of sizes, from the small single-stage Super Arcas, less than 3 meters high, to the four-stage Black Brant XII which stands 20 meters high. Figure 2-1 shows the relative dimensions of all 15 current launch vehicle systems [86].

The payload section near the nose of the last rocket stage carries the instruments to conduct experiments and send data back to Earth. Such studies are performed at specified times and at varied geographic locations and altitudes.

Sounding rockets are launched from permanently established sites or temporary launch ranges. Figure 2-2 [86] is a map of the Earth, showing global SRP launch site locations. Permanent sites include WFF in Wallops Island, Virginia; PFRR near Fairbanks, Alaska; WSMR in White Sands, New Mexico; Kwajalein Island, Marshall Islands Republic; Esrange, Kiruna, Sweden; and Norwegian Sounding Rocket Range, Andoya, Norway. In the past some of the temporary launch ranges were in Antarctica, Australia, Brazil, Greenland, Peru, and Puerto Rico.

Space physics, astrophysics, solar system exploration, and Earth sciences, assume scientific cognizance over aerospace shells surrounding the Earth with increasing distance from the Earth.

SOUNDING ROCKET LAUNCH VEHICLES



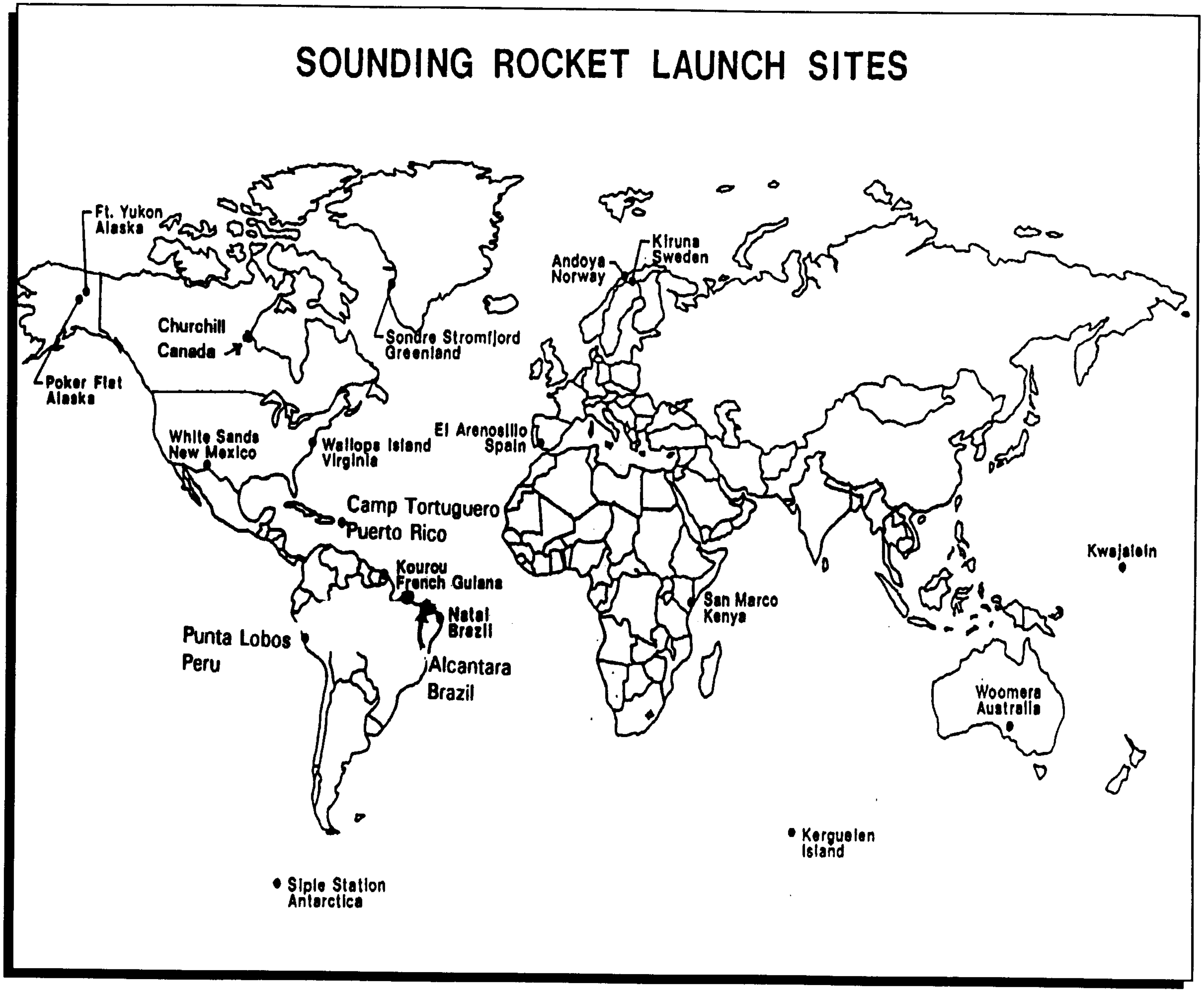


Figure 2-2. Sounding Rocket Launch Sites

Somewhat simplified, observations from sounding rocket payloads are of two types: (1) "optical," scanning different parts of the electromagnetic spectrum (ultraviolet, visible, infrared, X-ray, etc.); and (2) testing of matter in situ, such as nitrous oxide and ozone determinations by physical-chemical-electronic-magneticprobes or detectors. Optical observations can be closeup (in situ) or long-range (tens or hundreds of kilometers) or intermediate between the two. The payloads may be used in a number of ways. These are:

1. to carry optical scanning instrumentation and/or physical-chemical-electromagnetic probes or detectors and make appropriate measurements;
2. to release specific chemicals over a prescribed altitude range; or
3. to be simply a target whose motion is tracked by radar or telemetry for meteorological data.

The launch sites may or may not need to be specific. If the aurora borealis is observed, a northern latitude is needed, such as at PFRR, Fairbanks, Alaska. If equatorial phenomena must be observed, a site such as Brazil or Peru is indicated. For middle latitudes, Wallops Island, Virginia, or White Sands, New Mexico, are indicated. The time of day or the season of year frequently is also a factor, and sometimes the "window of opportunity" can be limited. Ability to recover payloads may also serve to define the usable launch ranges.

Table 2-2 lists the 290 payloads launched by the NASA SRP during the 10-year period - fiscal year (FY) 86 through FY95 by discipline [76]. During this period, the majority of the launches (148) were devoted to plasma physics, followed by upper atmosphere research (43), solar physics (30), galactic astronomy (24), planetary atmospheres (19), high energy astrophysics (14) and other (12). The 10-year sounding rocket activity by location is presented in Table 2-3, and by launch vehicle type in Table 2-4 [76]. Comparing permanent launch sites, about one-half of the launches are from WSMR, followed by WFF and PFRR. From Table 2-4, the trend in recent years has been to use more powerful launch vehicles in order to lift heavier payloads, now averaging 270 kilograms, to altitudes from 50 to over 1,500 kilometers. Flight times, from ground launch to surface impact, up to 20 minutes have been achieved.

The success rates for the NASA SRP during the last 10 years are presented in Table 2-5 [76]. This table shows an average vehicle success rate of 96.9 percent, and an average experimental success rate of 85.5 percent. Since the SRP was started in 1959, there have been 2,698 flights with an experimental success rate over 86 percent and a vehicle success rate of over 95 percent.

Here a vehicle success means that the actual flight trajectory was sufficiently close to the planned trajectory for the minimum scientific mission to be accomplished. Experimental or mission failure means that minimum success criteria were not achieved, due to a vehicle failure, experimental problems, or a combination.

Table 2-2
10-YEAR SOUNDING ROCKET ACTIVITY BY DISCIPLINE
FY86 THROUGH FY95[1]

Discipline	Fiscal Year										
	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	10-Year Total
Galactic Astronomy (A)[2]	4	1	3	2	6	2	2	1	1	2	24
High Energy Astrophysics (A)	2	0	4	1	1	2	1	2	0	1	14
Solar Physics (SR)	1	4	5	4	0	6	2	3	1	4	30
Plasma Physics (SP)	14	18	16	10	17	10	18	5	25	15	148
Upper Atmosphere (E)	9	5	3	4	1	2	7	8	2	2	43
Planetary Atmospheres (SS)	3	1	1	4	3	2	0	1	2	2	19
Other	0	0	1	0	2	1	2	0	2	4	12
All Disciplines	33	29	33	25	30	25	32	20	33	30	290

[1] [76]

[2] Office of Space Science and Application Division

A = Astrophysics
E = Earth Sciences
SP = Space Physics
SR = Solar Physics
SS = Solar System Exploration

Table 2-3
10-YEAR SOUNDING ROCKET ACTIVITY BY LOCATION
FY86 THROUGH FY95[1]

Location	Fiscal Year										
	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	10-Year Total
Wallops Island, VA	6	7	5	2	4	1	5	1	5	2	38
White Sands, NM	14	8	10	12	12	13	13	16	9	17	124
Poker Flat, AK	8	2	3	2	7	3	6	3	8	7	49
Norway - Andoya	2	4	8	3	0	1	0	0	1	1	20
Sweden - Kiruna	3	0	1	2	0	7	0	0	0	0	13
Canada- Churchill	0	0	0	4	0	0	0	0	0	0	4
Kwajalein Island	0	0	0	0	7	0	0	0	0	0	7
Australia - Woomera	0	0	6	0	0	0	0	0	0	0	6
Greenland - Sondre Stromfjord	0	8	0	0	0	0	0	0	0	0	8
Brazil - Alcantara	0	0	0	0	0	0	0	0	10	3	13
Puerto Rico - Tortuguero	0	0	0	0	0	0	8	0	0	0	8
All Disciplines	33	29	33	25	30	25	32	20	33	30	290

[1] [76]

Table 2-4
10-YEAR SOUNDING ROCKET ACTIVITY BY LAUNCH VEHICLE
FY86 THROUGH FY95[1]

Fiscal Year	Launch Vehicle[2]																
	12[3]	15	18	21	24	27	29	30	31	33	34	35	36	38	39	40	Annual Flights
1986	0	5	0	2	1	4	1	1	5	1	0	5	5	3	0	0	33
1987	0	4	1	0	0	5	2	2	1	3	1	1	6	3	0	0	29
1988	1	0	0	1	0	3	0	3	7	0	0	2	15	1	0	0	33
1989	0	0	0	4	0	2	1	0	2	2	0	5	9	0	0	0	25
1990	2	0	0	0	0	2	2	1	1	2	0	2	12	4	1	1	30
1991	1	3	0	3	1	1	0	0	4	0	0	0	11	0	0	1	25
1992	1	0	4	1	0	2	0	1	7	0	0	0	13	2	1	0	32
1993	0	0	0	0	1	1	0	0	8	0	0	1	7	0	0	2	20
1994	1	0	6	2	0	2	0	2	9	2	0	0	8	0	0	0	33
1995	1	0	1	2	0	1	0	2	5	1	0	2	15	0	0	0	30
10-Year Total	7	12	12	15	3	23	6	12	49	11	1	18	101	13	2	5	290

1 [76]
2 Current Vehicles: 15=Super Arcas, 18=Nike-Tomahawk, 21=Black Brant VB, 24=Aries, 27=Nike-Black Brant VB, 29=Terrier-Malemute, 30=Orion, 31=Nike-Orion, 33=Taurus-Orion, 34=Taurus-Tomahawk, 35=Black Brant IX, 36=Black Brant IX; 38=Taurus-Nike-Tomahawk, 39=Black Brant XI, 40=Black Brant XII.
3 Generic number assigned to test vehicles.

Table 2-5
MISSION SUCCESS RATES 10-YEAR ROCKET ACTIVITY
FY86 THROUGH FY95[1]

Fiscal Year	Vehicle			Experiment		
	Success	Failure	%Success	Success	Failure	%Success
1986	31	2	93.9	28	5	84.8
1987	28	1	96.6	26	3	89.7
1988	33	0	100	31	2	93.9
1989	23	2	92.0	21	4	84.0
1990	30	0	100	25	5	83.3
1991	24	1	96.0	22	3	88.0
1992	32	0	100	31	1	96.9
1993	18	2	90.0	14	6	70.0
1994	32	1	97.0	25	8	75.8
1995	30	0	100	25	5	83.3
10-Year Total	281	9	96.9	248	42	85.5

[1] [76]

Thus, a vehicle failure will always result in a mission failure, and the mission success rate will always lie at or below the vehicle success rate.

This section contains a description of the 15 launch vehicles. Each description includes a typical trajectory with a payload designed to achieve a specific mission. For each launch vehicle, one flight was selected from those carried out during FY88 or later.

Each suborbital trajectory is close to parabolic in shape, with the apogee and impact range (distance along the surface from launch site to impact of last spent rocket with or without payload) determined by the launch weight of the rocket system, the payload weight, the thrust of the rocket system, and the launch angle. Higher apogees are created by lower weights, higher thrusts, and steeper launch angles. Longer impact ranges are created by lower weights, higher thrusts, and less steep launch angles. Each mission is designed to lift a given payload to a specific part of the atmosphere. This is achieved by proper selection of launch vehicle (thrust/weight) and launch angle.

Of the 15 launch vehicles all but one (the single-stage Aries) are unguided, i.e., their trajectory is precomputed, providing the compass direction and elevation angle for "pointing" the vehicle at launch. A few vehicles have an onboard S-19 Boost Guidance System for the first 10 to 18 seconds of flight, but no other in-flight guidance. For "pointing," the vehicle is secured to 'launchers' which are rigid rails, tubes, or towers able to swivel and rotate into the desired launch attitude. In contrast, the Aries sits on a horizontal launch pedestal or platform and after vertical launch has built-in gimballed nozzles with an onboard flight guidance and control system to cause it to follow the desired trajectory.

During the flight of a typical three-stage rocket launch vehicle, some or all of the following materials are ejected into the atmosphere:

1. Burned propellant (exhaust gases and products of combustion) from the first-, second-, and third-stage rockets, mixing with the air and driven by the wind.

2. Spent rocket cases (mostly metallic) from the first, second, and third stages, in ballistic paths to ground impact.

3. Other launch vehicle solids (such as despin weights, nose cone, instrument doors) at different points in the trajectory, tumbling to ground impact.

4. Chemical releases from the scientific payload, usually gaseous or liquid, in the higher reaches of the trajectory, mixing with the air and driven by the wind.

5. Scientific payloads, either recovered by drogue/parachute or not recovered and allowed to follow the trajectory to ground impact.

6. Attitude control fluids or gases.

7. A release of residual propellants in case of launch failure.

8. Outgassing of materials due to ambient low pressure and aerodynamic heating.

If the flight is over water the stated impacts will be to water rather than ground. This means that heavier-than- water material will sink if no recovery system is used, while lighter- than-water material (or items provided with floats) will float and may be recovered later. The following pages graphically illustrate the characteristics of the 15 launch vehicles. Each vehicle description contains a set of sheets with the following information.

1. The subsection number, name, and SRP numerical designation, e.g., 2.2.1.1 Super Arcas (15).

2. An outline drawing of the launch vehicle to scale, with rockets and payload labeled.

3. Trajectory drawings (one or more, as needed for clarity) to scale with ignition and burnout for each stage and other important flight events indicated.

4. The launch vehicle design block containing launch weights, propellant weights, and impact weights, as well as vehicle dimensions.

5. The propellant composition with names of chemicals for each solid propellant rocket, as manufactured.

6. The exhaust emissions showing the weight of each chemical in the burned propellant for each rocket, and the altitudes and times in the trajectory when released. Basically, the type and amount of each chemical species present in the propellant combustion products are computed from thermochemical reaction theory and flow expansion through the exit nozzle. Sampling of the exhaust stream and thrust measurements are used to confirm the computation. In the present case, the emission data were obtained from the rocket manufacturers and the standard compilation by the Chemical Propulsion Information Agency (CPIA). The combustion dissociates metallic compounds in the raw propellant into the metallic element, e.g., lead beta resorcylate and lead salicylate into elemental lead.

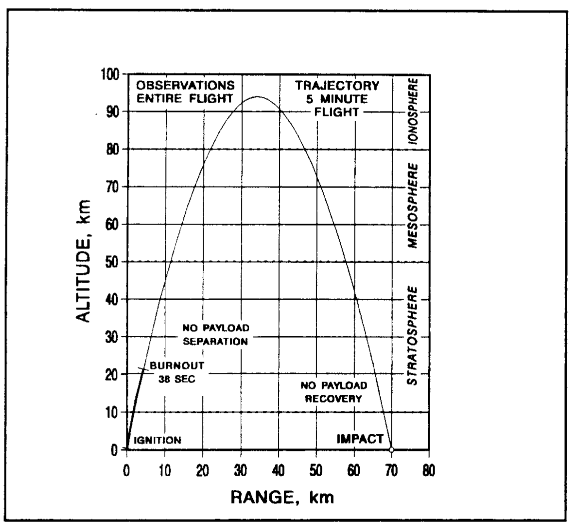
7. The missions and payloads block, containing the number of flights with this vehicle during FY86 through FY95, estimated planned flights during FY96, and a brief statement of the scientific mission purpose, including releases, recovery, and impact.

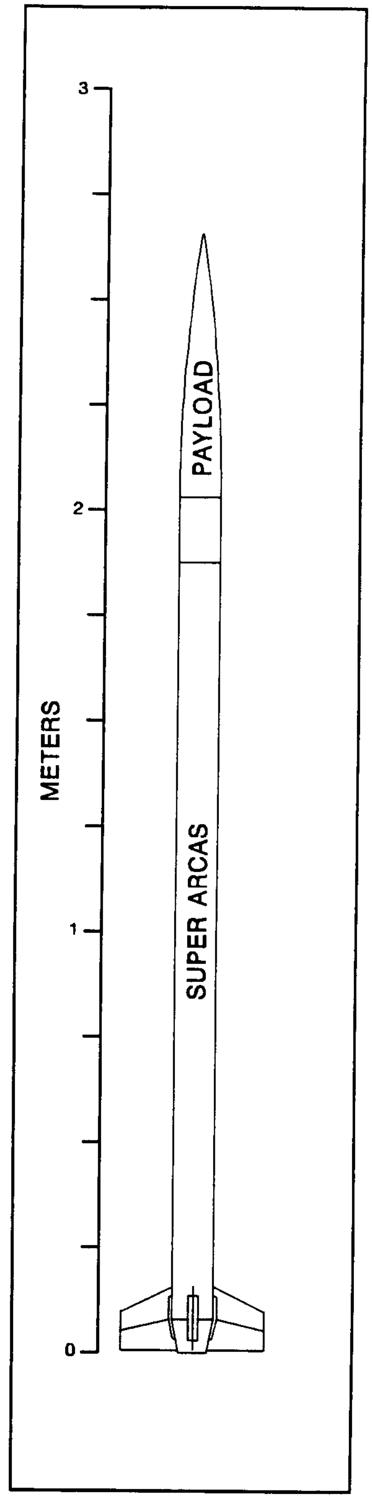
8. Text summarizing salient engineering features of the launch vehicle and typical missions for which it is used.

2.2.1.1 Super Arcas (15)

Since 1962, Super Arcas, a single stage, unguided solid propellant rocket has been used for carrying meteorological and other payloads weighing from 4 to 8 kilograms as high as 100 kilometers, with flight times of about 5 minutes and an impact range of 60 kilometers. The vehicle has a diameter of 0.114 meter and a total length between 2.50 and 2.75 meters, of which about 0.75 meter is taken up by the payload. During the last 10 years, 12 flights have taken place.

The solid rocket propellant is a mix of ammonium perchlorate, aluminum, and polyvinyl chloride and weighs 25 kilograms. The spent rocket has an impact weight of 12.5 kilograms. The rocket exhaust emissions are principally aluminum oxide, carbon monoxide, and hydrogen chloride. These compounds are emitted during the rocket burning time of 38 seconds over the associated altitude span from ground to some 20 kilometers. Usually, the experiment is housed in the nose cone. If recovery is desired, the experiment is mated to a parachute assembly with ground or air retrieval. [4, 36, 69, 86]





2.2.1.1 Super Arcas (15) (Concluded)

LAUNCH VEHICLE DESIGN					
Rocket	Diameter meter	Length meter	Total wt. kg	Propellant wt. kg	Impact wt. kg
Super Arcas	0.114	1.925	37.5	25.0	12.5
Payload	0.114	0.756	4.6	-	4.6
	Launch	2.681	42.1	25.0	

SUPER ARCAS PROPELLANT COMPOSITION	
Ammonium perchlorate	Polyvinyl chloride
Aluminum	Dioctyl adipate

SUPER ARCAS EXHAUST EMISSIONS, kilogram	
Compound	0-22 km; 0-38 sec
Aluminum oxide	9.9
Carbon monoxide	6.5
Hydrogen chloride	5.7
Nitrogen	1.8
Hydrogen	0.8
Other	0.3
Total	25.0

MISSIONS AND PAYLOADS					
No. of Flights		FY 91 Mission (Kiruna, Sweden)	Payload Releases	Payload Recovery	Impact Medium
FY 86-95	FY 96				
12	0 (estd)	HANLC&PMSE by MISTI	None	None	Land

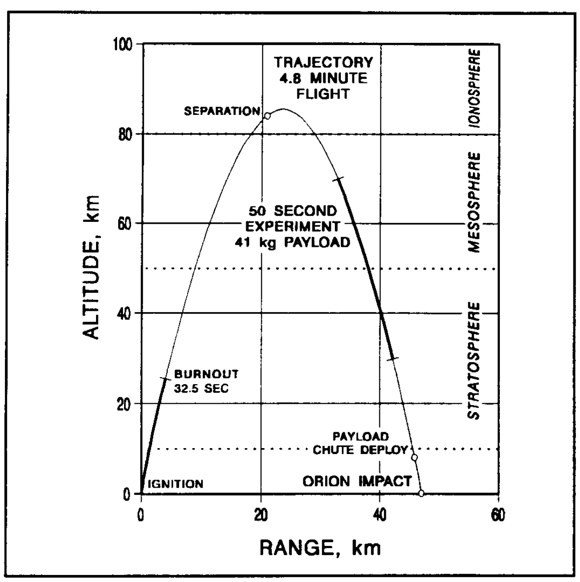
HANLC = High Altitude Noctilucent Clouds
PMSE = Polar Mesospheric Summer Echoes
MISTI = Mesospheric Ionization Structure and Turbulence Investigation

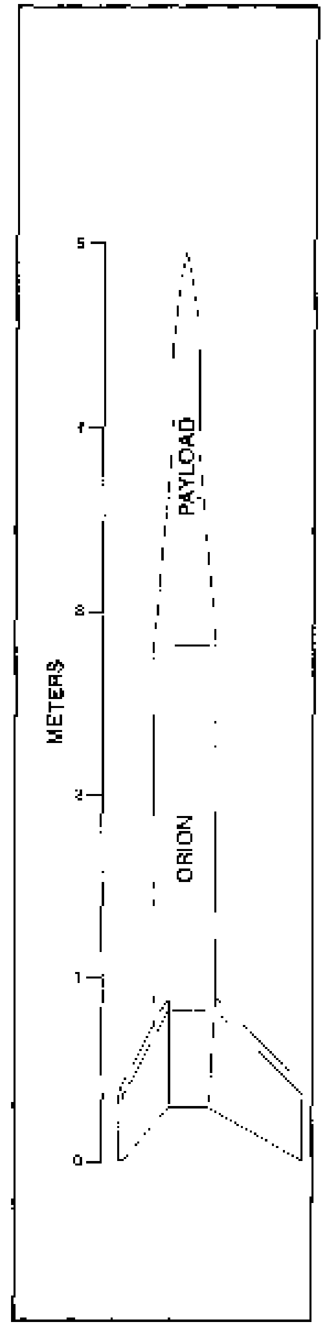
2.2.1.2 Orion (30)

Orion is a single-stage, unguided, solid propellant rocket system for lifting payloads to altitudes below 100 kilometers. Flight stability is achieved by three equidistant fins at the rocket aft end. The vehicle can carry a 38-kilogram payload to 88 kilometers, or a 68-kilogram payload to 71 kilometers. Impact ranges vary from 25 to 50 kilometers. The rocket and payload diameter is 0.36 meter. Vehicle length is 2.8 meters, to which a payload length from 1.8 to 2.5 meters is added. During the last 10 years, 12 flights have taken place.

The Orion propellant weighs 278 kilograms and is a mix of ammonium perchlorate, polyurethane, and nitroguanadine with an aluminum additive. The rocket exhaust emissions are mainly hydrogen chloride, water, carbon monoxide, carbon dioxide, and aluminum oxide. They occur during the 32.5-second burning time over the altitude span from ground to about 25 kilometers.

Standard hardware includes a separable clamshell nose cone. Separation systems can be provided to separate the rocket from the payload. [4, 68, 86]





2.1.2 Orion (30) (Concluded)

LAUNCH VEHICLE DESIGN					
Rocket	Diameter meter	Length meter	Total wt. kg	Propellant wt. kg	Impact wt. kg
Orion Payload	0.36 0.36/0.15	2.68 2.26	418 41	278 -	140 *41
	Launch	4.94	459	278	*Chute Recovery

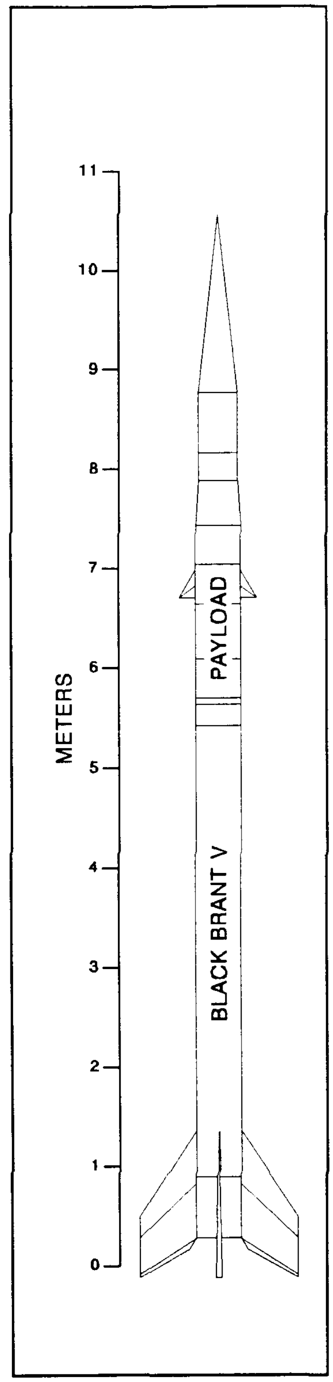
ORION PROPELLANT COMPOSITION	
Ammonium Perchlorate	Polyurethane
Aluminum	Nitroguanadine

ORION EXHAUST EMISSIONS, kilogram	
Compound	0-24.8 km; 0-32.5 sec
Aluminum oxide	31
Carbon monoxide	50
Carbon dioxide	44
Hydrogen chloride	64
Nitrogen	26
Hydrogen	4
Copper	1
Total	278

MISSIONS AND PAYLOADS					
No. of Flights		FY 91 Mission (Fairbanks, Alaska)	Payload Releases	Payload Recovery	Impact Medium
FY 86-95	FY 96				
12	0 (estd)	Extend atmospheric conductivity and electric field measurements to lower altitudes (70 to 30 km) simultaneous with launch vehicle (33) launch and measurements.	None	Yes - by parachute	Land

2.2.1.3 Black Brant V (21)

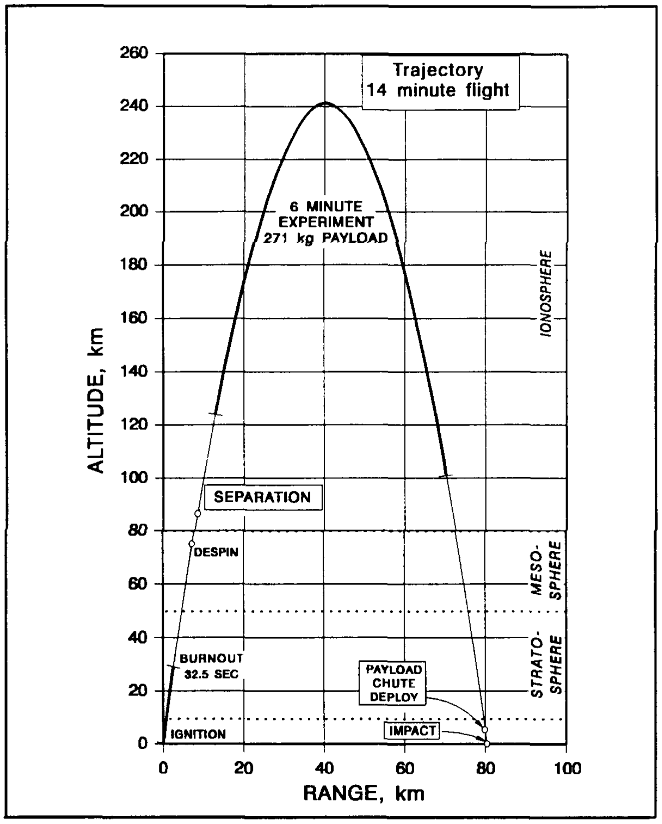
Black Brant V ("five") is a single-stage, unguided, solid propellant rocket. There is a three-fin version, VB, and a four-fin version, VC. The vehicle can lift a 180-kilogram payload to 290 kilometers, or a 450-kilogram payload to 140 kilometers. Maximum payload weight is 570 kilograms. Flight times vary from 10 to 15 minutes, and impact ranges from 80 to 200 kilometers. The Black Brant V (BBV) diameter is 0.44 meter which is also the maximum payload diameter. The total vehicle length is between 10 and 11 meters, of which the payload is limited to around 5 meters. During the last 10 years, 15 flights have taken place.



The BBV propellant weighs 997 kilograms and is of the ammonium perchlorate/aluminum/plastic binder type with small amounts of carbon black, iron, and sulfur. The rocket exhaust emissions consist mainly of aluminum oxide, carbon monoxide, hydrogen chloride, nitrogen, and water. They occur during the 32.5-second burning time over the altitude span from ground to about 30 kilometers. The spent rocket has an impact weight of 260 to 270 kilograms, varying with the number of fins. Standard hardware available for BBV vehicles includes despin systems and payload separation systems contained within the igniter housing.

Also, all payloads may be recovered by the Ogive Recovery System Assembly (ORSA) or aft recovery systems. Most of these can be mounted (in a stack) at the same time. [4, 61, 86].

2.2.1.3 Black Brant V (21) (Continued)



LAUNCH VEHICLE DESIGN					
Rocket	Diameter meter	Length meter	Total wt. kg	Propellant wt. kg	Impact wt. kg
Black Brant V Payload	0.44 0.44	5.3 5.3	1265 271	997 -	268 271
	Launch	10.6	1536	997	

2.2.1.3 Black Brant V (21) (Concluded)

BLACK BRANT V PROPELLANT COMPOSITION	
Ammonium perchlorate	Toluene di-isocyanate
Aluminum	Carbon black
Polypropylene glycol	Iron acetylacetate
Poly 1,4-butylene glycol	Sulfur
N-phenyl-beta-naphthylamine	Dioctylazelate

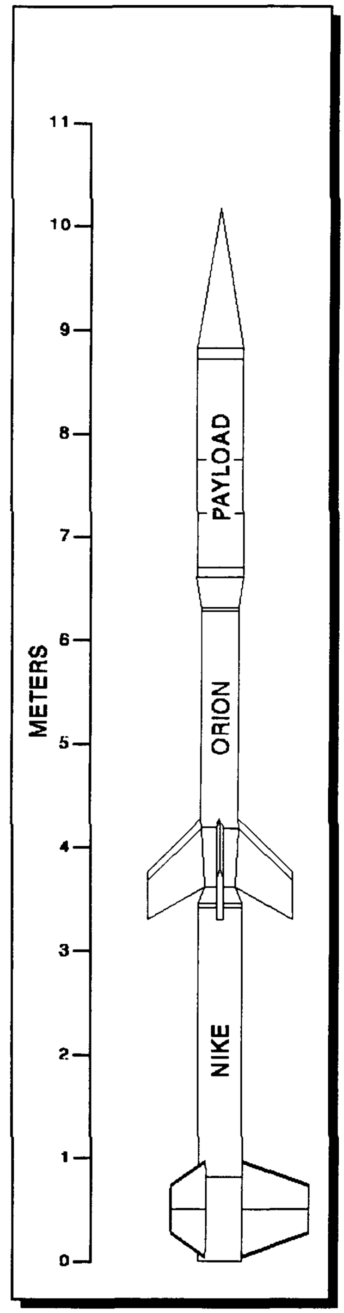
BLACK BRANT V EXHAUST EMISSIONS, kilogram	
Compound	0-29.8 km; 0-32.5 sec
Aluminum oxide	357
Carbon monoxide	288
Hydrogen chloride	187
Nitrogen	76
Water	40
Hydrogen	30
Carbon Dioxide	14
Sulfur	1
Other	4
Total	997

MISSIONS AND PAYLOADS					
No. of Flights		FY 89 Mission (White Sands, New Mexico)	Payload Releases	Payload Recovery	Impact Medium
FY 86-95	FY 96				
15	1 (estd)	EUV Solar irradiance calibration for ASSI	None	Yes - by drogue and parachute	Land

EUV = Extreme Ultraviolet; ASSI = Airglow Solar Spectrometer Instrument

2.2.1.4 Nike-Orion (31)

Nike-Orion is a two-stage, unguided, solid propellant rocket system with a Nike first stage and an Orion second stage. The Nike has three equally spaced fins, while the Orion has four fins in a cruciform arrangement for flight stability. This vehicle carries a 68-kilogram payload to 190 kilometers, a 204-kilogram payload to 90 kilometers, or a 350-kilogram payload to 60 kilometers. Impact ranges vary from 30 to 120 kilometers. The Nike diameter is 0.42 meter, while the Orion and payload have a 0.36-meter diameter. The vehicle length is 6.3 meters to which is added a payload length between 1.8 and 2.5 meters. During the last 10 years, 49 flights have taken place.

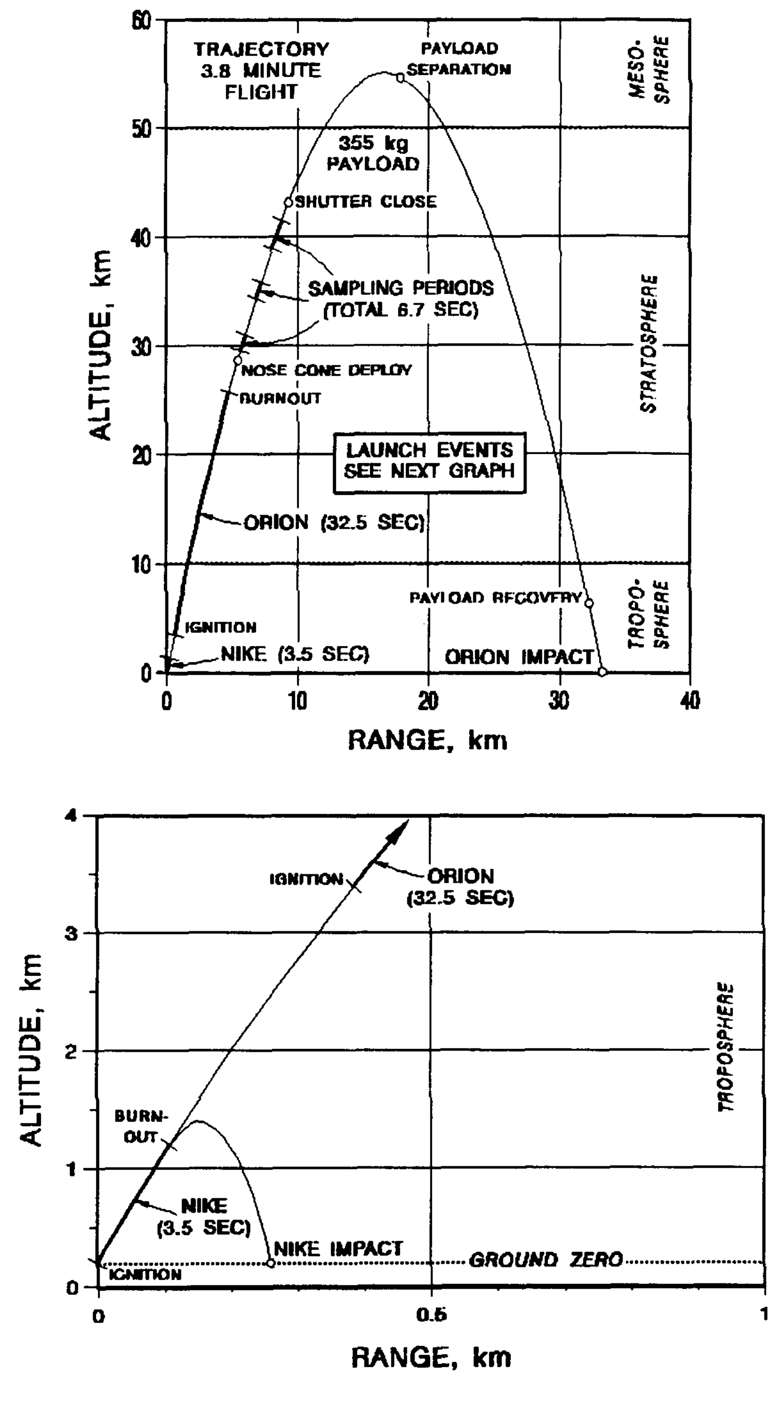


The Nike propellant weighs 340 kilograms and is of the nitrocellulose/ nitroglycerin family with small amounts of carbon black, iron, and sulfur added. The rocket exhaust emissions are mainly carbon monoxide, carbon dioxide, water, and nitrogen. They occur during the 3.5- second burning time over the altitude span from ground to about 15 kilometers. Nike impacts with a spent rocket weight of 276 kilograms about 0.3 kilometer from the launch pad.

The Orion propellant weighs 278 kilograms and is a mix of ammonium perchlorate, polyurethane, and nitro-guanadine with aluminum added. The rocket exhaust emissions are mainly hydrogen chloride, water, carbon monoxide, carbon dioxide, and aluminum oxide. They occur during the 32.5-second burning time which starts 6 seconds after Nike burnout, over the altitude span from 3.5 to 26 kilometers.

The spent rocket weight is 140 kilograms at final impact.Standard hardware includes a separable clamshell nose cone. Separation systems can be provided to separate the payload from the second stage during ascent. [4, 66, 86]

2.2.1.4 Nike-Orion (31) (Continued)



2.2.1.4 Nike-Orion (31) (Continued)

LAUNCH VEHICLE DESIGN					
Rocket	Diameter meter	Length meter	Total wt. kg	Propellant wt. kg	Impact wt. kg
Nike	0.42	3.64	616	340	276
Orion	0.36	2.66	418	278	140
Payload	0.36/0.44	3.71	355	-	355
	Launch	10.01	1389	618	

PROPELLANT COMPOSITION	
Nike	Orion
Nitrocellulose Nitroglycerin Triacetin 2-Nitrodiphenylamine Diphenyl-amino-methyl substituted phenols Lead stearate Graphite	Ammonium perchlorate Polyurethane Nitroguanadine Aluminum

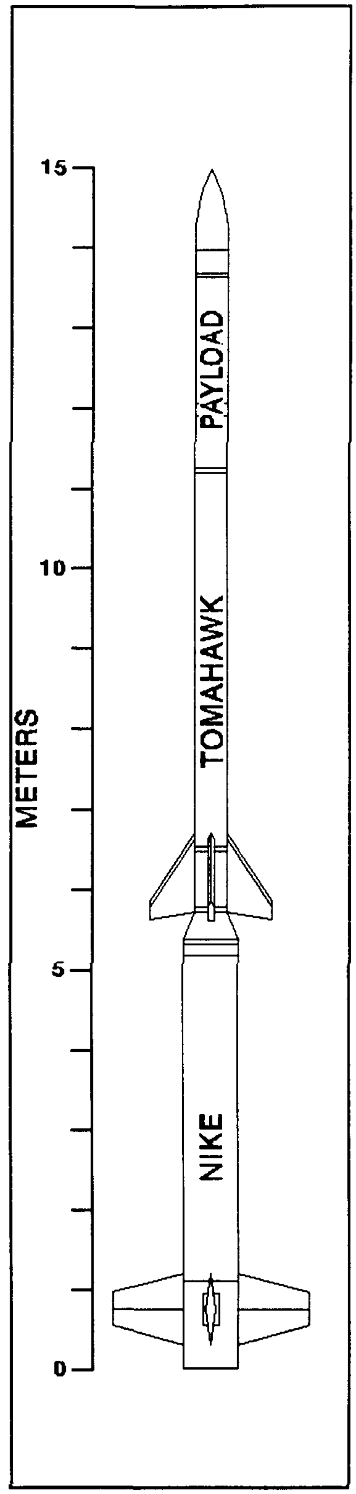
EXHAUST EMISSIONS, kilogram		
Compound	Nike 0.2-1.1 km 0-3.5 sec	Orion 3.3-25.7 km 9.0-41.6 sec
Carbon monoxide	182	50
Carbon dioxide	61	44
Water	44	58
Nitrogen	41	26
Hydrogen	6	4
Lead	6	-
Hydrogen chloride	-	64
Aluminum oxide	-	31
Copper	-	1
Total	340	278

2.2.1.4 Nike-Orion (31) (Concluded)

MISSIONS AND PAYLOADS				
No. of Flights		FY 91 Mission (Fairbanks, Alaska)	Payload Recovery	Impact Medium
FY 86-95	FY 96			
49	2 (estd)	Measure abundance of nitrous oxide, carbon dioxide, and methane by taking three cryogenic collection chambers in the 30 to 40 km range	Yes - By Parachute	Land

2.2.1.5 Nike-Tomahawk (18)

Nike-Tomahawk is a two-stage, unguided, solid propellant rocket system with a Nike first stage and a Tomahawk second stage. Each stage has four stabilizing fins in cruciform arrangement at its aft end. This vehicle can lift a 45-kilogram payload to 370 kilometers, or a 115-kilogram payload to 215 kilometers, with flight times to 10 minutes and an impact range of 150 to 300 kilometers. The Nike diameter is 0.42 meter, while the Tomahawk and payload have a 0.23- meter diameter. The total vehicle length is approximately 15 meters, of which the payload takes up 1.8 to 3.0 meters depending on size and weight. During the last 10 years, 12 flights have taken place.

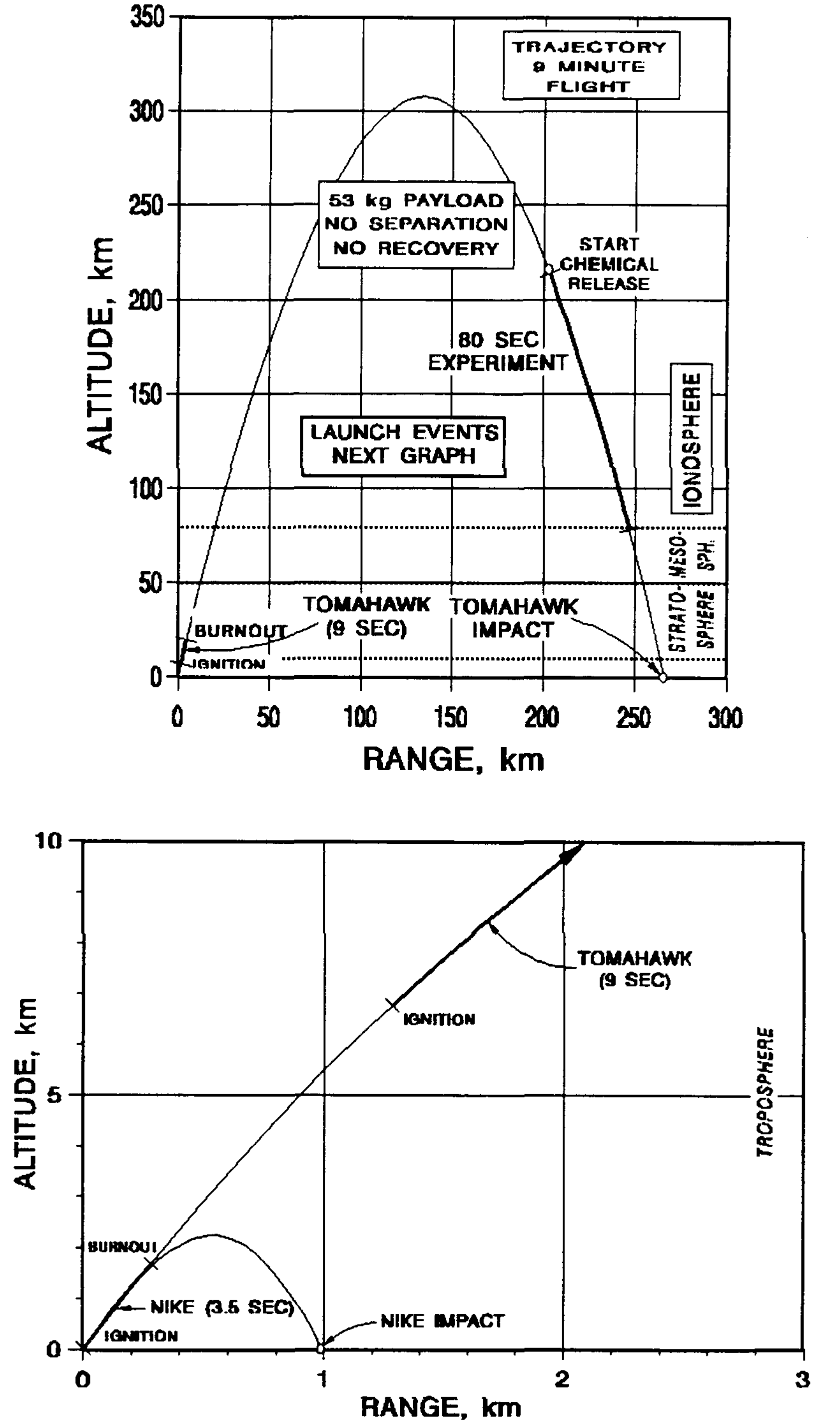


The Nike propellant weighs 340 kilograms and is of the nitrocellulose/ nitroglycerin family with small amounts of lead and graphite. The rocket exhaust emissions are mainly carbon monoxide, carbon dioxide, water, and nitrogen. They occur during the 3.5-second burning time over the altitude span from ground to about 2 kilometers. Nike impact is about 1 kilometer from the launch pad with a spent rocket weight of 276 kilograms.

The Tomahawk propellant weighs 180 kilograms and is a mix of ammonium perchlorate, polybutadiene, aluminum, and ferric oxide. The rocket exhaust emissions are mainly aluminum oxide, carbon monoxide, hydrogen chloride, and nitrogen. They occur during the 9-second burning time over a typical altitude span of 7 to 20 kilometers. The spent rocket weight is 65 kilograms at final impact.

Standard hardware includes a separable clamshell nose cone and despin module. Separation systems can separate the payload from the Tomahawk during ascent. [4, 67, 86, 99]

2.2.1.5 Nike-Tomahawk (18) (Continued)



2.2.1.5 Nike-Tomahawk (18) (Continued)

LAUNCH VEHICLE DESIGN					
Rocket	Diameter meter	Length meter	Total wt. kg	Propellant wt. kg	Impact wt. kg
Nike	0.42	3.68	616	340	276
Tomahawk	0.23	3.61	245	180	65
Payload	0.23	2.39	53	-	*41
	Launch	9.68	914	520	*After release

PROPELLANT COMPOSITION	
Nike	Tomahawk
Nitrocellulose Nitroglycerin Triacetin 2-Nitrodiphenylamine Diphenyl-amino-methyl substituted phenols Lead stearate Graphite	Ammonium perchlorate Carboxyl terminated polybutadiene Aluminum Ferric oxide

EXHAUST EMISSIONS, kilogram		
Compound	Nike	Tomahawk
	0-1.6 km 0-3.5 sec	6.8-19.5 km 12-21 sec
Carbon monoxide	182	45
Carbon Dioxide	61	2
Water	44	7
Nitrogen	41	14
Hydrogen	6	5
Lead	6	-
Hydrogen chloride	-	36
Aluminum oxide	-	69
Other	-	2
Total	340	180

2.2.1.5 Nike-Tomahawk (18) (Concluded)

MISSIONS AND PAYLOADS					
No. of Flights		FY 91 Mission (Fairbanks, Alaska)	Payload Releases	Payload Reco-very	Impact Media
FY 86-95	FY 96				
12	2 (estd)	Study effect of post-midnight auroral activity on composition and winds of the E-region between 200 and 80 km.	12 kg liquid TMA/TEA mixture at 212 km on downleg	None	Land

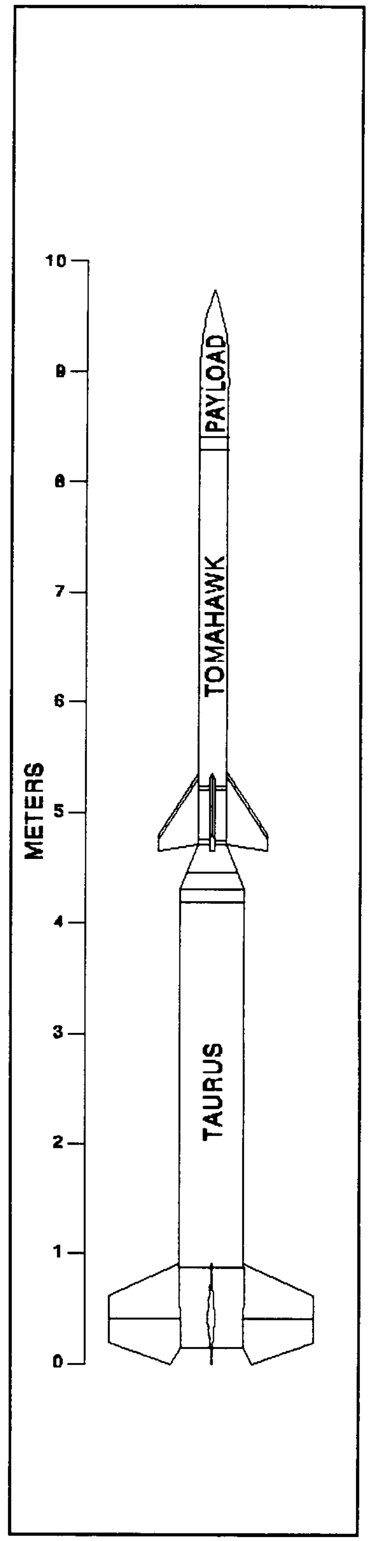
TMA - Trimethyl aluminum (80%); TEA = Triethyl aluminum (20%)

2.2.1.6 Taurus-Tomahawk (34)

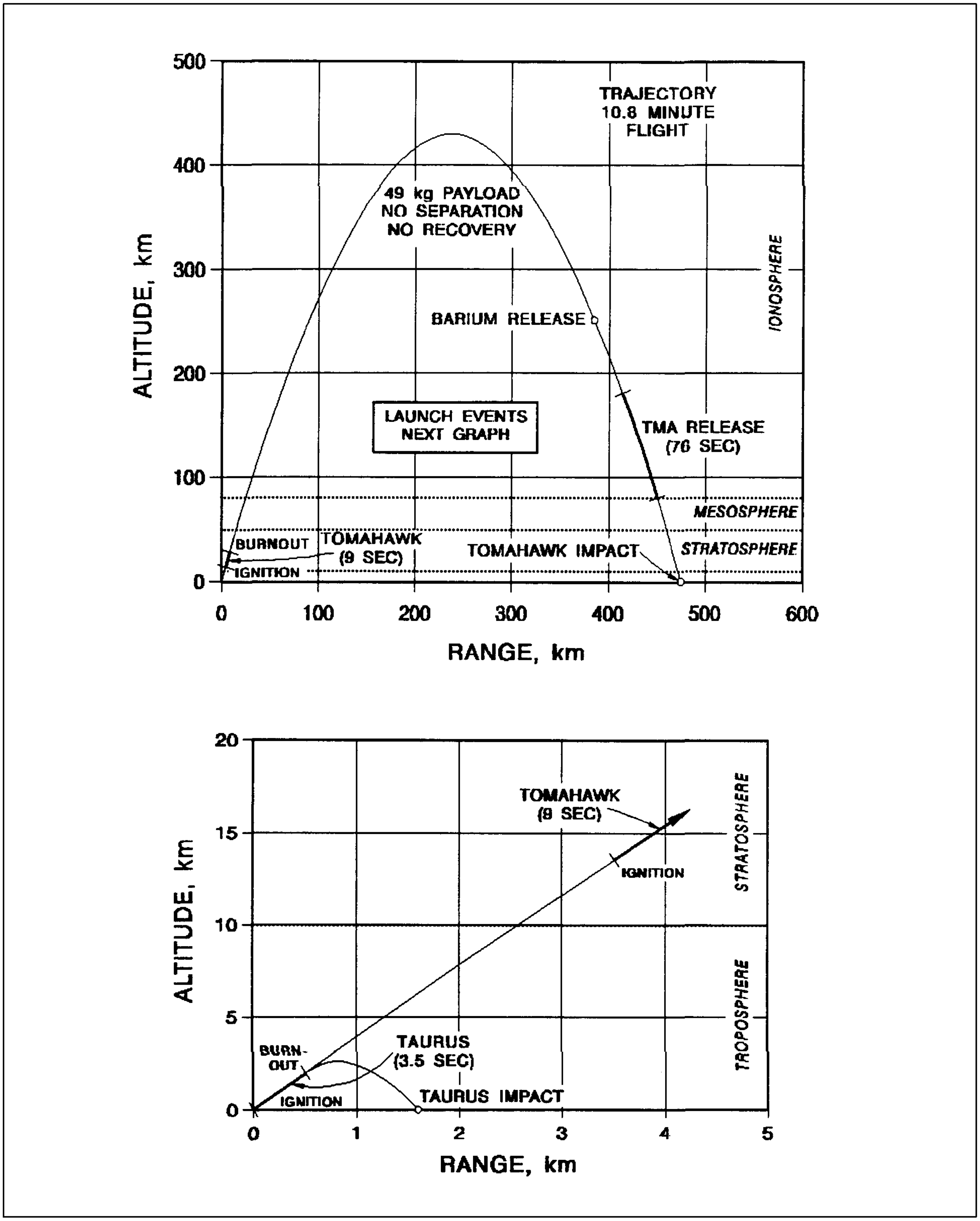
Taurus-Tomahawk is a two-stage unguided, solid propellant rocket system with a Taurus first stage and a Tomahawk second stage. Each stage has four stabilizing fins in cruciform arrangement at its aft end. This vehicle can lift a 27-kilogram payload to 590 kilometers, or a 59-kilogram payload to 490 kilometers. Impact ranges vary from 250 to 400 kilometers. The Taurus diameter is 0.58 meter, while the Tomahawk and payload have a 0.23-meter diameter. The vehicle is 7.8 meters long, to which is added a payload length of 1.9 meters or less. During the last 10 years, one flight has taken place.

The Taurus propellant weighs 754 kilograms and is of the nitrocellulose/ nitroglycerin family with lead compounds and graphite additives. The rocket exhaust emissions are mainly carbon monoxide, carbon dioxide, water, and nitrogen. They occur during the 3.5-second burning time over the altitude span from ground to about 2 kilometers. Taurus impact is about 1 kilometer from the launch pad, with a spent rocket weight of 606 kilograms. The Tomahawk propellant is ignited 14.5 seconds after Taurus burnout, weighs 180 kilograms and is a mix of ammonium perchlorate, polybutadiene, aluminum, and ferric oxide. The rocket exhaust emissions are mainly aluminum oxide, carbon monoxide, hydrogen chloride, and nitrogen. They occur during the 9-second burning time over a typical altitude span of 7 to 20 kilometers. The spent rocket weight is 65 kilograms at final impact.

Standard hardware includes a separable clamshell nose cone and despin module. Separation systems can separate the payload from the Tomahawk during ascent. [4, 17, 35, 86, 99]



2.2.1.6 Taurus-Tomahawk (34) (Continued)



2.2.1.6 Taurus-Tomahawk (34) (Continued)

LAUNCH VEHICLE DESIGN					
Rocket	Diameter meter	Length meter	Total wt. kg	Propellant wt. kg	Impact wt. kg
Taurus	0.58	4.60	1360	754	606
Tomahawk	0.23	3.61	248	180	68
Payload	0.23	1.51	49	-	*38
	Launch	9.72	1657	934	*After release

PROPELLANT COMPOSITION	
Taurus	Tomahawk
Nitrocellulose	Ammonium perchlorate
Nitroglycerin	Carboxyl terminated polybutadiene
Triacetin	Aluminum
2-Nitrodiphenylamine	Ferric oxide
Lead beta resorcylate	
Lead salicylate	
Carbon black	

EXHAUST EMISSIONS, kilogram		
Compound	Taurus	Tomahawk
	0-2 km 0-3.5 sec	13.5-28 km 18-27 sec
Carbon monoxide	333	45
Carbon dioxide	175	2
Water	125	7
Nitrogen	102	14
Hydrogen	8	5
Lead	11	-
Hydrogen chloride	-	36
Aluminum oxide	-	69
Other	-	2
Total	754	180

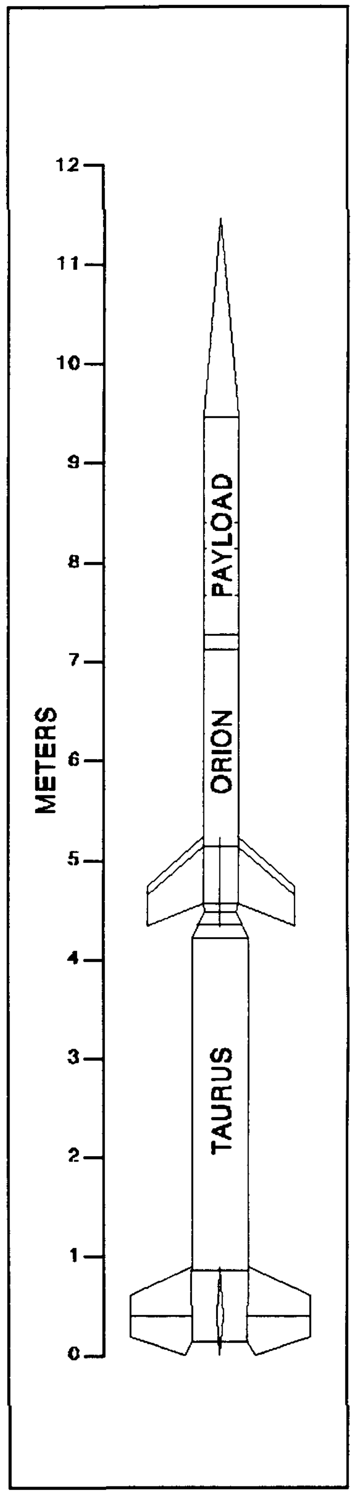
2.2.1.6 Taurus-Tomahawk (34) (Concluded)

MISSIONS AND PAYLOADS					
No. of Flights		FY 85 Mission (Sondre Stromfjord, Greenland)	Payload Releases	Payload Reco-very	Impact Media
FY 86-95	FY 96				
1	0 (estd)		2 kg barium at 250 km and 9 kg TMA over 180 to 80 km	None	Water

TMA = Trimethyl aluminum (80%); Triethyl aluminum (20%)

2.2.1.7 Taurus-Orion (33)

Taurus-Orion is a two-stage, unguided, solid propellant rocket system with a Taurus first stage and an Orion second stage. Each stage has four equally spaced fins for stability at its aft end. This vehicle can carry a 68-kilogram load to 260 kilometers, or a 227-kilogram payload to 140 kilometers, with flight times of approximately 10 minutes and impact ranges from 60 to 150 kilometers. The Taurus diameter is 0.58 meter, while the Orion and payload have a 0.36-meter diameter. The total vehicle length is 11.5 meters, of which the payload occupies between 1.8 and 4.5 meters. During the last 10 years, 11 flights have taken place.

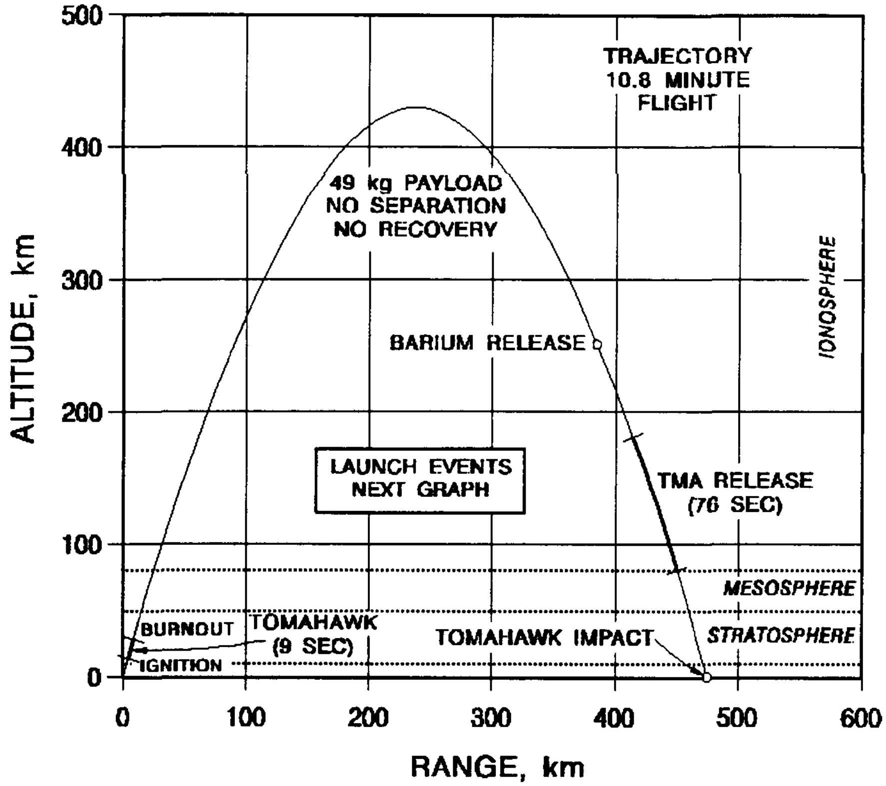


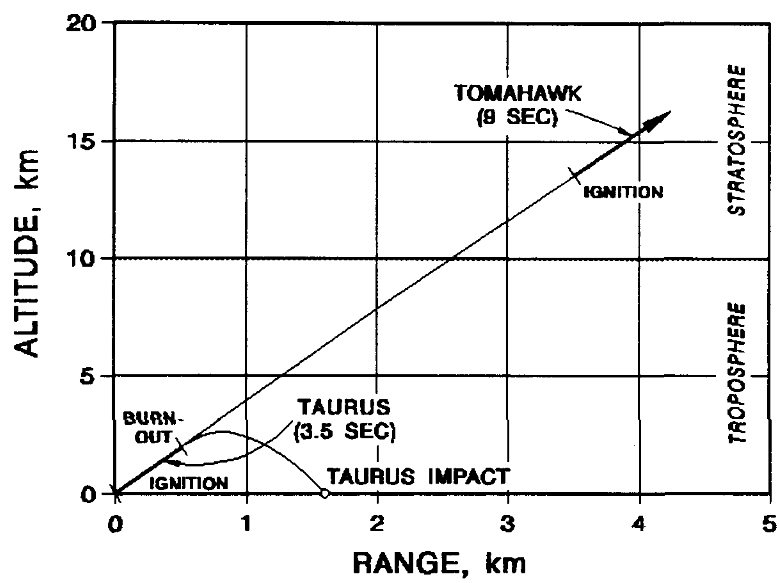
The Taurus propellant weighs 754 kilograms and is of the nitrocellulose/ nitroglycerin family with lead and graphite as additives. The rocket exhaust emissions are mainly carbon monoxide, carbon dioxide, water, and nitrogen. They occur during the 3.5-second burning time over the altitude span from ground to about 2 kilometers. Taurus impact is about 1 kilometer from the launch pad with a spent rocket weight of 606 kilograms.

The Orion propellant weighs 278 kilograms and is a mix of ammonium perchlorate, polyurethane, and nitroguanadine. The rocket exhaust emissions are mainly hydrogen chloride, water, carbon monoxide, carbon dioxide, and aluminum oxide. They occur during the 32.5-second burning time over a typical altitude span from 10 to 50 kilometers. The spent rocket weight is 140 kilograms at final impact.

Standard hardware includes a separable clamshell nose cone, a clamped interstage for improved stability for vehicles with long payloads, and separation systems to separate the payload from the Orion during ascent.
[4, 35, 71, 86]

2.2.1.7 Taurus-Orion (33) (Continued)





2.2.1.7 Taurus-Orion (33) (Continued)

LAUNCH VEHICLE DESIGN					
Rocket	Diameter meter	Length meter	Total wt. kg	Propellant wt. kg	Impact wt. kg
Taurus	0.58	4.46	1371	754	606
Orion	0.36	2.74	418	278	140
Payload	0.36	4.24	143	-	143
	Launch	11.44	1932	1032	

PROPELLANT COMPOSITION	
Taurus	Orion
Nitrocellulose	Ammonium perchlorate
Nitroglycerin	Polyurethane
Triacetin	Aluminum
2-Nitrodiphenylamine	Nitroguanadine
Lead beta resorcylate	
Lead salicylate	
Carbon black	

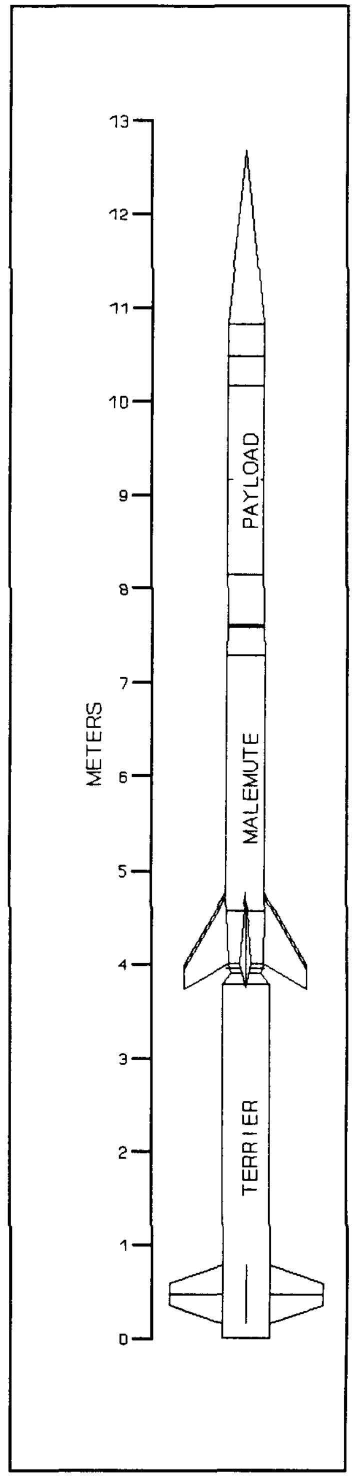
EXHAUST EMISSIONS, kilogram		
Compound	Taurus	Orion
	0-1.8 km 0-3.5 sec	10-52 km 15.0-47.5 sec
Carbon monoxide	333	50
Carbon dioxide	175	44
Water	125	58
Nitrogen	102	26
Hydrogen	8	4
Lead	11	-
Hydrogen chloride	-	64
Aluminum oxide	-	31
Copper	-	1
Total	754	278

2.2.1.7 Taurus-Orion (33) (Concluded)

MISSIONS AND PAYLOADS					
No. of Flights		FY 88 Mission (Fairbanks, Alaska)	Payload Releases	Payload Reco-very	Impact Media
FY 86-95	FY 96				
11	0 (estd)	Measure UV spectrum between 2100&2500A as function of altitude; also obtain data on 2143A atomic nitrogen line and molecular nitrogen bands.	None	Yes - by Para-chute	Land

2.2.1.8 Terrier-Malemute (29)

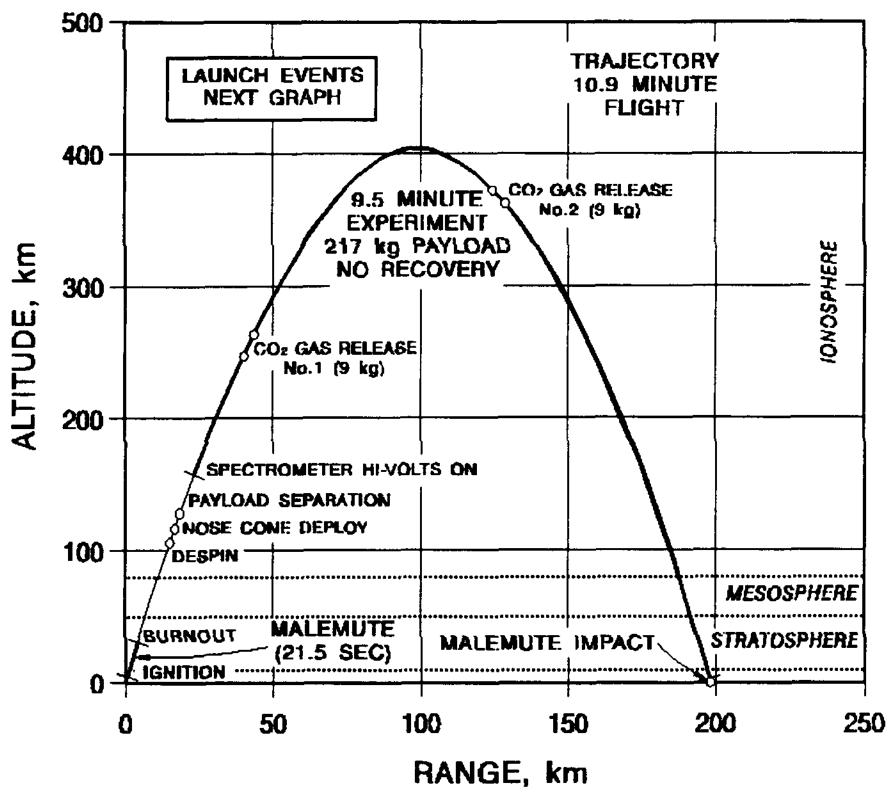
Terrier-Malemute is a two-stage high-performance, unguided, solid propellant rocket system with a Terrier first stage and a Malemute second stage. Each stage has four stabilizing fins at its aft end. This vehicle is designed for payloads not exceeding 180 kilograms. The second stage is specially designed for high-altitude research such as plasma physics. It can carry a 180-kilogram payload to 420 kilometers, or a 90-kilogram payload to 650 kilometers. The impact ranges vary from 200 to 300 kilometers. Diameters are 0.46 meter for the Terrier, 0.41 meter for the Malemute, and 0.36 or 0.41 meter for the payload. The length of the vehicle is 7.2 meters, to which is added the payload length which can be as long as 5.4 meters. During the last 10 years, 6 flights have taken place.

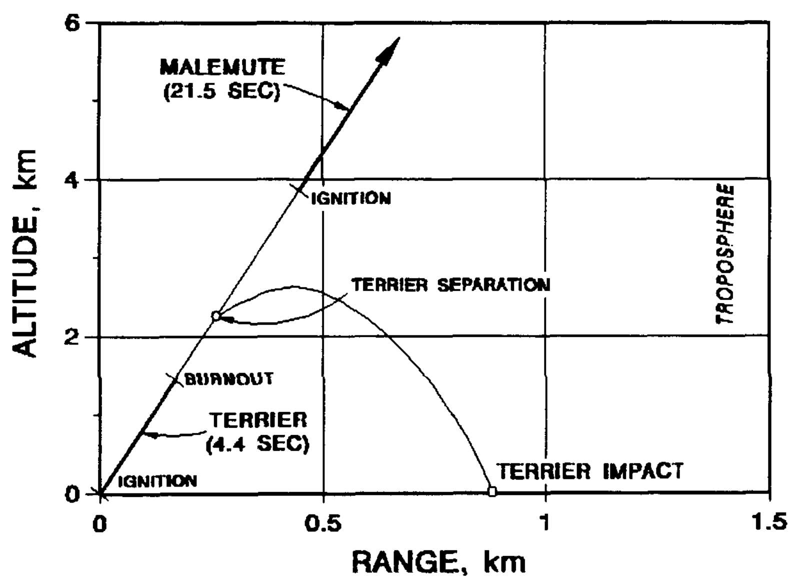


The Terrier propellant weighs 535 kilograms and is of the nitrocellulose/nitroglycerin family with added lead compounds and aluminum. The rocket exhaust emissions are mainly carbon monoxide, carbon dioxide, nitrogen, water, and aluminum oxide. They occur during the 4.4-second burning time over the altitude span from ground to 1.5 kilometers. Terrier impact is about 0.5 kilometer from the launch pad, with a spent rocket weight of 302 kilograms.

The Malemute propellant weighs 506 kilograms and is of the ammonium perchlorate/aluminum/plastic binder family. The rocket exhaust emissions are mainly aluminum oxide, carbon monoxide, hydrogen chloride, nitrogen, and water. They occur during the 21.5-second burning time over the altitude span from 4 to 34 kilometers. The spent rocket weight is 129 kilograms at final impact. [4, 32, 35, 86, 99]

2.2.1.8 Terrier-Malemute (29) (Continued)





2.2.1.8 Terrier-Malemute (29) (Continued)

LAUNCH VEHICLE DESIGN					
Rocket	Diameter meter	Length meter	Total wt. kg	Propellant wt. kg	Impact wt. kg
Terrier	0.46	3.94	837	535	302
Malemute	0.41	3.30	635	506	129
Payload	0.36	5.44	217	-	*199
	Launch	12.68	1689	1041	*After 18 kg gas release

PROPELLANT COMPOSITION	
Terrier	Malemute
Nitrocellulose	Ammonium perchlorate
Nitroglycerin	Polybutadiene, hydroxy terminated
Triacetin	Aluminum
2-Nitrodiphenylamine	Desmodour diisocyanate
Lead-2-ethyl hexoate	Propyleneimine
Lead salicylate	

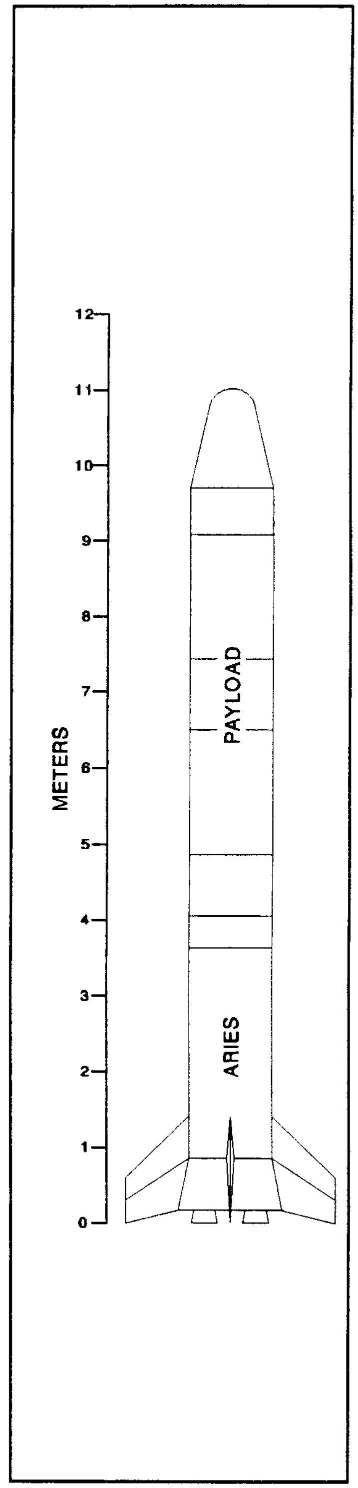
EXHAUST EMISSIONS, kilogram		
Compound	Terrier	Malemute
	0-1.5 km 0-4.4 sec	3.8-33.6 km 8-29.5 sec
Carbon monoxide	228	128
Carbon dioxide	160	12
Water	54	34
Nitrogen	73	42
Hydrogen	10	13
Lead	10	-
Hydrogen chloride	-	110
Aluminum oxide	-	167
Total	535	506

2.2.1.8 Terrier-Malemute (29) (Concluded)

MISSIONS AND PAYLOADS					
No. of Flights		FY 89 Mission (Wallops Island, Virginia)	Payload Releases	Payload Recovery	Impact Media
FY 86-95	FY 96				
6	0 (estd)	Release Experiments to Derive Airglow Induced Reaction (REDAIR) with single species ($C0_2$) released at two points in ionosphere to find aeronomic and plasma rate constants that govern 6300A air glow.	9 kg CO_2 at 250 km on upleg & 9 kg CO_2 at 375 km on downleg.	None	Water

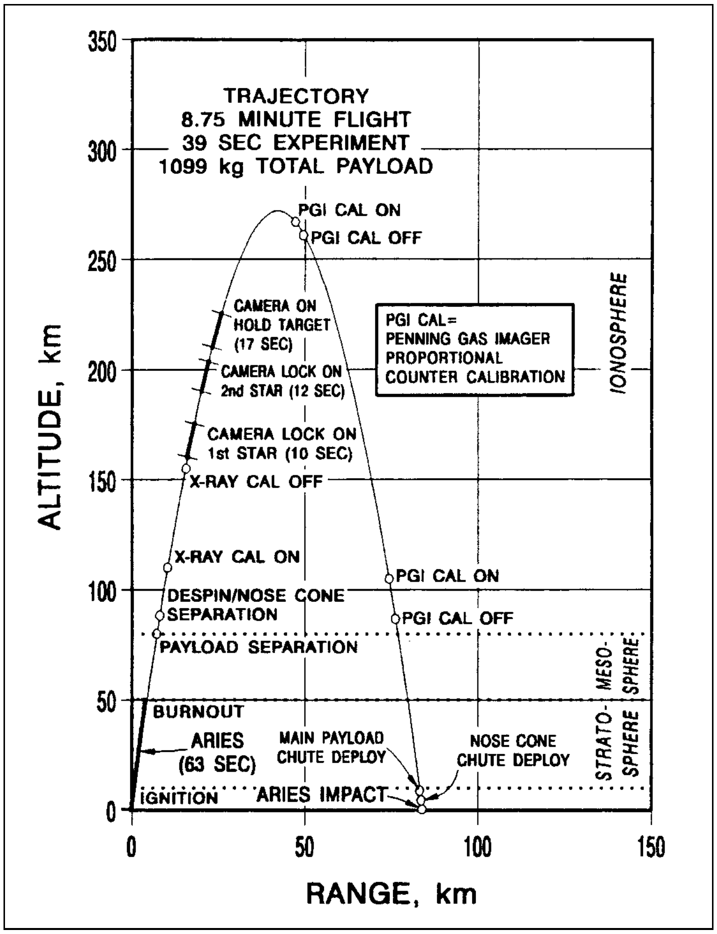
2.2.1.9 Aries (24)

Aries is the largest and longest burning single-stage SRP vehicle in use. It is a guided solid propellant rocket system with four fins for flight stability. Its large dimensions (1.13-meter diameter, up to 11-meter total length) and loaded weight (5,443 kilograms plus payload) preclude its launch from a tower or rail (as practiced with all other launch vehicles). Therefore, it is launched from a pedestal and supplied with gimballed nozzles with a flight guidance and control system. (The other vehicles are unguided, i.e., "pointed," with wind compensation techniques to stay on course.) The vehicle can lift a 907-kilogram payload to 500 kilometers, or a 1,770-kilogram payload to 225 kilometers. Payload diameters can be as large as 1.1 meters, with lengths from 3.4 to 7.3 meters. During the last 10 years, three flights have taken place.



The Aries propellant weighs 4,704 kilograms and is of the ammonium perchlorate/aluminum/polyurethane type. The rocket exhaust emissions consist mainly of aluminum oxide, carbon monoxide, hydrogen chloride, water, nitrogen, and carbon dioxide. They occur during the 63-second burning time starting at ground launch and ending at 50 kilometers altitude. The spent rocket has a 739-kilogram impact weight. The payload includes an experiment section and an impact absorption section. A service module features a TV system downlink and telemetry channels. The payload is recoverable via a two-stage parachute system. [4, 35, 59, 86]

2.2.1.9 Aries (24) (Continued)



LAUNCH VEHICLE DESIGN					
Rocket	Diameter meter	Length meter	Total wt. kg	Propellant wt. kg	Impact wt. kg
Aries Payload	1.12 1.12	4.1 6.9	5443 1099*	4704 -	739 1099*
	Launch	11.0	6542	4704	*975 main payload + 124 nose cone

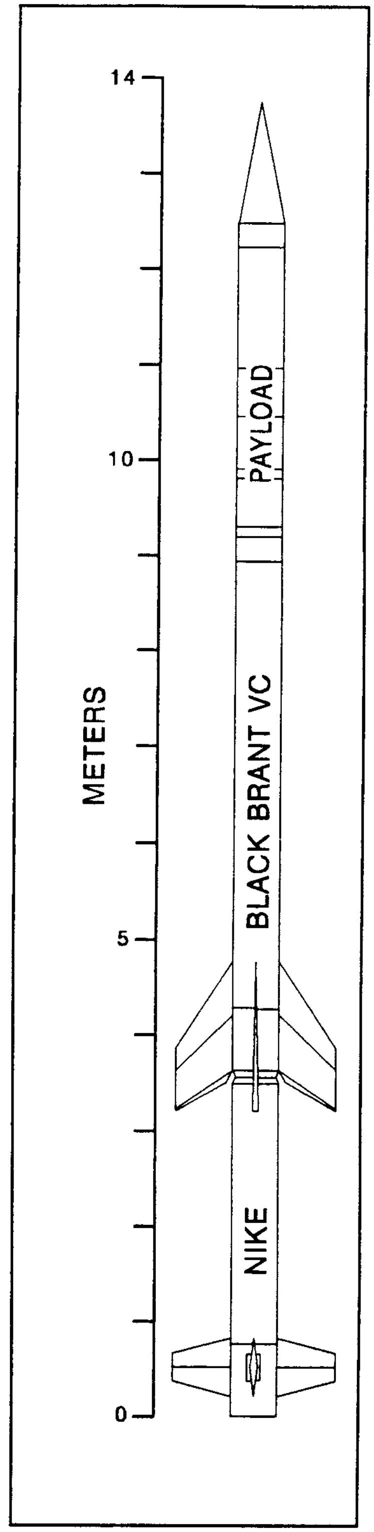
2.2.1.9 Aries (24) (Concluded)

ARIES PROPELLANT COMPOSITION	
Ammonium Perchlorate Aluminum	Polyurethane

ARIES EXHAUST EMISSIONS, 1.2-50 km, 0-63 sec			
Compound	kg	Compound	kg
Aluminum oxide	1515	Nitrogen	381
Carbon monoxide	1181	Carbon dioxide	141
Hydrogen chloride	941	Hydrogen	113
Water	423	Chlorine (monatomic)	9
		Total	4704

MISSIONS AND PAYLOADS					
No. of Flights		FY 91 Mission (White Sands, New Mexico)	Payload Releases	Payload Recovery	Impact Medium
FY 86-95	FY 96				
3	0 (estd)	Measure X-ray spectra of Crab Nebula using spectrograph consisting of X-ray reflection gratings, a grazing incidence Wolfer 1 telescope and an imaging proportional counter.	None	Separate chutes for main payload and nose cone.	Land

2.2.1.10 Nike-Black Brant VC (27)



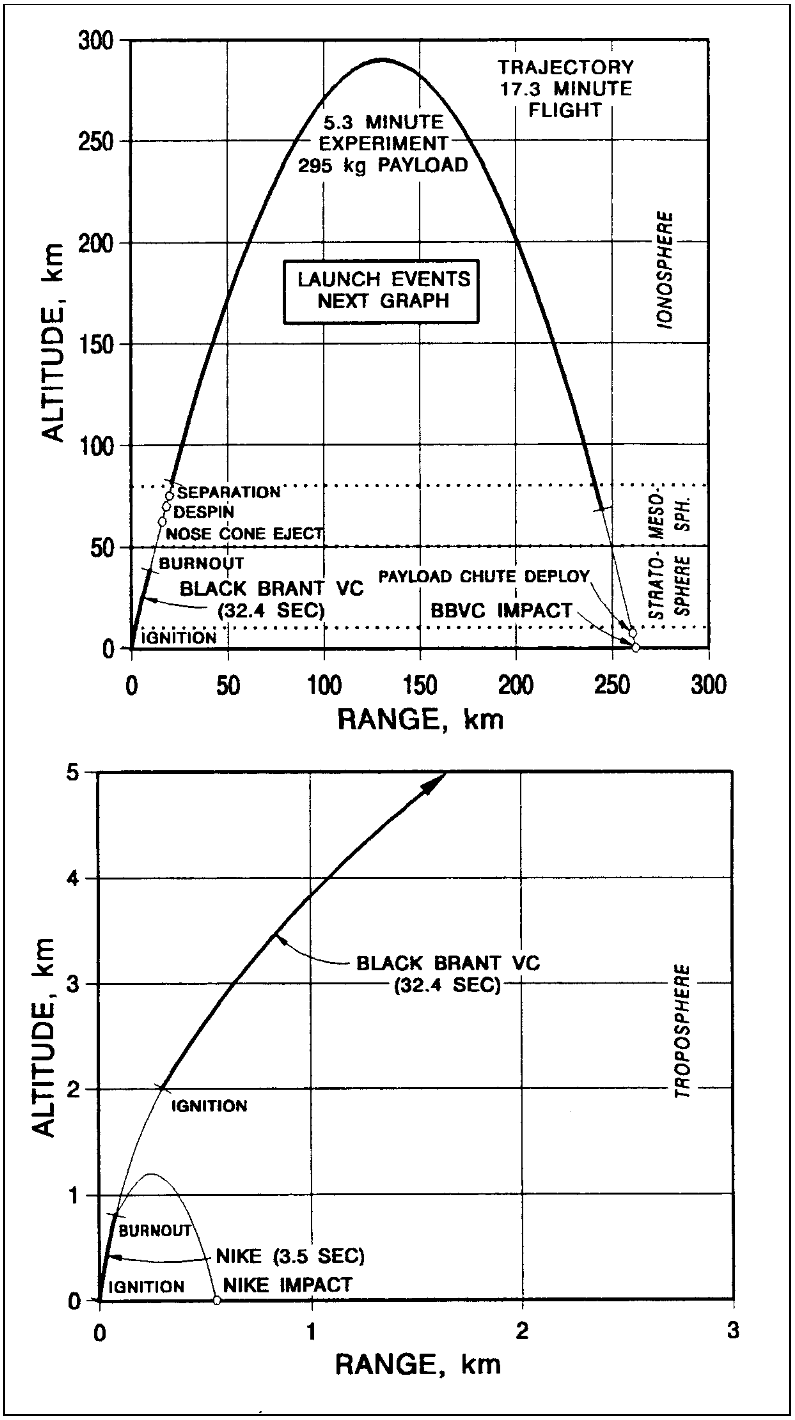
Nike-Black Brant V (B or C) is a two-stage, unguided, solid propellant rocket system with a Nike first stage and a Black Brant V (BBV) second stage. The two stages separate by drag action at Nike burnout. Each stage is fin stabilized at its aft end. This vehicle can carry a 136-kilogram payload to 430 kilometers, or a 408-kilogram payload to 230 kilometers with a maximum of 540 kilograms. Flight times vary from 6 to 18 minutes, and impact ranges from 100 to 300 kilometers. The Nike diameter is 0.42 meter and the BBV diameter is 0.44 meter which is also the maximum payload diameter possible. The total vehicle length, 14 meters, can include up to 5 meters of payload. During the last 10 years, 23 flights have taken place.

The Nike propellant weighs 340 kilograms and is of the nitrocellulose/ nitroglycerin family including small amounts of lead and graphite. The rocket exhaust emissions are mainly carbon monoxide, carbon dioxide, water, and nitrogen. They occur during the 3.5-second burning time over the altitude span from ground to about 1 kilometer. Nike impact is about 0.5 kilometer from the launch pad, with a spent rocket weight of 276 kilograms.

The Black Brant V propellant weighs 997 kilograms and is of the ammonium perchlorate/aluminum/plastic binder type including small amounts of carbon black, iron, and sulfur. The rocket exhaust emissions consist mainly of aluminum oxide, carbon monoxide, hydrogen chloride, nitrogen, and water. They occur during the 32.5-second burning time over the altitude span from typically 2 to 40 kilometers. The spent rocket weight at final impact is 260 to 270 kilograms, depending on the number of stabilizing fins.

Standard hardware available for the Nike-BBV vehicles includes aft recovery systems for medium weight payloads, an ogive recovery system assembly, payload separation systems, and despin systems. Most of these can be mounted (in a stack) at the same time. Also, the S-19 Boost Guidance Control System is available to control the location of final impact more accurately. [4, 38, 71, 86, 94, 100]

2.2.1.10 Nike-Black Brant VC (27) (Continued)



2.2.1.10 Nike-Black Brant VC (27) (Continued)

LAUNCH VEHICLE DESIGN					
Rocket	Diameter meter	Length meter	Total wt. kg	Propellant wt. kg	Impact wt. kg
Nike	0.42	3.45	616	340	276
Black Brant VB	0.44	5.45	1265	997	268
Payload	0.44	4.87	295	-	240
	Launch	13.77	2176	1337	

PROPELLANT COMPOSITION	
Nike	Black Brant VC
Nitrocellulose	Ammonium perchlorate
Nitroglycerin	Polypropylene glycol
Triacetin	Triethanolamine
2-Nitrodiphenylamine	Poly 1,4-butylene glycol
Diphenyl-amino-methyl-substituted phenols	Toluene di-isocyanate
Lead stearate	Aluminum
Graphite	Carbon black
	Iron acetyl acetate
	Sulfur
	Diodyl azelate
	N-phenol butyl naphthylamine

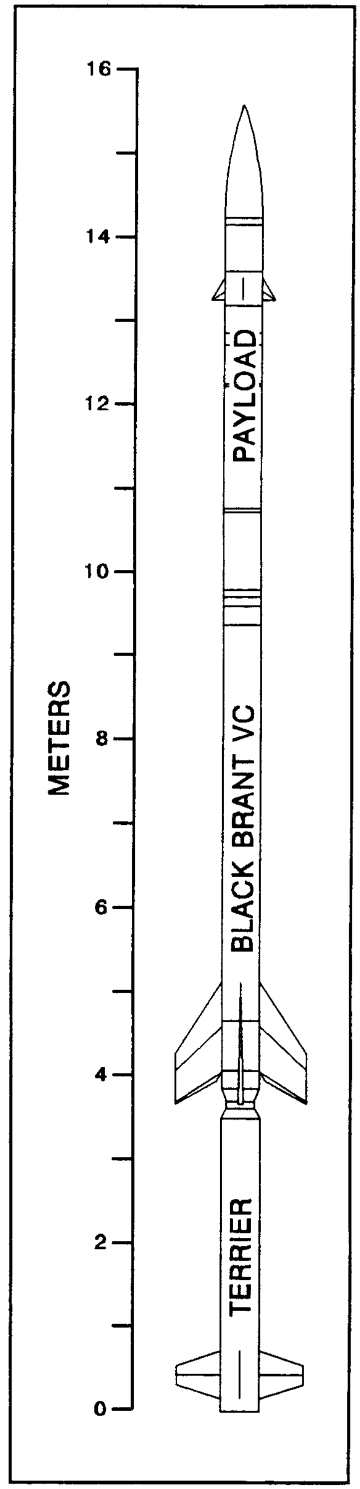
2.2.1.10 Nike-Black Brant VC (27) (Continued)

EXHAUST EMISSIONS, kilogram		
Compound	Nike	Black Brant VC
	0-0.7 km 0-3.5 sec	2.0-36.8 km 8.5-40.9 sec
Carbon monoxide	182	288
Carbon Dioxide	61	14
Water	44	40
Nitrogen	41	76
Hydrogen	6	30
Lead	6	-
Hydrogen chloride	-	187
Aluminum oxide	-	357
Sulfur	-	1
Other	-	4
Total	340	997

MISSIONS AND PAYLOADS					
No. of Flights		FY 91 Mission (Fairbanks, Alaska)	Payload Releases	Payload Reco-very	Impact Media
FY 86-95	FY 96				
23	2 (estd)	Study effect of post-midnight auroral activity on composition and winds of the E-region between 200 and 80 km.	None	Para-chute	Land

2.2.1.11 Black Brant IX (36)

Black Brant IX ("nine") is a two-stage, unguided, solid propellant rocket system with a Terrier first stage and a Black Brant VC (BBVC) second stage. Each stage has four stabilizing fins at its aft end. This vehicle will carry a 159- kilogram payload to 540 kilometers, or a 500-kilogram payload to 230 kilometers. Impact ranges vary from 50 to 150 kilometers. The diameters are 0.46 meter for the Terrier, and 0.44 meter for the BBVC and the standard payload configuration. The vehicle length is 9.3 meters, to which a payload length of typically 4 meters is added. During the last 10 years, 101 flights have taken place.

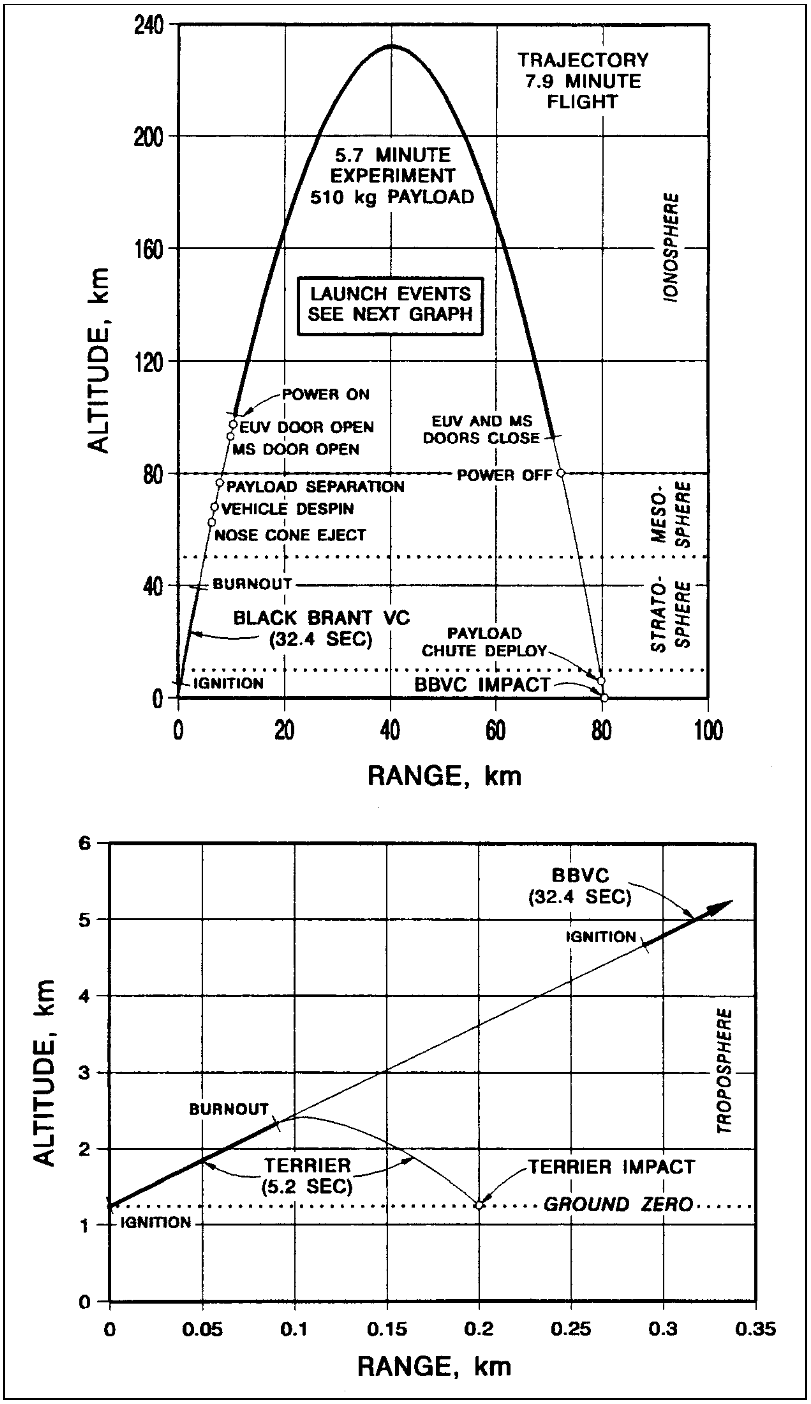


The Terrier propellant weighs 535 kilograms and is of the nitrocellulose/ nitroglycerin family with added lead compounds and aluminum. The rocket exhaust emissions are mainly carbon monoxide, carbon dioxide, nitrogen, water, and aluminum oxide. They occur during the 5-second burning time over the altitude span from ground to 2 kilometers. Terrier impact is about 1 kilometer from the launch pad with a spent rocket weight of 302 kilograms.

The Black Brant propellant weighs 997 kilograms and is of the ammonium/ perchlorate/aluminum/plastic binder type with small amounts of carbon black, iron, and sulfur. The rocket exhaust emissions are mainly aluminum oxide, carbon monoxide, hydrogen chloride, water, and nitrogen. They occur during the 32.4- second burning time over the altitude span from 5 to 44 kilometers. The spent rocket weight is 268 kilograms at final impact.

Standard hardware options available include aft recovery systems for medium size loads, payload separation systems, and despin systems. These can be mounted at the same time in a stack. Also, the S-19 Boost Guidance Control System is available to control the location of final impact more accurately. [4, 35, 60, 86]

2.2.1.11 Brant IX (36) (Continued)



2.2.1.11 Black Brant IX (36) (Continued)

LAUNCH VEHICLE DESIGN					
Rocket	Diameter meter	Length meter	Total wt. kg	Propellant wt. kg	Impact wt. kg
Terrier	0.46	4.27	837	535	302
Black Brant VC	0.44	5.30	1265	997	268
Payload	0.44	6.11	439	-	439
	Launch	15.68	2541	1532	

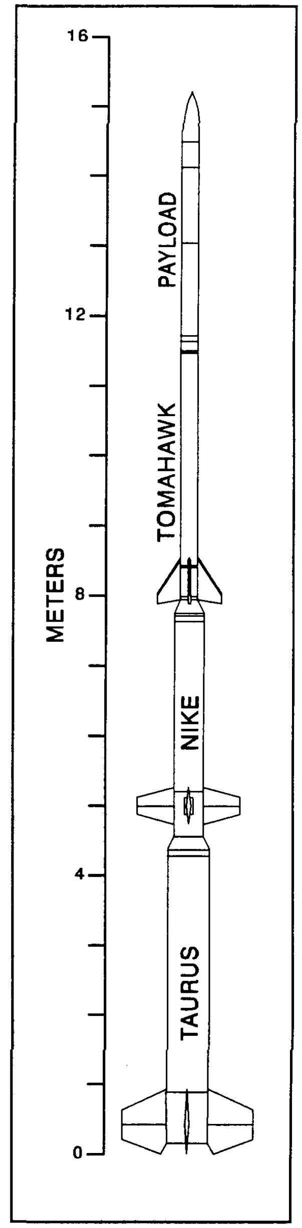
PROPELLANT COMPOSITION	
Terrier	Black Brant VC
Nitrocellulose	Ammonium perchlorate
Nitroglycerin	Polypropylene glycol
Triacetin	Triethanolamine
2-Nitrodiphenylamine	Poly 1,4-butylene glycol
Lead salicylate	Toluene di-isocyanate
Graphite	Aluminum
Lead-2-ethyl hexoate	Carbon black
	Iron acetyl acetate
	Sulfur
	Diodyl azelate
	N-phenol butyl naphthylamine

2.2.1.11 Black Brant IX (36) (Concluded)

EXHAUST EMISSIONS, kilogram		
Compound	Terrier	Black Brant VC
	1.2-2.3 km 0-5.2 sec	4.7-38 km 12-44.4 sec
Carbon monoxide	228	288
Carbon dioxide	160	14
Water	54	40
Nitrogen	73	76
Hydrogen	10	30
Lead	10	-
Hydrogen chloride	-	187
Aluminum oxide	-	357
Sulfur	-	1
Other	-	4
Total	535	997

MISSIONS AND PAYLOADS					
No. of Flights		FY 92 Mission (White Sands, New Mexico)	Payload Releases	Payload Reco-very	Impact Media
FY 86-95	FY 96				
101	25 (estd)	1. Atmospheric chemistry energy balance, secondary ionization phenomena. 2. F-Region vibrationally excited particles. 3. Study of Odd-Nitrogen chemistry. Pace payload includes 15 complementary simultaneous experiments for 1,2,3.	None	Yes - by Para-chute	Land

2.2.1.12 Taurus-Nike-Tomahawk (38)



Taurus-Nike-Tomahawk is a three-stage, unguided, fin-stabilized solid propellant rocket system with a Taurus first stage, Nike second stage, and Tomahawk third stage. All rockets have four equidistant fins at their aft ends for stability. A Taurus/Nike interstage adaptor provides for drag separation at Taurus burnout, and similarly a Nike/Tomahawk interstage adaptor causes drag separation at Taurus burnout. This vehicle will carry a 32- kilogram payload to 700 kilometers, or a 125-kilogram payload to 400 kilometers. Flight times vary up to 15 minutes, and impact ranges vary from 180 to 400 kilometers. The diameters are 0.58 meter for Taurus, 0.42 meter for Nike, and 0.23 meter for Tomahawk and for the payload. The total vehicle length is in excess of 15 meters, of which the payload occupies from 1.4 to 3.7 meters. During the last 10 years, 13 flights have taken place.

The Taurus propellant weighs 754 kilograms and is of the nitrocellulose/ nitroglycerin family with lead and graphite as additives. The rocket exhaust emissions are mainly carbon monoxide, carbon dioxide, water, and nitrogen. They occur during the 3.5-second burning time over the altitude span from ground to about 1 kilometer. Taurus impact is about 0.75 kilometer from the launch pad, with a spent rocket weight of 602 kilograms.

The Nike propellant weighs 340 kilograms and is of the nitrocellulose/ nitroglycerin family with small amounts of carbon black, iron, and sulfur. The rocket exhaust emissions are mainly carbon monoxide, carbon dioxide, water, and nitrogen. They occur during the 3.5-second burning time over the altitude span from 7 to 11 kilometers. Nike impact is about 5 kilometers from the launch pad with a spent rocket weight of 276 kilograms.

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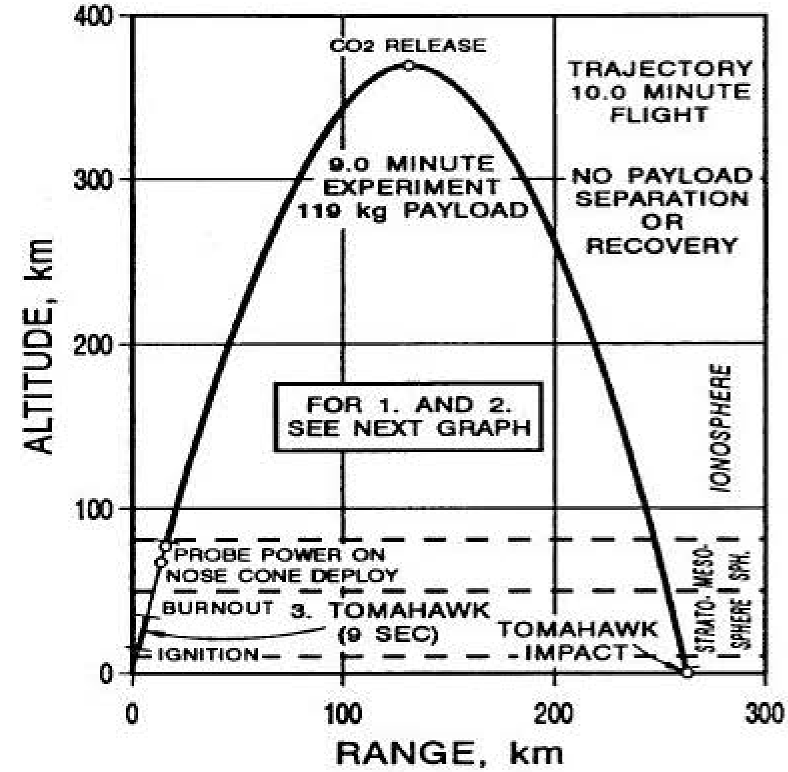
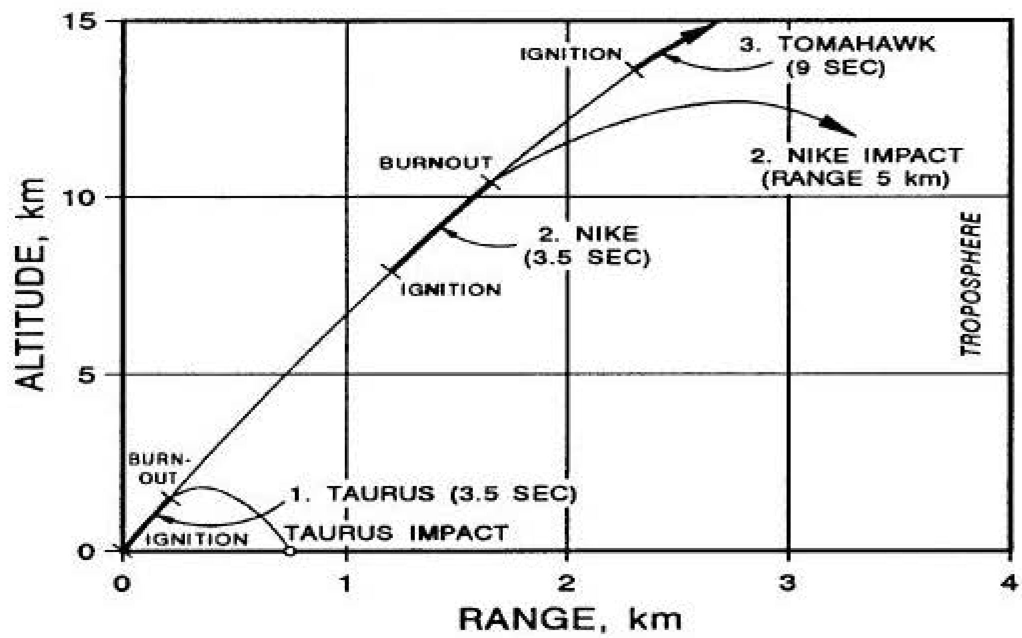
2.2.1.12 Taurus-Nike-Tomahawk (38) (Continued)





2.2.1.12 Taurus-Nike-Tomahawk (38) (Continued)

LAUNCH VEHICLE DESIGN					
Rocket	Diameter meter	Length meter	Total wt. kg	Propellant wt. kg	Impact wt. kg
Taurus	0.58	4.34	1356	754	602
Nike	0.42	3.68	630	340	290
Tomahawk	0.23	3.61	248	180	68
Payload	0.23	3.66	119		*95
	Launch	15.29	2353	1274	*After release

PROPELLANT COMPOSITION		
Taurus	Nike	Tomahawk
Nitrocellulose Nitroglycerin Triacetin 2-Nitrodiphenyl- amine Lead beta resorcylate Lead salicylate Carbon black	Nitrocellulose Nitroglycerin 2-nitrodiphenylamine Diphenyl-amino-methyl substituted phenols Lead stearate Graphite	Ammonium perchlorate Carboxyl terminated polybutadiene Aluminum Ferric oxide

EXHAUST EMISSIONS, kilogram			
Compound	Taurus	Nike	Tomahawk
	0-1.3 km 0-3.5 sec	7.6-10.3 km 16.0-19.5 sec	13.8-29.3 km 23-32 sec
Carbon monoxide	333	182	45
Carbon dioxide	175	61	2
Water	125	44	7
Nitrogen	102	41	14
Hydrogen	8	6	5
Lead	11	6	-
Hydrogen chloride	-	-	36
Aluminum oxide	-	-	69
Other	-	-	2
Total	754	340	180

2.2.1.12 Taurus-Nike-Tomahawk (38) (Concluded)

MISSIONS AND PAYLOADS					
No. of Flights		FY 92 Mission (Wallops Island, Virginia)	Payload Releases	Payload Reco-very	Impact Media
FY 86-95	FY 96				
13	0 (estd)	Observe large-scale F-region plasma variations, airglow patterns, high spatial resolution plasma densities and an ambient airglow altitude production	16 kg CO^2 at 372 km apogee	None	Water

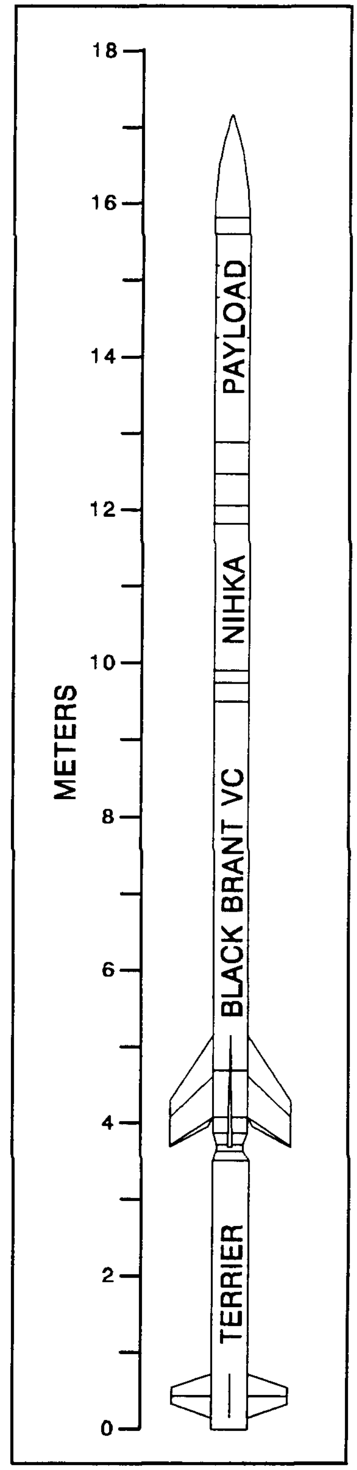
The Tomahawk propellant weighs 180 kilograms and is a mix of ammonium perchlorate, polybutadiene, aluminum, and ferric oxide. The rocket exhaust emissions are mainly aluminum oxide, carbon monoxide, hydrogen chloride, and nitrogen. They occur during the 9-second burning time over a typical altitude span of 14 to 30 kilometers. The spent rocket weight is 65 kilograms at final impact.

Standard third stage hardware includes a separable clamshell nose cone, a Tomahawk firing-despin module, and separation systems for payload separation.

[4, 35, 86, 99, 103, 107]

2.2.1.13 Black Brant X (35)

Black Brant X ("ten") is a three-stage, unguided, solid propellant rocket system with a Terrier first stage, a Black Brant VC (BBVC) second stage, and a Nihka third stage. The first and second stages employ four stabilizing fins at their aft ends. The third stage is finless. This vehicle is designed to carry moderate payloads to exoatmospheric altitudes. It carries a 90-kilogram payload to 1,200 kilometers, or a 317-kilogram payload to 550 kilometers. The impact ranges vary from 200 to 500 kilometers. The diameters are 0.46 meter for the Terrier, and 0.44 meter for the BBVC, Nihka, and payload. The vehicle length is 11.9 meters, to which is added a payload length of typically 3.8 meters. During the last 10 years, 18 flights have taken place.



The Terrier propellant weighs 535 kilograms and is of the nitrocellulose/nitroglycerin family with added lead compounds and aluminum. The rocket exhaust emissions are mainly carbon monoxide, carbon dioxide, nitrogen, water, and aluminum oxide. They occur during the 5-second burning time over the altitude span from ground to 2 kilometers. Terrier impact is about 1 kilometer from the launch pad with a spent rocket weight of 302 kilograms.

The BBVC propellant weighs 997 kilograms and is of the ammonium perchlorate/aluminum/plastic binder type including small amounts of carbon black, iron, and sulfur. The rocket exhaust emissions consist mainly of aluminum oxide, carbon monoxide, hydrogen chloride, nitrogen, and water. They occur during the 32.5-second burning time over the altitude span from 5 to 40 kilometers. The BBVC impacts about 25 kilometers from the launch pad with a spent rocket weight of 268 kilograms.

The Nihka propellant weighs 314 kilograms and is of the ammonium perchlorate/aluminum/plastic binder type with carbon black, iron, sulfur, and ferric oxide additives.

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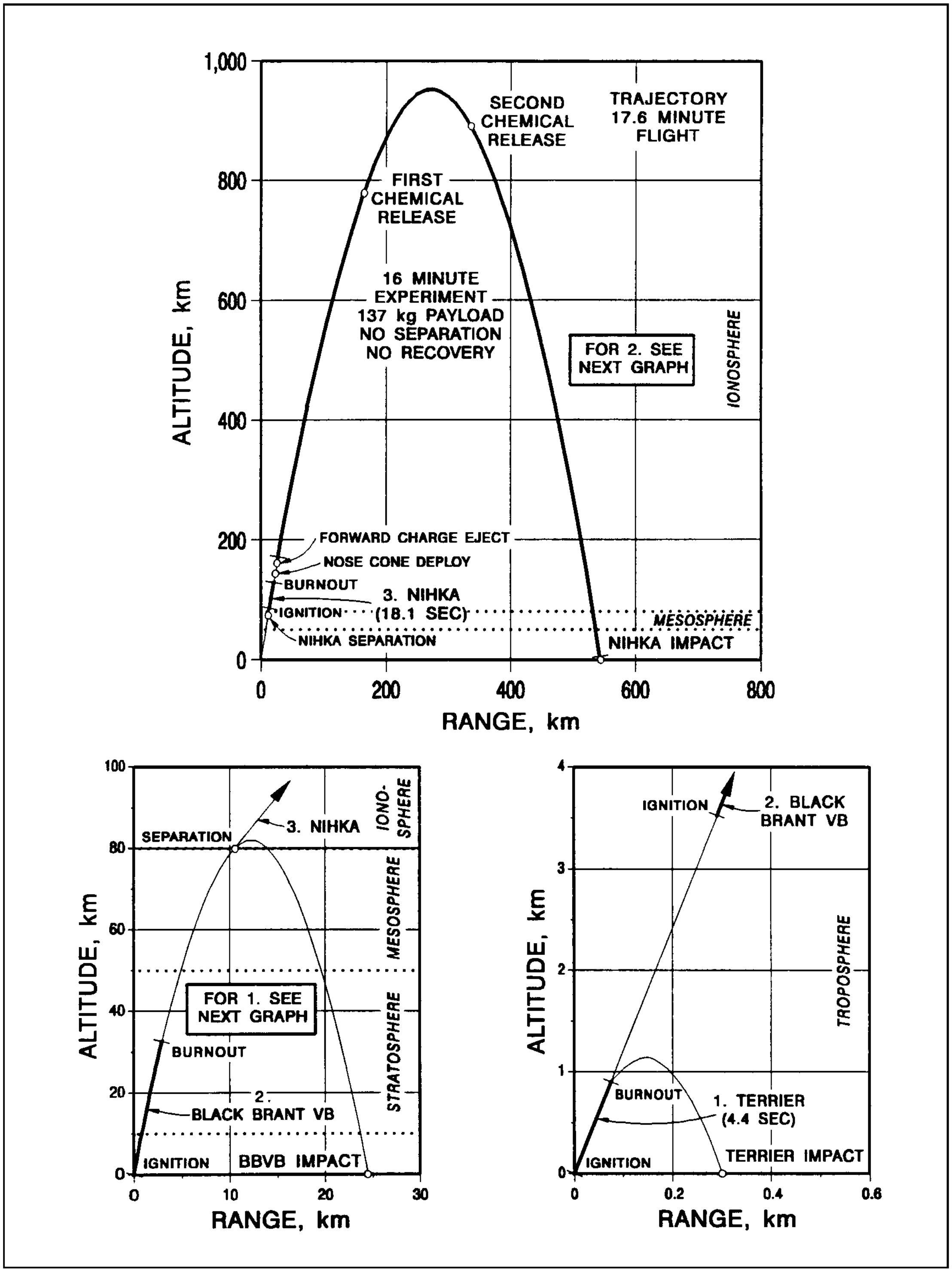
2.2.1.13 Black Brant X (35) (Continued)



2.2.1.13 Black Brant X (35) (Continued)

LAUNCH VEHICLE DESIGN					
Rocket	Diameter meter	Length meter	Total wt. kg	Propellant wt. kg	Impact wt. kg
Terrier	0.46	4.27	837	535	302
Black Brant VB	0.44	5.29	1265	997	268
Nihka	0.44	2.32	408	314	94
Payload	0.44	2.82	137		*127
	Launch	14.7	2647	1846	*After release

PROPELLANT COMPOSITION		
Terrier	Black Brant VB	Nihka
Nitrocellulose Nitroglycerin Triacetin 2-Nitrodiphenyl-amine Lead salicylate Lead 2-ethyl hexoate	Ammonium perchlorate Aluminum Polypropylene glycol Poly 1,4-butylene glycol N-phenyl-beta naphthylamine Triethanolamine Iron acetylacetate Sulfur Dioctylazelate Carbon black	Ammonium perchlorate Carboxyl terminated polybutadiene Aluminum Ferric oxide

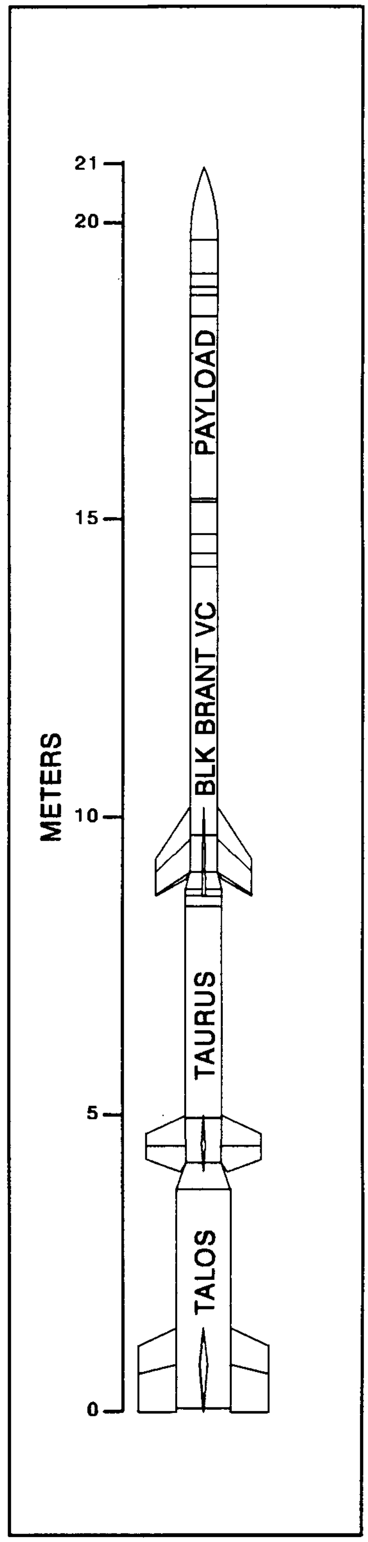
The rocket exhaust emissions are mainly aluminum oxide, hydrogen chloride, carbon monoxide, water, and nitrogen. They occur during the 18-second burning time over the altitude span from 87 to 122 kilometers. The spent rocket weight at final impact is 93 kilograms. Standard hardware options available include aft recovery systems, payload separation systems, and despin systems. These units are "stackable," providing experimental flexibility. Also, the S-19 Boost Guidance Control System is available to control the location of final impact more accurately. [4, 35, 38, 62, 86, 100]

2.2.1.13 Black Brant X (35) (Concluded)

EXHAUST EMISSIONS, kilogram			
Compound	Terrier	Black Brant VB	Nihka
	0-0.9 km 0-4.4 sec	3.6-35.4 km 12-44.4 sec	86-130 km 75-93.1 sec
Carbon monoxide	228	288	66
Carbon dioxide	160	14	9
Water	54	40	30
Nitrogen	73	76	26
Hydrogen	10	30	7
Lead	10	-	-
Hydrogen chloride	-	187	67
Aluminum oxide	-	357	106
Sulfur	-	1	1
Other		4	2
Total	535	997	314

MISSIONS AND PAYLOADS					
No. of Flights		FY 89 Mission Churchill, Manitoba	Payload Releases	Payload Reco-very	Impact Media
FY 86-95	FY 96				
18	0 (estd)	1. Detect and measure parallel electric fields from barium ion motions under active aurora. 2. Detect and measure ion accelerations from ambient plasma waves. 3. Measure convective electric fields from barium ions' horizontal motion. 4. Test new shaped charge design, observe resulting plasma perturbation and instabilities.	Barium releases at 778 km in upleg and at 893 km in downleg (10 kg total)	None	Land

2.2.1.14 Black Brant XI (39)



Black Brant XI ("eleven") is a three-stage, unguided solid propellant rocket system with a Talos first stage, a Taurus second stage, and a BBVC third stage. Each rocket has four equidistant stabilizing fins. Differential drag forces provide for Talos separation from the second stage. This vehicle is designed for carrying heavy payloads to high altitudes. This vehicle can lift 318 kilograms to 700 kilometers, or 545 kilograms to 350 kilometers. Flight times vary from 10 to 15 minutes and impact ranges vary from 300 to 500 kilometers. The diameters are 0.76 meter for the Talos, 0.58 meter for the Taurus, and 0.44 meter for the BBVC and the payload. The total vehicle length is some 21 meters, of which 7 meters is taken up by the payload. This vehicle is a FY90 development and has been flown twice.

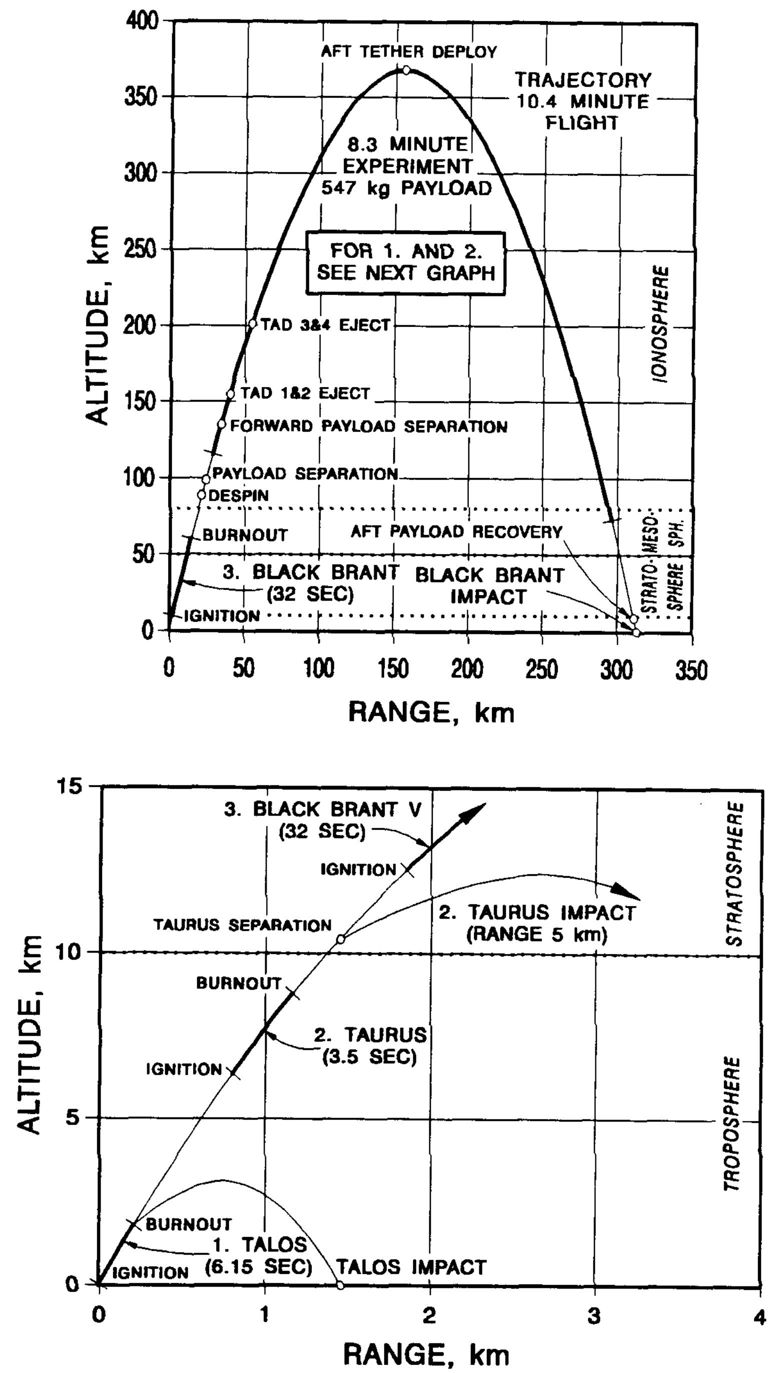
The Talos propellant weighs 1,285 kilograms and is of the nitrocellulose/ nitroglycerin family with lead compound additives. The rocket exhaust emissions are mainly carbon dioxide, carbon monoxide, nitrogen, and water. They occur during the 6.2-second burning time over the altitude span from ground to about 2 kilometers. Talos impact is about 1.5 kilometers from the launch pad with a spent rocket weight of 802 kilograms.

The Taurus propellant weighs 754 kilograms and is of the nitrocellulose/ nitroglycerin family with lead compounds and graphite as additives. The rocket exhaust emissions are mainly carbon monoxide, carbon dioxide, water, and nitrogen. They occur during the 3.5- second burning time over the altitude span from 6.6 to 8.5 kilometers. Taurus impact is about 5 kilometers from the launch pad with a spent rocket weight of 602 kilograms.

The Black Brant VC propellant weighs 997 kilograms and is of the ammonium perchlorate/ aluminum/plastic binder type with small amounts of carbon black, iron, and sulfur. The rocket exhaust emissions consist mainly of aluminum oxide, carbon monoxide, hydrogen chloride, nitrogen, and water.

*** Continued on Page 2-65**

2.2.1.14 Black Brant XI (39) (Continued)


AFT TETHER DEPLOY
TRAJECTORY
10.4 MINUTE
FLIGHT
8.3 MINUTE
EXPERIMENT
547 kg PAYLOAD
FOR 1. AND 2.
SEE NEXT GRAPH
TAD 3&4 EJECT
TAD 1&2 EJECT
FORWARD PAYLOAD SEPARATION
PAYLOAD SEPARATION
DESPIN
BURNOUT
AFT PAYLOAD RECOVERY
3. BLACK BRANT
(32 SEC)
BLACK BRANT
IMPACT
IGNITION
IONOSPHERE
MESO-SPH.
STRATO-SPHERE
ALTITUDE, km
RANGE, km
3. BLACK BRANT V
(32 SEC)
IGNITION
TAURUS SEPARATION
2. TAURUS IMPACT
(RANGE 5 km)
BURNOUT
2. TAURUS
(3.5 SEC)
IGNITION
BURNOUT
1. TALOS
(6.15 SEC)
IGNITION
TALOS IMPACT
STRATOSPHERE
TROPOSPHERE
ALTITUDE, km
RANGE, km

2.2.1.14 Black Brant XI (39) (Continued)

LAUNCH VEHICLE DESIGN					
Rocket	Diameter meter	Length meter	Total wt. kg	Propellant wt. kg	Impact wt. kg
Talos	0.76	3.73	2087	1285	802
Taurus	0.58	4.18	1360	754	606
Black Brant V	0.44	5.83	1265	997	268
Payload	0.44	7.09	547		*363
	Launch	20.83	5259	3036	*Aft only

PROPELLANT COMPOSITION		
Talos	Taurus	Black Brant V
Nitrocellulose	Nitrocellulose	Ammonium perchlorate
Nitroglycerin	Nitroglycerin	Aluminum
Triacetin	Triacetin	Polypropylene glycol
2-Nitrodiphenylamine	2-Nitrodiphenylamine	Poly 1,4-butelene glycol
Lead salicylate	Lead salicylate	N-phenyl-beta naphthylamine
Lead 2-ethyl hexoate	Lead beta-resorcylate	Toluene diisocyanate
	Graphite	Triethanolamine
		Iron acetylacetate
		Sulfur
		Dioctylazelate
		Carbon black

They occur during the 32.5-second burning time over the altitude span from 12.5 to 59 kilometers. The spent rocket weight at final impact is 268 kilograms.

Standard hardware available for this BBV vehicle includes aft recovery systems for medium size payloads, despin systems, and a high-velocity payload separation system. Most of these can be mounted (in a stack) at the same time.

[4, 35, 38, 63, 86, 100]

2.2.1.14 Black Brant XI (39) (Concluded)

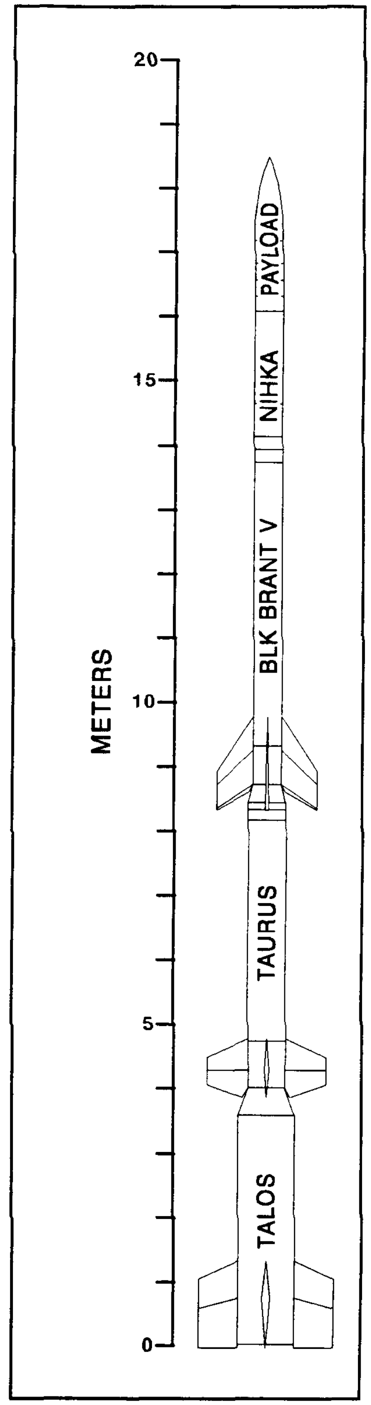
EXHAUST EMISSIONS, kilogram			
Compound	Talos	Taurus	Black Brant V
	0.2-1.8 km 0-6.2 sec	6.6-8.5 km 19.0-22.5 sec	12.5-59.1 km 28-60 sec
Carbon monoxide	465	333	288
Carbon dioxide	469	175	14
Water	137	125	40
Nitrogen	170	102	76
Hydrogen	22	8	30
Lead	22	11	-
Hydrogen chloride	-	-	187
Aluminum oxide	-	-	357
Sulfur	-	-	1
Other	-	-	4
Total	1285	754	997

MISSIONS AND PAYLOADS					
No. of Flights		FY 90 Mission (Fairbanks, Alaska)	Payload Releases	Payload Reco-very	Impact Media
FY 86-95	FY 96				
2*	0 (estd)	Study beam plasma discharge in near space environment using (1) non-recoverable forward payload, (2) four throwaway detector (TAD) packages and (3) recoverable aft payload with tethered experiment (main payload).	4 TAD packages	Aft portion	Land

* FY 90 was first year.

2.2.1.15 Black Brant XII (40)

Black Brant XII ("twelve") is a four-stage solid rocket system with a Talos first stage, a Taurus second stage, a BBV third stage, and a Nihka fourth stage. This vehicle is designed for carrying a variety of payloads to very high altitudes. This vehicle can lift a 136-kilogram payload to 1,500 kilometers, or a 522-kilogram payload to 500 kilometers. Flight times vary from 10 to over 20 minutes and impact ranges vary from 300 to over 1,200 kilometers. With extreme impact ranges, payload recovery is problematical. The diameters are 0.76 meter for the Talos, 0.58 meter for the Taurus, and 0.44 meter for the BBV, the Nihka, and the payload. The total vehicle length is over 16 meters, not counting the payload which may add up to 7 meters. This vehicle is a FY90 development and has been flown five times.



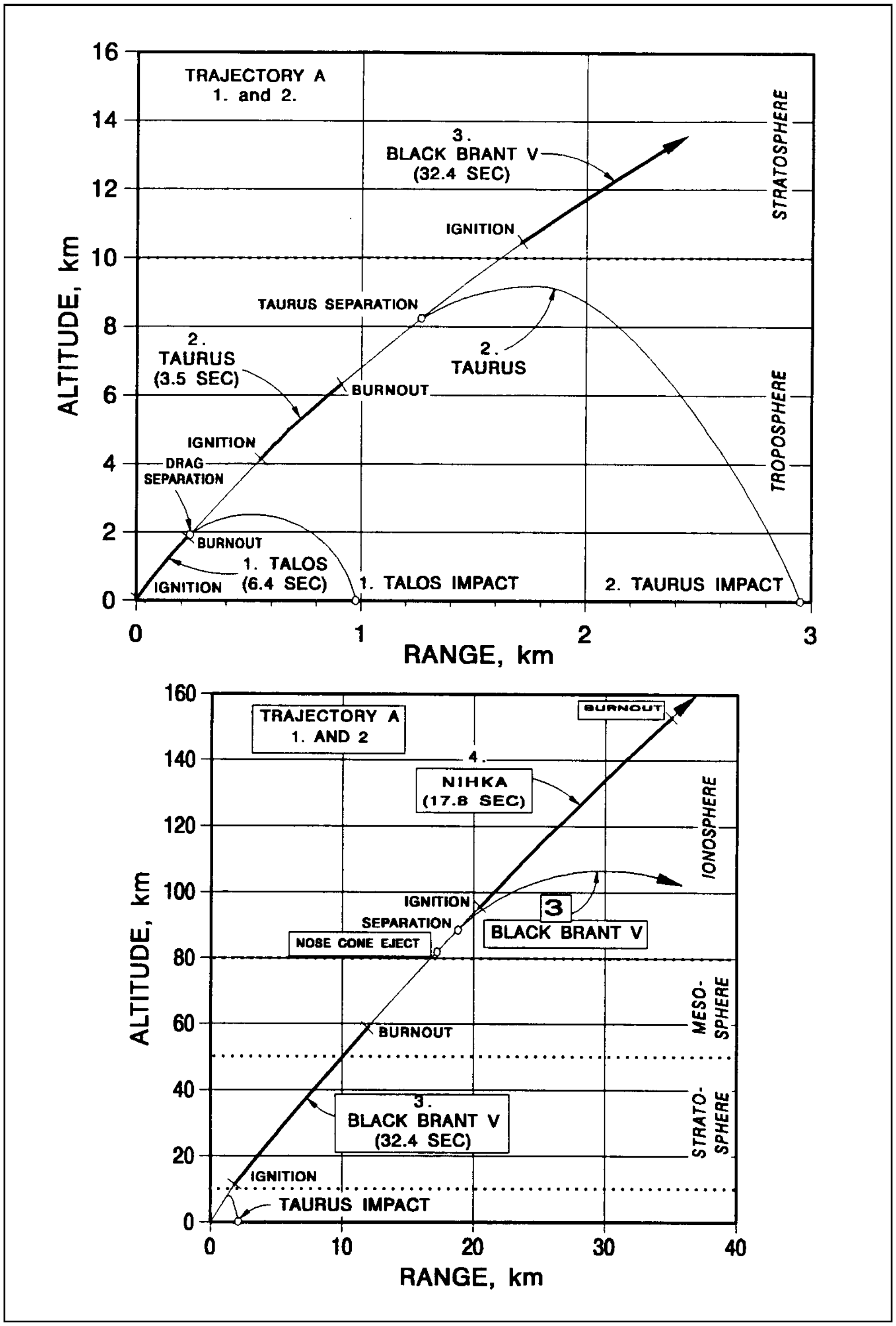
The Talos propellant weighs 1,285 kilograms and is of the nitrocellulose/ nitroglycerin family with lead compound additives. The rocket exhaust emissions are mainly carbon dioxide, carbon monoxide, nitrogen, and water. They occur during the 6.4-second burning time over the altitude span from ground to about 2 kilometers. Talos impact is about 1 kilometer from the launch pad with a spent rocket weight of 809 kilograms.

The Taurus propellant weighs 754 kilograms and is of the nitrocellulose/ nitroglycerin family with lead compounds and graphite as additives. The rocket exhaust emissions are mainly carbon monoxide, carbon dioxide, water, and nitrogen. They occur during the 3.5- second burning time over the altitude span from 4 to 6 kilometers. Taurus impact is approximately 3 kilometers from the launch pad with a spent rocket weight of 602 kilograms.

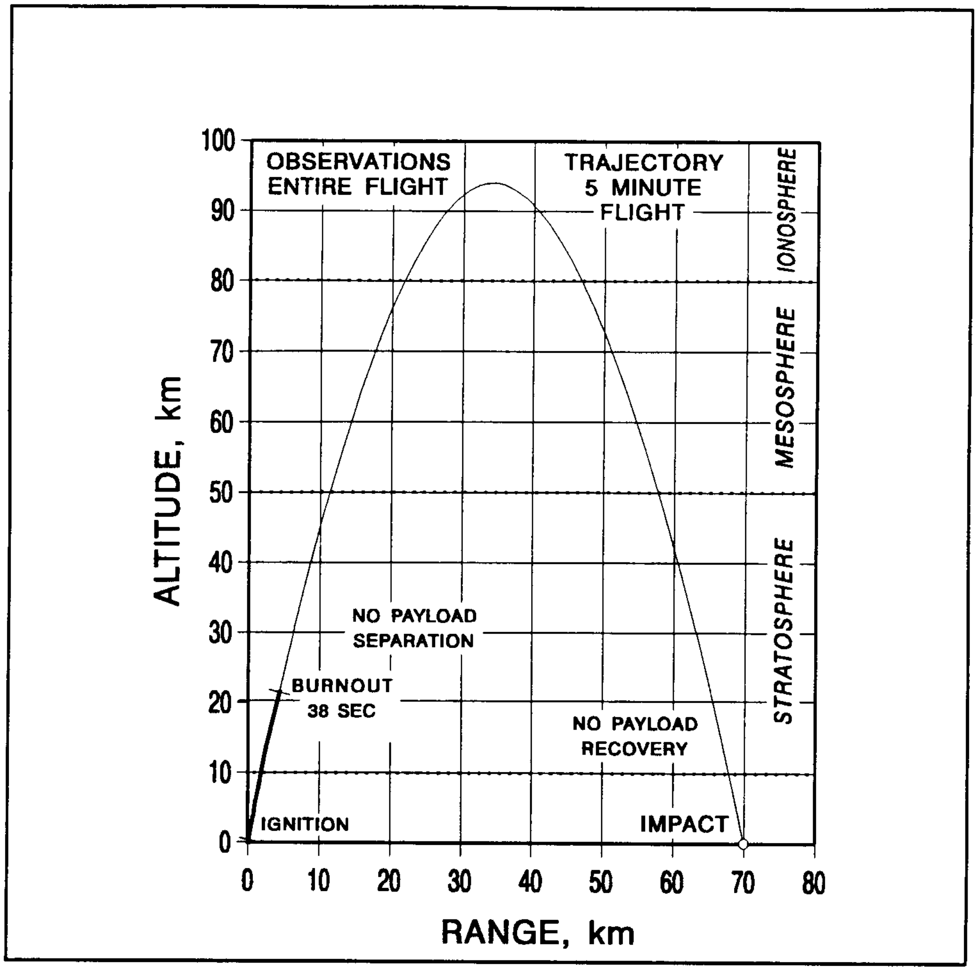
The BBV propellant weighs 997 kilograms and is of the ammonium perchlorate/aluminum/plastic binder type with small amounts of carbon black, iron, and sulfur. The rocket exhaust emissions consist mainly of aluminum oxide, carbon monoxide, hydrogen chloride, nitrogen, and water.

*** Continued on Page 2-71**

2.2.1.15 Black Brant XII (40) (Continued)



2.2.1.15 Black Brant XII (40) (Continued)



LAUNCH VEHICLE DESIGN					
Rocket	Diameter meter	Length meter	Total wt. kg	Propellant wt. kg	Impact wt. kg
Talos	0.76	3.35	2087	1285	802
Taurus	0.58	4.72	1360	754	606
Black Brant V	0.44	5.66	1265	997	268
Nihka	0.44	2.32	407	314	93
Payload	0.44	2.41	136		114
	Launch	18.46	5255	3350	

2.2.1.15 Black Brant XII (40) (Continued)

PROPELLANT COMPOSITION				
Compound	Talos	Taurus	Black Brant V	Nihka
Nitrocellulose	+	+		
Nitroglycerin	+	+		
Triacetin	+	+		
2-Nitrodiphenylamine	+	+		
Lead salicylate	+			
Lead 2-ethyl hexoate	+			
Lead beta-resorcylate		+		
Graphite		+		
Ammonium perchlorate			+	+
Aluminum			+	+
Polypropylene glycol			+	
Poly 1,4-butelene glycol			+	
N-phenyl-beta naphthylamine			+	
Toluene di-isocyanate			+	
Triethanolamine			+	
Iron acetylacetate			+	
Sulfur			+	
Dioctylazelate			+	
Carbon black			+	
Ferric oxide				+
Polybutadiene, hydroxy-terminated				+

EXHAUST EMISSIONS, kilogram				
Compound	Talos	Taurus	Black Brant V	Nihka
	0.2-1.9 km 0-6.4 sec	4.2-6.3 km 12.0-15.5 sec	10.6-58.9 km 21.0-53.4 sec	96.0-153.5 km 70.0-87.8 sec
Carbon monoxide	465	333	288	66
Carbon dioxide	469	175	14	9
Water	137	125	40	30
Nitrogen	170	102	76	26
Hydrogen	22	8	30	7
Lead	22	11	-	_
Hydrogen chloride	-	-	187	67
Aluminum oxide	-	-	357	106
Sulfur	-	-	1	1
Other	-	-	4	2
Total	1285	754	997	314

2.2.1.15 Black Brant XII (40) (Concluded)

MISSIONS AND PAYLOADS					
No. of Flights		FY 89 Mission (Fairbanks, Alaska)	Payload Releases	Payload Recovery	Impact Media
FY* 86-95	FY 96				
5	1 (estd)	Study AAP up to 1500 km altitudes, including HFEF, WPC, ES, and ions.	None	None	Stage 1,2,3: land; Stage 4 and Payload: Beaufort Sea.

* FY 90 was first year.
AAP = Aurora acceleration phenomena, WPC = Wave-particle correlations
HFEF = High frequency electron flux, ES = Electrostatic shocks

They occur during the 32.5-second burning time over the altitude span from 10 to 59 kilometers. The BBV impact is approximately 50 to 100 kilometers from the launch pad with a spent rocket weight of 268 kilograms.

The Nihka propellant weighs 314 kilograms and is of the ammonium perchlorate/aluminum/plastic binder type with carbon black, iron, sulfur, and ferric oxide additives. The rocket exhaust emissions are mainly aluminum oxide, hydrogen chloride, carbon monoxide, water, and nitrogen. They occur during the 18-second burning time over the altitude span from 96 to 154 kilometers with a spent rocket weight at final impact of 93 kilograms.

Standard hardware available for this BBV vehicle includes payload separation systems and despin systems. These units are "stackable," providing experimental flexibility.

[4, 35, 38, 64, 100]

2.2.2 METEOROLOGICAL ROCKET PROGRAM

This program is an adjunct to the SRP and uses some of the same launch sites as the SRP. Its purpose is to make in situ observations of meteorological (weather) and ozone-related properties of the atmosphere, from ground to the ionosphere.

The Meteorological Rocket Program (MRP) uses two small unguided rockets, the Super Loki and the Viper IIIA, for this purpose. Either of these rockets is the propulsive first stage of a two-stage vehicle, the second stage being an inert projectile, the Dart, which houses the instrumented payload. The function of the first stage, which has a short burn time, is to 'throw' the Dart into its desired suborbital trajectory just as a human would throw a dart or javelin.

The Super Loki Dart vehicle is treated in subsection 2.2.2.1 and the Viper IIIA Dart vehicle in subsection 2.2.2.2.

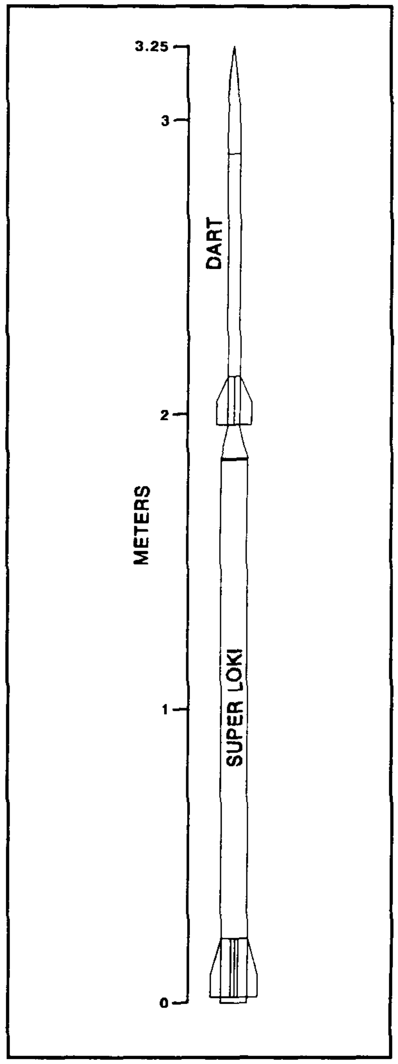
2.2.2.1 Super Loki Dart

The Super Loki is a meteorological two-stage rocket system used to obtain density, temperature, ozone and wind data at altitudes ranging from 85 to 110 kilometers to ground. The first stage is a solid propellant rocket, 0.1 meter in diameter and 2 meters long, with four aft stabilizing fins. The second stage is an inert instrumented Dart, 0.054 meter in diameter and 1.26 meters long. The second stage can house different payloads.

In operation, the vehicle (total length 3.26 meters) is launched from a tubular launcher. After a 2-second burning time, the vehicle has reached a 2- kilometer altitude. At this time, the spent rocket separates from the Dart and follows a trajectory to ground impact.

The MRP has used three types of Super Loki Dart during the last 10 years - the Datasonde, Sphere, and Ozonesonde. Table 2-6 is a listing by year of the 310 Super Loki Dart flights made during the 10-year period (FY86 through FY95).

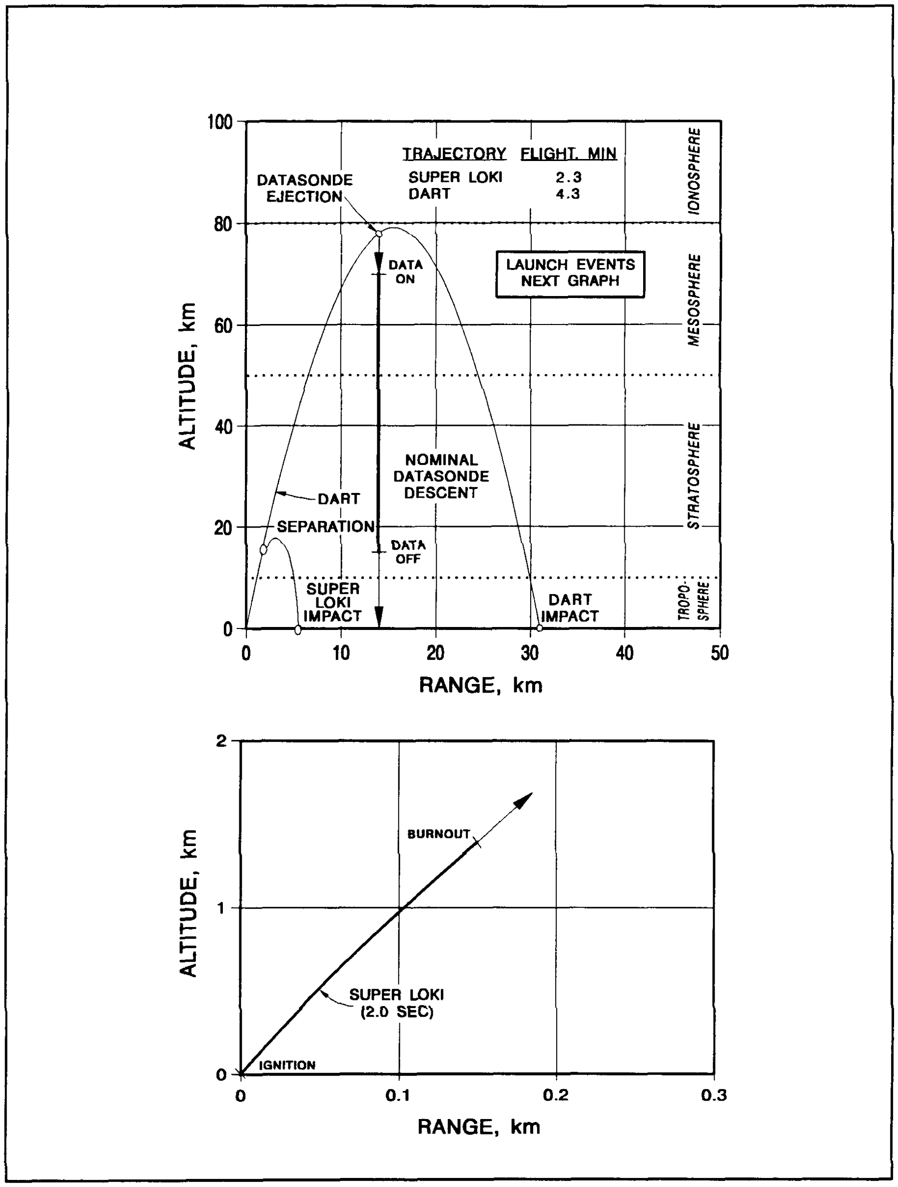
* Continued on Page 2-75



2.2.2.1 Super Loki Dart (Continued)

Chapter 2 Alternatives

2.2.2.1 Super Loki Dart (Continued)



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2.2.2.1 Super Loki Dart (Continued)

LAUNCH VEHICLE DESIGN					
Rocket	Diameter meter	Length meter	Total wt. kg	Propellant wt. kg	Impact wt. kg
Super Loki	0.100	2.00	25.9	16.9	9.0
Payload	0.054	1.26	4.5	-	4.5*
	Launch	3.26	30.4	16.9	*in pieces

SUPER LOKI PROPELLANT COMPOSITION	
Ammonium Perchlorate	Dibutyl phthalate
Aluminum	Diphenylquanadine
Polysulfide polymer	Quinone dioximine
Magnesium oxide	Sulfur

SUPER LOKI EXHAUST EMISSIONS, (0-1.39 km, 0-2.0 sec)			
Compound	kg	Compound	kg
Aluminum oxide	0.57	Magnesium oxide	0.11
Carbon monoxide	2.59	Sulfur dioxide	1.01
Hydrogen chloride	4.01	Sulfur monoxide	0.22
Nitrogen	1.60	Hydrogen sulfides	0.18
Hydrogen	0.13	Monoatomic chlorine	0.07
Carbon dioxide	2.16	Sulfur	0.05
Water	4.17	Other	0.03
		Total	16.90

2.2.2.1 Super Loki Dart (Continued)

MISSIONS AND PAYLOADS					
No. of Flights		FY 94 Mission (Wallops Island)	Payload Releases	Payload Recovery	Impact Medium
FY 86-95	FY 96				
310	12 (estd)	Correlative measurements of ozone (between 15 and 55 km) and temperature (between 15 and 60 km) in conjunction with UARS/HALOE satellite.	None	None	Ozonesonde Dart: Ocean

At its apogee the Datasonde Dart (168 flights) ejects a 0.56-square-meter starute (parachute) supporting an actively transmitting temperature-measuring transistor. The Sphere Dart (118 flights) similarly ejects an unfolding passive 1-meter diameter metallized mylar (plastic) sphere whose radar-tracked descent permits estimation of air density and wind. The Ozonesonde Dart (24 flights) functions like the Datasonde, except that the starute supports a transmitting optical ozone sensor.

After ejection all payloads fall to Earth under the combined action of gravity, wind, and air resistance. Once the dense atmosphere is reached, the starute or sphere collapses, impacting the surface at an estimated 6 meters per second, sufficiently strong to prevent reuse of any instruments.

Normally, with the Datasonde, the forward section of the Super Loki rocket is weighted with ballast to provide aerodynamic stability to the spent rocket which then pursues a predictable ballistic path to the ground, usually impacting about 3 kilometers from the launch pad.
The apogee is 85 kilometers, and the Dart impacts 28 kilometers from the launch pad with a spent weight of 5 kilograms.

With the Sphere, a higher apogee, 115 kilometers is often desirable and attainable by removing the ballast from the Super Loki rocket. The spent Dart impact is then 35 kilometers from the launch pad. The disadvantage is that the lack of ballast leads to an unstable spent rocket whose path to Earth is difficult to predict. Because of the risk to launch facilities and personnel, many launch sites do not permit flights of the unballasted Super Loki.

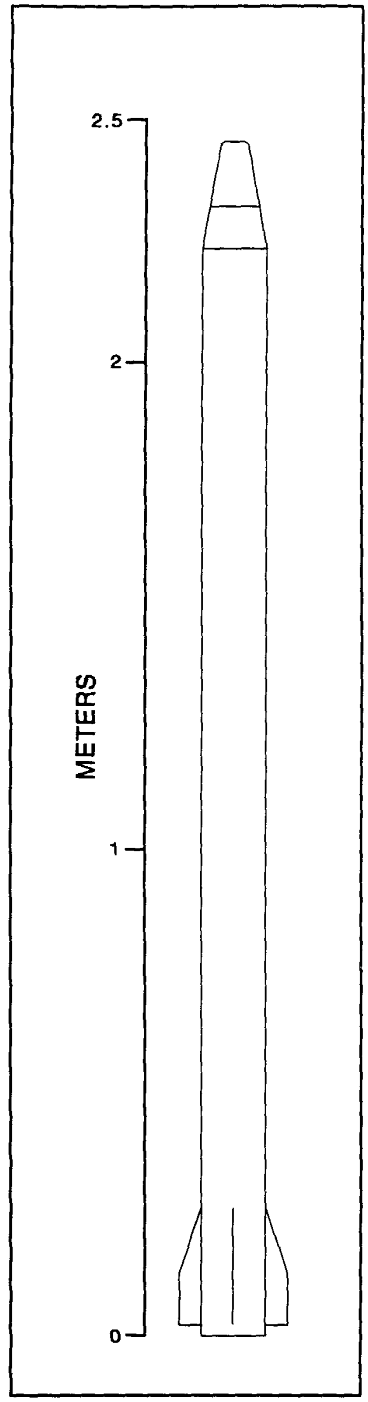
The Super Loki propellant weighs 16.9 kilograms and is of the ammonium perchlorate/aluminum/plastic binder type. The rocket exhaust emissions are mainly hydrogen chloride, carbon monoxide, carbon dioxide, and aluminum oxide. [8, 9, 50, 70, 104, 109, 110, 146]

Table 2-6
SUPER LOKI DART METEOROLOGICAL ROCKET FLIGHTS
FY86 THROUGH FY95

Fiscal Year	***Datasonde Dart***	***Sphere Dart***	***Ozonesonde Dart***	*Total Super Loki Dart*
1986	41	2	0	43
1987	14	4	0	18
1988	29	0	0	29
1989	23	3	10	36
1990	19	14	6	39
1991	6	19	0	25
1992	9	19	0	28
1993	7	18	3	28
1994	19	32	5	56
1995	1	7	0	8
10-Year Total	168	118	24	310

2.2.2.2 Viper IIIA Dart

The Viper IIIA is a meteorological, two-stage, solid propellant rocket system to obtain density, ozone, temperature, and wind data at altitudes ranging from 115 kilometers, or higher, to ground. This system is a scaled- up Super Loki with about 50 percent more propellant of the same type. The second stage is the same Dart with identical Datasonde, Sphere, or Ozonesonde payloads and modes of application. As a result, the Viper IIIA Dart can reach higher apogees (115 to 125 kilometers) than the Super Loki Dart (85 to 110 kilometers).

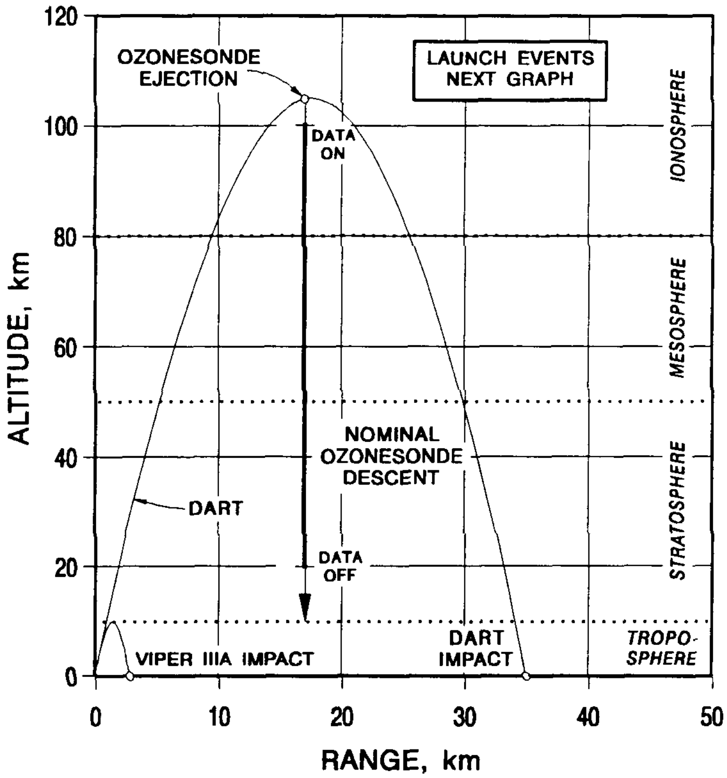


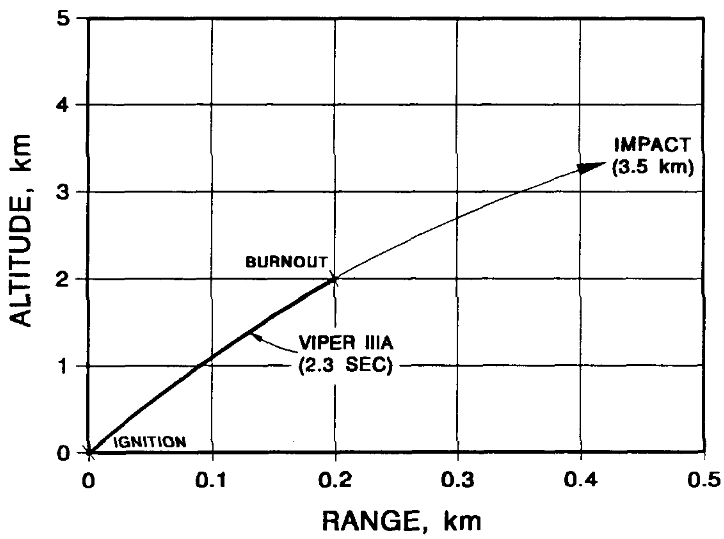
This system can attain a 115-kilometer apogee with the ballast in place so that the spent rocket remains aerodynamically stable with a predictable path to impact. This makes the Viper IIIA an acceptable system where the 115-kilometer altitude and adequate range safety are both essential. Also, if the lack of spent rocket stability is not a factor, the ballast may be removed, increasing the apogee to an estimated 125 kilometers.

The solid rocket has a 0.114-meter diameter and a 2.44-meter length, making the vehicle length (with a Datasonde Dart) 3.1 meters. The Viper IIIA propellant weighs 25.9 kilograms and is of the same ammonium perchlorate/ aluminum/plastic binder type as the Super Loki. The rocket exhaust emissions are mainly hydrogen chloride, carbon monoxide, carbon dioxide, and aluminum oxide. They occur during the 2.3-second burning time over the altitude span from ground to 2 kilometers. Viper IIIA impact is about 3.5 kilometers from the launch pad with a spent rocket weight of 8.3 kilograms.

The inert Dart typically impacts 30 to 40 kilometers from the launch pad (depending on launch angle) with an impact weight near 8 kilograms, in fragments. The MRP has employed the Viper IIIA rocket since FY91. There were 8 flights in FY91, 10 in FY92, 6 in FY93, 24 in FY 94, and 7 in FY95 [50, 111, 146].

2.2.2.2 Viper IIIA Dart (Continued)





2.2.2.2 Viper IIIA Dart (Continued)

LAUNCH VEHICLE DESIGN					
Rocket	Diameter meter	Length meter	Total wt. kg	Propellant wt. kg	Impact wt. kg
Viper IIIA	0.114	2.44	34.2	25.9	8.3
Dart (inert)	0.054	1.42	8.6	-	8.6*
	Launch	3.86	42.8	25.9	*in pieces

VIPER IIIA PROPELLANT COMPOSITION	
Ammonium Perchlorate	Dibutyl phthalate
Aluminum	Diphenylguanadine
Polysulfide polymer	Quinone dioximine
Magnesium oxide	Sulfur

VIPER IIIA EXHAUST EMISSIONS, (0-2.0 km, 0-2.3 sec)			
Compound	kg	Compound	kg
Aluminum oxide	0.82	Magnesium oxide	0.17
Carbon monoxide	3.97	Sulfur dioxide	1.55
Hydrogen chloride	6.15	Sulfur monoxide	0.34
Nitrogen	2.45	Hydrogen sulfides	0.27
Hydrogen	0.20	Monatomic chlorine	0.11
Carbon dioxide	3.31	Sulfur	0.08
Water	6.38	Other	0.05
Total			25.90

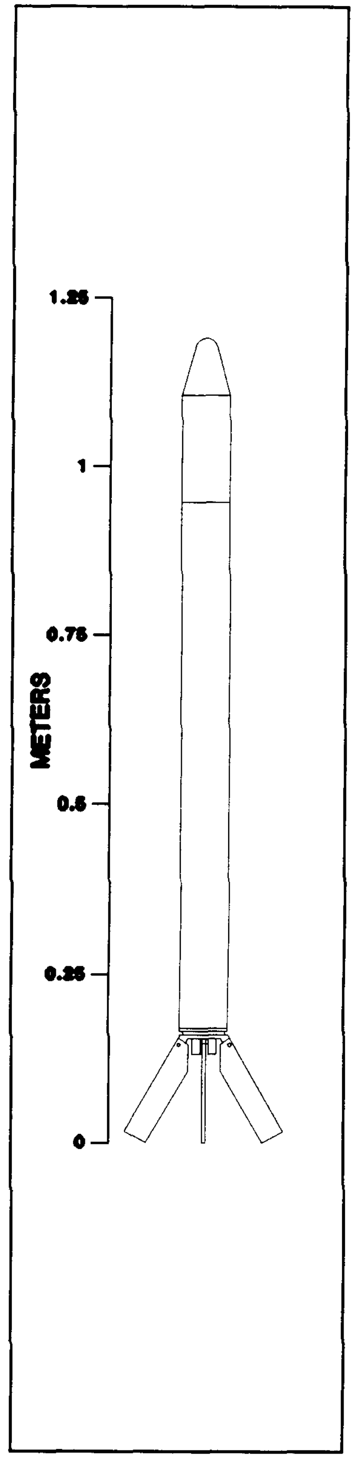
MISSIONS AND PAYLOADS					
No. of Flights		FY 94 Mission (Alcantara, Brazil)	Payload Releases	Payload Recovery	Impact Medium
FY 91-95	FY 96				
55 (FY91 was first year)	15 (estd)	Study of enhancement of diurnal atmospheric waves (between 30 and 90 km) due to interaction with 2-day and 16-day waves.	None	None	Ocean

2.2.3 TEST ROCKET PROGRAM

About one-half hour prior to each SRP or MRP flight, one or two small 70-millimeter test rockets are launched (without payloads) several minutes apart to serve as targets for prelaunch metric radar and tracking system checkout. Occasionally, only one test rocket is launched, typically when two SRP or MRP launches are to be carried out in quick succession. These rockets fly for 70 seconds and impact 3 kilometers from the launch site.

During the last 10 years, the SRP made 290 flights and the MRP made 323 flights (310 + 13), a total of 613 flights. The number of test rockets flown during the 10-year period was 712. The yearly flight breakdown appears on page 2-81.

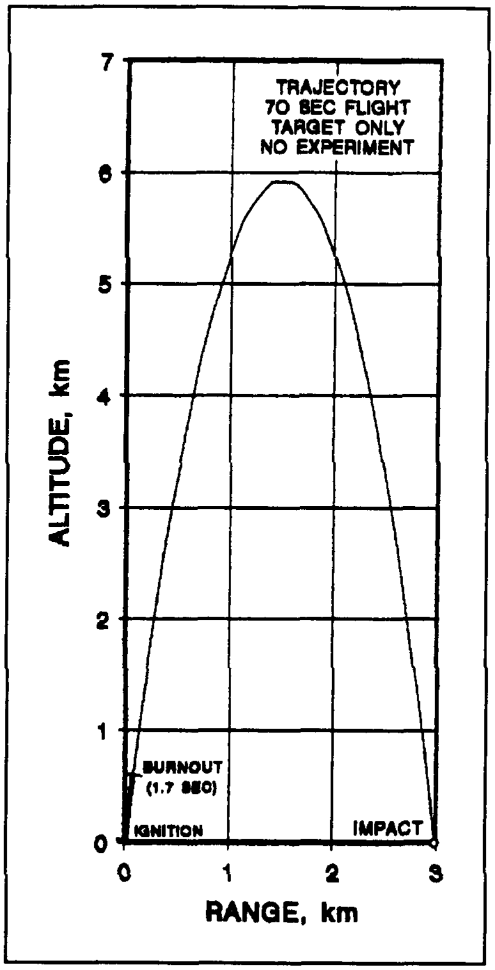
The 70-millimeter test rocket is a small, single-stage, solid propellant rocket system with a nose cone which houses an electric-pyrotechnic flare to serve as a target to check out the acquisition and tracking capabilities of ground radars prior to launching any of the 17 previously described launch vehicles (Sections 2.2.1 through 2.2.2). The total launch weight of the rocket system is 9.5 kilograms, the apogee of the test rocket trajectory is 6 kilometers, and impact occurs 3 kilometers from the launch pad after a 70-second flight time with a 6.8-kilogram spent weight. The system diameter is 0.07 meter and its length is 1.2 meters.



The test rocket propellant weighs 2.7 kilograms and is of the nitrocellulose/ nitroglycerin/plastic binder type with a lead compound additive. The rocket exhaust emissions consist mainly of carbon monoxide, carbon dioxide, nitrogen, and water. They occur during the 1.7-second burning time over the altitude span from ground to 0.6 kilometer.

[33, 35, 36, 72, 88]

2.2.3 TEST ROCKET PROGRAM (Continued)



Ten-Year Test Rocket Flights			
FY	Number of Flights	FY	Number of Flights
1986	87	1991	59
1987	73	1992	71
1988	130	1993	59
1989	71	1994	61
1990	66	1995	35
10 Year Total			712

2.2.3 TEST ROCKET PROGRAM (Concluded)

LAUNCH VEHICLE DESIGN					
Rocket	Diameter meter	Length meter	Total wt. kg	Propellant wt. kg	Impact wt. kg
70-mm Rocket	0.07	1.0	5.2	2.7	2.5
Nosecone	0.07	0.2	4.3	-	4.3
	Launch	1.2	9.5	2.7	

70-MM TEST ROCKET PROPELLANT COMPOSITION	
Nitrocellulose	Lead Stearate
Nitroglycerin	Other
Diethylphthalate	

70-MM TEST ROCKET EXHAUST EMISSIONS, (0-0.58 km, 0-1.7 sec)			
Compound	kg	Compound	kg
Carbon dioxide	0.80	Nitrogen	0.32
Carbon monoxide	1.34	Methane	0.01
Water	0.16	Lead	0.02
Hydrogen	0.05		
		Total	2.70

MISSIONS AND PAYLOADS					
No. of Flights		Mission (All launch sites)	Payload Releases	Payload Recovery	Impact Medium
FY 86-95	FY 96				
712	70 (estd)	Pre-launch dynamic radar and tracking system checkout. One or two rockets are launched 25-45 minutes prior to each scientific and weather rocket flight to serve as targets.	None	None	Land

2.2.4 PERMANENT LAUNCH FACILITIES

The site-specific components of the Proposed Action are the three major United States permanent sounding rocket launch facilities, located in the states of Virginia, New Mexico, and Alaska.

The three launch facilities are described in Chapter 3.0, Affected Environment, as follows:

Wallops Flight Facility (WFF), Eastern Shore of Virginia, in Section 3.2.1;

Poker Flat Research Range (PFRR), Fairbanks, Alaska, in Section 3.2.2; and

White Sands Missile Range (WSMR), White Sands, New Mexico, in Section 3.2.3.

2.3 NO ACTION ALTERNATIVE

This alternative consists of the cessation of the launching of the various SRP and MRP vehicles with their payloads from the three principal launch sites or from any other launch site. The impacts of SRP termination on NASA's scientific programs, the three principal launch sites, and on any other environmental receptor which was affected when the vehicle launches were performed are assessed in Chapter 4.0 of this SEIS.

3.0 AFFECTED ENVIRONMENT

The launching of sounding rockets impacts both atmospheric and terrestrial environments. The atmospheric impacts range from the troposphere to the ionosphere and are generally global in nature, though they also do affect site-specific air quality. The terrestrial impacts of rocket launching and the landing of spent rockets and payloads are site-specific to the launch range area. Terrestrial impacts affect both the land and aquatic environments.

This SEIS addresses both the programmatic (global) and site-specific impacts of the NASA SRP at WFF, PFRR, and WSMR. The existing atmospheric environment is addressed in global terms, and applies to each of the three permanent sites and any mobile or foreign site. The terrestrial environments are addressed in site-specific terms for each of the principal rocket launch facilities in the United States used by the NASA SRP.

3.1 GLOBAL ENVIRONMENT: THE ATMOSPHERE

The Earth's atmosphere is best described in terms of four principal layers: the troposphere, the stratosphere, the mesosphere and the ionosphere (Figure 3-1). These layers have indistinct boundaries. They are identified by temperature, structure, density, composition, and degree of ionization.

The lower, turbulent part of the atmosphere (troposphere) is impacted by the combustion products of propellants from the first-stage rockets. The upper reaches of the atmosphere (above 10 kilometers) are impacted by the exhaust from upper stage rockets, and by physical and chemical interactions between the vehicle/payload combination and the atmosphere. The environmental impacts on the atmosphere in this instance are global in nature and are not specific to any one site.

3.1.1 TROPOSPHERE

The lowest level of the atmosphere, the troposphere, extends from the Earth's surface to approximately 10 kilometers. The Earth's weather evolves within this very turbulent region. This layer contains an estimated 75 percent of the total mass of the atmosphere. Solar radiation penetrates the atmosphere causing heating at the surface which then decreases with height within the lower atmosphere. This variation in temperature makes the troposphere the most dynamic of the four atmospheric layers.

The troposphere is composed of 76.9 percent nitrogen and 20.7 percent oxygen by weight. The relative concentrations of these gases are highly uniform throughout the lower atmosphere. Water vapor is the next largest component (1.4-percent average by volume throughout the lower atmosphere), although its concentration is quite variable near the Earth's surface. Trace gases comprise the remainder of the lower atmosphere. These gases, in order of decreasing abundance are: argon, carbon dioxide, neon, helium, methane, krypton, nitrous oxide, hydrogen, xenon, and ozone.

3.1.2 STRATOSPHERE

The stratosphere (10 to 50 kilometers) is identified by both physical stability and maximum ozone concentration. It is characterized by an increase in temperature with altitude. This is due to the ozone layer, which absorbs ultraviolet solar radiation and reradiates it back at longer wavelengths. The base of the stratosphere is marked by an increase in ozone concentration over levels found in the troposphere. The highest ozone concentrations are found near the middle of the stratosphere, in the center of the ozone layer, at approximately 25 kilometers.

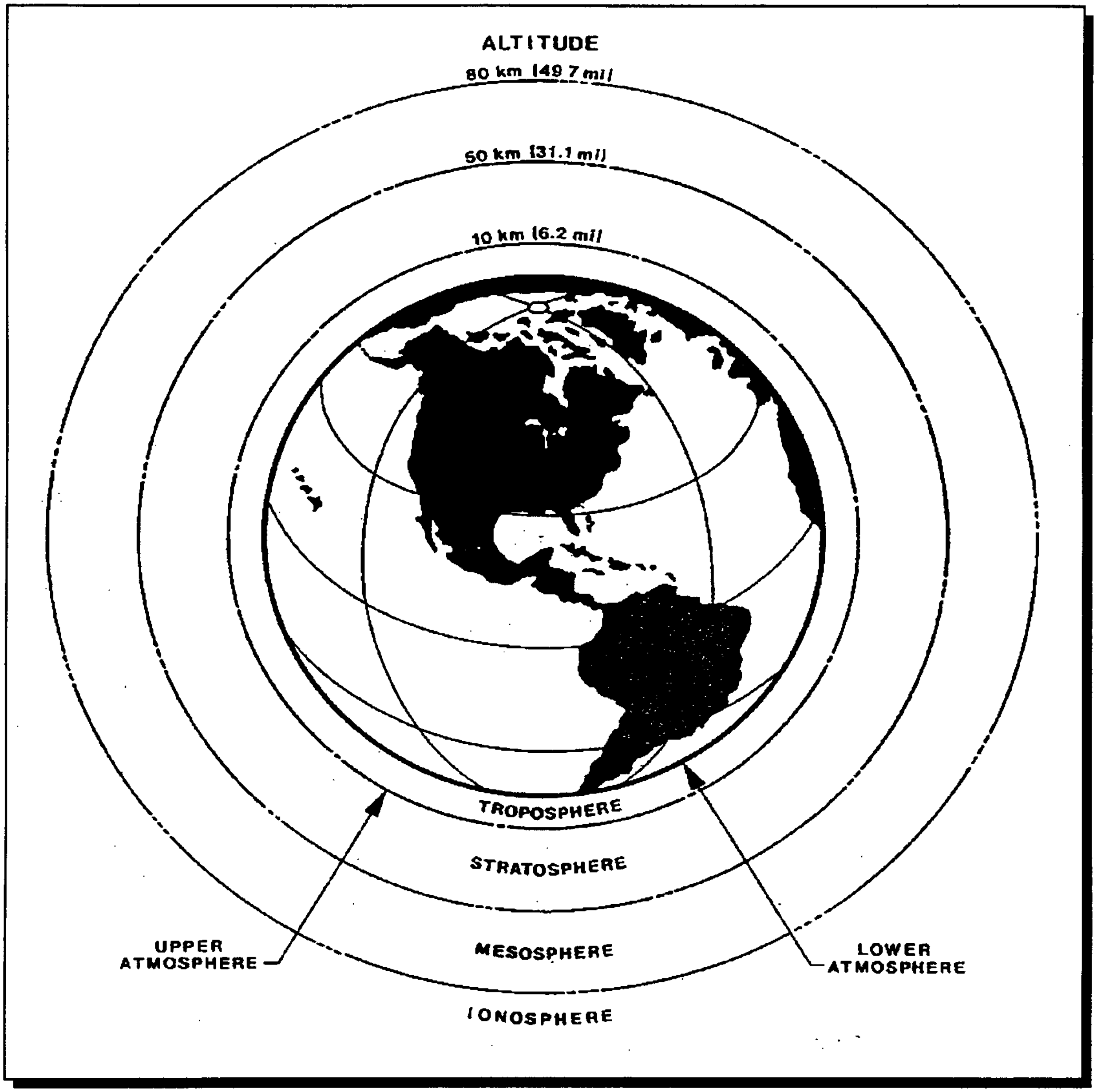


Figure 3-1. The Four Principal Layers of the Earth's Atmosphere

An ozone molecule contains three atoms of oxygen and is produced by the chemical combination of an oxygen molecule with an atom of oxygen. Atomic oxygen is produced by the breakdown of molecules of oxygen, nitrogen dioxide, or ozone.

The ozone distribution in the stratosphere is maintained as the result of a dynamic balance between creation and destruction mechanisms. The distribution fluctuates seasonally by approximately 25 percent and annually by approximately 5 percent.

Although it comprises only several parts per million in the stratosphere, ozone absorbs virtually all ultraviolet solar radiation of wavelengths less than 295 Angstroms, and much of the radiation in the range of 290 to 320 Angstroms (the ultraviolet - B [UV-B] region). Ozone also contributes to the heat balance of the Earth by absorbing radiation in the infrared near the 9,600-Angstrom wave-length.

3.1.3 MESOPHERE

The mesosphere (50 to 80 kilo-meters) is a transition layer between the stratosphere and the ionosphere. The base of the mesosphere marks the upper boundary of the ozone layer. This area is warmed by the absorption of solar ultraviolet energy by ozone. Ozone production/destruction also occurs in the lower part of the mesosphere, although these mechanisms are most critical in the stratosphere. The temperature of the mesosphere decreases with altitude, reaching a minimum at the top of the mesosphere. This layer is an area of varied wind speeds and directions due to the occurrence of turbulence and atmospheric waves.

3.1.4 IONOSPHERE

The ionosphere, or thermosphere, (80 to beyond 1,000 kilometers) is characterized by high ion and electron density. Although this region is highly rarefied compared to the atmosphere at the Earth's surface, it still causes some drag on satellites orbiting within it.

The ionosphere's several layers of differing properties are particularly important to low-frequency radio communications. It is also the region where radiations in the visible spectrum, such as the aurora, originate. The ionosphere is influenced by solar radiation, variations in the Earth's magnetic field, and motion of the upper atmosphere. Because of these interactions, the systematic properties of the ionosphere vary greatly with time (diurnally, seasonally, and over the approximately 11-year solar cycle) and geographical latitude.

3.2 SITE-SPECIFIC FACILITIES AND AFFECTED ENVIRONMENT

This section addresses physical plant (facilities) and the environmental setting at each of three fully equipped permanent launch facilities for sounding rockets in the United States used by the NASA SRP:

1. WFF at Wallops Island, Virginia
2. PFRR at Fairbanks, Alaska
3. WSMR at White Sands, New Mexico

The physical plant of a typical, fully equipped launch site encompasses rocket launching complexes and operations support facilities, including radar and telemetry.

Rocket launch complexes are comprised of a series of launch pads, each equipped with one or more launchers and a blockhouse/rocket firing control center. Individual launch pads are often provided with environmental shelters for protection from the elements during the staging of payload and vehicle. The shelters are mounted on rails or wheels and are mobile.

Clear zones and quantity distance siting are established for the storage, handling and launch of rockets. For facility siting, QD distances generally cited are the maximum for the facility and are based on either physical capacity of the given type of explosive or other limiting factors based on safety requirements (i.e. distance to nearest inhabited building). For operations, such as assembly and launch, the specific clear zones or hazard areas are defined for each system and published in operations documentation. These areas range in size from a few hundred feet to several thousand feet depending on the vehicle/payload and amount of explosives involved.

Operations support for sounding rockets begins at the rocket reception area. This is where the rockets are delivered, usually by truck, examined, and transferred to the rocket inspection and storage buildings. Separate support facilities are used for the payload preparation, test, and evaluation.

The vehicle assembly building, usually located in close proximity to the launch pad, is a place where final preparations for rocket/payload integration are made.

The launch pads are located at remote locations and are usually separated from the rest of the facility by explosive hazard zones. Radar, telemetry, and optical flight monitoring equipment also constitute a component part of a fully equipped rocket launch facility.

In addition to the permanent launch facilities in the United States, NASA uses mobile range sites and foreign launch facilities.

For example, in 1992, a mobile launch site at Vega Baja, Puerto Rico, was used by the SRP [53, 82][1]. The following foreign sites were used recently by the NASA SRP: Kwajalein Island, Republic of the Marshall Islands [83, 112]; Esrange, Kiruna, Sweden [113, 114]; and the Norwegian Sounding Rocket Range, Andoya, Norway [1].

The site-specific environmental settings of the three major rocket launching facilities used by the NASA SRP in the United States were examined in depth by review of available literature and by site visits to the WFF, PFRR, and WSMR [44, 45, and 46]. During these visits, discussions were held with the launch site operators, NASA programs and environmental personnel, and with representatives of Federal and State regulatory agencies.

As a result of the field studies and evaluation of existing literature, it was determined that a wealth of relevant, site-specific environmental information exists for the rocket launch facilities used by the NASA SRP at WFF, PFRR, and WSMR (see Chapter 6.0, Bibliography). These documents comprise the supporting library to this SEIS, and include detailed descriptions of the climate, air and water quality, land use, biological resources, threatened and endangered species, wetlands, and information related to the use and handling of toxic substances, cultural resources, economics, population, and

[1] Numbers in brackes correspond with document numbers contained in Bibliography.

employment. This information was used to determine the environmental consequences of the NASA SRP activities at each site as discussed in Chapter 4.0 of this report.

Chapter 4.0 also addresses the relationship between the short-term uses and long-term maintenance and enhancement of the environment and irreversible and irretrievable commitments of resources, including energy use.

3.2.1 WALLOPS FLIGHT FACILITY, EASTERN SHORE OF VIRGINIA

The origin of the WFF dates back to 1945, when the National Advisory Committee for Aeronautics (NACA) authorized the Langley Research Center to proceed with development of Wallops Island as a site for research with rocket-propelled aerodynamic research models. Among the chief activities conducted at Wallops today is the NASA SRP, a program which originated in 1959. In the course of the NASA SRP, WFF has rendered support to scientific organizations from the United States and foreign universities, commercial research organizations, the DOD, and other government agencies.

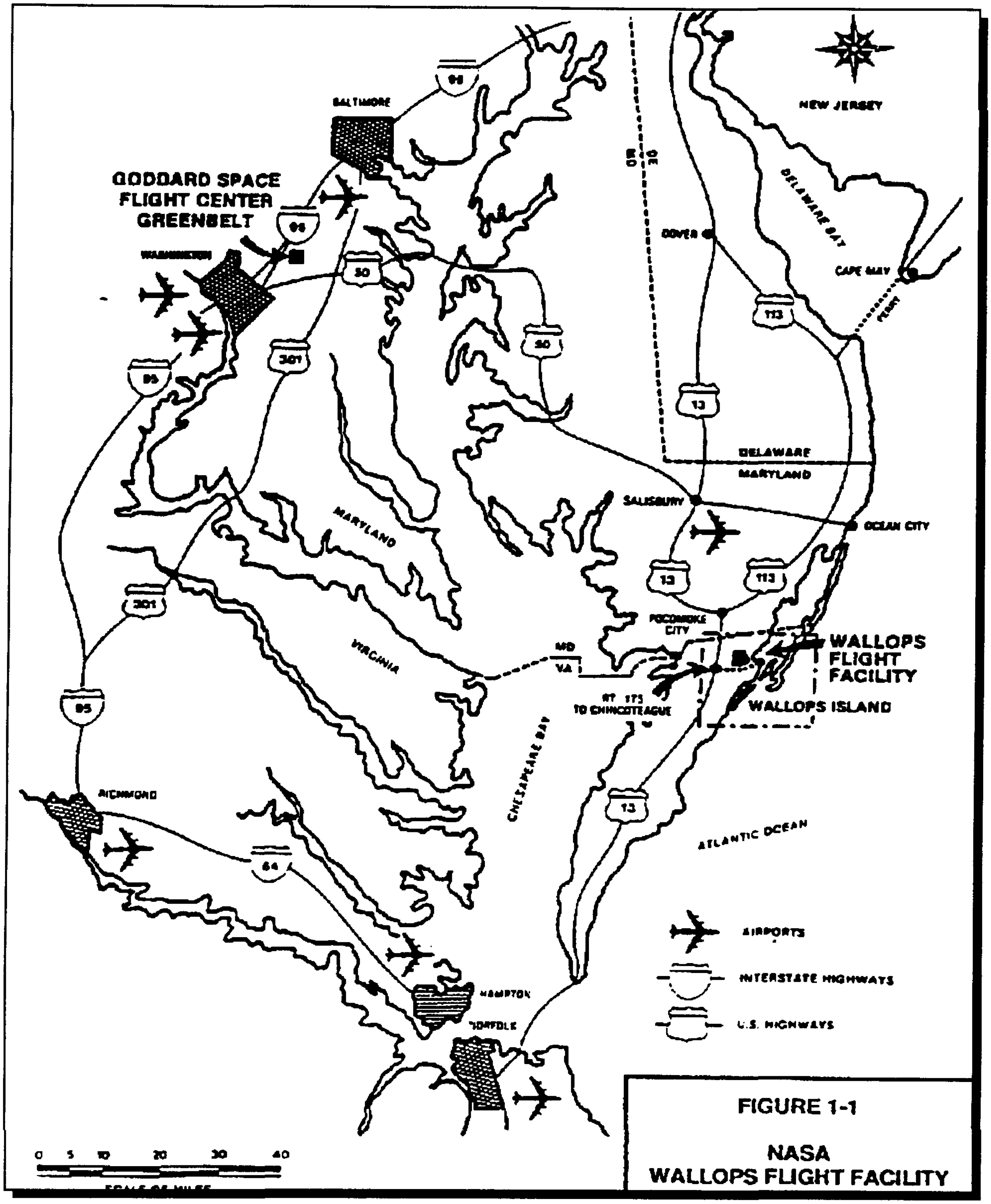
The information related to the site-specific environmental issues at WFF includes a number of earlier site-specific EA;s [22, 101, 136] and EIS's [57, 133], Test Directives [31, 32], Safety Plan [33], Range User Handbook which includes range operations and safety directive [83], biology [41, 126], and Wallops future plans [89], as well as site visits and facilities inspections [44]. The ***Final Environmental Resources Document*** (ERD) [54] for this NASA facility, published in August 1994, provides up-to-date information on environmental issues at the WFF and also addressed health and safety issues at this installation.

Three NASA documents, ***Goddard Space Flight Center: Facilities Master Plan***, Volume 1: General Information, [123] and Volume 3: Wallops Flight Facility [124], NASA, 1988, and ***the Space Utilization Handbook,*** Facilities Engineering Branch, NASA WFF, 1997 [87] provided a detailed description of the physical layout of WFF, including all the necessary maps and facilities descriptions. The collected documents also addressed the safety issues [15, 72], information on the mission and historical background of this NASA site [124], and information on environmental issues, including climate, land use, air and water quality, and wetlands [54].

Additional subject-specified documents analyzed as part of this SEIS preparation included reports dealing with architectural and archaeological resources inventories [51] and biological resource assessments [98] of the Wallops area.

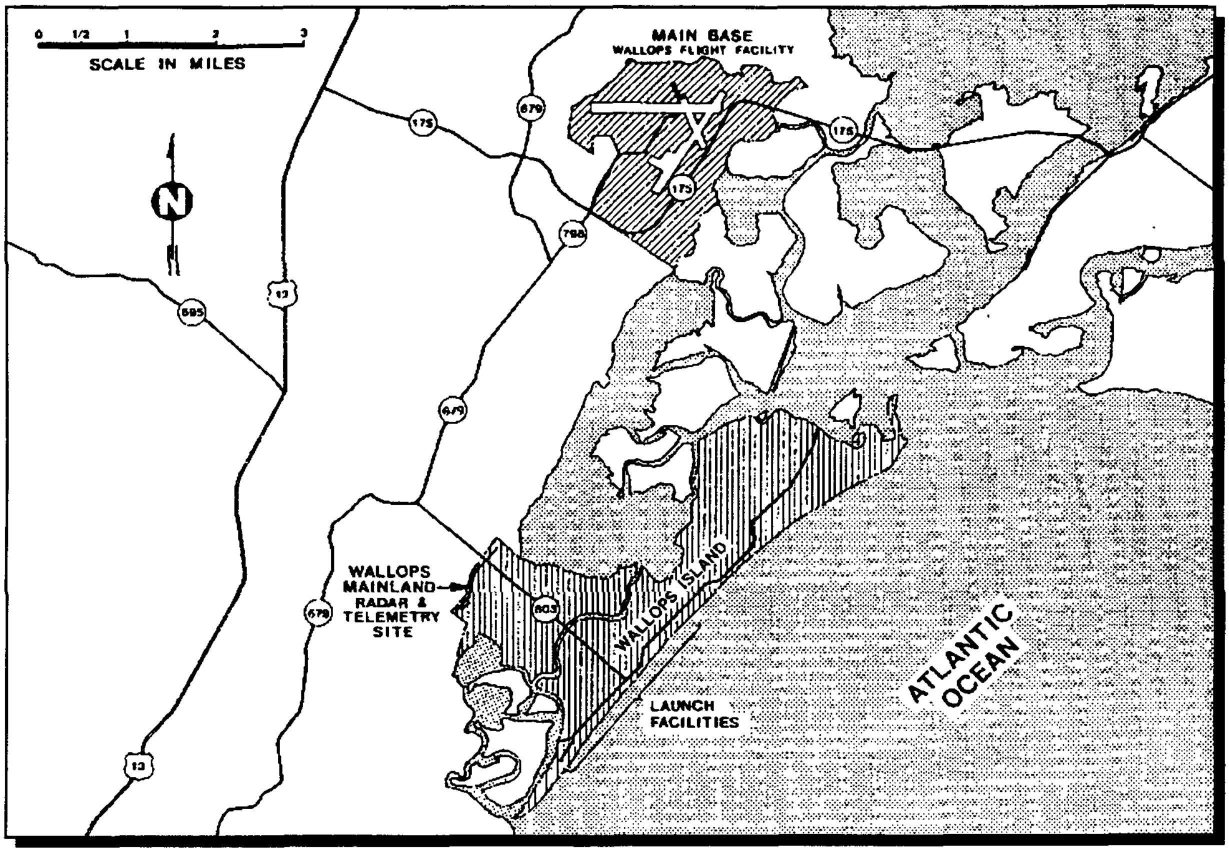
3.2.1.1 WFF Launch and Support Facilities

The WFF is located on the Delmarva Peninsula in the Mid-Atlantic region of the United States within the political boundaries of Accomack County on the Eastern Shore of Virginia. This location corresponds to approximately 37°56'N latitude and 75°27'W longitude. The facility is approximately 65 kilometers (40 miles) southeast of Salisbury, Maryland, and 144 kilometers (90 miles) north by northeast of Norfolk, Virginia [54, 122, 124], as shown on the map on page 3-7.



Location of WFF

3.2.1.1.1 Operations Areas of WFF, Virginia

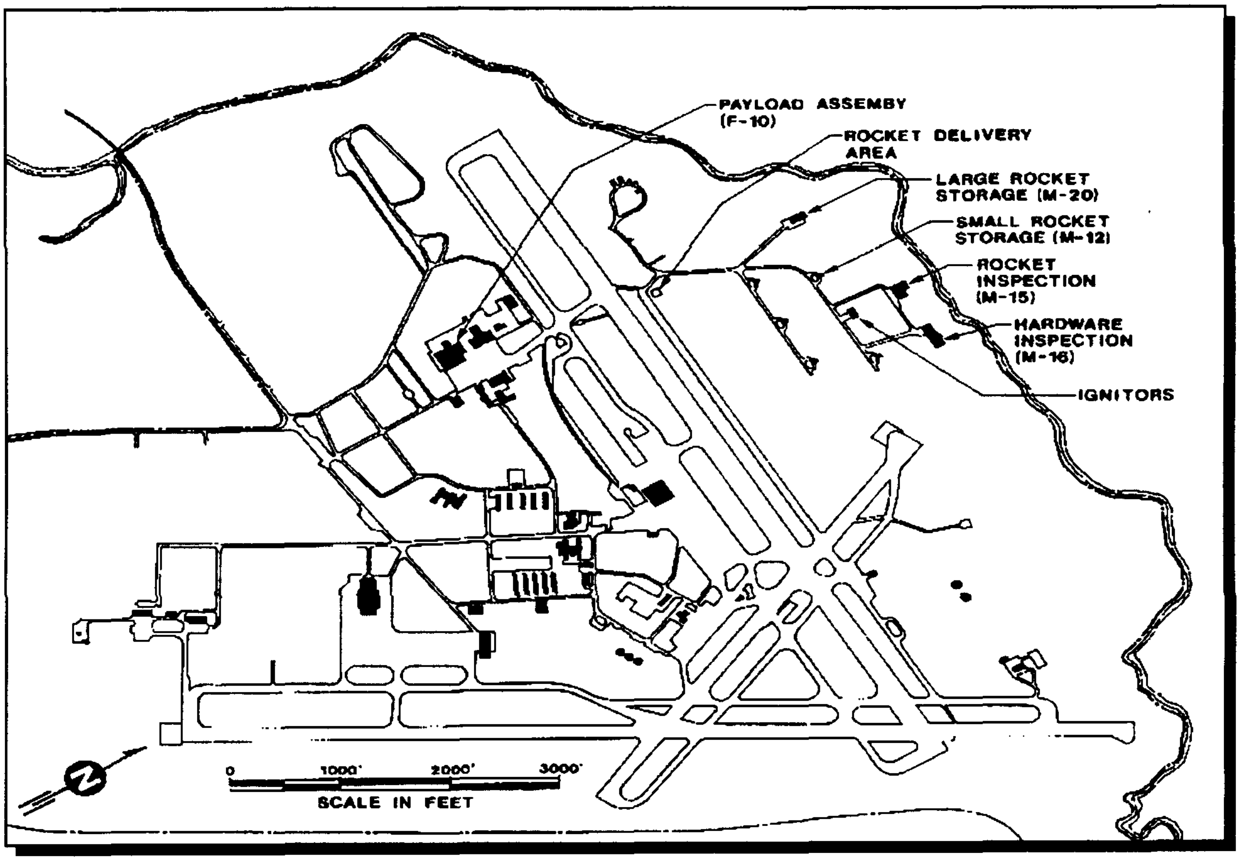


The WFF comprises three separate areas: the Main Base, the Mainland, and Wallops Island. The ***Main Base*** contains approximately 742 hectares (1,833 acres) of land. It is bordered on the east by marshlands and creeks. On the north and west, it is bordered by Mosquito Creek. On the south and southeast, it is bordered by State Routes 175 and 798. This area has some commercial, light industrial, and residential units [124].

Wallops Island is one of the Virginia Barrier Islands, approximately 11 kilometers (7 miles) long and 0.8 kilometer (0.5 mile) wide and contains 1,248 hectares (3,084 acres) of land. It borders the Atlantic Ocean on the east, and marshlands interlaced with small creeks on the west [124].

The ***Mainland*** area is located 3 kilometers (2 miles) west of Wallops Island and contains approximately 505 hectares (1,250 acres) of land. It faces the island on the east and is bordered by farmland on the south, west, and north [124].

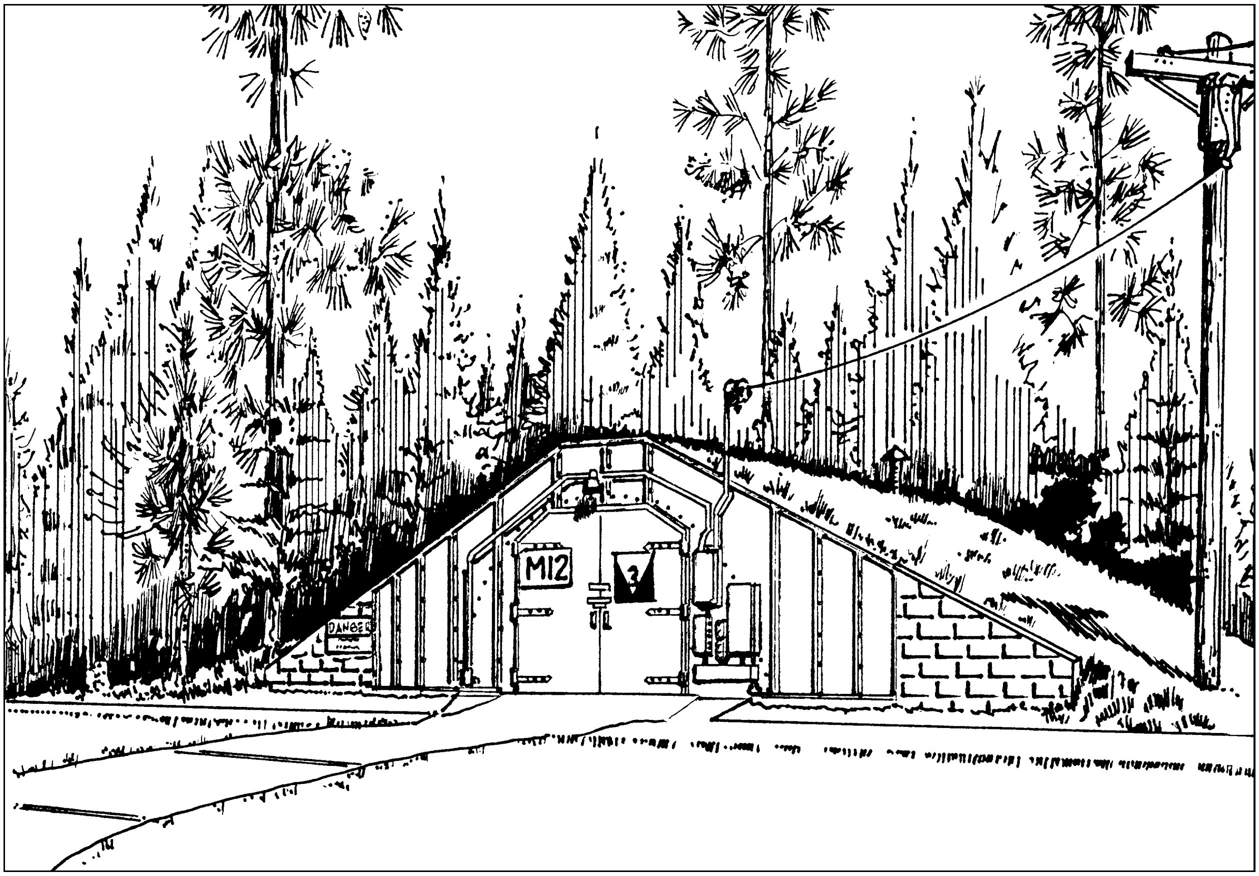
3.2.1.1.2 Main Base, WFF, Virginia



The ***Main Base***, shown above, is a controlled access area and comprises facility headquarters, administrative offices, an airfield, tracking facilities, a range control center, rocket and fuel storage depots, rocket motor inspection facilities, payload manufacturing and testing facilities, support shops, and housing. In addition, the Main Base has a number of office buildings, a post office, cafeteria, recreation center, and necessary utilities, including a wastewater treatment plant [87, 124].

The ***Technical Support Branch of the Engineering Division*** in Building F-10 provides support for the NASA SRP. The payload test and evaluation operations and integration areas are used for the preparation of payloads and the evaluation of the mechanical and electrical integrity of various systems, prior to their transfer to a final assembly and mating with the rockets on Wallops Island [44].

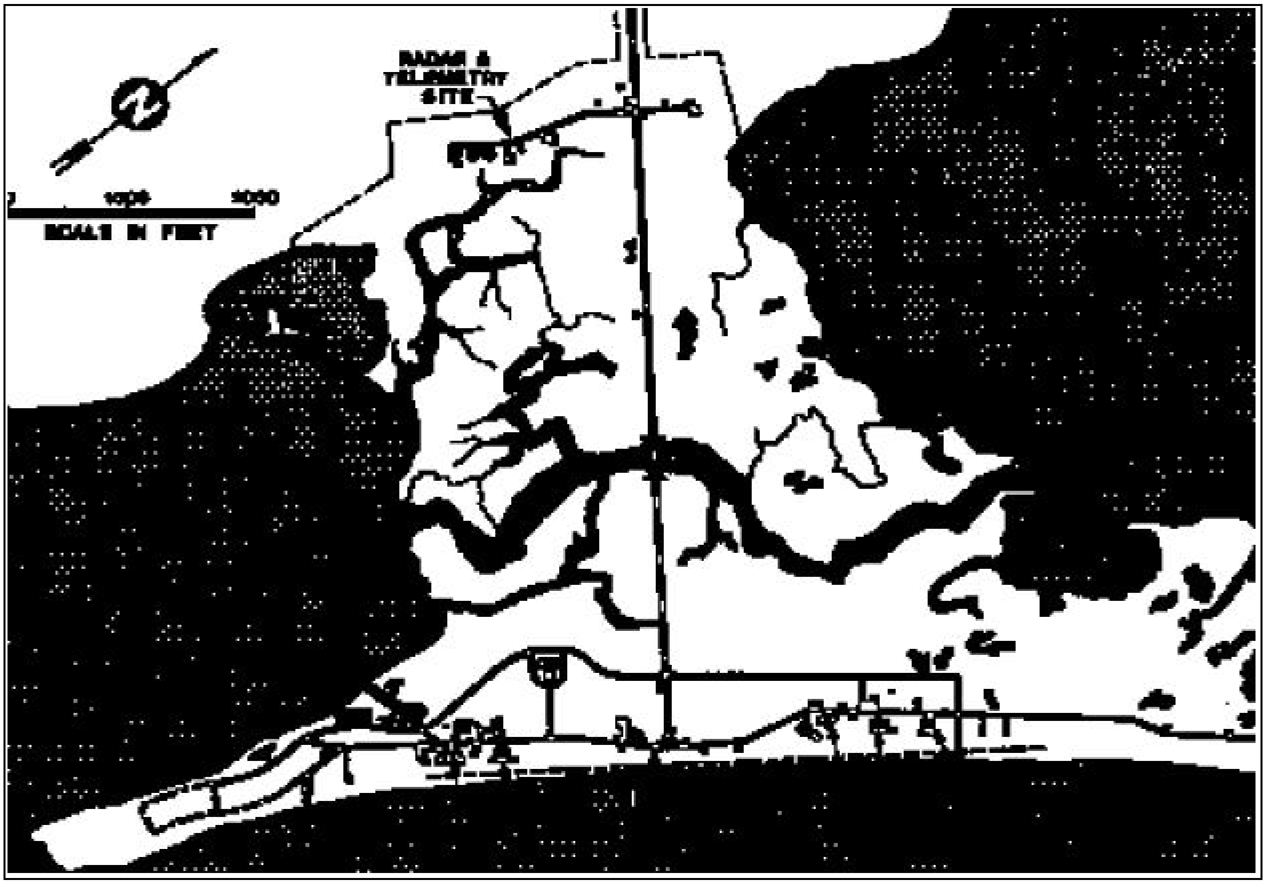
3.2.1.1.3 Rocket Storage and Inspection Area of the Main Base, WFF, Virginia



The ***Rocket Storage and Inspection Area*** of the Main Base is designed for the handling and storage of ordnance. It is located at the northern corner of the site and is physically separated from the Main Base by the airfield runway. Storage facilities for rockets and igniters include underground bunkers and large above-ground buildings which are used for inspection and storage of rocket motors and inert hardware. The inspected and refurbished rocket motors are stored prior to deployment in Building M-15; smaller rocket motors are stored in bunkers such as M-12, shown above. Six of these bunkers are located throughout the Rocket Storage Area. The handling of rocket motors is closely controlled by the inspection protocols individually designed for each propulsion system. Building M-16 is used for storage and handling of inert hardware for the rocket propulsion systems. Igniters are stored separately [44].

Storage of high-energy materials presents the potential for hazard, and strict safety procedures are enforced at all locations of this area. In keeping with established safety practices, and in order to minimize the hazard, standards for minimum safe distances from inhabited buildings (explosive quantity distances) comply with NASA Safety Standard 1740.12 for explosives, propellants and pyrotechnics [43].

3.2.1.1.4 Wallops Island and Wallops Mainland Facilities, WFF, Virginia

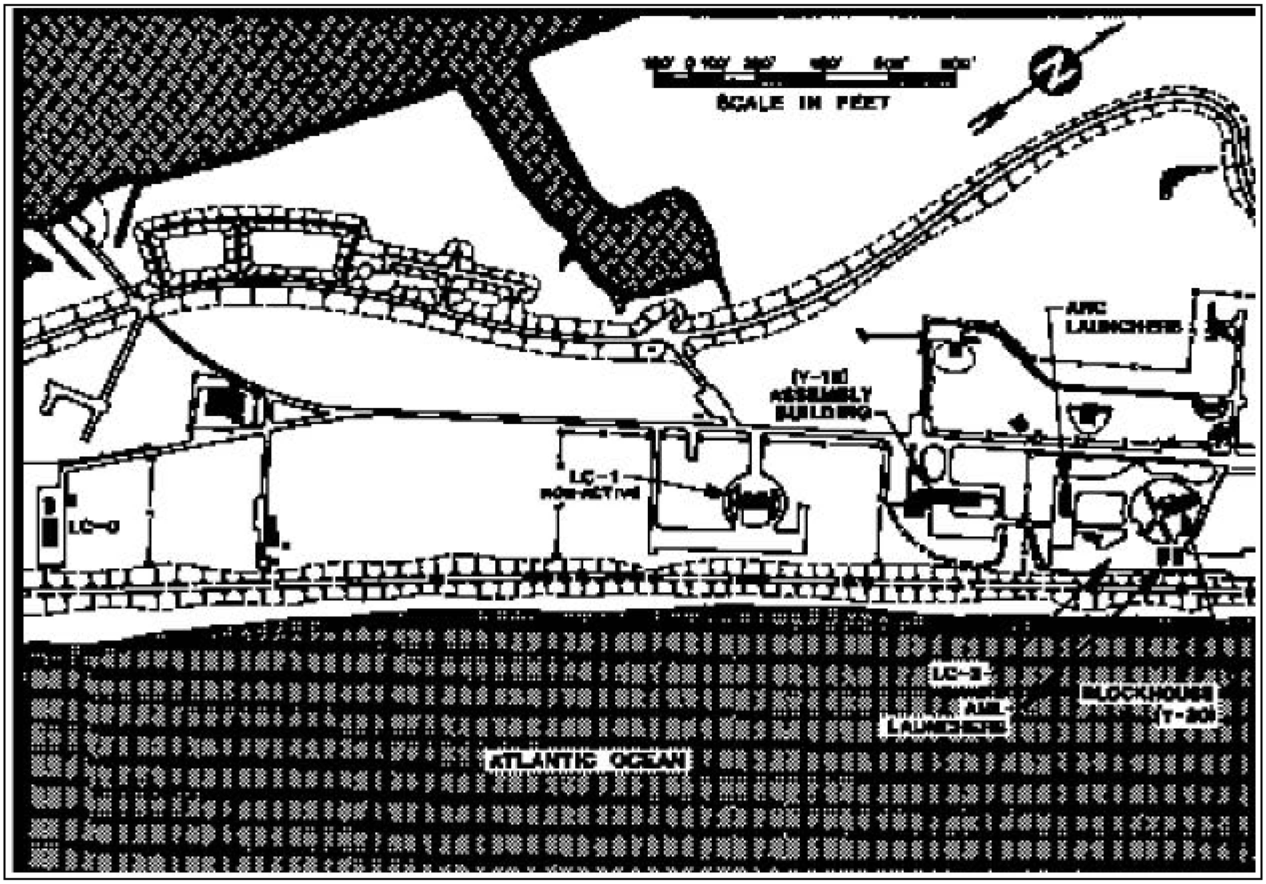


The ***Mainland*** site is a limited access area located approximately 11 kilometers (7 miles) southeast of the Main Base and is accessed by an existing public road network. This facility comprises a safety command transmitter, radar, telemetry, radio communications, and optical tracking installations. It is designed and built to support launch operations on Wallops Island and to provide rocket and satellite positional data [124].

There are also storage, service, and utility installations serving the Mainland and the Island. The Mainland site is connected to the island by a causeway and bridge [124].

Wallops Island is used as the site for various launch and tracking facilities associated with NASA, commercial, and Navy operations. The launch activities are aimed seaward. Launch Complexes (LC) are concentrated at the south- and north-central areas of the island [124].

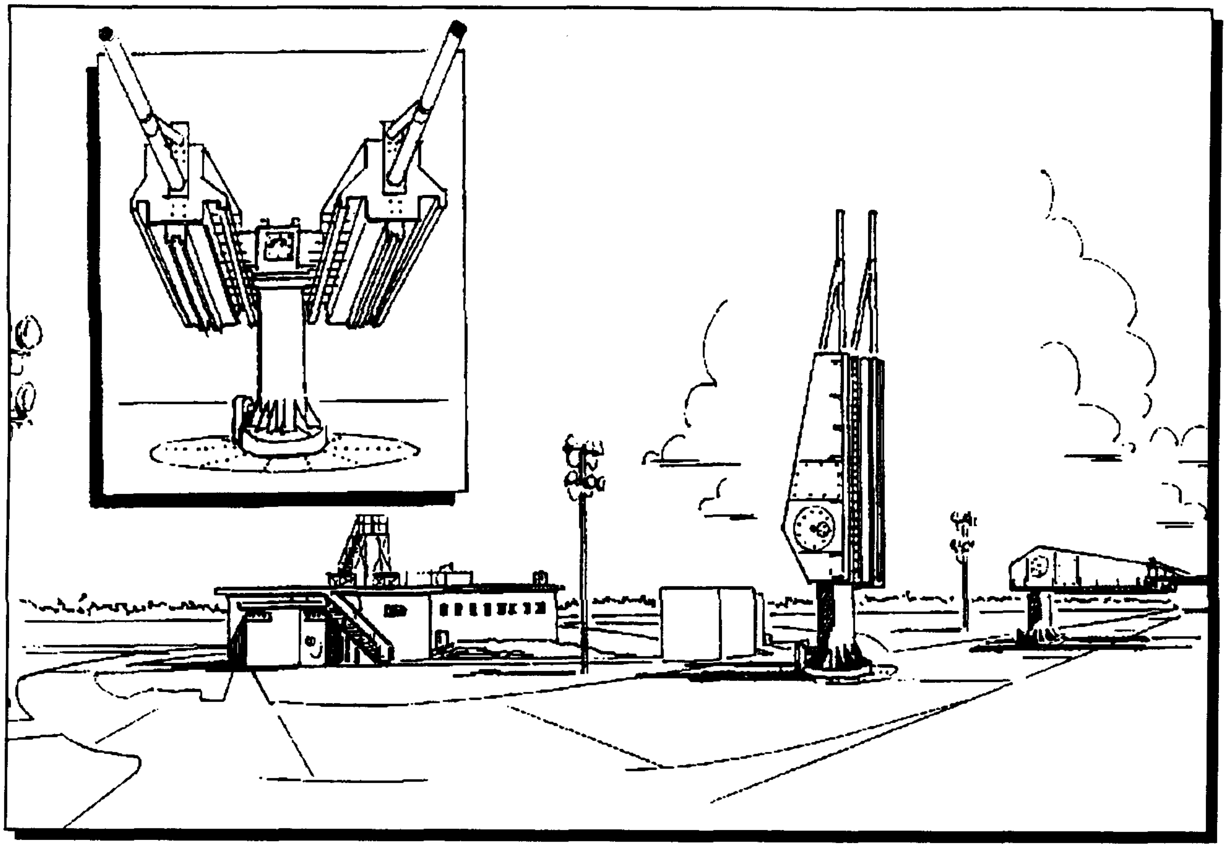
3.2.1.1.5 Southern Launch Complexes on Wallops Island, WFF, Virginia



The southern part of the island comprises two launch areas (LC No.'s 1 and 2) with an adjoining assembly shop (Z-65) and a launch control (blockhouse) building (Y-30). The recently rebuilt LC No. 1 will be equipped with a 50K Starfire launcher and a shelter for it. Additionally, an area for destruction of high-energy materials such as overage motors and unused ordnance is located at the extreme southern tip of the island.

This thermal destruction facility operates under interim status Part A and B Permits submitted for review to the State of Virginia Department of Waste Management and the U. S. Environmental Protection Agency (EPA) [44].

3.2.1.1.6 Launch Complex No. 2 on Wallops Island, WFF, Virginia

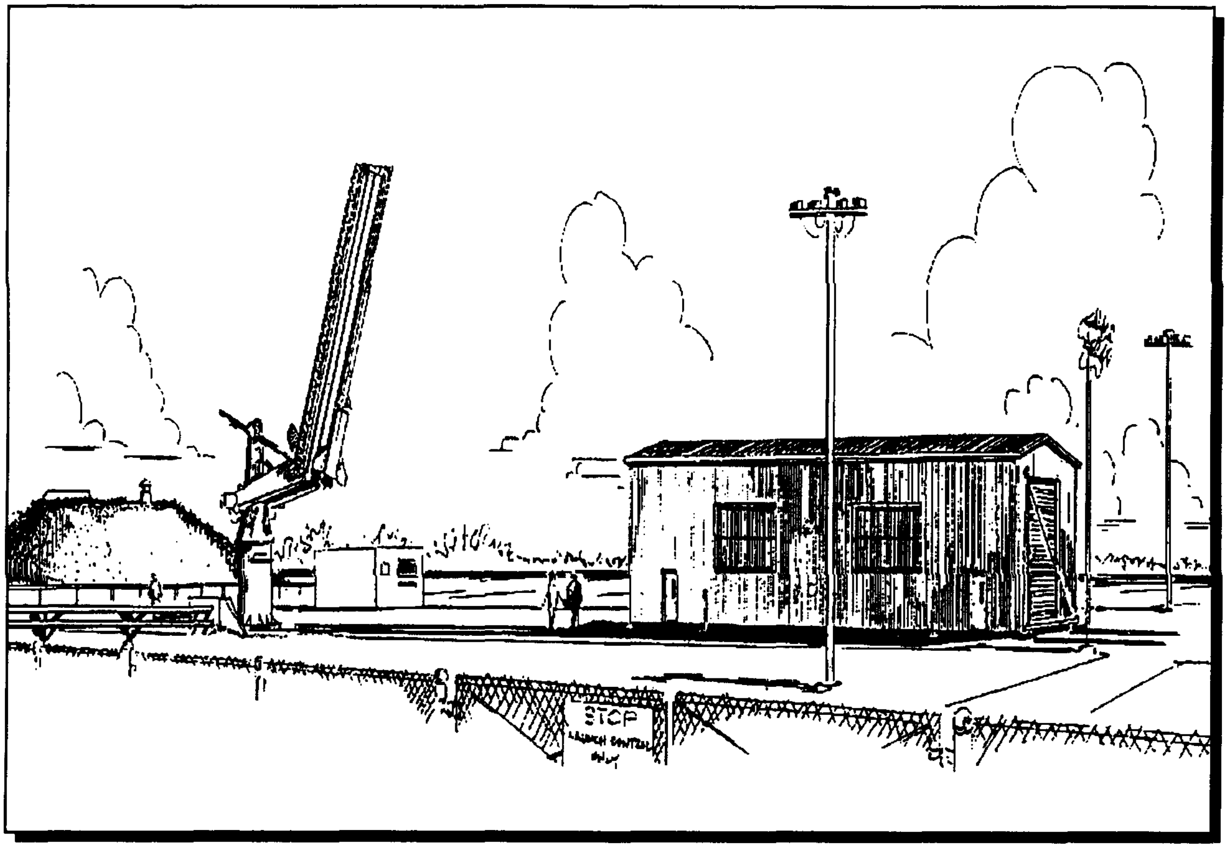


The LC No. 2, shown above, consists of a launch control center located in Blockhouse No. 2 (Y-30) and two Thiokol dual rail AML launchers capable of handling rocket vehicles up to 1,814 kilograms (3,999 pounds) in weight. These launchers are equipped with remote-sensing mechanisms and utilize adapters to launch Arcas and Super Loki vehicles. The Thiokol AML launchers are normally used at the WFF for launching smaller rockets [44].

The LC No. 2 is also equipped with one Atlantic Research Corporation (ARC) tubular launcher, shown on the next page, capable of handling larger launch vehicles ranging from one to several stages. The ARC launcher is capable of handling propulsion systems which develop up to 576,453 Newton-meters about the boom hinge [44].

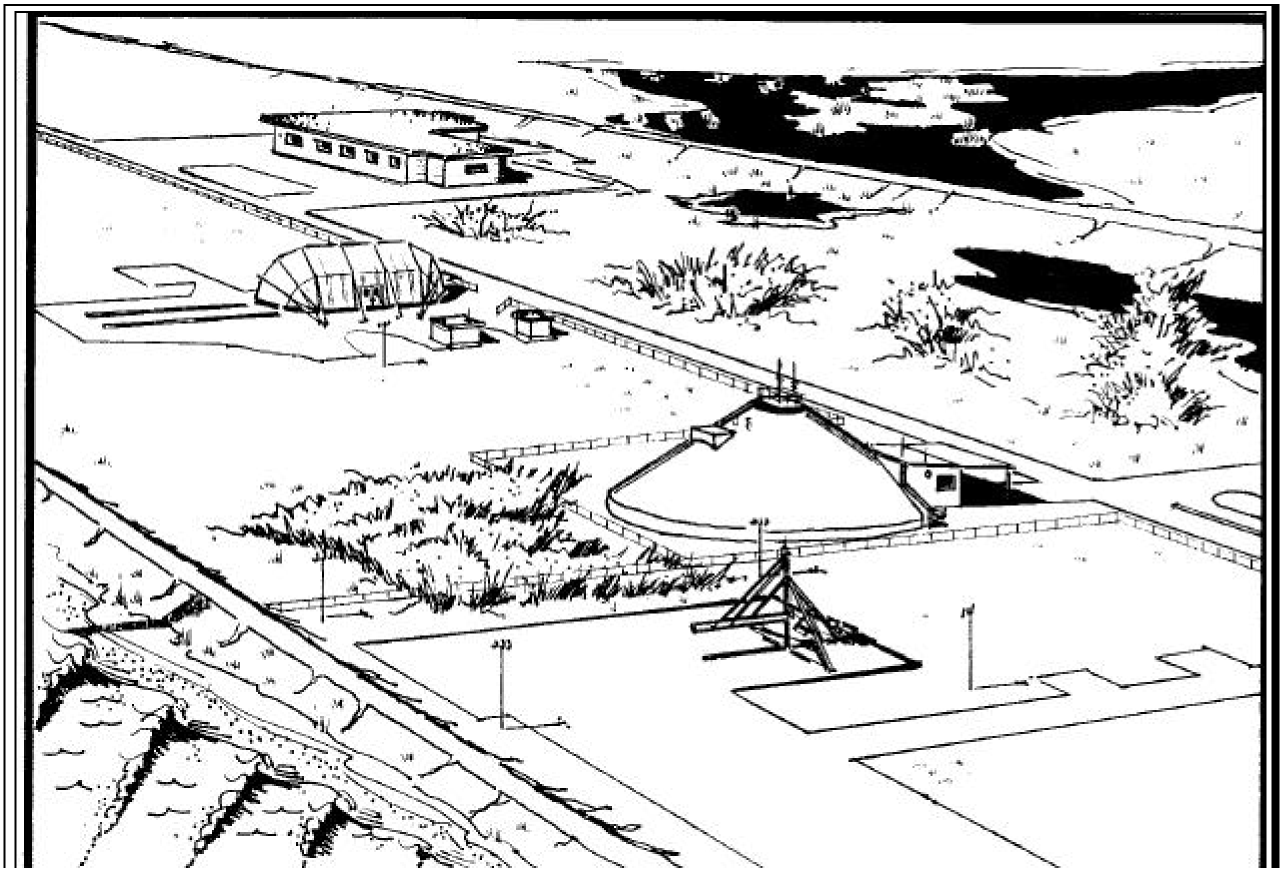
Checkout and assembly facilities, including mechanical and electrical support to LC No. 2 are provided in building Z-65. Rocket firing control is from Blockhouse No. 2 (Y-30), shown in the left corner of the picture above. The Blockhouse is designed for personnel protection and has complete vehicle and payload checkout and launch capabilities [44].

3.2.1.1.7 ARC Launcher with Shelter, Launch Complex No. 2, Wallops Island, WFF, Virginia



The ARC launcher shown above is used for launching a wide range of propulsion systems including, the Brant series of rockets, as well as combinations of Nike, Orion, Tomahawk, Taurus, Terrier, and Malemute rockets. An environmental shelter is provided to protect the final payload/vehicle integration, which is usually conducted on the launcher [44].

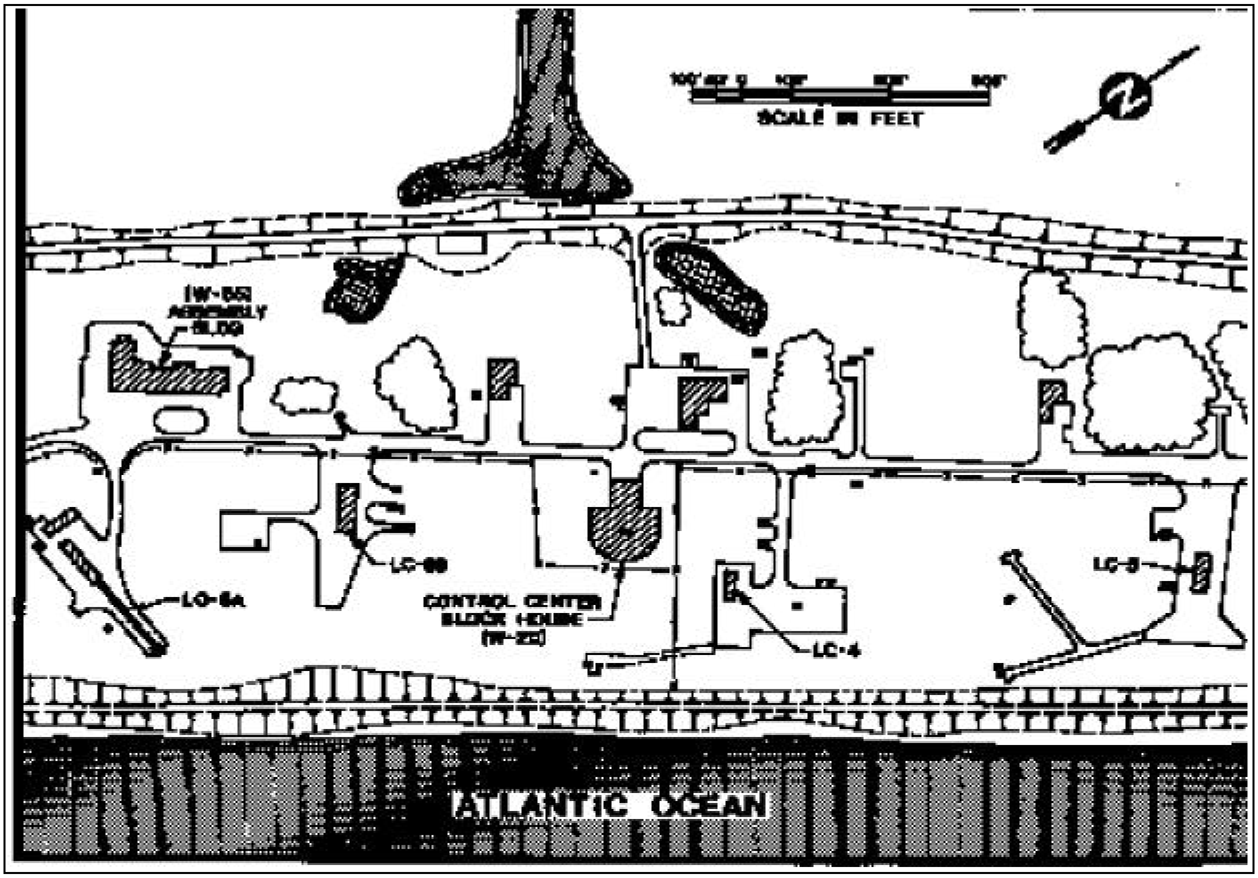
3.2.1.1.8 Launch Complexes No. 3B and No. 4B on Wallops Island, WFF, Virginia



Located in the north-central part of the island are LC's No. 3B and No. 4, shown above. ***Launch Complex 3B*** is comprised of a single rail 20K AML launcher. This launcher is capable of handling launch vehicles ranging from one to several stages, including the Black Brant series, as well as combinations of Nike, Orion, Tomahawk, Taurus, Terrier, and Malemute rockets. This launcher is provided with an environmental tent-like housing. The Inspection and Assembly Shop No. 3 (W-65) is used in support of this launch facility. It is a large machine shop equipped to conduct assembly and checkout support work on large rockets, such as the Aries. Assembly Shop No. 3 (W-65) is composed of six assembly bays, each of which is equipped with rollup doors and cranes ranging in capacity from 2.7 to 9 metric tons (3 to 10 tons) [44].

Launch Complex No. 4, shown in the center of the picture, has a multipurpose tubular launcher of older design and is not equipped with an environmental shelter. It utilizes Assembly Shops No. 3 (W-65) and No. 5 (W-40) for pre-pad assembly and check-outs of launch vehicles and payloads. This launch pad is used only occasionally. The launch control for both facilities is provided by Blockhouse No. 3 (W-20) [44].

3.2.1.1.9 Central and North-Central Launch and Support Facilities on Wallops Island, WFF, Virginia



The central part of the of the island is generally dedicated to institutional and administrative functions including fire fighting and rescue operations, general sounding rocket support activities, and project management functions. The principal rocket and payload assembly support functions for the NASA SRP are located in this area. These support functions include: Inspection and Assembly Shop No. 3 (W-65), Assembly Shop No. 4 (W-14), Assembly Shop No. 5 (W-40), and the Range Ground Support Building (W-22) [44].

The northern part of the island extends to the Chincoteague Inlet, and is generally underdeveloped. This area is currently utilized for launch range support activities which require a more remote location such as the Rocket Motor Storage Facility (V-80) and the payload spin-balance operation (V-45, V-50, and V-55). An explosion hazard zone has been established for protection around the Rocket Motor Ready Storage Magazine (V-80) [44].

The Dynamic Balance Facility (V-45, V-50, and V-55) is used for location of centers of gravity, determination of weight, measurements of mass distribution for static and dynamic balance, and other parameters in support of sounding rockets. It is also protected by an explosion hazard zone [44].

3.2.1.2 Environmental Setting at WFF

The principal source of information for the affected environment at WFF is the ***Environmental Resources Document, Goddard Space Flight Center Wallops Flight Facility, August,*** 1994 [54].

3.2.1.2.1 Climate

The WFF is located in the humid temperate zone of the mid-Atlantic, an area with typically hot summers and no distinct dry season. The average mean temperature is 13.3oC (56oF), with a mean maximum of 17.8oC (64oF) and a mean minimum of 8.9oC (48oF). The average annual precipitation is 105 centimeters (41 inches). Relative humidity averages 76 percent. Late summer and fall are the most humid, with average humidity of 78 to 79 percent from August through October. The prevailing wind direction is southerly during the summer and northwesterly during the winter. The average windspeed is 14 to 16 kilometers per hour (9 to 10 miles per hour) in the summer and 18 to 20 kilometers per hour (11 to 12 miles per hour) in the winter.

A sea breeze with wind shifting south-easterly occurs frequently in the late morning hours in the spring and early summer. Wallops Island has experienced hurricane force winds seven times during the past 100 years, as well as several strong northeastern storms annually. Measured wind profiles for Wallops Island are described in Reference 105. Additional details on climate of the area can be found in References 54, 101, 124, 133.

3.2.1.2.2 Air Quality

The WFF is located in Region VI of the State of Virginia air quality districts. This region does not violate either National or Virginia air quality standards for criteria pollutants. Criteria pollutants are particulates, carbon monoxide, sulfur oxides, nitrogen dioxide, ozone, and lead.

The Commonwealth of Virginia Ambient Air Quality Standards applicable to firing of sounding rockets are [54]:

	Primary ug/m^3	Secondary ug/m^3
1. Total Suspended Particulates (TSP)		
Annual Geometric Mean	75	60
Maximum 24-hour concentration 260	150	
2. Carbon Monoxide		
8-hour Average	10,000	10,000
1-hour Average	40,000	40,000
3. Lead		
Maximum Arithmetic Mean	1.5	1.5

Additional details on air quality can be found in References 16 and 54.

There are no heavy industrial plants or major air pollution sources in the area. The principal economic activities of the area contribute very little to air pollution. Consequently, the overall air quality at the WFF is excellent [54].

3.2.1.2.3 Water Quality

There are no major perennial streams in the vicinity of the WFF, so all water supplies for the WFF are obtained from ground water. Details on domestic water supplies, sanitary sewer systems, and other water quality issues can be found in References 54 and 124.

3.2.1.2.4 Land Use

The WFF is located in the coastal plain which extends from Cape Cod, Massachusetts, through the entire peninsula of Florida. Wallops Island is a barrier island, typical of those found on the east and gulf coasts of the United States. The majority of the land area on Wallops Island is 1.5 meters (5 feet) above sea level with an occasional area 3 meters (10 feet) above sea level. Most of the area surrounding the Main Base is productive farmland. Marshlands to the east of the Main Base separate it from Chincoteague Island. Principal activities are farming, tourism, and recreational uses like hunting and fishing. Land use at NASA WFF facilities is described in detail in References 57, and 124.

3.2.1.2.4.1 Hazardous Waste Contamination

The aviation fuel storage area and the fire training area have been deemed potential Comprehensive Environmental Response, Compensation, and Liability Act include the waste oil dump, the scrap yard, and the transformer pad [44].

(CERCLA) sites. Other areas being investigated as potential CERCLA sites include the waste oil dump, the scrap yard, and the transformer pad [44].

3.2.1.2.5 Biological Resources

The primary sources for this section were the ***Environmental Resources Document, Goddard Space Flight Center Wallops Flight Facility [54], Birds of Wallops Island, Virginia 1970-1992*** [140] and written correspondence from the United States Fish and Wildlife Service (USFWS), Virginia Department of Game and Inland Fisheries, and Commonwealth of Virginia. Refer to these documents for additional information on biological resources. See the Appendix for correspondence. This section will discuss vegetation, wildlife, and threatened and endangered species at WFF.

The WFF is classified as an estuarine ecosystem. The ecosystem is rich in biological diversity. Habitats identified within the ecosystem predominantly comprise tidal marsh, forest, and upland habitats. Dominant vegetative species at the marsh are saltmarsh and salt meadow cordgrass. On the mainland, loblolly pine, wax myrtle, black cherry, red maple, and sassafras make up the dominant vegetation.

Shorebirds and waterfowl are the most conspicuous wildlife species. Approximately 250 bird species have been observed and recorded at Wallops Island. Mammals such as white-tailed deer, opossum, raccoon, white-footed mouse, meadow vole, and occasionally red fox inhabit the area. Upland game species include bobtail quail, mourning dove, cottontail rabbit, grey squirrels, woodcock, and snipe. Common reptiles and amphibians are the eastern box, painted, mud, and snapping turtles; northern diamondback terrapin; southern and eastern hognose snakes; northern water snake; Fowler's toad; and southern leopard, bull, and green tree frogs. Forty species of saltwater fish occur in the area of Wallops Island. Finfish species found in the vicinity include the sheepshead minnow, rainwater fish, striped killifish, mummichog, banded killifish, tidewater silverside, threespine and fourspine stickle-back, white and yellow perch, and American eel.

3.2.1.2.5.1 Threatened and Endangered Species

The Department of Conservation and Recreation, Commonwealth of Virginia has identified Natural Heritage Resources within the WFF facilities, including Wallops Island, Mainland, and Main Base [Appendix D, pages D-35 and D-36]. The Natural Heritage Resources include rare plant and animal species, rare and exemplary natural communities, and significant geological features. The list of Natural Heritage Resources specific to WFF site together with their federal and state legal status are reported in Table 3-1.

WFF in consultation with the Virginia Department of Game and Inland Fisheries and U.S. Fish and Wildlife Service has undertaken a program to provide a necessary protection program for the critical species that might be affected by the rocket launch operation.

A bald eagle (*Haliaeetus Leucocephalus*) nest was constructed in 1993 at the Main Base. In order to protect this new nest site the U.S. Fish and Wildlife Service recommended that any activity planned within 0.4 kilometers (0.25 miles) should be coordinated with this service.

The piping plover (Charadrius melodius) is found at both ends of the island and is known to nest on the southern end near the WFF. Nesting activities of the piping plover are monitored by Chincoteaque National Wildlife Refuge and Virginia Department of Game and Inland Fisheries biologists. In continuing cooperation with the USFWS to protect the Wallops Island piping plover population, the northern and southern portions of the island have been closed effective March 15, through September 1 during the nesting season every year since 1989. Wilson's plover (Charadrius wilsonia) is listed as endangered by the State of Virginia. This species nests in the same area and is protected with the same measures as the piping plover.

A nesting pair of peregrine falcons are located at a tower near the northern end of the island. According to the USFWS, they should not be affected by the launches at the southern end of the island.

The Virginia Department of Conservation and Recreation, after reviewing the DSEIS has found that: *Provided that protection recommended for the bald eagle, piping plover, gull-billed tern, upland sandpiper, and Wilson's plover are followed as noted in this document, DCR does not anticipate that continuous operation of this facility at current levels will adversely impact natural heritage resources.*

Table 3-1
NATURAL HERITAGE RESOURCES DOCUMENTED WITHIN WFF

Common Name	Species	Status
	Wallops Island	
Seaside Plantain	*Plantago maritima*	C5/S1/NF/NS
Big-head Rush	*Juncus megacephalus*	G4G5/S2/NF/NS
Long-awned Sprangletop	*Leptochloa fasciscularis var maritima*	G5T3/S2S3/NF/NS
Southern Beach Spurge	*Chamaesyce bombensis*	G4G5/S2/NF/NS
Carolina Fimbristylis	*Fimbristylis caroliniana*	C4/S2/NF/NS
Blueflag	*Iris versicolor*	G5/S2/NF/NS
Loggerhead Sea Turtle	*Caretta caretta*	G3/S1BS/LT/LT
Wilson Plover	*Charadrius wilsonia*	G5//S1/NF/LE
Piping Plover	*Charadrius melodus*	G3/S2/LT/LT
Peregrine Falcon	*Falco peregrinus*	G3/S1/LE/LE
Estuarine Herbaceous *Vegetation*		
Oligotrophic Herbaceous *Vegetation*		
Oligotrophic Scrub		
Oligotrophic Woodland		
Eutrophic Seasonably Flooded Herbaceous Vegetation		
	Mainland	
Lake-bank Sedge	*Carex Lacustris*	G5/S1/NF/NS
A Sedge	*Carex striata*	G4/S1/S2/NF/NS
Blueflag	*Iris versicolor*	G5/S2/NF/NS

Note: According to Virginia Department of Conservation and Recreation.

Table 3-1 (Concluded)
NATURAL HERITAGE RESOURCES DOCUMENTED WITHIN WFF

Common Name	Species	Status
	Main Base	
Seapage Dancer	*Argia bipunctulata*	G4/S2S3/NF/NS
Low Frostweed	*Helianthemum propinquum*	G4/S1/NF/NS
Brown-Fruited Rush	*Juncus pelocarpus*	G5/S1/NF/NS
Blueflag	*Iris versicolor*	G5/S2/NF/NS
Furtive Forktail	*Ischnura prognatha*	G4/SH/NF/NS
Bald Eagle	*Haliaeetus leucocephalus*	G4/S2S3/LE/LE
Eastuarine Herbaceous Vegetation		
Oligotrophic Saturated Scrub		

Note:

S - Designates state rank
G - Designates global (total range) rank
S1 - Extremely rare; usually 5 or fewer populations of occurrences; or with many individuals in fewer occurrences; or may be a few remaining individuals; often especially vulnerable to becoming extirparation.
S2 - Very rare; usually between 5 and 20 populations or occurrences, but with large number of individuals in the same population; often susceptible to becoming extirpated.
S3- Rare to uncommon; usually between 20 and 100 populations or occurrences, may have fewer occurrences; may be susceptible to large-scale disturbance.
G3 - (Global) Rare to uncommon, usually between 20 and 100 populations or occurrences; may have fewer occurrences, but with a large number of individuals in some populations; may be susceptible to large scale disturbances.
G4 - (Global) Common; usually >100 populations or occurrences, but may be fewer with many large populations; may be restricted to only a portion of state; usually not susceptible to immediate treat.
G5 - (Global) Very common; demonstrably secure under present conditions.
SH - Historically known from the state; but not verified for an extended period, usually >15 years; this rank is used primarily when inventory was attempted recently.
T - Denotes rank for subspecies
LE - Listed Endangered (federal and state)
LT - Listed Threatened (federal and state)
NF - No federal legal status
NS - No state legal status

3.2.1.2.6 Wetlands

Wetlands at WFF can be classified as tidal and non-tidal. There are three predominant wetland systems in the WFF area: marine wetlands, estuarine wetlands, and palustrine wetlands. All marine and estuarine wetlands, and some palustrine wetlands, are considered tidal wetlands.

The WFF tidal wetland consists of approximately 456 hectares (1,127 acres). On the eastern portion of the Main Base there is an extensive tidal marsh which is not a part of the facility. Wallops Island is separated from the Mainland area by tidal marshlands interlaced by tidal streams. The marsh grasses of the wetlands around the WFF stabilize the soil and buffer wave action. This helps to cut down on erosion of the land bordering the tidal marshes. These grasses, like smooth cordgrass (Spartina alterniflora) act as nutrient traps. In this capacity, they prevent excessive nutrients from entering estuarine systems and causing increased rates of eutrophication.

Non-tidal wetlands are also found at WFF. They are defined as areas that are inundated or saturated by surface water or groundwater at a frequency and duration sufficient to support, and that under normal circumstantance do support, a prevalence of vegetation typically adopted for life in water saturated conditions.

A detailed description of tidal and non-tidal wetlands found at WFF is given in the ***Environmental Resources Document, Goddard Space Flight Center Wallops Flight Facility,*** August, 1994 [54]. This document provides details on wetland delineation and classification within the WFF facilities. The referenced document also provides National Wetland Inventory maps for Wallops Main Base, and northern and southern portions of Wallops Island and Wallops Mainland.

According to the ***Environmental Resources Document, Goddard Space Flight Center Wallops Flight Facility,*** August, 1994 [54], the predominant wetland types found in the vicinity of WFF are:

1. Forested Wetlands that typically include swamps dominated by trees over 20 feet in height and include many floodplain areas. They normally possess an overstory of trees, an understory of young trees or shrubs, and a herbaceous layer. Typical vegetation includes red maple, sweetgum, river birch, and ashes.
2. Scrub Shrub Wetland that includes tree shrub swamps or wetlands dominated by small trees less than 20 feet in height. Predominant wetland types include alder, buttonwood, dogwood, sweetbay magnolia, and spicebush.
3. Emergent Wetlands are known as marshes characterized by erect, rooted, herbaceous hydrophytes excluding mosses and lichens. Vegetation is present for most of the growing season in most years. Typical vegetation includes cattails, sedges, and rushes.
4. Aquatic Bed Wetlands are dominated by plants that grow principally on or below the surface of water. These plant species are best developed in relatively permanent water or under conditions of repeated flooding. Typical vegetation includes spatterdock and pickerelweed.
5. *Open Water Wetlands* are predominantly flooded areas

typically characterized as lakes or ponds.

The Accomack County Wetlands Board, Virginia Marine Resources Commission, and U.S. Army Corps of Engineers have jurisdiction over wetlands at WFF. NASA consults with appropriate regulatory agencies prior to initiation of any construction on wetlands.

3.2.1.2.7 Floodplains

The ***Environmental Resources Document, Goddard Space Flight Center Wallops Flight Facility***, August, 1994 [54] describes floodplain resources of WFF based on results of floodplain study that was designed to delineate more accurately the 100-year storm for WFF. The information from this study is presented as baseline information to be evaluated for future construction of proposed projects at WFF.
The items considered in this analysis are topography, local weather patterns, changes in sea level, existing floodplain measures, other models, and the actual transect development.

Based on predicted changes in sea level a sea level rise of 172 mm (6.6 inches) to 256 mm (10.1 inches) can be expected between 1987 and 2020. Given the local topography, the implications of these global sea level rise estimates on flooding are that the 100-year stillwater elevation, and thus the 100-year wave crest elevation, are likely to increase in the future.

During a tidal flood, both the 100-year stillwater elevation and the wave crest determine the final flood elevation. Based on these considerations it is predicted that during a 100-year storm, the wave crest would almost inundate Wallops Island.

The ***Environmental Resources Document, Goddard Space Flight Center Wallops Flight Facility,*** August, 1994 [54] presents flood maps for WFF Main Base, the northern portion of Wallops Island, and the southern portion of Wallops Island and Mainland. The maps of a 100-year floodplain are based on the wave crest elevation of approximately 4.2 m (14 feet) (based on the output from the WHAFIS model), and the maps for 500-year floodplain are based on wave crest elevation of approximately 3.3 m (10.9 feet) (MSL) (based on FEMA Insurance Study).

WFF is currently repairing the sea wall with stone and filter cloth on the eastern side of Wallops Island. Under a 100-year storm scenario, the sea wall will not completely hold back the storm; however, it should be effective for storms with recurring interval of 20 years or less.

3.2.1.2.8 Hazardous Waste Management

Hazardous wastes generated at the WFF are managed by the WFF Environmental Branch accordance with procedures referenced in [54].

3.2.1.2.9 Cultural Resources

The WFF is located on the eastern shore of Virginia which has a long history. Prior to the arrival of white settlers the area was home for the Accawmack and Accohowack Indians who were members of the Algonquin Nation. They owed allegiance to the "Powhatan Confederacy," even though this chief could not enforce any rule over them due to the absence of sufficient means to cross the Chesapeake Bay from the western to the eastern shores. The WFF is not recognized as a historical landmark.

The barrier islands were used as temporary fishing sites and later as a focal point for the smuggling activities of the colonists. To protect commerce, a fort was constructed near the northeastern corner of what is now the Main Base facility in the late 1770's. By 1800, census records indicate that ten families lived on Wallops Island. In 1883, the U.S. Coast Guard constructed a station, which still stands, on the island.

Currently, WFF is working with the Virginia Department of Historic Resources to fulfill its National Historic Preservation Act Section 110 requirements. In compliance with National Historic Preservation Act Section 106 the consultation process with regulatory agencies has been initiated by the Environmental Branch of WFF. Additional details on cultural resources can be found in Reference 54.

3.2.1.2.10 Economics and Employment

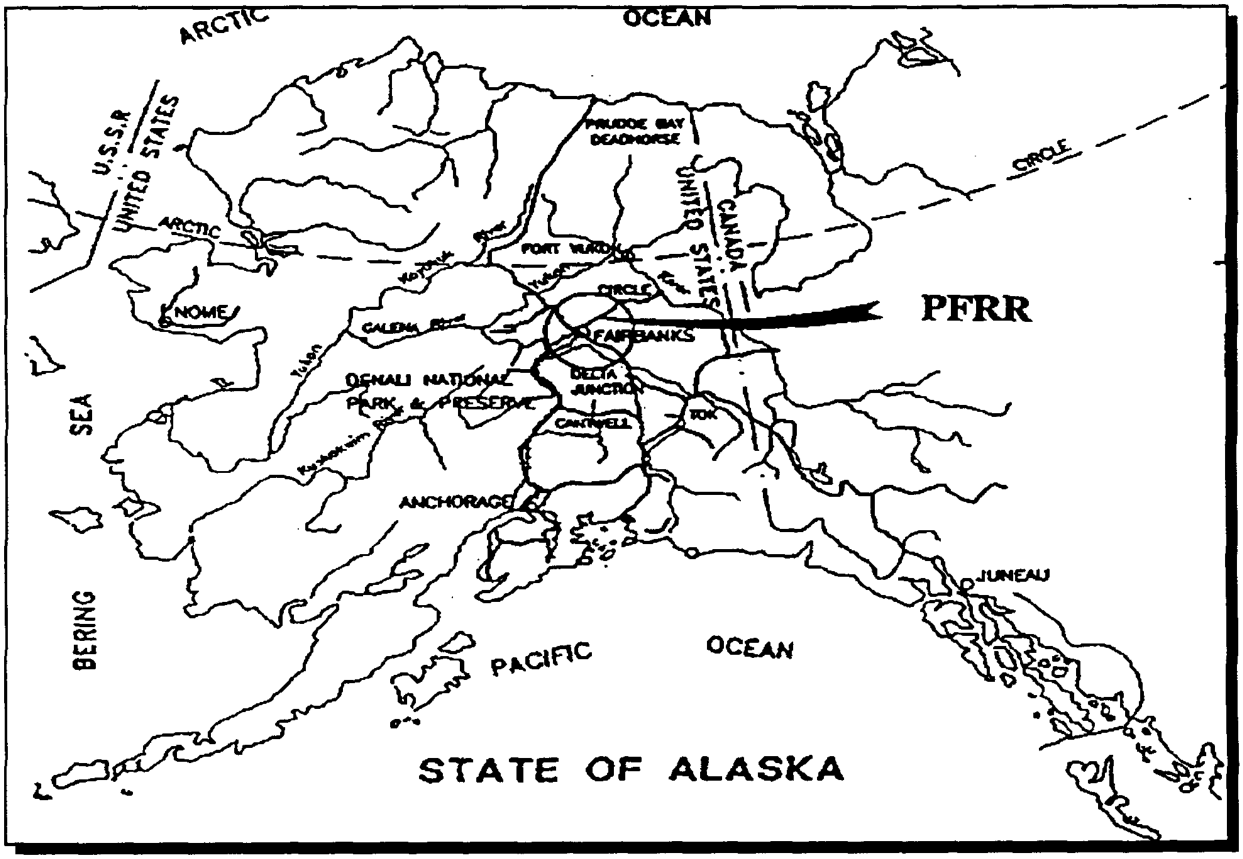
Accomack County's 1990 population of 31,703 represents a very small increase over 1980 figures. According to 1980 Census data, the major employment categories are manufacturing (25.5 percent); wholesale and retail trade (21.4 percent); government (18.2 percent); professional and related services (13.4 percent); and agriculture, forestry, fishing and mining (11.8 percent). Tourism is an important contributor to the economy in the immediate area of the WFF, especially during the summer months.

The WFF, with its annual budget of approximately $87 million, is a major contributor to the local economy both in Virginia and in the Maryland lower shore counties. The mean income level for the WFF is approximately $37,000 per year. It is a significant and beneficial contribution to the local economy. Employment at the WFF has shown a steady increase over the past decade, with a current employment of 1,366 personnel. The Facility employs approximately 900 Virginia residents, 450 Maryland residents and a few Delaware residents. Additional details on economics and employment can be found in Reference 54.

3.2.1.2.11 Population

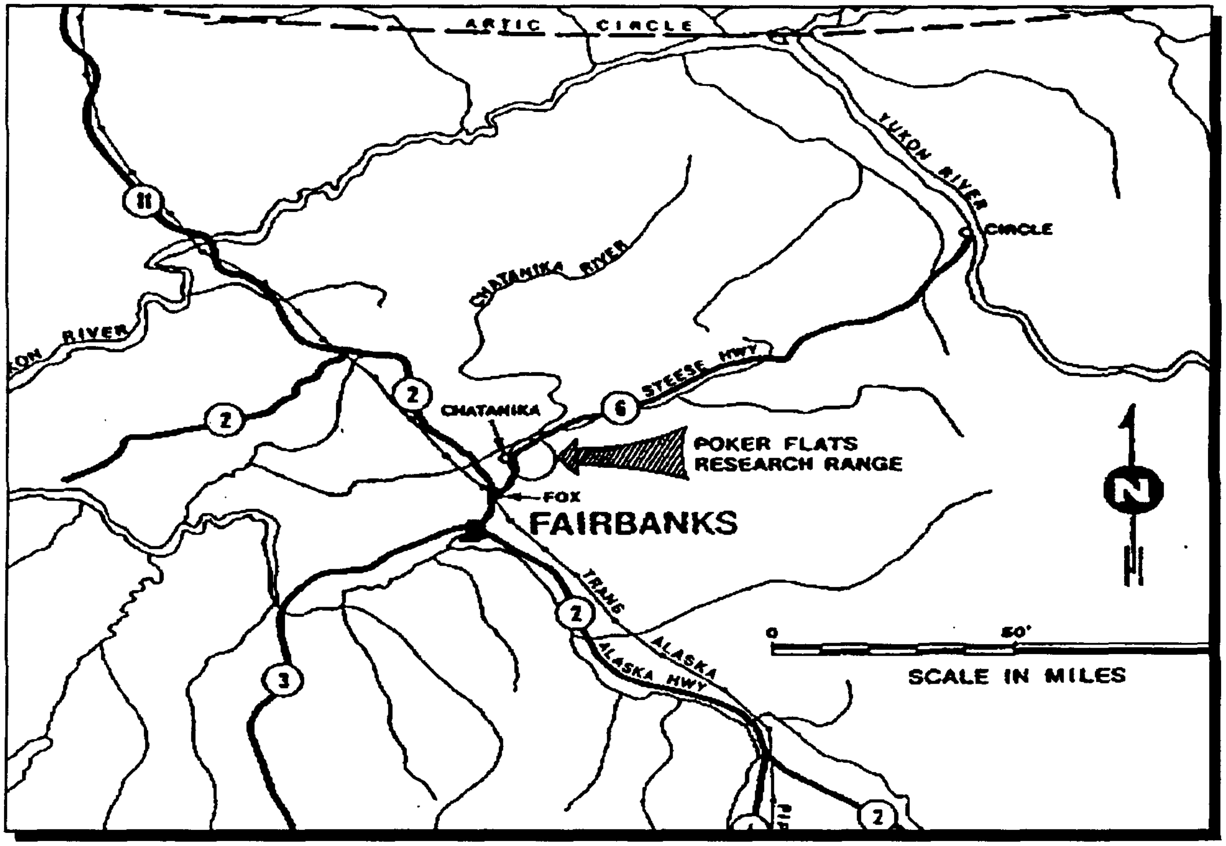
The density of population in the immediate, rural area is low. The 1990 Census shows Accomack County as having a population of 31,703 and a population density of 23.88 people per square kilometer. Chincoteague Island is the largest, densely populated area in the immediate proximity of the WFF. It is located approximately 8 kilometers (5 miles) from the Main Base area, and has a resident population of 3,555 people. This population swells during the summer months due to an influx of tourists and vacationers attracted to the Assateague Island beaches. Details on population can be found in Reference 54.

3.2.2 POKER FLAT RESEARCH RANGE (PFRR), ALASKA



The PFRR is located in the center of Alaska near Fairbanks, approximately 1.5 degrees below the Arctic Circle at 65°2'N latitude and 147°5'W longitude. The facility is located on the Steese Highway (State Route No. 6) in Chatanika, approximately 48 kilometers (30 miles) northeast from Fairbanks and 256 kilometers (159 miles) southwest from the village of Circle as shown on the next page [45, 97]. The information related to the site-specific environmental issues at PFRR is comprised of a number of documents including a number of relevant EA's [3, 23, 24] and EIS's [135], a river management plan [2], a series of descriptive reports related to the ***PFRR Improvement and Modernization Program*** [18, 25, 26, 27, 28, 29, 96, 97], and the ***Range User's Handbook*** [30] which includes range safety issues, and documents related to the biological character of the area [2, 6, 13, 14]. During the site visit to the PFRR [45], discussions were held with representatives of the regulatory community, including the Bureau of Land Management, Alaska Department of Environmental Conservation, and Alaska Department of Fish and Game. The regulatory agencies were instrumental in identifying sources of relevant information, and either provided or assisted in securing a number of key documents.

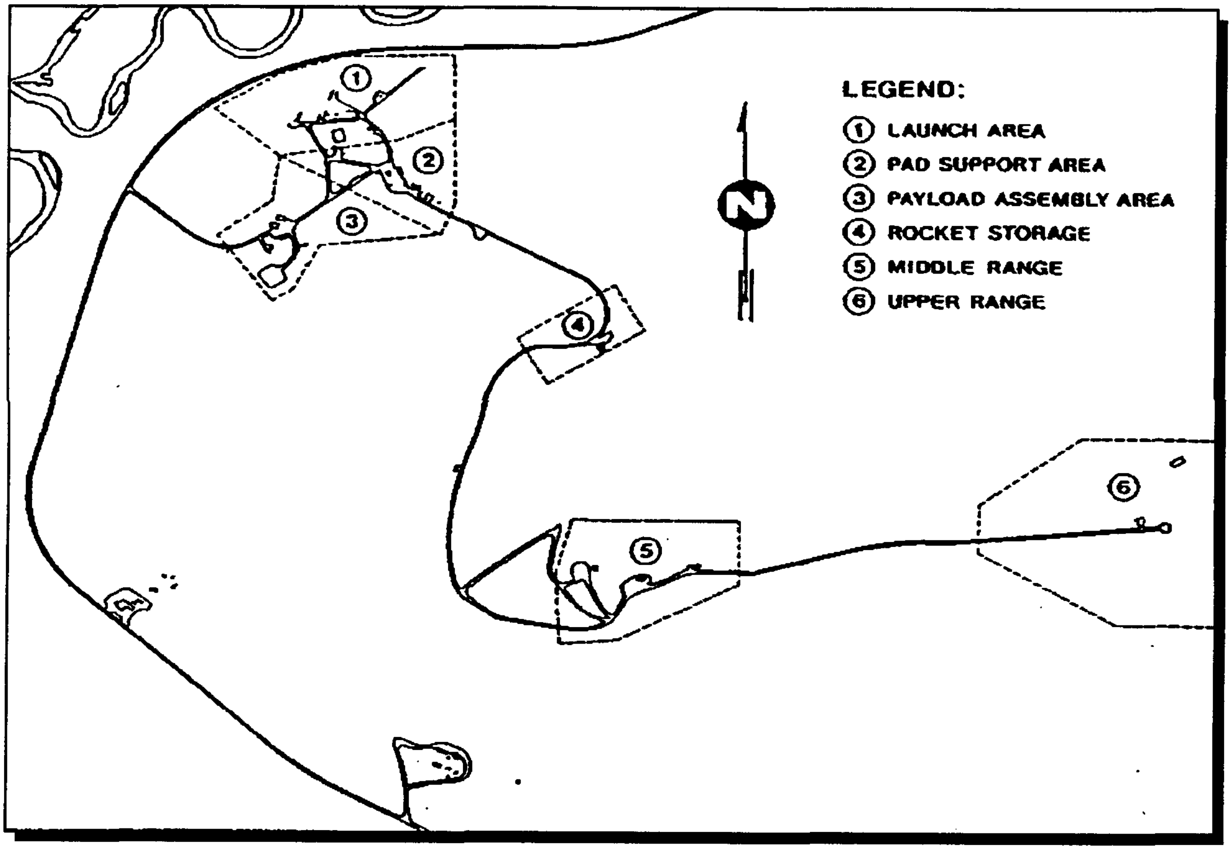
3.2.2.1 PFRR Launch and Support Facilities



The PFRR serves the launch requirements of NASA, the Department of Defence (DOD), and the scientific research community worldwide. It is used to conduct atmospheric studies in aurora borealis, electric and magnetic fields, ultraviolet radiation, solar protons, ozone and greenhouse effects and other phenomena. The NASA WFF contracts with the Geophysical Institute of the University of Alaska (UAF) for the operation of the range and provides technical advice and range safety oversight.

The PFRR facility is a fully equipped and operational rocket firing complex and includes five rocket firing pads, a block house, communication facilities, fire control and safety functions, payload and vehicle storage and assembly buildings, a clean room, geophysical monitoring and optical measurement instrumentation, radar and telemetry sites, downrange science monitoring sites, and administrative and miscellaneous support facilities [45].

3.2.2.1.1 Operations Areas of PFRR, Alaska



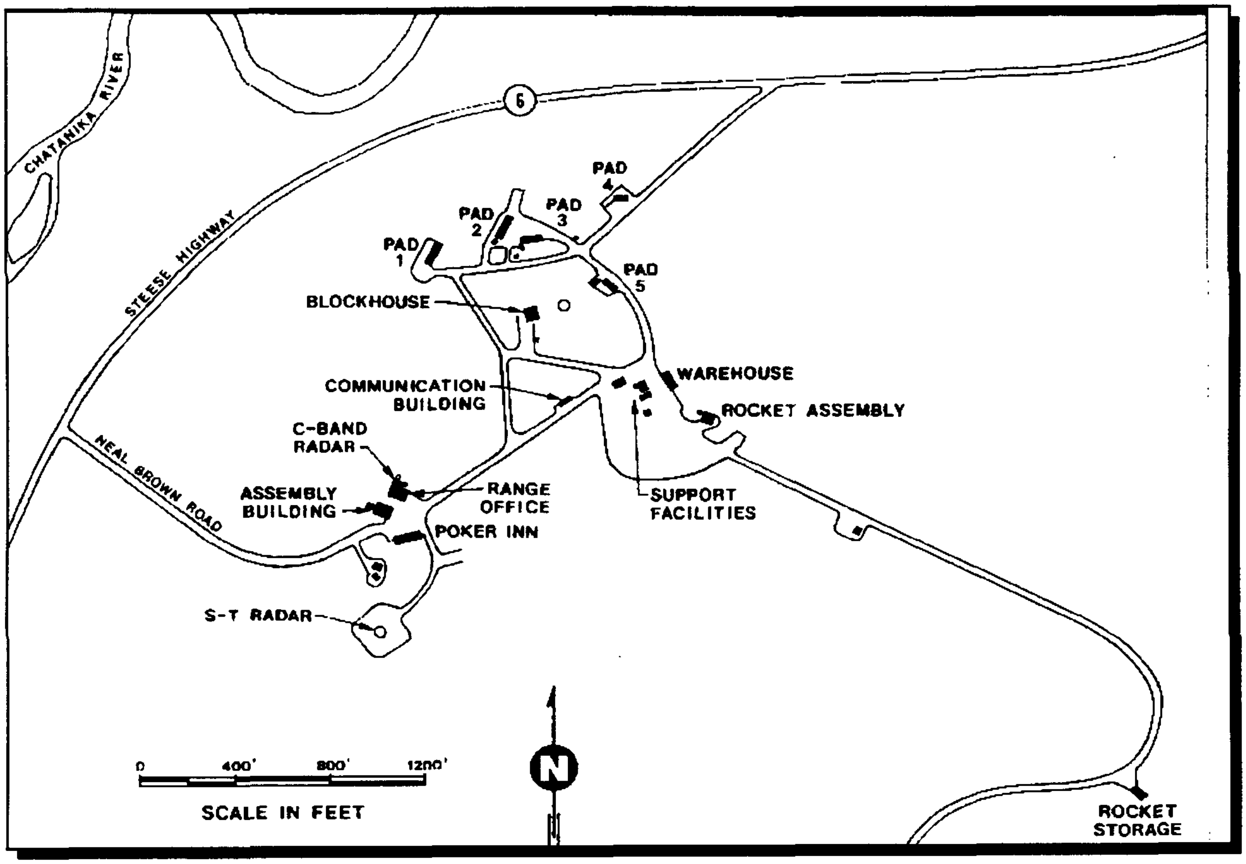
Geographically, PFRR comprises three separate operational areas: the Lower, Middle, and Upper Ranges [28, 45].

The ***Lower Range*** includes range offices, rocket launch facilities, blockhouse, pad support, payload assembly facilities, and a rocket storage building [28, 45]. The area is relatively flat with average elevation of 200 meters (656 feet) above mean sea level (msl).

The ***Middle Range*** is the area where the telemetry buildings and optical observatory are located. It is approximately 214 meters (700 feet) higher than the Lower Range, and approximately 2.7 kilometers (1.7 miles) distant from the Lower Range [28, 45]. The telemetry complex is a building comprised of approximately 362 square meters (3,900 square feet) of enclosed area with a roof-mounted antenna. Several smaller buildings which house radar installations are adjacent [28, 45].

The ***Upper Range*** is the area on the ridgetop above the Lower and Middle Ranges. The area's top elevation is 500 meters (1,640 feet) above msl. Facilities here are limited to a self-contained trailer housing electrical gear and a short radar tower [25, 28, 45].

3.2.2.1.2 Payload Assembly and Launch Support, Lower Range, PFRR, Alaska



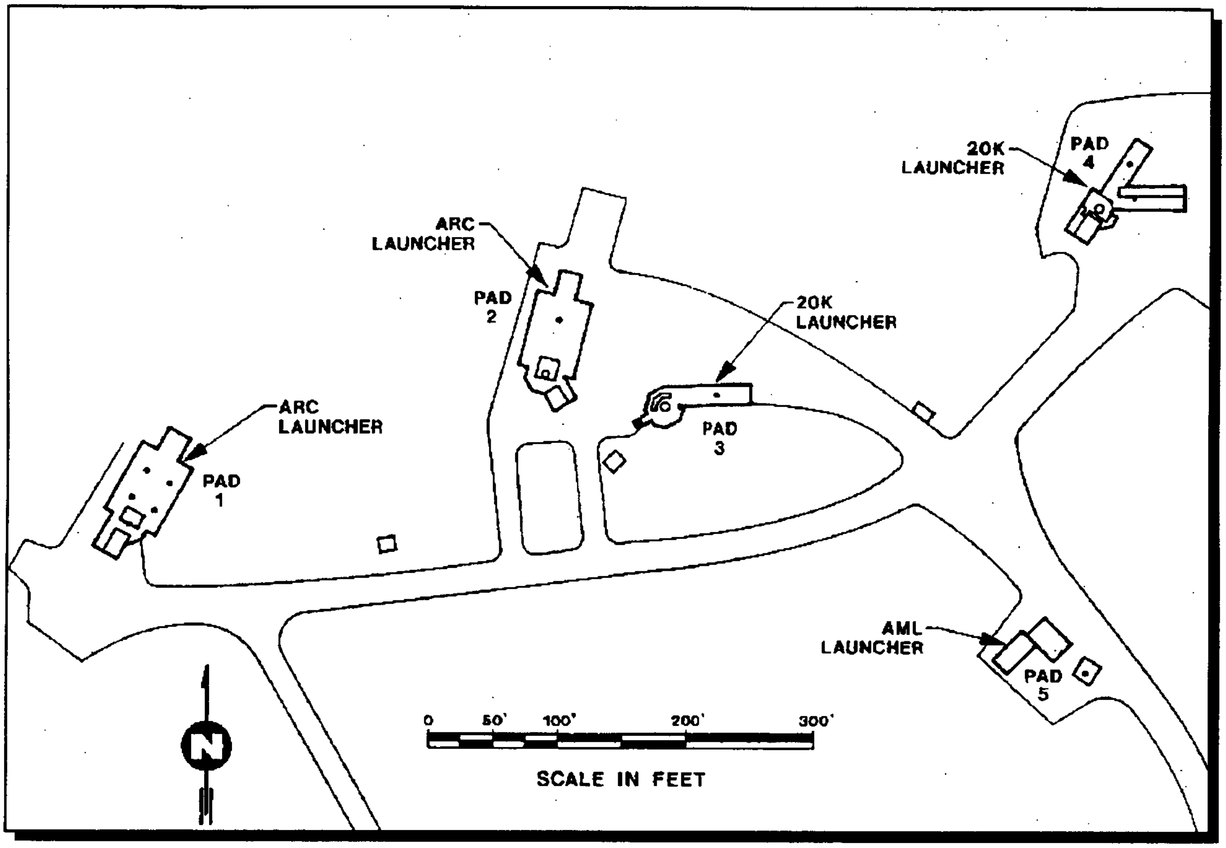
PFRR occupies approximately 2,100 hectares (5,200 acres) of land directly south of the Chatanika River. The facilities located at the Lower Range include: the Payload Assembly Area, the Launch Area, and the Launch Support Area [28, 45].

The ***Payload Assembly Area*** contains the PFRR administrative and support function and includes the range office building, a single-story structure, and the C-band radar installation. A concrete shelter is located at the base of the radar tower for occupation during critical launch periods.

The payload assembly building is approximately 6.7 meters (22 feet) tall and approximately 508 square meters (5,466 square feet) in size. South of the payload assembly building is the Stratosphere-Troposphere (S-T) radar installation [25].

The ***Launch Support Area*** includes: Rocket Assembly Buildings "A" and "B," a communication building, tool crib, grader shed, warehouse, and machine shop. The Rocket Assembly Building A (ARAB) and the Rocket Storage Facility are single-story structures. The warehouse is a building which is used for equipment storage and light repair work.

3.2.2.1.3 Launch Complex, Lower Range, PFRR, Alaska

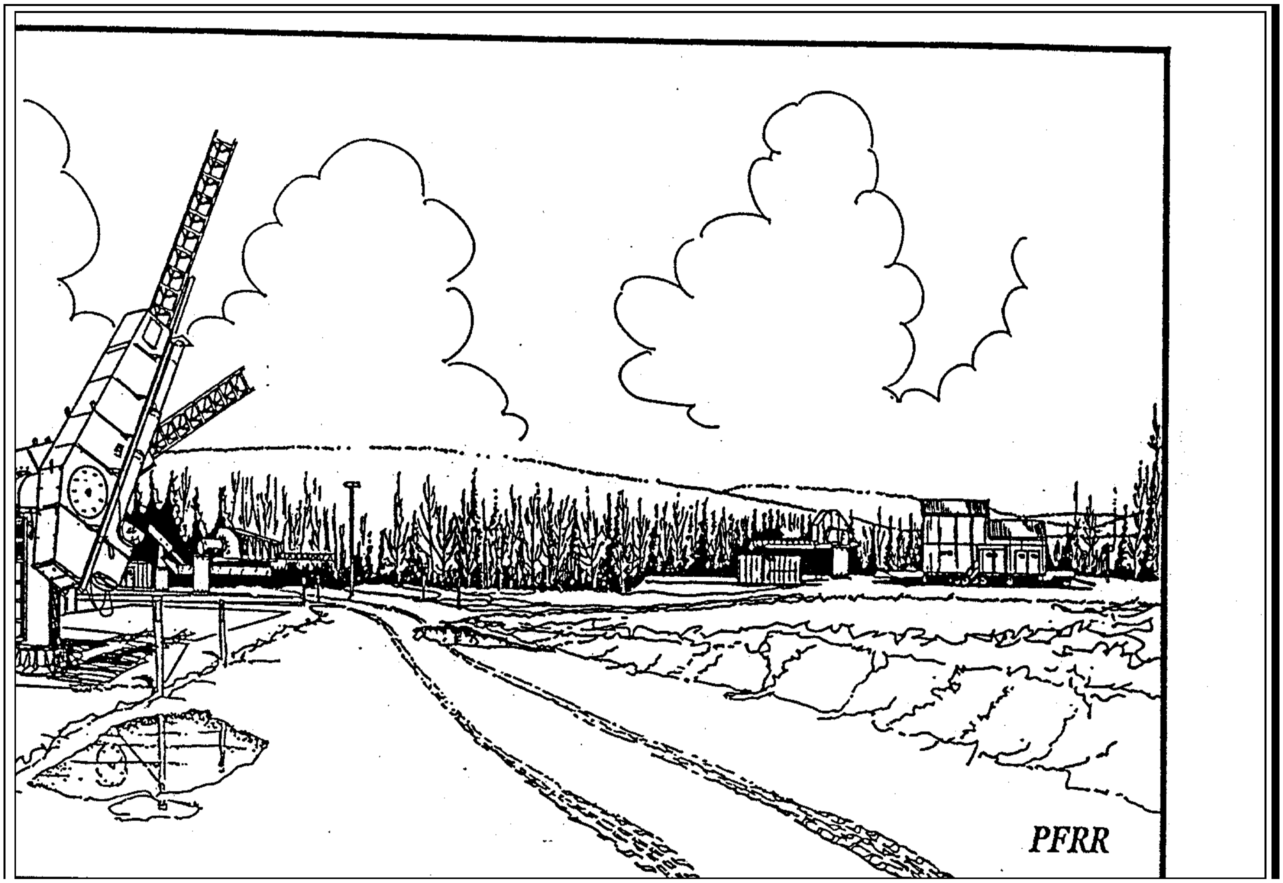


The ***Launch Complex*** at PFRR, is comprised of a control center/blockhouse (shown on the preceding page) and five rocket pads (shown above) arranged concentrically around the blockhouse. The blockhouse is approximately 186 square meters (2,000 square feet) in size. It is a single-story above-ground concrete structure, with an earthen embankment, which functions as a mission control center for rocket firing from all five launching pads. Each of the launching pads is equipped with a single launcher [25, 28, 45].

Launch Pads No. 1 and No. 2 are equipped with MRL 7.5K launchers capable of handling launch vehicles ranging from one to several stages.

The MRL launcher is capable of launching a wide range of propulsion systems including, the Black Brant series of rockets, as well as combinations of Nike, Orion, Tomahawk, Taurus, Terrier, and Malemute rockets [45].

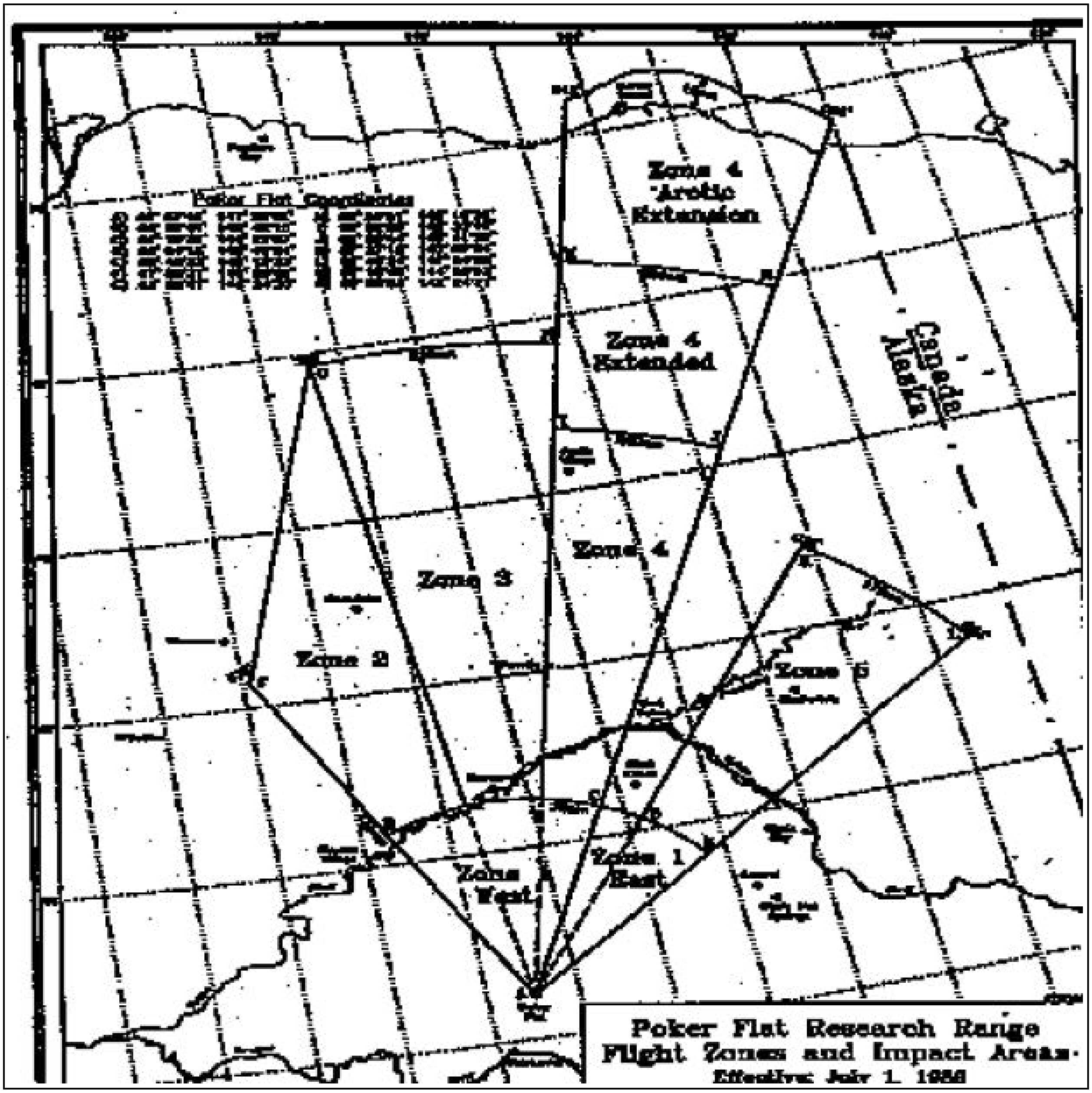
3.2.2.1.4 Launch Pads No.'s 3, 4, and 5, PFRR, Alaska



Launch Pads No. 3 and No. 4 are equipped with AML 20K launchers capable of handling launch vehicles ranging from one to several stages, including the Black Brant series, as well as combinations of Nike, Orion, Tomahawk, Taurus, Terrier, and Malemute rockets.

An environmental shelter is available to protect preflight preparation work on the 20K launcher. Launch Pad No. 5 is equipped with an AML 4.3K twin boom launcher and is used to launch smaller rockets such as the Arcas and Super Loki [45].

3.2.2.1.5 Impact Areas, PFRR, Alaska



Directly north (downrange) from the launch site are the White Mountain Recreation Area, Yukon Flats National Wildlife Refuge, Brooks Range, and the Arctic Ocean. The use of downrange landmasses is permitted by a series of agreements and letters of understanding between the Geophysical Institute of the UAF and the Native tribal governments, the Bureau of Land Management, U.S. Fish and Wildlife Service and other agencies [18, 45].

3.2.2.2 Environmental Setting at PFRR

The principal source of information on the affected environment at PFRR is the ***Environmental Assessment for the Improvement and Modernization Program, Poker Flat Research Range, Fairbanks, Alaska,*** April 1993 [25]. The information that follows is a brief summary of pertinent facts from this and other sources as they apply to the mission of SRP.

3.2.2.2.1 Climate

The forested interior region consists of the extensive lake-studded lowlands drained by the Yukon-Tanana River system, together with the hills and uplands that separate these two rivers. Precipitation in Fairbanks averages 26 centimeters (10 inches) per year. At Poker Flat, it is somewhat higher with an average of roughly 38 centimeters (15 inches) per year. Summers are warm, with daily temperatures reaching 21°C (70°F) more than 50 percent of the time during July and August. Summer winds typically flow from the west at 13 to 16 kilometers per hour (8 to 10 miles per hour). Winters are calm and severely cold. Temperatures can drop as low as -60°C (-76°F). In winter winds in the Chatanika Valley are typically 6 to 8 kilometer per hour (4 to 5 miles per hour) from the northeasterly direction. Large parts of the interior contain permafrost [25].

The Arctic region has a climate influenced by the existence of sea ice throughout most of the year and by darkness most of the winter. The region receives only about 25 centimeters (10 inches) of precipitation a year. Average monthly summer temperatures seldom exceed 10°C (50°F). Though the climate is very dry, the Arctic lowlands are wet and covered with lakes due to low evaporation rates. The dominant vegetation is a collection of lichens, mosses, and other small plants commonly referred to as tundra. The main weather hazard in the Arctic is the wind, which can create "whiteouts," or periods of reduced visibility. The temperatures in the Arctic are generally somewhat higher than those of the interior, due to the moderating influence of the adjacent Arctic Sea [3].

3.2.2.2.2 Air Quality

In the interior, thunderstorms with high, gusty winds are common during the summer. Frigid air drains down the valleys during severe cold spells, creating temperature inversions. At very low temperatures (-40°C [-40°F]), water vapor condenses into very fine ice particles that form "ice fog" and severely limit visibility. Ice fog sources at the PFRR include motor vehicles, building heat sources, and overflow from the Chatanika River. Localized ice fog at the PFRR is short-lived due to the prevalent downslope flow of air in the valley. Unlike Fairbanks, the Chatanika Valley does not have enough sources of water vapor to concentrate ice fog to produce a problem at PFRR. Air quality in the Arctic region is generally excellent due to very low levels of human activity [3, 25].

State of Alaska Ambient Air Quality Standards applicable to firing of sounding rockets are given in Alaska Department of Environmental Conservation, Regulation 18AAC-50, April 7,1993 as shown in the following table:

Applicable Alaska Ambient Air Quality Standards

Concentrations	ug/m^3
1. Suspended Particulates (as PM_{10})	
Annual Arithmetic Mean	50
Maximum 24-hour contration	150
2. Carbon Monoxide	
8-hour Average	10,000
1-hour Average	40,000
3. Lead	
Maximum Arithmetic Mean	1.5

3.2.2.2.3 Water Quality

Limited water quality data exist for the Chatanika River. Historically, most of the surface waters in the project area were severely impacted due to mining activities in the region. No water quality data exists for runoff from Poker Flat. However, activities associated with an average total of 10 launches per year, coupled with sporadic use of the three septic tank/leech fields, would indicate that no major water pollutant source is present. Ground water recently tested under the Fuel Storage Facility was found not to be contaminated with hydrocarbons. Runoff from the PFRR normally percolates through the natural ground cover and ends up in the Chatanika River. The limited activity at PFRR tends to limit the potential for water pollution. Additional details on the water quality of the area can be found in Reference 25.

3.2.2.2.4 Land Use

The PFRR is located on 780 hectares (1,927 acres) owned by the UAF. Additionally, more than 20,000 hectares (49,420 acres) of land north and east of the PFRR is used by the UAF under no cost Special Land Use Designation (SLUD) from the Northern Regional Office of the Division of Land, Alaska Department of Natural Resources. The PFRR is located in the Tanana River Basin. Lower regions of the PFRR are located in the Chatanika River Corridor. This corridor contains five areas designated for settlement while the remainder of the State land is retained in public ownership for recreation and preservation of fish and wildlife habitat. Upper areas of the PFRR are located in the Cleary Summit Subregion, an area with primary use designations of minerals and recreation with forestry as a secondary land use [25].

The Chatanika Lodge and F.E. Gold Camp are adjacent to the PFRR. They provide lodging for tourists and other visitors, including those interested in the PFRR programs [45].

The White Mountains National Recreation Area is located approximately 16 kilometers (10 miles) north of the project area. m This area is managed by the Bureau of Land Management and consists of 10 public recreation cabins, 280 kilometers (174 miles) of winter trails, and 34 kilometers (21 miles) of summer hiking trails. Areas for recreational gold panning are also available [13].

Two downhill ski areas are located

south of the PFRR. The first, Cleary Summit, is located at Mile 21 (33.8 kilometers) and the second, Skiland, at Mile 20 (32.2 kilometers), on the Steese Highway [45].

Recreational activities in the Chatanika area consist of berry picking, hiking, canoeing, fishing, horseback riding, snow machining, dog mushing, and cross-country skiing. The Chatanika River Corridor is recommended for legislative designation as a State Recreation River. The Chatanika River is one of the most popular recreation, hunting, and fishing rivers for Fairbanks residents [13].

3.2.2.2.5 Biological Resources

The primary sources for this section were the ***Environmental Assessment for the Improvement and Modernization Program Poker Flat Research Range Fairbanks, Alaska*** [25], and written correspondence from the USFWS. Refer to these documents for additional information on biological resources. See the Appendix for correspondence. This section will discuss vegetation, wildlife, and threatened and endangered species at PFRR.

The PFRR is located in a Boreal forest, or Taiga, ecosystem. The ecosystem is generally characterized by low levels of biological diversity. Habitats identified within the ecosystem include closed birch forest, closed broadleaf forest, needleleaf forest, mixed woodland, closed tall scrub shrub, mixed forest, needleleaf woodland, and wet grassland. Dominant vegetative species are white and black spruce, paper birch, quaking aspen, willow, and alder.

The Chatanika River contains a significant freshwater and anadromous fisheries resource. Species include Chum, Chinook, and Coho salmon; Northern pike; Arctic grayling; Dolly Varden; Burbot; and various whitefish. The area surrounding the PFRR is a moose rutting and calving area. Other mammalian species that may be common to the area are shrews, voles, mice, ermine, marten, mink, wolverine, snowshoe hare, beaver, muskrat, porcupine, brown and black bear, red fox, coyote, and wolves. Additionally, caribou and Dall sheep are occasionally found in the area, which is on the fringe of their range. Approximately 60 avian species including grouse, ptarmigan, ravens, and a wide variety of passerines, waterfowl, shorebirds, and raptors are known to inhabit the area.

The coastal area, located in the Arctic region downrange of the PFRR, supports marine mammals such as whales, seals, walruses, and polar bears all of which are protected by the Marine Mammals Act.

3.2.2.2.5.1 Threatened and Endangered Species

In response to a request for a list of threatened and endangered species specific to PFRR, the USFWS identified three Federally listed avian species: the endangered American peregrine falcon (*Falcon peregrinus anatum*), the threatened Arctic peregrine falcon (*Falco peregrinus tundrius*), and the recently listed as threatened spectacled eider (*Somateria fischeri*) (see Appendix A).

Peregrine falcon nest sites are known not to be within 24 kilometers (15 miles) of the launch facilities. However, both species migrate through the area during the spring and fall. Critical habitat for falcons and spectacled eiders has not been designated in Alaska (see Appendix A).

3.2.2.2.6 Wetlands

Much of the area in the Lower Range is designated as a palustrine wetland system composed primarily of scrub-shrub and forested class wetlands with saturated water regimes. For general purposes, most areas of the PFRR, facing north and northwest, downslope of the Upper Range ridgeline are classified as wetlands [25].

Details on wetlands at RFRR, including the associated vegetation are given in the ***Environmental Assessment, Improvement and Modernization Program, Poker Flat Research Range, Fairbanks, Alaska***, published by the Geophysical Institute, University of Alaska Fairbanks, Fairbanks, Alaska. The report provides a map that delineates wetlands within PFRR, and detailed description of associated vegetation.

The referenced report states that PFRR contains a prevalence of hydrophilic vegetation, such as Wet Graminoid Herbaceous vegetation, Needleleaf Woodland, Needleleaf Forest, Closed Birch Forest, and Mixed Woodland.

1. *Wet Graminoid Herbaceous* vegetation is dominated by marsh five-finger, cottongrass, carex, and the sandbar willow.

2. *Needleleaf Woodland* consists predominantly of black spruce. The understory shrub includes Labrador tea, mountain carndary, cloudberry, and resin birch. The herbaceous stratum is predominantly clubmoss but the lichen layer is prominent in open areas.

3. *Mixed Woodland* includes paper birch and black spruce. The understory is dominated by Labrador tea, bog blueberry, lowbush cranberry, spirea, and diamond-leaf willow. The herbaceous is predominantly feathermoss. Lichen is prominent in open area. Also present are cottongrass, bluejoint, and horsetail.

4. *Needleleaf Forest* is dominated by black spruce. Paper birch is also present. The understory consists of Labrador tea, lowbush cranberry, bog blueberry, and spirea. The herbaceous matt is thick with moss and lichens.

5. *Closed Birch Forest* is dominate by paper birch, with small components of black spruce. The understory consists of Labrador tea, cranberry, and moss matt.

6. *Mixed Forest* is dominated by quaking aspen, white spruce, and paper birch. The understory consists of bluejoint, Pyrola, and rose.

7. *Closed Tall Scrub Shrub* is dominated by a dense canopy of green alder, however, paper birch and aspen are also present. Understory consists of raspberry and bluejoint.

8. *Closed Broadleaf Forest* is dominated by paper birch, with scattering of quaking aspen, and white spruce. In understory common are green alder, lowbush cranberry,

bog blueberry, fireweed, and bluejoint.

3.2.2.2.7 Floodplains

The Chatanika River originates north and east of the project area and flows westward into the Tolovana river which flows into the Tanana River. The main flood seasons are spring and summer. Spring floods are the result of an above normal winter snowfall coupled with a cold spring and a rapid snowmelt. Summer flooding results from extreme rainfall in a short period of time. The Lower Range of this facility is located within the 100-year flood plain of the Chatanika River, but lies outside the 500-year floodplain.

The ***Environmental Assessment, Improvement and Modernization Program, Poker Flat Research Range, Fairbanks, Alaska*** [25], provides a FEMA Flood Insurance Map for the area.

3.2.2.2.8 Hazardous Waste Management

Hazardous waste generated on-site is managed by the UAF in accordance with ***UAF Risk Management Standard Safety Operating Procedures #401: Hazardous Materials Management Program*** [24].

3.2.2.2.9 Cultural Resources

A large part of the population of Arctic Alaska, as well as the population of interior Alaska, is made up of native people. Inuit occupy the Arctic coastal region, while Athapaskans occupy the interior. Native indigenous occupation dates back at least 10,000 years, to the end of the last ice age. Coastal Inuit culture is, in large part, a sea mammal hunting culture. Athapaskan culture is based largely on harvesting caribou, moose, and salmon. The indigenous cultural resources have been studied by the University of Alaska Department of Native Studies.

Remnants of the early mining days are evident at the PFRR. Three manmade Davidson Ditches were created to bring sluicing water to the mines on lower Cleary Creek and Chatanika Flats. The middle Davidson Ditch was constructed in 1909. The upper Davidson Ditch was constructed in 1925. The ditches are now overgrown with vegetation and breached at various points along their length. The lower ditch is nearly completely obliterated. These ditches are eligible for placement on the National Register of Historic Places. The historic Chatanika Gold Camp is located adjacent to the Steese Highway just south of the PFRR entrance road. Additional details on the cultural resources of PFRR can be found in References 24 and 25.

3.2.2.2.10 Economics and Employment

The economy of the interior region has a diverse base. Agriculture in the form of dairy and meat production is supported by locally produced feed, including barley. Tourism is a major contributor to the economy, especially during the summer months. Mineral resources such as lead, zinc, silver, gold, and copper have been a significant contributor to the economy of the interior for more than a century. Nonmineral resources such as coal and peat are also produced. Some local manufacturing, including petroleum refining, takes place. Forestry, largely for local consumption, is a factor. Fairbanks, by virtue of its location, is an important transportation link between Anchorage and the Prudhoe Bay oil fields. The Alaska Railroad and the Parks Highway connect Anchorage with Fairbanks. The Dalton Highway is the main land link between Fairbanks and the Prudhoe Bay oil fields.

The economy of the Arctic region is less diverse. Traditional subsistence activities support large numbers of Inuit people. Petroleum extraction in the Prudhoe Bay area accounts for approximately 20 percent of the United States' crude oil production, and is a significant economic asset.

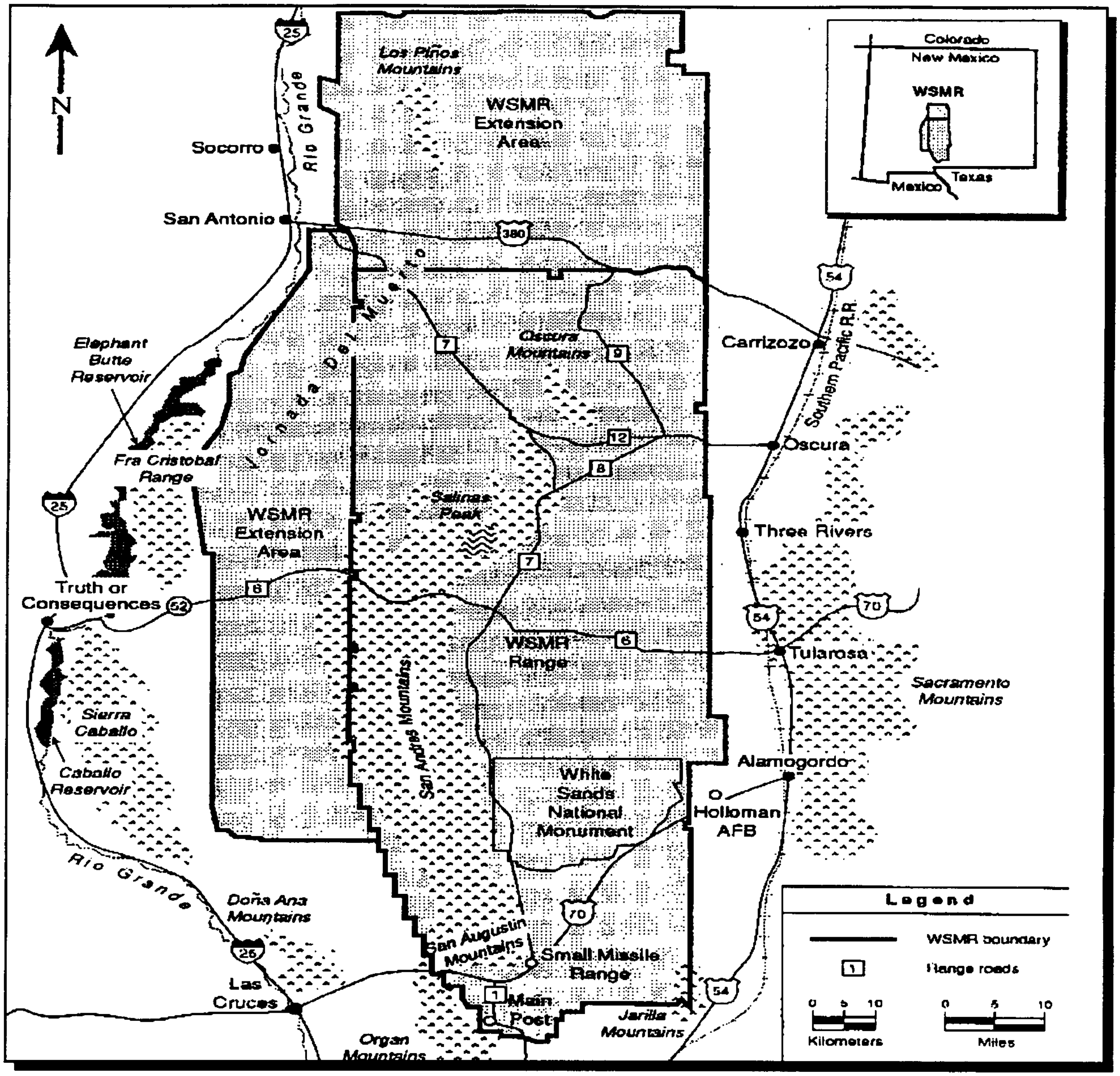
Defense and governmental expenditures account for a significant proportion of the economic base of both the interior and the Arctic regions of Alaska. If active duty military personnel are included, government of all types is the largest employer in Alaska. The Federal government is the largest land owner in the State, thus creating many jobs in land management programs.

The UAF Geophysical Institute currently has 13 full-time employees involved with the PFRR. Operations and maintenance costs for the PFRR average more than $1.5 million annually. During a major launch series, the operations crew may include up to 50 people with individual program budgets in excess of $1 million. Additional revenue is generated by visiting scientists and other interested parties. Additional details on economics and employment of this area can be found in References 24 and 25.

3.2.2.2.11 Population

The 1990 Census gives Fairbanks a population of 30,843, up from 22,645 in 1980, and 14,771 in 1970. The total population of the area (Burroughs) is estimated at 75,000. Fairbanks is the second largest city in Alaska [24].

3.2.3 WHITE SANDS MISSILE RANGE (WSMR), NEW MEXICO



WSMR is situated in the Tularosa Basin in south-central New Mexico. It is located within the political boundaries of five counties: Dona Ana, Sierra, Otero, Lincoln, and Socorro. The location of the range corresponds to approximately 32°5'N latitude and 106°5'W longitude. Post Headquarters are located 42 kilometers (26 miles) northeast from Las Cruces, New Mexico, and 72 kilometers (45 miles) northwest from El Paso, Texas. The major portion of the range lies within the closed Tularosa Basin, with the valley floor elevation ranging from 1,190 meters (3,900 feet) to 1,310 meters (4,300 feet) msl [144].

3.2.3.1 WSMR Launch and Support Facilities

WSMR is the DOD's largest overland national military test range. It encompasses a land area of approximately 750,000 hectares (1,853,250 acres). U.S. Army is the executive management agent for the facility, but both Navy and Air Force are afforded special status at the installation through creation of service deputies.

WSMR was originally conceived during the research and testing of captured German V-2 rockets and has been in continuous operation since 1945. The Test Range supports developmental tests for the Army, Navy, Air Force, Defense Nuclear Agency, and NASA. The unique characteristics of WSMR are needed to conduct safe, large-scale experiments on advanced weapons systems, including air-to-air/surface, surface-to-air, and surface-to-surface missiles, dispenser and bomb drop programs, target systems, upper atmospheric probes, and special tasks.

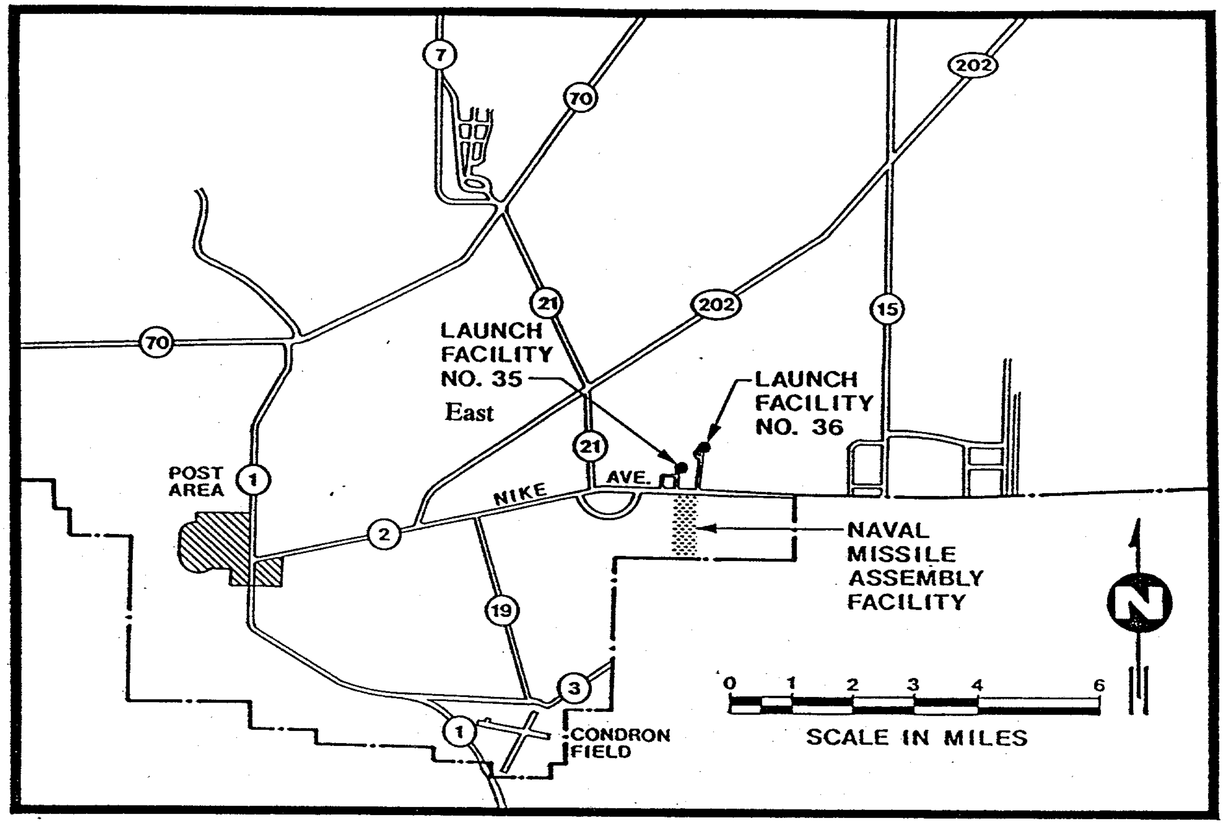
WSMR resources are available to support all U.S. military department and government agency programs, and authorized nongovernment agencies and foreign governments. WSMR capabilities include experimental payload and missile component recovery, target support, air and ground multiple target control, and ordinance and propellant storage. Facilities are available for environmental experiments, warhead and explosive tests, microwave and automated tests, and tactical and directed-energy weapons tests. Various Army laboratories and test facilities, including Temperature Test facility, Army Research Laboratories, and Nuclear Effects Directorate, are located at WSMR.

NASA is one of many organizations that use this facility on an irregular schedule. When the need arises for a NASA sounding rocket launch at WSMR, Naval Air Warfare Center Weapons Division provides NASA with necessary facilities and support. Out of approximately 5,000 missions carried at WSMR per year NASA SRP accounts on the average for 12 missions or 0.2% [144].

Research Rockets is the branch through which the Naval Air Warfare Center Weapons Division WSMR supports agency requirements to launch various sounding/research rockets. Customers of this branch are Naval Research Laboratory, Phillips Laboratory East, the Defense Nuclear Agency, the Ballistic Missile Defense Organization, NASA, and various domestic and foreign universities. Over an approximately two-year period from May 1992 through March 1994 1,129 research rockets have been launched from WSMR [144]. NASA SRP contributes to this activity approximately 12 launches per year or approximately 2% of the total sounding/research rocket launching operation.

The information related to the site-specific environmental issues at WSMR is based on the draft ***White Sands Missile Range Range-wide Environmental Impact Statement*** published by the White Sands Missile Range, New Mexico, Directorate of Environment and Safety, Environmental Services Division, WSMR, New Mexico 88002, June 1994 [144].

3.2.3.1.1 Facilities Used in NASA Operations, WSMR, New Mexico

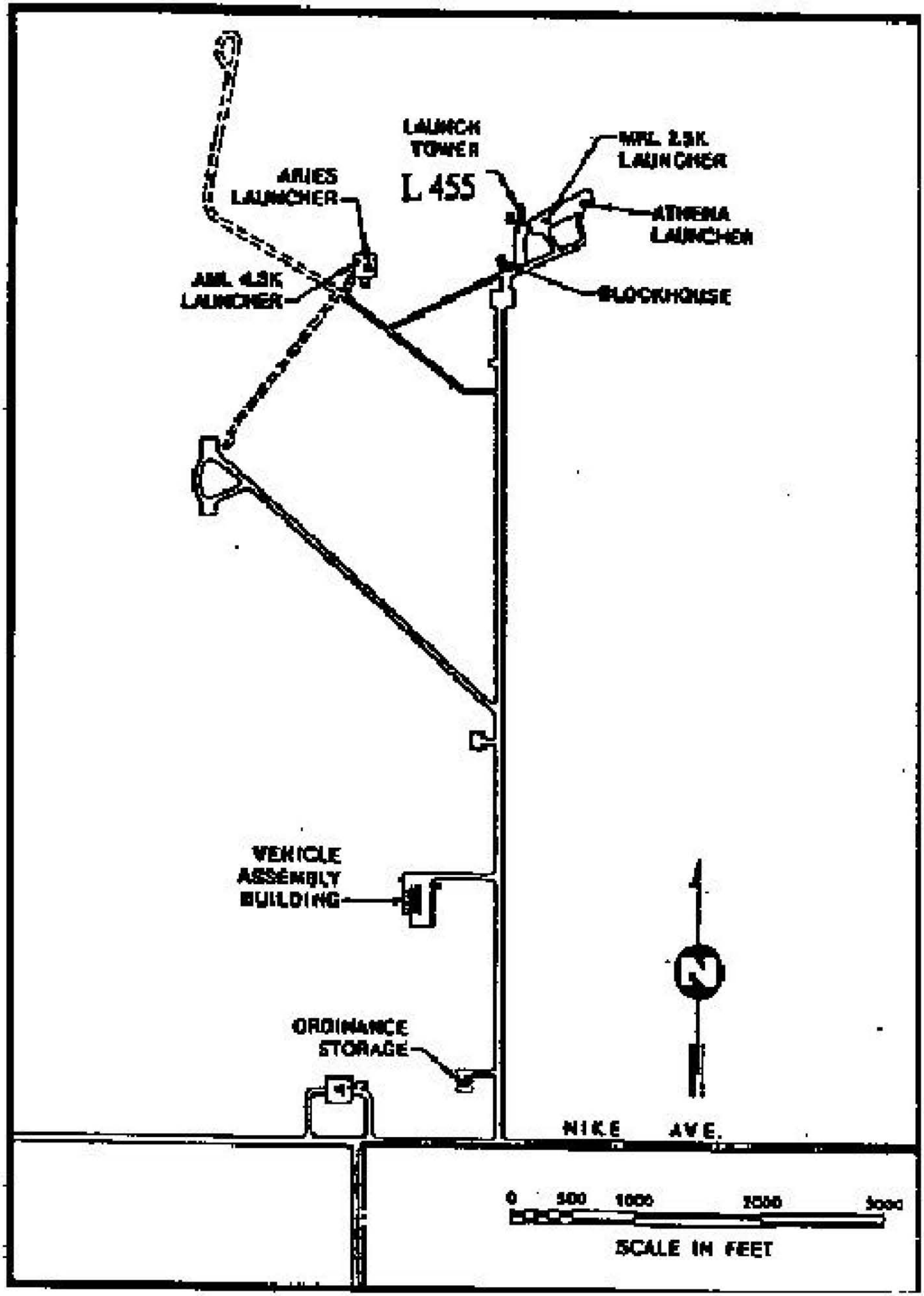


NASA sounding rocket launch activities at the WSMR use a missile assembly building, a part of Launch Complex No. 35 East, and the launch facilities of the

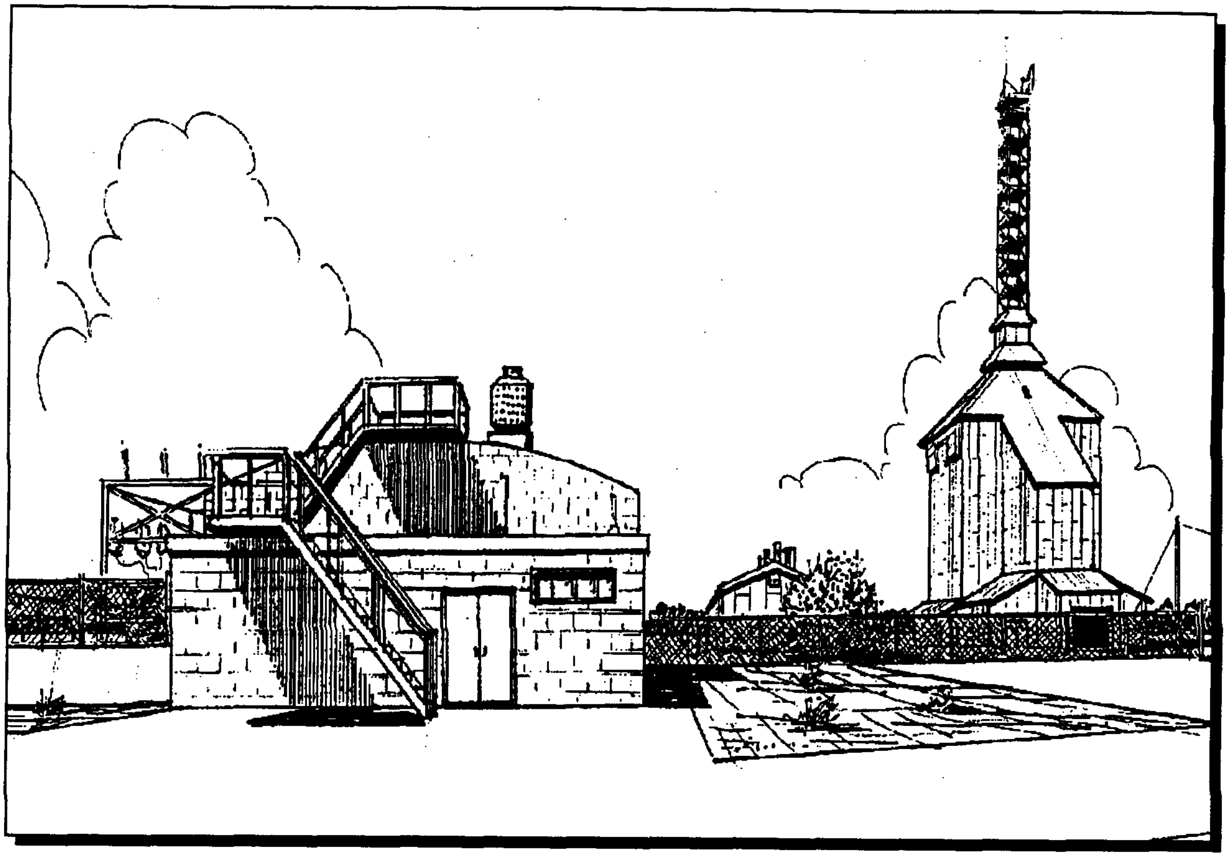
Launch Complex No. 36. These operations are located close to each other, north and south of Nike Avenue, approximately 8 kilometers (5 miles) from the Post area in an easterly direction.

The Naval Missile Assembly Facility is a restricted military area located directly across from and south of the Launch Complex No. 35. Bay No. 4 of this facility is dedicated to the NASA SRP. Rocket motors prepared in this bay are transferred to the Ready Service Magazine (Bldg. 23326) for temporary storage pending deployment.

Launch and launch support facilities used by the NASA SRP at WSMR are located at Launch Complexes No. 35 and No. 36. The LC No. 35 currently provides office and shop space to NASA personnel. Various general support facilities, such as office trailers, electronics assembly and checkout, and payload/launch vehicle integration operations are active and used on the NASA programs. At this time, all the NASA sponsored launches take place at LC No. 36, shown on the next page.


LAUNCH TOWER
L 455
MRL 2.5K LAUNCHER
ARIES LAUNCHER
ATHENA LAUNCHER
AML 4.3K LAUNCHER
BLOCKHOUSE
VEHICLE ASSEMBLY BUILDING
ORDINANCE STORAGE
N
NIKE AVE.
0 500 1000 2000 3000
SCALE IN FEET

3.2.3.1.2 Launch Complex No. 36, WSMR, New Mexico



The LC No. 36, shown above, includes launchers, a blockhouse to control propulsion and payload systems, a vehicle and payload assembly (integration) building, a portable magazine for storing explosives, telemetry pedestal, and associated support structures.

Five launchers are available for the NASA SRP: a large Launch Tower (L-455), Athena launcher (L-738), MRL 7.5K launcher (L-630), AML 4.3K launcher (l-479), and a pedestal launcher for Aries vehicles (L-536)[46].

The Launch Complex No.36 is capable of supporting the Aries and Black Brant series of rockets, as well as combinations of Nike, Orion, Tomahawk, Taurus, Terrier, and Malemute rockets [46].

The telemetry facilities used in support of the NASA SRP at the WSMR include: operational units at Launch Complex No. 35 East (Bldg. 23241) and at the Vehicle Assembly Building (Bldg. 23358) at Launch Facility No. 36, and a unit at the Parker Station site (Bldg. 20650) on Highway 70. [46].

3.2.3.2 Environmental Setting at WSMR

The principal source of information on the affected environment at WSMR used in preparation of this SEIS is the draft ***White Sands Missile Range Range-wide Environmental Impact Statement*** published by the White Sands Missile Range, New Mexico, Directorate of Environment and Safety, Environmental Services Division, WSMR, New Mexico 88002 in June 1994. [144]

3.2.3.2.1 Climate

The climate of the Tularosa Basin in south central New Mexico, where WSMR is located, is typical of arid regions at low latitudes. Sunshine is abundant throughout the year, with typical visibility of 71 km (44 mi). During sustained periods of strong winds, suspended gypsum particles may reduce visibility to less than 1.4 km (1 mile). Rainfall is insufficient for any growth except desert vegetation. The average annual precipitation is 28 cm (11 inches). The precipitation, however is highly variable with elevation. The spring months, April through May are the driest time of the year. Half of the annual precipitation falls during the summer "monsoon" season in form of afternoon and evening thunderstorms. The annual snowfall averages 16.5 centimeters (6.5 inches) per year. The range in annual mean temperatures is from 8^{o}C (46^{o}F) to 24^{o}C (75^{o}F) with a mean of 18^{o}C (64^{o}F). The region's mean relative humidity is 37 percent.

The prevailing wind direction throughout the year, with a significant exception, is from the west. The exception occurs in July and August when winds with a strong southerly component stimulate thunderstorm activity. Spring is notable for dust storms. The wind velocity averages 10 km per hour (6 miles per hour) and reaches gusts to 110 km per hour (68 miles per hour).

Local weather conditions across WSMR are influenced by the immediate topography. Snow and rain are usually higher in the mountains than on the valley floor. Temperatures at the Post Headquarters are typically a few degrees warmer at night and cooler during the day than at a lower elevation in the basin.

3.2.3.2.2 Air Quality

Almost all of WSMR is located in New Mexico Air Quality Control Region (AQCR) 6, which includes the counties of Dona Ana, Otero, Sierra, and Lincoln. These counties along with six counties in Texas, are part of the EPA El Paso-Las Cruces-Alamogordo Interstate AQCR 153. The northern part of the range in Socorro County is located in New Mexico AQCR 8. This county is in EPA AQCR 156.

All of WSMR is located in areas designated ATTAINMENT for six criteria pollutants designated under the National Ambient Air Quality Standards (NAAQS), i.e., carbon monoxide, nitrogen dioxide, sulfur dioxide, respirable particulate matter, and lead.

In addition to the federal standards, the state of New Mexico has set forth, in Air Quality Control Regulation 201, ambient air quality standards that are as strict or more strict than the NAAQS. In addition to protecting human health, the New Mexico standards are designed to protect against air pollution that injures animals and vegetation, corrodes building materials and works of art, reduces visibility, and generally diminishes the quality of life.

The New Mexico Air Quality Standards applicable to firing of sounding rockets [State of Mew Mexico Ambient Air Quality Regulation 201] are shown below.

Applicable New Mexico Ambient Air Quality Standards

1. Total Suspended Particulates (TSP)
(Aluminum Oxide particulates)

	Concentration
24-hour Average	150 ug/m^3
7-day Average	110 ug/m^3
30-day Average	90 ug/m^3
Annual Average	60 ug/m^3

2. Carbon Monoxide

8-hour Average	8.7 ppm
1-hour Average	13.1 ppm

3. Heavy metals (total combined)
10 ug/m^3

The point source limit for lead under New Mexico Air Quality Regulation 703 is 5 tons per year.

3.2.3.2.3 Water Quality

Basin fill deposits of the Tularosa Basin are saturated with ground water containing dissolved solids in concentrations from less than 1,000 milligrams per liter to greater than 100,000 milligrams per liter. While limited fresh water sources can be found in alluvial fan deposits, much larger quantities of highly saline water exist in the fine-grained sediments throughout the central portions of the basin. Potable water is supplied by wells located in the alluvial fans of the Organ and San Andres Mountains and transported to the Base via pipeline. Surface water throughout the basin is saline and occurs in relatively large bodies (Lake Lucero and the Big Salt Lake), springs (Malpais), and Salt Creek. Additional details on water quality, including physiographic setting, precipitation and surface water resources, groundwater resources, water supplies and wastewater treatment can be found in Chapter 3.2 Hydrology/Water Resources, pages 3-11 through 3-60, Reference 144.

3.2.3.2.4 Land Use

The White Sands Proving Ground was established in 1945. Its location was chosen for its geographical configuration, remoteness, excellent meteorological conditions, sparse ground cover, and sparse population. In 1958, the name was changed to WSMR. In 1961, the range was classified as a national range.

Highway 70 crosses WSMR and provides access to Interstate Highways 25 and 10 and State Highway 54. The Santa Fe and Southern Pacific railroads provide rail transportation to the Base through railheads at Holloman and Orogrande. The Post area provides support facilities for personnel and families, and the technical and administrative facilities necessary for range operations.

WSMR can be categorized into three major land areas: the main range, the range annexes, and the extension areas. The main range and the leased or co-use areas comprise over 1.54 million hectares (3.8 million acreas). The main range comprises all real estate within the WSMR boundary, totaling 923,387 hectares (2,281,659 acres). With the exception of White Sands National Monument, San Andreas National Wildlife Refuge, and

Jornada Experimental Range, which are operated under co-use agreement, the main range is under direct control of the U.S. Army on an exclusive-use basis, with unlimited use of restricted air space. This area has two major land-use functions: test operations on the range and base operational support.

WSMR has several operational areas throughout the main range that support the various test missions. Major mission-related areas and non-mission-related areas are identified as follows (page 3-37):

* The Main Post and cantonment,
* The south range launch complex and support areas (from the Main Post east along Nike Avenue to LC-39 vicinity),
* Other south range land use areas south of U.S. Highway 70 to the southern WSMR boundary,
* South range land use areas north of U.S. Highway 70,
* Southwestern range area,
* Central range land use (from Range Road 6 to coordinate N80),
* North range and Stallion Range land use (from coordinate N80 to the northern WSMR boundary),
* WSMR-controlled or joint-use outside the WSMR boundary, and
* Non-WSMR controlled nonjoint-use within 80 km (50 miles) of WSMR.

Site-specific information for various research, development, testing, and experimental programs and areas as well as for local recreation, national, federal, state, and private land use areas is listed in tables presented in the draft ***White Sands Missile Range Range-wide Environmental Impact Statement*** published by the White Sands Missile Range, New Mexico, Directorate of Environment and Safety, Environmental Services Division, WSMR, New Mexico 88002 in June 1994 [144]. Information is provided for each site unless it is operation sensitive.

3.2.3.2.5 Biological Resources

The primary source for this section is the draft ***White Sands Missile Range Range-wide Environmental Impact Statement*** published by the White Sands Missile Range, New Mexico, Directorate of Environment and Safety, Environmental Services Division, WSMR, New Mexico 88002 in June 1994 [144].

The WSMR is located within a desert ecosystem, specifically the northern extent of the Chihuahuan Desert. The installation has a variety of vegetation and habitat types that support a diversity of wildlife. These habitats are widely dispersed and form a mosaic of scrub, grasslands, savannas, woodlands, forests, and wetlands. WSMR wildlife resources include mammals, birds, reptiles, amphibians, and numerous kinds of interbrates. This section provides a summary of the general description of components of these habitats based on a far more detailed discussion of the subject matter as reported in Reference 144. It also identifies those plants and wildlife species that are listed as threatened or endangered by state and federal resources management agencies, or are otherwise of concern. In addition, this section describes habitats that are identified by the New Mexico Natural Heritage Projct (NMNHP).

3.2.3.2.5.1 Vegetation

WSMR is located in the south-central New Mexico near the northern edge of the Chihuahuan Desert region. The relatively warm, dry climate associated with this region is the primary factor influencing the vegetation in the area. Most of the surface of WSMR is located on the floor of the Tularosa Basin and Jornada del Muerta where summer rainfall is low. The vegetation of these lowlands includes Chihuahuan desert scrub, close basin scrub, and desert grasslands. The New Mexico National Heritage Project (NMNHP) (1992) has subdivided the vegetation types at WSMR into eleven vegetation/habitat types as shown in Table 3-2. The NMNHP classification of vegetation on WSMR is presented on a type-by-type basis in Table 3-3.

3.2.3.2.5.2 Wildlife

As with most desert environments, the availability of water is the greatest limiting factor to wildlife abundance and habitat use. In spite of this limitation there is high diversity of animals at WSMR, primarily due to variability in elevation and accompanying range of climatic conditions, diverse biogeographic history of the southwestern United States, and variations in vegetation association types.

Eighty-six mammals are found or expected to occur on lands of WSMR, including rodents (deer mouse, Marriams's and Ord's kangaroo rats), bats, coyote, gray and kit fox, bobcat and mountain lion, mule deer, pronghorn, desert bighorn sheep, wapiti, feral horse, and oryx [144].

There are 307 birds species that are found or expected to occur on WSMR. The most common to WSMR are blackthroated sparrow, northern mockingbird, mourning dove, and western kingbird. Raptors include Swanson hawk and red-tailed hawk. Also found are golden eagle, and a variety of falcons (American kestrel, the merlin, prairie falcon, peregrine falcon, and aplomado falcon). Also are present are owls (burrowing, great-horned, and barn), as well as turkey vultures. There are also neotropical migrants [144]. Several birds found at WSMR are associated with aquatic habitat, such as sewage run-off ponds located southeast of the Main Post.

This group includes ducks and geese, herons and egrets, and gulls, terns, plovers, and sandpipers. The primary game birds on WSMR land are scaled and Gambels quail, and mourning and white-winged doves [144].

Reptiles comprise an abundant and diverse group of inhabitants at WSMR, being ubiquitous throughout the range. The reptiles at WSMR include 2 genera types of turtle, 12 genera types of lizards, 21 genera types of snakes.

Table 3-2
EXTENT OF VEGETATION/HABITAT TYPES at WSMR

Vegetation Type	Hectares (acres)
Coniferous Woodlands (Pinyon Pine Series)	
Pinyon Pine	11,200 (27,700)
Pinyon Pine and Mountain Mahogany	23,400 (57,800)
Savanna and Plains-mesa Grassland	91,200 (225,400)
Desert Grassland and Plains-mesa Sandscrub	174,000 (430,000)
Chihuahuan Desert Scrub	
Cresote Bush	222,000 (548,000)
Mesquite	114,600 (283,200)
Lava	16,900 (41,800)
Closed-basin Scrub	
Fourwing Saltbush and Tarbush	107,900 (266,600)
Arroyo Riparian and Wetlands	10,000 (24,700)
Barren Land	69,500 (171,700)
Dune Land	35,600 (88,000)
Total	877,100 (2,167,300)

Notes: Does not include 9,400 hectares (23,200 acres) of WSMR, which NMNHP (1992) mapped as having no associated data.
The NMNHP (1992) provides no acreage for the lower montane coniferous forest vegetation.

Note: This and subsequent tables in this section are extracted from the draft ***White Sands Missile Range Range-wide Environmental Impact Statement*** published by the White Sands Missile Range, New Mexico, Directorate of Environment and Safety, Environmental Services Division, WSMR, New Mexico 88002 in June 1994.

Table 3-3
HABITAT/VEGETATION TYPES OCCURRING on WSMR

Hierarchical Vegetation Classification

CONIFEROUS FOREST
Ponderosa Pine Series
Ponderosa Pine/Arizona Foscue (*Pinus ponderosa/Festuca arizonica*) Habitat Type

CONIFEROUS WOODLAND
Pinyon Pine Series
Pinyon Pine/Gamble Oak (*Pinus edulis/Quercus gambelii*) Habitat Type
Pinyon Pine/Scribner Needlegrass (*Pinus edulis/Stipa scribner*) Habitat Type
Pinyon Pine/Wavyleaf Oak (*Pinus edulis/Quercus undulata*) Habitat Type
Pinyon Pine/Blue Grama (*Pinus edulis/Bouteloua gracilis*) Habitat Type
Pinyon Pine/Beargrass (*Pinus edulis/Nolina microcarpa*) Habitat Type
Pinyon Pine/Sideoats Grama (*Pinus edulis/Bouteloua curtipendulata*) Habitat Type
Pinyon Pine/New Mexico Muhly (*Pinus edulis/Muhlenbergia pauciflora*) Habitat Type

CONIFEROUS WOODLAND AND MONTANE SCRUB
Pinyon Pine Series
Pinyon Pine/Mountain Mahogany (*Pinus edulis/Cercocarpus montanus*) Community Type

Mountain Mahogany Series
Mountain Mahogany/Silktassle (*Cercocarpus montanus/Carrya flavescens*) Community Type
Mountain Mahogany/New Mexico Muhly (*Cercocarpus montanus/Muhlenbergia pauciflora*) Habitat Type
Mountain Mahogany/Fragment Sumac (*Cercocarpus montanus/Rhus aromatica*) Community Type

Gamble Oak Series
Gamble Oak/Snowberry (*Quercus ganbelii/Symphoricarpus oreophilus*) Community Type

Gray Oak Series
Gray Oak/Mountain Mahogany (*Quercus grisea/Cercocarpus montanus*) Habitat Type

Waveyleaf Oak Series
Wavyleak Oak/Mountain Mahogany (*Quercus undulata/Cercocarpus montanus*) Community Type

Scrub Oak Series
Scrub Oak/Mountain Mahogany (*Quercus turbinella/Cercocarpus montanus*) Community Type
Scrub Oak/Black Grama (*Quercus turbinella / Boutelous eripoda*) Habitat Type

(table continues)

Table 3-3 (Continued)
HABITAT/VEGETATION TYPES OCCURRING on WSMR

Hierarchical Vegetation Classification

SAVANNA AND PLAINS-MESA GRASSLAND

One-seed Juniper Series

One-seed Juniper/Sideoats Grama (*Juniperus monosperma/Bouteloua curtipendua*) Habitat Type
One-seed Juniper/New Mexico Needlegrass (*Juniperus monosperma/Stipa neomexicana*) Habitat Type
One-seed Juniper/Black Grama (*Juniperus monosperma/Bouteloua criopoda*) Habitat Type
One-seed Juniper/Blue Grama (*Juniperus monosperma/Bouteloua gracilis*) Habitat Type
One-seed Juniper/Hairy Grama (*Juniperus monosperma/Bouteloua hirsuta*) Habitat Type
One-seed Juniper/Mountain Mahogany (*Juniperus monosperma/Cercocarpus montanus*) Habitat Type
One-seed Juniper/Scrub Oak (*Juniperus monosperma/Quercus turbinealla*) Habitat Type

Sideoats Grama Series

Sideoats Grama/Sotal (*Bouteloua curtipendual/Dasylirion wheeleri*) Habitat Type

Blue Grama Series

Blue Grama/Western Wheatgrass (*Bouteloua gracilis/Agropyron smithii*) Habitat Type
Blue Grama/Bigelow's Sage (*Bouteloua gracilis/Artemisia biglovii)* Habitat Type
Blue Grama/Sideoats Grama (*Bouteloua gracilis/Bouteloua curtipendual*) Habitat Type
Blue Grama/Winterfat (*Bouteloua gracilis/Eurotia lanata*) Habitat Type
Blue Grama/Sand Dropseed (*Bouteloua gracilis/Sporobolus cryptandurs*) Habitat Type
Blue Grama/New Mexico Needlegrass (*Bouteloua gracilis/Stipa neomexicana*) Habitat Type

Hairy Grama Series

Hairy Grama/New Mexico Needlegrass (*Bouteloua hirsuta/Stipa neomexicana*) Habitat Type
Hairy Grama/Blue Grama (*Bouteloua hirsuta/Bouteloua gracilis*) Habitat Type
Hairy Grama/Sideoats Grama (*Bouteloua hirsuta/Bouteloua curtipendual*) Habitat Type

New Mexico Needlegrass Series

New Mexico Neeedlegrass/Sideoats Grama (*Stipa neomexicana/Bouteloma curtipendual*) Habitat Type
New Mexico Needlegrass/Sotol (*Stipa neomexicana/Dasylirion wheeleri*) Habitat Type

Little Bluestem Series

Litle Bluestem/Sandhill Muhly (*Schizachyrium scopurium/Muhlenbergia purgens*) Habitat Type

Table 3-3 (Continued)
HABITAT/VEGETATION TYPES OCCURRING on WSMR

Hierarchical Vegetation Classification

DESERT GRASSLANDS AND PLAINS MESA SANDSCRUB

Black Grama/Bigelow's Sage (*Bouteloua gracilis/Artemisia biglovii)* Habitat Type
Black Grama/Sideoats Grama (*Bouteloua gracilis/Bouteloua curtipendual*) Habitat Type
Black Grama/Blue Grama (*Boutelouaeriopoda/Bouteloua gracilis*) Habitat Type
Black Grama/Hairy Grama (*Boutelouacriopoda/Bouteloa hirsuta*) Habitat Type
Black Grama/Torrey Mormontea (*Boutelouaeriopoda/Ephedra torreyana*) Habitat Type
Black Grama/Sotol (*Bouteloua eriopoda/Dasylirion wheeleri*) Habitat Type
Black Grama/Desert Mormontea (Bouteloua criopoda/Ephedra trifurca) Habitat Type
Nolina microcarpa phase (NOMI; Beargrass)
Black Grama/Marioa (Bouteloua eriopoda/Parthenium incanum) Habitat Type
Black Grama/New Mexico Needlegrass (Bouteloua eriopoda/Stipa neomexicana) Habitat Type
Black Grama/Soaptree Yucca (Bouteloma eriopoda/Yucca elata) Habitat Type
Black Grama/Red Grama (Bouteloua eriopoda/Bouteloua trifida) Habitat Type

Curlyleaf Muhly Series

Curlyleaf Muhly/Ocotillo (*Muhlenbergia setifolia/Fouquieria splendens*) Habitat Type
Curlyleaf Muhly/Bigelove Sage (*Muhlenbergia sctifolia/Artemisia bigelovii*) Habitat Type
Curlyleaf Muhly/Sotol (*Muhlenbergia setifolia/Dasylirion wheeleri*) Habitat Type

Gypgrass Series

Gypgrass/Hartweg's Evening *Primrose (Sporobolus wealeyii/Calyophus hartwegi*) Habitat Type
Gypgrass/Hairy Coldenia *(Sporobolus mealleyii/Coldinia hispidual*) Habitat Type
Gypgrass/Ocotillo (Sporobolus nealleyii/Fouqueiria splendens) Habitat Type

Alkali Sacaton Series

Alkali Sacaton/Burrograss (Sporobulus airoides/Scleropogon brevifolius) Habitat Type
Alkali Sacaton/Blue Grama (Sporobolus airoides/Bouteloua gracilis) Habitat Type
Alkali Sacaton/Saltgrass (Sporobolus airoides/Distichlis stricta) Habitat Type

Mesa Dropseed Series

Mesa Dropseed/Broom Dalea (Sporobolus flexuosus/Psorthammus scoparisu) Habitat Type
Mesa Dropsed/Spike Dropseed (Sporobolus flexuosus/Sporobolus contractus) Habitat Type

Giant Sacaton Series

Giant Sacaton/Hall's Panic Grass (Sporobolus wrightii/Panicum hallii) Habitat Type

Table 3-3 (Continued)
HABITAT/VEGETATION TYPES OCCURRING on WSMR

Hierarchical Vegetation Classification

Sand Sage Series
Sand Sage/Black Grama (*Artenisia filifolia/Bouteloua eriopoda*) Habitat Type
Sand Sage/Mesa Dropseed (*Artemisia filifolia/Sporobolus flexuosus*) Habitat Type
Sand Sage/Giant Dropseed (*Artemisia filifolia/Sporobolus giganteus*) Habitat Type

CHIHUAHUAN DESERT SCRUB (CREOSOTE BUSH)
Creosote Bush Series
Creosote Bush/Black Grama (*Larrea tridentata/Bouteloua eriopoda*) Habitat Type
Creosote Bush/Blue Grama (*Larrea ttidentata/Bouteloua gracilis*) Habitat Type
Creosote Bush/Hairy Coldenia (*Larrea tridentata/Coldenia hispidissima*) Habitat Type
Creosote Bush/Fluff Grass (*Larrea tridentata/Erioneuron pulchellum*) Habitat Type
Creosote Bush/Bush Muhly (*Larrea tridentataMuhlenbergia porteri*) Habitat Type
Creosote Bush/Mariola (*Larrea tridentata/Parthenium incarnum*) Habitat Type
Creosote Bush/Sparse (*Larrea tridentata/Sparse*) Habitat Type
Creosote Bush/Alkali Sacaton (*Larrea tridentata/Sporobolus airoides*) Habitat Type

Tarbush Series
Tarbush/Sideoats Grama (*Flourensia cerrua/Bouteloua curtipendual*) Habitat Type
Tarbush/Alkali Sacaton (*Flourensia cernua/Sporobolus airoides*) Habitat Type
Tarbush/Southwestern Needlegrass (*Flourensia cernua/Stipa eminens*) Habitat Type

Ocotillo Series
Ocotillo/Sideoats Grama (*Fouquieria splendens/Bouteloua curtipendula)* Habitat Type
Ocotillo/Mariola (*Fouquieria splendens/Parthenium incanum*) Habitat Type
Ocotillo/Tufted Rockmat (*Fouquieria splendens/Petrophytum caespitosum*) Habitat Type

CHIHUAHUAN DESERT SCRUB (MESQUITE)
Honey Mesquite Series
Honey Mesquite/Fourwing Saltbush (*Prosopis glandulosa/Atriplex canescens*) Habitat Type
Honey Mesquite/Alkali Sacaton (*Prosopis glandulosa/Sporobolus airoides*) Habitat Type
Honey Mesquite/Mesa Dropseed (*Prosopis glandulosa/Sporobolus flexuosus*) Habitat Type

CLOSED-BASIN SCRUB (FOURWING SALTBUSH AND TARBUSH)
Fourwing Saltbush/Alkali Sacaton (*Atriplex canescens/Sporobolus aroides*) Habitat Type
Fourwing Saltbush/Giant Sacaton (*Atriplex cansescens/Sporobolus wrightii*) Habitat Type

Table 3-3 (Concluded)
HABITAT/VEGETATION TYPES OCCURRING on WSMR

Hierarchical Vegetation Classification
CLOSED-BASIN SCRUB (ARROYO RIPARIAN AND WETLANDS)
Fourwing Saltbush/Parthenium (Atriplex canescens/Parthenium confertum) Habitat Type
CLOSED-BASIN SCRUB AND BARREN LANDS (SALTBUSH/IODINE BUSH)*
CLOSED-BASIN SCRUB AND DUNE LAND (SALTBUSH AND GYPSUM DUNES)*
CLOSED-BASIN SCRUB AND LAVA*

Source: NMNHP (1992).

* The NMNHP (1992) has not delineated habitat types within this vegetation type.

Included in this collection are the ornate box turtle, the Texas banded gecko, roundtail horned lizard, checkered whiptail, bullsnake, blackneck garter snake, plains blackhead snake, and western diamondback rattlesnake [144].

Few amphibians are found in arid habitats. The amphibians of WSMR include one genus of salamander, and 5 genera of frogs and toads for a total of ten species. There are no sensitive amphibians present at WSMR [144].

The White Sands pupfish is the only native fish known to occur at WSMR. This species is listed as endangered by the New Mexico Department of Game and Fish (NMDGF) and as federal Category 2 candidate by the United States Fish and Wildlife Service (USFWS). The White Sands pupfish is known to occur in Salt Creek, Malpais Spring and its associated outflow, Mountain Spring, and Malone Draw/Lost River. This species occupies shallow pools and calm spring runs, which are characterized by high fluctuations in daily temperatures, very saline waters, and substrates of silt, sand, and gravel. Introduced fishes that are considered a treat to the White Sands pupfish include largemouth bass and mosquito fish.

3.2.3.2.5.3 Threatened and Endangered Species

PLANTS. New Mexico Forestry Resources Conservation Division and USFWS have indicated that 38 plant species of concern occur or may occur on WSMR, as shown in Table 3-4. The WSMR

Environmental Services Division lists 24 sensitive plant species that occur on WSMR. Habitat apparently suitable for an additional 14 plant species also occurs on WSMR [144].

Todson's pennyroyal is the only plant species listed as endangered by USFWS that currently is known to occur on WSMR. Four other species listed by USFWS as endangered potentially occur on WSMR. WSMR also provides habitat for five plant species listed as Category 2 for listing as threatened or endangered by by USFWS. WSMR also has habitat apparently suitable for an additional nine species listed as threatened or endangered by USFWS or that are candidates for listing. These nine species are not known to occur on the range currently.

Habitat for 33 (87%) of sensitive plant species is associated with coniferous woodland, and montane scrub or savanna, and plains-mesa grasslands. These three vegetation types represent approximately 14% of the areal extent of WSMR. Todson's and Mescalero pennyroyals, the only species listed as endangered by USFWS that occur at WSMR, are among the species that may occur in these three vegetation types.

Todson's pennyroyal can be found on north and east facing slopes in gravelly gypseous limestone soil in pinyon pine vegetation. On WSMR, the species has a restricted habitat of about 518 hectares (1,280 acres) in the upper reaches of the Rhodes Canyon area of the San Andreas Mountains.

WILDLIFE. WSMR provides habitat for a number of state and federally listed threatened and endangered wildlife species protected under the Endangered Species Act (federal) and the Wildlife Conservation Act (state). There are 44 sensitive wildlife species that may occur or potentially may occur on WSMR, as shown in Table 3-5. Of these 26 species that are known to occur on WSMR, five are federal and fourteen are state listed threatened and endangered species.

American bald eagle, the interior least tern, Aplomado falcons, Mexican spotted owls, the Western snowy plover are the federally listed endangered species that were occasionally sighted at or near WSMR. The state-listed endangered species sighted at WSMR include the common black-hawk, the varied bunting, Bell's vireo, the gray vireo, desert bighorn sheep, and the White Sands pupfish.

The protection of White Sands pupfish is of particular concern to federal (U.S. Department of the Interior) and New Mexico state (Department of Game and Fish) agencies. This species is listed as a federal Category 2 candidate and a state endangered (group 2) species. The species is found in shallow, calm, highly mineralized water charged by alkali salt springs and sand and/or gravel bottoms. This species is endemic to the Tularosa Basin of New Mexico and is known only to occur in Malpais Spring, Mound Spring, Salt Creek (all on WSMR) and Malone Draw/Lost River.

Table 3-4
SENSITIVE PLANT SPECIES KNOWN or EXPECTED to OCCUR at WSMR

Name	Status[a]	R-E-D[b]	WSMR[c]	Substrate	Vegetation Type[d]
Sacramento Prickly Poppy *Argemone pleiacantha ssp. pinnatisecta*	FE/L1	2-2-3	no		CWPP,CWMS,SPMG
Sneed's Pincushion Cactus *Coryphantha sneedii var. sneedii*	FE/L1	2-2-2	no	limestone	CWMS, CDSC
Kuenzler's Hedgehog Cactus *Echinocereus fendleri var. kuenzleri*	FE/L1	2-3-3	no	limestone	SPMG, DGPMS
Lloyd's Hedgehog Cactus *Echinocereus lloydii X*	FE/L1	NA	no	limestone	DGPMS, CDSC
Todson's Pennyroyal *Hedeoma todsenii*	FE/L1	2-2-3	yes	limestone with gypsum	CWPP, CWMS, SPMG
Sacramento Mountain Thistle *Cirsium vinaceum*	FT/L1	2-3-3	no	limestone	MCF, CWPP
Night Blooming Cereus *Cereus greggii*	C2/L1	1-3-1	yes		DGPMS, CDSC
Duncan's Pincushion Cactus *Coryphantha duncanii*	C2/L1	2-2-2	no	limestone	DGPMS, CDSC
Organ Mountain Evening Primrose *Oenothera organensis*	C2/L1	2-2-3	yes	wetlands	CWPP, CWMS
Sand Prickly Pear *Opuntia arenaria*	C2/L1	2-2-2	no	sand	DGPMS
Grama Grass Cactus *Pediocactus papyracantha*	C2/L1	1-2-2	yes		CWPP, CWMS, SPMG, DGPMS

Table 3.4 (Continued)
SENSITIVE PLANT SPECIES KNOWN or EXPECTED to OCCUR at WSMR

Name	Status[a]	R-E-D[b]	WSMR[c]	Substrate	Vegetation Type[d]
Alamo Penstemon *Penstemon alamosensis*	C2/L1	2-2-3	yes	limestone	CWPP, CWMS, SPMG
Nodding Cliff Daisy *Perityle cernua*	C2/L1	3-2-3	no	"cliffs, igneous rock"	CWPP, CWMS, SPMG
Mescalero Milkwort *Polygala rimulicola* var. *mescalerorum*	C2/L1	3-2-3	yes	limestone cliffs	CWPP, CWMS, SPMG
Smooth Figwort *Scrophularia laevis*	C2/L2	2-1-2	no	"moist soil, shade"	MCF, CWPP, CWMS, SPMG
Cliff Brittlebush *Apacheria chiricahuensis*	C3c/L1	1-1-2	yes	cliffs	MCF, CWPP
Castetter's Milkvetch *Astragalus castetteri*	C3c/L2	1-1-3	yes	limestone	CWPP, CWMS, SPMG
Dune Unicorn Plant *Proboscidea sabulosa*	C3c/L2	1-1-2	no	"deep sands, dunes"	DGPMS, CDSM
Plank's Catchfly *Silene plankii*	C3c/L2	1-1-2	yes	granitic	CWPP, CWMS, SPMG
Guadalupe Mescal Bean *Sophora gypsophyla* var. *guadalupensis*	C3c/L2	2-1-2	no	limestone	CWMS, SPMG
Orcutt's Pincushion Cactus *Coryphantha orcuttii*	None/L1	2-2-2	no		CWMS, DGPMS, CDSC
Scheer's Pincushion Cactus *Coryphantha scheeri* var. *valida*	None/L1	2-2-1	yes	alluvial soils	DGPMS,CDSC
Standley's Whitlowgrass *Draba standleyi*	None/L2	2-1-2	no		MCF, CWPP, CWMS, SPMG
Button Cactus *Epithelantha micromeris* var. *micromeris*	None/L1	1-2-1	yes	limestone	CWMS, SPMG, DGPMS, CDSC

(table continues)

Table 3.4 (Continued)
SENSITIVE PLANT SPECIES KNOWN or EXPECTED to OCCUR at WSMR

Name	Status[a]	R-E-D[b]	WSMR[c]	Substrate	Vegetation Type[d]
Sandberg's Pincushion Cactus *Escobaria sandbergii*	None/L1	2-2-3	yes		CWPP, CWMS, SPMG
Tall Prairie Gentian *Eustoma exaltatum*	None/L1	1-2-1	yes	riparian and wetlands	SPMG, DGPMS, CDSC, CDSM, CBSS&T CBSR&W, CBSBL, CBSDL
Wright's Fishook Cactus *Mammillaria wrightii* var. *wrightii*	None/L1	1-2-2	yes		CWPP, CWMS, SPMG, DGPMS
Pineapple Cactus *Neolloydia intertexta* var. *dasyacantha*	None/L1	1-2-1	yes	limestone	DGPMS, CDSC
Mosquito Plant *Agastache cana*	None/L2	1-1-2	yes	"moist, wetlands"	CWMS, SPMG
Organ Mountain Pincushion Cactus *Coryphantha organensis*	None/L1	1-2-3	yes		CWPP, CWMS
Mescalero Pennyroyal *Hedeoma pulcherrimum*	None/L2	1-1-3	yes		MCF, CWPP, CWMS
Payson's Hiddenflower *Cryptantha paysonii*	None/L2	1-1-2	yes	limestone	SPMG
Vassey's Bitterweed *Hymenoxys vaseyi*	None/L2	3-1-3	yes		CWPP, CWMS, SPMG
San Andres Rock Daisy *Perityle staurophylla* var. *homoflora*	None/L2	1-1-3	yes	limestone cliffs	CWPP, CWMS, SPMG
Desert Parsley *Pseudocymopterus longiradiatus*	None/L2	1-1-2	yes	limestone	CWPP, CWMS, SPMG
Supreme Sage *Salvia summa*	None/L2	1-1-2	yes	limestone cliffs	CWPP, CWMS, SPMG
Smooth Cucumber *Sicyos glaber*	None/L2	1-1-2	no		CWPP, CWMS, SPMG
Long-stemmed Flame Flower *Talinum longipes*	None/L2	1-1-3	yes	limestone	DGPMS, CDSC

(table continues)

Table 3.4 (Continued)
SENSITIVE PLANT SPECIES KNOWN or EXPECTED to OCCUR at WSMR

Sources: WSMR Environmental Services Division (1993b); U.S. Department of the Interior (1979); COE (1987)

[a]Federal Status

FE	Listed by the U.S. Fish and Wildlife Service (USFWS) as endangered.
FT	Listed by the USFWS as threatened.
C2	Category 2 candidate species for listing by the USFWS as threatened or endangered.
C3,	Previously considered for listing by the USFWS but now considered to be widespread or not threatened.
None	Not currently of concern to the USFWS.

New Mexico Status

L1	Listed by the New Mexico Forestry Resource Conservation Division (NMFRCD) as endangered (List 1).
L2	Listed by the NMFRCD as rare or sensitive (List 2).

[b]Rarity, Endangerment, and Distribution Code (R-E-D)

Rarity

1	Rare, but found in sufficient numbers and distributed widely enough that the potential for extinction is low for the foreseeable future.
2	Occurrence confined to several populations or to one extended population.
3	Occurrence limited to one or a few highly restricted populations, or present in such small numbers that it is seldom reported.

Endangerment

1	Not endangered.
2	Endangered in a portion of its range.
3	Endangered throughout its range.

(table continues)

Table 3.4 (Concluded)
SENSITIVE PLANT SPECIES KNOWN or EXPECTED to OCCUR at WSMR

DISTRIBUTION

1	More or less widespread outside New Mexico.
2	Rare outside New Mexico.
3	Endemic to New Mexico.

[c]Occurrence on WSMR

Yes	Presently known to occur or to have occurred on WSMR.
No	No known record of occurring or having occurred on WSMR.

[d]Vegetation Types With Which the Species May Be Associated

MCF	Montane coniferous forest
CWPP	Coniferous woodland (pinyon pine)
CWMS	Coniferous forest and montane scrub
SPMG	Savanna and plains-mesa grassland
DGPMS	Desert grassland and plains-mesa sandscrub
CDSC	Chihuahuan desert scrub (creosote)
CDSM	Chihuahuan desert scrub (mesquite)
CDSL	Chihuahuan desert scrub (lava)
CBSST	Closed-basin scrub (saltbush and tarbush)
CBSRW	Closed-basin scrub (riparian and wetland)
CBSBL	Closed-basin scrub (barren land)
CBSDL	Closed-basin scrub (dune land)

Table 3-5
SENSITIVE WILDLIFE SPECIES that OCCUR or MAY OCCUR at WSMR

Scientific Name	Common Name	USFWS Status[a]	NM Status[b]
Sterna antillarum athalassos	interior least term	FE	E1
Falco femoralis septentrionalis	northern Aplomado falcon	FE	E1
Falco peregrinus anatum	American peregrine falcon	FE	E1
Grus americana	whooping crane	FE	E2
Haliaeetus leucocephalus	bald eagle	FE	E2
Canis lupus baileyi	Mexican gray wolf	FE	E2
Falco peregrinus tundrius	artic peregrine falcon	FT	E1
Charadrius melodus circumcinctusp	Piping plover	FT	E1
Strix occidentalis lucida	Mexican spotted owl	FT	S
Empidomax traillii extimus	southwestern willow flycatcher	FPE	E2
Charadrius alexandrinus nivosus	western snowy plover	FPT	S
Zapus hudsonius luteus	New Mexico meadow jumping mouse	C1	E2
Cyprinodon tularosa	White Sands pupfish	C2	E2
Ammodranus bairdii	Baird's sparrow	C2	E2
Tarrias quadrivittatus australis	Organ Mountain Colorado chipmunk	C2	E2
Euderma maculatum	spotted bat	C2	E2
Cicindela nevadica olmosa	Los Olmos tiger beetle	C2	none
Dereonectes neomericana	Bonita diving beetle	C2	none
Lytta mirifica	Anthony blister beetle	C2	none
Phrynosoma cornutum	Texas horned lizard	C2	S
Accipiter gentilis	northern goshawk	C2	S
Buteo regalis	ferruginous hawk	C2	S
Charadrius montanus	mountain plover	C2	S
Lanius ludovicianus	loggerhead shrike	C2	S
Plegadis chihi	white-faced ibis	C2	S
Neotoma micropus leucophaeus	white Sands woodrat	C2	S
Sigmodon fulviventer goldmani	Hot Springs cotton rat	C2	S
Cynomys ludovicianus arizonensis	Arizona black-tailed prairie dog	C2	S
Eumops perotis californicus	greater western mastiff bat	C2	S
Myotis velifer brevis	southwestern cave myotis (bat)	C2	S
Myotis lucifugus	little brown myotis (bat)	C2	S
Ovis canadensis mexicana	desert bighorn sheep	none	E1
Ammodramus savannarum ammolegus	Arizona grasshopper sparrow	none	E2
Buteogallus anthracinus	common black-hawk	none	E2
Passerina versicolor	varied bunting	none	E2
Phalacrocorax brasiliensis	neotropic cormorant	none	E2

(table continues)

Table 3-5 (Concluded)
SENSITIVE WILDLIFE SPECIES that OCCUR or MAY OCCUR at WSMR

Scientific Name	Common Name	USFWS Status[a]	NM Status[b]
Vireo bellii	Bell's vireo	none	E2
Vireo vicinior	Gray vireo	none	E2
Ashmunella harrisi	land snail, no common name	none	S
Ashmunella kochi caballoensis	land snail, no common name	none	S
Ashmunella kochi kochi	land snail, no common name	none	S
Ashmunella kochi sanandresensis	land snail, no common name	none	S
Ashmunella salinasensis	land snail, no common name	none	S
Oreohelix socorroensis	Oscura Montain land snail	none	S

[a]Federal Status

FE	Listed by the U.S. Fish and Wildlife Service (USFWS) as endangered.
FT	Listed by the USFWS as threatened.
FPE	Proposed by USFWS for listing as endangered.
FPT	Proposed by USFWS for listing as threatened.
C1	Category 1 candidate species for listing by the USFWS as threatened or endangered.
C2	Category 2 candidate species for listing by the USFWS as threatened or endangered.
C3c	Previous considered for listing by the USFWS but now considered to be to widespread or not threatened.
None	Not currently of concern to the USFWS.

[b]New Mexico Status

E1	Listed by the New Mexico Department of Game and Fish (NMDGF) as endangered (group 1).
E2	Listed by the NMDGF as endangered (group 2).
S	Sensitive species; New Mexico species which have been singled out for special consideration, typically as being formally listed as threatened, endangered, or will be in the future.

In order to protect the habitat diversity at existing pupfish locations and assure long-term survival of the population the co-users of WSMR and interested government agencies signed on July 21, 1994 the *White Sands Pupfish Cooperative Agreement*. The signing principals to this agreement are U.S. Army -White Sands Missile Range, U.S. Air Force - Holloman Air Force Base, National Park service - White Sands National Monument, U.S. Fish and Wildlife Service, and New Mexico Department of Game and Fish. The full text of the Cooperative Agreement and White Sands Pupfish Conservation Plan is reproduced in the Appendix C of this report.

3.2.3.2.6 Wetlands

The USFWS National Wetland Inventory has mapped wetlands on WSMR lands, as shown in Table 3-6. The inventory maps show extensive pockets of wetlands south of Route 6 and at the lower end of several canyons. Lake Lucero and Malpais Springs are some of other large areas of wetlands mapped. There are isolated springs and sinkholes and small wetland areas throughout the Tularosa Basin and Jornada del Muerto. Springs also occur in the San Andres and Oscura mountains.

Of the 67,706 hectares (167,300 acres) of WSMR searched in the Geographic Information System (GIS) data base only approximately 3,816 hectares (9,430 acres) or 0.4% of the land surface was made of wetlands. The wetlands present are dispersed through the range. The majority of these wetlands were mapped as lacustrine wetlands, i.e., wetlands that are generally associated with ponds and lakes. Of the lacustrine wetlands, approximately 3,360 hectares (8,300 acres), were mapped as being open waters, which means that they do not support vegetation. The remaining 227 hectares (560 acres) of lacustrine wetlands were mapped as littoral flats that lie along the shoreline of playa lakes.

Palustrine wetlands are non-tidal wetland that are not in stream, pond,or lake beds. Of the palustrine wetlands found at WSMR, 150 hectares (370 acres) are palustrine scrub shrub. Approximately 69 hectares (170) acres) are palustrine flats, and 12 hectares (30 acres) are palustrine open water wetlands. Scrub shrub wetlands are dominated by woody vegetation less than 6 meter (20 feet) tall. Flats may not be vegetated or may be vegetated for only part of the year. Open water areas do not support rooted vegetation.

There are five different habitats associated with wetlands on WSMR.

Riparian/arroyo areas with seeps and springs that flow east to the Tularosa Basin or west to the Jornada del Muerta. Cottonwood and willows communities occur where water is permanent or predictably periodic.

Saline permanent water wetlands include springs (Maispais and Mound) and Salt Creek and Malone/Lost River. The wetlands associated with Malpais Spring form a relatively large salt marsh on the western edge of the lava flow. Dense stands of rushes, bulrushes, sedges, and cattails are typical of inundated marsh areas.

Playa wetlands are periodically flooded basins that often have water standing

Table 3-6

LOCATION of WETLANDS at WSMR

Map Name	Aerial Photograph Date	Scale
Lake Lucero, New Mexico	2/75	1:24,000
Lake Lucero N. E., New Mexico	2/71	1:24,000
Tres Hermanos, New Mexico	3/76	1:62,500
Holloman, New Mexico	3/76	1:62,500
Bear Peak, New Mexico	2/71	1:62,500
Lake Lucero, S.W., New Mexico	2/71	1:24,000
Lake Lucero, S.E., New Mexico	2/71	1:24,000
White Sands N.E., New Mexico	3/9/76	1:24,000
Carthage, New Mexico	6/75	1:62,500
Bingham, New Mexico	6/75	1:62,500
Granjean Well, New Mexico	2/71	1:62,500
Mockingbird Gap, New Mexico	2/71	1:62,500
Chihuahua Ranch, New Mexico	2/71	1:62,500
Salinas Peak, New Mexico	2/71	1:62,500
Capitol Peak, New Mexico	2/71	1:62,500
Three Rivers, New Mexico	2/71	1:62,500
Lumley Lake, New Mexico	2/71	1:62,500
Tularosa, New Mexico	2/71	1:62,500
Kaylor Mountain, New Mexico	2/71	1:62,500

Note: These Maps are U.S. Department of the Interior, Fish and Wildlife Service, and National Wetlands Inventory maps.

in them that prevent the establishment of perrenials in their center. The larger of playas may form marshlake ponds that rarely are completely dry.

Alkali flat wetlands occupy the lowest portion of the Tularosa Basin. The saline ground water aquifer lies extremely close to the surface, and rains produce huge shallow "lakes" that disappear through evaporation, rather than percolation. Vegetation, if present consists of iodine bush, saltbush, saltgrass, sacaton grasses, and seepweeds. Thermal water consists of one artesian well (Garton Well). It is the only known thermal water source at WSMR and provides a unique wetland and open water habitat.

3.2.3.2.7 Floodplains

While flash floods after rains are possible in WSMR, as everywhere in southwestern deserts, due to scarce precipitation and the desert character of the range there are no floodplains in a conventional sense at WSMR. According to Chapter 3.2.2 Climate, Precipitation, and Surface Water Resources of Reference 144 floods at WSMR have occurred infrequently, for which the greatest concern involved the Main Post area.

3.2.3.2.8 Hazardous Waste Management

The responsibility for hazardous waste contamination compliance (under CERCLA and RCRA) rests with the range operator, the U.S. Army. Toxic waste generated by the NASA SRP is handled by the Navy. The hazardous waste management issues at WSMR are addressed in great detail in Chapter 3.14.2 Hazardous Waste Management pages 3-227 through 3-234 of Reference 144. Referenced text addresses hazardous waste tracking system, hazardous waste minimization program, treatment and disposal facilities, and RCRA corrective action sites.

3.2.3.2.9 Cultural Resources

The WSMR contains a large number of prehistoric and historic archaeological sites. The total number of documented sites for WSMR and WSMR extension areas is approximately 3000, which is approximately 13 sites per square mile.

Detailed description of cultural resources at WSMR in given in Chapter 3.6 *Cultural Resources* pages 3-118 through 3-143 of Reference 144. This chapter describes past and current archaeological programs carried out at WSMR, including recent archaeological surveys and mitigation programs, consultations held with Native Americans, consultation of National and State Registers, and estimated area and density of archaeological sites. Cultural-temporal sequences on WSMR lands are also described in this chapter, including PaleoIndian, archaic, formative, protohistoric, euramerican, and government/military sequences.

3.2.3.2.10 Economics and Employment

The economy of the six counties containing the WSMR is diverse and includes agriculture, manufacturing, retail trade, finance and real estate, and services. Retail trade, construction, and manufacturing dominate the work force employment of the region. Economics and employment issues at WSMR are addressed in great detail in Section 3.5 *Socioeconomics* pages 3-114 through 3-118 of Reference 144. This section describes trends in employment, income, housing, and public services.

3.2.3.2.11 Population

The combined population of the six-county area encompassing the WSMR was 815,900 in 1990. This shows an increase of 162,900 or 25 percent from the previous 1980 census period. Population of the area is addressed in Chapter 3.5.1 Population page 3-114 of Reference 144. This Chapter describes population trends, demographics, and a table of historic population trends for the states of New Mexico and Texas, as well as for individual counties of Dona Ana, El Paso, Lincoln, Otero, Sierra, and Socorro for the 1980 through 1990 period.

4.0 ENVIRONMENTAL CONSEQUENCES

This chapter addresses programmatic and site-specific consequences of the Proposed Action (continuation of the NASA SRP), as well as the consequences of the No Action Alternative (termination of the NASA SRP). The consequences of the Proposed Action and its No Action Alternative are assessed in terms of environmental impacts. Additionally, the relationship between the short-term uses and long-term maintenance and enhancement of the environment, irreversible and irretrievable commitments of resources to the NASA SRP, and effects on minority and low-income communities are discussed. Mitigation measures are also presented and discussed, where appropriate.

The NASA SRP programmatic impacts (Section 4.1) are those due to launch vehicle flights on the upper and lower atmosphere, including impacts due to noise and landing and recovery operations. The effect of rocket exhaust emissions on air quality, payload chemical releases, and attitude control fluid emissions are assessed. Specific reference is made to stratospheric ozone, global warming, and radioactive sources.

The NASA SRP site-specific impacts (Section 4.2) deal with three permanent domestic launch sites (WFF, WSMR, and PFRR). For each site, the impact of the program as a whole, including launch and landing operations, is described as it affects air quality, land management, reentry safety, waste disposal, wetlands, floodplains, coastal areas, aquatic and terrestrial ecology, cultural resources, and regional socioeconomics.

The consequences of the NASA SRP termination (Section 4.3) are examined in terms of environmental, scientific, and economical impacts, including site-specific considerations.

The relationship between the short-term uses and long-term maintenance and enhancement of the environment (Section 4.4) is examined in terms of the critical role the NASA SRP plays in the area of scientific space research versus the minor and transient environmental impacts of the launch and recovery operations.

The commitment and use of natural resources by the NASA SRP (Section 4.5) is examined and evaluated by methods used in industry to examine utilization of resources.

The issue of environmental justice in minority and low-income populations is addressed in Section 4.6.

4.1 PROGRAMMATIC CONSEQUENCES OF PROPOSED ACTION

The NASA SRP consists principally of a series of rocket-powered parabolic suborbital launch vehicle flights, totaling approximately 30 to 40 per year. Each launch vehicle consists of one to four ground-launched solid-propellant rocket motors staged in series. The launch vehicle propels a scientific payload to the upper atmosphere, after which the payload and spent rockets fall back to Earth along a parabolic trajectory. Fifteen different launch vehicles are in current use, employing a dozen individual rockets in various configurations. Usually, two small 70-millimeter test rockets are launched into low-altitude trajectories, one after the other, before each flight, as targets for checkout and calibration of the ground radar which will track the flight (at WSMR other means for instrument calibration are used [147]). Also part of the NASA program are flights of two additional, meteorological, launch vehicles, which have payloads recording data on weather and atmospheric ozone. Thus, the complete NASA SRP deals with 18 discrete launch vehicles, which are characterized individually in Section 2.2.

Each main SRP flight typically entails the following programmatic components:

1. preflight activities including receiving, storing, and inspecting rockets, and assembling the scientific payload;

2. assembling rockets and scientific payload to make up the launch vehicle, transporting the launch vehicle to the launch pad, mounting the vehicle to the launcher, and pointing the launcher;

3. series launching of two small test rockets nearby for radar and telemetry checkout/calibration;

4. the actual launching and surface-to-surface flight, lasting a matter of minutes;

5. immediate post-flight activities, including, in some cases, the recovery of the payload and spent rockets, and storing of the launch equipment; and

6. closure activities such as restoring temporary launch sites to their original condition.

A flow chart detailing events 1 through 6 above appears as Figure 4-1. This figure consists of two sheets, the first illustrating the preflight actions 1 through 3, and the second, the flight and post-flight actions 4 through 6. A three-stage launch vehicle was assumed. Sheet 1 of Figure 4-1 starts with actions leading to the mounting of the launch vehicle on the launcher and the pointing of the launcher in readiness for the launch. The environmental risks during this phase are (1) premature reactions or burning of the rocket propellants, (2) premature escape of any chemicals (intended for later release during the flight) stored in the payload, and (3) mechanical accidents inherent in moving and assembling large masses which might cause structural failure (breakage) of slender objects.

The last action on Sheet 1 is the launching of the twin test rockets, one after the other, for radar/telemetry checkout, about one-half hour before the main launch. The population most at risk from items (1), (2), (3), and the test rocket launch is the crews who perform the various actions on Sheet 1.

Sheet 2 of Figure 4-1 shows the major components of a typical flight, followed by recovery operations and closure actions (if required). For the assumed three-stage rocket propulsion system on Sheet 2, three burns are followed by three separations, so that the flight article shrinks to the recovered payload, which itself may be the source of chemical releases. All the boxes with cross-hatched borders emit gaseous and condensed substances into the atmosphere. The launch, flight, and surface impact (ground or water) of all rockets creates noise. The surface (ground or water) impact of spent rockets affects the surface, plants, and animals.

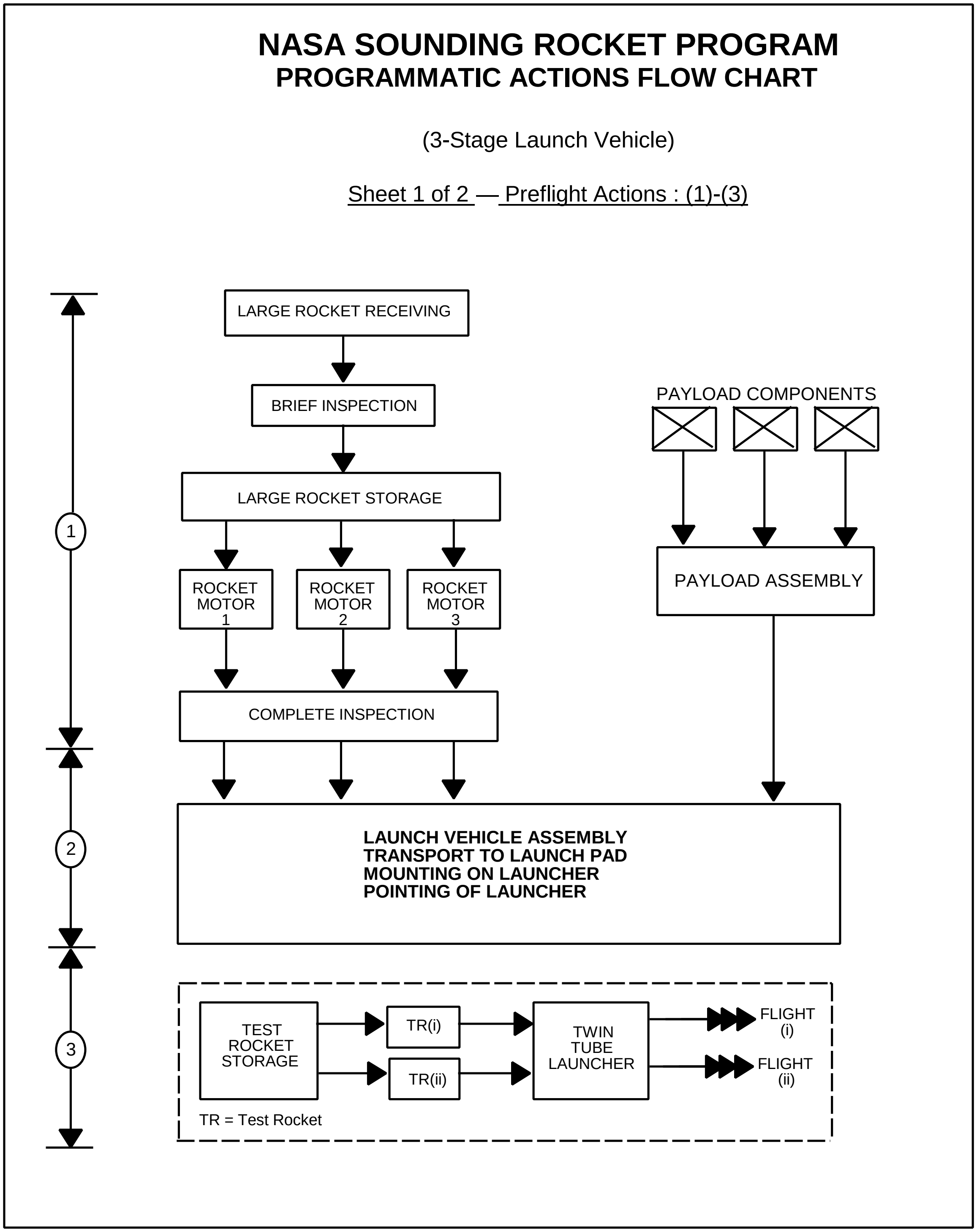


Figure 4-1. NASA SRP Programmatic Actions Flow Chart

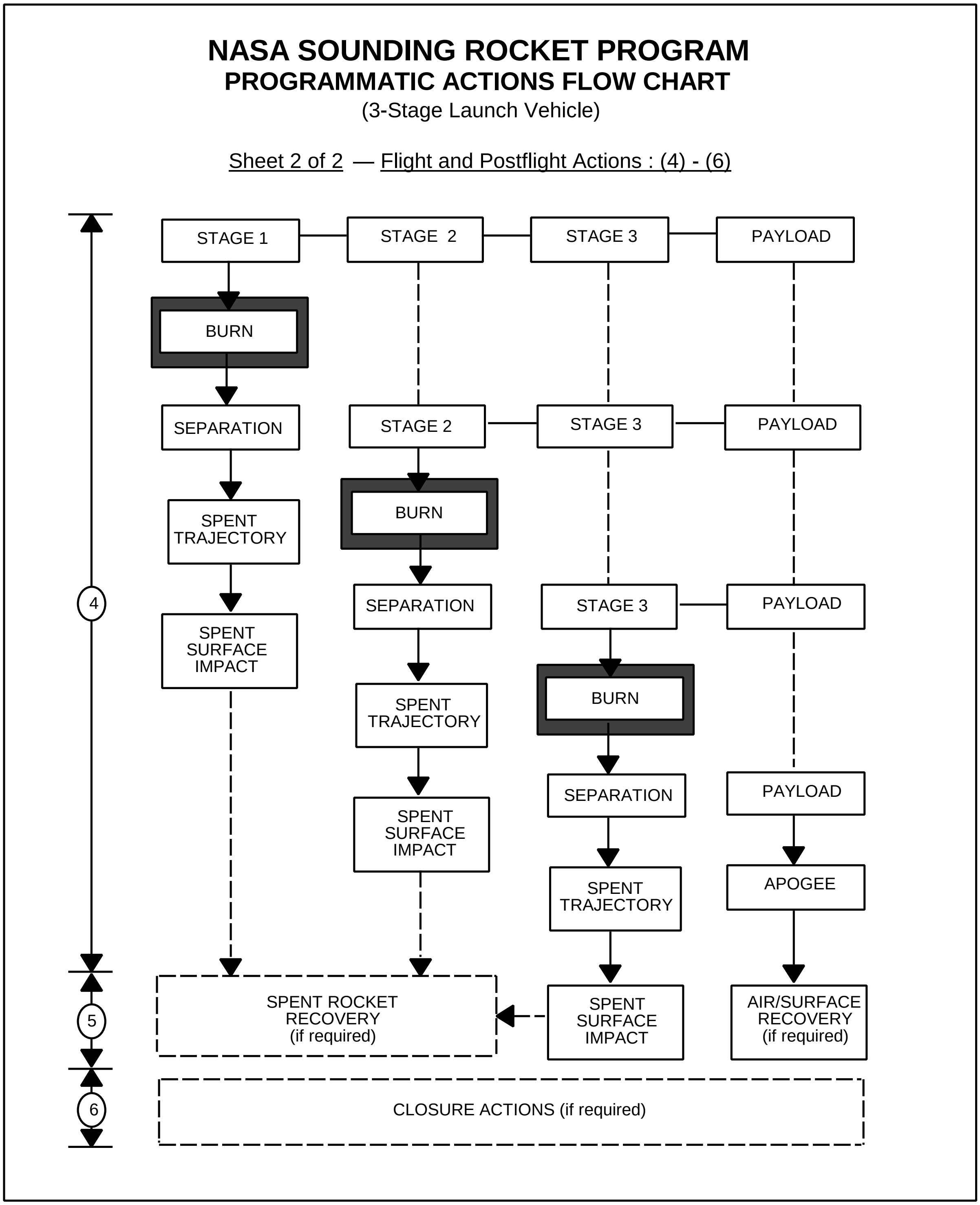


Figure 4-1. NASA SRP Programmatic Actions Flow Chart (Concluded)

Subsection 4.1.1 deals with atmospheric impacts , primarily the result of rocket exhaust emissions and payload releases of chemicals.

Subsection 4.1.2 deals with impacts of payload and radioactive sources.

Subsection 4.1.3 deals with noise impacts due to launch, flight, and landing of the rockets and payloads.

Subsection 4.1.4 deals with recovery/landing impacts from all flying objects, as well as dispersion (deviation of the actual landing point of the last stage rocket from the calculated point) and the mitigation of dispersion.

4.1.1 ATMOSPHERIC IMPACTS

This section deals with the impact on the Earth's atmosphere of gases, liquids, and solids emitted from rockets and payloads of the various NASA SRP launch vehicles during flight.

The Earth's atmosphere has been described in Section 3.1. For the present discussion, the following definitions and typical altitude ranges will be used.

1. Upper Atmosphere:

   a. Ionosphere - above 80 kilometers (50 miles), to beyond 1,000 kilometers (622 miles);
   b. Mesosphere - 50 to 80 kilometers (31 to 50 miles); and
   c. Stratosphere - 10 to 50 kilometers (6.2 to 31 miles)

2. Lower Atmosphere:

   a. Free Troposphere - 2 to 10 kilometers (1.25 to 6.2 miles); and
   b. Atmospheric Boundary Layer - 0 to 2 kilometers (0 to 1.25 miles).

The susceptibility of each atmospheric shell to change is based on naturally present matter, and the relative influence and proximity of the Earth and Sun. Emissions into the atmosphere include: halogens (chlorine), particulates (aluminum oxide), carbon monoxide, carbon dioxide, oxides of nitrogen, and trace metals.

The atmospheric impacts due to these substances could include:

1. Photochemical oxidation (smog);
2. Cloud nucleation due to particulates;
3. Acid rain due to chlorides, sulfides, etc.;
4. Ozone depletion;
5. Increase in ultraviolet radiation reaching the Earth;
6. Greenhouse effect (global warming); and
7. Formation of holes in ion/electron layers.

The programmatic trajectories and emissions detailed in Section 2.1 permit assessments to be made as to which of these impacts are likely. The known altitude ranges, emission times, types and amounts of chemical compounds all influence such assessments.

The totality of possible emissions (operational or accidental) from payloads includes:

1. Exhaust products from any pyrotechnic devices

2. Constituents of lithium-sulfur dioxide cell batteries, and
3. Chemical releases.

The first two items are strictly monitored by Range Safety Requirements contained in the Range Safety Handbook issued by NASA/GSFC [77]. The impact of chemicals under items 1 and 2 is several orders of magnitude smaller than that of item 3 and will not be addressed here.

4.1.1.1 Upper Atmosphere

Per the definition in Subsection 4.1.1, the upper atmosphere begins at 10 kilometers and extends to the upper reaches of the ionosphere. With three- and four-stage launch vehicles, such as the Taurus-Nike-Tomahawk and Black Brant X, XI, and XII, apogees up to the 1,500-kilometer level have been reached and will continue to be of interest. The highest altitudes for SRP emissions are in the hundreds of kilometers when chemical releases from payloads take place. At lower levels, there are emissions from the exhausts of SRP upper stage rockets and ACS fluid jets. The emissions and impacts of payload chemical releases, rocket exhausts, and ACS fluids are treated in the next three subsections.

4.1.1.1.1 SRP Payload Chemical Releases

Table 4-1 is a detailed listing of SRP payload chemical releases into the upper atmosphere during the last 10 years (FY86 through FY95) [115]. During 2 years (FY91 and FY 93), there were no releases. In the other 8 years, there were 31 flights with the mass of release varying from 5.0 to 272.2 kilograms per flight, and averaging 43.4 kilograms per flight. The 10-year total mass of released chemicals was 1,344.6 kilograms, for an annual average of 134.4 kilograms. Within a 15-month period, three releases of ammonium nitrate/fuel oil (ANFO) explosion amounted to 612 kilograms or 45.5 percent of the 10-year total. Mostly, "spot" releases were carried out at fixed altitudes in the 180- to 350-kilometer range. Otherwise, releases were in the form of "trails" over an altitude range, either on an "upleg" (e.g., 50 to 150 kilometers) or a "downleg" (e.g., 200 to 80 kilometers) of the flight. Of all releases, only 5 were trails.

The chemical symbols and abbreviations in Table 4-1 are explained in Table 4-2. The function of ANFO explosions is to generate water vapor. Thermite (titanium diboride, the reaction product of boron and titanium) and copper oxide (CuO) both are used to vaporize metals in contact with them. Only the water vapor and metal vapors from these reactions are deemed to impact the upper atmosphere.

The active substances released are grouped here by their interaction with the upper atmosphere.

1. Gases and vapors: Carbon dioxide, nickel carbonyl, sulfur hexafluoride, water vapor (generated by ANFO) -- absorb electrons.

2. Metal vapors: barium, lithium, neodymium, samarium, strontium -- these photoionize due to the ultraviolet in sunlight (forming luminous artificial clouds) and interact with electric and magnetic fields, their resonance lines being

Table 4-1
SRP PAYLOAD CHEMICAL RELEASES (FY86-FY95)

Date	Launch Site[1]	Launch Vehicle[2]	Chemicals Released[3]	Total kg[4]	Altitude (km)[5]
11-20-85	WI	38	Ba / Ti / B-Li / B-Ba / CuO	12.0	300 / 500
04-27-86	WI	38	SF_6	40.8	350
03-21-87	GRN	34	TMA	9.1	50-150
03-21-87	GRN	18	Nd-Thermite / TMA	5.0	250
03-21-87	GRN	27	1 Sa - 6 Ba / Thermite	35.0	250
08-07-87	WI	27	ANFO	136.1	350
01-29-88	WI	27	ANFO	204.1	350
09-10-88	WI	36	ANFO	272.2	350
04-02-89	WI	29	CO2	18.1	250 / 300
10-22-89	WI	27	CF_3Br / $Ni(CO)_4$	79.4	300-350
08-10-90	KWAJ	38	SF_6	34.0	350
08-14-90	KWAJ	38	SF_6	34.0	350
08-21-90	KWAJ	36	SF6 / Ba-Thermite	42.5	350
FY 91	NONE				
12-06-91	WI	38	CO_2	18.1	300
03-03-92	FB	18	TMA	9.1	200-80
03-03-92	FB	18	TMA	9.1	200-80
03-06-92	FB	18	TMA	9.1	200-80
05-25-92	PR	18	Ba-Thermite	25.0	250
05-30-92	PR	36	CF3Br	29.5	250
06-06-92	PR	36	Ba-Sr-Ti-B / Ba-Li-Ti-B	7.8	250
07-02-92	PR	36	Ba-Thermite	50.0	250
07-02-92	PR	36	Ba-Thermite	80.0	300
07-04-92	PR	36	Ba-Thermite	50.0	250
FY 93	NONE				

Table 4-1 (Concluded)
SRP PAYLOAD CHEMICAL RELEASES (FY86-FY95)

Date	Launch Site[1]	Launch Vehicle[2]	Chemicals Released[3]	Total kg[4]	Altitude (km)[5]
02-12-94	FB	18	TMA	9.8	100 up
			TMA	9.8	170 dn
02-12-94	FB	18	TMA	9.8	100 up
			TMA	9.8	170 dn
09-23-94	BR	18	TMA	9.8	180 dn
09-23-94	BR	18	Ba	8.4	250 up
			TMA	9.8	180 dn
09-24-94	BR	18	TMA	9.8	180 dn
09-24-94	BR	18	Ba	8.4	250 up
			TMA	9.8	180 dn
02-02-95	FB	18	TMA	9.8	76 up
			TMA	9.8	181 dn
03-26-95	FB	35	Ba 4.4 Ca 15.4	19.8	586
			TEN YEAR TOTAL	1344.6	---

1 BR=Alcantara, Brazil; FB=Fairbanks, AK; GRN=Sondre Stromfjord, Greenland; KWAJ=Kwajalein, Marshall Islands; PR= Camp Tortuguero, Puerto Rico; WI=Wallops Island, VA.

2 18=Nike-Tomahawk, 27=Nike-Black BrantVB, 29=Terrier-Malemute, 34=Taurus-Tomahawk, 35=Black BrantX, 36=Black BrantIX, 38=Taurus-Nike-Tomahawk.

3 For glossary of chemicals, see Table 4-2. Ca = Calcium

4 kg = kilogram(s).
5 km = kilometer(s).

Table 4-2

GLOSSARY OR CHEMICALS RELEASED BY SRP PAYLOADS

Abbreviation	*Definition*
ANFO	Ammonium Nitrate / Fuel Oil Explosion
B	Boron*
BA	Barium*
CF_3Br	Bromo-trifluoro-methane (fluid)
CO_2	Carbon Dioxide
CuO	Copper Oxide
Li	Lithium*
Nd	Neodymium*
$Ni(CO)_4$	Nickel Carbony[1]
Sa	Samarium*
SF_6	Sulfur Hexafloride (gas)
Sr	Strontium*
Thermite	Reaction product of B and Ti in the form of TiB_2 , used to vaporize a metal such as in Ba-Thermite, Nd-Thermite, Sa-Thermite, etc.
Ti	Titanium*
TiB_2	Titanium Diboride
TMA	Designation for mixture of 80% Trimethyl Aluminum (TMA) and 20% Triethyl Aluminum (TEA).

* Metallic element

detectable by ground-based observers.

3. Liquids: trimethyl aluminum (TMA) and bromo-trifluoro-methane (CF_3Br) -- create plasma depletions or enhancements to initiate instabilities, typically for equatorial ionospheric studies. Moreover, TMA reacts with moisture in the atmosphere to forrn an aluminum oxide smoke for measuring wind velocity and air density.

The identified environmental impacts due to chemical releases fall into two groupings: visible light emissions at high altitudes, and introduction of matter into the environment.

1. Visible Light Emissions:

    a. Sightings of chemical release optical emissions by the general population; and

    b. Light contamination of astronomical observations.

2. Introduction of Matter into the Environment:

    a. Release of trace amounts of hazardous materials into the biosphere;

    b. Possible triggering of magnetospheric (above 1,000 kilometers) storms which may produce weather variations;

    c. Temporary perturbations of the ionosphere (up to 1,000 kilometers), in turn causing temporary perturbations of communication links;

    d. Modification of trace element concentrations in the upper atmosphere; and

    e. Contamination of nearby spacecraft by released materials.

Analyses of these kinds of potential impacts will be performed for each individual campaign and mitigated accordingly. Examples are References 52, 80, 81, 116-120.

4.1.1.1.2 SRP Rocket Exhaust Emissions

Typical average annual upper stage rocket exhaust emissions during the last 10 years from the 15 launch vehicles in Subsection 2.2.1 are listed in Table 4-3. It was assumed that the emissions were uniform over the altitude range in which each rocket stage was burning. Direct proportionality was used to find the fraction of propellant emitted above 10 kilometers. This approximation was considered adequate since only one, typical, trajectory was presented for each launch vehicle.

The emissions occur as line sources along the arc of the trajectory between the stated altitude levels, with velocities on the order of 1 to 3 kilometers per second, measured vertically. Only the single-stage rockets emit more slowly, at about 0.8 vertical kilometers per second.

Table 4-3

AVERAGE ANNUAL UPPER ATMOSPHERE (above 10 km) SRP ROCKET EXHAUST EMISSIONS (in kg)
BASED 0N FY 86 THROUGH 95 LAUNCH HISTORY

Launch Vehicle[1]	Altitude Range, km[2]	Hydrogen Chloride	Aluminum Oxide	Carbon Monoxide	Carbon Dioxide	Hydrogen	Water	Nitrogen	Element[3]	Other	Total
15	10-22	3.7	6.7	4.2	---	0.4	---	1.2	---	0.4	16.6
30	10-25	46	22	36	22	3	42	19	1 Cu	---	201
21	10-30	187	356	288	14	30	40	76	2 Cu	4	997
31	10-26	218	106	172	151	14	199	90	4 Cu	---	954
18	10-20	32	62	40	2	4	6	12	---	2	160
34	13-28	3.6	7	4.6	0.2	0.6	0.8	1.4	---	0.2	18.4
33	10-52	71	34	55	48	4	64	29	1 Cu	---	306
29	10-34	52	79	61	5	6	16	20	---	---	239
24	10-50	232	373	291	35	28	104	94	2 Cl	---	1159
27	10-37	331	632	510	25	53	71	134	2 Pb	7	1765
36	10-38	1587	3030	2444	119	255	339	645	8 S	35	8462
38	14-29	47	89	58	3	7	9	18	---	3	234
35	10-130	390	704	533	36	56	112	157	4 S	9	2001
39	12-59	37	71	58	3	6	8	15	(0.2) S	1	199
40	10-153	128	232	177	13	18	35	50	1 Pb	2.5	656.5
Fifteen	Vehicles	3365.3	5803.7	4731.8	486.2	485	1045.8	1361.6	25.2	64.1	17368.5
Ten Pct. Added[4]		3702	6384	5205	535	533.5	1150	1498	28	70.5	19106

Table 4-3 (Concluded)

AVERAGE ANNUAL UPPER ATMOSPHERE (above 10 km) SRP ROCKET EXHAUST EMISSIONS
(in kg)
BASED ON FY 86 THROUGH 95 LAUNCH HISTORY

1 15=Super Arcas 18=Nike-Tomahawk 21=Black BrantVB 24=Aries 27=Nike-Black BrantVB 29=Terrier-Malamute 30=Orion 31=Nike-Orion
33=Taurus-Orion 34=Taurus-Tomahawk 35=Black BrantX 36=Black BrantIX
38=Taurus-Nike-Tomahawk 39=Black BrantXI 40=Black BrantXII.
2 km = kilometer(s)
3 Element Symbols: Cl=Chlorine, Cu=Copper, Pb=Lead, S=Sulfur.
4 For additional launches under NASA Reimbursable, Cooperative, and Memorandum of Agreement programs.

The emission data in Table 4-3 are in kilograms of chemical compounds emitted for all rocket stages in the launch vehicle of interest. In terms of metric tons (l metric ton = 1,000 kilograms), the SRP discharges an average annual total of 19.1 metric tons into the upper atmosphere based on the 10-year total, with an extra 10 percent estimated for launches under NASA Reimbursable and Cooperative Programs. This estimate is based on consultation with the SRP Projects Division at WFF in September 1992.

These programs are extensions of the NASA SRP which in some cases facilitate operating in various rocket ranges, with academic and industrial organizations, and in and with foreign countries.

Table 4-3 shows that for 13 of the 15 launch vehicles the emissions are essentially confined to the stratosphere (10 to 50 kilometers). Only vehicles 35 (Black Brant X) and 40 (Black Brant XII) emit in the ionosphere (above 80 kilometers).The upper atmosphere total exhaust emissions <u>per launch</u> for vehicles 35 and 40 are nearly the same, 1,112 kilograms versus 1,311 kilograms. During the 10-year period, 18 vehicles 35 were flown, but only 5 vehicles 40. Therefore, the average <u>annual</u> emissions, 2,001 kilograms for vehicle 35 versus 656.5 kilograms for vehicle 40, differ by a factor of 3.05.

The potential environmental impacts in the upper atmosphere include:

1. Global thermal radiation changes due to emission of water and carbon dioxide (which absorb and scatter incoming and outgoing heat radiation) and other species into the very thin atmosphere above 50 kilometers in the mesosphere and ionosphere;

2. Changes in the ionization level in the E-layer, at and above 90 kilometers in the ionosphere, affecting radio wave transmission, due to hydrogen chloride emissions;

3. Contribution to global warming due to carbon dioxide emissions raising the carbon dioxide level in the Earth's atmosphere; and

4. Contribution to depletion of the ozone layer in the stratosphere (10 to 50 kilometers) due to emission of hydrogen chloride and particulate aluminum oxide, both of which enter into reactions which can lead to ozone depletion.

Table 4-3 includes all the species mentioned in Items 1 through 4 above, but in relatively small quantities in the stratosphere, and even smaller in the ionosphere and can be considered not to be substantial. Typically, the average annual total hydrogen chloride emission into the stratosphere is 3.7 metric tons, which is inconsequential compared to worldwide total emissions (300,000 metric tons).

4.1.1.1.3 SRP Attitude Control Fluid Emissions

For certain observations of deep space phenomena, such as in galactic astronomy, it is necessary to align optical instruments accurately with celestial bodies. For this reason, an ACS using directed jets of compressed fluids to provide the needed reactive forces is included in payloads making such observations.

An ACS is generally used on launch vehicles with high apogees, with the fluids discharged from pressurized containers in the upper atmosphere close to the apogees. The container pressures range from 20,670 kilopascals (kPa) (3,000 pounds per square inch [psi]) to 34,450 kPa (5,000 psi). During the last 10 years, permanent gases and freons (chlorofluoro-carbons [CFCs]) were in use. In order of frequency, nitrogen was used over one-half the time, freons one-quarter, argon one-sixth, and neon one-twentieth [11].

The amounts emitted are variable, in the 1- to 6-kilogram range per flight with an ACS. An average of 20 ACS flights take place per year with an average 4-kilogram emission. This gives an average annual ACS emission as 80 kilograms [11]. All fluids except the freons are permanent gases found naturally in the Earth's atmosphere and their impact is merely to deliver momentum and energy to the ambient medium. The freons contain chlorine which is known to contribute to ozone depletion in the stratosphere (10 to 50 kilometers). Since the ACS application is primarily at altitudes above 50 kilometers and outside the ozone formation zone, the freons will not create adverse impacts.

4.1.1.1.4 Effects on Stratospheric Ozone and Global Warming

Stratospheric Ozone. In order to assess the effects of the NASA SRP upper atmosphere emissions on stratospheric ozone (SO), these emissions must be briefly placed in their proper global perspective [5, 7, 37, 143] .

The stratosphere (10 to 50 kilometers) is the main region of ozone production in the Earth's atmosphere. Stratospheric ozone absorbs ultraviolet radiation from the Sun and other sources so effectively that very little radiation with wavelengths shorter than 300 Angstroms reaches the Earth's surface. Depletion of SO has been measured over the past 15 years. In particular, an Antarctic ozone hole has been formed, more persistent during cold, long winters.

In nature, SO is produced in the equatorial latitudes by chemical action and reaches the higher latitudes and polar regions by stratospheric circulation. The SO concentration varies with time (e.g., the seasons) and place (lower at the poles) and is the result of a dynamic chemical balance, with ozone continually created and destroyed in complex reactions.

The most destructive species leading to SO depletion are believed to be atmospheric chlorine and bromine. The principal terrestrial sources are industrial chlorinated compounds such as CFCs and emissions from active volcanoes. Rocket activity directly in the stratosphere is a contributor. Ultimately, all the chlorinated compounds are converted to elemental chlorine (or its radical).

Table 4-4 is a comparison of annual stratospheric chlorine releases using recent data for industrial sources.

Table 4-4
Comparison of Annual
Stratospheric Chlorine Releases

Chlorine Source	Annual Release metric tons)
SRP	3.6*
All Industrial Sources	300,000

* From 3.7 metric tons hydrogen chloride (Table 4-3).

Other rocket exhaust compounds which can potentially perturb SO include nitrogen compounds, hydrogen compounds (hydrogen and water), and metallic oxides.

The SRP annual amounts emitted into the upper atmosphere (from Table 4-3) are:

1. Nitrogen	1.5 metric tons
2. Hydrogen	0.5 metric tons
3. Water	1.2 metric tons
4. Aluminum Oxide	6.4 metrtic tons

The catalytic destruction of SO can result from the radicals formed directly or indirectly from these rocket exhaust compounds. The effects of rocket exhausts on SO has been investigated in terms of local, regional, and global effects. For the Titan III, actual measurements of ozone loss were made in the exhaust trail. At an 18-kilometer altitude, only 13 minutes after launch, SO was reduced by more than 40 percent below background. However, after a few hours, recovery to near background levels occurred. Similarly, no total ozone reduction was measured at Kennedy Space Center a few hours after a Space Shuttle launch [143].

The annual SRP stratospheric chlorine releases, from Table 4-4, are less than 0.46 percent of those of the major United States rocket programs, and smaller than all industrial sources by a factor of 83,000. It is, therefore, postulated that there may be very small temporary local SO reduction effects in the wake of SRP upper stage rockets, and no global effects.

Global Warming. Carbon dioxide and other gases in the atmosphere act like glass in a greenhouse, letting the Sun's rays through, but trapping some of the heat that would otherwise be radiated back into space. In 1896, Svante Arrhenius, the great Swedish chemist, coined the phrases "greenhouse effect" and "global warming" and predicted that the burning of fossil fuels would increase the amount of carbon dioxide in the atmosphere and lead to a warming of the world's climate.

Currently, activities on Earth are emitting 24 billion metric tons of carbon dioxide per year into the atmosphere and this rate is increasing with time [42]. The total NASA SRP carbon dioxide emissions for the upper and lower atmosphere average 4.8 metric tons per year, from Tables 4-3 and 4-8. This is an amount eight orders of magnitude less than emissions from other sources. Therefore, the NASA SRP contribution to global warming is considered not to be substantial.

4.1.1.2 Lower Atmosphere

The lower atmosphere, or troposphere, from ground to 10 kilometers, contains 75 percent of the Earth's atmosphere by weight. It may be divided into the atmospheric boundary layer (ground to 2 kilometers) and the free troposphere (2 to 10 kilometers).

The boundary layer may or may not be stable and may have an inversion or a strong wind condition. Thus, the initial launch rocket plume may move in an unforeseen direction.

The potential environmental impacts in the boundary layer include:

1. Formation of "smog" due to entrainment of atmospheric nitrogen into the launch rocket exhaust plume, leading to afterburning and the formation of nitrogen oxides which take part in chemical reactions to form nitric acid and tropospheric ozone;

2. Deposition of hydrogen chloride in the boundary layer and subsequent evolution from surfaces near the launch site;

3. Disposal and/or deposition of trace heavy metals and organics in the boundary layer, such as lead and sulfur which are present in small amounts in some SRP rocket propellants; and
4. Diffusion of exhaust particulates such as aluminum oxide into the boundary layer depending on meteorological conditions.

The potential environmental impacts in the free troposphere include:

5. Cloud nucleation due to aluminum oxide particles acting as condensation nuclei and forming high-altitude clouds which could lead to weather modification;

6. Cloud chemical processing such as absorption of water-soluble acids like hydrogen chloride, resulting in acid rain; and

7. Photochemical oxidation of carbon monoxide to carbon dioxide, and nitrogen oxides to nitric acid and ozone.

The lower atmosphere receives the SRP launch vehicle rocket exhaust emissions from all first stages, plus many second stages in three- and four-stage launch vehicles. The first, or launch, stage usually contains more propellant than the second stage, the second stage more than the third, and so on. Thus, the lower atmosphere receives most of the rocket exhaust emissions from a given launch vehicle.

Also, weather and ozone rockets and 70-millimeter test rockets all emit into the lower atmosphere, close to ground level, typically at altitudes less than 2 kilometers, i.e., into the atmospheric boundary layer.

The next three subsections treat the lower atmosphere emissions of exhausts from the SRP launch vehicle rockets, weather and ozone rockets, and 70-millimeter test rockets.

4.1.1.2.1 SRP Rocket Exhaust Emissions

Typical lower atmosphere rocket exhaust emissions during the last 10 years from the 15 launch vehicles in Subsection

2.2.1. are listed in Table 4-5. It was assumed that the emissions were uniform over the altitude range in which each rocket was burning. Direct proportionality was used to find the fraction of propellant emitted below 10 kilometers. This approxi-mation was considered adequate since only one, typical, trajectory was presented for each launch vehicle.

Table 4-5 shows that for 11 of the 15 launch vehicles the emissions extended through all or most of the 0- to 10-kilometer altitude range. For two vehicles, the range was 0 to 6 kilometers, and for another two, it was 0 to 2 kilometers.

The emission data in Table 4-5 are in kilograms of chemical compounds emitted for the launch stage or (launch + second) stages falling into the 0- to 10-kilometer range. In terms of metric tons, the NASA SRP launch vehicles discharge an average annual total of 18.9 metric tons into the lower atmosphere based on the 10-yeartotal, including an extra 10 percent for launches under NASA Reimbursable and Cooperative, Programs, which are described in Subsection 4.1.1.1.2. The atmospheric impact of these emissions is discussed in Subsection 4.1.1.2.4.

The Federal Clean Air Act (CAA) and its Amendments (CAAA) have set National Ambient Air Quality Standards (NAAQS) for six "Criteria Pollutants," three of which are emitted by the NASA SRP launch vehicles at low altitudes: lead, carbon monoxide, and particulates (aluminum oxide). Table 4-5 gives the 10-year totals and average annual emissions of these substances, which are released intermittently at various terrestrial launch sites.

In the case of lead, which is the most potentially impacting substance of the three, Table 4-6 was prepared to show the <u>per flight</u> low altitude lead emissions for the relevant 12 (of 18) launch vehicles detailed in Section 2.2. These data can be transformed by the use of air diffusion models to lead concentrations in air at the launch site and surroundings. The air quality impacts can then be assessed by comparing these concentrations with the Primary (health related) NAAQS for lead which is 1.5 micrograms per cubic meter, maximum 3-month average [56].

4.1.1.2.2. Meteorological Rocket Exhaust Emissions

Table 4-7 lists the emissions from two vehicles used to make observations of weather (meteorological data) and stratospheric ozone. The weather payloads are of the "datasonde" or "sphere" type and the ozone payload is the "ozonesonde." Per Subsection 2.2.2, the Super Loki Dart vehicle was in use for all payloads in the 10-year period, with 310 launches, or 31 average annual launches.

Table 4-5. AVERAGE ANNUAL LOWER ATMOSPHERE (below 10 km) SRP EXHAUST EMISSIONS (in kg) BASED ON FY86 THROUGH FY95 LAUNCH HISTORY

Launch Vehicle[1]	Altitude Range, km[2]	Hydrogen Chloride	Aluminum Oxide	Carbon Monoxide	Carbon Dioxide	Hydrogen	Water	Nitrogen	Lead[3]	Other	Total
15	0-10	3.3	5.4	3.7	----	0.4	---	0.8	---	(0.2)	14
30	0-10	31	15	24	21	2	28	13	1 Cu	---	135
21	0-10	94	179	143	7	15	20	38	1 S	2	499
31	0-10	94	45	966	364	35	300	239	31	---	2074
18	0-2,7-10	10	20	232	74	8	54	54	8	(0.6)	460
34	0-2	---	---	33.4	17.6	0.8	12.6	10.2	1.2	---	76
33	0-2	---	---	367	192	9	137	112	12	---	829
29	0-2,4-10	14	21	153	98	8	36	49	6	---	385
24	0-10	51	82	64	8	6	23	21	1 Cl	---	256
27	0-1,2-10	99	189	570	147	30	122	134	15	2	1308
36	0-2,5-10	302	577	2769	1639	149	610	861	102	6	7015
38	0-10	---	---	670	307	18	220	186	23	---	1424
35	0-10	67	129	514	293	29	112	158	18	2	1322
39	0-6	---	---	160	129	6	52	54	7	---	408
40	0-6	---	---	400	322	15	130	135	18	---	1020
Fifteen	Vehicles	765.3	1262.4	7069.1	3618.6	331.2	1856.6	2065	244.2	12.8	17225
Ten pct.	Added[4]	842	1389	7776	3980	364	2042	2272	269	14	18948

1 15=Super Arcas 18=Nike-Tomahawk 21=Black BrantVB 24=Aries 27=Nike-Black BrantVB 29=Terrier-Malemute 30=Orion 31=Nike-Orion 33=Taurus-Orion 34=Taurus-Tomahawk 35=Black BrantX 36=Black BrantIX 38=Taurus-Nike-Tomahawk 39=Black BrantXI 40=Black BrantXII.

2 km = kilometer(s)

3 Numbers in this column denote elemental lead unless otherwise indicated (Cu=copper, Cl=chlorine, S=sulfur). 4 For additional launches under NASA Reimbursable, Cooperative and Memorandum of Agreement programs.

Table 4-6

ATMOSPHERIC LEAD EMISSIONS PER TYPICAL SRP FLIGHT
FOR ALL VEHICLES WITH LEADED ROCKET PROPELLANTS[1]

Launch Vehicle	Rocket System[2]	Altitude Span (km)	Burn Time (sec)	Total Lead Emitted (kg)
31	Nike-Orion	0.2 - 1.1	0 - 3.5	6
18	Nike-Tomahawk	0 - 1.6	0 - 3.5	6
34	Taurus-Tomahawk	0 - 2.0	0 - 3.5	11
33	Taurus-Orion	0 - 1.8	0 - 3.5	11
29	Terrier-Malemute	0 - 1.5	0 - 4.4	10
27	Nike-Black Brant	0 - 0.7	0 - 3.5	6
36	Terrier-Black Brant	1.2 - 2.3	0 - 5.2	10
38	Taurus	0 - 1.3	0 - 3.5	11
	Nike-Tomahawk	7.6 - 10.2	16 - 19.5	6
35	Terrier Black Brant-Nihka	0 - 0.9	0 - 4.4	10
39	Talos	0.2 - 1.8	0 - 6.2	22
	Taurus-Black Brant	6.6 - 8.5	19 - 22.5	11
40	Talos	0.2 - 1.9	0 - 6.4	22
	Taurus-Black Brant-Nihka	4.2 - 6.3	12 - 15.5	11
70 mm	Test Rocket	0 - 0.6	0 - 1.7	0.02

[1] km = kilomters
sec = seconds
kg = kilograms
mm = millimeter

[2] Underline designates leaded propellant rockets.

Table 4-7

AVERAGE ANNUAL EXHAUST EMISSIONS (kg) FROM SMALL WEATHER, OZONE AND 70-MILLIMETER TEST ROCKET VEHICLES

Launch Vehicle (Yearly Flights)	Typ. Alt. Range (km)	CO	CO_2	H_20	N_2	HCl	Al_2O_3	SOx	H_2	Elements	MgO	CH_4	Other	Total Vehicle
Super Loki Dart(31)	0-1.4	80.3	66.9	129.2	49.6	124.2	17.7	38.15	4.1	7.15 S 2.1 Cl	3.4	---	0.9	523.7
Viper IIIA Dart(11)	0-2.0	43.6	36.4	70.0	27.0	67.7	9.5	20.8	2.0	3.9 S 1.2 Cl	1.8	---	0.6	284.7
70mm Test Rocket (71)	0-0.6	95.2	56.9	11.4	22.8	---	---	---	3.6	1.4 Pb	---	0.7	---	192.0
Average Annual Emissions		219	160	211	99	192	27	59	9.9	15.8	5.2	0.7	1.5	1000

Chemical Symbols:

Al_2O_3=Aluminum oxide, CH_4=Methane, Cl=Chlorine, CO=Carbon monoxide, CO_2=Carbon dioxide, H_2=Hydrogen, HCl=Hydrogen chloride, H_2O=Water, MgO=Magnesium oxide, N_2=Nitrogen, Pb=Lead, S=Sulfur, SOx=Sulfur oxides.

In FY91 the more powerful Viper IIIA Dartvehicle also came into use, with 55 launches over the 5-year period, or 11 average annual launches. With these annual figures, Table 4-7 shows the total vehicle annual emissions to be 523.7 kilograms for the Super Loki Dart and 284.7 kilograms for the Viper IIIA Dart. The altitude range of emissions for these single-stage rockets is from ground to 1.4 or 2.0 kilometers. These emissions are small. Their atmospheric impact will be discussed in Subsection 4.1.1.2.4 as part of all the rockets emitting into the lower atmosphere.

4.1.1.2.3 70-Millimeter Test Rocket Exhaust Emissions

As stated in Sections 2.2 and 4.1, whenever ground radar is participating in a launch, usually one or two 70-millimeter test rockets are launched to checkout and calibrate the radar before the main launch. In Subsection 2.2.3, the 10-year test rocket use was 712, or 71 average annual launches. Table 4-7 lists the test rocket emissions as totaling 192 kilograms annually, which is of the same order of magnitude as the totals for the Super Loki Dart or Viper IIIA Dart. The impact of test rocket emissions on the lower atmosphere is included in Sub-section 4.1.1.2.4.

4.1.1.2.4 Lower Atmosphere Impacts

Table 4-8 collects the most important emissions by all 18 launch vehicles into the lower atmosphere, from Tables 4-5 and 4-7. These data are related to the seven atmospheric impacts listed in Subsection 4.1.1.2.

Ground level concentrations of the air pollutants resulting from sounding rocket launches were estimated for solid rockets containing ammonium perchlorate (e.g., Black Brant VC) in the 1973 NASA SRP Programmatic EIS. This was accomplished by using a multipoint source atmospheric diffusion model which assumes a buoyant rise of the exhaust cloud. The calculations were performed for two critical air pollutants: carbon monoxide and hydrochloric acid (hydrogen chloride) under three atmospheric conditions: slightly unstable, neutral, and slightly stable.

Estimated peak concentrations for hydrochloric acid and carbon monoxide were well below threshold limit values (TLV) within 100 meters downwind from the launch site. The TLV are time-weighted maximum concentrations of toxic substances used in industrial settings for 7- or 8-hour work days and a 40-hour work exposure. The TLV's are thought to be conservative for short duration exposures of controlled populations. Since rocket firings are events of short duration, usually lasting less than one minute, no significant atmospheric effects were anticipated at ground level from the firing of solid propellant sounding rockets.

In the current NASA SRP, the launch, or first stage, rocket with the largest propellant weight is the Aries with 4,704 kilograms. This is actually Minuteman II Stage 2. Here is a listing of the three stages of Minuteman II, all of which use ammonium perchlorate and aluminum solid propellant:

Minuteman II Stage No.	Propellant Weight (kilograms)
1	20,811
2 (Aries)	4,704
3	1,659

Table 4-8

LOWER ATMOSPHERE IMPACTS OF ROCKET EXHAUST EMISSIONS

FROM ALL 18 LAUNCH VEHICLES[1]

Major Chemical Compound	*Total Annual Emission, Metric Tons*	*Lower Atmosphere Impacts*[2]
Hydrogen Chloride	1.03	2,6
Nitrogen	2.37	1(contributory)
Carbon Monoxide	7.99	7
Carbon Dioxide	4.14	7
Aluminum Oxide	1.42	4,5
Sulfur Oxides	0.06	6
Trace Metals		
Lead	0.268	3
Sulfur	0.012	3

1 Using Section 4.1.1.2 and Tables 4-5 and 4-7.
2 Key to Impacts: 1=smog formation, 2=hydrogen chloride deposition, 3=deposition of trace heavy metals, 4=dispersal of particulates, 5=cloud nucleation, 6=acid rain, 7=photochemical oxidation

In Reference 121 reference is made to Reference 131 where air quality impacts due to static firings of Minuteman II Stages 1 and 3 were calculated using the Products of Combustion/Atmospheric Dispersion (PCAD) and the Industrial Source ComplShort Term (ISCST) air diffusion models. With worst case scenarios, maximum pollutant concentrations for hydrogen chloride, aluminum oxide and carbon monoxide were obtained for ground level.

These were compared in Table 4-9 with NAAQS and TLV criteria as applicable. For both l-hour and 24-hour exposures, it is seen that all maximum impacts represent only a small fraction of the suggested safe concentrations. Since Aries has a propellant loading less than 25 percent of Minuteman II Stage 1, it can be safely stated that Aries (and the smaller SRP launch rocket stages) also have acceptable air quality impacts for the principal rocket exhaust emission compounds.

Table 4-9
SUGGESTED CRITERIA VERSUS MAXIMUM PREDICTED CONCENTRATIONS OF AIR CONTAMINATION FROM STATIC FIRING OF A MINUTEMAN II STAGE 1 OR STAGE 3 ROCKET MOTOR

	One-hour (μ*g/m3)*		*24-hour* (μ*g/m3)*	
Emission Products	Suggested Criteria	Maximum Predicted Concentration	Suggested Criteria	Maximum Predicted Concentration
Aluminum Oxide	1000(a)	140	150(b)	5.7
Carbon Monoxide	40,000(b)	2.5	10,000(b)	0.1
Hydrogen Chloride	750(a)	80	75(c)	3.3
Nitric Oxide	3,000(a)	18	300(c)	0.7

(a) Threshhold Limit Value/10
(b) National Ambient Air Quality Standard
(c) Threshhold Limit Value/100

4.1.2 IMPACTS OF PAYLOADS WITH RADIOACTIVE SOURCES

A small fraction of all launches in the SRP includes sealed radioactive sources (RS) as part of instruments in the payload. These RS are exclusively small quantities of isotopes of various elements and are accordingly considered minor radioactive sources (MRS).

Table 4-10 is a record, based on [91] and [106], of SRP flights with MRS during the period 1988-1995. Only 8 flights with MRS have occurred, all of them launched from WSMR. An additional flight (31.071) used MRS for ground calibration only, none of the MRS in this flight flew in the payload. In the past MRS have been part of flights launched from WFF and RFRR, as well as overseas ranges. However, the data in Table 4-10 are typical of the RS flights to be expected during the next 5 years.

MRS are classified by source strength into three hazard categories A, B, and C. Only one of the flights in Table 4-10 was in category A (highest hazard). The remainder are in category B. No category A launches are expected during the next five years.

4.1.3 NOISE IMPACTS

Noise generated by the suborbital NASA SRP flights can be grouped into launch noise, flight noise, and landing noise. The noise from rocket launches has been investigated for some time, and quantitative estimates of sound pressure levels at

Table 4-10
MINOR RADIOACTIVE SOURCES IN NASA SPR PAYLOADS 1988-1995

SRP Flight[1]	Launch Date	Launch Site	No. of Sources	Isotope	Total Activity Milli-Curies	Hazard Category[2]	Remarks
36.041	10/88	WSMR	2	H3	275.11	B	Recovery with payload
27.121	12/88	WSMR	3	Cm244	2.52	A	Recovery with payload
36.059	8/89	WSMR	2	H3	275.11	B	Recovery with payload
36.034	1/90	WSMR	1	Fe55	0.12	B	Recovery with payload
24.011	4/91	WSMR	2	Fe55	100.5	B	Recovery with payload
24.017	8/93	WSMR	2	Fe55	100.5	B	Recovery with payload
31.071	2/94	WSMR	1	Cd109	0.008	C	Not flown on vehicle-ground calibration only (all sources exempt)
			1	Co57	0.001	C	
			1	Am241	0.00005	C	
			1	C14	0.00015	C	
27.132	4/94	WSMR	1	Cm244	0.88	B	Recovery with payload
			1	Ca41	0.003	B	Recovery with payload
			1	Fe55	0.005	C	Not flown on vehicle
36.092	5/95	WSMR	1	Fe55	0.1	B	Recovery with Payload

NOTES:
1. First two digits in flight denote launch vehicle (Fig. 2-1).
2. Hazard categories defined in NASC Nuclear Safety Review and Approval Procedures (1970).

distances from the launch site can be made. The same cannot be said for flight noise and landing noise.

The NASA SRP flights follow ballistic trajectories modified by air resistance and in particular by reentry into the denser lower atmosphere which decelerates and heats the reentering spent rockets and non-recovered payloads. Even so, the landing speeds of these objects are supersonic, similar to those of artillery shells and missiles which enter at directions not far from the vertical.

Therefore, the noise of flight and landing is of a dynamic nature, apparently not quantitatively characterized, but very familiar to those who have experienced incoming ballistic objects at ground level. This means that the sonic booms associated with supersonic flight of aerodynamic bodies flying horizontally or at small angles to the horizontal are absent in the SRP, including the weather, ozone, and test rocket flights. The next three subsections deal, in turn, with launch noise, flight noise, and landing noise.

4.1.3.1. Launch Noise

The advent of large booster rockets for space flight sparked the measurement of launch rocket noise and theory to try to explain the results. After decades of effort, no universally accepted noise prediction methods have been devised. Of interest here is the "far-field" ground level noise outside the immediate launch pad area. Sound level estimation relies on a simplified far-field prediction method [47, 48, 49] and a NASA computer model as used in the ***Kauai Test Facility Environmental Assessment*** [102, 103].

The overall sound power due to the launch rocket is taken to be one-half percent of the mechanical power (or kinetic energy flux) of the launch rocket. The mechanical power is simply half the product of the rocket thrust and the gas velocity at the rocket nozzle exit plane. The gas exit velocity does not vary too much for different rockets, so it is the thrust which mainly determines the sound power. Overall sound power and far-field sound levels of sounding rockets are presented in Tables 4-11 and 4-12 respectively. The five most powerful launch rockets in the NASA SRP are Taurus, Talos, Terrier, Aries, and Nike, respectively.

They launch 12 of the 15 NASA SRP launch vehicles. Table 4-11 lists the sound power for these launch rockets, in the range from 2,715 (Taurus) to 988 (Nike) in kilo-Newton-meters per second (kNm/sec). Actually, Talos and Taurus are practically equal in sound power close to 2,700 kNm/sec. Knowing launch rocket overall sound power and geometry, and making assumptions about sound spreading and attenuation, the computer model finds maximum sound levels as a function of distance from the launch pad.

Table 4-12, adapted from the ***Kauai Test Facility Environmental Assessment*** [102, 103], shows the results for Taurus/ Talos, Terrier, and Nike at various distances from the launch pad in dBA, an "A-weighted" sound level used internationally in human acoustics. The spread between Taurus/Talos and Nike is 4 to 6 dBA. These sound levels will persist for a fraction of a minute as the launch vehicle gains altitude. Increasing distance and atmospheric attenuation then sharply reduce the surface sound level.

Table 4-11

OVERALL SOUND POWER OF SRP ROCKET LAUNCHES

SRP Vehicles Launched[1]	*Launch Rocket (First Stage)*	*Maximum Thrust (T_m) (kiloNewton)*	*Exit Plane Velocity (Ve) (meter per second)*	*Overall Sound Power (0.0025 T_mVe) (kiloNewton-meter per second)*
33, 34 ,38	Taurus	516	2105	2715
39, 40	Talos	512	2085	2670
29, 35, 36	Terrier	314	2117	1660
24	Aries	218	2644	1440
18, 27, 31	Nike	207	1909	988

1

18 = Nike-Tomahawk, 24 = Aries, 27 = Nike-Black Brant VB, 29 = Terrier-Malemute, 31 = Nike-Orion,
33 = Taurus-Orion, 34 = Taurus-Tomahawk, 35 = Black Brant X, 36 = Black Brant IX,
38 = Taurus-Nike-Tomahawk, 39 = Black Brant XI, 40 = Black Brant XII

Table 4-12

FAR-FIELD SOUND LEVELS DUE TO SRP ROCKET LAUNCHES

		Maximum Sound Levels (dBA) at Distances (D) from Launch Pad[2]		
Launch Rocket	*Overall Sound Power kNm/s*[1]	*D = 1 km*	*D = 3 km*	*D = 11 km*
Taurus	2715	113[3]	97[3]	75[3]
Talos	2670			
Terrier	1660	111	95	74
Nike	988	107	91	71

[1] - kN/s = kiloNewton-meter per second; [2] - km =kilometer(s); [3] - Computed for Talos
Source: Sandia National Laboratories, ***Kauai Test Facility (KTF) Environmental Assessment***
U. S. Department of Energy, Albuquerque Operations, Albuquerque, NM, July 1992

The highest sound levels on Table 4-12 are 113 dBA at 1 kilometer, 97 dBA at 3 kilometers, and 75 dBA at 11 kilometers. The Occupational Safety and Health Administration (OSHA) limits for employees are 115 dBA for 15 minutes, 97 dBA for 3 hours, and no limit for 75 DBA. The launch noise persists for less than a minute. Proper personnel protective equipment, such as earplugs and head-phones, reduces noise levels by 30 decibels. The unprotected public at 11 kilometers will be exposed to a noise lower than a diesel truck at 64 kilometers per hour (40 miles per hour) from 15 meters (50 feet), which generates 85 dBA.

4.1.3.2 Flight Noise

As long as the rockets on the SRP launch vehicles are burning, noise will be generated, especially at the lower altitudes when the air density is appreciable. Estimates of sound levels at distances of several kilometers above the ground may be made by the method outlined above for the launch noise. However, the attenuation due to increasing distance and the thinning of the atmosphere will reduce sound transmission. Above a 10-kilometer altitude where vacuum conditions are approached, no sound will be propagated.

When the rockets become spent, only aerodynamic noise will prevail. As the spent rockets (and there may be two, three, or four stages in a launch vehicle) follow a ballistic path to the ground or water, oblique shock systems are formed as the denser air slows down the incoming projectile-like objects to lower but still supersonic speeds at, say the 1,000 meters per second level.

The characteristic "screaming" or "roaring" frequently reported when such high-velocity projectiles approach the ground in close to vertical trajectories has apparently not been analyzed. It is clear, though, that the sound levels must be smaller than when the rockets are burning.

4.1.3.3 Landing Noise

The impact of spent rockets or unrecovered payloads as supersonic projectiles will produce momentary sounds as a ground or water surface is broken. With solid ground, acoustic waves will propagate below the surface. The lateral spreading of such waves will depend on the nature of the ground material.

Diffuse, sand-like formations will allow the sound energy to propagate, as with earthquakes, and shocks may be felt at some distance from the impact. Dense formations (rocks) will resist and absorb sound energy, reducing the spreading. Unless humans or animals are in the immediate vicinity of a landing ballistic spent rocket or payload, noise will not be a problem.

When payload recovery is desired, usually a parachute is deployed at an altitude of about 6 kilometers to slow down the payload for aerial or ground recovery. For aerial recovery, specially equipped aircraft or helicopters are used to locate and retrieve the payload prior to touchdown. The payload is then transported directly by the recovery plane/helicopter to a landing area support facility. For ground recovery, trucks, autos, and helicopters are used.

The noise generated by these vehicles while searching for, recovering, and transporting the payload to the support facility is comparable to that from normal daily transportation activities. The landing site, however, may be in a remote area that is seldom visited by automobiles or aircraft. Nonetheless, the noise generated during recovery operations should not exceed 110 decibels and is of short duration. Therefore, no substantial adverse environmental impacts are expected.

4.1.4 LANDING/RECOVERY IMPACTS AND MITIGATION

All metallic and other solid heavier-than-air objects which are propelled into the atmosphere by the launch vehicles land back on Earth in more or less ballistic trajectories. The objects include spent rockets (whose propellants have been totally burned and exhausted), payloads (which may have released chemicals), nose cone doors (blasted away for instruments to "see" their targets), and spin weights which were released to change rotation of a rocket stage of a launch vehicle.

The sounding rocket program uses solid propellant motors and small quantities of hazardous materials. Toxic corridors are minimal and are contained within the launch hazard areas. Since each mission is different, an Operation and Safety Directive is developed for each program. If a toxic material problem is present, specific procedures are developed.

The spent first stages or launch rockets of multistage vehicles land less than 2 kilometers from the launch point. Impacts from these short-range spent rockets are treated in Subsection 4.1.4.1.

The spent second-stage rockets of three-stage and four-stage launch vehicles land more than 3 kilometers from the launch point. Impacts from these medium-range spent rockets (also including weather, ozone, and 70-millimeter test rockets) are treated in Subsection 4.1.4.2.

The final stage spent rockets of all vehicles typically land in the range from 50 to over 1,000 kilometers from the launch point, depending on the vehicle propulsion and payload weight. Impacts from these final stage spent rockets are treated in Subsection 4.1.4.3. The impact of landing payloads and other hardware from the launch vehicles is treated in Subsection 4.1.4.4

For safe range operation, the landing points of all spent rockets and payloads must be predictable. In fact, 17 of the 18 launch vehicles lack onboard guidance. This means that the launches are typically a matter of "point and shoot." The "point" relies on known characteristics of the propelling rockets, payload weight, launch vehicle drag data, and wind conditions at the launch site.

The deviation of actual landing points from those predicted is known as "dispersion." Dispersion data for most vehicles were measured during the period 1986 to 1995 [147] and are presented in Subsection 4.1.4.5.

Lastly, mitigation of landing and dispersion impacts, including safety procedures, application of known dispersion data, installation of boost guidance systems, and effects of launch site location, is treated in Subsection 4.1.4.6.

4.1.4.1 Short-Range Spent Launch Rockets

In multistage SRP launch vehicles, the first stage of launch rocket invariably flies a very short trajectory following a burn time of only a few seconds. The function of the launch rocket is literally to get the remaining stages and the payload off the ground. In Table 4-13, the values of impact range (distance from launch point along

Table 4-13
SHORT-RANGE ROCKET TRAJECTORIES

Launch Vehicle Number[1]	Number of Stages	Launch Rocket (First Stage)	Typical Launch Rocket Trajectory[2]		Typical Impact Weight (kg) [3]
			Apogee (km)	Impact Range (km)	
31	2	Nike	1.3	0.3	276
18	2	Nike	2.2	1.0	276
34	2	Taurus	2.5	1.6	606
33	2	Taurus	3.0	1.0	606
29	2	Terrier	2.6	0.9	302
27	2	Nike	1.2	0.5	276
36	2	Terrier	2.3	0.2	302
38	3	Taurus	1.8	0.8	606
35	3	Terrier	1.2	0.3	302
39	3	Talos	3.0	1.5	802
40	4	Talos	2.5	1.0	802

[1] 18 = Nike Tomahawk, 27 = Nike Black Brant VB, 29 = Terrier Malemute, 31 = Nike Orion, 33 = Taurus-Orion, 34 = Taurus-Tomahawk, 35 = Black Brant X, 36 = Black Brant IX, 38 = Taurus-Nike-Tomahawk, 39 = Black Brant XI, 40 = Black Brant XII

[2] km = kilometer(s) [3] kg = kilogram(s)

surface to impact point of spent rocket) for the launch rockets of all multistage vehicles are shown to be less than 1.5 kilometers, with some as small as 0.3 kilometer. Spent rocket impact weights are in the 270- to 800-kilogram range. These data are taken from the typical trajectories of Subsection 2.1.2. This means that an area of radius 1.5 kilometers or more in the launch direction needs to be completely cleared around the launch point to permit an SRP spent launch rocket landing without endangering any persons, animals, or objects. This is essential in case of any launch rocket malfunction on the launch pad.

4.1.4.2 Medium-Range Spent Launch Rockets

According to Table 4-14 (typical data taken from Subsection 2.1.2) the spent second stage in a three-stage launch vehicle has an impact range from 5 to 25 kilometers presumably varying with selected payload weight and apogee. The spent rocket impact weights are in the 270- to 600-kilogram range.

Also shown in Table 4-14 are impact ranges for the spent weather, ozone, and 70-millimeter test rockets, from 2.8 to 5.5 kilometers. The spent rocket impact weights vary from 7 to 9 kilograms. Range safety demands that medium-range impact distances also be cleared for landing of spent rockets. Important are the 70-millimeter test rockets which are flown to calibrate ground radar before NASA SRP, weather, or ozone rocket flight, with short 3-kilometer impact range.

4.1.4.3 Final Stage Spent Launch Rockets

Table 4-15 tabulates the impact ranges and impact weights of final stage spent rockets for all NASA SRP launch vehicles. Data are from Subsection 2.1.2. With impact ranges varying from values below 100 kilometers for single-stage vehicles to over 1,000 kilometers for the four-stage Black Brant XII, it is clear that each flight presents a specific case. Furthermore, the payload will, if sacrificed and not recovered by parachute or separated, stay attached to the final stage and possibly add hundreds of kilograms to its impact weight. The final stages are lighter than preceding stages, so that impact weights are 140 kilograms or less, except for the Black Brant (268 kilograms) and Aries (739 kilograms).

When impact ranges in the hundreds of kilometers or more are expected, terrestrial ranges are limited to vast uninhabited areas (such as Alaskan tundra or taiga). Therefore, the majority of long flights are designed to terminate in an ocean.

4.1.4.4 Payloads

Most payloads are recovered for data extraction, inspection, refurbishing and prospective re-use. This is normally done by first separating the payload from the final stage and then deploying a parachute at about a 6-kilometer altitude. As a result, the payload decelerates and floats down at a rate and in a direction determined by local wind conditions. The payload is located by its proximity to the final stage rocket and often by radio signals emanating from the payload.

The payload may be recovered aerially by helicopter or special airplane, or it may be allowed to impact the ground, usually at speeds near 10 meters per second. In either case, air or ground transportation equipment enter remote areas and may disturb flora and fauna. Such impacts must be assessed on a case by case basis, and if

Table 4-14

MEDIUM-RANGE SRP SPENT ROCKET TRAJECTORIES
(INCLUDING WEATHER, OZONE, AND 70-MILLIMETER TEST ROCKETS)

Launch Vehicle Number and Name	Number of Stages	Stage Number and Name	Apoge e (km)	Impact Range (km)	Typical Impact Weight (kg)[2]
38 (Taurus-Nike-Tomahawk)	3	2 Nike	12.5	5.0	276
35 (Black Brant X)	3	2 Black Brant	80.0	25.0	268
39 (Black Brant XI)	3	2 Taurus	12.5	5.0	606
40 (Black Brant XII)	4	2 Taurus	9.0	3.0	606
		3 Black Brant	105.0	60.0	268
Super Loki - Dart	2[3]	Super Loki	17.7	5.5	9.0
Viper III - Dart	2[3]	Viper IIA	10.0	2.8	8.3
70-Millimeter Test Rocket	1	70-Millimeter Test Rocket	5.8	3.0	6.8

[1] - km = kilometer(s)
[2] - kg = kilograms(s)
[3] - Second Stage (Dart) has no propulsion but carries payload

Table 4-15

SRP FINAL STAGE SPENT ROCKET TRAJECTORIES AND DISPERSIONS
(DISPERSION DATA FROM TABLE 4-16)

Launch Vehicle Number[1]	Number of Stages	Name of Final Stage	Typical Impact Weight (kg)[2]	Typical Final Stage[3]		Absolute Dispersion (1ó) of Final Stage[3]	
				Apogee (km)	Impact (km)	Downrange (km)	Crossrange (km)
15	1	Super Arcas[4]	13	94	70	-	-
30	1	Orion[4]	140	86	48	11	8
21	1	Black Brant[4]	268	241	80	43	29
24	1	Aries[4]	739	272	85	14[5]	8[5]
31	2	Orion	140	55	33	6	4
18	2	Tomahawk	68	310	270	27	26
34	2	Tomahawk	68	430	480	64	21
33	2	Orion	140	186	105	27	14
29	2	Malemute	129	405	198	52	44
27	2	Black Brant	268	285	265	46	39
36	2	Black Brant	268	230	80	5[6]	5[6]
38	3	Tomahawk	68	375	260	65	28
35	3	Nihka	94	960	550	208	208
39	3	Black Brant	268	375	320	54	45
40	4	Nihka	94	1460	1156	250	219

Table 4-15 (Concluded)
SRP FINAL STAGE SPENT ROCKET TRAJECTORIES AND DISPERSIONS
(DISPERSION DATA FROM TABLE 4-16)

[1] - 15 = Super Arcas; 18 = Nike-Tomahawk; 21 = Black Brant VB; 24 = Aries; 27 = Nike-Black Brant VB; 29 = Terrier-Malemute; 30 = Orion; 31 = Nike-Orion; 33 = Taurus-Orion; 34 = Taurus-Tomahawk; 35 = Black Brant IX; 38 = Taurus-Nike-Tomahawk; 39 = Black Brant XI; 40 = Black Brant XII.

[2] - kg =kilogram
[3] - km = kilometer
[4] - Also name of launch vehicle
[5] - Equipped with guidance and control system
[6] - Equipped with S-19 Boost Guidance System

terrain is altered, the original conditions must be restored. Associated noise impacts were treated in Subsection 4.1.3.3. In the case of weather and ozone launch vehicles, the second stage (Dart) is non-propulsive, but houses the payload which usually is integral with a parachute device. After the Dart separates from the first stage rocket (Super Loki or Viper IIIA), it rises to an altitude in the 65- to 115-kilometer range where it fragments into a number of pieces and releases the payload (Datasonde, Sphere, or Ozonesonde) whose parachute unfolds. As the payload floats to Earth, it broadcasts weather or ozone data, but is usually not recovered. The Dart pieces are considered to follow a ballistic trajectory and have a typical impact range of 30 kilometers.

4.1.4.5 Payloads with Radioactive Sources

4.1.4.5.1 Launches over the Ocean

In SRP operation, approximately 10% of the launch vehicles from WFF are provided with destruct mechanisms. Their action is first to separate the payload from the rocket(s) and then to blow up the rocket(s). If a destruct command is given, hazardous matter, including RS in the payload, is recovered from the ocean floor as long as it enters the ocean on the shallow continental shelf, typically 50 to 100 foot deep. The shelf extends many miles from shore, but detectors are sensitive enough to locate even small intensity sources. No recovery attempts are made beyond 75 miles from shore. If the payload blows up in the atmosphere, the RS will disperse and, being minor sources, will cause no detectable increase in radiation [101].

4.1.4.5.2 Launches over Land

As can be seen from Table 4-10, all recent flights with RS have been made or are planned to be made from WSMR. All the flight vehicles with a Black Brant Rocket (including 27 and 36, see Table 4-10) and 90% of all vehicles carry destruct mechanisms. Whenever a destruct command is given, recovery teams are formed to recover all fragments (on-range and off-range), guided by radar tracking and radiation detectors. The recovery is straightforward if the flight proceeds as planned. Very few RS are flown from PFRR, but the recovery procedure is similar to that at WSMR. The impact of a payload with RS blowing up in the atmosphere will not be significant as discussed above [101].

4.1.4.6 Dispersion

The term "dispersion" in the present context means the deviation of the actual impact range of a spent rocket stage from the predicted value. All launch vehicles (with the exception of Aries) lack onboard guidance. To achieve a desired payload apogee and associated spent rocket impact ranges, predictive calculations are made to define the required quadrant elevation (launch angle with horizontal) and azimuth (compass direction) of the launcher. Inputs to the calculations include known characteristics of propelling rockets, timing of stage separations, payload weight, launch vehicle drag data, and wind conditions at the launch site.

Due to uncertainties in the inputs and the variability of atmospheric conditions, actual trajectories deviate from the predicted ones. The dispersion has downrange (short or long) and crossrange (left or right) components. Table 4-16 [34] shows the results of a statistical analysis of hundreds of flights of all launch vehicles, over ranges of payload weights and launch angles for a given launch vehicle. The downrange and cross-range dispersion components are stated as "one-sigma" apogee percentages, where "one-sigma" denotes the standard deviation of the mean of the dispersion data. Statistical analysis of the measured data leads to a number of conclusions:

1. Dispersion is dependent on apogee, e.g., dispersion is higher for a light payload with higher apogee than for a heavy payload with lower apogee (for a given launch vehicle);
2. Downrange dispersion (short or long) always exceeds crossrange dispersion (right or left); and
3. Dispersion is somewhat higher as the number of rocket stages in a launch vehicle increases.

The dispersion results in Table 4-16 were applied to the final stage spent rocket trajectories in Table 4-15 to obtain absolute dispersions in kilometers, shown in the last two columns of Table 4-15. These component dispersions are from 10 to 40 percent of the predicted impact ranges. If such values are excessive for a flight range of limited extent, mitigation of dispersion is indicated. At WSMR, dispersion is reduced for four launch vehicles (21, 27, 35, and particularly 36) by use of the S-l9 Boost Guidance System. This acts during a short period after launch to maintain the designated launch angle by gyroscopic means. The Aries (24) has an onboard flight guidance system in the form of gimballed rocket exit nozzles. A typical comparison among these features is given below.

"One-Sigma" Dispersion

Vehicle	Feature	Downrange % Apogee	Crossrange % Apogee
36	As is	10.8	11.3
36	With S-l9	2.2	2.2
24	Onboard guidance	5.0	3.0

Table 4-16

4.1.4.7 Mitigation of Landing/ Recovery Impacts

In the normal launch of a sounding rocket, one or more spent rocket stages and often the payload will follow a ballistic trajectory and land, intact, in the ocean or an unpopulated land area. To avoid endangering, to any appreciable extent, any property and any living plant or animal

Table 4-16

MEASURED DISPERSION OF SRP FINAL STAGE SPENT ROCKETS, 1986-1995

Launch Vehicle[1]	*Payload Weight Range,kilogram*	*QE*[2] *Range, degrees*	*No. of Flights*	*1 óDRD*[3]*, % Apogee*	*1s CRD*[4]*, % Apogee*
18	42.2-183	73-86	12	8.9	8.5
21[6]	157-634	78-86	15	17.7	12.2
27[7]	244-515	82-89	23	16.2	13.8
29	93-239	76-85	6	12.9	10.9
30	36-106	80-86	10	13.1	8.7
31	50-408	74-86	49	11.1	7.9
33	65-238	70-86	11	14.3	7.4
34	26-67	78-85	1	14.9	4.9
35	70-376	76-86	18	21.7	21.7
36(w/S-19)[5]	324-544	85-87	75	2.2	2.2
36[6]	185-491	81-85	26	10.8	11.3
38	32-119	79-84	13	17.3	7.4
39[7]	527-701	84-85	2	14.3	12.1
40[7]	112-429	80-83.5	9	17.1	15.0

1 18=Nike-Tomahawk, 21=Black BrantVB, 27=Nike-Black BrantVB, 29=Terrier-Malamute, 30=Orion, 31=Nike-Orion, 33=Taurus-Orion, 34=Taurus-Tomahawk, 35=Black BrantX, 36=Black BrantIX, 38=Taurus-Nike-Tomahawk, 39=Black BrantXI, 40=Black BrantXII.
2 QE= Quadrant elevation or launch angle.
3 DRD= Down Range Dispersion.
4 CRD= Cross Range Dispersion.
5 S-19= Boost Guidance System.
6 Dispersion based on rail-launched vehicles only.
7 Theoretical dispersion.

species, including man, the landing locations are carefully planned. Since the flightpath of sounding rockets is influenced by atmospheric winds, careful consideration is given to wind velocities before any launch. The impact range of a given rocket and its dispersion about the predicted impact points are important since they may be the limiting factor in the ability to launch a particular vehicle from a specific site. The dispersion data in Tables 4-15 and 4-16 are used for such determinations. An area corresponding to a dispersion of "three-sigma" is assumed safe for spent rocket landings. If the "one-sigma" dispersion is too great for a particular case, consideration is given to using a boost guidance system (such as S-19) on the launch vehicle of interest to reduce the dispersion. Four types of launchers are used in the NASA SRP. They are the tube launcher, zero length launcher, rail launcher, and tower launcher. The first three are easily transportable. The fourth, the tower launcher, is normally a permanent fixture at an established rocket launching range. The tower launcher is utilized for launching the higher performance vehicles to minimize dispersion. The impact areas are carefully selected. If it is an ocean area, ship traffic is advised so that there will be no hazard to property or people. Sometimes aircraft and radar surveillance is exercised over these areas when sounding rocket launches are planned. In the case of land areas, exclusion is practiced, and the areas are under surveillance during periods of activity. When spent stages or payloads impact in the ocean, no recovery is attempted. When spent stages or unrecovered payloads impact on land, it is planned that this occur in unoccupied areas.

For example, WSMR is a desert area and only range land surface is disturbed. In northern areas, for example PFRR, any launch over land will cause impacts on tundra and taiga. Because most rockets are fin stabilized, they impact nose down and the surface disturbance will be minimal.

From 1959 through FY 1995, 2698 launch vehicles have been flown in the NASA SRP. As evidence of the effectiveness of the precautions observed, no casualties, injuries, or property damage are known to have resulted from landing impacts or recovery of payloads, spent rockets, or fragments, aside from occasional damage to launchers. Based on worldwide experience to date, the landing impacts due to SRP launches have been safely minimized without incident.

4.2 SITE-SPECIFIC CONSEQUENCES OF THE PROPOSED ACTION

During the 10-year period, FY86 though FY95, the NASA SRP launched 290 flights from 11 global sites. Seventy three percent of these flights were launched from three permanent domestic sites: WFF, Virginia; WSMR, New Mexico; and PFRR, Alaska. An average of at least one flight per year was launched from three foreign sites, amounting to another 16 percent: Andoya, Norway; Kiruna, Sweden; and Alcantara, Brazil. In FY95, 87 percent of the launches were from the three permanent domestic sites (WFF, WSMR, PFRR). During FY96 it is planned to launch 33 flights [76].

At mobile and foreign SRP launch sites environmental concerns are considered a routine part of flight or campaign (an overseas series of several related flights) preparation. The assessment of site-specific consequences of the Proposed Action in this SEIS will be limited to the three permanent domestic launch sites: WFF, WSMR, and PFRR.

This Section is divided into four subsections devoted to Generic Site Impacts (Subsection 4.2.1), WFF (Subsection 4.2.2), PFRR (Subsection 4.2.3), and WSMR (Subsection 4.2.4). The generic site impacts include generic lower atmosphere and terrestrial impacts linked to programmatic impacts (Section 4.1) and hazardous material and waste management. Impacts and mitigation that are truly specific to the selected three launch sites, linked to site-specific environments (Section 3.2), appear in the last three subsections where brief references to the generic impacts are included.

4.2.1 GENERIC SITE IMPACTS

The relevant programmatic subsections are 4.1.1.2.4 Lower Atmosphere Impacts (Air Quality), 4.1.3.1 Launch Noise, 4.1.3.3 Landing Noise, and 4.1.4 Landing/Recovery Impacts (Range Safety). Each of these impacts is described concisely in the following paragraphs. For more details the reader should refer to the numbered programmatic subsections.

4.2.1.1 Air Quality Impacts

Ground air quality impacts of the principal emitted compounds from static firings of Minuteman II Stages 1 and 3 were found to be within safe limits for both 1-hour and 24-hour exposures [128]. The current SRP propellant with the largest mass is in the Aries rocket (= Minuteman II Stage 2) which weighs less than 25 percent of Minuteman Stage 1. Further, an actual launch impacts ground air quality less than a static firing. Hence, firing of Aries and the other, smaller, SRP launch rockets will also result in acceptable air quality impacts.

4.2.1.2 Launch and Landing Noise

Using an accepted NASA computer model, far-field ground launch noise levels were computed [102] for the five most powerful SRP launch rockets. With OSHA-required ear protection, NASA SRP personnel experience safe dBA levels. The unprotected public at 11 kilometers is exposed to 75 dBA, which is less than the 85 dBA experienced 15 meters (50 feet) from a diesel truck traveling at 64 kilometers per hour (40 miles per hour). The launch noise persists for only a fraction of a minute.

The landing noise due to the impact of high-speed reentering spent rockets or unrecovered payloads is momentary as a ground or water surface is broken. In the case of solid ground, acoustic waves will propagate below the surface. When payloads are recovered by parachute, special aircraft or helicopters are used for aerial recovery, or standard ground vehicles for ground recovery. The noise from these operations does not exceed 110 dBA, is of short duration, and usually occurs in remote areas. Therefore, no substantial adverse landing noise impacts are expected.

4.2.1.3 Range Safety

All SRP first stage (launch) spent rockets land between 0.3 and 1.5 kilometers from the launch pad with impact weights in the 270- to 800-kilogram range. The small weather and test spent rockets (impact weight 7 to 9 kilograms) land between 2.8 and 5.5 kilometers from the launch pad. Therefore, an area of radius 1.5 to 5.5 kilometers, depending on the mission, is cleared around the launch pad to prevent injury or damage to personnel or facilities.

The medium-range and final-stage spent rockets have impact ranges up to hundreds of kilometers, and are subject to dispersion, i.e., deviations from the pre-calculated landing point, because most of the SRP launch vehicles and all the weather rockets lack onboard guidance. Downrange and crossrange dispersion components have been measured as 10 to 25 percent of the calculated impact range. The scientific missions are not affected, because they only specify altitudes to be attained by the flight trajectory. The mitigation measures are discussed below and in the site-specific portions to follow.

All NASA SRP missions are required to contain both Ground and Flight Safety Plans to minimize risk to human life, property, and natural resources. Both impact and overflight criteria are considered in the Flight Safety Plans and, while risk cannot be entirely eliminated, they are reduced to an acceptable margin. All flights must be designed so that the impact or reentry of any part of the launch vehicle over any landmass, sea, or airspace will not produce a casualty expectancy of 10^{-6} unless a Safety Analysis Report is prepared or one of the following conditions are met: (l) the reentry vehicle will be completely consumed by aerodynamic heating; or (2) the momentum of the solid pieces reentering the atmosphere will be reduced to a degree which precludes injury or damage; or (3) a formal agreement is reached with the land owners to allow the use of the landmass for impact or reentry.

At all times there is strict adherence to the NASA Safety Manual. All launches are evaluated on an individual basis. If any factor, or combination of factors, causes the launch to enter the probability ellipse for any downrange feature, then the launch is postponed until such time as the probability ellipse is clear.

The S-l9 Boost Guidance System - currently in use with the Black Brant V, Nike-Black Brant V, Terrier-Black Brant V, and Black Brant X systems - reduces the trajectory impact point dispersion by a factor of 5 to 10, depending on the specific conditions.

When NASA launches sounding rockets from a foreign site, the host range is responsible for range safety. The safety requirements established by NASA shall be used as a minimum unless requirements of the host range are more stringent in which case the more stringent requirements will apply.

4.2.1.4 Management of Hazardous Materials and Waste

At all NASA SRP sites where hazardous materials are stored and used, and where solid and/or hazardous wastes are produced, there is strict adherence to applicable Federal laws and the regulations which implement these laws. The laws include the latest versions of the Hazardous Materials Transportation Act (HMTA), Toxic Substances Control Act (TSCA), Resource Conservation and Recovery Act (RCRA), and Hazardous and Solid Waste Act (HSWA). Of particular interest are the regulations governing the transportation of hazardous materials by any mode (road, rail, water and air). In addition, any State regulations in these areas are also adhered to.

Some scientific payloads incorporate sealed radioactive sources (RS) as parts of instruments, sometimes for calibration purposes. The RS are strictly monitored by the GSFC Radiation Protection Program which requires approvals from a Radiation Safety Committee [73, 75] during the flight planning phase.

Transportation of RS to a launch site is governed by DOT Regulations contained in 49 CFR 173.415-.445. *Inter alia*, these regulations provide that all personnel handling RS must be properly licensed. If the RS are in non-dispensable form, they can be exempt from the DOT regulations, per 49 CFR 173.425. Any required disposal of RS is carried out by the GSFC Radiation Officer [93].

Safety data requirements for all NASA SRP missions include an inventory of all hazardous and radioactive materials (typically listed in Subsection 4.1.1.1.1) and waste disposal methods which conform to individual safety requirements. Mitigating actions include designation of a secured area for the storage of hazardous materials, and on- and off-site tracking of regulated substances.

4.2.2 WALLOPS FLIGHT FACILITY (WFF), WALLOPS ISLAND, VIRGINIA

Site-specific information for Wallops Flight Facility (WFF) was updated and enhanced in the Final SEIS using the latest site-specific information from the ***Environmental Resources Document***, NASA Goddard Space Flight Center, Wallops Flight Facility, Wallops Island, Virginia 23337, published in August 1994 and correspondence from the Department of Environmental Quality, Commonwealth of Virginia dated June 12, 1995, as well as information provided by NASA WFF.

During the past ten years (FY86 through FY95) 38 SRP missions were launched from WFF. The NASA vehicle success rate for this facility was 100%. while overall mission (experiment) success rate was 86 . 8 % .

4.2.2.1 Air Quality Impacts: Lower Atmosphere

Sounding rocket launches occur throughout the year at WFF and are invariably directed oceanward. The prevailing wind direction on the island is southerly during the summer and northwesterly during the winter. The average windspeed is 14 to 16 kilometers per hour (9 to 10 miles per hour) in the summer and 18 to 20 kilometers per hour (11 to 12 miles per hour) in the winter. Sea breezes with shifting wind direction occur in the spring and early summer. Because of this, the initial emissions from the SRP launch rockets, whose burn time is only a few seconds, may be wind carried toward either ocean or land. As the launch vehicle gains altitude, the emissions are entirely over the ocean.

In any event, per Subsection 4.1.1.2.4, which is rephrased in Sub-section 4.2.1.1, the firing of any NASA SRP launch rocket will result in an acceptable ground air quality impact.

4.2.2.2 Land Management

The principal terrestrial impacts of sounding rocket launches occur either during launching operation or impact/recovery operations. At WFF all launch pads are located on the beach, typically 200-300 feet from the surf. The surrounding area is either paved or consists of an urban managed landscape of low grasses. Since the trajectories of all flights are directed towards the ocean, there is essentially no terrestrial impact of rocket launches at WFF. The recovery of payloads, if attempted, is carried out over the open ocean, usually by aircraft.

4.2.2.2.1 Range Safety, Payload Recovery and Mitigation

The site-specific generic description, is given in Subsection 4.2.1.3. Mitigation at WFF consists of the reduced impact of dispersion because all launch pads are located close to shore and the flight direction is always toward the ocean, so that no ground overflight occurs. Impact areas, allowing for dispersion, are carefully selected, ship traffic is advised, and, in some cases, aircraft surveillance is exercised.

Three types of payload recoveries are practiced at WFF: air recovery, surface water recovery, and no recovery [145].

Air recovery is used for low-weight payloads, which are separated from the last rocket stage and equipped with parachutes. A low-speed airplane collects the unfolded parachute with attached payload as it floats down in the air. A radio signal from the payload helps to locate it.

Surface water recovery involves deployment of parachutes to cushion splash-down of payloads. The package is designed to be water tight and to float undamaged on top of the water after descent through the air. Boats, such as Coast Guards vessels, guided by radio signals, collect the floating package.

No recovery is attempted with disposable payloads. Most payloads send telemetered data during the flight, and are not needed after completion of the mission. They remain attached to the last rocket stage, and crash into the ocean. Usually, the impact smashes the payload into pieces of debris which sink to the ocean floor.

4.2.2.2. Management of Hazardous Materials and Waste and Mitigation

The site-specific generic description, including mitigation, is given in Subsection 4.2.1.5. At WFF, the Safety, Environmental and Security Office performs hazardous waste management according to procedures described in Reference 57, as well as on- and off-site tracking of regulated substances.

4.2.2.2.3. Impacts on Wetlands, Floodplains, and Coastal Areas and Mitigation

All rocket launches at WFF are from the beach and directed toward the ocean. Consequently, the impacts on wetlands or floodplains at WFF are minimal and are limited to the launch pad area. Chemical compounds emitted as part of solid propellant launch rocket exhausts include hydrogen chloride gas, water vapor, and aluminum oxide particles. It is likely that storm water runoff will collect aluminum oxide particulates which settled following launch. Aluminum oxide is not listed by the EPA as a hazardous substance which requires special treatment or disposal.

Numerous NASA studies quoted in Reference 101 have evaluated the hydrogen chloride-aluminum oxide scavenging process. Aluminum oxide particulates are known to gather water vapor and hydrogen chloride gas to form acidic droplets in the immediate vicinity of the pad. Should a storm event occur soon after a launch event, the potential for strongly acidic storm water runoff from the pad area exists. However, since launches are not undertaken under potentially adverse weather conditions, the chances of a storm event very soon after a launch are small. Any stream or surface water in the vicinity of the launch pad may incur a short-term increase in acidity as a result of localized emission cloud formation. The salinity of estuarine and ocean waters will buffer acidity changes in such water bodies. Based on analysis of impacts of a larger commercial launch vehicle Conestoga on wetlands, flood-plains, and coastal areas [101], the impacts of firing smaller SRP rockets will not be substantial.

The coastal impacts are largely due to fragments entering the ocean and sinking to the bottom. The rocket fragments entering oceanic waters are inert. Minute quantities of unburned propellants that may remain on solid particles are considered to be *de minimis.* Because of the relatively small size and volume of such fragments, and the low frequency of launches at WFF there is no appreciable or detectable impact on the ocean.

Virtually all NASA SRP flights launched from WFF have their spent rockets impacting in the ocean. Payloads are either recovered in the air or impact in the ocean. The spent rocket ocean impact zone for sounding rockets launched from WFF ranges from 1.5 km to greater than 180 km. Most spent rockets, however, land in the ocean between 1.5 km and 10 km. Unspent rocket propellant and combustion by-products contained in the spent rockets landing in the ocean off WFF are of such minimal quantities that they should not constitute an environmental hazard.

4.2.2.3 Aquatic and Terrestrial Ecology

4.2.2.3.1 Flora

The impacted land area around the launch pads at WFF is either paved, or is a managed urban landscape of low grasses, and does not constitute sensitive habitats. Ground safety requirements for NASA SRP missions minimize the potential for wildfires to occur as the result of rocket firing. Launch facilities are cleared of all but grasses and low weedy species. These are maintained and not allowed to run wild, thus producing an urban vegetative landscape with minimal fire potential. The WFF Fire Department is on standby during rocket firing to extinguish any fires and protect vegetation.

4.2.2.3.2 Fauna

Noise associated with launch activities (Subsection 4.2.1.2) may have a startle effect upon the local fauna. Sounding rocket launch vehicles accelerate rapidly and the time duration to launch rocket impact is a few seconds. The noise from an SRP launch is like the thunder associated with lightning discharges, but it is short and episodic.

For nesting bird species, the noise associated with a launch may cause brief abandonment of the nest, exposing nestlings briefly to possible predation. Response studies on raptors exposed to sonic booms and low level military jets [19] concluded that these stimuli had no detrimental effects on the reproductive success of the species examined. Permanent abandonment of the nest is unlikely, given the length of time the SRP has been in existence and that the species continue to be resident during the nesting period.

4.2.2.3.3 Endangered and Threatened Species and Mitigation

The USFWS has identified two federally listed threatened and endangered species specific to WFF: the piping plover (*Charadrius melodus*) and the peregrine falcon (*Falco peregrinus*). Wilson's plover (*Charadrius wilsona*) which nests in the same area as the piping plover is listed as endangered by the State of Virginia.

Peregrine falcons nesting at the north end of Wallops Island should not be impacted by SRP launches at the south end of the island. The piping plover is found at both ends of the island [140]. For its protection, NASA WFF annually closes the northern and southern portions of the island during nesting season (March 15 through September 1) [89]. This closure has taken place every year since 1986. This protection is also enjoyed by Wilson's plover. The startle effect mentioned in Subsection 4.2.1.3.2 and 4.2.2.3.2 has obviously not caused these nesting species to leave the island. In 1993 a bald eagle (*Haliaeetus leucocephalus*) nest was constructed next to the sewage treatment plant at the Main Base. Any activity planned within 0.4 kilometers (0.25 miles) of the nest site be will coordinated with the U.S. Fish and Wildlife Service.

4.2.2.4 Cultural Resources

No impacts to identified cultural resources are predicted as a result of the NASA SRP. In the event that previously undiscovered cultural resources are identified during the course of the SRP, NASA will take no action affecting the resources until the requirements of 36 CFR Part 800 are satisfied.

4.2.2.5 Socioeconomic Effects

The NASA SRP activity contributes approximately 32 percent of the $87 million budget at WFF. The continuation of the NASA SRP activity will assure a future beneficial contribution to the local economy.

4.2.3 POKER FLAT RESEARCH RANGE (PFRR), FAIRBANKS, ALASKA

Site-specific information for Poker Flat Research Range is based largely on information contained in the ***Environmental Assessment, Improvement and Modernization Program Poker Flat Research Range***, Fairbanks, Alaska published by Geophysical Institute, University of Alaska in April 1993.

During the past ten years (FY86 through FY95) 49 SRP missions were launched from PFRR. The NASA vehicle success rate for this facility was 89.8%. while overall mission (experiment) success rate was 73.5%.

4.2.3.1 Air Quality Impacts: Lower Atmosphere

Sounding rocket launches typically occur during the winter months, and are aimed in a general northerly direction, from north-northwest to north-northeast. Winter winds in the Chatanika Valley typically consist of 6.4- to 8.0-kilometer-per-hour (4- to 5-mile per hour) winds from the northeast. These winds are not strong enough to carry the launch rocket exhaust emissions, lasting only a few seconds, to the south.

No effects due to NASA SRP launches have been noted at the closest settlements, the Chatanika Lodge and F.E. Gold Camp which are adjacent to the southwest side of the PFRR. In lesser proximity are two downhill ski areas (Cleary Summit and Skiland) on the Steese Highway to the south of PFRR.

In any event, per Subsection 4.1.1.2.4, which is rephrased in Subsection 4.2.1.1, the firing of any NASA SRP launch rocket will result in an acceptable ground air quality impact.

4.2.3.2 Land Management

Sounding rocket operations have influenced land management practices in the vicinity of the PFRR and downrange. No additional changes in land management are anticipated due to the continuation of the NASA SRP. A long period of activity has been consistent with agreements with responsible state and federal agencies [45].

4.2.3.2.1 Range Safety, Payload Recovery and Mitigation

The site-specific generic description, is given in Subsection 4.2.1.3. Mitigation at PFRR consists of maintaining close cooperation between the UAF and all downrange agencies such as BLM, the Department of Forestry, the Department of Natural Resources, and various tribal governments; and continuing the UAF's aggressive campaign to identify and recover spent rockets in downrange areas.

As reported in Subsection 4.2.3.1, SRP flights typically take place in the winter months when the ground is frozen and presents minimum danger for a bog fire. Areas around launch sites are cleared of vegetation to reduce the probability of fire, and downrange launch vehicle impact sites are identified to appropriate Fire Response Teams that would suppress any outbreaks.

PFRR has a good working relationship with the Borough, State, and Military agencies in the area. On downrange fires PFRR works with the Alaska Fire Service which is a state agency and with BLM which handles fires in the more remote locations. Generally, fires danger is only present in the summer months for a short time in May and June.

According to Mr. Robert J. Beyma, Flight Safety Group, Wallops Flight Facility Safety Office, a safety analysis is performed for each rocket launch at Poker Flat. The Alaska Oil Pipeline is outside of the range boundary and NASA endeavors to stay within the defined range boundary. NASA utilizes criteria furnished by the University of Alaska, Poker Flat Research Range and standard safety methodology for defined probability in establishing launch criteria. All NASA launches have less than 1 in 100,000 probability of hitting a defined strip which is 100 meters wide and which contains the pipeline. Therefore the chance of hitting the actual pipeline is even much less than 1 in 100,000.[149]

4.2.3.2.2 Management of Hazardous Materials and Waste and Mitigation

The site-specific generic description, including mitigation, is given in Subsection 4.2.1.5. At PFRR, generation of solid waste will be mitigated by the following actions:

1. Organic waste will be transported to the Fairbanks North Star Borough Landfill by local haulers;
2. Combustible debris will be burned on site; and
3. Recyclable/reusable material will be recycled or reused.

Hazardous waste generated onsite is managed by the UAF in accordance with ***UAF Risk Management Standard Safety Operating Procedures #401: Hazardous Materials Management Program*** [24]. The storage and/or handling of hazardous materials and/or toxic substances will be further mitigated by the use of new specialized and upgraded facilities, part of the PFRR Improvement and Modernization Program.

4.2.3.2.3 Impacts on Wetlands, Floodplains, and Coasta Areas and Mitigation

Most of the rocket launch activities at PFRR take place during the winter month, when the ground is frozen and covered by snow. This period of the year in the area of PFRR is also characterized by minimal biological activity. Consequently, the impacts to wetlands and floodplains are minimal or non-existent. The fragments of rocket entering taiga are inert. Minute quantities of unburned propellants that may remain on solid particles are considered to be de minimis.

Specific mitigation consists of recovery, where possible, of spent portions of the sounding rockets. The impacts of infrequent summer launches is also minimal, due to infrequency of such launches and small size and volume of fragments impacting the land.

4.2.3.3 Aquatic and Terrestrial Ecology

4.2.3.3.1 Flora

No direct impacts to flora in the vicinity of the PFRR are anticipated as a result of the NASA SRP firings. In the event of a motor exploding at the launch facility, there is a chance of igniting a wildfire. In addition, launch vehicles with either partially consumed fuel or burning elements do on occasion ignite wildfires.

Wildfires are of great concern to the PFRR. The areas around launch sites are cleared of vegetation to reduce the probability of wildfires. Downrange launch vehicle impact sites are identified to appropriate Fire Response Teams and any wildfires resulting from NASA SRP operations are suppressed.

4.2.3.3.2 Fauna

The majority of the NASA SRP launches take place during the winter months. An analysis of the NASA SRP launches from the PFRR over the last 10 years shows 71.4 percent of the launches have taken place between October 1st and April 30th. Only 28.6 percent of the launches have taken place between May 1st and September 30th. Most avian species migrate out of the area during the winter. Many large mammals, such as the moose and caribou, winter in the vicinity of the PFRR. Other mammals, such as the brown bear, spend the winter months in a dormant state of hibernation.

Noise associated with the NASA SRP launches may have a startle effect upon the local fauna. Impacts are also associated with infrequent summer launches. The startle effect may drive avian species off nests, exposing eggs and young to cooling and to predators; however, raptor studies [19] have shown no reproductive impacts from either sonic booms associated with launch vehicle reentry or noise from low flying jet aircraft which would exceed the noise produced from the launch.

4.2.3.3.3 Endangered and Threatened Species

The USFWS has identified three Federally listed threatened or endangered avian species (American peregrine falcon [*Falco peregrinus anatum*], Arctic peregrine falcon [*Falco peregrinus tundrius*], and spectacled eider [*Somateria fischeri*]) occurring within the PFRR flight range, as described in Subsection 3.2.2.2.5.1 and in the Appendix A. Data in these two sources also show that none of these species are impacted by the NASA SRP. No State listed species have been identified by the Alaska Department of Fish and Game.

4.2.3.4 Cultural Resources

No impacts to cultural resources are anticipated as a direct result of the NASA SRP. Impacts due to the proposed expansion of the Poker Flat facility are being evaluated under a separate EA currently published by the UAF Geophysical Institute [25].

In the event that previously undiscovered cultural resources are identified during the course of the SRP, NASA will take no action affecting these resources until the requirements of 36 CFR Part 800 are satisfied.

4.2.3.5 Socioeconomic Effects

Sounding rocket launches generate between $1 and $1.5 million of spending per mission. At an average of six launch missions per year at $1.25 million per launch, the program would inject approximately $75 million into the economy over the next 10 years. This money is spent in the surrounding area on food, lodging, and services. Existing businesses profit from the activity; however, due to the irregular launch schedule, no additional jobs are expected to be generated by the NASA SRP activity. Overall impacts are considered positive.

4.2.3.6 Secondary Effects and Mitigation

Launch facility mishaps resulting in the explosion of a launch vehicle or its impact within the facility are extremely rare in the NASA SRP, but cannot be ruled out. Ground safety requirements minimize risk to human life; however, the chance of igniting wildfires does exist. Mitigation measures include a telephone link to the local fire department.

4.2.4 WHITE SANDS MISSILE RANGE (WSMR), WHITE SANDS, NEW MEXICO

Site-specific information for White Sands Missile Range (WSMR) was re-analyzed using information from the draft ***White Sands Missile Range Range-wide Environmental Impact Statement*** published by the White Sands Missile Range, New Mexico, Directorate of Environment and Safety, Environmental Services Division, WSMR, New Mexico 88002 in June 1994.

During the past ten years (FY86 through FY95) 124 SRP missions were launched from WSMR. The NASA vehicle success rate for this facility was 96.8%. while overall mission (experiment) success rate was 85.5%.

4.2.4.1 Air Quality Impacts: Lower Atmosphere

Prevailing winds in the White Sands area of New Mexico are from the west in the fall, winter, and spring. In the summer, the winds become southeasterly. The NASA SRP launches take place throughout the year, and the flights are entirely over land. Launch rocket emissions are wind-carried in different directions as the seasons change.

In any event, per Subsection 4.1.1.2.4, which is rephrased in Subsection 4.2.1.1, the firing of any SRP launch rocket will result in an acceptable ground air quality impact.

4.2.4.2 Land Management

The principal terrestrial impacts of sounding rocket launches occur either during launch or landing/recovery operations.

The terrestrial impacts at WSMR due to launches (first stage) of two currently used NASA sounding rockets (Black Brant IX and Nike-Orion) are limited to a radius of 1.5 km from the launching pads of LC 36. The area surrounding launch pads at LC 36 is either paved or consists of dry desert land. LC 36 is located in an actively used operational area that includes, a missile assembly plant, payload preparation plants, operations offices and launch control bunkers, explosive storage areas, and rocket launchers. It is managed in a manner consistent with management of operational use areas.

The landing and recovery areas for all NASA SRP are carefully selected to avoid impacting environmentally sensitive habitats. Payloads of NASA SRP missions at WSMR are deployed by parachute, and recovered by helicopters to minimize terrestrial impacts. An attempt is made to recover all booster debris [147].

The recovery operations for NASA SRP at WSMR are the responsibility of the Navy. In order to safeguard sensitive habitats, including pupfish habitats during such operations, the Navy instituted operational recovery procedures as described below.

4.2.4.2.1 Range Safety, Payload Recovery and Mitigation

The site-specific generic description, is given in Subsection 4.2.1.3. At WSMR, NASA SRP recovery activities are coordinated with the Army (site manager) and are carried out by the Navy (facility operator for the NASA SRP).

As part of Navy recovery operations, a NAWCWPNS WS (Naval Air Weapons Center, Weapons White Sands) environmental representative is always present during recovery operations. If rocket debris impact a sensitive area, e.g., Pupfish habitat, NAWCWPPNS WS Environmental contacts the WSMR Chief of Environment and they direct the recovery. If the impact is off range or upon the National Monument, it would be considered outside the designated impact/recovery area. This case will be considered as much a safety issue as an environmental one and the WSNR Chief of Range Operations would be contacted to make the decisions [147].

Under the standard operating procedures for payload recovery radar data locate the impact sites of both payload and spent rockets. Recovery is achieved through the use of helicopters and ground crews to minimize ground disturbance and facilitate the recovery effort. WSMR has entered into cooperative agreements with other agencies which further govern recovery efforts within the co-use area of White Sands National Monument, the San Andreas National Wildlife Refuge, and the Jornada Experimental Range.

The National Range Recovery Support Section (NR-CS) has the responsibility to recover all test items which impact within the Salt Creek area or outside the designated impact area. Specific Navy directives for payload recovery in such cases are reprinted in Appendix B.

4.2.4.2.2 Management of Hazardou Materials and Waste and Mitigation

At present, the Navy, through its Facilities Engineers, handles hazardous wastes generated by the NASA SRP missions at WSMR. In addition NASA SRP complies with the requirements of White Sands Missile Range Regulation 200-1.
The site-specific generic description, including mitigation, is given in Subsection 4.2.1.5.

4.2.4.2.3 Impacts on Wetlands Floodplains, and Coastal Areas

At WSMR, the fragments of the first stage launch rockets of two currently used vehicles (Black Brant IX and Nike-Orion) land relatively close to the launch pads of LC 36 (0.5 km, with a safety perimeter of 1.5 km), bury themselves, nose down, in the ground with little disturbance beyond the rocket diameter which does not exceed 0.5 meter. *There are no wetlands, floodplains, or coastal areas in the proximity of LC 36.*

All NASA landing/recovery areas at WSMR are carefully selected to avoid impacting wetlands, and attempts are made not only to recover the payload, deployed by parachute and collected by helicopter, but also to collect all booster debris.

Specific procedures for protection of wetlands implemented by the Navy during recovery of NASA payloads and sustainers are described in the ***Information on the White Sands Pupfish for Inclusion in the EIS for the Sounding Rocket Program***, Department of the Navy, Naval Air Warfare Center, Weapons Division, White Sands Missile Range, January 25, 1996. This information is reproduced in Appendix B.

4.2.4.3 Aquatic and Terrestrial Ecology

4.2.4.3.1 Flora

Payload recovery activities may involve entry into remote areas where access is difficult. The use of helicopters for recovery operations minimizes the potential of impacting plant communities.

4.2.4.3.2 Fauna

During the decades of launches by SRP (and other agencies) there have been no known substantial impacts on the wildlife of WSMR.

4.2.4.3.3 Endangered and Threatened Species

The current launch operations and impacts of launches (first stage) of NASA sounding rockets at LC 36 of WSMR are limited to a radius of 1.5 km from the launch pads, which are located in an active operational zone of this military installation. The probability of impacting any wild species, including endangered or threatened in this case is low and is considered to be not substantial.

The potential impacts to the endangered and threatened species during NASA SRP payload recovery operations are minimal due careful selection of landing/recovery areas, and to low frequency of NASA rocket launches at WSMR (NASA SRP accounts for only 2% of all sounding/test rocket launches at WSMR) and operational safety procedures implemented by the Navy, which is in charge of NASA SRP payload recovery operations.

The probability of contact between avian species and the inert payloads suspended from a parachute during reentry into atmosphere, or a sustainer is extremely low, and is considered to be not substantial.

Protection of White Sands pupfish habitat is assured by a strict compliance with the ***White Sands Pupfish Cooperative Agreement*** signed by U.S. Army - White Sands Missile Range, U.S. Air Force - Holloman Air Force Base, National Park Service - White Sands National Monument,U.S. Fish and Wildlife Service, and New Mexico Department of Game and Fish on July 21, 1994. The full text of the agreement is reproduced in Appendix C.

The provisions of this agreement are implemented by the Navy through a series of directives and specific protocols for recovery of NASA SRP payloads.

The full text of Naval payload recovery protocols is reproduced in Appendix B. Key provisions of referenced protocols include the following definitions and directives:

Essential Habitat and Limited Use Areas

The Essential Habitat of the White Sands Pupfish is habitat that must be protected from anthropogenic disturbances and perturbations to ensure survival of the species.

Essential Habitat for White Sands Pupfish and the Limited Use Areas were defined by the WSMR Pupfish Conservation Team as:

a/ Salt Creek and all tributaries with perennial flow or perennial springs between Range Road 6 and Range Road 8, including a corridor 200 meters (660 feet) wide, extending 100 meters (330 feet) from either side of the center of the stream of perennial tributary channel and all land within 100 meters of any perennial tributary spring, *b/ Mound Springs, including the area within 100 meters of the perimeter of the spring ponds,*

c/ Malpais Springs, including the area within 100 meters of the perimeter of the spring pond; its outflow streams including a corridor 200 meters wide, extending 100 meters from either side of the center of the stream channel, and the associated wetlands and playas, including all land within 100 meters of the high water boundary of the wetlands and playas associated with Malpais Springs.

The location of these water bodies is shown in Appendix B.

All non-emergency vehicular traffic is prohibited within the Essential Habitat with the exception of existing improved and unimproved roads. Likewise, all non-emergency military activities are prohibited within Essential Habitat. In the case of emergency activities that affect habitats of the White Sands pupfish, such as chemical spills, missile debris, or recovery the Navy Environmental Representative is required to contact the WSMR Army Environmental Office for coordination of mitigation activities.

Limited Use Areas are adjacent lands where activities must be managed to ensure that degradation of Essential Habitat does not occur through direct or indirect effects,such as contaminant runoff and excessive soil erosion.

All activities proposed within Limited Use Areas, with the exception of emergency activities, must be coordinated with the Navy Environmental Office in accordance with the National Environmental Policy Act of 1969, and be consistent with the intent of the Wildlife Conservation Act of 1974, with particular emphasis given to avoidance of impacts to habitats and populations of the pupfish.

NASA Sounding Rocket Mitigation Measures Currently in Place at WSMR

The current environmental protection policies at WSMR, as promulgated by the Navy for the NASA SRP activities at WSMR, fully recognize the sensitivity of the White Sands pupfish habitat and have built-in mitigation to ensure no impact. Specific procedures associated with the recovery of the sustainer and payloads are as follows:

After launch/impact the recovery team is transported via helicopters to locate the sustainer and payload. The sustainer is ground recovered by entering the desert single file from the nearest point of an existing road. The payload is recovered by helicopter, no vehicles are required for payload recovery. A representative from the Navy Environmental Office is always present and is an essential part of the recovery team. In addition to ensuring compliance with the Safety Standard Operating Procedure for Recovery of Space Rockets, a detailed Environmental Recovery Report is completed for every mission. Videos and still photos are also taken to support the Environmental Recovery Report entries, such as ground disturbance, distance to sensitive areas, vegetation, soil type, distance to nearest water source, any animal life in the area, and to document the overall recovery operation. Historically, the only rocket debris that could pose a threat to the Pupfish population is the payload, as the sustainer typically impacts to the south and away from the pupfish habitat.

The payload soft lands via parachute and normally the only ground disturbance is equal to the diameter of the end of the payload and a depression 5 to 13 cm (2 to 5 inches) deep. Because of the soft landing, there is no potential impact to the environment or the pupfish.

Furthermore the worst case scenario, a direct hit on Salt Creek, would not impact the pupfish population unless it directly impacted a pupfish. Of the 1162 recorded impacts of space rockets missions since 1967, there have been no impacts on Salt Creek. Based on history, the probability of impacting Salt Creek is less than the probability of an off-range impact. The statistical calculations in effect at WSMR dictate a 10^{-6} statistical likelihood of an off-range impact. Therefore, the probability of impacting a pupfish is very low.

Additional Recommended Mitigation

The assessment of the available information is that it is not necessary to actually move the aim point of suborbital rockets. However, in order to mitigate the pupfish related concerns Navy proposed amending the existing launch day aim point procedures. This amendment would incorporate a real-time assessment of parameters affecting predicted impact, with an adjustment of aim point to reduce the potential for impact into Salt Creek. The Navy has initiated discussion with the National Range on this matter, and believes it can be implemented as a no cost solution.

4.2.4.4 Cultural Resources and Mitigation

There are numerous charted and uncharted archeological sites on WSMR territory. Damage to such sites from motor vehicles is possible during payload recovery operations, although it is minimized by utilizing existing vehicular trails where possible. The principal mitigation methods are the use of helicopters and consulting field archaeologists in the course of land based recovery activities.

In the event that previously undiscovered cultural resources are identified during the course of the SRP, NASA will take no action affecting these resources until the requirements of 36 CFR Part 800 are satisfied.

4.2.4.5 Socioeconomic Effects

The NASA contracts with the Navy to operate the launches, the Army for the use of the range, and several private companies for mission support. In addition, each mission will import approximately five to six experimenters and eight individuals from WFF. Much of the launch activity is carried out by Navy personnel through an interagency agreement. Overall effect of NASA SRP on local economy is positive.

4.2.4.6 Secondary Effects

Secondary effects of the NASA SRP at WSMR are minimal, since no growth in activities is anticipated and no corresponding demand on the infrastructure is projected.

4.3 IMPACT OF THE NO ACTION ALTERNATIVE

Termination of the NASA SRP activity is a No Action Alternative in the framework of this SEIS. This alternative will result in overall negative environmental, scientific, and economical consequences.

4.3.1 PROGRAMMATIC CONSEQUENCES

Termination of NASA SRP activity will result only in the elimination of minor and transient environmental impacts of sounding rocket launches. The reduction in emissions of air pollutants (carbon dioxide, carbon monoxide, aluminum oxide, hydrochloric acid, metals, and other chemicals) will be approximately 39 metric tons annually on a worldwide basis (based on average 10 year activity FY 86 through 95). The No Action Alternative will reduce hydrogen chloride and aluminum oxide emissions and, thus, have a minor beneficial effect on stratospheric ozone. The overall reduction in use of materials and energy due to the termination of NASA SRP activity will be proportional to materials and energy used in the production and operation of 20 to 30 automobiles.

Termination of sounding rocket launches will also result in a reduction or elimination of a number of atmospheric environmental research studies, including some that are dealing with ozone depletion, and greenhouse atmospheric effects. The termination of environmental research studies will produce adverse effects on our ability to deal rationally and in a technologically sound manner with critical issues of protecting our environment. Consequently, the overall programmatic effect of the No Action Alternative will be negative.

4.3.2 SITE-SPECIFIC CONSEQUENCES

Termination of NASA SRP activity at the three principal permanent launch sites in the United States: WFF, Virginia; PFRR, Alaska; and WSMR, New Mexico; will result in the elimination of minor and transient environmental impacts of a local nature, such as emissions of exhaust gases and noise associated with the launches. The noise impacts of 2- to 35- second duration occurring at a frequency of 6 to 10 times a year at a given location will be eliminated. The total noise reduction will be on the order of 3 to 6 minutes per year. The propellant emissions, occurring also 6 to 10 times a year, are normally below TLV within a 100-meter distance from a launch pad, and well within the controlled properties of launch complexes. No adverse impacts of such air emissions were observed or reported in the past. Consequently, it can be assumed that the No Action Alternative has no substantial impact on the quality of air or water in the impacted areas.

The termination of the NASA SRP will have an adverse impact on local economies, especially in the area of the Eastern Shore of Virginia, where WFF makes a significant contribution to the local economy. Consequently, the overall impact of the No Action Alternative will be negative on the local level economy in the impacted areas.

4.3.3 SCIENTIFIC CONSEQUENCES

The ability to conduct studies in plasma physics, ultra-violet and x-ray astrophysics, solar physics, Earth's upper atmosphere, and planetary atmospheres will be reduced as a result of the No Action Alternative, because access to altitude of 50 to 90 kilometers will be eliminated. Reduced ability to conduct studies dealing with ozone layer depletion phenomena in the upper atmosphere will be an immediate negative environmental consequence of the No Action Alternative. Ability to conduct fast response studies, when required by suddenly occurring upper atmospheric events, will be greatly reduced and eliminated completely in some instances. Capability for cost-effective development of payloads for space missions will be reduced.

4.4 THE RELATIONSHIP BETWEEN THE SHORT-TERM USES AND LONG-TERM MAINTENANCE AND ENHANCEMENT OF THE ENVIRONMENT

The past, current, and future conduct of the NASA SRP activities is a scientific endeavor designed to increase the depth of knowledge of near-space, the Earth's atmosphere and outer space. This activity enhances the ability to protect the environment through technological means. The short- and long-term effects resulting from the NASA SRP activities have a positive impact on the understanding of the physical environment in the near-space and the atmosphere, while not having a significant negative effect on the environment. The launch and recovery processes represent relatively minor transient effects. The results of the scientific experiments in the near-space and atmosphere, on the other hand, are making substantial contributions to the protection of the environment.

It is impractical here to itemize all known and potential benefits generated by past or planned sounding rocket activities; but, the general value can be expressed simply as follows. It is axiomatic that practical and cost-effective means for protecting the environment can be developed only on the basis of knowledge and understanding of the physical, chemical, and biological processes affecting such an environment. Scientifically, more has been learned about the immediate environment and that of the solar system in the last two decades than in all the previous decades combined. Specifically, the NASA SRP makes unique contributions to the total effort to provide an operational capability to measure, monitor, and manage environmental conditions and natural resources from a local to global scale. Some of these contributions are:

1. Serving as a test bed for development of novel instruments and measurement techniques in a hostile environment (e.g., vacuum, rocket launch vibrations, temperature extremes). In fact, instruments so developed have later been used on satellites, space shuttles, and space probes.

2. Providing a short lead time capability in flight preparation for observing short-term and sudden events, such as the 1987 Super Nova. The mobile launch capability permits flights from specific locations, such as the equator and arctic.

3. Providing opportunities for university research groups to perform space science research, for graduate student training, and for beneficial international scientific cooperation in the space area.

The application of sounding rocket technology in studies dealing with ozone depletion in the upper atmosphere is but one of the latest examples of the critical role the NASA SRP activity is playing in protecting our environment.

In fulfilling its responsibility, the NASA SRP has followed a philosophy that has emphasized safety and economy in conducting these experiments, both in near-space and in the near and far reaches of the atmosphere. At the same time, the NASA SRP has provided a relatively inexpensive approach to partial satisfaction of the fundamental need to better understand, utilize, predict, and control the life sustaining, and sometimes hostile, environment.

4.5 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

The continuation of the NASA SRP would result in irreversible and irretrievable commitment of small quantities of structural materials and propellants.

Materials such as aluminum, nickel, stainless steel, carbon, copper, titanium, and other metallic and plastic components are used in the fabrication of rocket propulsion systems and payloads. The propellants used in these rockets are synthetic organic and inorganic compounds.

The quantities of physical resources used by the NASA SRP are minuscule indeed. For example, the total SRP rocket launching activity in FY92 resulted in the consumption of 27,708 kilograms of structural materials and 37,402 kilograms of propellants. The 5-year (FY87 to FY92) average use of propellants was: 22 tons of AP/Al and 14 tons NC/NG. This level of consumption corresponds roughly to materials used in the manufacturing of 17 standard size cars, and a 1-year fuel equivalent (as mass) for maintaining 28 automobiles. It is considered not to be substantial in terms of national resources use.

Use of military surplus solid propellant rockets, such as Nike, Orion, Talos, Taurus, Terrier, and Aries, in the NASA SRP activities further reduces the commitment of new raw materials and provides for the beneficial use of already expended resources which might other-wise become hazardous waste. Consequently, the continuation of the NASA SRP will not commit expenditures of natural resources in substantial quantities.

4.6 FEDERAL ACTIONS TO ADDRESS ENVIRONMENTAL JUSTICE IN MINORITY POPULATIONS AND LOW-INCOME POPULATIONS.

During February 1994, President Clinton issued two documents, Executive Order 12898 and an Executive Memorandum to all departments and Agencies pertaining to Federal action and their impacts to minority and low-income populations. The Executive Order mandates that all federal entities incorporate Environmental Justice (EJ) into their mission, by identifying programs and determining whether federal actions may disproportionally and adversely effect minority and low-income populations. In response to this mandate the Wallops Flight Facility (WFF) has developed an Environmental Justice Implementation Plan.

As part of this activity Federal actions were evaluated in accordance with the Executive Order and Memorandum to determine the impacts to an affected population [148]. Based upon this evaluation it was determined that Federal actions conducted at WFF, WSMR, and PFRR do not disproportionately or adversely affect minority or low-income populations.

WFF evaluated the demographic information pertaining to the area and identified the surrounding communities affected by Environmental Justice (EJ). WFF then performed an extensive evaluation of all the programs and operations, including tenant activities, to determine the impacts to human health and the environment.

The scenarios that could possibly affect the affected community are an accidental release of a hazardous material or an aircraft/rocket mishap. An accidental release or a mishap, however, does not discriminate against low-income or minority populations. The key to effectively implementing EJ is to develop a program that communicates information pertaining to a release or mishap to all the community, including the low-income and minority populations.

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9200 Rumsey Road
Columbia, MD 21045-1934

Commander
U.S. Army Test & Evaluation Command
(TECOM)
Attn: AMSTE-EQ Mr. Nicholas J.
Cavallaro
Aberdeen Proving Ground, MD 21005-5055

Mr. E. F. Kadar
CONATEC
5900 Princess Garden Parkway, Suite 710
Lanham, MD 27076

Mr. Joseph B. Kritz
25028 Dunterry Court
Laytonsville, MD 20882

Maryland Office of Planning
State Clearinghouse
ATTN: Mr. Roland English
301 West Preston Street
Baltimore, MD 21201 2365

Department of the Interior
National Park Service
Assateague Island National Seashore
Route 611
7206 National Seashore Lane
Berlin, MD 21811

Audubon Naturalist Society
Mr. Ed Risley
8940 Jones Mill Pond

Chevy Chase, MD 20815

NEW JERSEY

Mr. Peter Allan
4 Barry Lane
Short Hills, NJ 07078

NEW MEXICO

Alamogordo Daily News
P. O. Box 870
Alamogordo, NM 88310

Alamogordo Library
920 Oregon Ave
Alamogordo, NM 88310

City of Alamogordo
ATTN: Daniel King, Mayor
1376 East 9th Street
City of Alamogordo, NM 88310

Department of Agriculture
Lincoln National Forest Service
ATTN: Lee Poague, Supervisor
11th and New York Federal Building
Alamogordo, NM 88310

Department of Interior
National Park Service
White Sands National Monument
ATTN: Mr. Dennis Ditmanson
Superintendent
P. O. Box 1086
Holloman AFB, NM 88330

Otero County
Virginia Yearley, County Manager
1000 New York Avenue,
Room 101
Alamogordo, NM 88310

Otero County Commission
ATTN: Robert Bishop, Chairman
1000 New York Ave
Room 101
Alamagordo, NM 88310-6935

Otero County Commissioners
ATTN: Robert Ortiz, Chairman
1000 New York Ave
Room 101
Alamogordo, NM 88310

Otero County Planning Committee
ATTN: Ms. Virginia Fletcher
1000 New York Ave. Rm. 101
Alamogordo, NM 88310-6935

Sierra Club
ATTN: President,Tularosa Basin Group
Box 207
Alamogordo, NM 88310

Audubon Society of New Mexico
ATTN: Director
P. 0. Box 30002
Albuquerque, NM 87190

Department of Agriculture
U.S. Forest Service
ATTN: Mr. Mike Draper
517 Gold Ave
Albuquerque, NM 87103

Department of Interior
Bureau of Indian Affairs
ATTN: Director
P. O. 26567
615 N. 1st Street
Albuquerque, NM 87125-6567

Department of Interior
U.S. Fish and Wildlife Service
ATTN: Dr. John Rogers, Director
P. O. Box 1306
Albuquerque, NM 87103

Department of Interior
U. S. Fish and Wildlife Service
Ecological Services
ATTN: Ms. Jennifer Fowler-Propst
Suite D,
3530 Pan American Highway, NE
Albuquerque, NM 87107

Department of Transportation
Office of Environment and Safety
ATTN: Director, Room 9422
NASSIF Building
400 7th Street SW
Albuquerque, NM 87103

Mayor Louis Saabedra
P. O. Box 1293
City of Albuquerque, NM 87103

Mr. Bill Bierch
8500 Menual Blvd NE
Suite B370
Albuquerque, NM 87112

U.S. Army Corps Of Engineers
ATTN: Mark Sifuentes
Environmental Section
P. O. Box 1580
Albuquerque, NM 87103

City of Belen
ATTN: Richard E. Aragon, Mayor
525 Becker Ave
Belen, NM 87002

City of Carrizozo
ATTN: Cecilia Kuhnel, Mayor
P. O. Box 247
Carrizozo, NM 88301

Lincoln County
ATTN: Andrew Wynham, Manager
P. O. Box 711
Carrizozo, NM 88301

Lincoln County Commission
ATTN: Mr. Sterling Spencer
Carrizozo, NM 88301

Commander Holloman AFB
ATTN: 49 FW/CC (BG John S. Miller Jr.)
490 First Street,
Suite 1700
Holloman AFB, NM 88330-5571

Holloman AFB
ATTN: 49CES/CEV (LTC Fitz)
550 Tabosa Ave
Holloman AFB, NM 88330-8458

City of Las Cruces
ATTN: Bruno Zaldo, City Manager
P. 0. Drawer CLC
Las Cruces, NM 88004

Department of Interior
Bureau of Land Management
Linda Rundell, District Manager
1800 Marquess
Las Cruces, NM 88005

USDA-ARS-JORNADA Experimental
Range ATTN: Chris Havstad, Research
Leader
P. O. Box 30003
New Mexico State University Dept. 3JER
Las Cruces, NM 88003

NM Game and Fish Department
401 N. 17th Street, Suite 4
ATTN: Craig Nordyke
Southwest Area Supervisor
Las Cruces, NM 88005

Director of Planning
ATTN: Judy Price
430 S. Main, Rm. 120
Las Cruces, NM 88001-1205

Las Cruces Sun News
P. O. Box 1749
Las Cruces, NM 88004

Las Cruces Branigan Library
200 East Picacho Avenue
Las Cruces, NM 88001

City of Las Cruces
ATTN: Ruben Smith, Mayor
P. O. Drawer CLC
Las Cruces, NM 88004

Mr. Greg White, County Planner
430 South Main Street
Las Cruces, NM 88004

The Wildlife Society, NM Chapter
ATTN: Mr. E. Leon Fisher
Box 4901
New Mexico State University
Las Cruces, NM 88003

New Mexico State University
Office of the President
Hadley Hall, Box 3Z
Las Cruces, NM 88003

South Central Council of Governments
P. O. Box 7385
Las Cruces, NM 88006

Department of Interior
San Andres National Wildlife Refuge
U. S. Fish and Wildlife Service
ATTN: Steve Berendzen, Refuge Manager
P. O. Box 756
Las Cruces, NM 88004

City of Las Lunas
ATTN: Louis F. Huning, Mayor
P. O. Box 1209
Las Lunas, NM 87031

Mescalero Apache Tribe
ATTN: Wendel Chino, President
P. O. Box 176
Mescalero, NM 88340

NM Department of Game and Fish
ATTN: Andrew V. Sandoval, Chief,
Habitat, Environment and Lands Division
Villagara Building
Santa Fe, NM 87503

New Mexico Dept of Game & Fish
ATTN: Bill Montoya, Director
Villagra Building
Santa Fe, NM 87503

Department of the Interior
Bureau of Land Management
ATTN: Director
P. O. Box 1449, S. Federal Place
Santa Fe, NM 87504

The Nature Conservancy
New Mexico Field Office
ATTN: William Waldman, Director
107 Cienega St
Santa Fe, NM 87501

NM Energy, Minerals & Natural
Resources Department
ATTN: James Norwick, State Forester
P. O. Box 1948
Santa Fe, NM 87504-1948

Forestry and Resources
Conservation Division
ATTN: Karen Lightfoot
P. O. Box 1948
Santa Fe, NM 87504-1948

NM Office of Cultural Affairs,
Historic Preservation Division
ATTN: Mr. Thomas Merlan
Room 101, Villa Rivera
228 East Palace Ave
Santa Fe, NM 87503

New Mexico State Engineer
ATTN: Mr. Eluid Martinez
Bataan Memorial Building, Room 101
Santa Fe, NM 87503

New Mexico Department of Public Lands
ATTN: Mr. James Baca
P. O. Box 1148
Santa Fe, NM 87504

NM Wilderness Study Committee
ATTN: Mr. George Crossman
1391 Santa Rosa Drive
Santa Fe, NM 87501

Native Plant Society of New Mexico
ATTN: Mr. Theodore Hodoba
P. O. Box 5917
Santa Fe, NM 87502

NM State Highway & Transportation
Department
Environmental Section
ATTN: Gregory Rawlings
P. O. Box 1149
Santa Fe, NM 87504-1149

NM State Department of Energy,
Minerals and Natural Resources
2040 S. Pacheco
Santa Fe, NM 87505

New Mexico Energy, Minerals &
National Resources Department
Forestry & Resource Conservation Division
ATTN: Mr. Robert Sivinski, Botanist
P. O. Box 1948
Santa Fe, NM 87502

Bureau of Land Management
Socorro Resource Area
ATTN: Harlen Smith
198 Neel Ave. NW
Socorro, NM 87801

Socorro County Commissioners
ATTN: Chair, Daniel Romero
Box 1
Socorro, NM 87801

City of Socorro
ATTN: Ravi Bahasker, Mayor
P. O. Drawer K
Socorro, NM 87801

National Radio Astronomy Observatory
ATTN: Mr. William D. Brundage
P. O. Box 0
Socorro, NM 87801

NM Institute of Mining and Technology
Office of the President
Socorro, NM 87801

Department of the Interior
U. S. Fish & Wildlife Service
Bosque del Apache National
Wildlife Refuge
ATTN: Phil Norton, Refuge Manager
Box 1246
Socorro, NM 87801

Socorro Library
410 Park, SW
Socorro, NM 87801

Socorro County Manager
ATTN: Tony Jaramillo
P. O. Box I
Socorro, NM 87801

Socorro Defensor Chiefton
P. O. Box Q
Socorro, NM 87801
City of Truth or Consequences
ATTN: Freddie Torres, Mayor
505 Simms

Truth or Conquences, NM 87901

Village of Tularosa
ATTN: Mary Stanfill, Mayor
705 4th Street
Tularosa, NM 88352

Commander, White Sands Missile Range
ATTN: STEWS-ES-E (Bldg. T150)
White Sands Missile Range, NM 88002-5048

Officer in Charge Naval Air Warfare Center
Weapons Division
White Sands Missile Range, NM 88002-5510

Mr. Tom Gonzales
Research Rockets Branch
Code 52W530F
White Sands Missile Range, NM 88002-5510

PENNSYLVANIA

U.S. Environmental Protection Agency, Region III
Chief, Environmental Planning and Assessment Section
841 Chestnut Street
Philadelphia, PA 19107-4431

TENNESSEE

Mr. Harry A. Bryson
5728 Wooded Acres Drive
Knoxville, TN 37921-3919

TEXAS

Commander
William Beaumont Army Medical Center
El Paso, TX 79920-5001

City of El Paso
ATTN: Larry Francis, Mayor
#2 Civic Center Plaza
El Paso, TX 79901

University of Texas at El Paso
ATTN: Dr. Diana Natalico, President
El Paso, TX 79968-0500

Commander, U.S. AADACEN and
Fort Bliss
Attn: ATZC-DOE
Directorate of Environment (Sheri Bone)
Ft. Bliss, TX 79916-0058

VIRGINIA

County of Accomack
ATTN: A. K. Fisher
Accomack County Administrator
Accomac, VA 23301

Honorable Herbert H. Bateman
U.S. Representative
P. O. Box 447
Accomac, VA 23301

Eastern Shore Public Library
Accomac, VA 23301

U.S. Army Corps of Engineers
Eastern Virginia Regulatory Section
Eastern Shore Field Office
ATTN: Mr. Gerald Tracy
P. O. Box 68
Accomac, VA 23301

Virginia Society of Ornithology
7495 Little River Turnpike, #201
Annandale, VA 22003

Virginia Department of Forestry
Mr. Michael Foreman
Alderman & McCormick Roads
P. O. Box 3758
Charlottesville, VA 22903

Accomack County Board of Supervisors
ATTN: Mr. Paul Merritt
6325 Maddox Boulevard
Chincoteague, VA 23336

Chincoteague Chamber of Commerce
ATTN: Tom Hobbs, President
Chincoteague, VA 23336

Coast Guard Group Eastern Shore
Chincoteague, VA 23336

Department of the Interior
Fish & Wildlife Service
Chincoteague National Wildlife Refuge
ATTN: Mr. John Schroer
P. O. Box 62
Chincoteague, VA 23336

Ms. Alice Spangler
4427 N. Main St.
Chincoteague, VA 23336

Town of Chincoteague
ATTN: Stewart Baker, Town Manager
4026 Main Street
Chincoteague, VA 23336

Town of Chincoteague
ATTN: Harry S. Thornton, Mayor
4026 Main Street
Chincoteague, VA 23336

Department of Environmental Quality
Waste Resources Division
ATTN: Berry Wright
4900 Cox Road,
Innsbrook Corporate Center
Glen Allen, VA 23060

Department of Environmental Quality
Water Division Office
of Water Resources Management
ATTN: Mr. Chester Bigelow III
4900 Cox Road,
Innsbrook Corporate Center
Glen Allen, VA 23060

Virginia Institute of Marine Science
Mr. Thomas A. Barnard, Jr. Associate
Marine Scientist
Gloucester Point, VA 23062

Resource Management Associates
ATTN: Stephen Mallette
P. O. Box 119
Locustville, VA 23404

Honorable Robert S. Bloxom
P. O. Box 27
Mappsville, VA 23407

Eastern Shore Chamber of Commerce
ATTN: David Parker
P. O. Drawer R
Melfa, VA 23410

Accomack County Board of Supervisors
ATTN: Mr. C. D. Fleming
P. O. Box 101
New Church, VA 23415

The Nature Conservancy
Manager, Virginia Coast Reserve
ATTN: Barry Truitt
Nassawadox, VA 23413

Virginia Marine Resources Commission
ATTN: Mr. Robert W. Grabb,
Assistant Commissioner
P. O. Box 756
2600 Washington Avenue
Newport News, VA 23607

United States Department of the Army
Norfolk District, Corps of Engineers
Environmental Analysis Branch
ATTN: Mr. James Melchor, Chief
804 Front Street
Norfolk, VA 23510-1096

Mr. John H. Price, Jr.
23471 East Point Road
Onancock, VA 23417

Virginia Department of Agriculture
and Consumer Services
Office of Policy Analysis & Development
ATTN: Ms. Cheryl Cashman
Washington Bldg., 2nd Floor,
Capitol Square
Richmond, VA 23219

Virginia Department of Environmental
Quality
ATTN: Ms. Dona Huang Air Division
629 East Main Street, 8th Floor
Richmond, VA 23219

Virginia Department of Environmental
Quality
Office of Public and Intergovernmental
Affairs ATTN: Ms. Ellie Irons
629 East Main Street 6th Floor
Richmond, VA 23219

Virginia Department of Conservation and
Recreation
ATTN: Mr. John R. Davy,
Planning Bureau Manager
203 Governor Street, Suite 326
Richmond, VA 23219

Department of Game and Inland Fisheries
ATTN: Mr. Raymond T. Fernald
4010 West Broad Street
Richmond, VA 23230

Department of Health
ATTN: Dr. Donald Stem
1500 East Main Street
Richmond, VA 23219

Virginia Department of Historic Resources
ATTN: Mr. Robert Carter
221 Governor Street
Richmond, VA 23219

Virginia Department of Mines,
Minerals and Energy
ATTN: Ms. Robin Brannon
202 North Ninth Street, Suite 835
Richmond, VA 23219

Department of Transportation
Environmental Quality Division
ATTN: Heather Stevenson
1221 East Broad Street
Richmond, VA 23219

Chesapeake Bay Local Assistance Board
ATTN: Ms. Michele Carter
8th Street Office Bldg, Room 701
Richmond, VA 23219

NOAA NESDIS-CDA Station
P. O. Box 39
Wallops Station, VA 23337

Aegis Combat Systems Center
ATTN: Marilyn Ailes
Wallops Island, VA 23337

Department of the Navy
Naval Surface Warfare Center
Wallops Detachment
ATTN: Mr. Larry Kuty
Wallops Island, VA 23337

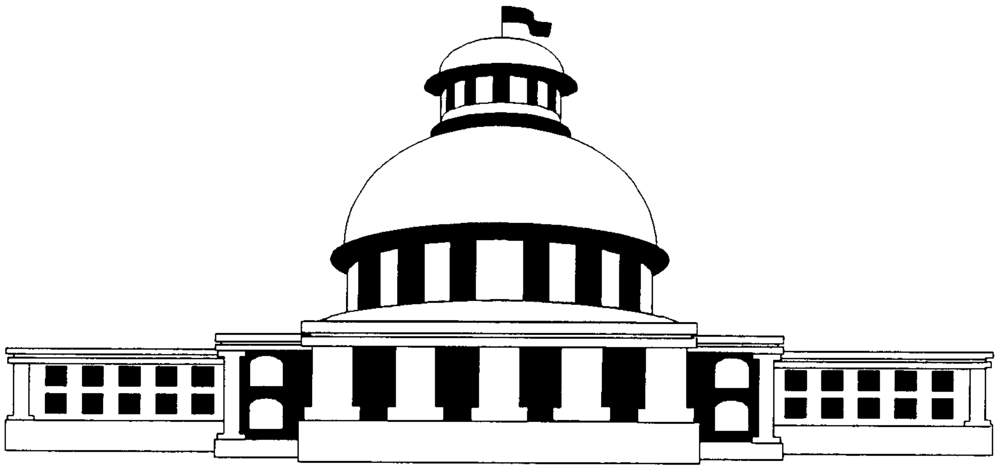
Wallops Island Marine Science Consortium
Box 16, Enterprise Street
Wallops Island, VA 23337

Accomack County Board of Supervisors
ATTN: Mr. Thomas J. Matthews
P. O. Box 471
Wattsville, VA 23483

Mr. David Hickman
P. O. Box 310
Wattsville, VA 23395

U.S. Fish & Wildlife Service
Ecological Services Mid-County Center
ATTN: Ms. Karen Mayne
U.S. Route 17
P. O. Box 480
White Marsh, VA 23183

Senator Thomas Norment
P. O. Box 1697
Williamsburg, VA 23187



APPENDIX A

CONSULTATIONS WITH REGULATORY COMMUNITY

CONSULTATIONS WITH REGULATORY COMMUNITY

The regulations for implementing the procedural provisions of the National Environmental Policy Act (40 CFR 1502.25) require that draft EIS's should be prepared concurrently with and integrated with surveys and studies required by the Fish and Wildlife Coordination Act (16 U.S.C. Sec. 661 et seq.), the National Historic Preservation Act 1966 (16 U.S.C. 470 et seq.), the Endangered Species Act of 1973 (16 U.S.C. 1531 et seq.), and other environmental review laws and executive orders.

The information required for compliance with these requirement was generated by examination of available literature (existing site-specific EIS, EA, ERD, biological, and archeological/historical reports), face-to-face and telephone consultations and correspondence with responsible regulatory agencies.

WALLOPS FLIGHT FACILITY, VIRGINIA

The required coordination with the regulatory community in Virginia was carried out by the NASA/WFF Environmental Department staff as part of preparation of an ERD for this facility (58). Pertinent to this SEIS communications are enclosed in this Appendix. The enclosed letters are:

1. Commonwealth of Virginia, Department of Agriculture and Consumers Services, dated March 11, 1992. The letter deals with the endangered plant species and is signed by John R. Tate, Endangered Species Coordinator.

2. United States Department of the Interior, Fish and Wildlife Service, dated April 2, 1992. The letter deals with endangered species and is signed by Karen L. Mayne, Supervisor, Virginia Field Office.

3. United States Department of the Interior, Fish and Wildlife Service, dated July 16, 1993. The letter deals with endangered species and is signed by Karen L. Mayne, Supervisor, Virginia Field Office.

4. Commonwealth of Virginia, Department of Historic Resources, dated July 20, 1993. The letter deals with the historical resources and is signed by Bruce J. Larson, Project Review Supervisor.

5. Commonwealth of Virginia, Department of Agriculture and Consumers Services, dated July 13, 1993. The letter deals with the endangered plant species and is signed by John R. Tate, Endangered Species Coordinator.

6. Commonwealth of Virginia, Department of Agriculture and Consumers Services, dated July 14, 1993. The letter deals with the endangered plant species and is signed by John R. Tate, Endangered Species Coordinator.

POKER FLATS RESEARCH RANGE, ALASKA

The face-to-face consultations with regulatory community in Fairbanks, Alaska included:

1. Robert F. McLean, Habitat Biologist, Alaska Department of Fish and Game.
2. Paul J. Salvadore, Realty Specialist, Bureau of Land Management.
3. W.D. (Pete) McGee, P.E. Regional Environmental Supervisor, State of Alaska, Department of Environmental Conservation.
4. Randy R. Rogers, Environmental Specialist, Northern Regional Office, State of Alaska, Department of Environmental Conservation.

The relevant correspondence included following letters:

1. United States Department of the Interior, Fish and Wildlife Service, Ecological Services, Fairbanks, dated September 18, 1992. The letter deals with the endangered species in the area of Poker Flats and is signed by Skip Ambrose, Branch Chief.

2. United States Department of the Interior, Fish and Wildlife Service, Ecological Services, Fairbanks, dated May 21, 1993. The letter deals with the endangered species in the PFRR impact area and is signed by Janey Fadely, Wildlife Biologist.

WHITE SANDS MISSILE RANGE, NEW MEXICO

The relevant correspondence with the regulatory community in New Mexico included:

1. United States Department of the Interior, Fish and Wildlife Service, Ecological Services, Albuquerque, dated June 22, 1992. The letter deals with the endangered species in the WSMR impact area and is signed by Jennifer Fowler-Propst, Field Supervisor.

2. State of New Mexico, Energy, Minerals, and Natural Resources Department, Santa Fe, dated August 7, 1992. The letter deals with the endangered plant species in the WSMR impacts area and is signed by Karen S. Lightfoot.

3. State of New Mexico, Department of Game and Fish, Santa Fe, dated August 7, 1992. The letter deals with protection of pupfish in the WSMR impact area and is signed by Bill Montoya, Director.

-V

CLINTON V. TURNER
COMMISSIONER

COMMONWEALTH of VIRGINIA

C. KERMIT SPRUILL, JR.
DIRECTOR

DEPARTMENT OF AGRICULTURE AND CONSUMER SERVICES
Division of Product and Industry Regulation
P. O. Box 1163, Richmond, Virginia 23209

March 11, 1992

Terry M. Potterton
Associate Chief, Health, Safety,
and Security Office
NASA
Goddard Space Flight Center
Wallops Island, Virginia 23337

Dear Mr. Potterton:

This letter is in response to your request for information on state listed threatened or endangered plant or insect species in the vicinity of Wallops Island, Virginia. To date, there are no known state listed endangered or threatened plant or insect species in the immediate vicinity of Wallops Island.

The Virginia Department of Agriculture and Consumer Services has jurisdiction over state listed plant and insect species only. Additional information on unique geologic formations, rare habitat and species, and candidates proposed for listing can be obtained from Mr. Thomas L. Smith at the Division of Natural Heritage (804-786-7951). This information should be readily available from their database.

Thank you for your interest in the endangered or threatened plant or insect species in Virginia. If you have any questions or need any additional information, please contact me.

Sincerely,

John R. Tate
Endangered Species Coordinator
(804) 786-3515

cc: Thomas L. Smith

United States Department of the Interior

FISH AND WILDLIFE SERVICE
FISH AND WILDLIFE ENHANCEMENT
MID-COUNTY CENTER, U.S. ROUTE 17
P.O. BOX 480
WHITE MARSH, VIRGINIA 23183

April 2, 1992

Mr. Terry M. Potterton
National Aeronautics and
Space Administration
Wallops Island Flight Facility
Wallops Island, Virginia 23337

Re: Commercial Experiment Transporter
Launches at Wallops Island, Virginia

Dear Mr. Potterton:

This responds to your March 5, 1992 request for information on the presence of species that are Federally listed or proposed for listing as endangered or threatened that may be impacted by the three commercial experiment transporter launches to be conducted at Wallops Island, Accomack County, Virginia. We have reviewed the information you enclosed and are providing comments in accordance with provisions of the Endangered Species Act (87 Stat. 884, as amended; 16 U.S.C. 1531 et seq.).

As you know, the Federally listed endangered and threatened species known to occur at Wallops Island are the peregrine falcon (Falco peregrinus) and piping plover (Charadrius melodus). The peregrine falcon is found at the tower near the northern end of the island and should not be affected by these launches. Piping plovers have been found at both ends of the island and are known to nest on the southern end. Your letter indicates that the launches will take place on the southernmost launch pad of the island and the first launch will occur in September, 1992. This launch should not affect the plovers as the breeding season will be over by this time. If the remaining two launches are carried out prior to March 1, 1993 there should not be any impacts to plovers. After this time, launches should be conducted between September 1 and March 1 to ensure that impacts to plovers do no occur. Otherwise, it may be necessary to begin informal Section 7 consultation on possible impacts to plovers. Please inform this office as to when the other two launches will occur.

Mr. Terry M. Potterton Page 2

This response relates only to endangered species under our jurisdiction. It does not address other U.S. Fish and Wildlife Service concerns under the Fish and Wildlife Coordination Act or other legislation. If you have any questions or need further assistance, please contact Cindy Schulz of this office at (804) 693-6694.

Sincerely,

Karen L. Mayne

Karen L. Mayne
Supervisor
Virginia Field Office

Need to [illegible] issue

TAKE PRIDE IN AMERICA

United States Department of the Interior

FISH AND WILDLIFE SERVICE
FISH AND WILDLIFE ENHANCEMENT
MID-COUNTY CENTER, U.S. ROUTE 17
P.O. BOX 480
WHITE MARSH, VIRGINIA 23183

July 16, 1993

Mr. Terry M. Potterton
National Aeronautics and
Space Administration
Wallops Island Flight Facility
Wallops Island, Virginia 23337

Re: Sounding Rocket Program and Environmental Resources Document, Wallops Island, Virginia

Dear Mr. Potterton:

This responds to your June 23, 1993 request for concurrence that the National Aeronautics and Space Administration's Sounding Rocket Program (SRP) and a revision of Wallops Flight Facility Environmental Resources Document (ERD) will not impact Federally listed species at Wallops Island in Accomack County, Virginia. We have reviewed the information you enclosed and are providing comments in accordance with provisions of the Endangered Species Act (87 Stat. 884, as amended; 16 U.S.C. 1531 et seq.).

The Federally listed endangered and threatened species known to occur at Wallops Island are the peregrine falcon (Falco peregrinus), piping plover (Charadrius melodus), and bald eagle (Haliaeetus leucocephalus). Your letter states that both the SRP and activities associated with the ERD are continuations of current operations. For the peregrine falcon and piping plover, we concur that continuation of current operations is not likely to adversely effect these Federally listed species. However, since the bald eagle nest has just been constructed this year, we cannot concur for operations that have not taken place since nest construction. Although future operations may be part of current operations, the eagles nesting at this site have not been exposed to these operations and may be adversely effected by them. The U.S. Fish and Wildlife Service (Service) recommends that any activity planned within 0.25 miles of the nest site be coordinated with this office.

Mr. Terry M. Potterton Page 2

This response relates only to endangered species under our jurisdiction. It does not address other Service concerns under the Fish and Wildlife Coordination Act or other legislation. If you have any questions or need further assistance, please contact Cindy Schulz of this office at (804) 693-6694.

Sincerely,

Cindy Schulz

for Karen L. Mayne
Supervisor
Virginia Field Office

COMMONWEALTH of VIRGINIA

H. C. Miller, Director

Department of Historic Resources
221 Governor Street
Richmond, Virginia 23219

TDD: (804) 786-1934
Telephone (804) 786-3143
FAX (804) 225-4261

July 20, 1993

Mr. Terry M. Potterton
Associate Chief, Safety, Environmental, & Security Office
Goddard Space Flight Center
Wallops Island, Virginia 23337

RE: Continued Operation at Goddard Space Flight Center Wallops Flight Facility
Wallops Island, Accomack County
VDHR File No. 93-1430-F

Dear Mr. Potterton:

Thank you for your letter of June 23, 1993 describing the project listed above. Our staff has completed review of the project. Based on the information submitted, we have determined that the proposed undertaking will have no effect on historic properties.

Thank you for the opportunity to comment on this project. You have met the requirements of Section 106 of the National Historic Preservation Act of 1966, as amended. If you have any questions regarding staff review of the undertaking, or if we can provide further assistance, please contact Antony Opperman.

Sincerely,

Bruce J. Larson
Project Review Supervisor

TS/P ui

COMMONWEALTH of VIRGINIA

Clinton V. Turner
Commissioner

Donald G. Blankenship
Deputy Commissioner

C. Kermit Spruill, Jr.
Director

Department of Agriculture and Consumer Services
Division of Product & Industry Regulation
PO Box 1163, Richmond, Virginia 23209

Divisions

Administration
Animal Health
Consumer Affairs
Dairy & Foods
Marketing
Product & Industry Regulation

July 13, 1993

Mr. Terry M. Potterton
Associate Chief
Safety, Environmental and Security Office
Goddard Space Flight Center
Wallops Island, VA 23337

RE: Endangered or threatened plant or insect species in or near Goddard Space Flight Center/Wallops Flight Facility

Dear Mr. Potterton:

This letter is in response to your request for information on listed threatened or endangered plant or insect species in the vicinity of Goddard Space Flight Center/Wallops Flight Facility located on Wallops Island, Virginia. To Date, there are no listed threatened or endangered plant or insect species known to occur in the area outlined on the topographic map that you provided.

The Virginia Department of Agriculture and Consumer Services has jurisdiction over listed plant and insect species only. The Virginia Department of Game and Inland Fisheries has jurisdiction over all other listed threatened or endangered species. Information regarding other listed species may be obtained from Ray Fernald, Environmental Section, Virginia Department of Game and Inland Fisheries, 4010 West Broad Street, Richmond, VA 23230.

Additional information on unique geologic formations, rare or critical habitat, rare species, and candidate species proposed for listing can be obtained from Mr. Tim O'Connell at the Division of Natural Heritage (804)786-7951. This information should be readily available from their database.

Thank you for your interest in the endangered or threatened plant and insect species in Virginia. If you have any questions or need any additional information, please contact me.

Sincerely,

John R. Tate
Endangered Species Coordinator
Office of Plant Protection
(804) 786-3515

cc: Tim O'Connell
Cheryl Cashman
Cindy Schulz
Ray Fernald

Clinton V. Turner
Commissioner

Donald G. Blankenship
Deputy Commissioner

C. Kermit Spruill, Jr.
Director

COMMONWEALTH of VIRGINIA

Department of Agriculture and Consumer Services
Division of Product & Industry Regulation
PO Box 1163, Richmond, Virginia 23209

Divisions

Administration
Animal Health
Consumer Affairs
Dairy & Foods
Marketing
Product & Industry Regulation

July 14, 1993

Mr. Terry M. Potterton
Associate Chief
Safety, Environmental and Security Office
Goddard Space Flight Center
Wallops Flight Facility
Wallops Island, Virginia 23337

RE: Impact on endangered species for continuation of operations at Goddard Space Flight Center.

Dear Mr. Potterton:

In response to your correspondence of June 23, 1993 regarding the conclusion that continuation of current operations at Goddard Space Flight Center/Wallops Flight Center will have no impact on listed threatened or endangered plant or insect species. We concur with your conclusion because at the present time there are no listed threatened or endangered plant or insect species known to occur in the vicinity of the facility.

Thank you for your interest in the endangered or threatened plant and insect species in Virginia. If you have any questions or need any additional information, please contact me.

Sincerely,

John R. Tate
Endangered Species Coordinator
Office of Plant Protection
(804) 786-3515

United States Department of the Interior

FISH AND WILDLIFE SERVICE

IN REPLY REFER TO:

Ecological Services, Fairbanks
Endangered Species
1412 Airport Way
Fairbanks, AK 99701
September 18, 1992

Mr. Ray Romero
Environmental Department
Computer Sciences Corporation
1324 West Avenue J, Suite 5
Lancaster, CA 93534

Dear Mr. Romero:

This responds to your June 1, 1992, letter requesting a list of endangered and threatened species and critical habitats in the vicinity of the Poker Flats rocket facility north of Fairbanks.

Two listed species occur in the Poker Flats area. The threatened arctic peregrine falcon (*Falco peregrinus tundrius*) nests in the tundra areas of northern and western Alaska and migrates through the area during spring and fall migration. American peregrine falcons (*Falco peregrinus anatum*) nest in the forested areas of interior Alaska, and also migrate through the area during spring and fall migration. There is no designated critical habitat in Alaska.

There are no known nest sites of American peregrine falcons within 10 miles of the Poker Flats area. As mentioned above, some arctic and American peregrine falcons likely migrate through the area each spring and fall.

I apologize for such a delay in responding to your request. Please write or call if you need additional information (907-456-0239).

Sincerely,

Skip Ambrose

Skip Ambrose
Branch Chief

United States Department of the Interior

FISH AND WILDLIFE SERVICE

TAKE PRIDE IN AMERICA

IN REPLY REFER TO

Ecological Services, Fairbanks
Endangered Species
1412 Airport Way
Fairbanks, AK 99701
May 21, 1993

Mr. Walter Unterberg
Computer Sciences Corporation
43439 Copeland Circle
Lancaster, CA 93535

Dear Mr. Unterberg:

This responds to your request for a list of endangered and threatened species and critical habitats pursuant to Section 7 of the Endangered Species Act of 1973, as amended (Act). This information is being provided for the proposed flight zones of the Poker Flats Research Range.

Three listed species occur in the area of the proposed activity. The endangered American peregrine falcon (*Falco peregrinus anatum*) nests in the forested areas of interior Alaska, and migrates through the area during spring and fall migration. The threatened arctic peregrine falcon (*Falco peregrinus tundrius*) nests in the tundra areas of northern and western Alaska and also migrates through the area during spring and fall migration. There is no designated critical habitat for peregrine falcons in Alaska.

Spectacled eiders were recently listed as a threatened species under the Act. Spectacled eiders nest in coastal tundra areas on the North Slope. Information of nesting habitat and nest locations is limited, and the population in Alaska has declined considerably in recent years. The U.S. Fish & Wildlife Service has developed draft recommended protection measures for spectacled eiders which are enclosed for your information. There is no designated critical habitat for spectacled eiders in Alaska.

Thank you for your concern for endangered species. If I can be of further assistance, please contact me at (907) 456-0297.

Sincerely

Janey Fadely

Janey Fadely
Wildlife Biologist

Recommended Protection Measures for Spectacled Eiders

The following protection measures are intended as general guidelines and may not be appropriate in all situations. Current knowledge of spectacled eider breeding biology is limited and the level of protection needed may vary with topography, vegetation and the sensitivity of individual birds to human activity. When feasible, proposed activities should be examined on a case by case basis by a biologist knowledgeable of the habits and behavior of spectacled eiders.

Service-approved surveys for spectacled eiders are required for proposed activities within their historical range. Nest sites are defined as those sites used by spectacled eiders for nesting in the current year and/or in the previous five years.

A. Within 200m of nest sites:

   1. Prohibit all ground level activity from May 1 to August 1, except on existing thoroughfares, or when nest site is unoccupied in current year.
   2. Prohibit the construction of permanent facilities.
   3. Prohibit habitat alterations.

B. Within 1 km of nest sites, prohibit high noise level activities or operation of high-noise level facilities May 1 through August 31. These include but are not limited to: airports, blasting, and compressor stations. Existing facilities and thoroughfares are excepted.

C. Maintain adequate access from nest sites to potential brood-rearing ponds.

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
Ecological Services
Suite D, 3530 Pan American Highway, NE
Albuquerque, New Mexico 87107

June 22, 1992

Cons. No. 2-22-92-I-261

Mr. Ray Romero
Environmental Department
Computer Sciences Corporation
1324 West Avenue J, Suite 5
Lancaster, California 93534

Dear Mr. Romero:

This responds to your letter to the Regional Director, U.S. Fish and Wildlife Service (Service), dated June 1, 1992, requesting a list of species Federally listed or proposed to be listed as threatened or endangered. Your geographic area of interest is White Sands Missile Range, which occupies portions of Dona Ana, Lincoln, Otero, Sierra, and Socorro Counties, New Mexico.

The American peregrine falcon, bald eagle, aplomado falcon, Sneed pincushion cactus, and Todsen's pennyroyal may be found in your area of interest. The enclosed list also includes Category 1 and Category 2 candidate species. Category 1 candidates are those species which the Service has substantial information to support their listing as endangered or threatened. Development and publication of proposed rules for these species is anticipated. Category 2 candidates are those species for which the Service has information indicating that proposing to list is possibly appropriate, but for which substantial data on biological vulnerability or threats are not currently known to support the immediate preparation of proposed rules. Candidate species have no legal status under the Endangered Species Act and are included in this document for planning purposes only. However, the Service would appreciate receiving any status information currently available or recently gathered concerning these species.

On January 30, 1992, the Service received a petition to list the southwestern willow flycatcher (*Empidonax traillii extimus*), a Category 1 candidate species. The petition is currently under review to determine if it presents substantial scientific information indicating the petitioned action is warranted.

We suggest you contact the New Mexico Department of Game and Fish and the New Mexico Energy, Minerals and Natural Resources Department, Forestry and Resources Conservation Division for information concerning fish, wildlife, and plants of state concern.

Mr. Ray Romero

2

If we can be of further assistance, please call Mr. Gerry Roehm or Ms. Anne Cully at (505) 883-7877.

Sincerely,

Jennifer Fowler-Propst
Field Supervisor

Enclosure

cc: (wo/enc)
Director, New Mexico Department of Game and Fish, Santa Fe, New Mexico
Director, New Mexico Energy, Minerals and Natural Resources Department, Forestry and Resources Conservation Division, Santa Fe, New Mexico

State of New Mexico
ENERGY, MINERALS and NATURAL RESOURCES DEPARTMENT
Santa Fe, New Mexico 87505

DRUG FREE

BRUCE KING
GOVERNOR

ANITA LOCKWOOD
CABINET SECRETARY

7 August, 1992

Richard L. Wessel
Computer Sciences Corporation
Applied Technology Division
1324 West Avenue J, Suite 5
Lancaster, California 93534

Dear Mr. Wessel,

This letter responds to your requests for information addressed to Karen Lightfoot and Bob Sivinski concerning state listed endangered plants likely to occur in the proposed launch and impact areas for the NASA Sounding Rocket Program (SRP) on White Sands Missile Range, New Mexico. Enclosed is a list of state endangered plants, some in addition to the list of federally listed threatened, endangered, and candidate species that you sent.

One species on the list you sent, Escobaria villardii, (Villard's pincushion cactus) is not likely to occur on the mapped payload impact and launch sites that you enclosed with your letters. It is found only in the foothills of the Sacramento Mountains, to the east of Alamogordo.

We suggest that you contact David Anderson, a botanist currently working at White Sands Missile Range, at (505) 678-7817. David can help you with identification of plants on the missile range and should also be called upon to edit the botanical parts of your EIS for correctness.

If you have any questions, please do not hesitate to call Karen Lightfoot at 827-7853 or Bob Sivinski at 827-7865, Endangered Species Botanists for the State of New Mexico.

Sincerely,

Raymond R. Gallegos
State Forester

By:

Karen S. Lightfoot

VILLAGRA BUILDING - 408 Galisteo
Forestry and Resources Conservation Division
P.O. Box 1948 87504-1948
827-5830
Park and Recreation Division
P.O. Box 1147 87504-1147
827-7465

2040 South Pacheco
Office of the Secretary
827-5950
Administrative Services
827-5925
Energy Conservation & Management
827-5900
Mining and Minerals
827-5970

LAND OFFICE BUILDING - 310 Old Santa Fe Trail
Oil Conservation Division
P.O. Box 2088 87504-2088
827-5800

A-17

GOVERNOR
Bruce King

STATE OF NEW MEXICO
DEPARTMENT OF GAME & FISH
Villagra Building
P.O. Box 25112
Santa Fe, N.M. 87504

STATE GAME COMMISSION
JAMES H. (JAMIE) KOCH, CHAIRMAN
SANTA FE
THOMAS P. ARVAS, O.D., VICE-CHAIRMAN
ALBUQUERQUE
BOB JONES
CROW FLATS
J.W. "JOHNNY" JONES
ALBUQUERQUE
BRUCE WILSON
MESILLA PARK
DAVID M. SALMAN
LA CUEVA
ANDREA MAES CHAVEZ
NAVAJO DAM

DIRECTOR AND SECRETARY
TO THE COMMISSION
Bill Montoya

August 4, 1992

Mr. Richard L. Wessel
Computer Sciences Corporation
1324 West Avenue J, Suite 5
Lancaster, California 93534

Dear Mr. Wessel:

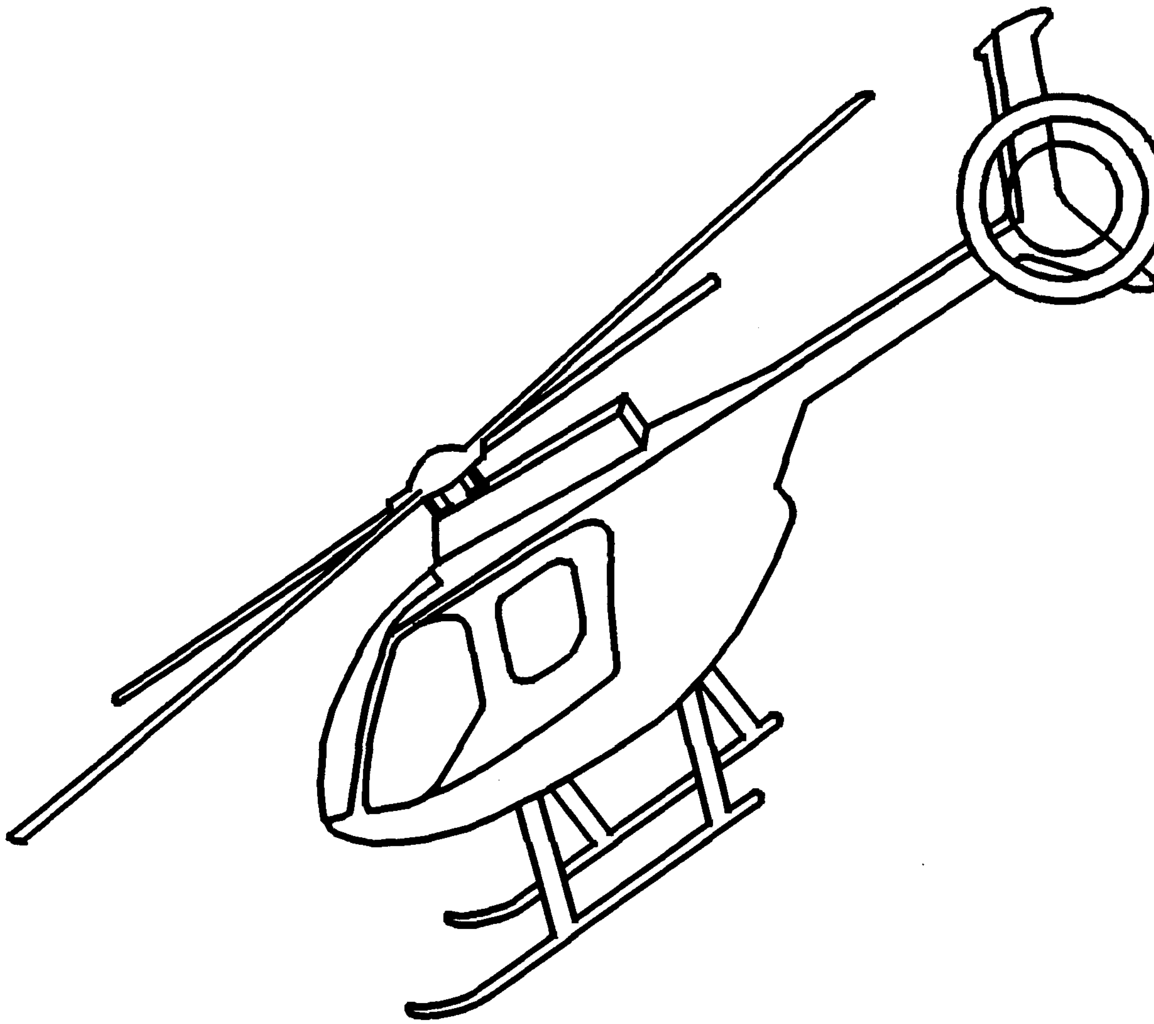
This letter is in response to your inquiry of July 23, 1992 regarding information for an update of the Environmental Impact Statement for the Sounding Rocket Program at White Sands Missile Range, New Mexico. The occupied habitat of the White Sands pupfish (Cyprinodon tularosa), a federal candidate (category 2) and New Mexico endangered (Group 2) species is outlined in yellow on the map you included. Based upon the information you have provided, approximately 10 missile payload impacts have occurred since 1987 in the immediate vicinity of habitats occupied by the White Sands pupfish. The White Sands Pupfish Conservation Plan specifically prohibits such activities within occupied habitats and associated buffer zones. The Department is committed to enforce the Conservation Plan and finds it unacceptable for these impacts to continue.

Lists of state-endangered wildlife occurring in these five counties are enclosed. If you have any questions or need additional information, please contact John Pittenger (505-827-9907) or David L. Propst (505-827-9906).

Sincerely,

Bill Montoya
Director

BM/dlp/ap
Enc.



APPENDIX B

NAVAL PROTOCOLS FOR PAYLOAD RECOVERY AT WSMR

DEPARTMENT OF THE NAVY
NAVAL AIR WARFARE CENTER
WEAPONS DIVISION
WHITE SANDS MISSILE RANGE NM 88002-5510

5090
Ser 52W4C0F/003
25 JAN 1996

From: Officer in Charge, Naval Air Warfare Center Weapons Division
To: National Aeronautics and Space Administration, Goddard Space Flight Facility (Code 841), Attn: Mr. Warren Gurkin), Wallops Island VA 2337-5099

Subj: INFORMATION ON THE WHITE SANDS PUPFISH FOR INCLUSION IN THE EIS FOR THE SOUNDING ROCKET PROGRAM

Encl: (1) U.S. Department of Interior ltr of 13 Jul 95
(2) State of New Mexico Department of Fish and Game ltr of 1 Aug 95
(3) U.S. Army WSMR ltr of 23 Aug 95
(4) White Sands Pupfish Conservation Team ltr of 4 Dec 95
(5) WSMR Pupfish Locations and Other Environmentally Sensitive Areas on WSMR
(6) SSOP Nr. NOMTS 50-09-92 of 6 Aug 92
(7) NAWCWPNS Environmental Recovery Report
(8) Risk Assessment and Its Application to Flight Safety Analysis
(9) Nominal Impact Point for Nike Black Brant on WSMR
(10) Video of a Typical Recovery

1. PURPOSE

This document provides, for the Sounding Rocket Program at White Sands Missile Range (WSMR), a recommended mitigation for environmental concerns related to the White Sands Pupfish. The combination of this with existing mitigation in place will clearly result in no environmental impact on the White Sands Pupfish. In support of this recommendation, this document also provides information on the Pupfish habitat; mitigation measures that are and have been in place to protect the Pupfish; maps that show the aim point and its relationship to Salt Creek; and general information, such as copies of recovery reports and recovery videos.

2. CONCERNS

Since the release of your latest Draft Environmental Impact Statement (EIS) for the Sounding Rocket Program dated August 1994, we have received several letters of concern regarding the potential impact from the project on the White Sands Pupfish. A representative subset of these letters is provided as enclosures (1) through (4). It should be reasonably easy for the EIS to address the concerns, as potential impacts are already being mitigated.

Subj: INFORMATION ON THE WHITE SANDS PUPFISH FOR INCLUSION IN THE EIS FOR THE SOUNDING ROCKET PROGRAM

3. **WHITE SANDS PUPFISH**

a. While the White Sands Pupfish seems to do quite well at White Sands, they are considered a Category 2 Candidate Species by the U.S. Fish and Wildlife Service (USFWS) and listed as a Category 2 Endangered Species by the New Mexico Department of Game and Fish. The White Sands Pupfish occurs only in the Tularosa Basin, New Mexico, on lands administered by the Department of Defense (WSMR and Holloman Air Force Base) and on lands administered by the National Park Service (White Sands National Monument). As a result, WSMR has the responsibility to carry out both the military and land management missions, with consideration for the mandates of the National Environmental Policy Act of 1969 and the Endangered Species Act of 1973. A concern of WSMR is the Pupfish could very easily become federally endangered. If that were the case, additional restrictions on testing could result.

b. The following definitions and descriptions are provided for your information:

(1) The Essential Habitat of the White Sands Pupfish is habitat that must be protected from anthropogenic disturbances and perturbations to ensure survival of the species. All non-emergency vehicular traffic is prohibited within Essential Habitat with the exception of existing improved and unimproved roads. Likewise, all non-emergency military activities are prohibited within Essential Habitat. In the case of emergency activities that may affect habitats of the White Sands Pupfish, such as chemical spills, missile debris, or recovery, the Navy Environmental Representative is required to contact the WSMR Army Environmental Office for coordination of mitigation activities.

(2) Essential Habitat, per the WSMR Pupfish Conservation Team, consists of:

(a) Salt Creek and all tributaries with perennial flow or perennial springs between Range Road 6 and Range Road 8, including a corridor 200 meters (660 feet) wide, extending 100 meters (330 feet) from either side of the center of the stream of perennial tributary channel and all land within 100 meters of any perennial tributary spring; see enclosure (5).

(b) Mound Springs, including the area within 100 meters of the perimeter of the spring ponds; see enclosure (5).

(c) Malpais Springs, including the area within 100 meters of the perimeter of the spring pond; its outflow stream, including a corridor 200 meters wide, extending 100 meters from either side of the center of the stream channel; and the

Subj: INFORMATION ON THE WHITE SANDS PUPFISH FOR INCLUSION IN THE EIS FOR THE SOUNDING ROCKET PROGRAM

associated wetlands and playas, including all land within 100 meters of the high water boundary of the wetlands and playas associated with Malpais Springs; see enclosure (5).

(3) Limited Use Areas are adjacent lands where activities must be managed to ensure degradation of Essential Habitat does not occur through direct or indirect effects, such as contaminant runoff and excessive soil erosion. All activities proposed within Limited Use Areas, with the exception of emergency activities, must be coordinated with the Navy Environmental Office in accordance with the National Environmental Policy Act of 1969, and be consistent with the intent of the Wildlife Conservation Act of 1974, with particular emphasis given to avoidance of impacts to habitats and populations of the Pupfish.

c. Most of the above description and mitigation should be incorporated into the EIS. This will assist the reader in understanding the project recognizes the sensitivity of the Pupfish and has built-in mitigation to ensure no impact.

4. NASA SOUNDING ROCKET MITIGATION MEASURES CURRENTLY IN PLACE

a. After launch/impact the recovery team is transported via helicopters to locate the sustainer and payload. The sustainer is ground recovered by entering the desert single file from the nearest point of an existing road and the payload is recovered by helicopter; no vehicles are required. A representative from the Navy Environmental Office is always present and an essential part of the recovery team. In addition to ensuring compliance with the Safety Standard Operating Procedure for Recovery of Space Rockets (enclosure (6)), a detailed Environmental Recovery Report (enclosure (7)) is completed for every mission. Videos and still photos are also taken to support the Environmental Recovery Report entries, such as ground disturbance, distance to sensitive areas, vegetation, soil type, distance to nearest water source, any animal life in the area; and to document the overall recovery operation. Historically, the only rocket debris that could pose a threat to the Pupfish population is the payload, as the sustainer typically impacts to the south and away from Pupfish habitat.

b. The payload soft lands via parachute and normally the only ground disturbance is equal to the diameter of the end of the payload and a depression two to five inches deep. Because of the soft landing and the nature of the payload (typically totally inert), there is no potential impact to the environment or Pupfish. Furthermore, the worst case scenario, a direct hit on Salt Creek, would not impact the Pupfish population unless we directly impacted a Pupfish. Of the 1162 recorded impacts of

Subj: INFORMATION ON THE WHITE SANDS PUPFISH FOR INCLUSION IN THE EIS FOR THE SOUNDING ROCKET PROGRAM

Space Rockets missions since 1967, there have been no impacts on Salt Creek. Based on history, the probability of impacting Salt Creek is less than the probability of an off-range impact (see enclosure (8)). The statistical calculations in effect at WSMR dictate a 10^{-6}:1 statistical likelihood of an off-range impact. Therefore, the probability of directly impacting a Pupfish is very low. Enclosure (10) is a video of a typical Space Rockets recovery.

5. RECOMMENDED MITIGATION

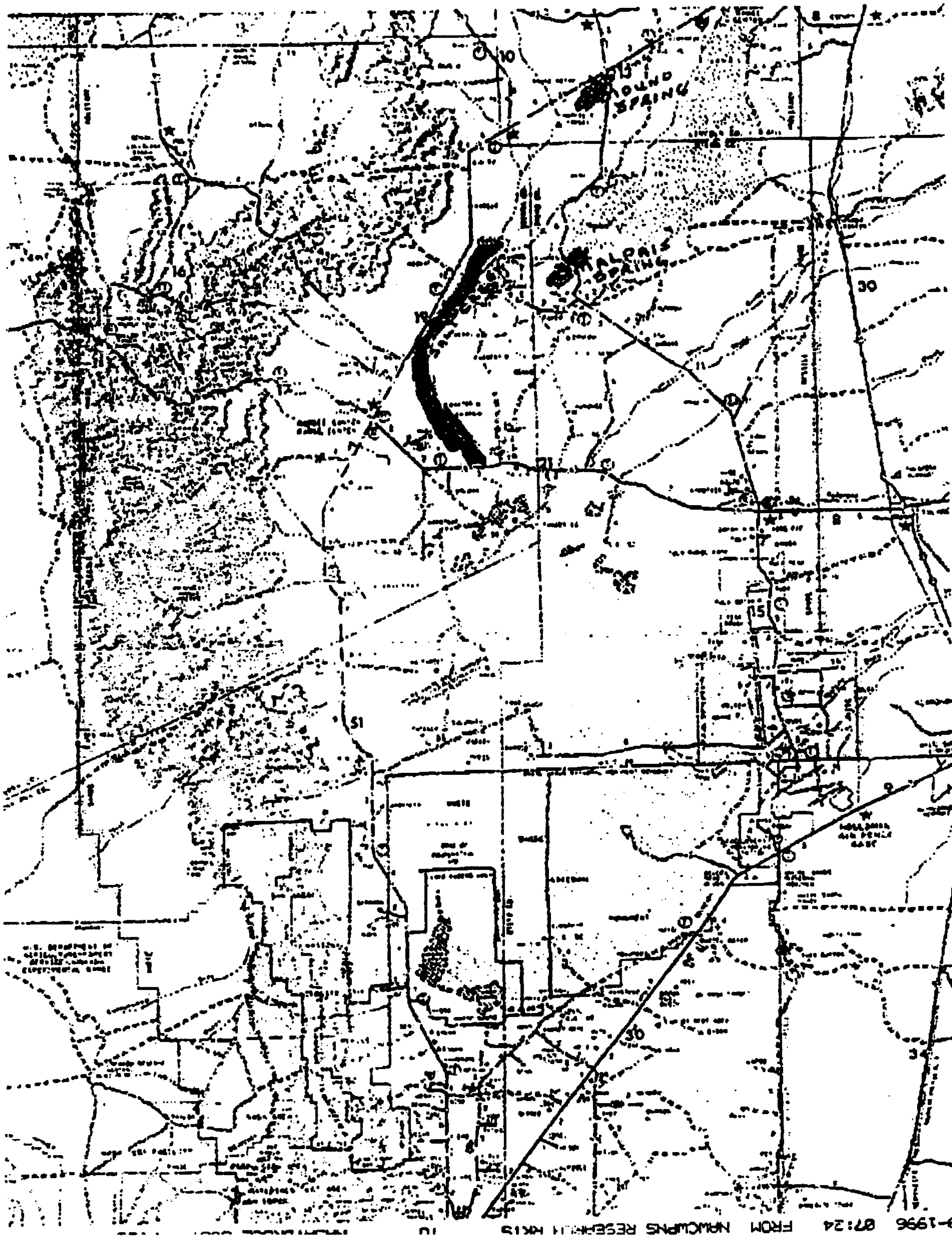
a. Our assessment of the information presented in enclosures (1) through (9) is that it is not necessary to actually "move" the aim point. In order to mitigate the Pupfish related concerns, however, we propose amending the existing launch day aim point procedures. This amendment would incorporate a real-time assessment of parameters affecting predicted impact, with an "adjustment" of aim point to reduce the potential for impact into Salt Creek. We have initiated discussion with the National Range on this matter, and believe it can be implemented as a no cost solution.

b. Recommend the information contained herein be provided to your environmental personnel for use in their environmental documentation preparation.

6. NAWCWPNSDIV WS point of contact for this action is Research Rockets Director, Mr. Tom Gonzales, (505) 678-5502, or the Environmental Officer, Mr. Tom Coleman, (505) 678-7899.

C.F. Broski-Konczey

C.F. BROSKI-KONCZEY
Acting



UDS 804
REVISION NO. ORIGINAL
OPERATION NO. 9

SSOP NR. NOMTS 60-09-92
DATE: 06 AUGUST 1992

SAFETY STANDARD OPERATING PROCEDURES
FOR
RECOVERY OF SPACE ROCKETS

AREA	PLACE
SALT CREEK OUTSIDE IMPACT AREA	VARIOUS

EXPLOSIVE LIMITS: N/A

PERSONNEL LIMITS: AS REQUIRED

NOTE

THIS OPERATION DICTATED BY NAWCWPNSWS
AND WSMR ENVIRONMENTAL OFFICE.

1. PROCEDURES

a. The National Range Recovery Support Section (NR-CS) has the responsibility to recover all test items which impact within the Salt Creek area or outside the designated impact area.

b. Upon receipt of information or discovery that an impact occurred within 400 meters of the Salt Creek area. Recovery personnel will immediately notify the Chief, Range Support Section. Absolutely no recovery operation will be undertaken at the Salt Creek area without the concurrence of the Chief, Range Support Section, Space Rockets Director, NOMTS and the Chief, Environmental and Safety Directorate.

c. Recovery at Salt Creek will begin at the earliest possible moment. An assigned Army Air aircraft will pick up the Environmental personnel at the WSMR parade grounds or area designated and proceed to the impact point. An environmental representative must be present during all recovery operations within 400 meters of Salt Creek.

d. Under no circumstances will any NR-CS vehicles enter within 400 meters of Salt Creek unless the OIC or NCOIC of the recovery team, or in their absence the ranking individual present, has personally coordinated the matter with the Environmental Chief or his authorized representative.

e. All recovery operations will be coordinated with the Environmental representative on recovering missile debris within 400 meters of Salt Creek.

f. Upon receipt of information or discovery that an impact occurred outside the designated impact area, the recovery personnel will be observant for any artifacts. If any artifacts are discovered they will not be disturbed. The Space Rockets Director, NOMTS Environmental Office, Chief, Range Support Section, and Chief, Environmental and Safety Directorate, will be notified.

PAGE 30 ENCL (6)

UDS 804
REVISION NO. ORIGINAL
OPERATION NO. 9

SSOP NR. NOMTS 50-09-92
DATE: 06 AUGUST 1992

g. Excavation of missile debris at Salt Creek or outside designated impact area. Prior to any excavation the OIC, NCOIC of the recovery team, or in their absence the ranking individual present, will contact the NOMTS Environmental Office, Chief, Range Support Section; and Chief, Environmental and Safety Directorate will be notified. No excavation will be conducted without an Environmental representative present at site. After removal of debris all disturbed areas will be refilled to a level matching the surrounding terrain.

h. Absolutely no deviations from this policy will be permitted.

NAWCWPNS ENVIRONMENTAL RECOVERY REPORT

PROJECT NAME DATE

OP CODE REC/EA/EIS/REFERENCE

GIS/X, Y/SURVEY OF IMPACT

1. Provide a brief description of the recovery operation including variables such as air or ground recovery, miles driven off the nearest roadway, number and type of recovery vehicles, approx. size of surface disturbance, EOD required to destroy debris, percentage of debris recovered, size of debris, any ground contamination associated with debris (fuel, batteries, hydraulics), fire resulting from impact, and any other information which may be environmental concern.

NAWCWPNS ENVIRONMENTAL RECOVERY REPORT

2. DESCRIPTION OF THE AREA OF IMPACT (Place an “X” next to the best description)

a. GEOLOGY/TOPOGRAPHY

(1) FLAT
(2) FOOTHILLS
(3) MOUNTAINOUS
(4) GYPSUM DUNES (WHITE)
(5) DRY LAKEBED
(6) ARROYO
(7) SAND DUNES (BROWN)

COMMENTS

b. SOIL

(1) SAND
(2) ROCK MIXED WITH SOIL-SAND
(3) GYPSUM (WHITE SAND)
(4) HEAVY SOIL (CLAY OR CALICHE)

COMMENTS

C. VEGETATION (IDENTIFY SPECIFIC SPECIES IN COMMENTS IF POSSIBLE)

(1) GRASSLAND
(2) CACTUS
(3) MESQUITE
(4) MIXED SHRUBS
(5) NONE
(6) CREOSOTE
(7) OTHER
(8) PERCENTAGE COMBINATIONS OF 1-7

COMMENTS

d. WATER RESOURCES IN THE IMPACT AREA

(1) SPRING
(2) TEMPORARY LAKE
(3) PERMANENT LAKE
(4) NONE
(5) APPROX. DISTANCE FROM NEAREST WATER RESOURCE

COMMENTS

e. WILDLIFE (IDENTIFY IN COMMENTS IF POSSIBLE

(1) BIRDS
(2) FISHES
(3) REPTILES/AMPHIBIANS
(4) MAMMALS

COMMENTS

f. HISTORIC SITES (OLD)

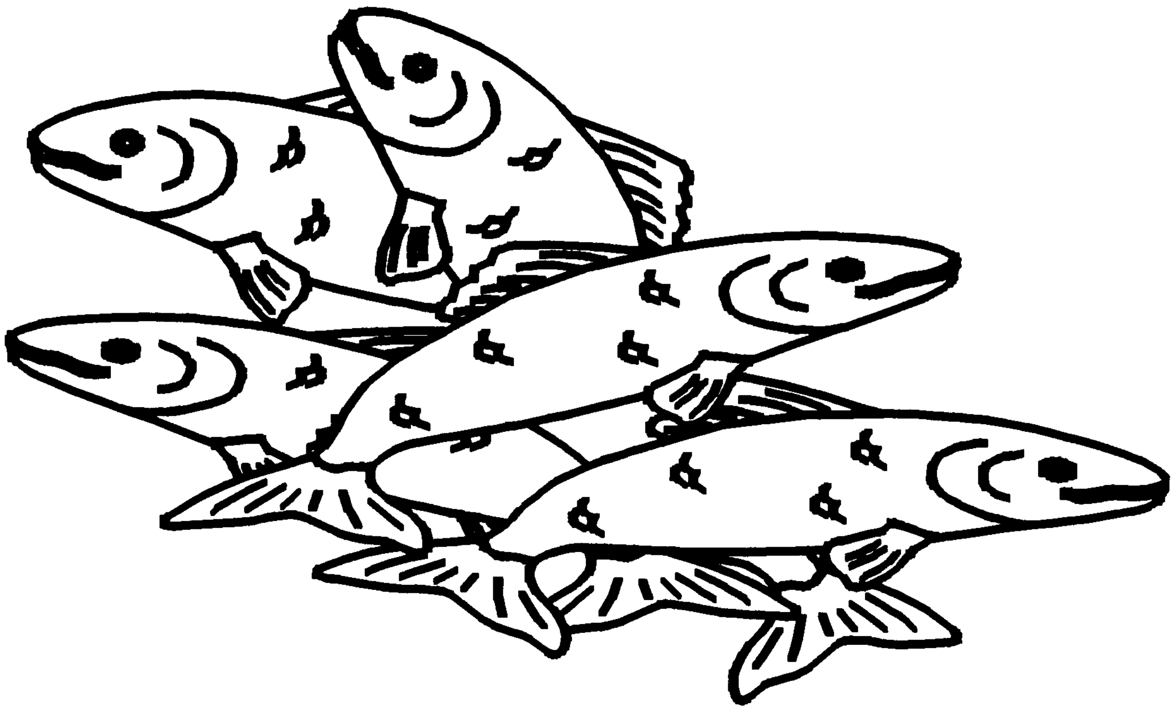
(1) RANCH
(2) MINE
(3) FENCE
(4) WINDMILL
(5) CORRAL

COMMENTS

g. PREHISTORIC SITES (OLDER)

(1) PIECES OF BROKEN FLINT
(2) PIECES OF POTTERY
(3) BURNT ROCK
(4) BONES

COMMENTS



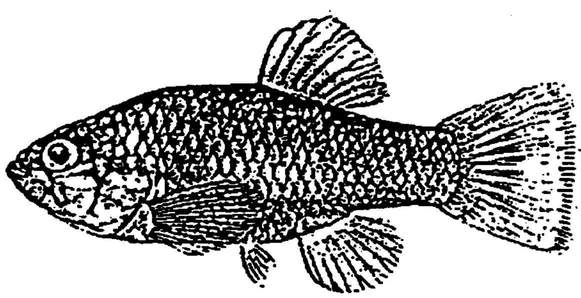
APPENDIX C

WHITE SANDS PUPFISH
COOPERATIVE AGREEMENT

White Sands Pupfish
Cooperative Agreement

Signatories:

U. S. Army – White Sands Missile Range
U.S. Air Force – Holloman Air Force Base
National Park Service – White Sands National Monument
U.S. Fish and Wildlife Service
New Mexico Department of Game and Fish



Pupfish figure O by Joseph R. Tomellen
Excerpted with permission from "Fishes of New Mexico" by James E. Suhlette, Michael D. Hatch and Mary Sublette

Cooperative Agreement
for
Protection and Maintenance of White Sands Pupfish
between
U.S. Army - White Sands Missile Range
U.S. Air Force - Holloman Air Force Base
National Park Service - White Sands National Monument
U.S. Fish and Wildlife Service
New Mexico Department of Game and Fish

JULY 21, 1994

Whereas, the White Sands pupfish is considered a Category 2 Candidate Species by the U.S. Fish and Wildlife Service (USFWS), and is listed as a Category 2 Endangered Species by the New Mexico Department of Game and Fish (NMGF); and

Whereas, the White Sands pupfish occurs only in the Tularosa Basin, New Mexico, on Department of Defense lands administered by the U.S. Army - White Sands Missile Range (WSMR) and U.S. Air Force - Holloman Air Force Base (HAFB), and on lands administered by the National Park Service - White Sands National Monument (WSNM); and

Whereas, the USFWS has the responsibility to review the status of species and determine the need to provide protection through the Endangered Species Act of 1973, as amended; and,

Whereas, WSMR and HAFB have the responsibility to carry out their respective military and land management missions, and WSNM has responsibility to carry out its land management mission, with consideration to the mandates of the National Environmental Policy Act of 1969 and the Endangered Species Act;

Therefore, the parties signatory to this document agree to abide by the management and protection practices set forth in the attached *White Sands Pupfish Conservation Plan* (Plan), (Appendix I).

I. PURPOSE

This Cooperative Agreement is formulated to delineate an effective and cooperative working relationship between its signatories in protecting and maintaining viable populations of the White Sands pupfish (*Cyprinodon tularosa* Miller and Echelle) in its natural habitats on White Sands Missile Range, Holloman Air Force Base, and White Sands National Monument.

II. AUTHORITIES

National Environmental Policy Act of 1969 (42 U.S.C. 4321)
Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq*.)
New Mexico Wildlife Conservation Act (17-2-37 to 17-2-46 NMSA 1978)

III. OPERATIONS

A. DESCRIPTION OF THE AREA AND GENERAL INTENT

1. Essential Habitat of the White Sands pupfish is habitat that must be protected from anthropogenic disturbances and perturbations to ensure survival of the species. All non-emergency vehicular traffic shall be prohibited within Essential Habitat with the exception of use of existing improved and unimproved roads. Likewise, all non-emergency military activities, with the exception of natural and cultural resource management, conservation and research (to include, but not be limited to pupfish monitoring, research and conservation activities), shall be prohibited within Essential Habitat. In the case of emergency activities that may affect habitats of White Sands pupfish, such as chemical spills, missile debris recovery, or carrion removal, NMGF and USFWS shall be notified and consulted, as appropriate.

2. Essential Habitat shall consist of:

   a. Salt Creek and all tributaries with perennial flow or perennial springs between Range Road 6 and Range Road 8, including a corridor 200 meters (660 feet) wide, extending 100 meters (330 feet) from either side of the center of the stream or perennial tributary channel and all land within 100 meters (330 feet) of any perennial tributary spring (Appendix I, Figure 3);

   b. Mound Spring, including the area within 100 meters (330 feet) of the perimeter of the spring ponds (Appendix 1, Figure 3);

c. Malpais Spring, including:

   i. The area within 100 meters (330 feet) of the perimeter of the spring, pond (Appendix 1, Figure 3);

   ii. Its outflow stream, including a corridor 200 meters (660 feet) wide, extending 100 meters (330 feet) from either side of the center of the stream channel; and

   iii. The associated wetlands and playas, including all land within 100 meters (330 feet) of the high-water boundary of the wetlands and playas associated with Malpais Spring;

d. All stream channel of Malone Draw and Lost River on HAFB and WSNM and a corridor 200 meters (660 feet) wide, extending 100 meters (330 feet) from either side of the center of the stream channel (Appendix 1, Figure 3).

e. In addition to the delineations described above, Essential Habitat shall also include any other areas where White Sands pupfish are found or transplanted to, as well as a 100-meter (330-foot) buffer around said habitat, as demonstrated in the previous delineations.

3.. Limited Use Areas are adjacent lands where activities must be managed to ensure that degradation of Essential Habitat does not occur through direct or indirect effects such as contaminant runoff and excessive soil erosion. All activities proposed within Limited Use Areas, with the exception of emergency activities (such as chemical spill response, rescues, and carrion removal), shall be coordinated with NMGF and USFWS as required by the National Environmental Policy Act of 1969 and consistent with the intent of the Wildlife Conservation Act of 1974, with particular emphasis given to avoidance of impacts to habitats and populations of White Sands pupfish.

4. Limited Use Areas shall consist of all land within the topographic drainage basin of Salt Creek, Malpais Spring and Malone Draw-Lost River and other areas, as described above (III.A.2.a, c, d and e). Additionally, the are defined above as Essential Habitat at Mound Spring (III.A.1.b), shall also be a Limited Use Area.

B. AGENCY RESPONSIBILITIES

2. WSMR agrees to:

   a. Protect, manage and enhance habitats of the White Sands pupfish within Limited Use Areas on WSMR, in coordination with the signatory agencies.

   b. Assist in research and monitoring of habitats and populations of White Sands pupfish to further protection and management of said habitats and populations within the Limited Use Areas on WSMR, in coordination with the signatory agencies.

   c. Prohibit the transport of any live non-native aquatic organisms to or in the vicinity of habitats occupied by White Sands pupfish. Furthermore, aquatic habitats within WSMR not currently inhabited by White Sands pupfish shall not be considered for establishment of non-native aquatic organisms without prior consultation with and consent by USFWS and NMGF.

   d. Cooperate with the signatory agencies in the chemical or mechanical removal of specifically identified populations of non-native fishes within WSMR to prevent the potential contamination of habitats or populations of White Sands pupfish.

   e. Develop a management plan for feral horses, in coordination with the signatory agencies, to facilitate the protection, management and enhancement of populations and habitats of White Sands pupfish on WSMR.

   f. Coordinate all unclassified activities proposed for implementation within the Limited Use Areas with the signatory agencies to prevent negative impacts to White Sands pupfish or its habitat and review current project activities to ensure that no potential negative impacts to the species or its habitat are impending. Monitor all unclassified activities within Limited Use Areas on WSMR to ensure that no negative impacts occur.

   g. Evaluate all classified project activities that may affect the White Sands pupfish or it habitat and ensure that no negative impacts to the species or its habitat will occur. Monitor all classified activities within Limited Use Areas on WSMR to ensure that no negative impacts occur.

   h. Develop and implement incident response programs for accidental chemical spills, impacts from missile debris, vehicle accidents, etc. and coordinate the resolution of any unforeseen perturbation to the White Sands pupfish or its habitats with signatory agencies immediately upon detection or advisement of such event(s).

i. Develop a Customer Orientation Package to provide all WSMR mission customers and their agents with written procedures for ensuring their project activities are carried out in accordance with the Plan.

j. Monitor all project customer activities within the Limited Use Areas to ensure compliance with this agreement.

k. Allow unescorted access to the area designated as Essential Habitat on WSMR (III.A.2.a, b, c and e), for three representatives of each signatory agency (these representatives shall hereafter be referred to as the Conservation Team for the purpose of implementing the Plan).

l. Provide in-briefing for non-WSMR Conservation Team personnel outlining scheduling, safety, and security principles and practices.

m. Provide the Conservation Team with photo permits and military transportation authorizations (flight orders).

n. Inform NMGF of any infraction of the New Mexico Wildlife Conservation Act of 1974.

2. HAFB agrees to:

a Protect, manage and enhance habitats of the White Sands pupfish within Limited Use Area on HAFB, in coordination with the signatory agencies.

b. Assist in research and monitoring of habitats and populations of White Sands pupfish to further protection and management of said habitats and populations within the Limited Use Areas on HAFB, in coordination with the signatory agencies.

c. Prohibit the transport of any live non-native aquatic organisms to or in the vicinity of habitats occupied by White Sands pupfish. Furthermore, aquatic habitats within HAFB not currently inhabited by White Sands pupfish shall not be considered for establishment of non-native aquatic organisms without prior consultation with and consent by USFWS and NMGF.

d. Cooperate with the signatory agencies in the chemical or mechanical removal of specifically identified populations of non-native fishes within HAFB to prevent the potential contamination of habitats of populations of White Sands pupfish.

e. Coordinate all unclassified activities proposed for implementation within the Limited Use Areas with the signatory agencies to prevent negative impacts to

White Sands pupfish or its habitat and review current project activities to ensure that no potential negative impacts to the species or it habitat are impending. Monitor all unclassified activities within Limited Use Areas on HAFB to ensure that no negative impacts occur.

f. Evaluate all classified project activities that may affect the White Sands pupfish or its habitat and ensure that no negative impacts to the species or it habitat will occur. Monitor all classified activities within Limited Use Areas on HAFB to ensure that no negative impacts occur.

g. Develop and implement incident response programs for accidental chemical spills, impacts from airborne debris, vehicle accidents, etc. and coordinate the resolution o f any unforeseen perturbation to the White Sands pupfish or its habitat with signatory agencies immediately upon detection or advisement of such event(s).

h. Allow unescorted Conservation Team access to the areas designated as Essential Habitat on HAFB (III.A.2.d and e).

i. Inform NMGF of any infraction of the New Mexico Wildlife Conservation Act of 1974.

3. WSNM agrees to:

a. Protect, manage and enhance habitats of the White Sands pupfish within Limited Use Areas on WSNM, in coordination with the signatory agencies.

b. Assist in research and monitoring of habitats and populations of White Sands pupfish to further protection and management of said habitats and populations within the Limited Use Areas on WSNM, in coordination with the signatory agencies.

c. Prohibit the transport of any live non-native aquatic organisms to or in the vicinity of habitats occupied by White Sands pupfish. Furthermore, aquatic habitats within WSNM not currently inhabited by White Sands pupfish shall not be considered for establishment of non-native aquatic organisms without prior consultation with and consent by USFWS and NMGF.

d. Cooperate with the signatory agencies in the chemical or mechanical removal of specifically identified populations of non-native fishes within WSNM to prevent the potential contamination of habitats or populations of White Sands pupfish.

Cooperative Agreement - 6

e. Coordinate all activities proposed for implementation within the Limited Use Areas with the signatory agencies to prevent negative impacts to White Sands pupfish or its habitat and review current project activities to ensure that no potential negative impacts to the species or its habitat are impending. Monitor all activities within Limited Use Areas on WSNM to ensure that no negative impacts occur.

f. Coordinate the resolution of any unforeseen perturbation to the population of White Sands pupfish or its habitat with signatory agencies immediately upon detection or advisement of such event(s).

g. Allow Conservation Team access to the area designated as Essential Habitat on WSNM (III.A.2.d and e).

h. Inform NMGF of any infraction of the New Mexico Wildlife Conservation Act of 1974.

4. USFWS agrees to:

a. Participate in protection, management, enhancement, research and monitoring of habitats and populations of White Sands pupfish in accordance with the Plan (Appendix I).

b. Provide consultation to WSMR, HAFB, and WSNM on all activities that may impact habitats or populations of White Sands pupfish.

c. Provide WSMR, through the WSMR sponsor, with a written request for unescorted access to Uprange areas for each of its Conservation Team personnel. Included in the request will be a listing of personal specifications for each individual. Changes in Conservation Team personnel shall also be implemented by written request and coordinated with the Security Directorate, WSMR.

d. Have its Conservation Team representatives sign hold harmless agreements releasing WSMR and HAFB from liability in case of personal injury while on WSMR or HAFB property.

e. Provide enforcement, at WSMR’s, HAFB’s, or WSNM’s request, of any violations of Federal fish and wildlife statutes (e.g. Lacey Act and Black Bass Act).

5. NMGF agrees to:

   a. Participate in protection, management, enhancement, research and monitoring of habitats and populations of White Sands pupfish in accordance with the Plan (Appendix 1).

   b. Provide consultation to WSMR, HAFB, and WSNM on all activities that may impact habitats or populations of White Sands pupfish.

   c. Provide an annual species status report to all signatory agencies.

   d. Provide WSMR, through the WSMR sponsor, with a written request for unescorted access to Uprange areas for each of its Conservation Team personnel. Included in the request will be a listing of personal specifications for each individual. Changes in Conservation Team personnel shall also be implemented by written request and coordinated with the Security Directorate, WSMR.

   e. Have its Conservation Team representatives sign hold-harmless agreements releasing WSMR and HAFB from liability in case of personal injury while on WSMR or HAFB property.

   f. Provide enforcement of violations of the New Mexico Wildlife Conservation Act.

6. The signatory agencies jointly agree to:

   a. Endeavor to provide the logistical and financial resources necessary to carry out the responsibilities detailed in this agreement and the Plan. In accordance with the availability of funds, agencies will provide:

      i. Personnel and equipment to monitor habitats and populations of White Sands pupfish semi-annually, exclusive of all other Plan activities.

      ii. Limited exchange of manpower, equipment and funds to carry out activities pursuant to this agreement, exclusive of semi-annual monitoring.

   b. Meet annually to discuss pertinent concerns regarding White Sands pupfish and its habitat, exclusive of all other activities.

   c. Develop and disseminate a public information pamphlet on White Sands pupfish.

   d. Participate in professional meetings to apprise the scientific community of the status of White Sands pupfish and the Plan.

C. OTHER PROVISIONS

1. Safety, Security and Scheduling:

To engage in Plan activities on WSMR, HAFB, and WSNM, Conservation Team members of the signatory agencies shall abide by the following stipulations:

a. All military rules and regulations and National Park Service policies and regulations will be observed. When entering WSMR, relevant rules and regulations will be presented to non-WSMR personnel during the in-briefing process.

b. Conservation Team personnel will obtain proper permits for entry into HAFB. All field activities will be scheduled with the Natural Resources Manager prior to entry to HAFB.

c. Conservation Team personnel will schedule all entries into WSNM with the Superintendent or his representative and will obtain proper permits to conduct work on WSNM.

   i. Schedule requests will be submitted one week prior to proposed entry, or as soon as possible.

   ii. All research and monitoring activities must be conducted under an approved National Park Service collection permit. No research, sampling or collecting will be initiated on WSNM without an approved permit.

   iii. Various portions of WSNM are periodically subject to evacuation in support of WSMR operations. During evacuations, Conservation Team personnel will not be permitted access to effected areas.

   iv. Conservation Team members will not be permitted to stay on WSNM property overnight without prior notification to, and approval from, the Superintendent or his representative.

d. Conservation Team personnel will schedule all entries into WSMR uprange areas with WSMR Range Scheduling, through the sponsor.

   i. Schedule requests will be submitted one week prior to proposed entry or as soon as possible.

   ii. Team members will advise WSMR Range Scheduling up to the day before of any required changes or cancellations.

e. For daily use of the Range Conservation Team personnel shall coordinate with WSMR Range Control (678-2222) prior to entry into, and upon exit from, WSMR land or airspace to:

i. Verify access into Essential Habitat and ensure that no interference with military operations occurs.

ii. Provide Range Control with precise areas of operations and entry/exit point and times for all field activities.

iii. Advise Range Control when Conservation Team personnel are no longer on WSMR property.

f. Conservation Team personnel will enter and exit Uprange areas through the staffed gates at Stallion Range Center, Small Missile Range or Tularosa.

g. The Conservation Team will not be permitted to stay on WSMR property overnight without prior notification to their sponsor and approval from WSMR Range Scheduling and Security. WSMR uprange facilities may be used by field personnel on an “as needed” basis following coordination through the WSMR sponsor.

h. Through the Conservation Team personnel will be issued WSMR and HAFB photography permits, all photography will pertain only to White Sands pupfish and its habitats. No other photographs will be permitted. All slides, prints, and negatives must be declassified and cleared through the normal WSMR and HAFB Operations and Security process prior to public dissemination. Further rules and regulations on photography on WSMR and HAFB will be presented to non-WSMR and non-HAFB Conservation Team members during their in-briefing.

i. All military activities on WSMR and HAFB will take precedence over White Sands pupfish investigation activities both on the ground and in the air if conflicts arise that cannot be resolved through the scheduling process.

j. Various portions of WSMR are periodically subject to evacuations in support of military operations. During evacuations, Conservation Team personnel will not be permitted access to affected areas.

2. Progress Report

   Copies of all interim reports and an annual report will be provided to all signatories to this agreement.

3. Conditions

   a. This agreement shall be reviewed on an annual basis by the signatory agencies in conjunction with the annual meeting, and renewed every five years.

   b. This agreement may be terminated by any signatory agency upon 30 days written notice to all signatory parties. Upon dissolution of this agreement, the remaining parties are not bound by terms of the agreement.

   c. This agreement becomes effective when all parties have signed.

Signatory Agencies

BG, USA.

Commanding General, U.S. Army, White Sands Missile Range — 16 Dec 94

Date

Commander, U.S. Air Force, 49FW, Holloman Air Force Base — 11 Oct 94

Date

Superintendent, White Sands National Monument, National Park Service — 12/1/94

Date

Regional Director, Region 2, U.S. Fish and Wildlife Service — 10/28/94

Date

Director, New Mexico Department of Game and Fish — 10-31-94

Date

APPENDIX 1

LIST OF FIGURES

WHITE SANDS PUPFISH CONSERVATION PLAN

June 27, 1990

David L. Propst
New Mexico Department of Game and Fish
Endangered Species Program

Revised
September 14, 1994

John S. Pittenger
New Mexico Department of Game and Fish
Conservation Services Division

Santa Fe, New Mexico 87503

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PREFACE

This conservation plan has been developed as a cooperative effort among the Department of the Army, U.S. Fish and Wildlife Service, and the New Mexico Department of Game and Fish to provide a synopsis of the biological data available on the White Sands pupfish, to recommend what additional data are needed to enhance and improve conservation strategies, to delineate actual and potential threats to the survival of the species, and to outline the measures necessary to protect, secure, and enhance existing pupfish populations. The plan will be reviewed and revised as necessary to reflect and incorporate additional data on the species and the achievement of various conservation objectives. The successful implementation of this plan should provide the protection necessary to ensure the survival of the White Sands pupfish.

INTRODUCTION

The White Sands pupfish, *Cyprinodon tularosa* Miller and Echelle, is a federal Category 2 Notice-of-Review species for listing under the Endangered Species Act (U.S. Department of Interior 1989). The New Mexico Department of Game and Fish lists the species as Endangered, Category 2 (New Mexico State Game Commission 1988), and it is considered a Species of Special Concern by the American Fisheries Society (Williams et al. 1989).

DESCRIPTION AND RELATIONSHIPS

Cyprinodon tularosa is a small, robust pupfish up to 44 mm in standard length. The breast and abdomen are fully scaled or nearly so. Other distinctive features include 26-28 scales in the lateral series, typically 6 pelvic fin rays, and normally 21-25 gill rakers (Miller and Echelle 1975). Breeding males are grayish-blue, with half to almost all of the dorsal, anal, pectoral, and pelvic fins bright yellow-orange to orange. The caudal fin is pale-to greenish yellow with a black terminal band that is about equal to the width of the pupil. Fins are variously bordered with milky to dark pigmentation. Females in breeding condition are less conspicuously colored than males, but, nevertheless, have a characteristic spawning coloration. The body of the female is white to silvery laterally with a yellow-green suffusion. Dorsally, females are olivaceous. Pectoral and pelvic fins are pale yellow, with the remaining fins nearly colorless to watery white.

The White Sands pupfish belongs to the closely related *Cyprinodon variegatus* Lacepede complex of species (Miller and Echelle 1975; Echelle and Echelle 1978, 1986, 1992) (Figure 1). Members of this complex occur in western and coastal Texas, western Oklahoma, and eastern New Mexico (Figure 2). The current distribution of this group is believed to have occurred as a result of the alignment of various Pleistocene drainages (Miller 1978, Echelle and Echelle 1986, Smith and Miller 1986).

Within the *variegatus* complex, C. *tularosa* is meristically and morphometrically most similar to *C. bovinus* Baird and Girad of western Texas and *C. pecosensis* Echelle and Echelle of the Pecos River in Texas and New Mexico. *Cyprinodon tularosa* differs from these species in a variety of scale counts and body measurements (Miller and Echelle 1975; Echelle and Echelle 1978). Genetically, however, the White Sands pupfish is apparently most closely related to the Red River pupfish, *C. rubrofluviatilis* Fowler, of the Red and Brazos rivers of north-central Texas (Echelle and Echelle 1992).

HISTORIC AND CURRENT DISTRIBUTION

Prior to the recession of Pleistocene Lake Otero about 12,000 to 15,000 years ago (Miller 1981), the White Sands pupfish, or its progenitor, was probably widespread in the endorheic Tularosa Basin (Lake Otero) of southern New Mexico (Miller and Echelle, 1975). However, the historic record (Dice 1940, Lewis 1950, Koster 1957, Hubbs and Echelle 1972) documents the species only from remnants of that lake (Figure 3). Miller and Echelle (1975) described the species from specimens obtained from Malpais Spring and noted is presence in the associated spring run, Mound Spring, and Salt Creek. A population in Malone Draw and Lost River on Holloman Air Force Base and White Sands National Monument near Alamogordo is believed to be introduced (Echelle et al. 1986). However, this stream is within the Pleistocene Lake Otero, and for management purposes it should therefore be treated as native. A population was introduced to a playa lake (Alamogordo Pond) near Alamogordo (Suminski 1977, Jester and Suminski 1982), but did not survive. All waters in which the White Sands pupfish currently occurs are administered by White Sands Missile Range, Holloman Air Force Base or White Sands National Monument. The occurrence of White Sands pupfish in Malone Draw upstream from Holloman Air Force Base is unknown.

BIOLOGY

Habitat

Malpais Spring (including its outflow and associated wetlands and play lakes), Mound Spring, and Salt Creek comprise the primary habitat of the White Sands pupfish. A population of presumed introduced origin exists in Malone Draw and Lost River. Ambient water temperatures remain fairly constant in spring habitats, but vary considerably on a diurnal and seasonal basis in Salt Creek and the playa lakes. Salinity is high (15,000-30,000 mg/1) in all habitats (Miller and Echelle 1975). Water depths are 1 m or more in the springs and Salt Creek pools, but are 10 cm or less in much of the wetland and playa lake habitat (C. Springer and J. Pittenger, per. obs.; Sublette et al. 1990). The extent of habitat varies seasonally and is correlated, particularly in Salt Creek and the Malpais Spring wetland and playa lakes, with local precipitation.

Salt cedar (*Tamarix chinensis*), creosotebush (*Larrea tridentata*) iodine-bush (*Allenrolfea occidentalis*) and salt grass (*Distichlis stricta*), border Salt Creek and the springs. Rushes (*Juncus* sp.), sedges (*Carex* sp.), and giant reeds (*Phragmites communis*), occur in the wetlands of Malpais Spring. Salt cedar and salt grass border the play lakes. Pondweed

(Potamogeton sp.), and filamentous algae are found in most lentic habitats.

Reproduction

Spawning apparently begins in early spring, when water temperature is about 18 C (Suminski 1977). Males establish and guard territories in the shallow littoral areas of springs and the playa lake and slow-velocity vegetated margins of Salt Creek. Spawning behavior involves a series of ritualized movements by the male to entice a female into its territory. Ova are released and fertilized while the male's anal fin is wrapped around the female's vent. Only 12-15 ova are released during a single spawning episode. Suminski (1977) observed spawning activity in an aquarium from 0900-1530 hrs, with peak activity during mid-morning and early afternoon. A female may spawn twice a day, but it is unknown if an individual female spawns throughout a season or within a shorter period. Each female likely spawns several times during the spawning season. Suminski (1977) suggested that spawning was cyclic, with peaks occurring every three weeks and lasting until August or early September.

Age-I females are capable of spawning, and total fecundity increases with age (Suminski 1977, Jester and Suminski 1982). Age-I females produced an average of 810 ova, Age-II females produced an average of 1,134 ova, Age-III females produced an average of 1,693 ova, and Age-IV females produced an average of 2,996 ova (Jester and Suminski 1982). A maximum of 6,069 ova was found in an Age-II specimen (Jester and Suminski 1982).

Age and Growth

White Sands pupfish ova probably have an incubation period of 4-8 days, similar to that of other *Cyprinodon* spp. (Able, 1984). Upon hatching, pupfish grow rapidly and attain a total length (TL) of 25-30 mm by the end of their first growing season. Thereafter, the growth rate is moderate, and sexually-different growth rates were not found (Suminski, 1977). The largest White Sands pupfish specimens reported by Suminski (1977) were a 55 mm TL male and female.

Suminski (1977) reported that White Sands pupfish may survive 4+ years, but mean longevity was about 2.7 years. Differences in survivorship between sexes were not significant. Suminski (1977) did not indicate if mortality was related to spawning activity, seasonal, or other environmental conditions.

Food Habits

The White Sands pupfish is omnivorous (Suminski 1977)j. Mosquito larvae (Culicidae) and organic detritus constituted the bulk of the diet of the White Sands pupfish, but algae and aquatic insects were also important dietary components. Food selectivity studies by Suminski (1977) indicated that mosquito larvae were preferred. She did not indicate whether food habits changed with maturation of if seasonal differences existed.

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Population Dynamics

White Sands pupfish populations are often dense, but may experience wide fluctuations in numbers. Jester and Suminski (1982) estimated that the maximum number of pupfish inhabiting the 0.1 ha Alamogordo Pond (now eliminated) in a year was 1,920,056 and the minimum 30,527. Populations in Malpais Springs, its outflow and playa lake, Mound Spring, and Salt Creek are also dense, and each probably exceeds several hundred thousand. No data are available to assess seasonal population dynamics or the effects of natural perturbations upon the pupfish populations.

<u>Associated Species</u>

Within its native range, the White Sands pupfish is the only native fish species, and it alone inhabits each of the currently occupied habitats. Mosquitofish (*Gambusia affinis*), goldfish (*Carassius auratus*), and largemouth bass (*Micropterus salmoides*), occur in ponds on White Sands Missile Range and Holloman Air Force Base in the Tularosa Basin. If any of these non-native species, particularly mosquitofish and largemouth bass, were introduced to habitats supporting White Sands pupfish, it is likely the latter would be eliminated.

MAJOR THREATS

The extremely limited range of the White Sands pupfish is the primary factor that makes the species vulnerable to human activities. Its native range is restricted to Malpais Spring, its outflow and associated wetlands and playa lakes, Mound Spring, Salt Creek, and Malone Draw-Lost River. In addition to being small, these habitats are all in relatively close geographic proximity to each other. Although population density is normally high, in very constrained habitats this imparts little security to a species. Historically, White Sands pupfish populations were doubtlessly subject to natural catastrophes such as flood and drought. It is possible that perturbations could exterminate a population, and that one or several traumas could eliminate the species.

On White Sands Missile Range and Holloman Air Force Base, an array of activities might occur with detrimental impacts upon White Sands pupfish populations. Broadly, these activities would be those that render pupfish habitat unsuitable for the species for varying periods of time, although other activities (e.g., taking fish) could also be detrimental. The following list of potential threats is not exhaustive. Such a list would require knowledge of all ongoing or future activities on White Sands Missile Range and Holloman Air Force Base. Rather the following list is intended to be indicative of potential threats to the survival of the White Sands pupfish.

1. Chemical or other contamination
   a. pesticides
   b. herbicides
   c. toxic residues
   d. petroleum spills
   e. chemical weapons
   f. ordinance chemicals
   g. biological weapons
   h. feral horses and oryx (carcasses, urine, feces)

2. Biological
   a. introduction of non-native (exotic) fishes or other aquatic forms, with attendant competition, predation, disease, and/or hybridization

3. Physical
   a. activities which alter the natural features of White Sands pupfish habitats (e.g., tracked and wheeled vehicle operation in the vicinity of or in pupfish habitats)

   b. direct missile or target impact

   c. activities outside occupied habitats that ultimately modify Essential Habitats (e.g., construction activities within the drainage, alteration of secondary drainages)

   d. habitat degradation by feral livestock and wildlife (e.g., bank destabilization, accelerated erosion and siltation)

4. Dewatering
   a. water withdrawal, diversion, or ground water pumping

   b. lowering of water table due to encroachment of non-native vegetation (e.g., salt cedar)

RECOMMENDATIONS

1. Form a White Sands Pupfish Conservation Team. A team composed of knowledgeable persons representing each of the cooperating agencies should be formed. Members of this team should be qualified biologists or other specialists capable of assessing the biological needs and requirements of the White Sands pupfish. The function of the team would be to: 1) review activities which might affect White Sands pupfish or its habitat; and 2) make recommendations and provide advice and information to the concerned agencies regarding conservation of the White Sands pupfish.

2. Initiate Habitat Protection. A considerable level of protection to existing White Sands pupfish populations is necessary. An important and essential means of obtaining this protection could be achieved by restricting or eliminating certain activities within hydrologically and biologically sensitive areas around each occupied habitat (i.e., establishment of buffer zones). The Conservation Team should be responsible for identifying the boundaries of the buffer zones and detailing activities to be eliminated or restricted.

3. Prohibit Introduction of Non-native Fishes. It is imperative that no non-native species be introduced to any habitat occupied by White Sands pupfish. Avoidance of such will require establishment and enforcement of regulations prohibiting live-fish transport onto White Sands Missile Range, Holloman Air Force Base or White Sands National Monument. Removal of existing populations of non-native fishes from potential habitat of White Sands pupfish (e.g., Tule Ponds) should be conducted.

4. Establish Additional White Sands Pupfish Populations. Permanently watered habitats within the Tularosa Basin not currently supporting White Sands pupfish should be evaluated to assess their potential for establishment of additional populations of the species.

5. Develop a Non-Technical Guidelines and Policy Manual. A detailed manual should be developed and made available to all users of White Sands Missile Range, White Sands National Monument and Holloman Air Force Base whose activities might impact White Sands pupfish populations or habitats. Strict adherence to guidelines and policies should be required of all Range users.

6. Establish a White Sands Pupfish Population and Habitat Monitoring Program. A protocol for monitoring the status of each White Sands pupfish population and the habitats it occupies should be developed. This protocol should include a schedule, reporting requirements and identification of personnel to perform monitoring. Monitoring data should be provided to involved agencies for use in assessing status of populations and habitats.

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7. Conduct Research. A variety of research activities is required to improve conservation techniques and enable the Conservation Team to assess potential impacts of proposed activities. This research should include the following:

   a) Physico-chemical characterization of occupied habitats.

   b) Hydrographic characterization of surface and subsurface water resources.

   c) Detailed life history, ecological, and other biological studies of White Sands pupfish.

   d) Characterization of White Sands pupfish population dynamics seasonally, annually, and in response to natural perturbations (i.e., floods and droughts).

   A detailed experimental design or protocol for each of the foregoing research activities should be developed by the Conservation Team or submitted for review and approval by the Conservation Team if proposed by a non-Team entity.

   Provide Necessary Support. Activities necessary to monitor, protect, enhance, research, and resolve potential conflicts will incur financial costs. While these should be shared, the major portion associated with monitoring, protecting, enhancing, and resolving conflicts should be borne by those agencies or entities proposing activities which might negatively impact White Sands pupfish populations. Research costs should be equitably divided among the agencies.

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U.S. Department of Interior. 1989. Endangered and threatened wildlife and plants; Annual Notice of review. Fed. Regist. 54:554-579.

Williams, J. E., J. E. Johnson, D. A. Hendrickson, S. Contreras-Balderas, J. D. Williams, M. Navarro-Mendoza, D. E. McAllister, and J. E. Deacon. 1989. Fishes of North America Endangered, Threatened, or of special concern: 1989. Fisheries 14:2-20.

ACKNOWLEDGEMENTS

General Burton and Daisan Taylor were instrumental in the initial development of this conservation plan and provided valuable information and insights. The comments and suggestions of R. R. Miller, J. E. Brooks, A. A. Echelle, R. J. Edwards, D. A. Young, G. P. Garrett, A. L. Hobbes, J. P. Hubbard, and A. Schull improved the plan and their contributions are appreciated.

Figure 1. Distance - Wagner phylogenetic tree based on Rogers genetic distance among populations of *Cyprinodon* and a sample of *Jordanella*. From page 698 in Echelle and Echelle (1992).

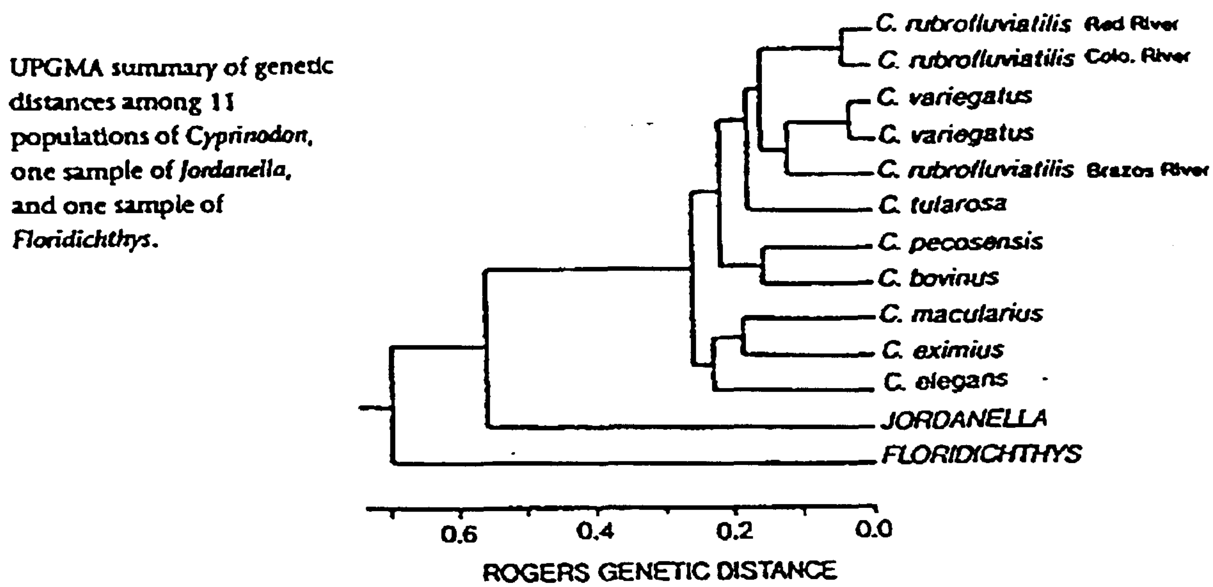
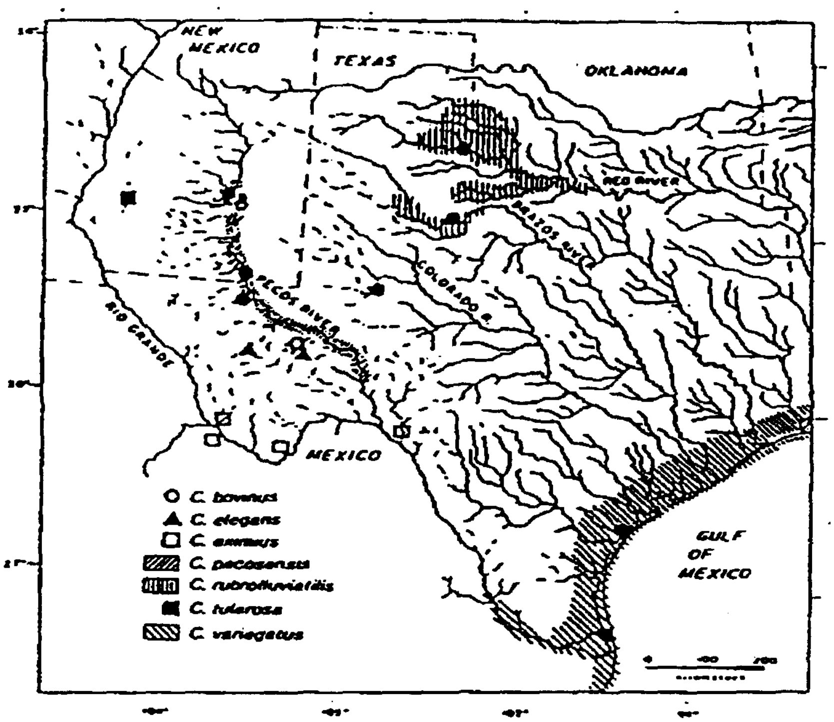


Figure 2. Native ranges of species of the *Cyprinodon variegatus* complex, including the White Sands pupfish, *C. tularosa*. Only a portion of the native range of *C. variegatus* is given. From page 693 in Echelle and Echelle (1992).



Native ranges of seven of the eight species of *Cyprinodon* examined. Only partial ranges are shown for the primarily Mexican species, *C. eximius*, and the coastal species, *C. variegatus*. *Cyprinodon macularius*, the eighth species examined, occurs west of the Continental Divide. The eastern population indicated for *C. elegans* has been extinct since the 1950's. Dots for *C. pecosensis*, *C. rubrofluviatilis*, and *C. variegatus* show collecting localities for the present study.

APPENDIX D

RESPONSES TO COMMENTS

TABLE OF CONTENTS
Appendix D

RESPONSES TO COMMENTS

INTRODUCTION

The Draft Supplemental Environmental Impact Statement (DSEIS) for the NASA Sounding Rocket Program (SRP) became available for public review on May 16, 1995. The availability of this report was advertised by NASA in the Federal Register and in local newspapers of the affected communities.

A total of 194 copies of the DSEIS were distributed to government officials and the general public in the District of Columbia and these 12 states: Alabama, Alaska, Arizona, California, Florida, Georgia, Maryland, Missouri, New Mexico, Pennsylvania, Ohio, and Virginia.

Recipients of the DSEIS in the government included: Members of the U.S. Congress and U.S. Government agencies; State government agencies in Alaska, New Mexico and Virginia; Native communities; and county and municipal officials in the affected communities.

Public recipients of the DSEIS included individuals, news media, public interest advocacy organizations, environmental protection advocacy groups, as well as business, labor and professional organizations and universities. The group of professional recipients included scientific and technical organizations and associations, as well as the medical establishment.

As a result of this report distribution written comments were received from federal government agencies, state and local government agencies, and universities and scientific institutions. A total of 23 written communications were received as shown below.

Comments made by	Number of Comments	Commentors
Federal Government Agencies	8	U.S. Environmental Protection Agency (2) U.S. Dept. of the Interior (2) U.S. Dept. of Agriculture (1) U.S. Navy with 3 enclosures (1) U.S. Army/White Sands Missile Range(1) National Radio Astronomy Observatory (1)
State and Local Government Agencies	13	Commonwealth of Virginia (11) State of New Mexico (1) Town of Chincoteague (1)
Universities and Scientific Institutions	2	University of Alaska, Geophysical Institute (1) Virginia Institute of Marine Sciences (1)

As a result of the consideration of the received comments, changes were made in the text of the Final SEIS as warranted. The FSEIS text was re-written using more recent data and information. The programmatic elements of the report were updated and new site-specific information was added. The information base for programmatic content was extended through Fiscal Year (FY) 1995 by collecting and incorporating into the text pertinent data for FY's 1993, 1994, and 1995 from NASA operating records.

The 10-year review period for the SRP launches was changed to FY 1986 through FY 1995.

Site-specific information used in the preparation of the original DSEIS was likewise updated and enhanced by using derivative information from reports through FY 1995 which became available. This new information is being addressed at the local level of each site as follows.

Site-specific information for Wallops Flight Facility (WFF) was updated and enhanced using the latest information from the ***Environmental Resources Document,*** NASA Goddard Space Flight Center, Wallops Flight Facility, Wallops Island, Virginia 23337, published in August 1994 and correspondence from the Department of Environmental Quality, Commonwealth of Virginia, dated June 12, 1996.

Site-specific information for White Sands Missile Range (WSMR) was re-written using information from the ***White Sands Missile Range-wide Environmental Impact Statement*** published by the White Sands Missile Range, New Mexico, Directorate of Environment and Safety, Environmental Services Division, WSMR, New Mexico 88002 in January 1998.

Site-specific information for Poker Flat Research Range is based largely on information contained in the ***Environmental Assessment, Improvement and Modernization Program Poker Flat Research Range,*** Fairbanks, Alaska published by Geophysical Institute, University of Alaska, in April 1993.

The text of all written comments and responses to each are presented on the following pages of this report. NASA deeply appreciates all the comments received.

Written comments that were received and considered in this report are from the following sources:

	Date	Organization	Name and Position
1	7/31/95	U.S. EPA, Office of Federal Activities	Richard E. Sanderson, Director
2	6/12/95	U.S. EPA, Region III	Roy E. Denmark, Jr., NEPA Review Coordinator
3	7/13/95	U.S. Department of the Interior, Fish and Wildlife Service, New Mexico Ecological Services State Office	Jennifer Fowler-Propst, State Supervisor
4	10/24/95	U.S. Department of the Interior, Office of Secretary, Office of Environmental Policy and Compliance	Willie R. Taylor, Director
5	6/14/96	U.S. Department of Agriculture, Natural Resources Conservation Service	Calvin A. Miller, State Resource Conservationist
6	9/21/95	U.S. Department of the Navy, Naval Air Warfare Center, Weapons Division, WSMR with enclosed comments from U.S. Dept. of the Interior, State of New Mexico, and White Sands Missile Range	C.F. Broski-Konczey, By direction
7	7/23/95	White Sands Missile Range, Environmental Office	David A. Holdermann, Wildlife Biologist
8	6/20/95	Commonwealth of Virginia, Department of Environmental Quality, Grants Management & Intergovernmental Affairs	Michael P. Murphy, Director
9	6/6/95	Commonwealth of Virginia, Department of Environmental Quality, Tidewater Regional Office	Traycie L. West, Environmental Specialist
10	6/9/95	Commonwealth of Virginia, Department of Environmental Quality, Office of Technical Assistance/Waste	Ulysses B. Brown, Jr. Solid Waste Compliance Manager
11	6/12/95	Commonwealth of Virginia, Department of Environmental Quality, Air Division	Dona Huang, Senior Environmental Engineer

Written comments that were received and considered in this report are from the following sources (Concluded):

	Date	Organization	Name and Position
12	6/9/95	Commonwealth of Virginia, Department of Transportation	Christopher G. Collins, Environmental Program Analyst
13	6/8/95	Commonwealth of Virginia, Department of Conservation and Recreation	John R. Davy, Jr., Planning Bureau Manager
14	6/2/95	Commonwealth of Virginia, Department of Chesapeake Bay Local Assistance	Darryl M. Glover, Senior Environmental Engineer
15	5/25/95	Commonwealth of Virginia, Department of Health, Office of Water Programs	A. E. Douglas, P.E., Senior Environmental Engineer
16	6/14/95	Commonwealth of Virginia, Department of Game and Inland Fisheries	Raymond T. Fernald, Environmental Manager
17	5/30/95	Commonwealth of Virginia, Marine Resources Commission	Chris W. Frye, Environmental Engineer
18	6/5/95	Commonwealth of Virginia, Department of Mines, Minerals and Energy	Eugene K. Rader, Geological Supervisor
19	6/9/95	Town of Chincoteague	Stewart Baker, Town Manager
20	7/1/95	State of New Mexico, Department of Game and Fish	Jerry A. Maracchini, Director
21	6/8/95	Virginia Institute of Marine Science	T. A. Barnard, Jr., Marine Scientist
22	6/18/96	Geophysical Institute, University of Alaska	Ronald M. Pierce, Range Manager
23	5/23/95	National Radio Astronomy Observatory, Frequency Coordination	Clinton Janes

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

AUG 3 - 1995
NASA
GSFC/WALLOPS

JUL 31 1995

OFFICE OF
ENFORCEMENT AND
COMPLIANCE ASSURANCE

Mr. William B. Johnson
National Aeronautics and Space Administration
Goddard Space Flight Center, Wallops Flight Facility
Wallops Island, Virginia 23337

Dear Mr. Johnson:

The Environmental Protection Agency (EPA) has reviewed the National Aeronautics and Space Administration (NASA) draft supplemental environmental impact statement (EIS) for the Sounding Rocket Program (SRP). This review was conducted in accordance with our responsibilities under section 309 of the Clean Air Act and the National Environmental Policy Act (NEPA).

In general, we believe that the document was organized very well. The format for the summary section gives the reader a good understanding of what is to come, and makes it easier to review the entire document. While the SRP as a whole does not seem to have a significant direct impact on the environment, at the local level the SRP combined with other activities may have a cumulative impact to a resource. In the interest of full disclosure, EPA believes that it would be useful to break down some of the information in the generic SRP sections into site specific information in the final EIS. Some specific suggestions are enclosed. 1.1

In view of the above, we have classified this draft Supplemental EIS as EC-2 (environmental concerns, insufficient information). This rating primarily reflects our belief that while the SRP poses no significant threat to the environment overall, the final EIS should contain additional information. 1.2

Thank you for the opportunity to review and comment on the draft supplemental EIS. If you have any questions please call me at (202) 260-5053 or Pat Haman at 260-3358. 1.3

Sincerely,

Richard E. Sanderson
Director
Office of Federal Activities

Enclosure

RESPONSE TO COMMENTS

Commentor No. 1: Richard E. Sanderson.
U.S. Environmental Protection Agency, Office of Enforcement and Compliance Assurance.

Response to Comment 1.1:

Comment noted. Thank you.

Response to Comment 1.2:

Some of the generic information in Section 4.2.1 **Generic Impacts** was broken down and transferred into site-specific descriptions of each individual site, as suggested by EPA. Additionally, new information from reports that become recently available, were incorporated into site-specific sections of Chapter **3.0 Affected Environment** and Chapter 4.0 **Environmental Consequences.**

Response to Comment 1.3:

FSEIS contains additional information as suggested by EPA. This new information enhances text of chapters 3.0 **Affected Environment** and 4.0 **Environmental Consequences** and includes extracts from the ***Environmental Resources Document***, NASA Goddard Space Flight Center, Wallops Flight Facility, Wallops Island, Virginia 23337, August 1994; and the ***White Sands Missile Range Range-wide Environmental Impact Statement*** published by the White Sands Missile Range, New Mexico, Directorate of Environment and Safety, Environmental Services Division, WSMR, New Mexico 88002, January 1998.

GENERAL COMMENTS

Payload and Spent Rocket Recovery

1.4 Reference is made to Ground and Flight Safety Plans for each mission, which include payload and spent rocket recovery (4-37). It would be useful to know the site-specific success rate of such recovery, how the recovery process impacts the terrestrial environment, and what kind of waste and pollutants are not recovered. The site specifics of recovery plans should be published in the final EIS.

Air Quality

1.5 Chapter 4 presents generalized data for comparing SRP predicted maximum concentrations with Threshold Limits and National Ambient Air Quality Standards. Chapter 3 presents the applicable state ambient air quality standards for each of the three facilities. While the pollutant levels presented in Chapter 4 seem insignificant, it also would be useful to have a table presenting the national, state and predicted ambient levels for each facility in Chapter 4.

Atmospheric Impacts

1.6 EPA agrees with NASA that the stratospheric ozone layer will not be significantly affected by SRP activities as presented in this EIS. According to the EIS the SRP will typically emit 3.7 metric tons of hydrogen chloride (HCL) directly into the stratosphere on an annual basis. While the introduction of chlorine into the stratosphere does destroy ozone molecules, it is a relatively small increase in the total chlorine loading of the stratosphere and does not significantly adversely affect the stratospheric ozone layer.

Wetlands

1.7 The discussion of impacts to wetlands, flood plains and coastal areas for each site is generic, even though reference is made to site-specific Ground and Flight Safety Plans (4-37~. It would be more useful to the reader if the final EIS, in a detailed map, showed wetland categories and descriptions to give a better picture of potential impacts. This may be particularly important in rocket stage and payload recovery plans. The amount and frequency of water coverage will be an important parameter in gauging the potential impacts of chemical waste dispersion from spent rockets and payloads.

Commentor No. 1: Richard E. Sanderson (Continued), U.S. Environmental Protection Agency, Office of Enforcement and Compliance Assurance.

Response to Comment 1.4:

New information on the mission success rates was added to the text by incorporating appropriate data into each site-specific section of the text. Description of site-specifics of recovery procedures and resulting terrestrial impacts was added to the text of FSEIS, where appropriate.

Response to Comment 1.5:

Due to a small number of launches and low volume of pollutants, NASA currently has no plan to conduct air diffusion studies at the sites. In the event that future legislation requires mandatory diffusion studies for atmospheric pollutants, studies will be conducted.

Response to Comment 1.6:

Comment noted. Thank you.

Response to Comment 1.7:

The information on wetlands, flood plains and coastal areas was enhanced and enlarged for each site using latest data, derived from the ***Environmental Resources Document***, NASA Goddard Space Flight Center, Wallops Flight Facility, the ***White Sands Missile Range Range-wide Environmental Impact Statement***, White Sands Missile Range, New Mexico, and the ***Environmental Assessment***,

Commentor No. 1: Richard E. Sanderson (Continued),
U.S. Environmental Protection Agency, Office of Enforcement and Compliance Assurance.

Respond to Comment 1.7 (Continued)**:**

Improvement and Modernization Program Poker Flat Research Range, Fairbanks, Alaska.

Site specific information that was used in analysis of environmental impacts of NASA SRP on wetlands, flood plains and coastal areas at each site included data on wetland categories, maps, and descriptions that are a part of the supporting file to this FSEIS. This information is identified for each site as follows:

Wallops Flight Facility. Description of wetland categories, including pertinent maps for this facility is presented in the ***Environmental Resources Document,*** August 1994, under the heading **4.1.4 Wetlands and Floodplains** pages 4-36 through 4-51.

White Sands Missile Range. Description of hydrology/water resources, including surface water, floodplains, and ground water, as well as pertinent maps for this facility are presented in the ***White Sands Missile Range Range-wide Environmental Impact Statement*** January 1998, under the heading **3.2 Hydrology/Water Resources,** pages 3-9 through 3-58 and ***3.4.4.2 Wetland and Riparian Habitats*****,** pages 3-109 through 3-113.

Poker Flat Research Range. Description of hydrology/water resources, including surface water, floodplains, and ground water, as well as pertinent maps for this facility are presented in the ***Environmental Assessment***, ***Improvements and Modernization Program***, April 1993, under the heading **3.1.5 Water Resources** pages 17 through 22. Description of wetland is found in Chapter **3.1.5.3 Wetlands** page 22.

SITE SPECIFIC COMMENTS

Poker Flat Research Range, Alaska:

Noise

There does not appear to be any discussion on the human impact of noise at the launch site, which is near Chatanika Lodge and F.E. Gold Camp, as well as two downhill ski areas. Does the infrequency of launchings mean that the disturbances are minimal? There are no reported interviews of local visitors to at least provide anecdotal evidence of the level of disturbance.

1.8

NASA may wish to review the Environmental Assessment, Western Wilderness Area Lakes (EPA 910/9-85-125, March 1985). The human impacts of loud, interruptive noises (helicopters, in this case) are discussed in relation to the "wilderness experience" (pp. 49-56). Appendix B contains several references to related studies.

1.9

White Sands Missile Range, New Mexico

The information on the White Sands Missile Range is dated; the Rangewide EIS was completed last year and should be reflected in future documentation of cumulative effects.

1.10

Commentor No. 1: Richard E. Sanderson (Concluded), U.S. Environmental Protection Agency, Office of Enforcement and Compliance Assurance.

Response to Comment 1.8:

The data considered in the FSEIS indicate that the noise associated with firing of sounding rockets at PFF is of very short duration, relatively low intensity, occurs at infrequent intervals and is considered to be not substantial.

Response to Comment 1.9:

Comment noted. Thank you.

Response to Comment 1.10:

The text of the site-specific description for this location was re-written using the information base contained in the ***White Sands Missile Range Range-wide Environmental Impact Statement*** published by the White Sands Missile Range, New Mexico, Directorate of Environment and Safety, Environmental Services Division, WSMR, New Mexico 88002, January 1998.

Cumulative Effects: Based on information in above reference it was determined that NASA SRP contributes approximately 0.5% to overall mission activity at WSMR, and 2% to all research rocket launches

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION III
841 Chestnut Building
Philadelphia, Pennsylvania 19107-4431

JUN 12 1995

Mr. William Johnson
Code 840
National Aeronautics & Space Administration
Goddard Space Flight Center
Wallops Flights Facility
Wallops Island, Virginia 23337

RE: Supplemental Draft Environmental Impact Statement (SDEIS) for Sounding Rocket Program

Dear Mr Johnson:

In accordance with the National Environmental Policy Act (NEPA) and Section 309 of the Clean Air Act, EPA Region III has reviewed the Supplemental Draft Environmental Impact Statement (DEIS) for the above referenced project. EPA believes that the major environmental issues have been documented in the Supplemental DEIS. However, we suggests that information regarding Environmental Justice (EJ) should be included in the FEIS. 2A

Executive order 12898, dated February 11, 1994 requires Federal agencies when they are preparing NEPA documents to include project effects on minority and low-income communities. It also provides for agencies to consider the inclusion of mitigation measures to mitigate significant and adverse effects of proposed actions on minority and low-income communities, and to improve opportunity for community input into the NEPA process. 2B

Thank you for this opportunity to review and comment on this project. Any further correspondence concerning this matter should be directed to Pamela J. Phillips (215/597-6289) of my staff.

Sincerely,

Roy E. Denmark, Jr.

Commentor No. 2: Roy E. Denmark, Jr.
U.S. Environmental Protection Agency, Region III
NEPA Review Coordinator

Response to Comment 2A:

Comment noted. Thank you.
New information added, as stated below.

Response to Comment 2B:

A section titled **4.6 Federal Action to Address Environmental Justice In Minority Populations and Low-Income Populations** was added to the text of the FSEIS to address the issue.

United States Department of the Interior

FISH AND WILDLIFE SERVICE
New Mexico Ecological Services State Office
2105 Osuna NE
Albuquerque, New Mexico 87113
Phone: (505) 761-4525 Fax: (505) 761-4542

July 13, 1995

Cons. #2-22-92-I-261

Memorandum

To: Assistant Regional Director, Ecological Services, Region 2

From: State Supervisor, New Mexico Ecological Services State Office

Subject: Draft Supplemental Environmental Impact Statement for the Sounding Rocket Program at White Sands Missile Range

This responds to a request for comments on the above referenced program. The New Mexico Ecological Services State Office offers the following comments on the subject Supplemental Environmental Impact Statement (SEIS):

GENERAL COMMENTS

The scope of the subject SEIS covers the launching of sounding rockets on a world-wide basis, including White Sands Missile Range (WSMR), located in southern New Mexico. The proposed action includes a suborbital space flight program supporting space and earth science activities. The program employs 15 launch vehicle systems, plus test and meteorological rockets, as well as supporting studies on atmospheric ozone. In addition, other ozonesonde and meteorological rockets (utilizing the same launch system as the Sounding Rocket Program,) including the Super Loki and the Viper IIIA Darts, are covered under this SEIS.

3.1

The SEIS under review is dated August 1994. The New Mexico Ecological Services State Office of the U.S. Fish and Wildlife Service (Service) initially reviewed and commented on this program in a letter dated June 22, 1992. Communication with the Environmental Division at WSMR indicates that the last contact regarding the Sounding Rocket Program was in June 1993. While nearly 3 years have elapsed since the Service's initial review of the program, the principal sources of information used to prepare the baseline section of the SEIS are now greater than 10 years old. Many of the comments below could have been avoided had more recent coordination been conducted; however, because the SEIS has been published using outdated material, much of the impact analyses contained in the document are also outdated.

Commentor No. 3: Jennifer Fowler-Propst
U. S. Department of the Interior
Fish and Wildlife Service
New Mexico Ecological Services State Office

Response to Comment 3.1:

The letter from the U.S. Department of the Interior Fish and Wildlife Service, New Mexico Ecological Services State Office, dated June 22, 1992, (see Appendix A, page A-15) did not initially review and commented on this program. Instead, the subject letter was in response to request by Mr. Ray Romero for a list of endangered and threatened species in WSMR.

Site-specific information regarding WSMR was updated in this FSEIS on the basis of the ***White Sands Missile Range Range-wide Environmental Impact Statement*** published by the White Sands Missile Range, New Mexico, Directorate of Environment and Safety, Environmental Services Division, WSMR, New Mexico 88002, January 1998. New site-specific information from this document was used in FSEIS for updating environmental impact analysis for NASA SRP at WSMR.

SPECIFIC COMMENTS

Section 1.1.1.1. Alternatives to the Proposed Action, Alternatives, Programmatic Alternatives, Ground Observations (Page 2-1)

This section indicates that environmental impacts from the proposed program are confined to ground level and are minimal. Because up-dated information regarding sensitive resources, as discussed below, have been omitted from analyses, to issue such a determination is premature. Realizing that about one-half of the total launches covered under this programmatic document will occur in the sensitive desert ecosystem of southern New Mexico, we recommend further analyses be conducted incorporating the information provided in this letter. In addition, further coordination with our office and the Environmental Division of White Sands Missile Range should be conducted to determine if significant impacts exist. 3.2

Section 3.2.3 Affected Environment, Site Specific Facilities and Affected Environment, White Sands Missile Range (Page 3-34 through 3-45)

Table 3-2 provides a list of endangered and threatened species found in the WSMR area. The following list should be incorporated in the existing list and within the text to update the status of species of concern to the Service. 3.3

Big free-tailed bat, Nyctinomops macrotis (= Tadarida m., T. molossa), C2
Black-footed ferret, Mustela nigripes, E
Desert pocket gopher, Geomys bursarius arenarius, C2
Fringed Myotis, Myotis thysanodes, C2
Greater western mastiff bat, Eumops perotis californicus, C2
Pale Townsend's big-eared bat, Plecotus townsendii pallescens, C2
Small-footed Myotis, Myotis ciliolabrum, C2
Yuma myotis, Mvotis yumanensis, C2
Baird's sparrow, Ammodramus bairdii, C2
Black tern, Chlodonias niqer, C2
Interior least tern, Sterna antillarum, E
Loggerhead shrike, Lanius ludovicianus, C2
Mexican spotted owl, Strix occidentalis lucida, T w/CH
Northern aplomado falcon, Falco femoralis sePtentrionalis, E
Southwestern willow flycatcher, Empidonax traillii extimus, E w/PCH
Western burrowing owl, Athene cunicularia hypuqea, C2
White-faced ibis, Plegadis chihi, C2
Whooping crane, Grus americana, E
Anthony blister beetle, Lytta mirifica, C2
Dona Ana talussnail, Sonorella todseni, C2
Sandhill goosefoot, Chenopodium cycloides, C'2

Index		
	E = Endangered	C2= Category 2 Candidate
	T=Threatened	S/A=Similarity of Appearance

Commentor No. 3: Jennifer Fowler-Propst (Continued),
U.S. Department of the Interior
Fish and Wildlife Service
New Mexico Ecological Services State Office

Response to Comment 3.2:

Section **3.2.3 WHITE SANDS MISSILE RANGE (WSMR), NEW MEXICO** was re-written using recent information contained in the *White Sands Missile Range Range-wide Environmental Impact Statement* published by the White Sands Missile Range, New Mexico, Directorate of Environment and Safety, Environmental Services Division, WSMR, New Mexico 88002 in January 1998. Further environmental impact analyses were conducted using this new information and the results were incorporated into the revised text of FSEIS.

Response to Comment 3.3:

Updated information regarding sensitive resources at WSMR was added to the report and used in analysis of environmental impacts. A series of tables of sensitive species present or potentially present at WSMR, including endangered and threatened species, were extracted from the draft *White Sands Missile Range Range-wide Environmental Impact Statement* and reproduced in the text of the report.

Section 4.0 Environmental Consequences (Pages 4-2 through

3.4 Effects to several federally listed species (e.g., "startle") are identified as potentially resulting from program activities in Table 4-16 (page 4-45). Under Section 7(a)(2) of the Endangered Species Act, Federal agencies are required to consult with. the Service on any action that "may affect" a listed species. If indeed the determination is made that the proposed activities will have an affect on the listed species identified, we recommend formal section 7 consultation be initiated at the earliest possible time.

3.5 In a desert ecosystem such as that found at WSMR, impacts resulting from ground disturbance can be exacerbated in regions with very little rainfall. For example, areas denuded of vegetation are subject to desertification due to loss of nutrients. Impacts due to removal of vegetation and fragmentation of habitat could accumulate to significant levels, such as those experienced when habitat no longer has the characteristics necessary to support sensitive plant or wildlife species. In addition, due to lack of water sources in general, the importance of existing water sources is increased, as are the significance of impacts.

3.6 Two regions, estimated to cover approximately 1,200 square kilometers each and located 80 and 120 kilometers north o the WSMR launch site, are identified on page 3-35 as areas that could be used for recovery of payloads. We interpret this to mean that payload hardware could be deposited anywhere within this 1,200 kilometer area. No discussion is provided in the document regarding where booster hardware will impact, with the exception of an allusion to a 1.5 kilometer area that must be cleared around launch sites. Nor, is there discussion regarding how large a disturbance area is expected from ground impact of payload and booster hardware and its recovery.

3.7 Page 4-23 indicates that impacts to wetlands can be expected from the introduction of metallic matter and release of residual propellants, and recovery activities. Chemical releases are mentioned several times in the document (pages 2-4, 2-10, and 2-15); however, no discussion is provided in this document regarding how much residual chemical is expected to adhere to payload hardware, and the potential for impacts from such chemicals.

3.8 Potential for impacts to the White Sands pupfish are of particular concern to the Service. This species is a category 2 candidate for listing under the Endangered Species Act and is found in Salt Creek, Mound Spring, Malpais Spring, and their associated outflow channels and wetlands where Lincoln, Otero, Sierra, and Socorro Counties converge. Because the White Sands pupfish inhabits fine mud-silt and sand-gravel bottoms of clear, shallow, strongly alkaline pools and streams, impacts to this species occur from degradation of wetlands. In a Cooperative Agreement signed by the WSMR Commanding General on December 16, 1994, the topographic drainages of Salt Creek are designated as "limited use areas" where management will ensure degradation of habitat through contaminant runoff will not occur.

3.9 Impacts could occur as a result of the impact of payload canisters or rocket parts carrying contaminants or unburned propellant, or disturbance of the habitat as a result of recovery activities. If any debris expected to result from the proposed program has potential of impacting the limited use area that would adversely affect White Sands

Commentor No. 3: Jennifer Fowler-Propst (Continued),
U.S. Department of the Interior
Fish and Wildlife Service
New Mexico Ecological Services State office

Response to Comment 3.4:

The launch noise of NASA sounding rockets, as well as many other sources of noise may startle birds. At WSMR noise associated with sounding rockets launches is limited to operational area of LC 36. It is periodic in nature, short in duration, and not unlike the natural sound of thunder, and is considered to have minimal, if any, effect.

Response to Comment 3.5:

Comment noted. Thank you.

Response to Comment 3.6:

The dimensions of the two regions described in DSEIS Chapter **3.2.3.1 WSMR Launch and Support Facilities**, page 3-35 were developed on the basis of examination of past records (prior to 1992) at WSMR and are of historic interest only. Each NASA SRP launch serves a different scientific mission, and is designed individually. The discussion regarding disturbance area from ground impact of payload 3.8 and booster hardware and payload recovery can he found in Section **4.2.4.3.3 Endangered and Threatened Species**, Sub-Section **NASA Sounding Rocket Mitigation Measures**, and Appendix B.

pupfish, further coordination with the Service and the New Mexico Department of Game and Fish will be required.

SUMMARY

Concerns of the New Mexico State office regarding the proposed Sounding Rocket Program include use of outdated material in analyses, omission of impacts resulting from booster drops and recovery activities, and impacts to federally listed and otherwise protected species. If you have any questions regarding the above comments, please contact Ms. Karen Cathey at (505) 761-4525.

Jennifer Fowler-Propst

cc:
Director, New Mexico Department of Game and Fish, Santa Fe, New Mexico
Director, New Mexico Energy, Minerals, and Natural Resources Department, Forestry and Resources Conservation Division, Santa Fe, New Mexico
Refuge Manager, San Andres National Wildlife Refuge, Las Cruces, New Mexico
Baisan Taylor, U.S. Army White Sands Missile Range (STEWS-DES-E), White Sands Missile Range, New Mexico

Commentor No. 3: Jennifer Fowler-Propst (Concluded),
U.S. Department of the Interior,
Fish and Wildlife Service
3.10 New Mexico Ecological Services State Office

Response to Comment 3.7:

NASA sounding rocket landings are not targeted at wetlands at WSMR. At WSMR, parachute deployment is used for payload re-entry, and following a soft landing the payload is recovered by a recovery team using helicopter transportation to minimize ground disturbance. Additionally, an attempt is made to locate and recover all booster debris, including residual chemicals, if any, on metal debris. The text of FSEIS is corrected accordingly.

Response to Comment 3.8:

All NASA SRP launches at the WSMR are carried out by the Navy in strict adherence to **White Sands Pupfish Cooperative Agreement** of July 21, 1994, the full text of which is reproduced as Appendix C to this report.

Response to Comment 3.9:

See Response to Comments 3.7 and 3.8.
According to the Navy communication reported in Appendix B, out of 1162 recorded space rocket missions since 1967, there have been 110 impacts on Salt Creek.

Response to Comment 3.10:

Areas of concern are addressed in the revised FSEIS.

RECEIVED
OCT 30 1995
NASA
GSFC/WALLOPS

United States Department of the Interior

OFFICE OF THE SECRETARY
Washington, D.C. 20240

~~In Reply Refer To:~~
ER 95/411

OCT 2 4 1995

Mr. William Johnson
National Aeronautics and Space Administration
Code 840 Goddard Space Flight Center
Wallops Flight Facility
Wallops Island, Virginia 23337

Dear Mr. Johnson:

The Department of the Interior has reviewed the draft supplemental impact statement for the Sounding Rocket Program prepared by the National Aeronautics and Space Administration (NASA) and has the following comments.

General

We note that the principal sources of information used to prepare the baseline section in the draft supplement for the White Sands Missile Range (WSMR) are now greater than 10 years old. Therefore, because the draft supplement has been published using outdated material for the WSMR, much of the impact analyses contained in the document are also outdated. 4.1

Section 1.1.1.1. Alternatives to the Proposed Action, Alternatives, Programmatic Alternatives, Ground Observations (Page 2-1)

This section indicates that environmental impacts from the proposed program are confined to ground level and are minimal. Because updated information regarding sensitive resources, as discussed below, have been omitted from the analyses, to issue such a determination is premature. Realizing that about one-half of the total launches covered under this programmatic document will occur in the sensitive desert ecosystem of southern New Mexico, we recommend further analyses be conducted incorporating the information provided in this letter. In addition, further coordination with the New Mexico Ecological Services State Office and the Environmental Division of WSMR should be conducted to determine if significant impacts exist. 4.2

Section 3.2.3 Affected Environment, Site Specific Facilities and Affected Environment, White Sands Missile Range, (page 3-34 through 3-45)

Table 3-2 provides a list of endangered and threatened species found in the WSMR area. The following list should be incorporated in the existing list and within the text to update the status of species of concern to our Service. 4.3

Commentor No . 4: Willie R . Taylor
U.S. Department of the Interior
Office of the Secretary
Office of Environmental Policy and Compliance

Response to Comment 4.1:

See response to Comment 3.1.

Response to Comment 4.2:

See response to Comment 3.2.

Response to Comment 4.3:

See response to Comment 3.3.

Commentor No . 4: Willie R . Taylor (Continued),
U.S. Department of the Interior
Office of the Secretary
Office of Environmental Policy and Compliance

2

Big free-tailed bat, Nyctinomops macrotis (=Tadarida m., T. molossa), C2
Black-footed ferret, Mustela nigripes, E
Desert pocket gopher, Geomys bursarius arenarius, C2
Fringed Myotis, Myotis thysanodes, C2
Greater western mastiff bat, Eumops perotis californicus, C2
Pale Townsend's big-eared bat, Plecotus townsendii pallescens, C2
Small-footed myotis, Myotis ciliolabrum, C2
Yuma myotis, Myotis yumanensis, C2
Baird's sparrow, Ammodramus bairdii, C2
Black tern, Chlodonias niger, C2
Interior least tern, Sterna antillarum, E
Loggerhead shrike, Lanius ludovicianus, C2
Mexican spotted owl, Strix occidentalis lucida, T w/CH
Northern aplomado falcon; Falco femoralis septentrionalis, E
Southwestern willow flycatcher, Empidonax traillii extimus, E w/PCH
Western burrowing owl, Athene cunicularia hypuqea, C2
White-faced ibis, Plegadis chihi, C2
Whooping crane, Grus americana, E
Anthony blister beetle, Lytta mirifica, C2
Dona Ana talussnail, Sonorella todseni, C2
Sandhill goosefoot, Chenopodium cycloides, C2 4.3

Index		
	E=Endangered	C2=Category 2 Candidate
	T--Threatened	CH=Critical Habitat
	PCH= Proposed Critical Habitat	

Section 4.0 Environmental Consequences (Pages 4-2 through 4-49)

Effects to several federally listed species (e.g., "startle") are identified as potentially resulting from program activities in Table 4-16 (page 4-45). Under Section 7(a)(2) of the Endangered Species Act (Act), Federal agencies are required to consult with the Service on any action that "may affect" a listed species. If the determination is made that the proposed activities will have an effect on the listed species identified, we recommend formal section 7 consultation be initiated at the earliest possible time. 4.4

In a desert ecosystem such as that found at WSMR, impacts resulting from ground disturbance can be exacerbated in regions with very little rainfall. For example, areas denuded of vegetation are subject to desertification due to loss of nutrients. Impacts due to removal of vegetation and fragmentation of habitat could accumulate to significant levels, such as those experienced when habitat no longer has the characteristics necessary to support sensitive plant or wildlife species. In addition, due to lack of water sources in general, the importance of existing water sources is increased, as are the significance of impacts. 4.5

Response to Comment 4.4:

See response to Comment 3.4.

Response to Comment 4.5:

See response to Comment 3.5.

Two regions, estimated to cover approximately 1,200 square kilometers each and located 80 and 120 kilometers north of the WSMR launch site, are identified on page 3-35 as areas that could be used for recovery of payloads. We interpret this to mean that payload hardware could be deposited anywhere within this 1,200 kilometer area. No discussion is provided in the document regarding where booster hardware will impact, with the exception of an allusion to a 1.5 kilometer area that must be cleared around launch sites. Also there is no discussion regarding how large a disturbance area is expected from ground impact of payload and booster hardware and its recovery. 4.6

Page 4-23 indicates that impacts to recovery activities and to wetlands can be expected from the introduction of metallic matter and release of residual propellants. Chemical releases are mentioned several times in the document (pages 2-4, 2-10, and 2-15); however, no discussion is provided in this document regarding how much residual chemical is expected to adhere to payload hardware, and the potential for impacts from such chemicals. 4.7

Potential for impacts to the White Sands pupfish are of particular concern to the Service. This species is a category 2 candidate for listing under the Act and is found in Salt Creek, Mound Spring, Malpais Spring, and their associated outflow channels and wetlands where Lincoln, Otero, Sierra, and Socorro Counties converge. Because the White Sands pupfish inhabits fine mud-silt and sand-gravel bottoms of clear shallow, strongly alkaline pools and streams, impacts to this species occur from degradation of wetlands. In a Cooperative Agreement signed by the WSMR Commanding General on December 16, 1994, the topographic drainages of Salt Creek are designated as "limited use areas" where management will ensure degradation of habitat through contaminant runoff will not occur. 4.8

Impacts could occur as a result of the impact of payload canisters or rocket parts carrying contaminants or unburned propellant, or disturbance of the habitat as a result of recovery activities. If any debris expected to result from the proposed program has potential of impacting the limited use area that would adversely affect White Sands pupfish, further coordination with the Service and the New Mexico Department of Game and Fish will be required. 4.9

We hope these comments will be helpful to you.

Commentor No. 4: Willie R. Taylor (Concluded),
U.S. Department of the Interior
Office of the Secretary
Office of Environmental Policy and Compliance

Response to Comment 4.6:

See response to Comment 3.6.

Response to Comment 4.7:

See response to Comment 3.7.

Response to Comment 4.8:

See response to Comment 3.8.

Response to Comment 4.9:

See response to Comment 3.9.

United States Department of Agriculture

Natural Resources Conservation Service

[illegible]

June 14, 1996

William B. Johnson
National Aeronautics & Space Administration
Goddard Space Flight Center
Wallops Flight Facility
Building F6
Wallops Island, Virginia 23337

Dear William:

I reviewed the Poker Flat Research Range (PFRR) Sounding Rocket Program alternatives at Fairbanks, Alaska. None of the project improvements identified include land capability class II and III soils. Therefore, none of the project activities will impact state and locally important farmlands. Prime or unique agricultural lands are excluded from Alaska by definition because of cold soils. 5.1

United States Department of Agriculture Departmental Regulation 9500-3, Agricultural Land Protection, requires our agency to implement federal, state, and local policies for protection of farmland. The Land Evaluation (LE) portion is assigned to the Natural Resources Conservation Service. AD Form 1006, Farmland Conversion Impact Rating, is used for determining whether the site, for project activity, is subject to the Act. 5.2

The enclosed AD Form 1006 (part II) is checked "No" to indicate that no important farmlands in this project. Please keep this form (copies A and B) attached to this letter as your proof that the Farmland Protection Policy Act does not apply. You are not required to complete any parts of the form because there are no important farmlands.

Thank you for the opportunity to review the PFRR Sounding Rocket Program. If, in any future projects important farmlands are involved, I will send appropriate information for doing the Site Assessment criteria. 5.3

Sincerely,

Calvin A Miller

CALVIN A. MILLER
State Resource Conservationist

Enclosure

Commentor No. 5: Calvin A. Miller
State Resources Conservationist
U.S. Department of Agriculture
Natural Resources Conservation Service

Response to Comment 5.1:

Comment noted. Thank you.

Response to Comment 5.2:

Comment noted. Thank you.

Response to Comment 5.3:

Comment noted. Thank you.

U.S. Department of Agriculture

FARMLAND CONVERSION IMPACT RATING

PART I (To be completed by Federal Agency)	Date Of Land Evaluation Request: May 7, 1996
Name Of Project: Poker Flat Research Range Sounding Rocket Program	Federal Agency Involved: DOD
Proposed Land Use: at Fairbanks, Alaska	County And State: Alaska
PART II (To be completed by SCS)	Date Request Received By SCS

Does the site contain prime, unique, statewide or local important farmland? (If no, the FPPA does not apply — do not complete additional parts of this form)	Yes ☐ No ☒	Acres Irrigated	Average Farm Size
Major Crop(s)	Farmable Land In Govt. Jurisdiction Acres: %		Amount Of Farmland As Defined in FPPA Acres: %
Name Of Land Evaluation System Used	Name Of Local Site Assessment System		Date Land Evaluation Returned By SCS

PART III (To be completed by Federal Agency)	Maximum Points	Alternative Site Rating Site A	Site B	Site C	Site D
A. Total Acres To Be Converted Directly					
B. Total Acres To Be Converted Indirectly					
C. Total Acres In Site					
PART IV (To be completed by SCS) Land Evaluation Information					
A. Total Acres Prime And Unique Farmland					
B. Total Acres Statewide And Local Important Farmland					
C. Percentage Of Farmland In County Or Local Govt. Unit To Be Converted					
D. Percentage Of Farmland In Govt. Jurisdiction With Same Or Higher Relative Value					
PART V (To be completed by SCS) Land Evaluation Criterion Relative Value Of Farmland To Be Converted (Scale of 0 to 100 Points)					
PART VI (To be completed by Federal Agency) Site Assessment Criteria (These criteria are explained in 7 CFR 658.5(b))	Maximum Points				
1. Area In Nonurban Use					
2. Perimeter In Nonurban Use					
3. Percent Of Site Being Farmed					
4. Protection Provided By State And Local Government					
5. Distance From Urban Builtup Area					
6. Distance To Urban Support Services					
7. Size Of Present Farm Unit Compared To Average					
8. Creation Of Nonfarmable Farmland					
9. Availability Of Farm Support Services					
10. On-Farm Investments					
11. Effects Of Conversion On Farm Support Services					
12. Compatibility With Existing Agricultural Use					
TOTAL SITE ASSESSMENT POINTS	160				
PART VII (To be completed by Federal Agency)					
Relative Value Of Farmland (From Part V)	100				
Total Site Assessment (From Part VI above or a local site assessment)	160				
TOTAL POINTS (Total of above 2 lines)	260				

Site Selected:	Date Of Selection	Was A Local Site Assessment Used? Yes ☐ No ☐

5.4

Commentor No. 5: Calvin A. Miller (Concluded),
State Resources Conservationist
U.S. Department of Agriculture
Natural Resources Conservation Service

Response to Comment 5.4:

Comment noted. Thank you.

RECEIVED
-2 1995
NASA
GSFC/WALLOPS

DEPARTMENT OF THE NAVY

5090
Ser 52W400F/0332
21 SEP 1995

From: Officer in Charge, Naval Air Warfare Center Weapons Division
To: National Aeronautics and Space Administration, Goddard Space Flight Center, Wallops Flight Facility (Mr. William Johnson Code 8401, Wallops Island VA 23337

Subj: COMMENTS ON NASA EIS

Ref: (a) NASA Draft Supplemental Environmental Impact Statement (EIS) for the Sounding Rocket Program of August 1994

Encl: (1) Comments from United States Department of Interior, Fish and Wildlife Service
(2) Comments from State of New Mexico, Department of Fish and Game
(3) Comments from White Sands Missile Range (WSMR) Environmental Office (STEWS-DES-E)

1. Reference (a) was submitted to WSMR Environmental Office and subsequently to local State and Federal regulators. Their comments are provided back to you as enclosures (1) through (3). 6.1

2. A number of concerns are expressed. These concerns are primarily due to lack of existing information or mention of program-specific mitigation procedures, which, insure/reduce potential impact on threatened/endangered species like the White Sands Pupfish. 6.2

3. Recommend all agencies get together as soon as possible to resolve these workable issues. Environmental point of contact for your EIS is Tom Coleman, (505) 678-7899. 6.3

C.F. Broski-Konczey

C.F. BROSKI-KONCZEY
By direction

Commentor No . 6: C . F . Broski-Konczey
Department of the Navy
Naval Air Warfare Center
White Sands Missile Range

Response to Comment 6.1:

Comment noted. Thank you.

Response to Comment 6.2:

Expressed concerns are addressed under response to each individual agency listed as enclosures in your letter:

1. U.S. Department of the Interior
   Fish and Wildlife Service

2. State of New Mexico
   Department of Game and Fish

3. White Sands Missile Range
   Environmental Office

Response to Comment 6.3:

Mr. Tom Coleman of the Naval Air Warfare Center, White Sands Missile Range Environmental Office served as a spokesman to address the concerns of all parties thus negating the necessity of a formal meeting.

STEWS-DES-E (200-1a) 23 Aug 95

MEMORANDUM FOR DES-E (Karen Hay, NEPA Coordinator)

SUBJECT: Wildlife Review for NASA's Sounding Rocket Program (SRP) Draft Supplemental Environmental Impact Statement (SEIS)

1. References:

a. Facsimile, New Mexico Department of Game and Fish, 14 Sep 94, subject: White Sands Pupfish Conservation Plan.

b. Facsimile, US Department of the Army (DA), White Sands Missile Range (WSMR), US Air Force (AF), Holloman Air Force Base (HAFB), US Department of Interior (USDI), White Sands National Monument (WSNM), USDI, US Fish and Wildlife Service (USFWS), and New Mexico Department of Game and Fish (NMDGF), 21 Jul 94, subject: White Sands Pupfish Cooperative Agreement.

c. Memorandum, USFWS, Ecological Services Division, 13 Jul 95, subject: Draft Supplemental Environmental Impact Statement for the Sounding Rocket Program at White Sands Missile Range.

d. Federal Register, USDI, USFWS, 15 Nov 94, subject: Endangered and Threatened Wildlife and Plants; Animal Candidate Review for Listing as Endangered or Threatened Species; Proposed Rule.

e. Final Report, USDI, USFWS, Jun-Nov 92, subject: Habitat Assessment for Aplomado Falcons on WSMR.

2. I have reviewed for wildlife considerations NASA's SRP draft SEIS and provide the following comments and recommendations.

3. **Section 2.1.2 Site-Specific Alternatives**
White Sands Pupfish

a. Concerns. See Section 3.2.3.2.5 White Sands Pupfish

4. **Section 3.2.3.2.5 Biological Resources (WSMR)**

a. Concern. Treatment of biological resources is poorly developed and contains numerous inaccuracies. This section should contain sufficient information about Chihuahuan Desert flora, fauna, and their ecological relationships that effects of the proposed action on aquatic and terrestrial environments in the Tularosa Basin can be assessed.

b. Recommended. Section 3.2.3.2.5 should be redrafted

= =
7.1
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7.2
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7.3

Commentor 7: David A. Holdermann
White Sands Missile Range
Environmental Office (STEWS-DES-E)

Comment 7.1

The concerns regarding the White Sands Pupfish Agreement were addressed by personal reply of Mr. Tom Coleman of the Navy White Sands Missile Range Environmental Office and by response to Comments 3.7; 3.8; 3.9; and 7.3.

Comment 7.2.

See response to Comment 7.3 below.

Comment 7.3.

Section 3.2.3.2.5 was redrafted using current biological data. The source of new information is the *White Sands Missile Range Range-wide Environmental Impact Statement,* recently published by the White Sands Missile Range, New Mexico, Directorate of Environment and Safety, Environmental Services Division.

STEWS-DES-E (200-1a) 23 Aug 95
SUBJECT: Wildlife Review for NASA's Sounding Rocket Program (SRP) Draft Supplemental Environmental Impact Statement (SEIS)

after a review of current biological literature dealing with the Chihuahuan Desert and consultation with natural resource specialists who possess expertise in this bioregion.

5. **Section 3.2.3.2.5.1 Threatened and Endangered Species General**

a. Concern. This section contains numerous errors and omissions and reflects use of obsolete information. Assessment of the effects of the proposed action on threatened and endangered species cannot be made using the data presented in Table 3-2.

b. Recommended. Revise Table 3-2 according to information and recommendations provided in reference 1.c. Additionally, Federal status of the western snowy plover (Charadrius alexandrinus nivosus) should be changed from a C2 to C3 candidate species as listed in reference 1.d.

6. **Section 3.2.3.2.5.1 Mexican Spotted Owl**

a. Concerns.

(1) The Mexican spotted owl (Strix occidentalis lucida) is listed as species of concern on WSMR by the USFWS (reference 1.c.). Surveys for this species have not been undertaken at WSMR, but the Oscura Mountains, portions of which fall within 70-mi payload landing/recovery area, constitute potential habitat.

(2) Description of the proposed action concerning the nature and frequency of rocket/payload landings in the 70-mi landing/recovery area are insufficient to evaluate potential impacts on the Mexican spotted owl.

b. Recommended.

(1) Informal consultation with the New Mexico Ecological Services Division, USFWS to further define their concerns with the Mexican spotted owl at WSMR, particularly the need to conduct surveys for this species prior to initiating the proposed action.

(2) Under the description of the proposed action, specific data are needed concerning the nature and frequency of rocket/payload landings in the 70-mi landing/recovery area.

Commentor 7: David A. Holdermann (Continued),
White Sands Missile Range
Environmental Office (STEWS-DES-E)

Comment 7.4.
7.3 See response to Comment 7.5 below.

Comment 7.5.
Section 3.2.3.2.5.1 was revised using new information. This
7.4 new section in FSEIS is based on data from the *White Sands Missile Range Range-wide Environmental Impact Statement,* recently published by the White Sands Missile Range, New Mexico, Directorate of Environment and Safety, Environmental Services Division. All tables in this section
7.5 were revised using up-dated information.

Comment 7.6
While the existence of the Spotted Owl is not disputed, the operational area of the NASA SRP does not include the Oscura mountains which are the primary habitat of this species. It is potentially possible that this species might be
7.6 spotted in the area, but to date it has not been noticed in the impact areas utilized by NASA SRP.

7.7 **Comment 7.7**
There is no 70-mi landing/recovery zone. See response to comment 3.6.

Comment 7.8
7.8 Proposed action was initiated in 1959, and has been continuously on-going since.

Comment 7.9
7.9 See response to 7.7.

STEWS-DES-S (200-1a) 23 Aug 95
SUBJECT: Wildlife Review for NASA's Sounding Rocket Program (SRP) Draft Supplemental Impact Statement (SEIS)

7. **Section 3.2.3.2.5.1**
Northern Aplomado Falcon

a. Concern. There have been 3 confirmed sightings of the northern aplomado falcon (*Falco femoralis septentrionalis*) on WSMR since 1991. Both the 50-mi and 70-mi payload landing/recovery areas fall within potential northern aplomado falcon habitat according to a USFWS habitat assessment study (reference 1.e.). Although the northern aplomado falcon is included in Table 3-2 of the SEIS, no assessment of the proposed action on the species is made.

b. Recommended. Informal consultation with the New Mexico Ecological Services Division, USFWS to further define their concerns with the northern aplomado falcon at WSMR, particularly the need to conduct surveys for this species prior to initiating the proposed action.

8. **Section 3.2.3.2.5.1**
Southwest Willow Flycatcher

a. Concern. The southwestern willow flycatcher (*Empidonax trillii extimus*) is listed as a species of concern on WSMR by the USFWS (reference 1.c.). Surveys for the southwestern willow flycatcher have not been conducted; however, the riparian corridor along Salt Creek represents potential habitat. The southwestern willow flycatcher was not identified in this section, and potential effects of the proposed action on the species were not considered.

b. Recommended. Informal consultation with the New Mexico Ecological Services Division, USFWS to further define their concerns with the southwestern willow flycatcher at WSMR, particularly the need to conduct surveys for this species prior to initiating the proposed action.

9. **Section 3.2.3.2.5.1**
White Sands Pupfish

a. Concerns.

(1) The native range of the White Sands pupfish (*Cyprinodon tularosa*) is restricted to Malpais Spring, Salt Creek, and Mound Spring with an introduced population at Malone draw-Lost River (ref. 1.a.). The extremely limited range of the species is the primary factor that makes it vulnerable to human disturbance. The 50-mi payload landing/recovery area encompasses most of the Salt Creek and all of the Malpais Spring populations.

Comment 7.9

See response to comment 3.6. Each specific NASA SRP flight at WSMR is designed individually, with full attention to all environmental concerns and in accordance with Navy Standard Operating Procedures (SOP) as illustrated in Appendix B.

7.10

Comment 7.10

See response to comments 3.6 and 7.9.

7.11

Comment 7.11

See response to Comment 7.8.

Comment 7.12

There is a great amount of care taken to mitigate negative impacts during NASA SRP recovery. All reasonable effort taken to avoid impact to native species such as the pupfish and southwestern willow flycatcher and the habitat that is occupied by these and other species. Individual recovery operations are documented both with film prints and a video recording of the operations. A written recovery report is generated with verbal description of affected areas and is included in the flight record. The WSMR Environmental Office feels the NASA SRP has some of the best mitigation and documented methods at WSMR.

7.12

7.13

Comment 7.13

In light of the long history of impacts into this geographic area with no negative results, we do not feel that it is necessary to consult at this time. Also see the response to Comment 7.12.

Comment 7.14

Comment noted. Thank you.

7.14

STEWS-DES-E (200-1a) 23 Aug 95
SUBJECT: Wildlife Review for NASA's Sounding Rocket Program (SRP) Draft Supplemental Impact Statement (SEIS)

Essential Habitats and Limited-Use Areas with special land use guidelines are defined by the White Sands Pupfish Cooperative Agreement (WSPCA) (ref. 1.b.) for all populations of this species.

(2) Chemical contamination and physical disturbance from WSMR weapons (missile) testing are identified by the WSPCA as potential threats to pupfish (ref. 1.b.). Chemical contamination and physical disturbance from rocket or payload landings and recovery are given superficial consideration in the SEIS.

b. Recommended.

(1) The SEIS should identify and assess the use of alternative payload landing/recovery areas either at WSMR or at another location where potential conflicts with rare/sensitive species and/or habitats are a lesser concern.

(2) The WSPCA (ref. 1.b.) established the White Sands Pupfish Conservation Team (WSPCT) and identifies agency responsibilities and management guidelines for this species. The WSPCT provides an interagency mechanism to address pupfish conservation issues. NASA should initiate consultation with the WSPCT at the earliest date possible to address specific issues and concerns related to the SRP. WSMR POC for the WSPCT is Mr. Patrick Morrow (DES-E) who can be reached at (505) 678-7095.

DAVID A. HOLDERMANN
Wildlife Biologist

Commentor 7: David A. Holdermann (Concluded),
White Sands Missile Range
Environmental Office (STEWS-DES-E)

Comment 7.15.

7.14 See response to comment 3.7.

Comment 7.16

7.15

Impacts on all ranges are planned to avoid sensitive areas and habitat. At WSMR in particular, there are several designated areas that have been categorically set aside for live weapons impacts and distinctly negative testing. Although the SRP is not considered to be in the same category it certainly has the option of utilizing an alternative impact site. This has been done as a standard feature of the SRP at WSMR for other reasons and to the extent permissible for flight safety reasons. On occasion the 70 and 90 mile impact areas are currently used for the SRP in lieu of the 'standard' 50 mile area. There is no reason this can not be continued. See also Appendix B-4, paragraph 5.

7.16

Comment 7.17

7.17

See response to comment 3-9.

Commentor 8: Michael P. Murphy
Commonwealth of Virginia
Department of Environmental Quality
Grants Management & Intergovernmental Affairs

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NASA
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COMMONWEALTH of VIRGINIA

DEPARTMENT OF ENVIRONMENTAL QUALITY

June 20, 1995

Peter W. Schmidt
Director

P.O. Box 10009
Richmond, Virginia 23240-0009
(804) 762-4000

Mr. William Johnson
National Aeronautics & Space Administration
Goddard Space Flight Center
Wallops Flight Facility, Code 205.3
Wallops Island, Virginia 23337

RE: Draft Supplemental Environmental Impact Statement & Finding of No Significant Impact for the proposed Sounding Rocket Program at Goddard Space Flight Center/Wallops Flight Facility, Wallops Island, Virginia.

Dear Mr. Johnson:

The Commonwealth of Virginia has completed its review of the Environmental Assessment of the above referenced project. The Department of Environmental Quality is responsible for coordinating Virginia's review of federal environmental documents and responding to appropriate federal officials on behalf of the Commonwealth. The following agencies and locality took part in this review:

Department of Environmental Quality
Department of Game and Inland Fisheries
Department of Conservation and Recreation
Department of Health
Department of Mines, Minerals, and Energy
Marine Resources Commission
Virginia Institute of Marine Sciences
Chesapeake Bay Local Assistance Department
Town of Chincoteague

The Department of Historic Resources, Department of Forestry, Department of Agriculture and Consumer Services, Accomack-Northampton Planning District Commission, and Accomack County were also invited to comment.

629 East Main Street, Richmond, Virginia 23219 - Fax (804) 762-4500 - TDD (804) 762-4021

8.1 The Commonwealth has no objection to the proposed changes in the Sounding Rocket Program (SRP). This Supplemental EIS reflects programmatic changes in the SRP which have occurred since the Final EIS was prepared in July 1973. These changes include deleting launch vehicles that are no longer used, adding new launch vehicles and systems that are currently in use, and updating applicable environmental statutes and regulations.

8.2 The Commonwealth concurs with NASA's "Finding of No Significant Impact" for this proposal provided the facility is operated in strict accordance with all applicable federal, state, and local regulations. The proposed action to continue the SRP, a suborbital space flight program supporting space and earth science activities sponsored by NASA, should not adversely affect the environment and natural resources. We urge you to review the detailed comments of reviewing agencies which are attached.

Environmental Impacts and Mitigation

8.3 1. *Water quality.* This proposal should not adversely affect water quality. However, potential adverse impact to water quality resulting from surface runoff must be minimized by using Best Management Practices. The implementation and maintenance of proper erosion and sediment control measures should minimize the impacts further.

8.4 2. *Air quality.* No adverse impacts to air quality are anticipated providing the launching of various rockets are kept within the proposed launching frequency schedule.

8.5 3. *Natural heritage resources.* According to the information in the files of the Department of Conservation and Recreation's Division of Natural Heritage (DNH), there are several species of rare plants at the Wallops Flight Facility (see DCR's comments for details). DCR is currently conducting an inventory of natural resources at the WFF. Natural heritage resources are defined as the habitat of rare, threatened, or endangered animals, plants, unique or exemplary natural communities and significant geologic formation. Provided that NASA complies with recommendations to protect wildlife species such as the peregrine falcon (Falco peregrinus), a federally listed endangered species, this proposal should not adversely affect natural heritage resources.

8.6 4. *Historic structures and archaeological resources.* The Department of Historic Resources indicated that this project will have no adverse effect on historic properties.

8.7 5. *Erosion and sediment control.* Non-point source impacts to waters from sediment and runoff from impervious surfaces such as launching pads, roadways, and roofs could result from the Sounding Rocket Program. However, no additional impacts are anticipated. Implementation of strict erosion and sediment control measures at WFF should minimize non-point source pollution.

Commentor 8: Michael P. Murphy (Continued),
Commonwealth of Virginia
Department of Environmental Quality
Grants Management & Intergovernmental Affairs

Comment 8.1
Comment noted. Thank you.

Comment 8.2
Comment noted. Thank you.

Comment 8.3
Comment noted. Thank you.

Comment 8.4
Comment noted. Thank you.

Comment 8.5
WFF is in full compliance with regard to all applicable endangered species regulations and works in close cooperation with the U.S. Fish and Wildlife Service and the Virginia Department of Game and Inland Fisheries.

Comment 8.6
Comment noted. Thank you.

Comment 8.7
The Wallops Storm Water Management Plan covers soil erosion and adheres to all state regulations and best management practices.

6. Solid and Hazardous Wastes. All solid wastes generated at the site should be reduced at the source, re-used, or recycled. All hazardous wastes should be minimized. DEQ's Office of Enforcement has negotiated an enforcement order with NASA to address past violations of the Virginia Hazardous Waste Management Regulations. 8.8

7. State Scenic Rivers. The Department of Conservation and Recreation has indicated that the SRP will not affect any streams on the National Park Service Nationwide Inventory, Final List of Rivers, or existing or potential State Scenic Rivers. Nor will the project affect existing or potential State Scenic Byways. 8.9

8. Pesticides and Herbicides. The use of herbicides or pesticides for landscape maintenance should be in accordance with the principles of integrated pest management. The least toxic pesticides that are effective in controlling the target species should be used. We recommend that the use of pesticides containing volatile organic compounds as their active ingredient be avoided to the maximum extent practicable in order to protect air quality. Please contact the Department of Agriculture and Consumer Services ((804) 786-3501) for more information. 8.10

<u>Regulatory and Coordination Needs</u>

1 . Erosion and .sediment control and .stormwater management. If NASA wishes review of applicable standards and specifications or technical review of either erosion and sediment control plans or stormwater management plans, contact the Department of Conservation and Recreation's Division of Soil and Water Conservation ((804) 371-7483). 8.11

2. Air quality regulation. Certain operation at the Wallop Flight Facility may be subject to regulation by the Department of Environmental Quality - Air Division (DEQ-AD). Also, any new source of emission or any modification to existing permitted sources will be subject to permitting requirements of the DEQ-AD. Please contact the DEQ's-Tidewater regional office at 2010 Old Greenbrier Road in Chesapeake ((804) 424-6707) for additional information . 8.12

3. Natural heritage resources. For updated natural heritage resource information please contact the Department of Conservation and Recreation's Natural Heritage Program (Leslie D. Trew (804) 786-7951). Also, in order to ensure compliance with protected species legislation, development activities should be coordinated with the Department of Game and Inland (Raymond T. Fernald (804) 367-8999) and the U.S. Fish and Wildlife Service. 8.13

4. Solid Waste and Hazardous Substances. All solid waste, hazardous waste, and hazardous material must be managed in accordance with all applicable federal, state, and local environmental regulations. For more information, contact Milt Johnston at DEQ- Tidewater Regional Office ((804) 552-1849). 8.14

Commentor 8: Michael P. Murphy (Continued),
Commonwealth of Virginia
Department of Environmental Quality
Grants Management & Intergovernmental Affairs

Comment 8.8

Comment noted. Thank you.

Comment 8.9

Comment noted. Thank you.

Comment 8.10

Comment noted. Thank you.

Comment 8.11

Comment noted. Thank you.

Comment 8.12

Comment noted. Thank you.

Comment 8.13

Comment noted. Thank you.

Comment 8.14

Comment noted. Thank you.

5. *Federal Consistency Certification.* Pursuant to the Coastal Zone Management Act of 1972, as amended, the proposed project must be operated in a manner which is consistent with the Virginia Coastal Resources Management Program (VCRMP). NASA must receive all the applicable permits and approvals listed under the Enforceable Programs of the VCRMP (Attachment 1). No further action is necessary to be in compliance with the VCRMP. 8.15

Thank you for the opportunity to review the Supplemental EIS for this undertaking. We urge your review of the detailed comments of reviewing agencies which are attached.

Sincerely,

Michael P. Murphy, Director
Grants Management & Intergovernmental Affairs

Enclosures

cc. Joseph P. Hassell, DEQ-OWRM
John R. Davy, DCR
Ulysses Brown, DEQ-WMD
Raymond T. Fernald, DGIF
Dona Huang, DEQ-AD
Traycie L. West, DEQ-TRO

Commentor 8: Michael P. Murphy (Continued),
Commonwealth of Virginia
Department of Environmental Quality
Grants Management & Intergovernmental Affairs

Comment 8.15

Comment noted. Thank you.

Commentor 8: Michael P. Murphy (Continued),
Commonwealth of Virginia
Department of Environmental Quality
Grants Management & Intergovernmental Affairs

COMMONWEALTH of VIRGINIA

DEPARTMENT OF ENVIRONMENTAL QUALITY

Enforceable Regulatory Programs comprising Virginia's Coastal Resources Management Program

a. Fisheries Management - The program stresses the conservation and enhancement of finfish and shellfish resources and the promotion of commercial and recreational fisheries to maximize food production and recreational opportunities. This program is administered by the Marine Resources Commission (Virginia Code §28.1-23.1) and the Department of Game and Inland Fisheries (Virginia Code §29-13 and §29-125).

The State Tributyltin (TBT) Regulatory Program has been added to the Fisheries Management program. The General Assembly amended the Virginia Pesticide Use and Application Act as it related to the possession, sale, or use of marine antifoulant paints containing TBT. The use of TBT in boat paint constitutes a serious threat to important marine animal species. The TBT program monitors boating activities and boat painting activities to ensure compliance with TBT regulations promulgated pursuant to the amendment. The MRC, DGIF, and VDACS share enforcement responsibilities.

b. Subaqueous Lands Management - The management program for subaqueous lands establishes conditions for granting or denying permits to use state-owned bottomlands based on considerations of potential effects on marine and fisheries resources, wetlands, adjacent or nearby properties, anticipated public and private benefits, and water quality standards established by the Department of Environmental Quality, Water Division. The program is administered by the Marine Resources Commission (Virginia Code §62.1-13.1 et. seq.).

c. Wetlands Management - The purpose of the wetlands management program is to preserve tidal wetlands, prevent their despoliation, and accommodate economic development in a manner consistent with wetlands preservation. This program is administered by the Marine Resources Commission (Virginia Code §62.1-13.1 through §62.1-13.20).

d. Dunes Management - Dune protection is carried out pursuant to The Coastal Primary Sand Dune Protection Act and is intended to prevent destruction or alteration of primary dunes. This program is administered by the Marine Resources Commission (Virginia Code §62.1-13.21 through §62.1-13.28).

Commentor 8: Michael P. Murphy (Concluded),
Commonwealth of Virginia
Department of Environmental Quality
Grants Management & Intergovernmental Affairs

e. Non-point Source Pollution Control - Virginia's Erosion and Sediment Control Law requires soil-disturbing projects to be designed to reduce soil erosion and to decrease inputs of chemical nutrients and sediments to the Chesapeake Bay, its tributaries, and other rivers and waters of the Commonwealth. This program is administered by the Department of Conservation and Recreation (Virginia Code §10.1-560 et.seq.).

f. Point Source Pollution Control - The point source program is administered by the State Water Control Board pursuant to Virginia Code §62.1-44.15. Point source pollution control is accomplished through the implementation of:

(i) The National Pollutant Discharge Elimination System (NPDES) permit program established pursuant to Section 402 of the federal Clean Water Act and administered in Virginia as the VPDES permit program.

(ii) Water Quality Certification pursuant to Section 401 of the Clean Water-Act.

g. Shoreline Sanitation - The purpose of this program is to regulate the installation of septic tanks, set standards concerning soil types suitable for septic tanks, and specify minimum distances that tanks must be placed away from streams, rivers, and other waters of the Commonwealth. This program is administered by the Department of Health (Virginia Code §32.1-164 through §32.1-165).

h. Air Pollution Control - The program implements the federal Clean Air Act to provide a legally enforceable State Implementation Plan for the attainment and maintenance of the National Ambient Air Quality Standards. This program is administered by the State Air Pollution Control Board (Virginia Code §10-17.18).

Rec'd. by Dept. of Environmental Quality

JUN 9 1995

Public & Inter-governmental Affairs

COMMONWEALTH of VIRGINIA

DEPARTMENT OF ENVIRONMENTAL QUALITY

PETER W. SCHMIDT
DIRECTOR

TIDEWATER REGIONAL OFFICE
287 INDEPENDENCE BOULEVARD
PEMBROKE TWO, SUITE 310
VIRGINIA BEACH, VIRGINIA 23462
(804) 552-1840
FAX (804) 552-1849 TDD # - RICHMOND (804) 762-4021

FRANCIS L. DANIEL
REGIONAL DIRECTOR

June 6,1995

Ms. Ellie Irons
Department of Environmental Quality
Office of Environmental Impact Review
629 East Main Street, Sixth Floor
Richmond, Virginia 23219

Ms. Irons,

WASTE:

The Office of Enforcement has negotiated an enforcement order with NASA to address past violations of the Virginia Hazardous Waste Management Regulations (VHWMR). Currently, the order has been sent to NASA for their review and concurrence. John Ely, Director of Waste Enforcement, is the point contact on this issue. Additionally, Kerita Kegler had recently closed a complaint regarding the improper disposal of NASA's solid waste by a contractor. 9.1

The continued operation of the facility must adhere to the Virginia Solid Waste Management Regulations and the Virginia Hazardous Wastes Management Regulations to prevent impacts to the environment. 9.2

PLANNING:

All water quality concerns have been adequately addressed. Although impacts on wetlands and coastal areas can be expected in the vicinity of the Wallops Island Sounding Rocket Program (SRP) launch site, section 4.2.1.4 states that "[b]ased on the analysis of impacts of a larger commercial launch vehicle Conestoga on wetlands, floodplains, and coastal areas, the impacts of firing smaller SRP rockets will not be substantial." It is expected that, on impact, not enough rocket propellant will be remaining in the motors to be an environmental hazard. 9.3

Commentor 9: Traycie L. West
Commonwealth of Virginia
Department of Environmental Quality
Tidewater Regional Office

Comment 9.1

Comment noted. Thank you.

Comment 9.2

Comment noted. Thank you.

Comment 9.3

Comment noted. Thank you.

Supplemental Environmental Impact Statement Sounding Rocket Program
June 6, 1995
Page 2

AIR:

All air concerns have been addressed.

The Tidewater Regional Office thanks you for the opportunity to participate in the review process.

Traycie L. West
Environmental Specialist
Tidewater Regional Office

COPIES: Milt Johnston (Solid Waste Compliance, TRO), Karen Sismour (Air Quality, TRO), Tracey Harmon (OWRM, Innsbrook), Bob Jackson (TRO), file

Commentor 9: Traycie L. West (Concluded),
Commonwealth of Virginia
Department of Environmental Quality
Tidewater Regional Office

Comment 9.4

9.4 Comment noted. Thank you.

Rec'd. by Dept. of
Environmental Quality

JUN 13 1995

Public & Inter-
governmental Affairs

COMMONWEALTH of VIRGINIA

DEPARTMENT OF ENVIRONMENTAL QUALITY

OFFICE OF TECHNICAL ASSISTANCE/WASTE
4900 Cox Road, Room 2166
Glen Allen, Virginia 23060

Peter W. Schmidt
Director

P. O. Box 10009
Richmond, Virginia 23240-0009
(804) 762-4000

JUN 09 1995

Ms. Ellie Irons
DEQ Office of Environmental Impact Review
629 East Main St., Sixth Floor
Richmond, Virginia 23219

Project No.: **95-068F**
Project Title: **Sounding Rocket Program**

Dear Ms. Irons:

The Office of Technical Assistance/Waste (OTAW) has completed a review of the environmental impact report regarding the above referenced subject. Please note that the OTAW does not object to the proposed activity as described. We offer no comment at this time. 10.1

Should you require additional assistance regarding solid or hazardous waste management issues, please feel free to contact me at (804) 527-5148.

Sincerely,

Ulysses B. Brown Jr.
Solid Waste Compliance Manager
Office of Technical Assistance/Waste

cc: Mohammad Habibi, OTAW

C:\REVIEWS\UOSACKC.LET

629 East Main Street, Richmond, Virginia 23219 - Fax (804) 762-4500 - TDD (804) 762-4021

Commentor 10: Ulysses B. Brown, Jr.
Commonwealth of Virginia
Department of Environmental Quality
Solid Waste Compliance Manager
Office of Technical Assistance.

Comment 10.1

Comment noted. Thank you.

If you cannot meet the deadline, please notify ELLIE IRONS at 804/762-4325 or R. THOMAS GRIFFIN AT 804/762-4337 prior to the date given. Arrangements will be made to extend the date for your review if possible. An agency will not be considered to have reviewed a document if no comments are received (or contact is made) within the period specified.

REVIEW INSTRUCTIONS:

A. Please review the document carefully. If the proposal has been reviewed earlier (i.e. if the document is a federal Final EIS or a state supplement), please consider whether your earlier comments have been adequately addressed.

B. Prepare your agency's comments in a form which would be acceptable for responding directly to a project proponent agency.

C. Use your agency stationery or the space below for your comments. **IF YOU USE THE SPACE BELOW, THE FORM MUST BE SIGNED AND DATED.**

Please return your comments to:

DEPARTMENT OF ENVIRONMENTAL QUALITY
OFFICE OF ENVIRONMENTAL IMPACT REVIEW
629 EAST MAIN STREET, SIXTH FLOOR
RICHMOND, VA 23219
FAX #804/762-4319

Rec'd Dept. of Environmental Quality
JUN 13 1995
Public & Inter-governmental Affairs

Ellie Irons
Environmental Program Planner

COMMENTS

Based on the SEIS, the exhaust emissions of ~~for~~ 7 certain pollutants are anticipated to be below State air toxic regulatory limits. Hence, if the proposed launchings of various ~~air~~ rockets w/in the SRP are kept w/in ~~schedule~~ the proposed launching frequency/schedule, then, little no air quality impacts are foreseen.

(signed) Dona Huang (date) 6-12-95
(title) Sr. Env. Eng.
(agency) DEQ – Air Div

PROJECT # 95-068F 5/95

Commentor 11: Dona Huang
Commonwealth of Virginia
Department of Environmental Quality
Air Division.

Comment 11.1

Comment noted. Thank you.

11.1

JUN.-16'95(FRI) 16:35 VDOT ENVIRONMENTAL TEL:804 786 7401 P.002

COMMONWEALTH *of* VIRGINIA

DEPARTMENT OF TRANSPORTATION
1401 EAST BROAD STREET
RICHMOND, 23219-1939

DAVID R. GEHR
COMMISSIONER

EARL T. ROBB
ENVIRONMENTAL ENGINEER

June 9, 1995

FONSI - NASA Langley

Ms. Tricia Romanowski
Office of Environmental Engineering
OSEMA, M/S 429
5 Hunsaker Loop
NASA Langley Research Center
Hampton, Virginia 23681-0001

Dear Ms. Romanowski:

The Virginia Department of Transportation has reviewed the information contained in the EA/FONSI on the above referenced project. It is not anticipated that these activities will have any impact on existing or proposed transportation facilities.

Thank you for the opportunity to comment on this project.

Sincerely,

Christopher G. Collins
Environmental Program Analyst

TRANSPORTATION FOR THE 21ST CENTURY

12.1

Commentor 12: Christopher G. Collins
Commonwealth of Virginia
Department of Transportation

Comment 12.1

Comment noted. Thank you.

George Allen
Governor

Becky Norton Dunlop
Secretary of Natural
Resources

H. Kirby Burch
Director

COMMONWEALTH of VIRGINIA

DEPARTMENT OF CONSERVATION AND RECREATION

203 Governor Street, Suite 302

TDD (804) 786-2121 Richmond, Virginia 23219-2010 (804) 786-6124 FAX: (804) 786-6141

MEMORANDUM

Rec'd. by Dept. of
Environmental Quality

JUN 15 1995

Public & Inter-
governmental Affairs

DATE : June 8, 1995

TO: Ellie Irons, Department of Environmental Quality

FROM: John R. Davy, Jr., Planning Bureau Manager JRD

SUBJECT: Sounding Rocket Program, DEQ 95-068F

The Department of Conservation and Recreation (DCR) has review the Draft Supplemental Environmental Impact Statement for the Sounding Rocket Program (SRP) and would like to offer the following comments.

13.1 Based on a review of the document, the proposed action is to continue the SRP activity in the present form and at the current level of effort; there will be no significant changes in the programmatic scope, or site-specific elements of the rocket program at the Wallops Fight Facility (WFF).

13.2 DCR's-Division of Natural Heritage is currently inventorying the WFF for occurrences of natural heritage resources. Natural heritage resources are defined as the habitat of rare, threatened, or endangered plant and animal species, unique or exemplary natural communities, and significant geologic formations. The final report will be submitted to WFF in the Spring of 1996 and will provide comprehensive information regarding the resources at the facility. This document will detail the extant natural heritage resources and will include both management and protection recommendations on a site-specific basis.

13.3 According to the information currently in our files, the following natural heritage resources have been documented within the WFF:

Wallops Island:

- Estuarine herbaceous vegetation
- Oligotrophic herbaceous vegetation
- Oligotrophic scrub
- Oligotrophic woodland
- Eutrophic seasonally flooded herbaceous vegetation
- Plantago maritima seaside plantain G5/S1/NF/NS
- Juncus megacephalus big-head rush G4G5/S2/NF/NS
- Leptochloa fascicularis var maritima long-awned sprangletop G5T3/S2S3/NF/NS
- Chamaesyce bombensis southern beach spurge G4G5/S2/NF/NS
- Fimbristylis caroliniana Carolina fimbristylis G4/S2/NF/NS
- Iris versicolor blueflag G5/S2/NF/NS

An Agency of the Natural Resources Secretariat

Commentor 13: John R. Davy, Jr.
Commonwealth of Virginia
Department of Conservation and Recreation

Comment 13.1

Comment noted. Thank you.

Comment 13.2

Comment noted. Thank you.

Comment 13.3

The text of the FSEIS was revised to reflect information provided in this letter. Specifically, Table 3-1 *Endangered or Threatened Species Found in the WFF Area,* was replaced by Table 3-1, *Natural Heritage Resources Document within* WFF, content of which is based on information provided in this letter.

Commentor 13: John R. Davy, Jr. (Continued),
Commonwealth of Virginia
Department of Conservation and Recreation

DEQ 93-044F, Page 2

Caretta caretta	loggerhead sea turtle	G3/S1BS/LT/LT
Charadrius wilsonia	Wilson's plover	G5/S1/NF/LE
Charadrius melodus	piping plover	G3/S2/LT/LT
Falco peregrinus	peregrine falcon	G3/S1/LE/LE

Main Base:

Estuarine herbaceous vegetation
Oligotrophic saturated scrub

Argia bipunctulata	seepage dancer	G4/S2S3/NF/NS
Helianthemum propinquum	low frostweed	G4/S1/NF/NS
Juncus pelocarpus	brown-fruited rush	G5/S1/NF/NS
Iris versicolor	blueflag	G5/S2/NF/NS
Ischnura prognata	furtive forktail	G4/S1I/NF/NS
Haliaeetus leucocephalus	bald eagle	G4/S2S3/LE/LE

Mainland:

Carex lacustris	lake-bank sedge	G5/S1/NF/NS
Carex striata	a sedge	G4/S1/S2/NF/NS
Iris versicolor	blueflag	G5/S2/NF/NS

13.4 Provided that the protection recommendations for the bald eagle, piping plover, and Wilson's plover are followed as noted in this document, DCR does not anticipate that the continued operation of this facility at the current level will adversely impact natural heritage resources.

An explanation of species' rarity ranks and legal status abbreviations is enclosed for your reference.

13.5 The proposed project is not anticipated to have any adverse impacts on existing or planned recreational facilities nor will it impact any streams on the National Park Service Nationwide Inventory, Final List of Rivers, potential State Scenic Rivers or existing or potential State Scenic Byways.

Thank you for the opportunity to comment on this project.

JRD:dlv

cc: Cindy Schulz, USFWS
Andy Moser, USFWS - Annapolis
Ray Fernald, VDGIF
Rebecca Wajda, VDGIF

Comment 13.4

Comment noted. Thank you.

Comment 13.5

13.3 Comment noted. Thank you.

Commentor 13: John R. Davy, Jr., (Concluded),
Commonwealth of Virginia
Department of Conservation and Recreation

Definition of Abbreviations Used on Natural Heritage Resource Lists
of the
Virginia Department of Conservation and Recreation

Natural Heritage Ranks

The following ranks are used by the Virginia Department of Conservation and Recreation to set protection priorities for natural heritage resources. Natural Heritage Resources, or "NHR's," are rare plant and animal species, rare and exemplary natural communities, and significant geologic features. The primary criterion for ranking NHR's is the number of populations or occurrences, i.e. the number of known distinct localities. Also of great importance is the number of individuals in existence at each locality or, if a highly mobile organism (e.g., sea turtles, many birds, and butterflies), the total number of individuals. Other considerations may include the quality of the occurrences, the number of protected occurrences, and threats. However, the emphasis remains on the number of populations or occurrences such that ranks will be an index of known biological rarity.

S1 Extremely rare; usually 5 or fewer populations or occurrences in the state; or may be a few remaining individuals; often especially vulnerable to extirpation.

S2 Very rare; usually between 5 and 20 populations or occurrences; or with many individuals in fewer occurrences; often susceptible to becoming extirpated.

S3 Rare to uncommon; usually between 20 and 100 populations or occurrences; may have fewer occurrences, but with a large number of individuals in some populations; may be susceptible to large-scale disturbances.

S4 Common; usually >100 populations or occurrences, but may be fewer with many large populations; may be restricted to only a portion of the state; usually not susceptible to immediate threats.

S5 Very common; demonstrably secure under present conditions.

SA Accidental in the state.

SB# Breeding status of an organism within the state.

SE Exotic; not believed to be native in the state.

SH Historically known from the state, but not verified for an extended period, usually > 15 years; this rank is used primarily when inventory has been attempted recently.

SN# Non-breeding status within the state. Usually applied to winter resident species.

SR Reported from the state, but without persuasive documentation to either accept or reject the report.

SU Status uncertain, often because of low search effort or cryptic nature of the element.

SX Apparently extirpated from the state.

SZ Long distance migrant whose occurrences during migration are too irregular, transitory and/or dispersed to be reliably identified, mapped and protected.

Global ranks are similar, but refer to a species' rarity throughout its total range. Global ranks are denoted with a "G" followed by a character. Note that GA and GN are not used and GX means apparently extinct. A "Q" in a rank indicates that a taxonomic question exists concerning that species. A "?" in a rank indicates uncertainty as to that species' rarity. Ranks for subspecies are denoted with a "T". The global and state ranks combined (e.g. G2/S1) give an instant grasp of a species' known rarity.

These ranks should not be interpreted as legal designations.

Federal Legal Status

The Division of Natural Heritage uses the standard abbreviations for Federal endangerment developed by the U.S. Fish and Wildlife Service, Division of Endangered Species and Habitat Conservation.

LE - Listed Endangered
LT - Listed Threatened
PE - Proposed Endangered
PT - Proposed Threatened
C1 - Candidate, category 1
C2 - Candidate, category 2
3A - Former candidate - presumed extinct
3B - Former candidate - not a valid species under current taxonomic understanding
3C - Former candidate - common or well protected
NF - no federal legal status

State Legal Status

The Division of Natural Heritage uses similar abbreviations for State endangerment.

LE - Listed Endangered
LT - Listed Threatened
C - Candidate
PE - Proposed Endangered
PT - Proposed Threatened
NS - no state legal status
SC - Special Concern

For information on the laws pertaining to threatened or endangered species, contact:
U.S. Fish and Wildlife Service for all FEDERALLY listed species
Department of Agriculture and Consumer Services Plant Protection Bureau for STATE listed plants and insects
Department of Game and Inland Fisheries for all other STATE listed animals

TOTAL P.04

Rec'd. by Dept. of
Environmental Quality

JUN 7 1995

COMMONWEALTH of VIRGINIA

Public & Inter-
governmental Affairs

CHESAPEAKE BAY LOCAL ASSISTANCE DEPARTMENT

George Allen
Governor

Becky Norton Dunlop
Secretary of Natural Resources

805 East Broad Street, Suite 701
Richmond, Virginia 23219
Fax (804) 225-3447

Kathleen W. Lawrence
Executive Director

(804) 225-3440
1-800-243-7229 Voice/TDD

MEMORANDUM

TO: Ms. Ellie Irons
Department of Environmental Quality

FROM: Darryl M. Glover
Senior Environmental Engineer

DATE: June 2, 1995

SUBJECT: Sounding Rocket Program - Wallops Island & Out of State
National Aeronautics & Space Administration -
Accomack County
Environmental Assessment - Project #95-068F

We have reviewed the environmental assessment for the sounding rocket program located at Wallops Island in Accomack County, Virginia and other sites out of state.

Adoption of a Chesapeake Bay Preservation Area (CBPA) Program is required for all Tidewater Virginia localities. Local governments have the option however, to exclude portions of their jurisdictions that do not drain to the Chesapeake Bay. Accomack County has not included areas that drain to the Atlantic Ocean in their CBPA Program. This site drains directly to the Atlantic Ocean, not the Chesapeake Bay. Therefore, this project would not be affected by our program. 14.1

c: Ms. Sandra Mantor, Accomack County
Ms. Shawn E. Smith, CBLAD

eis:95-068F.NSA

An Agency of the Natural Resources Secretariat

Commentor 14: Darryl M. Glover
Commonwealth of Virginia
Chesapeake Bay Local Assistance Department

Comment 14.1

Comment noted. Thank you.

If you cannot meet the deadline, please notify ELLIE IRONS at 804/762-4325 or R. THOMAS GRIFFIN AT 804/762-4337 prior to the date given. Arrangements will be made to extend the date for your review if possible. An agency will not be considered to have reviewed a document if no comments are received (or contact is made) within the period specified.

REVIEW INSTRUCTIONS:

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C. Use your agency stationery or the space below for your comments. **IF YOU USE THE SPACE BELOW, THE FORM MUST BE SIGNED AND DATED.**

Please return your comments to:

DEPARTMENT OF ENVIRONMENTAL QUALITY
OFFICE OF ENVIRONMENTAL IMPACT REVIEW
629 EAST MAIN STREET, SIXTH FLOOR
RICHMOND, VA 23219
FAX #804/762-4319

Rec'd. by Dept. of Environmental Quality
MAY 31 1995
Public & Inter-governmental Affairs

Ellie I—
Environmental Program Planner

COMMENTS

VDH has reviewed the Draft Supplemental Impact Statement for the Sounding Rocket Program of NASA; and the Department has no objections to the report. 15.1

(signed) A. E. Douglas, P.E. (date) 5-25-95
(title) Environmental Engineer Sr
(agency) VDH - Office of Water Programs

PROJECT # 95-068F 5/95

Commentor 15: A. E. Douglas, P.E.
Commonwealth of Virginia
Department of Health
Office of Water Programs

Comment 15.1

Comment noted. Thank you.

If you cannot meet the deadline, please notify ELLIE IRONS at 804/762-4325 or R. THOMAS GRIFFIN AT 804/762-4337 prior to the date given. Arrangements will be made to extend the date for your review if possible. An agency will not be considered to have reviewed a document if no comments are received (or contact is made) within the period specified.

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OFFICE OF ENVIRONMENTAL IMPACT REVIEW
629 EAST MAIN STREET, SIXTH FLOOR
RICHMOND, VA 23219
FAX #804/762-4319

Rec'd. by Dept. of Environmental Quality

JUN 16 1995

Public & Inter-governmental Affairs

Ellie Irons
Environmental Program Planner

COMMENTS

We do not anticipate significant adverse impacts upon fish and wildlife resources under our jurisdiction to result from the proposed project. 16.1

(signed) Raymond T Fernald (date) 6/14/95 BAP

(title) Environmental Manager

(agency) Department of Game and Inland Fisheries

PROJECT # 95-068F 5/95

Commentor 16: Raymond T. Fernald
Commonwealth of Virginia
Department of Game and Inland Fisheries

Comment 16.1

Comment noted. Thank you.

If you cannot meet the deadline, please notify **ELLIE IRONS at 804/762-4325 or R. THOMAS GRIFFIN AT 804/762-4337 prior to the date given. Arrangements will be made to extend the date for your review if possible. An agency will not be considered to have reviewed a document if no comments are received (or contact is made) within the period specified.**

REVIEW INSTRUCTIONS:

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B. Prepare your agency's comments in a form which would be acceptable for responding directly to a project proponent agency.

C. Use your agency stationery or the space below for your comments. **IF YOU USE THE SPACE BELOW, THE FORM MUST BE SIGNED AND DATED.**

Please return your comments to:

DEPARTMENT OF ENVIRONMENTAL QUALITY
OFFICE OF ENVIRONMENTAL IMPACT REVIEW
629 EAST MAIN STREET, SIXTH FLOOR
RICHMOND, VA 23219
FAX #804/762-4319

Rec'd. by Dept. of Environmental Quality
JUN 6 1995
Public & Inter-governmental Affairs

Ellie Irons
Environmental Program Planner

COMMENTS

Program does not appear to have any need for wetlands, subaqueous, or coastal primary sand dune permits. However, any erosion protection or new construction in jurisdictional areas would require agency review. 17.1

(signed) Chris W. Frye (date) 5-30-95
(title) Env Eng.
(agency) VMRC

PROJECT # 95-068F 5/95

Commentor 17: Chris W. Frye
Commonwealth of Virginia
Marine Resources Commission

Comment 17.1

Comment noted. Thank you.

If you cannot meet the deadline, please notify **ELLIE IRONS** at 804/762-4325 or R. THOMAS GRIFFIN AT 804/762-4337 prior to the date given. Arrangements will be made to extend the date for your review if possible. An agency will not be considered to have reviewed a document if no comments are received (or contact is made) within the period specified.

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Rec'd. by Dept. of
Environmental Quality

JUN 6 1995

Public & Inter-
governmental Affairs

Ellie Irons
Environmental Program Planner

COMMENTS

NO COMMENTS
Department of Mines, Minerals & Energy

18.1

(signed) Eugene K. Rader (date) June 5, 1995
(title) Geologist Supervisor
(agency) DMME/DMR

PROJECT # 95-068F 5/95

Commentor 18: Eugene K. Rader
Commonwealth of Virginia
Department of Mines, Minerals and Energy

Comment 18.1

Thank you.

If you cannot meet the deadline, please notify ELLIE IRONS at 804/762-4325 or R. THOMAS GRIFFIN AT 804/762-4337 prior to the date given. Arrangements will be made to extend the date for your review if possible. An agency will not be considered to have reviewed a document if no comments are received (or contact is made) within the period specified.

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RICHMOND, VA 23219
FAX #804/762-4319

Rec'd. by Dept. of Environmental Quality

JUN 14 1995

Public & Inter-governmental Affairs

Environmental Program Planner

COMMENTS

NO COMMENTS

19.1

(signed) T. Stewart Baker (date) 6-9-95

(title) Town Manager

(agency) Town of Chincoteague

PROJECT # 95-068F

5/95

Commentor 19: Stewart Baker
Town of Chincoteague
Town Manager

Comment 19.1

Thank you.

GOVERNOR
Gary E. Johnson

STATE OF NEW MEXICO
DEPARTMENT OF GAME & FISH
Villagra Building
PO Box 25112
Santa Fe, N.M. 87504

DIRECTOR AND SECRETARY
TO THE COMMISSION
Gerald A. Maracchini

RECEIVED
AUG 1995
NASA
GSFC/WALLOPS

August 1, 1995

Mr. William Johnson, Code 840
National Aeronautics and Space Administration
Goddard Space Flight Center, Wallops Flight Facility
Wallops Island, Virginia 23337

Dear Mr. Johnson:

The New Mexico Department of Game and Fish (Department) has reviewed the draft Supplemental Environmental Impact Statement (SEIS) for the ongoing Sounding Rocket Program (SRP) at White Sands Missile Range (WSMR). The SEIS describes changes in this program since the final EIS was published in 1973. SRP launches about 30 to 40 rockets per year at WSMR to provide research opportunities in astrophysics and earth science applications.

20.1 SRP rockets return to earth at two major payload recovery areas (pp. 3-35). One of these, the 50-mile impact area, contains most existing habitat for the White Sands pupfish. The SEIS recognizes that pupfish habitat is severely restricted and that the species is highly vulnerable to habitat loss from natural or manmade disasters (pp. 3-41). The EIS also includes our Department's letter to Mr. Richard Wessel of Computer Sciences Corporation (August 4, 1992). That letter expressed Department concerns about missile payload impacts in the immediate vicinity of habitats occupied by pupfish.

20.2 The SEIS, however, does not refer to the White Sands Pupfish Cooperative Agreement, which has been signed by representatives of this Department, WSMR, and other agencies. A primary purpose of that agreement is to "...ensure that no negative impacts to the species or its habitat will occur." (p. 4 of agreement.)

20.3 No determination of potential for impacts to pupfish is presented, so the SEIS has failed to disclose impacts to this state-listed species from the SRP. The Department recommends that the final EIS correct this deficiency by describing probabilities of impacts to pupfish habitat, severity of any such expected impacts, and how such impacts may be mitigated.

Commentor 20: Jerry A. Maracchini
State of New Mexico
Department of Game & Fish

Comment 20.1

See response to Comment 3.6

Comment 20.2

See response to Comment 3.8. Full text of White Sands Pupfish Cooperative Agreement is reproduced as Appendix C of this report.

Comment 20.3

The indicated deficiency is corrected in FSEIS. The probability of potential impacts to pupfish, as well as mitigation measures for protection of pupfish at WSMR are addressed in Section **4.2.4.3.3 Endangered and Threatened Species**, Sub-Section **NASA Sounding Rocket Mitigation Measures**, and in Appendix B. Mitigation procedures described in Section 4.2.4.3 and Appendix B provide for high level of protection for endangered and threatened species. According to Navy communication reported in Appendix B, out of 1162 recorded space racket missions since 1967, there have been no impacts on Salt Creek.

Commentor 20: Jerry A. Maracchini (Concluded)
State of New Mexico
Department of Game & Fish

Mr. William Johnson -2- August 1, 1995

We appreciate the opportunity to review the EIS. If you have any questions, please call Bob Wilson at (505) 827-7827.

Sincerely,

Jerry A. Maracchini
Director

JAM/BW/ia

xc: Thomas A. Ladd (Directorate of Environment, WSMR)
Jennifer Fowler-Propst (Ecological Services Supvsr., USFWS)
Craig Nordyke (Southwest Area Operations Chief, NMDGF)
Andrew Sandoval (Cons. Services Division Chief, NMDGF)
Jim Bailey (Cons. Serv. Asst. Division Chief, NMDGF)
Bob Wilson (Habitat Specialist, NMDGF)
John Pittenger (Aquatic Habitat Specialist, NMDGF)

WETLANDS PROGRAM TEL:804-642-7179 Jun 08.95 15:03 No.001 P.01

If you cannot meet the deadline, please notify ELLIE IRONS at 804/762-4325 or R. THOMAS GRIFFIN AT 804/762-4337 prior to the date given. Arrangements will be made to extend the date for your review if possible. An agency will not be considered to have reviewed a document if no comments are received (or contact is made) within the period specified.

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RICHMOND, VA 23219
FAX #804/762-4319

Ellie Irons
Environmental Program Planner

COMMENTS

We have reviewed the subject document from a marine environmental viewpoint and have no comments at this time. 21.1

(signed) TABarnard Jr (date) 6/8/95

(title) T. A. Barnard, Jr. ~~Marine Scientist~~

(agency) VIMS, Gloucester Point, VA

5/95

PROJECT # 95-068F (NASA)

Commentor 21: T.A. Barnard, Jr.
Virginia Institute of Marine Science

Comment 21.1

Comment noted. Thank you.

Commentor 22: Ronald M. Pierce
Geophysical Institute, University of Alaska

Comment 22.1

Comment noted. Thank you.

RECEIVED
JUN 24 1996
NASA
GSFC/WALLOPS

Mr. William B. Johnson
National Aeronautics and Space Administration
Goddard Space Flight Center, Wallops Flight Facility
Wallops Island, Virginia 23337

June 18, 1996

Dear Bill,

Thank you for the opportunity to review the Supplemental Environmental Impact Statement for Sounding Rocket Program, Volume 1. We know that this caused you some delay for Alaskans to reply.

We have noted several minor problems with the section on Poker Flat Research Range. They are descriptive discrepancies that are the result of out dated reference material that you used to put this document together. They in no way detract from the document and do represent the range in character. They are not worth changing or delaying publication. 22.1

Congratulations on your job completion!

Ronald M. Pierce
Range Manager

National Radio Astronomy Observatory
P.O. Box O, 1003 Lopezville Road, Socorro, New Mexico 87801-0387
Telephone: (505) 835-7000 Fax: (505) 835-7027

RECEIVED
MAY 26 1995
NASA
GSFC/WALLOPS

May 23, 1995

Mr. William Johnson
Code 840, National Aeronautics and Space Administration
Goddard Space Flight Center
Wallops Flight Facility
Wallops Island, VA 23337

Ref: National Aeronautics and Space Administration, Draft Supplemental Environmental Impact Statement for Sounding Rocket Program, August 1994.

Dear Mr. Johnson:

I am writing to comment on the Sounding Rocket Program proposed for White Sands Missile Range, New Mexico. Would you please include this information in the Final Environmental Impact Statement (EIS) on the Sounding Rocket Program? 23.1

The National Radio Astronomy Observatory (NRAO) operates two radio telescope facilities in New Mexico, the Very Large Array (VLA) and the Very Long Baseline Array (VLBA). The VLA is an array of twenty-seven 25 meter diameter radio antennas distributed over a 36 kilometer diameter area on the Plains of San Augustin, 80 km west of Socorro, New Mexico. The VLBA is a transcontinental array of ten 25 meter diameter antennas located as far east as St. Croix in the U. S. Virgin Islands and as far west as Mauna Kea on the island of Hawaii. Because the VLA and VLBA are operated by NRAO for the National Science Foundation, and because the instruments are among the foremost scientific facilities in the U. S. Government inventory, NRAO requests that these comments be indexed under "Federal Agencies" in the EIS process. 23.2

All of the radio antennas for the VLA and VLBA are equipped with cryogenically cooled low noise receivers designed to detect the extremely weak signals from cosmic radio sources. Radio sources are routinely studied with a spectral power flux density of -300 dB(W/m²/Hz). *With such low sensitivity levels, the VLA could be severely impacted by the Sounding Rocket* Program use of the RF spectrum at the White Sands Missile Range (WSMR) proposed location. 23.3

Two VLBA antenna are located in New Mexico, one at Pie Town, NM, and the other on the grounds of the Los Alamos National Laboratory (LANL), Los Alamos, NM. Although both sites are further from WSMR than the VLA, those locations can still be impacted by increased activity in the radio frequency spectrum as a result of the Sounding Rocket program.

There is precedent to include concerns about the radio frequency (RF) spectrum at non-ionizing power levels in the EIS process. A case in point is the EIS for the El Paso Transmission Line Project, 1985, which included comments on the impact on the VLA RF environment of a proposed high-voltage electrical power transmission line. As a result of the EIS process, the transmission line path was moved substantially south from the path originally proposed so as not to interfere with VLA present and future operations. Out-of-band emissions 23.4

Commentor 23: Clinton James
National Radio Astronomy Observatory
(Federal Agency)

Comment 23.1

Requested information is included in FSEIS.

Comment 23.2

NRAO is identified as “Federal Agency” as requested.

Comment 23.3

NASA SRP is an on-going program at WSMR. The contribution of this program to the radio frequency activity of the region is minimal and is considered to be not substantial, due the limited nature of NASA SRP activity - 0.5% of mission activity at the site and 2% of all research launches at WSMR.

Comment 23.4

Comment noted. Thank you.

from the Sounding Rocket program may fall within frequency bands protected by 47 Code of Federal Regulations, the National Telecommunications and Information Administration (NTIA) policy, and by International Telecommunications Union (ITU) regulations, such as ITU-R RA.769. Allocations of frequencies to the Sounding Rocket program in bands adjacent to the radio astronomy bands where the program is line-of-site to the VLA or one of the VLBA antennas, can result in gain compression of the radio receiver, and loss of data. The VLA location on the Plains of San Augustin offers a unique opportunity to observe southern skies from a relatively high altitude in an area with less than average RF interference. Since there are no alternatives to this location for NRAO, diminution of the RF-quiet environment on the Plains 23.4
represents a severe impact to the Radio Astronomy Service and to the national effort in scientific research. Therefore, NRAO requests that the impact of the proposed Sounding Rocket program on the RF environment especially for the VLA, but also for the VLBA antennas, be included as an important impact in the Final EIS. The electromagnetic spectrum is a vital national resource to be preserved for use by present and future generations.

The VLA is located 122 km northwest of the WSMR Stallion site and is line-of-site to emitters at an elevation of 3 - 4 km above average terrain over much of the northern part of the range. As an example of the impact of RF usage on the VLA, an emitter 30 meters above ground level near the Stallion Site on WSMR, 33° 20' latitude and 106° 39' longitude, with an effective isotropic radiated power (EIRP) of 11 milliwatt and a center frequency of 1380 MHZ, would exceed the harmful level of the VLA in a radio astronomy (RA) band. If the emitter were elevated to 3 km, the harmful EIRP would be 5 microwatts. The 5 microwatt level could be exceeded by harmonic or spurious emissions of a transmitter tuned to a frequency not in the RA 23.5
band. These harmful levels are based on an average sidelobe gain of O dBi for the radio antenna; if the emitter were to pass through the main beam of the antenna, the harmful level would be much lower. In fact, equipment damage could occur. The Sounding Rocket program operation at WSMR will require close coordination of frequency assignment and usage through the office of the DOD Area Frequency coordinator at WSMR.

Although the Draft Supplemental EIS does not mention an "extended range" as a possible location of Sounding Rocket operations, NRAO's greatest concern is that the rocket range may be extended at some point to include the VLA or areas in the vicinity. Increased RF activity near the VLA represents the severest threat to the VLA operation and to Radio Astronomy in general. For example, emissions less than a billionth of a watt could corrupt VLA data if the frequencies were in a radio astronomy band and the emitter were directly over the 23.6
VLA. Frequency assignments in bands adjacent to the radio astronomy bands are also a severe problem if the transmitters are close to the VLA; the frequency bands of the antenna receivers extend beyond the radio astronomy bands in order to observe doppler-shifted spectral lines. For example, a 10 watt EIRP transmitter in the vicinity of the VLA can cause receiver gain compression and lost data even if the observations are being conducted within the RA band.

The Sounding Rocket program may include the use of weather balloons, radar, or other surveillance equipment. Weather balloons equipped with radiosondes transmitting in an adjacent band can disrupt VLA activities for several hours when located line-of-site to the antennas by causing gain compression of the receivers. Telemetry and voice communication in 23.7
an adjacent band can cause gain compression of the receivers, and out-of-band emissions such as harmonics and intermodulation products can corrupt data if the frequencies fall within an RA band, even with very low emission levels. Since much of the RF emission will be airborne, the possibility increases that the emission will be in the main beam which could result in damage to the receivers. Tracking, meteorological, and surveillance radar transmissions all can lead to out-of-band interference in a radio astronomy frequency band or gain compression in an adjacent

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Under Cooperative Agreement with the National Science Foundation

Commentor 23: Clinton James (Continued)
National Radio Astronomy Observatory
(Federal Agency)

Comment 23.5

Comment noted. Thank you.

Comment 23.6

Comment noted. Thank you.

Comment 23.7

Comment noted. Thank you.

band.

Sounding Rocket operation in the vicinity of the VLA would impact more than the RF environment. Although the location of the array is given as North Latitude 34° 04' 43" and West Longitude 107° 37' 04", the included map shows the arms of the array extend 20 km from the center, so that the scattering of debris within a 20 km radius of the VLA location would impact the safety of both equipment and personnel at the VLA.

Although no sonic booms are anticipated from the rocket itself, surveillance aircraft may travel supersonically. Loud noises such as sonic booms or explosions that may result from Sounding Rocket activity would impact the safety of personnel working on a VLA or VLBA antenna. The amplification of the sound at the focal point of the antenna can be 10s of dB, causing a worker to be startled and perhaps fall or drop a tool, or in severe cases to suffer hearing damage.

Use of the VLA vicinity by the Sounding Rocket Program would establish an unfortunate precedent that could weaken NRAO's efforts to preclude other projects on the Plains of San Augustin that would adversely effect the RF environment.

In short, the impact of the Sounding Rocket program on the VLA and radio astronomy must be examined closely during the EIS process to insure that the use of the U. S. Government's astronomical research instruments are not unnecessarily compromised by the proposed program. I am including a table of RA frequency bands used at the VLA and VLBA showing harmful levels, a table of the adjacent bands used at the VLA and VLBA, pamphlets about the VLA and VLBA, and information about the impact of the RF environment on radio astronomy. I would be pleased to provide additional information and calculations to you on request.

Sincerely yours,

Clinton Janes
Frequency Coordinator

Enclosures: (addressee only)
- Map showing VLA location
- Table of RA bands and harmful levels
- Table of adjacent bands and harmful levels
- VLA pamphlet
- VLBA pamphlet
- Radio Astronomy and Interference -- A Brief Overview
- Interference and Radioastronomy, Physics Today, 1991

xc:
- W. Brundage
- A. Clegg, NSF Spectrum Management Office
- S. Greene, WSMR DOD Area Frequency Coordinator
- R. Sramek

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Under Cooperative Agreement with the National Science Foundation.

Commentor 23: Clinton James (Continued)
National Radio Astronomy Observatory
(Federal Agency)

23.8 **Comment 23.8**

No areas outside WSMR are targeted by NASA SRP.

23.9 **Comment 23.9**

No supersonic surveillance aircraft is used by NASA SRP.

23.10 **Comment 23.10**

NASA SRP is an on-going program since 1959 and as such does not establish precedents.

23.11 **Comment 23.11**

Comment noted. Thank you.

Commentor 23: Clinton James (Continued)
National Radio Astronomy Observatory
(Federal Agency)

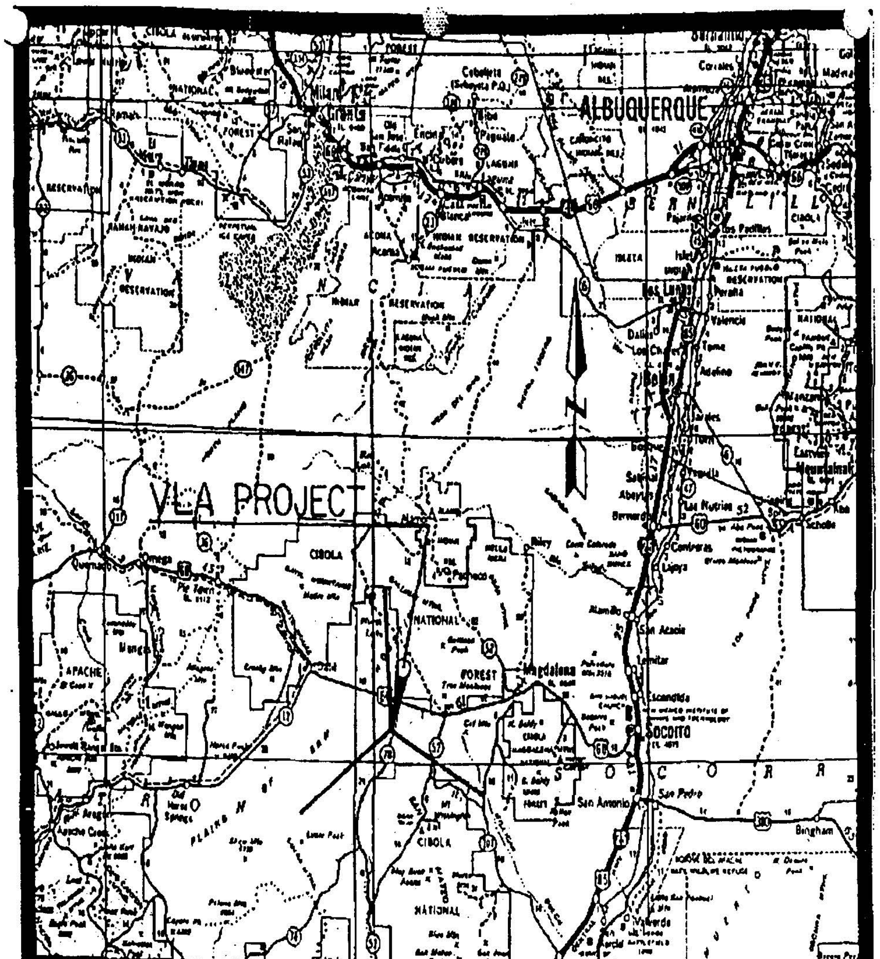
Figure 2

RADIO ASTRONOMY BANDS AND ADJACENT FREQUENCY BANDS AT VLA AND VLBA

Band	VLA Adjacent Band (MHz)	VLBA Adjacent Band (MHz)	Radio Astronomy Band (MHz)	Harmful Power Density in the 0dBi sidelobe for RA band[1] (dBW/m^2) VLA	VLBA
4	72.9 - 74.7	none	73.0 - 74.6	-210	-182
P	300- 345	300- 345	322.0 - 328.6	-204	-175
	future	609 - 613	608.0 - 614.0	-200	-171
L	1155- 1734	1260- 1840	1330.0- 1427.0	-196	-166
			1610.6- 1613.8	-194	-165
			1660.0 -1670.0	-194	-165
			1718.8- 1722.2	-194	-165
S	future	2000 - 2800	2290.0 - 2300.0[2]	-189	-159
			2640.0 - 2655.0[2]	-189	-159
			2655.0 - 2700.0	-189	-159
C	4300 - 5100	4500 - 5200	4825.0 - 4835.0	-183	-151
			4950.0 - 5000.0	-183	-151
X	7600 - 9000	7900 - 8900	8400.0 - 8450.0[2]	-176	-145
	none	10.1k - 11.3k	10.60k - 10.7k	-173	-142
Ku	14.2k - 15.7k	11.82k- 15.63k	14.47k - 14.5k	-169	-135
			15.20 - 15.35k[2]	-169	-135
			15.35k - 15.4k	-169	-135
K	2l.7k - 24.5k	21.3k - 24.7k	22.01k - 22.5k	-162	-129
			22.81k - 22.86k	-162	-129
			23 .07k - 23.12k	-161	-128
			23.60k - 24.0k	-161	-128
Q	40k - 50k	40k - 45k	42.50k - 43.5k	-153	-116
			48.94k - 49.04k	-152	-115
W	none	86k - 92k (Future)	86.00k - 92.0k	-144	-106

Notes:
1. Harmful levels are derived from spectral power flux densities recommended in ITU-R RA.769, 1992.
2. Allocated for space research.

Commentor 23: Clinton James (Continued)
National Radio Astronomy Observatory
(Federal Agency)



VICINITY MAP

Commentor 23: Clinton James (Continued)
National Radio Astronomy Observatory
(Federal Agency)

Radio Astronomy and Interference -- A Brief Overview

What is radio astronomy?

Radio astronomy is the study of distant objects in the universe by collecting and analyzing the radio waves emitted by those objects. Though radio astronomy is little more than a half-century old, it has been a major factor in revolutionizing our concepts of the universe and how it works. Radio observations have provided a whole new outlook on objects we already knew, such as galaxies, while revealing exciting objects such as pulsars and quasars that had been completely unexpected. Radio telescopes today are among the most powerful tools available for astronomers studying nearly every type of object known in the universe.

Why do radio astronomers worry about interference?

The radio signals arriving on earth from astronomical sources are extremely weak -- millions (or billions) of times weaker than the signals used by communication systems. For example, a one-tenth-watt transmitter located on the moon would produce a signal on earth that radio astronomers consider quite strong. Because the cosmic radio sources are so weak, they are easily masked by man-made interference. Possibly even worse than complete masking, weaker interfering signals can contaminate the data collected by radio telescopes, potentially leading astronomers to erroneous interpretations.

What kinds of signals interfere with radio astronomy?

A number of frequency bands are allocated to radio astronomy by international agreement. Radio transmissions are prohibited in some of these bands and restricted to a varying extent in others, but this type of regulation does not prevent an increasing amount of interference to important radio astronomy programs. Much interference comes from transmitters emitting spurious or harmonic signals outside the band allocated to their own radio service. This type of interference is particularly troublesome for radio astronomy when it comes from satellites. An increasing number of low-power transmitters is being used in devices such as garage door openers, wireless computer networks, home security systems, and others. Many of these are quite capable of interfering with radio astronomy. In addition, many types of equipment not normally considered to be radio transmitters, particularly computers or systems incorporating microprocessors, emit undesirable radio signals.

In addition, radio astronomers often seek to detect frequencies that indicate the presence of particular elements or molecules. These frequencies, called spectral lines, often either fall outside the bands allocated to radio astronomy or are Doppler shifted out of those bands by the large velocities resulting from the expansion of the universe.

How can interference be minimized?

Radio astronomers constantly seek to minimize the effect of interfering signals on their observations. A wide variety of techniques is used, ranging from locating radio telescopes away from urban centers whenever possible to designing a new generation of antennas less susceptible to sidelobe interference. Still, there are many ways that other users of the radio spectrum can help.

First, transmitters of all types should incorporate methods to prevent out-of-band signals such as spurious sidebands or harmonics. This is particularly important for transmitters aboard satellites. Systems using spread-spectrum techniques should exercise care to prevent spurious sidebands. The amount of filtering required to prevent interference to radio astronomy frequently is considerably greater than that ordinarily used to prevent same-service interference.

Near radio astronomy facilities, shielding of many types of electronic equipment, particularly computers, can prevent much interference.

Finally, communication between radio astronomers and other users of the radio spectrum is vital. Engineers at radio telescope facilities often can help with suggestions for ways to minimize interference. If, for some reason, interference is inevitable, astronomers would like to know when it will be transmitted so they may avoid its effects to the extent possible.

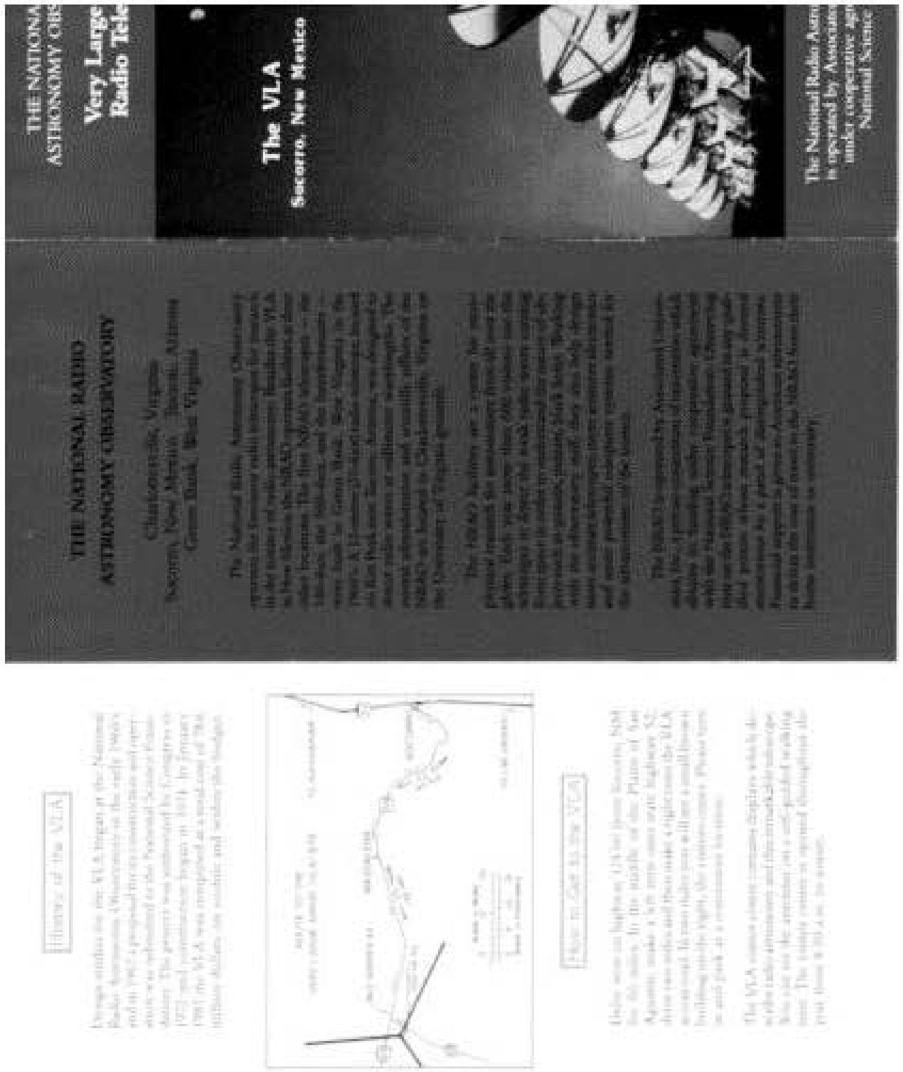
Further reading:

"Interference and Radioastronomy," A. Richard Thompson, Tomas E. Gergely and Paul A. Vanden Bout, *Physics Today*, November 1991, pp. 41-49.

Light Pollution, Radio Interference and Space Debris, conf. ser. 17, D.L. Crawford, ed., Astronomical Society of the Pacific, San Francisco, 1991.

National Radio Astronomy Observatory, P.O. Box O, Socorro, NM 87801

Commentor 23: Clinton James (Continued)
National Radio Astronomy Observatory
(Federal Agency)


THE NATIONAL RADIO
ASTRONOMY OBSERVATORY

Charlottesville, Virginia
Socorro, New Mexico Tucson, Arizona
Green Bank, West Virginia

The VLA
Socorro, New Mexico

Commentor 23: Clinton James (Continued)
National Radio Astronomy Observatory
(Federal Agency)

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Commentor 23: Clinton James (Concluded)
National Radio Astronomy Observatory
(Federal Agency)

INTERFERENCE AND RADIOASTRONOMY

The radioastronomer's struggle against a growing flood of interfering sources, from garage door openers to digital audio broadcast satellites, must be fought in the technical and political arenas.

A Richard Thompson,
Thomas E. Gengely,
and Paul A. Vanden Bout

Richard Thompson is a staff scientist at the National Radio Astronomy Observatory in Charlottesville, Virginia.
Tomas Cergely is electromagnetic spectrum manager of the National Science Foundation's astronomy division.
Paul Vanden Bout is the director of NRAO.