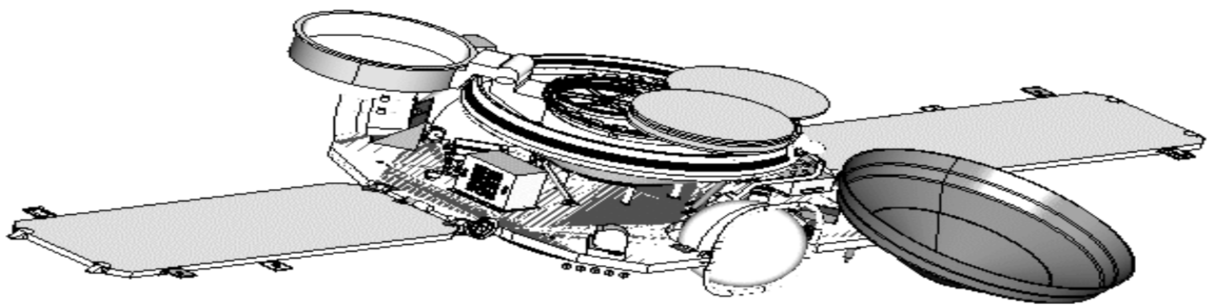
National Aeronautics and
Space Administration

# Genesis Mission Environmental Assessment



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**FINAL ENVIRONMENTAL ASSESSMENT
FOR THE GENESIS LAUNCH AT CAPE CANAVERAL AIR FORCE STATION, FLORIDA AND SAMPLE RETURN TO UTAH TEST AND TRAINING RANGE, UTAH**

Lead Agency: National Aeronautics and Space Administration (NASA)

Proposed Action: The proposed action is to place the Genesis spacecraft into a halo orbit about the L1 point, after which ultra-pure collectors would be exposed to the incoming solar wind. Ions from the solar wind would accumulate as they implant in the collector materials. After two years, the spacecraft would stow the collectors into a contamination-tight canister within a sample return capsule and return the samples to Earth.

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Abstract: This Environmental Assessment (EA) addresses the proposed action of completing the integration of the Genesis spacecraft with the launch vehicle and launching the Genesis mission from Cape Canaveral Air Force Station (CCAFS), Florida, during the launch opportunity beginning in June 2001. The Genesis spacecraft would be comprised of a spacecraft bus and the sample return capsule (SRC). Solar wind collection would be accomplished via five silicon collector arrays and an electrostatic concentrator. The flight system would be assembled and tested at Lockheed-Martin Astronautics, Denver, Colorado, and shipped to Kennedy Space Center in Florida for checkout. The spacecraft would then be transferred to Launch Complex 17 on CCAFS where it would be integrated with the baseline launch vehicle, a Delta II 7326.

This EA also addresses the proposed action of returning the solar wind samples to Earth in the summer of 2004. The Utah Test and Training Range (UTTR) outside Salt Lake City, Utah is baselined as the proposed recovery site. Alternatives to the proposed action considered included those that: (1) utilize an alternate launch vehicle/upper stage combination, (2) utilize an alternate launch site, (3) utilize an alternate recovery site, or (4) eliminate the Genesis mission (the No-Action alternative).

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## Figures

**TABLES**

## ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| 45SW | 45th Space Wing |
| ACGIH | American Conference of Government Industrial Hygienists |
| AF | Air Force |
| AFB | Air Force Base |
| AFLC | Air Force Logistics Command |
| AGL | above ground level |
| AIHA | American Industrial Hygiene Association |
| AK | Alaska |
| Al | aluminum |
| AlCl | aluminum chloride |
| $AlCl_2$ | aluminum bichloride |
| $AlCl_3$ | aluminum trichloride |
| AlClO | aluminum hypochlorite |
| $Al_2O_3$ | aluminum oxide |
| ALC | Air Logistic Center, (Ogden, Utah) |
| AQCR | air quality control region |
| AS | Air Station |
| Au | gold |
| AU | Astronomical unit, distance between the Earth and the Sun, 150 million kilometers, (93 million miles) |
| AZ | Arizona |
| B | boron |
| Be | beryllium |
| BEMC | Brevard County Emergency Management Center |
| BLM | Bureau of Land Management |
| C | Celsius temperature scale, Carbon |
| $C_2F_4$ | tetrafluorethene |
| $C_2F_6$ | freon |
| $C_2O$ | ketenylidene |
| $C_3$ | injection energy |
| Ca | calcium |
| CA | California |
| CAA | Clean Air Act |
| $CaCO_3$ | calcium carbonate |
| C-C | carbon-carbon |
| CCAFS | Cape Canaveral Air Force Station |
| CEQ | Council on Environmental Quality |
| $CF_4$ | carbon tetrafluoride |
| CFR | Code of Federal Regulations |
| $CH_2O$ | formaldehyde |
| $CH_3OH$ | methanol (methyl alcohol) |

| | |
|---|---|
| $CH_4$ | methane |
| CIT | California Institute of Technology |
| Cl | chlorine |
| $Cl_2$ | diatomic chlorine |
| $ClNO_3$ | chlorine nitrate |
| cm | centimeter(s) = 0.01 m = 0.3937 inch |
| CN | cyanide |
| Co | cobalt |
| CO | carbon monoxide |
| $CO_2$ | carbon dioxide |
| $CO_3$ | carbonate |
| COMPLEX | Committee on Planetary & Lunar Exploration |
| CONUS | Continental U.S. |
| COSPAR | Committee on Space Research, International Council of Scientific Unions |
| Cr | chromium |
| Cu | copper |
| CWA | Clean Water Act |
| dBA | decibels, A-weighted |
| DACS | Deployable Aft Conical Section |
| deg | degree(s) |
| DEQ | Department of Environmental Quality (Utah State Agency) |
| DMCO | Delta Mission Check-Out |
| DoD | Department of Defense |
| DoI | Department of the Interior |
| DoT | Department of Transportation |
| DPG | Dugway Proving Grounds, UTTR, Utah |
| DRMO | Defense Reutilization and Marketing Office |
| DSN | Deep Space Network |
| DWQ | Division of Water Quality |
| EA | Environmental Assessment |
| EEGL | Emergency Exposure Guidance Level |
| EO | Executive Order |
| EOD | explosive ordnance disposal |
| EPA | Environmental Protection Agency |
| EPCRA | Emergency Planning & Community Right-To-Know Act |
| ER | Eastern Range, Emergency Response |
| ERPG | Emergency Response Planning Guideline |
| ESE | East-South-East |
| EX | extirpated |
| F | Fahrenheit temperature scale, fluoride |
| FAC | Florida Administrative Code |
| FCREPA | Florida Commission on Rare and Endangered Plants and Animals |
| FDA | Florida Department of Agriculture |

| | |
|---|---|
| FDEP | Florida Department of Environmental Protection,<br>Federal Directorate of Environmental Programs |
| FDH | formaldehyde |
| Fe | iron |
| FE | Federal endangered |
| FGFWFC | Florida Game and Fresh Water Fish Commission |
| FNAI | Florida Natural Areas Inventory |
| fps | feet per second |
| FRP | Facilities Response Plan |
| ft | feet |
| ft/s | feet per second |
| FT | Federal Threatened |
| FTS | Flight Termination System,<br>Federal Telephone System |
| FWD | forward |
| FWS | U.S. Fish and Wildlife Service |
| FY | fiscal year |
| g | gram |
| gal | gallon |
| GEM | Graphite Epoxy Motor,<br>Genesis Electron Monitor |
| GIM | Genesis Ion Monitor |
| GPS | Global Positioning System |
| $H_2$ | diatomic hydrogen |
| $H_2O$ | water |
| $H_2S$ | dihydrogen sulfide |
| $H_2SO_4$ | hydrogen sulfate |
| $H_3N$ | ammonia |
| HAFB | Hill Air Force Base |
| HAFR | Hill Air Force Range |
| HAZMAT | hazardous materials |
| HCl | hydrogen chloride or hydrochloric acid |
| HCN | hydrogen cyanide |
| $HCO_3$ | hydrogen bicarbonate |
| HFI | high Federal interest |
| HNCO | cyanic acid |
| $HNO_3$ | nitric acid |
| HPF | Horizontal Processing Facility |
| HS | hydrogen sulfide |
| $HSO_2$ | sulfuric acid |
| HTPB | Hydroxyl-Terminated PolyButediene |
| IDLH | Immediately Dangerous to Life or Health |
| in | inch(es) |

| | |
|---|---|
| ISDN | integrated services digital network |
| JASPPA | Joint Acquisition Sustainment Pollution Prevention Activity |
| JG-PP | Joint Group – Pollution Prevention |
| JPL | Jet Propulsion Laboratory |
| JPC | Joint Propellants Contractor |
| JSC | Johnson Space Center |
| K | potassium |
| | Kelvin, absolute temperature scale, -273.4 degrees Celsius = 0 K |
| kHz | KiloHertz (1,000 cycles per second) |
| KSC | Kennedy Space Center |
| kg | kilogram = 2.2 pounds |
| km | kilometer = 1 x $10^3$ meters = 1,000 meters = 0.62 mile |
| km/s | kilometers per second |
| kPa | KiloPascals, unit of pressure |
| kph | kilometers per hour |
| *l* | liter |
| L1 | Sun-Earth libration point |
| LANL | Los Alamos National Laboratory |
| lb | pound(s) |
| LBSC | Launch Base Support Contractor |
| LC-17 | Launch Complex 17, CCAFS |
| Ldnmr | onset-adjusted day-night sound Levels |
| LEO | low Earth orbit |
| LGA | low gain antenna |
| $LiSO_2$ | lithium sulfur dioxide |
| LMA | Lockheed Martin Astronautics |
| LV | launch vehicle |
| LVA | launch vehicle adapter |
| m | meter(s) = 39.37 in |
| MAA | Michael Army Airfield, Dugway Proving Grounds, UTTR, Utah |
| MAC | maximum allowable concentration |
| McREL | Mid-Continent Research for Education and Learning |
| MECO | main engine cut off |
| Mg | magnesium |
| mg | milligram |
| $mg/m^3$ | milligram per meter cubed (mass per volume) |
| mg/l | milligrams/liter |
| MGA | medium gain antenna |
| MGS | Mars Global Surveyor |
| MHz | Megahertz (1 x $10^6$ cycles/second = 1 million cycles per second) |
| mi | mile(s) |
| mi/s | miles per second |
| mJ | milliJoule (.001 Joule), unit of energy |

| | |
|---|---|
| MLV | medium launch vehicle |
| Mn | manganese |
| Mo | molybdium |
| MOAs | Military Operations Areas |
| mph | miles per hour |
| m/s | meters per second |
| MSDS | Material Safety Data Sheets |
| MSL | mean sea level |
| MSPSP | Missile System Pre-Launch Safety Plan |
| mW | milliWatt |
| μg/l | microgram per liter |
| $\mu g/m^3$ | Micrograms per cubic meter (.000001 gram/meter$^3$) |
| μm | micron (or micrometer) = 1 X $10^{-6}$ meter = .000001 meter = 3.937 x $10^{-5}$ in |
| μmhos/cm | Micromhos per centimeter |
| μs | Microsecond, 1 x $10^{-6}$ second |
| N | Newton = 1 kg m/s$^2$, Nitrogen |
| $N_2$ | diatomic nitrogen |
| Na | sodium |
| Nb | niobium |
| $N_2H_4$ | hydrazine |
| $N_2O_4$ | nitrogen tetroxide |
| NAAQS | National Ambient Air Quality Standard |
| NaOH | sodium hydroxide |
| NAS | National Academy of Sciences |
| NASA | National Aeronautics and Space Administration |
| NCA | Noise control Act |
| NCO | cyanato |
| ND | not detected |
| NDMA | nitrosodimethylamine |
| NEPA | National Environmental Policy Act |
| NESHAPs | National Emission Standard for Hazardous Air Pollutants |
| $NH_2$ | amidogen |
| $NH_3$ | ammonia |
| NHL | National Historic Landmark |
| Ni | nickel |
| Nm | Nautical mile (6076.12 ft = 1.151 standard mile) |
| NM | New Mexico |
| NO | not observed |
| $NO_2$ | nitrogen dioxide |
| $NO_3$ | nitrate |
| $NO_x$ | nitrogen oxides (generic) |
| NRHP | National Register of Historic Places |
| NRC | National Research Council |

| | |
|---|---|
| NRCS | Natural Resource Conservation Service, U.S. Dept. of Agriculture |
| NRD | National Register District |
| NSI | NASA Standard Initiator |
| NTU | Nephelometric Turbidity Units |
| NUTTR | North UTTR, includes Hill Air Force Range |
| NV | Nevada |
| O | oxygen |
| $O_2$ | diatomic oxygen |
| $O_3$ | ozone |
| OCONUS | outside Continental U.S. |
| OFW | Outstanding Florida Water |
| OH | hydroxide |
| OSHA | Occupational Health and Safety Administration |
| PAF | payload attach fitting |
| PAFB | Patrick Air Force Base |
| Pb | lead |
| PCA | power control assembly |
| PCB | polychlorinated biphenyls |
| PEL | Permissible Exposure Level |
| pH | level of acidity or alkalinity relative to water |
| PHSF | Payload Hazardous Servicing Facility |
| PICA | Phenolic Impregnated Carbon Ablator |
| PIP | parachute interface plate |
| PLF | payload fairing |
| PM-10 | particulate matter less than 10 microns in diameter |
| PM-2.5 | particulate matter less than 2.5 microns in diameter |
| PPA | Pollution Prevention Act |
| ppb | parts per billion |
| PPE | Personal Protective Equipment |
| ppm | parts per million |
| PPMP | Pollution Prevention Management Action Plan |
| PPPG | Pollution Prevention Program Guide |
| ppt | parts per thousand |
| PRI | primary rate interface |
| PSD | Prevention of Significant Deterioration |
| psf | pounds per square foot |
| PSP | Project Safety Plan |
| Pt | platinum |
| RANS | Range Support Squadron |
| RCRA | Resource Conservation and Recovery Act |
| REEDM | Rocket Exhaust Effluent Diffusion Model |
| RF | radio frequency |
| ROI | Region of Influence |

| | |
|---|---|
| RP-1 | thermally stable kerosene fuel |
| S&A | Safe & Arm |
| SAMY | solar array minus - Y |
| SAPY | solar array plus - Y |
| SARA | Superfund Amendments & Reauthorization Act |
| SD | State declining |
| SE | State endangered |
| sec | second |
| SECO | Second engine cut off |
| $SiH_4$ | silane |
| SiO | silicon oxide |
| $SiO_2$ | silicon dioxide |
| $SiC_4H_{12}$ | tetramethyl silane |
| SKM | station keeping maneuver |
| SL | State Limited |
| SLA-561V | Super Lightweight Ablator |
| Sn | tin |
| $SO_2$ | sulfur dioxide |
| $SO_4$ | sulfate |
| SOA | Supersonic Operating Area |
| SPCCP | Spills Prevention, Control, and Countermeasures Plan |
| SPDT | single pole double throw |
| SPEGL | Short-term Public Emergency Guidance Level |
| SPI | Single Process Initiative |
| sq | square |
| SQ | status questioned |
| SRC | sample return capsule |
| SRM | solid rocket motor |
| SRP | Safety Review Panel |
| SSEP | Solar System Exploration Program |
| ST | State threatened |
| STEL | Short-term Exposure Level |
| STP | Sewage Treatment Plant |
| STS | Space Transportation System (Space Shuttle) |
| SUTTR | South UTTR, includes Dugway Proving Grounds and Wendover Air Force Range |
| Ta | tantalum |
| TCM | trajectory correction maneuver |
| TDS | Total Dissolved Solids |
| TECO | third engine cut off |
| Ti | titanium |
| TLV | Threshold Limit Value |
| TPS | Thermal Protection System |

| | |
|---|---|
| TRI | Toxic Chemical Release Inventory |
| TSP | Total Suspended Particles |
| TTU | Thermal Treatment Center |
| TWA | Time Weighted Average |
| UDMH | Unsymmetrical Dimethyl Hydrazine |
| U.S. | United States |
| USAF | United States Air Force |
| UST | underground storage tank |
| UTTR | Utah Test and Training Range |
| VAFB | Vandenburg Air Force Base |
| VHF | very high frequency |
| VHF-DF | very high frequency – direction finding |
| VOC | Volatile Organic Compounds |
| W | tungsten |
| WAFR | Wendover Air Force Range |
| WNW | West-North-West |
| WSA | Wilderness Study Area |
| WWW | World Wide Web |
| XPNDR | transponder |
| Zn | zinc |

# EXECUTIVE SUMMARY

## PROPOSED ACTION

This environmental assessment (EA) addresses the proposed action to complete the integration of the Genesis spacecraft with the launch vehicle and launch the Genesis mission from Cape Canaveral Air Force Station (CCAFS), Florida, during the launch opportunity beginning in June 2001, and recover the sample return capsule (SRC) at Utah Test and Training Range (UTTR) approximately forty miles southwest of Salt Lake City, Utah, during the summer of 2004.

## LAUNCH

The spacecraft would be assembled and tested at Lockheed-Martin Astronautics (LMA) Denver, and shipped to Kennedy Space Center (KSC) for checkout and propellant loading. The Transfer Orbit stage (Star 37 FM third stage) would be assembled and integrated with the spacecraft at KSC. The integrated spacecraft and Transfer Orbit stage would then be transferred to Launch Complex 17 (LC-17) on CCAFS.

The baseline launch vehicle, a Delta II 7326, would be assembled in facilities at CCAFS before being transferred to LC-17. The Delta II 7326 consists of a liquid bipropellant main engine, a liquid bipropellant second stage engine, and three graphite epoxy motor (GEM) strap-on solid rocket motors (SRMs). While most of the check-out of the spacecraft and launch vehicle would be performed at individual integration buildings, operations completed at the launch site would include mating of the spacecraft and third stage with the launch vehicle, integrated systems test and check-out, launch vehicle liquid propellant servicing, and ordnance installation.

## ENTRY, DESCENT, AND RECOVERY OPERATIONS AT UTTR

Depending on the actual launch date in 2001, the Genesis spacecraft would return to Earth during the summer of 2004. At a prescribed time during it's approach to Earth, a command sequence would be sent to the spacecraft to orient itself for separation from the SRC (about four hours prior to Earth entry). After separation from the spacecraft, the SRC would directly enter the atmosphere where atmospheric drag would reduce its speed from 11 km/s to approximately 400 m/s; it would further decelerate to 4.6 m/s (15 ft/s) with the aid of a parachute system (i.e., drogue parachute followed by a parafoil), over UTTR, to be captured midair via helicopter as it descends. Following mid-air retrieval, the SRC would be removed to a staging area at UTTR established in order to prepare it for transport to the planetary materials curatorial facility at Johnson Space Center (JSC). Should conditions, such as weather over the recovery site, be unfavorable, there is an opportunity at entry minus 12 hours to enter a 19-day parking orbit for one or two revolutions (19 or 38 days) prior to a second Earth entry opportunity.

## PURPOSE AND NEED FOR THE ACTION

Genesis would support two of the NASA's Solar System Exploration program's primary objectives: (1) to understand the origin, evolution, and present state of the solar system; and, (2) to establish the scientific and technical database required for undertaking major human endeavors in space, including the survey of near-Earth resources and the characterization of planetary surfaces. Specifically, Genesis would seek to address questions about the materials and processes involved in the origins of the solar system by providing precise knowledge of solar isotopic and elemental compositions. (An isotope is an atomic species of a chemical element with different atomic mass and physical properties, e.g., carbon-12 versus carbon-14.)

Current compilations of solar elemental abundances are based mainly on analyses of carbon iron chondrite meteorites, not direct measurements of the Sun. More complete and accurate direct measurements of solar abundances are required. Furthermore, few data exist on solar isotopic compositions, which are important for astrophysics and solar physics. Planetary science requires greater elemental coverage and higher levels of precision than has heretofore been possible. The sensitivities and accuracies required for planetary science can be achieved only by analysis in sophisticated laboratories located on Earth. These data are deemed to be critical for judging the accuracy of models of the nebular processes by which planetary materials and the various bodies in the solar system formed. The Genesis mission could achieve a major improvement in our knowledge of the average chemical and isotopic composition of the solar system by collecting samples of matter emitted by the Sun (solar wind) in high purity collector materials, and returning them to Earth for chemical analysis. This would provide a cornerstone data set around which theories for materials, processes, events, and time scales in the solar nebula are built, and from which theories about the evolution of planets begin. The samples collected by Genesis would provide a reservoir of solar material for 21st century science.

## MISSION DESCRIPTION

The Genesis mission involves placing a single spacecraft at the so-called Sun-Earth libration point (L1 point), approximately 1.5 million kilometers (km) [0.93 million miles (mi) or 0.01 Astronomical Unit (AU)] away from the Earth (approximately one percent of the Earth-Sun distance) where the gravitational pulls of the Sun and the Earth are balanced. This would also place the spacecraft well beyond the confounding influence of the Earth’s magnetosphere. The spacecraft would be placed into a halo orbit about the L1 point (Figure 2-1), after which the mostly ultra-pure silicon collectors would be exposed to the incoming solar wind. The ions from the solar wind would be accumulated as they implant in the collector materials. After two years, the spacecraft would stow the collectors into a contamination-tight canister in the SRC for return to Earth and subsequent recovery at UTTR.

## ALTERNATIVES CONSIDERED

Alternatives to the proposed action that were considered included those relating to launch system, launch site, and recovery site. Specifically, alternatives considered were those that (1) utilize an alternate launch vehicle/third stage combination; (2) utilize an alternate launch site; (3) utilize an alternate recovery site; or 4) eliminate the Genesis mission (the No-Action alternative).

### Alternate Launch Vehicles

#### Selection Criteria

Selecting a launch vehicle/upper stage combination (launch system) for a planetary mission largely depends on matching the payload mass and the energy required to achieve the desired trajectory to the capabilities of the prospective launch system. Normally, the most desirable launch system would meet, but would not greatly exceed, the mission's minimum launch performance requirements.

For the Genesis mission, constraints on launch system performance are the Genesis launch mass of approximately 636 kg (1400 lb) and an injection energy ($C_3$) of -0.6 $km^2/s^2$ (-10 $mi^2/s^2$). [JPL 1999-C] Other considerations that must be addressed in the selection of the launch system include reliability, cost, and potential environmental impacts associated with use of the launch system. Feasible alternative Genesis launch systems include the Space Transportation System (STS) and various Taurus, Atlas, Delta, and Titan configurations.

#### Space Transportation System

The STS greatly exceeds the Genesis mission requirements and would not be considered a reasonable alternative launch system.

#### U.S. Expendable Launch Systems

Potential alternative U.S. expendable launch systems include the Taurus, Titan IIG/Star 48, Titan IIS/Star 48, Delta II 7425/Star 48B, Delta II 7920, Delta II 7925/Star 48B, and the Atlas IIA/Centaur.

- The payload fairings available for the Taurus are not large enough to accommodate the Genesis spacecraft.
- The Titan IIG/Star 48 does not meet the minimum mass performance criteria, and is not considered as a reasonable alternative. [AIAA 1995, MDA 1996]
- The Delta II 7425 contains more solid propellant than the Delta II 7326, and therefore would produce slightly greater potential environmental impacts.
- The Delta II 7920 series of vehicles (7920 and 7925) would meet the minimum Genesis mission requirements, but would exhaust the more potentially environmentally impacting effluents, and they are more costly; they are therefore not considered a reasonable alternative.
- The Atlas IIA launch vehicle would contribute less potential environmental impacts than the Delta II 7326 because it does not have the solid rocket boosters, but it exceeds the launch capability of the Delta II 7326 by greater than 1000 kg, and would cost significantly more than the Delta II 7326.

Of the several alternative U.S. launch vehicles considered, the Delta II 7326 most closely matches the Genesis mission requirements:

- The mass performance of the Delta II 7326 most closely matches the Genesis performance requirement.
- The Delta II 7326 is the lower cost alternative launch system of those systems meeting the Genesis performance criteria.
- Of the reasonable alternative launch systems examined, all except the Atlas II/Centaur were approximately equal in their potential environmental impacts. The additional cost of the Atlas II launch vehicle would preclude launching the cost-constrained Genesis mission.

## Alternative Launch Sites

CCAFS and Vandenburg Air Force Base (VAFB) have the only currently approved facilities to launch Delta II launch vehicles. Since the Delta II 7326 is the preferred launch vehicle for the Genesis mission, alternative launch sites to CCAFS and VAFB would not be available.

The direction of launch, commonly referred to as flight azimuth, depends on range safety considerations that prohibit flying over certain land and ocean areas. Flights from VAFB must launch west and south to avoid overflying the heavily populated West Coast. This means that the launch vehicle is moving in the direction opposite to Earth's rotation. Launches from CCAFS are toward the east and in the direction of Earth's rotation, and thus do not require the extra fuel to achieve the same orbit as those originating from VAFB. Therefore, a larger launch vehicle would be required to launch Genesis onto the same trajectory from VAFB, and the preferred alternative launch site is CCAFS.

## Alternative Recovery Sites

Selecting a recovery operations site for a sample return mission largely depends on matching the safety and mission critical criteria to the facilities and capabilities of the prospective recovery site. Issues of concern include minimal risk to public safety and to the returned samples. Because a water recovery would most probably compromise the mission science objectives by increasing the risk of contaminating the collected samples, a recovery site on land is mandated. Moreover, in the event that an off-nominal case arises such that the helicopters are unable to fly due to weather, etc., the recovery site must be relatively free of vegetation to aid in finding the SRC once it lands. Sites that can effectively be closed to the public minimize any chance of the reentering SRC harming individuals or their possessions within the controlled site boundary.

### Alternative Recovery Sites Considered

Potential recovery sites investigated included Yuma Marine Corps Air Station (AZ), Luke Air Force Base (AZ), Edwards Air Force Base (CA), Chocolate Mountain Gunnery Range (CA), Twenty-Nine Palms Marine Corps Base (CA), Camp Pendleton Marine Corps Base (CA), Fort Bliss Military Reserve (NM), White Sands Missile Range (NM), Tonopah Test Range (NV), Nellis Air Force Range (NV), China Lake/Fort Irwin (CA), Poker Flats (AK), and UTTR (Utah).

The Genesis 84 km x 30 km (52 x 19 mi) three-sigma recovery footprint requires a large, flat, bare, relatively unpopulated, and restricted area to ensure safety of personnel, the public, structures, and the mission science to be returned. Of the recovery sites examined, UTTR has been determined to be the best-suited potential recovery site for the Genesis mission, for the reasons that follow:

- Recovery over water has been rejected due to unacceptable risk to the returned science, higher risk of capsule loss, and higher cost of recovery

- U.S. recovery sites were chosen in order to ensure the integrity, safety, and security of the samples.

- Of the possible U. S. recovery sites considered, only Nellis Air Force Range (Nevada), China Lake/Fort Irwin (California), Poker Flats (Alaska), and UTTR (Utah) meet the required footprint area. Both Nellis Air Force Range and China Lake/Fort Irwin have large areas of mountainous terrain which represent an unacceptable risk to a successful science return. Poker Flats is a highly forested terrain, which could complicate or impede recovery operations.

- UTTR has the largest overland special use airspace (measured from the surface or near surface, 43,126 square (sq) km [16,651 sq mi]), as well as the largest overland contiguous block of supersonic authorized, restricted airspace in the contiguous United States (See Figure 2-8).

- UTTR has been identified as the proposed Genesis project recovery operations site because it uniquely satisfies all of the selection criteria discussed in Section 2.2.3.

### <u>No-Action Alternative</u>

The No-Action alternative would result in termination of the mission, which would disrupt the progress of NASA's Inner Solar System Exploration Program. While environmental impacts would be avoided by cancellation of the proposed mission, the loss of the scientific knowledge and database from carrying out the mission could be significant.

## SUMMARY OF ENVIRONMENTAL IMPACTS

The only expected environmental effects of the proposed action are associated with normal launch vehicle operation and entry, descent, and recovery of the SRC; these are summarized in the following paragraphs.

### <u>Launch</u>

All launch preparation activities would be conducted in accordance with applicable federal, state, and local environmental regulations at both CCAFS, and no new or revised environmental licenses or permits would be required.

Air Quality

The Air Force uses the Rocket Exhaust Effluent Diffusion Model (REEDM) to determine the concentration and areal extent of launch cloud emission dispersion from LVs. The Delta II 7425 is considered to bound the upper limit of propellants for the 7320-7420 series of Delta II launch vehicles. The Delta II 7425 differs from the 7326 in that it has an extra GEM and a Star 48 third stage, which has 2010 kg (4422 lb) of propellant compared to the Star 37 FM motor which has 1077 kg (2368 lb) of the same propellant. Using the Delta II 7425 mass fractions, data obtained during early Delta launches, and rocket engine chamber tests, REEDM was run to calculate peak ground level concentrations of various pollutants in the ground clouds. For this assessment, Air Force personnel from 45SW ran REEDM for the Delta II 7425 LV nominal launch case (normal launch mode) in two different weather scenarios (2 runs). The model was also run for two failure modes (conflagration and deflagration) in two credible weather scenarios (4 runs). (A credible weather scenario is one in which launch would proceed.) The two weather scenarios include a high over the eastern US, producing easterly winds which could cause adverse inland toxic hazard corridors; the second weather case is for a cold front over southern Florida, producing northerly wind components and inversions which could also cause an adverse toxic hazard corridor toward the closest and densest population center at Port Canaveral. A total of six runs was performed. Selected output from the model runs is included in Appendix B.

Concentrations for carbon monoxide (CO), carbon dioxide ($CO_2$), chlorine (Cl), aluminum oxide ($Al_2O_3$), and hydrochloric acid (HCl) were considered. The exhaust cloud is predicted to stabilize at about 5 km (3 mi) downwind of the launch pad. REEDM outputs predict that the 60-minute average concentrations would be less than 0.05 ppm for all species considered for a normal launch in either of the two weather scenarios.

During the last twenty years there has been an increased concern about human activities that are affecting the upper atmosphere. Space vehicles that use SRMs have been studied concerning potential contribution to stratospheric ozone ($O_3$) depletion because of their exhaust products, with the primary depleting component being HCl. However, rockets contribute very minor amounts of HCl to the atmosphere when compared with other human-made sources.

The cumulative net stratospheric ozone depletion caused by rocket exhaust effluents would be on the order of $5.5 \times 10^{-3}$ percent for twelve Delta II 7425 launches during a one-year period.

## Land Resources

Overall, launching a Delta II vehicle would not be expected to have substantial negative effects on the landforms surrounding LC-17. However, launch activities could have some small impacts near the launch pad associated with fire and acidic depositions. Minor brush fires are infrequent by-products of Delta launches, and are contained and limited to the ruderal vegetation within the launch complexes; past singeing has not permanently affected the vegetation near the pads. Wet deposition of HCl could damage or kill vegetation, but would not be expected to occur outside the pad fence perimeter.

## Local Hydrology and Water Quality

The primary surface water impacts from a normal Delta II launch involve HCl and $Al_2O_3$ deposition from the exhaust plume. The ground cloud would not persist or remain over any location for more than a few minutes. Depending on wind direction, most of the exhaust may drift over the Banana River or the Atlantic Ocean. A brief acidification of surface waters may result from HCl deposition. A normal Delta II launch would have no substantial impacts to the local water quality due to amount of water available for dilution.

## Ocean Environment

In a normal launch, the first stage and the SRMs would impact the ocean. The trajectories of the spent stage and SRMs would be programmed to impact at a safe distance from any U.S. coastal area or other landmass. Toxic concentrations of metals would not be likely to occur due to the slow rate of corrosion in the deep ocean environment.

The spent stage and GEMs would have relatively small amounts of propellant. Concentrations in excess of the maximum allowable concentration (MAC) of these compounds for marine organisms would be limited to the immediate vicinity of the spent stage. No substantial impacts would be expected from the reentry and ocean impact of the spent stage and GEMS, since the amount of residual propellants would disperse in the large volume of water and, therefore, would not constitute a danger to the marine environment.

## Biotic Resources

A normal Delta II launch would not be expected to substantially impact CCAFS terrestrial, wetland, or aquatic biota. The elevated noise levels of a launch are of short duration and would not substantially affect wildlife populations. Wildlife encountering the launch-generated ground cloud could experience brief exposure to exhaust particles, but would not experience any substantial impacts. If the launch were to occur immediately before a rain shower, aquatic biota could experience acidified precipitation. This impact would be expected to be insignificant due to the brevity of the small ground cloud and the high buffering ability of the surrounding surface waters to rapidly neutralize excess acidity.

Radioactive Materials

The proposed design of this spacecraft includes no radioactive materials. Thus, there is no radiological risk to the health and safety of human life or the environment from this mission.

Threatened and Endangered Species

The U.S. FWS has reviewed those actions that would be associated with a Delta II launch from LC-17 and has determined that those actions would have no effect on state or federally listed threatened (or proposed for listing as threatened) or endangered species residing on CCAFS and in adjoining waters or critical habitats.

Population and Economics

The Genesis mission would create negligible impact on local communities, since no additional permanent personnel would be expected beyond the current CCAFS staff. Launch Complex 17 has been used exclusively for space launches since the late 1950s. The Genesis mission would cause no additional adverse impacts on community facilities, services, or existing land uses.

Pollution Prevention

Recently the Joint Logistics Commanders and NASA formally approved the Joint Group – Pollution Prevention (JG-PP) as the single agency responsible for pollution prevention for the Military Services. The JG-PP combines the pollution prevention mission of the depot maintenance and acquisition communities. The JG-PP includes NASA and strengthens the link with Single Process Initiative (SPI). It does this by providing military depots, acquisition programs, NASA centers and defense contractors with an accessible means to improve depot maintenance and manufacturing processes by reducing total ownership costs, eliminating emissions of hazardous materials, and minimizing the use of multiple material specifications. Direction and execution of the JG-PP initiative is provided by the Joint Acquisition Sustainment Pollution Prevention Activity (JASPPA). The Genesis mission would comply with JG-PP policies and requirements.

Environmental Justice

EO 12898 directs Federal agencies to identify and address disproportionately high and adverse human health or environmental effects of their programs, policies, and activities on low-income populations and minority populations.  Given the launch direction and trajectories of the Genesis mission, REEDM analyses indicate little or no potential of substantial environmental effects on any human populations outside CCAFS boundaries. The Genesis mission would not result in disproportionate adverse impacts on low-income or minority populations.

Safety and Noise Pollution

Normal operations at CCAFS include preventative health measures for workers such as hearing protection, respiratory protection, and exclusion zones to minimize or prevent exposure to harmful noise levels or hazardous areas or materials.

The engine noise and sonic booms from a Delta II launch are typical of routine CCAFS operations.  In the history of USAF space-launch vehicle operations at CCAFS, there have been no problems reported as a result of sonic booms.  To the surrounding community, the noise from this activity appears, at worst, to be an infrequent nuisance rather than a health hazard.

Cultural Resources

Since no surface or subsurface areas would be disturbed, no archeological, historic, or other types of cultural sites would be expected to be affected by launching the Genesis mission.

Cumulative Impacts

CCAFS accommodates various ongoing space programs.  The environmental effects associated with these programs have been included in the baseline environmental conditions described in section 3.

POTENTIAL LAUNCH ACCIDENTS

Liquid Propellant Spill

The potential for an accidental release of liquid propellants would be minimized by strict adherence to established safety procedures.  Post-fueling spills from the launch vehicle would be channeled into a sealed concrete catchment basin and disposed of according to the appropriate state and federal regulations and CCAFS standard operating procedures.

The most severe propellant spill accident scenario would be releasing the entire launch vehicle load of nitrogen tetroxide at the launch pad while conducting propellant transfer operations. This scenario would have the greatest potential impact on local air quality. Airborne $NO_X$ levels from this scenario are expected to be reduced to 5 ppm within about 150 m (500 ft) and to 1 ppm within approximately 300 m (1,000 ft). Activating the launch pad water deluge system would substantially reduce the evaporation rate, limiting exposure to concentrations that are above federally established standards to the vicinity of the spill. Propellant transfer personnel would be outfitted with protective clothing and breathing equipment. Personnel not involved in transfer operations would be excluded from the area.

Launch Vehicle Destruction

In the unlikely event of a launch vehicle destruction, either on the pad or in-flight, the liquid propellant tanks and GEM casings would be ruptured either by the automatic destruct system on the LV or by Range Safety commanding the flight termination system (FTS). Due to their hypergolic (ignite on contact) nature, a launch failure would result in a spontaneous burning of 10 to 30 percent of the liquid propellants, and a somewhat slower burning of GEM propellant fragments. [USAF 1997-A] Any such release of pollutants would have only a short-term impact on the environment near the pad.

Launch failure impacts on water quality would stem from unburned propellant being released into CCAFS surface waters. For most launch failures, propellant release into surface waters would be substantially less than the full fuel load, primarily due to the reliability of the vehicle destruct system. However, if there were an early flight termination and failure of the vehicle destruct system, it is remotely possible that the entire Stage II propellant quantity could be released to the ocean. Impacts to ocean biotic systems would be localized, transient in nature, and these systems would be expected to recover rapidly, due to dispersion of the propellent in the large quantity of ocean water.

Under normal or catastrophic launch scenarios, concentrations would not be hazardous except in the immediate vicinity of the launch pad for approximately two minutes after launch or near the centroid of the launch cloud for a short time after the launch. The launch cloud would be several hundred meters above ground level, depending on weather conditions. These hazardous concentrations near the centroid of the launch cloud would persist for an estimated ten minutes, but could occur for shorter or longer periods depending on meteorological conditions. Airplanes and boats are not allowed near the CCAFS area during launches. Prior to launch, personnel are cleared from the areas where potentially hazardous concentrations would occur, and there should be no hazard to humans associated with exhaust effluents.

SAMPLE RETURN CAPSULE ENTRY, DESCENT, AND RECOVERY OPERATIONS

Air Quality

Upper altitude emissions associated with reentry of the SRC would include ablation products of the thermal protection system (TPS) on the forebody. The material baselined to be used for the forebody heatshield is a carbon-carbon (C-C) composite recently developed at LMA. The peak heating would occur at approximately 60 seconds after reentry begins, which corresponds to an altitude of approximately 60 km (196,860 ft) above the earth. The ablation would continue for about twenty seconds and would cease at an altitude of approximately 48 km (157,500 ft) above the earth. Models conservatively predict that less than five percent of the total C-C material would ablate during reentry. The total mass of the C-C material would be about 40.32 kg (88.7 lb); of this a maximum of 2.05 kg (4.5 lb) would be ablated during reentry. The chemical species that would be produced during ablation of the C-C material are shown in Table 4-8. These chemical species would be dissipated in the shock wave behind the SRC. Therefore, these concentrations would disperse in the large volume of air in the upper atmosphere and would not constitute a danger to health or life on earth. The SRC heatshield would be rapidly cooling during the subsonic portion of the descent, and would not be emitting into the lower atmosphere.

The Super Lightweight Ablator (SLA-561V) material comprising the TPS of the back shell portion of the SRC undergoes far less heating during reentry than does the C-C material on the forebody. Of the estimated 2 kg (4.4 lb) of SLA-561V comprising the back shell heatshield, approximately 0.3 kg (0.66 lb) would be lost during reentry. There are no toxic species produced from this heatshield material.

Emissions of criteria pollutants would occur as a result of helicopter and possibly ground vehicle activity during Genesis SRC recovery operations. The SRC itself would not generate any air pollutants in the lower atmosphere, nor is it expected that it would contain any chemicals or substances that could emit hazardous air pollutants regulated under National Emission Standard for Hazardous Air Pollutants (NESHAPs). Given that the Genesis mission is a single sample return, the quantities of helicopter emissions would be extremely small. Furthermore, when affected sectors would be scheduled for the Genesis recovery operation, other aircraft would be curtailed, thereby resulting in lower short-term emission levels. It is unlikely that overall emissions in the area would be greater during Genesis recovery operations than under baseline conditions. The proposed action is not expected to result in any violations of the National Ambient Air Quality Standards or to interfere with Tooele County’s ability to reach or maintain attainment.

Land Resources

The helicopters might set down to secure the SRC prior to flight to the staging area; if so, the local soils in the immediate vicinity might be disturbed. Based on test data and the Genesis mid-air retrieval operations scenario, the probability that the helicopters would actually miss the SRC is less than 1 percent. However, should the helicopters miss during all five opportunities to retrieve the SRC, the proposed action would slightly disturb in the soils in the location of the SRC touchdown, as might any land vehicles sent out to recover the SRC. Helicopter landings are currently common on UTTR and should have no additional effect. The SRC would have a diameter of 1.52 m (60 in) and would weigh approximately 225 kg (495 lb). It would have a parachute system that would slow its velocity to approximately 4.6 m/s (15 ft/s). The area affected would measure only a few meters. Any disturbance to the surface could easily be recovered if desired. Due to the single event nature of this recovery operation, the resulting impact would be negligible. The SRC would contain no propellant, except for the mortar charge (0.75 gram) that would expel the drogue chute, and this would be expended at 33 km (108,000 ft) altitude.

Biotic Resources

The SRC recovery operations could affect vegetation in the immediate vicinity of the touchdown of either the helicopter or the SRC, should that prove necessary for any reason. Although the proposed recovery area at UTTR has very sparse vegetation, individual plants within a localized area could be crushed. The impact to plant communities in the area would be negligible. Ground disturbance could increase the potential for invasive species like halogeton to establish in the area, but the small size of the area disturbed would not increase this effect noticeably above the baseline conditions. The proposed Genesis impact area does not contain any sensitive habitats that could be affected by recovery operations.

Noise

Noise from helicopter operations would not differ from baseline conditions and is therefore not anticipated to have any impact on local wildlife. The sonic boom from the SRC reentry would not have any impact due to its high altitude. The recovery area is overlain by the Gandy Supersonic Operating Area, which experiences sonic booms at lower altitudes and higher overpressures than those that would be created by the Genesis SRC.

Numerous studies have been conducted on the sensitivity of wildlife to noise and sonic boom, including studies of big horn sheep, pronghorn, and elk at UTTR. A literature survey of studies on effects of supersonic and subsonic aircraft noise on animals conducted by the USAF in 1986 revealed few effects from sonic booms. These same studies have shown that there is more potential for effects from subsonic aircraft operations, especially helicopters, and indicated that wildlife acclimated to recurring events. In any case, the proposed project area does not include sensitive wildlife species likely to be adversely affected, and any wildlife in the area is likely already acclimated to the on-going range operations.

Threatened and Endangered Species

No threatened or endangered species are expected to be affected by the proposed action. The probability of a collision between the SRC or a helicopter and a bald eagle or Peregrine falcon in the area is extremely remote -- raptors have a very low incidence of airstrike. It is highly unlikely that any candidate species that could be affected occur in the proposed recovery area.

Health and Safety

There would be three areas of concern with respect to health and safety during the entry, descent, and recovery phase of the mission. The first involves range safety considerations; the second is concerned with SRC recovery safety issues; and the third is the inadvertent reentry of the spacecraft.

UTTR Range Safety Considerations

Scheduling procedures for use of UTTR would preclude any risk of flight hazards involving other aircraft in the area during the time of SRC entry, descent, and mid-air retrieval. There a negligible risk of mishap involving the helicopters that would be used in the SRC recovery operations. This risk would be comparable to currently on-going risks at the range. In the event of a helicopter accident, there are no inhabited areas in the proposed recovery area that would be exposed to hazardous conditions. Therefore, the potential for adverse effect to personnel or the public is considered insignificant.

The Monte Carlo analysis[1] performed by NASA's Langley Research Center for the Genesis project shows that the risk of casualty from the SRC reentry is no greater than one in a million ($1 \times 10^{-6}$). [JPL 1999-G]

[1] A Monte Carlo analysis is a numerical method that evaluates the properties of complex, many-body systems, as well as non-deterministic processes, and is used routinely in many diverse fields to simulate complex physical phenomena. Monte Carlo methods are used to simulate problems that have an enormous number of dimensions or a process that involves a path with many possible branch points, each of which is governed by some fundamental probability of occurring.

Back Contamination

The Genesis mission would collect ions emitted by the Sun in nearly ultra-pure silicon collector arrays, and the electrostatic concentrator would concentrate the elements hydrogen, helium, lithium, beryllium, boron, carbon, nitrogen, oxygen, fluorine, and neon. Sample collection would only occur at the L1 point with the sample collection system sealed at all other times. The samples would be returned to Earth in a sealed reentry capsule.

The trajectory and associated halo orbit assures that the space vehicle would not travel near any extraterrestrial body. During the journey Genesis would be impacted by high velocity (1 km/sec or greater) interplanetary dust, in addition to solar wind. The dust is not a science objective and would be destroyed by vaporization upon impact with temperatures exceeding 500 degrees Celsius. There would also be a possibility of capturing low velocity dust, primarily in near-Earth transit. This low velocity dust accumulation would be equivalent to that commonly experienced during Space Shuttle missions and U2 flights. Furthermore, the background radiation environment at the L1 point is extremely high, and the general consensus of the science community is that no organism would be able to sustain life in such a harsh environment. For these reasons, there is very little probability that back contamination of the Earth could occur due to the sample return. The Genesis project has requested and received classification from NASA's Planetary Protection Officer as a Planetary Protection Category V mission, "Unrestricted Earth Return," for this mission phase. No further planetary protection requirements would be levied on this mission. [JPL 1998-C, NASA 1999-B, NASA 1999-D]

SRC Recovery Safety Considerations

Four potential hazards have been identified in regards to handling the SRC once it has been recovered. They include safing of potential unfired parachute deployment ordnance; lithium battery faults such as the production of sulfur dioxide ($SO_2$), or a lithium fire should the battery be damaged; RF emissions from the Global Positioning System (GPS) transmitter and the very high frequency (VHF) beacon; and physical handling of the SRC outer surfaces. These are discussed in detail in the following paragraphs.

Ordnance Safing

There would be redundant NASA Standard Initiators (NSIs) in the SRC to fire the mortar and deploy the drogue chute. The drogue mortar would not be a handsafe pyrotechnic (pyro) device. In the nominal recovery scenario, i.e., the parachute deploys as engineered, it would indicate that at least one NSI fired, but would not provide information that the redundant NSI also fired. Therefore, it is possible that there would be an unfired

NSI within the drogue mortar. If the Deployable Aft Conical Section (DACS) separation and main parafoil deployment occur as intended, the mortar canister would remain with the DACS, and be separated from the SRC. Genesis plans to recover the drogue/DACS assembly, and to engage a UTTR Explosive Ordinance Disposal (EOD) expert to isolate and remove the parachute initiator NSIs in an electrostatic discharge control area. Procedural methods are planned to minimize personnel exposure to an unfired NSI in the mortar.

There would be three dual bridgewire devices connected to the three separation bolts, which would all have to fire to release the DACS, and deploy the main parafoil. All three separation bolts must operate for nominal reentry. If a bolt failed to operate, the main parafoil would not deploy, and there is a possibility of unfired ordnance. The separation bolts would not be hand safe. The end of the bolt is designed to be ejected upon firing which could pose a hazard to personnel. However, recovery within the 3-sigma footprint would not be dependent upon drogue chute or parafoil deployment.

The drogue pyro cable cutter would be initiated by a single dual bridgewire device located on the parachute deck. The drogue cable cutter must operate to permit full release of the DACS from the SRC. Failure of the drogue cable cutter to operate may result in mission loss, but the device would remain handsafe in the unfired state. The parafoil brake cutters would be mechanically actuated devices packed in the main parafoil compartment. Due to redundant cutters, one device could fail to be expended upon recovery. The parafoil brake cutters would be handsafe ordnance devices.

Lithium Battery Faults

The SRC would contain twin 7.5-amp-hour lithium sulfur dioxide ($LiSO_2$) batteries, comprised of eight (8) cells each. These lithium cells would be about the size of a commercial "D" cell. These cells would be used only for the SRC return and are diode-protected from reverse charging. The battery case has been designed to leak before bursting and the cables would be protected at possible abrasion points. Potential hazardous characteristics resulting from damaged batteries would be lithium fire, and $SO_2$ production. The recovery team would include a safety inspector, who would perform a test to verify the absence of airborne toxins before the SRC is declared safe for human handling.

RF Emissions from the VHF Beacon

The GPS transmitter would emit a 100 ms pulse at 384 MegaHertz (MHz) every second with a maximum output power of 5 Watts. The whip antenna for this GPS transmitter would be sewn into a parafoil riser. The VHF beacon antenna would be a wire approximately 10 inches long sewn into a parachute riser. The average transmitting power is 100 mW at 242.000 MHz, with a duty cycle of 3 seconds on, 5 seconds off. The American Conference of Government Industrial Hygienists (ACGIH) allows exposure to antennas radiating 7 Watts or less at frequencies between 100 kHz to 450 Mhz, since these devices would not be attached to a human body on a continual basis. Best practices mandate minimizing exposure to RF radiation, which would be satisfied by requiring that recovery personnel be only briefly exposed to the RF emanations resulting from SRC handling and disassembly.

SRC Handling

The primary method of handling the SRC would be via helicopter suspension, except when it is secured in its handling fixture. Gloves would be used for all handling of potentially hot, SRC-ablated surfaces.

Off-nominal Recovery Operations

The recovery footprint location for the Genesis capsule would be predicted by tracking the spacecraft with the DSN prior to SRC release from the spacecraft. Roughly thirteen hours prior to entry, an updated footprint would be provided to the NASA SRC recovery management team for review of the predetermined safe entry decision criteria. Since the SRC would not have a propulsion system, attitude control system or flight termination system, there would be no way to abort the entry sequence following SRC release. Therefore, one of the criteria is that the command would not be sent to separate the SRC from the spacecraft unless the trajectory meets the entry corridor requirements.

The Monte Carlo analysis performed by NASA's Langley Research Center for the Genesis project shows that the risk of casualty from the SRC reentry would be no greater than one in a million ($1 \times 10^{-6}$). [JPL 1999-G] This would meet the UTTR range safety requirements with regards to a helicopter or the SRC impacting a person or damaging a range asset. [AFI 13-212] Assuming the criteria for safe entry are satisfied, the SRC would be released from the spacecraft approximately four hours before entry. Therefore, the SRC reentering and landing at some place other than within the 3-sigma safety ellipse is considered to be non-credible.

In the off-nominal case in which the SRC is not retrieved by the helicopters, it would have the potential for landing anywhere within the designated safety zone (also known as the 3-sigma footprint), which includes targets and areas that may contain unexploded ordnance. In the event that the SRC landed on a target, there is a chance it could initiate an explosion. This could destroy the SRC and result in a release of any materials contained within it. The risk of this occurrence is substantially less than the risk of a military aircraft crashing on unexploded ordnance on the range. To reduce the possibility of the SRC triggering an explosion upon landing, the AF would search out and explode any undetonated munitions in the proposed recovery site prior to the expected date of reentry.

SRC Recovery Safety Considerations

In the off-nominal event that the SRC would impact the ground, it would weigh approximately 225 kg (495 lb), and would be touching down at 4.6 m/s (15 ft/s). This is comparable in mass to one of the 500-pound inert bombs the range typically drops in this area during bombing exercises, except that the SRC would land at a much lower velocity. Therefore, it would pose no additional risk to personnel or structures. All potentially unfired Genesis ordnance devices would be isolated and removed by certified ordnance handlers.

Reentry of the Spacecraft

Current plans call for performing a controlled deboost maneuver on the spacecraft approximately one hour after releasing the SRC. This would result in the spacecraft entering the upper atmosphere high above the Pacific Ocean, where it would burn up due to atmospheric friction. The proposed Genesis deboost maneuver would comply with the guideline for footprint clearance of landmasses (45 km [28 miles] from US soil, 370 km [230 miles] from any non-US landmass).

Based on the Genesis Spacecraft Breakup Analysis, the main spacecraft composite structure is conservatively predicted to break apart at altitudes above 68 km (223,108 ft). Even in the most conservative case wherein the spacecraft bus would reenter the atmosphere along the same trajectory as the SRC, all components would burn up above 47 km (154,000 ft). The small quantities of gases produced during burn-up are left at these extreme altitudes. Table 4-10 lists the predominant species that would be generated during spacecraft reentry. Figure 4-3 shows the spacecraft entry groundtrack.

Off-Nominal Reentry with SRC Attached

If a No-Go decision to release the SRC is reached, the spacecraft with SRC still attached would be deboosted, and the whole flight system would reenter over the Pacific Ocean. Some of the SRC components (e.g., heatshield) might survive, but would harmlessly impact in the Pacific Ocean.

Economics

The proposed action would not affect demographics, housing, or the structure of the economy in the region. The Genesis recovery operations would be compatible with the purpose and use of UTTR and the DoD land in the proposed impact area.

In the off-nominal event that the helicopter fails to capture the SRC mid-air, there is a small possibility that the SRC could land on public lands administered by the Bureau of Land Management (BLM) within the safety zone. The BLM lands involved are along the outside edges of the impact area, so the probability of a landing occurring on BLM land is small. This would not adversely affect the land or grazing if the touchdown occurred.

Pollution Prevention

The Genesis Mission would fully comply with the Joint Group-Pollution Prevention program guidelines, in which NASA and USAF jointly determine Pollution Prevention policies.

Environmental Justice

Given the characteristics of the SRC that is to land at UTTR, analysis indicates little or no potential of substantial environmental effects on any human populations outside UTTR boundaries. The Genesis mission would not result in disproportionate adverse impacts on low-income, Native American, or minority populations.

## ENVIRONMENTAL IMPACTS OF ALTERNATIVES

### Alternative Launch Vehicles

Of the alternative launch vehicle systems available, all except the Delta II 7326 greatly exceed the Genesis mission requirements. The Atlas II would contribute less potential environmental effects; however, its cost to launch would prohibit the launch of this cost-capped Discovery mission. All other launch vehicle alternatives would contribute potentially comparable environmental impacts.

### Alternative Launch Sites

CCAFS and Vandenburg Air Force Base (VAFB) have the only currently approved facilities to launch Delta II launch vehicles. Since the Delta II is the preferred launch vehicle for the Genesis mission, alternative launch sites to CCAFS and VAFB would not be available. Because a larger launch vehicle would be required to launch Genesis onto the same trajectory from VAFB, the potential environmental effects would most likely exceed those of launching from CCAFS.

## Alternative Recovery Sites

Of the potential recovery sites reviewed for the Genesis mission, all would have the same environmental impacts, due to the ablation of the C-C heatshield in the upper atmosphere, and the recovery of the SRC over land. Analysis of possible trajectories for Genesis to land at other ranges shows that only choosing UTTR would allow the SRC to enter Earth's atmosphere directly over the range and into restricted airspace. The sparse human population surrounding UTTR adds a measure of personnel safety not readily achievable at other potential recovery sites. Therefore, recovery of the SRC at the other sites reviewed would entail greater safety risks to commercial air traffic and to surrounding human populations, as well as risk to the science if the SRC landed in the mountainous regions bordering the other locations.

## No-Action Alternative

The No-Action alternative would result in termination of the mission, which would disrupt the progress of NASA's Solar System Exploration program. While environmental impacts would be avoided by cancellation of the proposed mission, the loss of the scientific knowledge and database from carrying out the mission could be significant.

## SECTION 1
## PURPOSE AND NEED

The National Aeronautics and Space Administration (NASA) has prepared an Environmental Assessment (EA) for the Proposed Action of preparing for and implementing the Genesis mission. The Proposed Action includes integration of the Genesis spacecraft with the launch vehicle, its proposed launch from Cape Canaveral Air Force Station (CCAFS), Launch Complex 17 (LC-17), Florida, beginning in June 2001, and the proposed sample return capsule (SRC) recovery operations at Utah Test and Training Range (UTTR) sixty-five kilometers (km) [forty miles (mi)] from Salt Lake City, Utah, during the summer of 2004. This EA discusses the mission's objectives as well as its potential environmental impacts. Feasible alternatives to the proposed action and their potential environmental impacts are also examined. Among the possible effects that will be considered are air and water quality impacts, local land area contamination, adverse health and safety impacts, the disturbance of biotic resources, economic impacts, and adverse effects in wetland areas and areas containing historical sites. This document was completed in accordance with the National Environmental Policy Act (NEPA) of 1969, as amended (42 U.S.C. 4321, et seq.), the Council on Environmental Quality (CEQ) Regulations for Implementing the Procedural Provisions of NEPA (40 CFR Parts 1500-1508), and NASA's policy and procedures (14 CFR Subpart 1216.3).

### 1.1 PURPOSE OF THE PROPOSED ACTION

The National Aeronautics and Space Act of 1958, as amended (42 U.S.C. 2451(d)(1)(5)) establishes a mandate to conduct activities in space that contribute substantially to the "expansion of human knowledge of the E~~e~~arth and of phenomena in the atmosphere and space," and to "the preservation of the role of the United States as a leader in aeronautical and space science and technology and in the application thereof to the conduct of peaceful activities within and outside the atmosphere." In response to this mandate, NASA, in coordination with the National Academy of Sciences (NAS), has developed a prioritized set of science objectives to be met through a long-range program of planetary missions (i.e., the U.S. Solar System Exploration program [SSEP], which includes the primary objectives of exploration of the solar system, understanding its origins and the evolution of planets, comets, and asteroids, and understanding the environment for life).

These missions are designed to be conducted in a specific sequence based on technological readiness, launch opportunities, timely data return, and a balanced representation of scientific disciplines.

The Discovery program was initiated to enhance human understanding of the solar system by providing answers to the fundamental questions at the root of the SSEP primary objectives. Discovery missions address focused scientific objectives using limited instrument sets and stable science requirements. The missions are implemented by university and industry partnerships in coordination with NASA Centers or other agencies where unique capabilities exist. Because these small missions are conducted quickly and inexpensively, they provide the opportunity for more frequent access to space, permitting the exploration of targets of
opportunity, whose orbital characteristics may not allow investigation again in our lifetimes. All solar system targets and science are valid candidates for the Discovery program.

As a part of the Solar System Exploration program on planetary science, the Discovery program goals are to: 1) perform high-quality, focused science investigations that will maintain U.S. leadership in planetary science and that will assure continuity in the SSEP, 2) pursue innovative ways of doing business with more frequent launches, fast turn-around times, and a requirement that the missions within the Discovery program's purview remain within a well-defined cost ceiling, 3) encourage the use and transfer of new technologies in achieving program objectives, and 4) enhance the general public awareness of, and appreciation for, solar system exploration and support the Nation's educational initiatives. Thus, the Discovery program solicits proposals for smaller missions, designed by a consortia comprised of industry, small businesses, and universities. Genesis has been chosen as a Discovery mission, and is a partnership between the California Institute of Technology (CIT), Jet Propulsion Laboratory (JPL), Los Alamos National Laboratory (LANL), NASA Johnson Space Center (JSC), Lockheed Martin Astronautics (LMA), and the Mid-Continent Research for Education and Learning (McREL).

In the National Research Council's Committee on Planetary and Lunar Exploration (COMPLEX) report, "An Integrated Strategy for the Planetary Sciences: 1995-2010," it states, "The broad scientific goals for solar system exploration are to: understand how physical and chemical processes determine the main characteristics of the planets; learn how planetary systems originate and evolve. . ." Under primary objectives for understanding origins, COMPLEX includes "to define the conditions and processes active during the evolution of the solar nebula," and "to construct an internally consistent, quantitative theory of the formation of our entire planetary system that contains sufficient detail to permit comparison with as much observational evidence as possible." The primary observational evidence about solar nebular processes is compositional. Genesis data would provide the "enabling technology" to reach the COMPLEX goals. Moreover, Genesis data would make major contributions to understanding planetary atmospheres.

Another major objective set forth by COMPLEX is to "measure the isotopic ratios of the reactive elements hydrogen (H), carbon (C), nitrogen (N), and oxygen (O) and of the noble gases to a minimum accuracy of 10% for all substantial planetary atmospheres; this would enable meaningful comparisons with elemental compositions observed in the Sun, in meteorites, and in other planets." Such comparisons would not be "meaningful" without precise solar data from a mission such as Genesis.

Finally, one of the approaches COMPLEX is using to rank scientific objectives is to "prioritize scientific questions of significance to the whole of the planetary sciences rather than to just localized regions of the solar system." The broad application of the results of the Genesis mission to the models for evolution of the Sun, meteorites, planets, and nebula would certainly meet that criterion for high priority.

Genesis would support two of the Solar System Exploration program's primary objectives: (1) to understand the origin, evolution, and present state of the solar system; and, (2) to establish the scientific and technical database required for undertaking major human endeavors in space, including the survey of near-Earth resources and the characterization of planetary surfaces. Specifically, Genesis would seek to address questions about the materials and processes involved in the origins of the solar system by providing precise knowledge of solar isotopic and elemental compositions. (An isotope is an atomic species of a chemical element with different atomic mass and physical properties, e.g., carbon-12 versus carbon-14.) This data would provide a cornerstone data set around which theories for materials, processes, events, and time scales in the solar nebula are built, and from which theories about the evolution of planets begin.

The purpose of Genesis is to launch a spacecraft on a low energy trajectory to L1, a libration point in the Sun-Earth system, where the gravitational pulls of the Sun and the Earth are balanced. The spacecraft would be placed into a halo orbit about the L1 point, after which the ultra-pure collectors would be exposed to the incoming solar wind flux. The ions from the solar wind would be accumulated as they are implanted in the collector materials. After two years, the spacecraft would stow the collectors in a contamination-tight canister contained within a Sample Return Capsule (hereafter referred to as the SRC).

Depending on the actual launch date, Genesis would return the samples to Earth during the summer of 2004. The instruments and objectives of the Genesis mission are described in detail in Section 2 of this EA.

## 1.2 NEED FOR THE PROPOSED ACTION

The Sun continuously emits a stream of energetic ions (atoms striped of one or more of their electrons) and electrons, which is called the "solar wind." It is likely that the elemental composition of the solar wind broadly mirrors that of the outer regions of the Sun. Since the Sun contains most of the mass in the solar system, the composition of the Sun, essentially by definition, is the average for the solar system. Differences in composition among the Sun and various other parts of the solar system (e.g., planets, asteroids, comets) from the average for the solar system in regard to particular elements or isotopes are widely recognized as the most powerful way to probe the conditions prevailing and processes that occurred during the formation and evolution of the solar system. In general, theories of planet formation and evolution lead to predictions of the elemental and isotopic composition of the various bodies in the solar system relative to the average for the solar system. Solar composition provides a baseline for assessing loss processes and separation into different elemental and isotopic portions in solar system bodies, particularly for volatiles. It also provides a basis for judging the accuracy of various theories of solar system formation.

Current compilations of solar elemental abundances are based mainly on analyses of carbon iron chondrite meteorites, not direct measurements of the Sun. There are significant limitations to this approach. More complete and accurate direct measurements of solar abundances are required. Furthermore, few data exist on solar isotopic compositions, which is important for astrophysics and solar physics. Planetary science requires greater elemental coverage and higher levels of precision than has heretofore been possible. The sensitivities and accuracies required for planetary science can be achieved only by analysis in sophisticated laboratories located on Earth. These data are deemed to be critical for judging the credibility of models of the nebular processes by which planetary materials and the various bodies in the solar system formed. The Genesis mission would achieve a major improvement in our knowledge of the average chemical and isotopic composition of the solar system by collecting samples of matter emitted by the Sun (solar wind) in high purity collector materials, and returning them to Earth for chemical analysis. The samples collected by Genesis would provide a reservoir of solar material for 21st century science.

While a number of other spacecraft have (or will have) monitored the composition of the solar wind (ISEE-3, Ulysses, SOHO, ACE) prior to Genesis, none of these provide the isotopic data and elemental coverage of the breadth and precision required to maximize constraints on the processes of solar system formation and evolution.

# SECTION 2

# PROPOSED ACTION AND ALTERNATIVES

## 2.1 PROPOSED ACTION

This section describes the Proposed Action of preparing for and implementing the Genesis mission. This would include integration of the Genesis spacecraft with a Delta II 7326 launch vehicle, launch from Launch Complex-17 (LC-17) at Cape Canaveral Air Force Station (CCAFS), and sample return capsule (SRC) recovery operations at the Utah Test and Training Range (UTTR) approximately 31 months later. Alternatives to this Proposed Action, including the No-Action alternative, are discussed in Section 2.2.

### 2.1.1 MISSION DESCRIPTION [JPL 1997-A, JPL 1999-C]

The Genesis mission involves placing a single spacecraft at the so-called Sun-Earth libration point (L1 point), approximately 1.5 million kilometers (km) [0.93 million miles (mi) or 0.01 Astronomical Unit (AU)] away from the Earth (approximately one percent of the Earth-Sun distance) where the gravitational pulls of the Sun and the Earth are balanced. This would also place the spacecraft well beyond the confounding influence of the Earth’s magnetosphere (magnetic field). The spacecraft would be placed into a halo orbit about the L1 point, after which the mostly ultra-pure silicon collectors would be exposed to the incoming solar wind. The ions from the solar wind would be accumulated as they implant in the collector materials. After two years, the spacecraft would stow the collectors into a contamination-tight canister in the SRC for return to Earth and subsequent recovery at UTTR. Current plans call for using a Delta II 7326 expendable launch system to inject the Genesis spacecraft into its low energy trajectory to the L1 point during the launch window beginning in June 2001.

Depending on the actual launch date in 2001, the spacecraft would return to Earth during the summer of 2004. At a prescribed time on it’s return voyage to Earth, a command sequence would be sent to the spacecraft to orient itself for separation from the SRC (about four hours prior to Earth entry). After separation, the SRC would directly enter the atmosphere where atmospheric drag would reduce its speed from 11 km/s to approximately 400 m/s; it would further decelerate to 4.6 m/s (15 ft/s) with the aid of a parachute system (i.e., drogue parachute followed by a parafoil), over UTTR, to be captured midair via helicopter as it descends. Following mid-air retrieval, the SRC would be removed to a staging area at UTTR established in order to prepare it for transport to the planetary materials curatorial facility at Johnson Space Center (JSC). Should conditions, such as weather over the recovery site, be unfavorable, there is an opportunity at entry minus 12 hours to enter a 19-day parking orbit for one or two revolutions (19 or 38 days) prior to a second Earth entry opportunity.

Upon release of the SRC, the spacecraft would reorient itself and fire its thrusters, placing it on a trajectory that would cause it to reenter over the Pacific Ocean. Analysis shows that it would burn up upon reentry above 47-km altitude. It would therefore not re-enter Earth's atmosphere in an uncontrolled fashion, nor contribute to the debris in Earth orbit.

Like the lunar samples returned by the Apollo mission, the Genesis samples would be stored under dry nitrogen in stainless steel glove boxes; they would be handled in much the same manner as on-going programs of curation and distribution of lunar samples, Antarctic meteorites, cosmic dust samples collected in the stratosphere, and returned spacecraft parts that have experienced exposure to micrometeoroid bombardment and other space exposure effects.

### 2.1.2 MISSION SCIENCE OBJECTIVES [JPL 1997-A]

The Genesis science objectives are derived from the recommendations of the Solar System Exploration Committee in their report, "Planetary Exploration Through Year 2000: A Core Program." [NASA 1983] From these general science objectives a well-defined set of 18 prioritized specific measurement objectives (Table 2-1) has been determined. In turn, these specific objectives define mission science requirements from which flow instruments, spacecraft, and mission design. The areas of scientific investigation for the Genesis mission are summarized in the following paragraphs:

#### 2.1.2.1 Achieve a major improvement in our knowledge of the average chemical and isotopic composition of the solar system.

The primary science goal of the Genesis mission would be to collect solar wind samples and return them to Earth for laboratory isotopic and chemical analysis. The isotopic and elemental compositions of solar matter define solar system averages and thus represent the starting point for the interpretations of isotopic differences among planetary materials.

Genesis would measure solar composition by collecting solar wind for analysis in terrestrial laboratories. The solar wind is a convenient source of solar matter readily available outside the Earth's magnetosphere. Solar wind ions have velocities that would allow them to be retained when they strike the passive collectors. This was demonstrated by the highly successful Apollo solar wind foil experiments. With 100-times longer exposure and, especially, with higher purity collector materials, Genesis would provide precise solar isotopic compositions and greatly improved solar elemental composition for most of the Periodic Table. (Comparatively, the Apollo foils were only sufficiently pure for the study of noble gases, but demonstrated a totally-unexpected 38 percent difference in the isotopic composition of neon between the solar wind and the Earth's atmosphere.) [Geiss 1972]

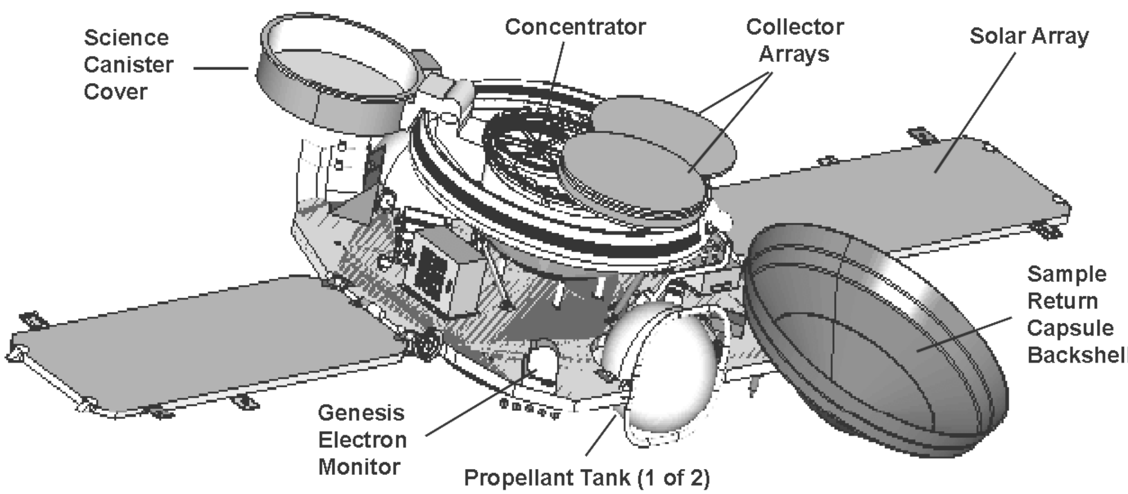
From a consideration of which elements and isotopes are deemed most important, a set of prioritized measurement objectives has been developed (Table 2-1). Based on feasibility, some measurements have been scheduled for early analysis and publication within one year after sample return to assure the timeliness of reporting the results of the Genesis mission. These are designated as the *early science return*[a] in Table 2-1.

**Table 2-1. Prioritized Measurement Objectives**

| |
|---|
| *(1) Oxygen isotopes* |
| *(2) Nitrogen isotopes in bulk solar wind*[a] |
| *(3) Noble gas elements and isotopes*[a] |
| *(4) Noble gas elements and isotopes; regimes* |
| (5) Carbon isotopes[a] |
| (6) Carbon isotopes in different solar wind regimes |
| (7) Magnesium, Calcium, Titanium, Chromium, and Barium isotopes |
| (8) Key first ionization potential elements |
| (9) Mass 80-100 and 120-140 elemental abundance patterns |
| (10) Survey of solar-terrestrial isotopic differences |
| (11) Noble gas and Nitrogen, elements and isotopes for higher energy solar particles |
| (12) Lithium/Beryllium/Boron elemental and isotopic abundances |
| (13) Radioactive nuclei in the solar wind[a] |
| (14) Fluorine abundance |
| (15) Pt-group elemental abundances |
| (15) Key s-process heavy elements |
| (17) Heavy-light element comparisons |
| (18) Solar rare Earth elements abundance pattern |
| (19) Comparison of solar and chondritic elemental abundances |
| *Objectives 1-4 are required objectives* |
| [a]Early science return |

Source: [JPL 1997-A]

Solar wind collection would be accomplished via five passive collector arrays and an electrostatic concentrator (Figure 2-1). The collector arrays would use high purity materials into which the solar wind ions would be implanted. Three of the deployable arrays would be used to cover the different regimes of solar wind. The three major solar wind regimes are: high-speed streams from coronal holes; low-speed, interstream wind; and transient wind associated with coronal mass ejections. Genesis samples from different regimes would provide an important capability to correct for possible differences between composition of the solar wind and the outer layers of the Sun. In addition to the regime-specific collector arrays, two fixed bulk solar wind collection arrays would also be exposed to the solar wind.




Source: [JPL 1999-E]

Figure 2-1. Proposed Genesis Spacecraft Collection Configuration

In the case of some elements, like oxygen (and actually all elements of atomic numbers 6 through 22), the collector material purity would not be sufficient to allow the particles to be distinguished from the background environment in a two-year exposure. A concentrator would be required to obtain enhanced collection of the particle streams. The concentrator would be an electrostatic mirror that would concentrate solar-wind ions to obtain high signal-to-background ratios for measurement of carbon (C), nitrogen (N), and oxygen (O) isotopes. Such concentration is considered necessary for accomplishment of the highest priority science objectives. Table 2-2 lists the precision and accuracy requirements that the Genesis mission would need to meet for elemental and isotopic analyses.

**Table 2-2. Precision and Accuracy of Elemental and Isotopic Analyses**

Elemental Accuracy (2-sigma limits) = ±10% of the number of atoms of each element per $cm^2$ on the collector materials

Isotopic Precision (2-sigma limits on the relative number of the different isotopes of an element compared to a terrestrial reference standard)

| | |
|---|---|
| Oxygen, Magnesium, Calcium, Titanium, Chromium, Barium | ± 0.1% |
| Carbon | ± 0.4% |
| Nitrogen | ± 1.0 % |
| Noble Gases (a) | ± 1.0 % |
| Others | ± 1% |

(a) For the rare isotopes: $^{78}$Krypton, $^{124}$Xenon, $^{126}$Xenon, 1% may not be achievable. A goal for these isotopes is better than ± 3%, 2 sigma.

Source: [JPL 1997-A]

#### 2.1.2.2 Provide a reservoir of solar material for 21st century science.

Because planetary objects are complex and resources are limited, NASA cannot afford missions that completely characterize planetary objects. Knowledge must be accumulated incrementally, and it is likely that Genesis would return a reservoir of solar matter that could be used to meet presently unforeseen requirements for solar composition. When more precise data are needed, it is likely that improved analytical techniques will be developed to meet those requirements using curated samples acquired by Genesis.

Following recovery, the canister containing the collector arrays and the concentrator would be taken to the curatorial facility at JSC, the designated NASA Center for curation of extraterrestrial materials. Procedures and facilities within the Planetary Missions and Materials Branch, Earth Science and Solar System Exploration Division, at JSC would be modified to accommodate the Class-10 clean room environment required to assure adequate curation of the returned samples. This would entail modifications to the air handling equipment and the installation of fume hoods in one interior room.

After the capsule recovery, material would be removed from the return capsule lid (Figure 2-1) at Lockheed Martin Astronautics (LMA) for measurement of radioactive nuclei; this work does not have to be done under the clean-room conditions required for handling the rest of the samples. It is anticipated that about one million atoms of carbon-14 and beryllium-10 would be the maximum collected in all of the lid foils. This represents about $2 \times 10^{-16}$ grams of these elements. [JPL 2000-B] This material would be sent to the University of California at Berkeley which would search for radioactive nuclei using an existing accelerator mass spectrometry facility. No new instrumentation or facility modifications would be required.

2.1.2.3 Create greatly improved models of the nebular processes by which planetary materials and the various bodies in the solar system (planets, comets, asteroids, Kuiper belt, bodies yet to be discovered, etc.) formed.

Investigating events and processes in the solar nebula is equivalent to exploring the solar system back in time. Qualitatively, this can be done by reading the fossilized record in the structure of the solar system and, better yet, in the composition of its materials. As a simple example, the large enrichment of high temperature elements in lunar materials revealed by Apollo samples is a major argument, based on composition, for the widely-accepted theory that a giant Earth impact created the moon and shaped the entire future history of the Earth. Similarly, the absence of differences in the isotopic composition of potassium between lunar and terrestrial matter is a major constraint, not accounted for by present impact models. Quantitatively, models for solar nebula processes are tested by calculating differences in composition of a given planetary material from average solar composition. Presently, one must assume that solar isotopic and elemental abundances are equal to the composition of the most primitive meteorites. Data and solar wind sample material collected by Genesis could eliminate these major assumptions, about which there is cause for concern. The imperative underlying the Genesis mission is that solar abundances should be based on solar data.

## 2.1.3 SPACECRAFT DESCRIPTION [JPL 1999-B]

### 2.1.3.1 General

The Genesis spacecraft would provide a spin-stabilized platform for collection of the solar wind particles by the collectors. The baseline design is derived in large part from the Stardust spacecraft, with necessary modifications made for spin-stabilization and to incorporate the instruments required to meet the science objectives.

### 2.1.3.2 Spacecraft Pyrotechnic Devices [JPL 1999-D]

The Genesis spacecraft would include ten functions that are pyrotechnically actuated; Table 2-3 lists the ten proposed ordnance events, the type and description of each device, and at which facility each would be installed. The ordnance events are designed to produce no fragments or released parts with three notable exceptions. Each solar array separation nut would release by spring force the bolt, spring, Bellville washers, upon activation. Also, released bolt ends would be ejected from the deployable aft conical section (DACS) separation bolts upon DACS release. The drogue parachute ejection, drogue cable cutting, DACS separation from the SRC, and parafoil brake release would be events scheduled on the SRC in Earth atmosphere upon SRC return. All other events would be scheduled during mission phases in space.

**Table 2-3: Proposed Genesis Pyrotechnic Events**

| Ordnance Event | Ordnance Devices | Ordnance Description | Installation Location |
|---|---|---|---|
| Solar Array Deployment | 2 Separation nuts | 4 NASA Standard Initiators (NSIs), 2 NSIs per separation nut | Kennedy Space Center (KSC) |
| Genesis Electron Monitor (GEM) Aperture Release | 2 Dimple motors | Part of GEM instrument | LMA Denver |
| Genesis Ion Monitor (GIM) Aperture Release | 2 Dimple motors | Part of GIM instrument | LMA Denver |
| SRC Hinge Cable Cutting | 2 Cable cutter | 2 dual bridgewire initiators, one initiator per cable cutter | KSC |
| SRC Hinge Release | 4 Separation bolts | 4 dual bridgewire initiators, one initiator per separation bolt | KSC |
| SRC Bipod Separation | 3 Separation bolts | 6 NSIs, 2 NSIs per separation bolt | KSC |
| Drogue Parachute Ejection | 1 Parachute mortar | 2 NSIs and 1 mortar cartridge | LMA Denver |
| Drogue Cable Cutting | 1 Cable cutter | 1 Dual bridgewire initiator on cable cutter | LMA Denver |
| DACS Separation from SRC | 3 Separation bolts | 3 dual bridgewire initiators, one initiator per separation bolt | LMA Denver |
| Parafoil Brake Release | 2 Cable cutters | 2 lanyard pull- activated devices, no electrical initiation | LMA Denver |

Source: [JPL 1999-B]

### 2.1.3.3 Spacecraft Science Payload Description [JPL 1997-A, JPL 1999-C]

The payload would consist of:

- Five arrays of solar wind collectors, four that are deployable and one that is fixed;
- An electrostatic concentrator to concentrate the flow of N, O and other light ions in the solar wind onto a small target for collection;
- A canister in the SRC for storing the collectors and concentrator in an ultra-clean environment; and

- A pair of solar wind monitor instruments (spectrometers) for determining the regime and speed of the solar wind at any time in order to control deployment of collectors and voltages on the concentrator.

2.1.3.3.1 Silicon Collectors

Intact capture of solar wind particles is the highest priority of the mission. The major constraint in the design of the Genesis payload would be the need to utilize as large a collection area as possible, while minimizing risks of contamination or malfunction. The fact that most of the solar wind collectors would be thin wafers of mostly ultra-pure silicon dictates that these wafers should be mounted on rigid arrays and deployed in space by means of simple rigid rotations (see Figure 2-1). The collector arrays and the concentrator would be stored in a very clean environment by housing them in a sealed "canister." The diameter of the SRC would be made as large as possible to maximize the exposed area of solar wind collectors while remaining within launch vehicle mass and payload fairing diameter limits.

2.1.3.3.2 Electrostatic Concentrator

Collecting precise data on the isotopes of nitrogen and oxygen in the solar wind is a particularly high priority Genesis science objective. Since both of these elements are prevalent in Earth's atmosphere, they pose the special challenge of minimizing atmospheric and organic contamination during the manufacture and preparation of collector materials. For this reason, Genesis plans to use a parabolic electrostatic concentrator, in addition to the flat arrays, to collect carbon, nitrogen, and oxygen. This concentrator would be an electrostatic analog of an optical reflector telescope. The solar wind ions impinging on the 40-cm aperture of the electrostatic concentrator would be reflected and focused by the electric field onto a target with a 6-cm diameter.

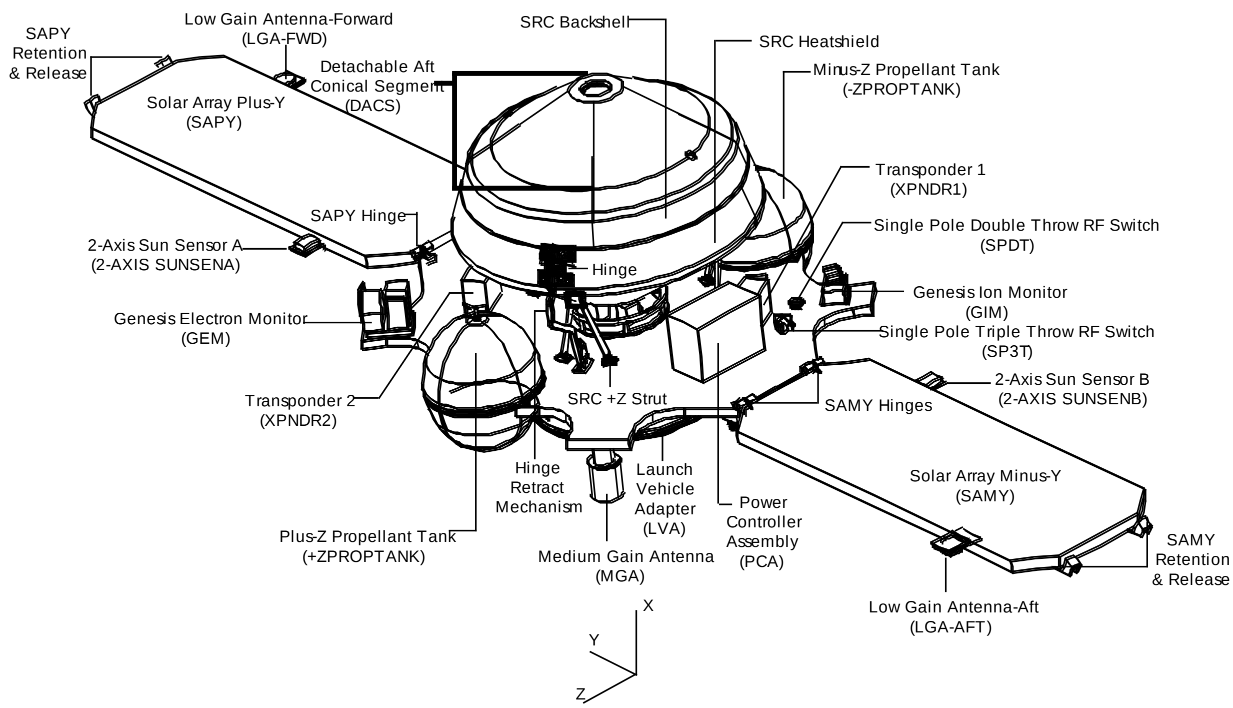
2.1.3.3.3 Ion and Electron Monitors

Genesis would utilize both an ion monitor (GIM) and an electron monitor (GEM) (see figure 2-2) to measure properties of the solar wind. These would be mounted on the spacecraft bus. The monitors would measure the distribution in space and time of ion and electron energies from which the following properties listed would be determined:

- The Hydrogen/Helium ratio;
- The bulk wind velocity;
- Ion and electron temperatures;
- Densities; and

- The angular distribution of electrons.

These data would be fed into an expert system resident in the spacecraft computer, which would thereby determine, in real time, when a solar wind change occurs. When such a change occurs, the spacecraft computer would command the mechanical actuators to expose the proper individual solar wind collector array and change the voltage on the concentrator appropriately.




Source: [JPL 1999-E]

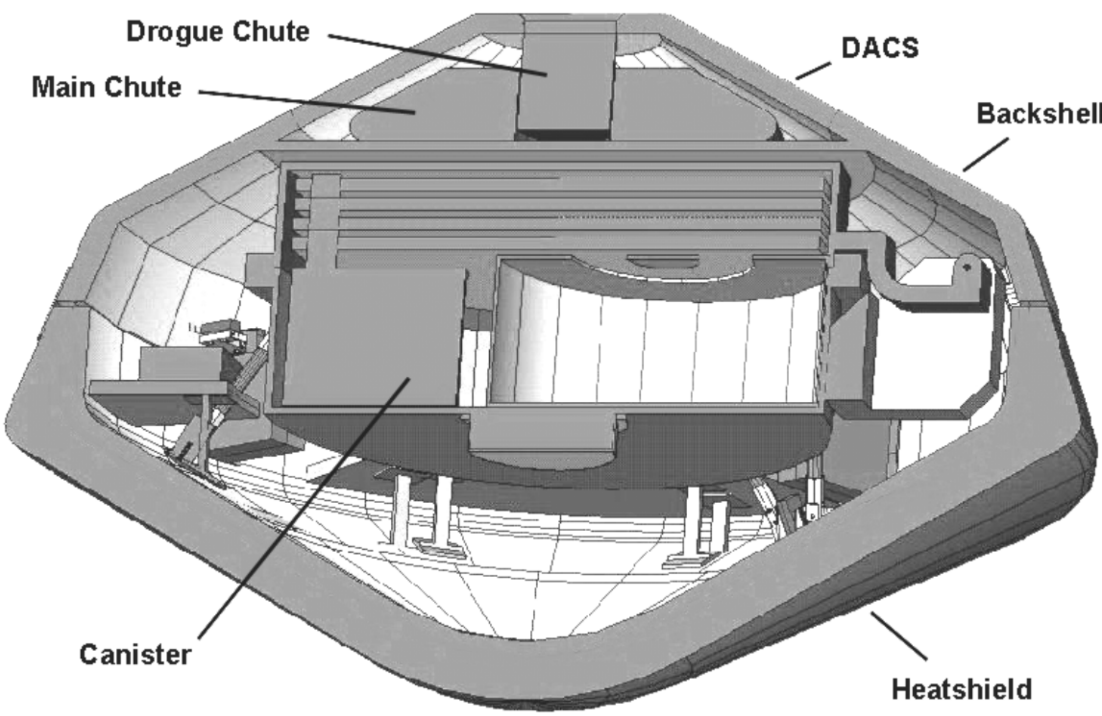
Figure 2-2. Proposed Genesis Spacecraft Cruise Configuration

Data from the solar wind monitors and solar wind determination process would be returned to Earth on approximately a weekly basis. The data would be examined by mission scientists at Los Alamos National Laboratory (LANL) and Jet Propulsion Laboratory (JPL). These investigators would track the performance of the on-board algorithms for determination of the solar-wind regimes and develop new computer algorithms, if necessary. The monitor data would be used to calculate (i) the total amount of hydrogen and helium on each set of collectors and (ii) any mass separation corrections to be made to the analyses of concentrator samples. The monitor data would also be used to place the returned samples in the context of solar-cycle and other variations in the solar wind.

The Genesis data would be placed in the relevant NASA archive on a continuing basis throughout the mission. Documentation concerning the instrument design, performance, and calibration would also be archived.

### 2.1.4 SAMPLE RETURN CAPSULE (SRC) [JPL 1999-B]

The SRC, shown in Figure 2-3, would be designed with minimal requirements when compared to traditional entry vehicles. It would need no active attitude control, no propulsion, no active thermal control, and no new technology. The SRC would house the science canister and provide for its safe return. Descent and deceleration would be achieved by a 60-degree half-angle cone SRC forebody, a small drogue parachute, and a main parafoil. The SRC avionics would include lightweight battery-powered tracking aids to support recovery at UTTR. The configuration of the proposed payload canister within the SRC is shown in Figure 2-3.




Source: [JPL 1999-E]

Figure 2-3. The Proposed Genesis Sample Return Capsule

The SRC would be attached to the spacecraft via three bipod struts made of graphite-polycyanate composite tubes and metallic end fittings. The spacecraft bus would consist of a composite-faced sandwich deck and a cylindrical launch vehicle adapter. The baseline design calls for the spacecraft bus to be 1.7 meters (m) [(67 inches (in)] diameter by 0.5 m (20 in) height, and the SRC would have a diameter of 1.52 m (59.8 in) and a height of 0.97 m (38.3 in), to maximize the science payload collector area.

Separation of the SRC from the spacecraft would occur approximately four hours prior to capsule entry. The SRC would not enter into Earth orbit, but would directly enter Earth's atmosphere, with an entry velocity of 11.0 km/s (6.9 mi/s). SRC atmospheric entry would be defined as occurring at an altitude of 125 km (77.5 mi) above a 6378 km (3954 mi) spherical Earth radius reference. Taking into account SRC separation and entry corridor uncertainties, vehicle aerodynamics uncertainties and atmospheric dispersions, the recovery footprint ellipse for the SRC has been determined to be approximately 84 km long by 30 km wide (52 mi x 19 mi) (three standard deviations in each direction). The flight path of the SRC as it approaches UTTR would be approximately a northwest to southeast trajectory. The parachute system would consist of a mortar-deployed drogue chute to provide stability at supersonic speeds, and a main parafoil (10.5 x 3.7-m, 34.6 x 12.1-foot rectangle), which would be released at about 6.7 km (22,000 feet [ft]). It is anticipated that the first helicopter intercept attempt would occur at an altitude of approximately 2.8 km (9,200 ft) about 19 minutes from SRC entry. The gliding velocity of the SRC at aerial capture would be approximately 16.3 m/s (53 ft/second [ft/s]). The vertical descent rate would be 4.6 m/s (15 ft/s). Time elapsed from entry to capture would be a maximum of 23 minutes, should all five planned helicopter passes be required. Following capture in the daytime, the SRC would be transported to a staging area at UTTR in preparation for transport by NASA to the planetary materials curatorial facility at JSC.

Given the small size and mass of the SRC (see section 2.1.4.1), it is not expected that recovery and transportation of the capsule would require extraordinary handling measures or hardware other than a specialized handling fixture to be provided by LMA to cradle the capsule during transport. Other than the parachute deployment-separation system, the SRC would not contain any explosive ordnance, pyrotechnic devices (pyros), rocket motors, etc. The SRC will be discussed in detail in section 2.1.4.1 and the potential environmental effects associated with the recovery operation will be discussed in section 4.3 of this document.

### 2.1.4.1 Recovery Vehicle Description [JPL 1999-B]

The SRC would be composed of six major components: heatshield, back shell, DACS, sample canister, parachute system, and avionics. The total mass of the SRC, including parachute system would be approximately 225 kilogram (kg) (495 pounds [lb]). The SRC would have a diameter of 1.52 m (59.8 in).

#### 2.1.4.1.1 Heatshield

The forebody heatshield would be made of a carbon-carbon (C-C) composite thermal protection system (TPS) developed by LMA for use on high-speed reentry vehicles. The SRC forebody heatshield would remain attached to the capsule throughout descent.

#### 2.1.4.1.2 Back Shell

The back shell structure would also be made of a graphite/epoxy composite covered with a TPS.  The TPS that is planned for use on the back shell is a cork based material called Super Lightweight Ablator-561V (SLA-561V) that was developed by LMA for use on the Viking missions to Mars and is currently used on the Space Shuttle External Tank.  The back shell would provide the attach points for the parachute system.

#### 2.1.4.1.3 Deployable Aft Conical Section (DACS)

The DACS would consists of the composite structure, the thermal protection layer (SLA), the parachute interface plate (PIP), canister thermal cover, and bridle attachment fittings.  The three attachment fittings would be mounted to the PIP for bridle attachment of the main chute bag to the DACS.  The DACS would be jettisoned at approximately 6.7 km (22,000 ft), thereby releasing the drogue chute from the SRC, and deploying the main parafoil.

#### 2.1.4.1.4 Sample Canister

The sample canister would be an aluminum enclosure that holds the solar wind particle capture medium (mostly ultra-pure silicon) and the deployment mechanism used to deploy and stow the collectors during the mission.   The canister would be mounted to an equipment deck suspended between the back shell and forebody heatshield.

#### 2.1.4.1.5 Parachute System

The parachute system would incorporate a mortar-deployed drogue and a lifting main parachute (parafoil).  The drogue mortar, mounted on the DACS, would contain two NASA Standard Initiators (NSIs), and a small (less than one gram) propellant charge to expel the drogue.  The drogue chute would be deployed at an altitude of approximately 33 km (108,000 ft) mean sea level (MSL) at a speed of about Mach 1.8 to provide SRC stability.  A gravity sensor would start a timer that would initiate deployment of the drogue chute.  The same timer would fire the three separation bolts that would release the DACS and drogue chute from the SRC at approximately 6.7 km (22,000 ft) MSL.  As the drogue chute moves away from the SRC, it would extract the main chute from the parachute tray.

##### 2.1.4.1.6 SRC Avionics

The current Genesis SRC baseline design includes a Global Positioning System (GPS) transmitter and very high frequency (VHF) locator beacon to be used in conjunction with VHF-DF (direction finding) equipment on the ground.  Both beacons would be turned on at main parachute deployment and would remain on until the batteries are disconnected by recovery personnel.  The beacons would be powered by redundant sets of primary cell lithium sulfur dioxide batteries, which have long shelf life, tolerance to wide temperature extremes, and handling safety. The SRC would carry sufficient battery capacity on-board to operate both beacons for at least three hours.

#### 2.1.4.2 Recovery Footprint Determination Accuracy [JPL 1999-G]

The driving requirement to meet the proposed footprint onto UTTR is the entry flight path angle.  An accuracy of 0.08 degrees (three standard deviations or three sigma) is necessary to maintain the downrange footprint within UTTR.  In order to support the trajectory accuracy needed, navigation tracking requirements have been established by JPL.  Based on navigation telemetry, a maneuver solution would be translated by LMA into a spacecraft command sequence to be uplinked through the NASA's Deep Space Network (DSN).  At entry minus thirty days the spacecraft would perform the trajectory correction maneuver (TCM) to implement preliminary entry targeting.  Another TCM to refine entry targeting would be performed ten days prior to entry.  The final entry targeting TCM would be performed 24 hours prior to entry.

The Earth entry conditions for the Genesis capsule would be predicted by tracking the spacecraft with the DSN prior to SRC release from the spacecraft.  Since the SRC would not have a propulsion system, attitude control system or flight termination system, there would be no way to abort the entry sequence following SRC release.  Roughly fifteen hours prior to entry, an updated flight path would be provided to the Genesis SRC recovery management team for review of the predetermined safe entry decision criteria, and a decision to proceed or to divert to the 19-day parking orbit.  Approximately eight hours prior to entry, another flight path update would be provided for a decision to proceed with SRC release or divert the spacecraft with SRC attached into the Pacific Ocean.  Roughly four hours prior to entry, a final flight path estimate would be provided to improve the staging of the recovery helicopters. The Monte Carlo analysis[1] performed by NASA's Langley Research Center for the Genesis project shows that the risk of casualty from the SRC reentry would be no greater than one in a million ($1 \times 10^{-6}$). [JPL 1999-G] This would meet the UTTR range safety requirements with regards to a helicopter or the SRC impacting a person or damaging a range asset. [AFI 13-212] Assuming the criteria for safe entry are satisfied, the SRC would be released from the spacecraft four hours before entry.

Following SRC release, Earth's atmosphere would quickly decelerate the SRC. The SRC trajectory would remain above 30 km (100,000 ft) until the SRC is over UTTR. Atmospheric data from high altitude weather balloons would be used for final updates to the predicted aerocapture location.

The spacecraft would perform a deboost maneuver at three hours prior to entry, and burn up over the Pacific Ocean above an altitude of 47 km (150,000 ft). A no-go decision for Genesis SRC separation after the parking orbit would represent mission failure and would be considered if personnel are in danger or serious property damage is probable.

### 2.1.5 LAUNCH VEHICLE [USAF 1988, USAF 1994, JPL 1999-B]

The Delta II 7326 has been selected as the baseline launch vehicle for the Genesis mission. The Delta II launch vehicle (Figure 2-4) consists of a payload fairing, the first and second stage propulsion systems with three graphite epoxy motors (GEMs) used as strap-on boosters to the first stage, and a Star 37FM upper (third) stage.

#### 2.1.5.1 Payload Fairing (PLF)

During ascent, the Genesis spacecraft/Star 37FM third stage combination would be protected from aerodynamic forces by a 2.9-m (9.5-ft) payload fairing (Figure 2-5). The PLF would be jettisoned from the launch vehicle during second stage powered flight at an altitude of at least 130 km (80 mi).

#### 2.1.5.2 Delta II First and Second Stage and GEMs [MDSSC 1992]

The first stage of the Delta II is powered by a liquid bipropellant main engine and two vernier engines. The first stage propellant load consists of approximately 96,243 kg ([211,735 lb of RP-1 fuel (thermally stable kerosene) and liquid oxygen as an oxidizer. First

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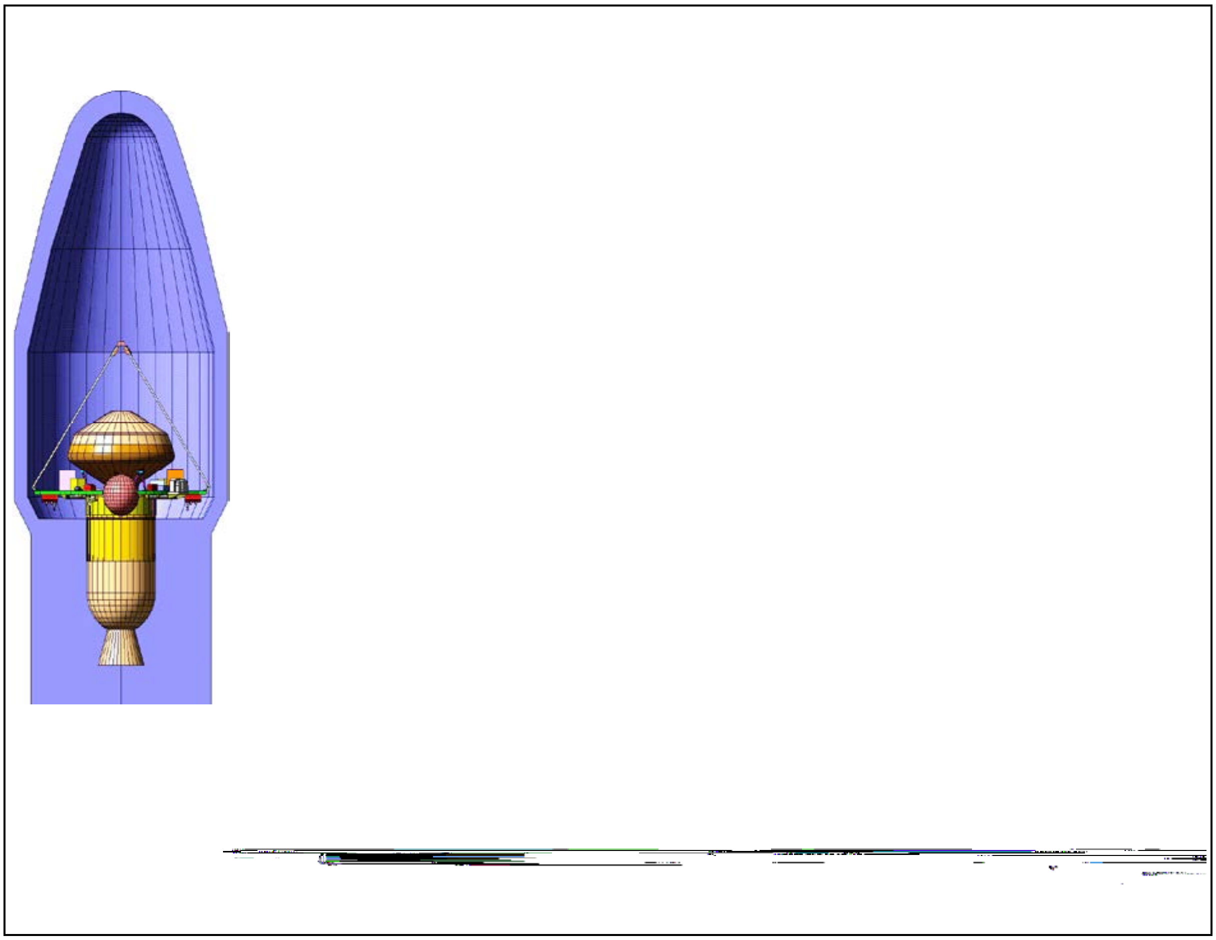
[1] A Monte Carlo analysis is a numerical method that evaluates the properties of complex, many-body systems, as well as non-deterministic processes, and is used routinely in many diverse fields to simulate complex physical phenomena. Monte Carlo methods are used to simulate problems that have an enormous number of dimensions or a process that involves a path with many possible branch points, each of which is governed by some fundamental probability of occurring.

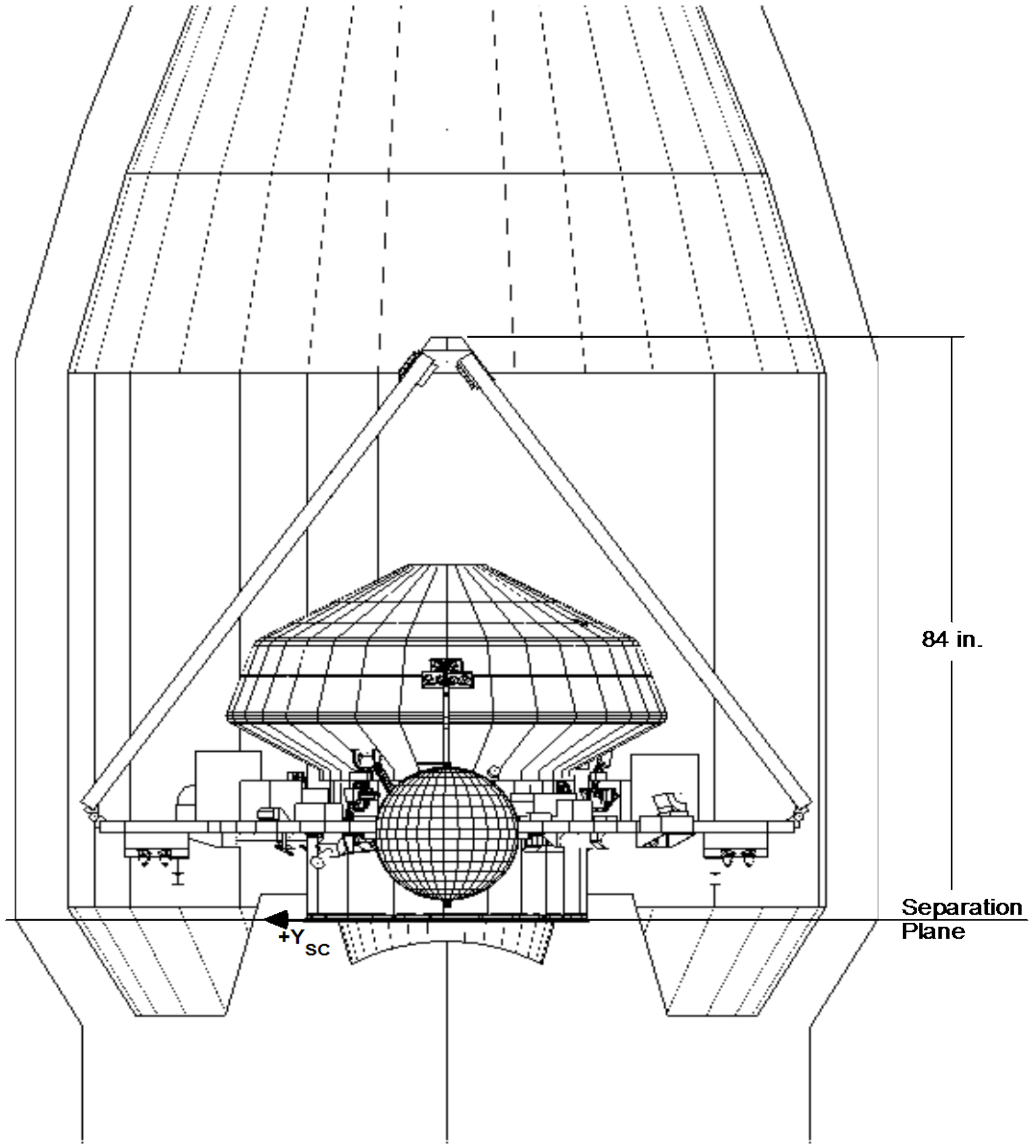
stage thrust is augmented by three GEMs, each fueled with 11,870 kg (26,114 lb) of Hydroxyl-Terminated PolyButediene (HTPB) solid propellant. The main engine, vernier engines, and the GEMs are ignited at liftoff. The GEMs are jettisoned after burnout of the solid propellant.

The Delta II second stage propulsion system has a bipropellant engine that uses Aerozine 50 (a 50/50 mix of hydrazine and unsymmetrical dimethyl hydrazine (UDMH)) as fuel and nitrogen tetroxide ($N_2O_4$) as oxidizer. The second stage has a total propellant load of 6,019 kg (13,242 lb).



Source: [JPL 1999-B]

Figure 2-4. Delta II 7326 Launch Configuration




Source: [JPL 1999-B]

Figure 2-5. Genesis Spacecraft inside Payload Fairing

### 2.1.5.3 Star 37 FM Third Stage [Boeing 1997]

The third stage of the launch vehicle provides the final velocity required to insert the Genesis spacecraft onto its trajectory. This third stage consists of: (1) a spin table to support, rotate, and stabilize the Genesis spacecraft/upper stage combination before separation from the second stage, (2) a Star 37FM solid rocket motor for propulsion, (3) a payload attach fitting (PAF) to mount the Star 37FM motor to the spacecraft, and, (4) a nutation control system to despin the spacecraft prior to third stage separation. The Star 37FM is fueled with 1,077 kg (2,370 lb) of solid propellant (HTPB). The PAF, spacecraft separation system, nutation control system, and cabling between the upper stage and the spacecraft do not remain with the spacecraft after its separation from the upper stage.

### 2.1.5.4 Flight Termination System [EWR 127-1]

The Eastern Range (ER), Range Safety Office has the responsibility for establishing flight safety limits for the trajectory of a launch vehicle. These limits are defined to ensure that errant launch vehicles (or debris resulting from a launch failure) would not pose a danger to human life or property. These flight safety limits are determined before launch, using predicted values for winds, explosively produced fragment sizes and velocities, human reaction time, transmission delay time, and other pertinent data. During a launch, if the vehicle trajectory indicates that these limits would be exceeded, the ER Mission Flight Control Officer would take appropriate action, including destruction of the vehicle.

As specified by Range Safety requirements, the Genesis launch vehicle would be equipped with a Flight Termination System (FTS). This system would be capable of destroying the vehicle based on commands sent from the ER Mission Flight Control Officer. In the event of an unplanned separation of the first and second stages, the FTS would automatically issue a destruct command. This function would be activated when electrical paths between stages are interrupted and stage-separation commands have not been issued by the flight computer.

An electromechanical Safe and Arm (S&A) device would be located on each of the first and second stages. Upon activation of the FTS, either by a Range Safety destruct command or by sensing vehicle breakup, the S&A device would enable the power and sequence box to trigger the destruction of the vehicle. The first stage S&A device would be connected to several strands of explosive detonating cord, which would be attached to the propellant tanks. When activated, these detonations would rupture the tanks, initiating the rapid burning and dispersion of propellants before the vehicle impacts the ground. The second stage S&A device would be connected to a linear shape charge designed to sever the second stage propellant tanks. [MDSSC 1991]

### 2.1.5.5 Launch Vehicle Debris

Delta launch vehicles use containment devices to mitigate the spread of debris generated during normal staging operations. Once separated, the Delta II payload fairing, first stage, and GEMs do not achieve Earth orbit. After burnout, the GEMs fall into the Coast Guard-controlled area of the Atlantic Ocean. The first stage burns to depletion to avoid potential tank rupture and breakup from over-pressurization caused by solar heating, then falls into the Atlantic Ocean. After third stage separation, the second stage propellants also burn to depletion. The second stage achieves and remains in low Earth orbit (LEO) until its orbit decays (in approximately sixty days). Its orbital decay time falls below the limit NASA has set for orbital debris consideration. The second stage is designed to burn up upon reentry; however, in the event that it does not completely incinerate, its footprint would be approximately 10$m^2$ total footprint. [JPL 2000-C]

The Genesis spacecraft/third stage would be "parked" in LEO for less than one hour before the third stage engine fires, putting the spacecraft on its initial trajectory. While the greatest probability is that the third stage would leave the solar system after burn out and spacecraft separation, there is a slight probability that the third stage could reenter Earth's atmosphere. Various credible reentry scenarios are presently being analyzed to determine the probability of the third stage surviving reentry. The Genesis Project will follow the NASA guidelines regarding orbital debris and limiting the risk of human casualty for uncontrolled reentry into the Earth's atmosphere. [NASA 1997-B, NASA 1995-A]

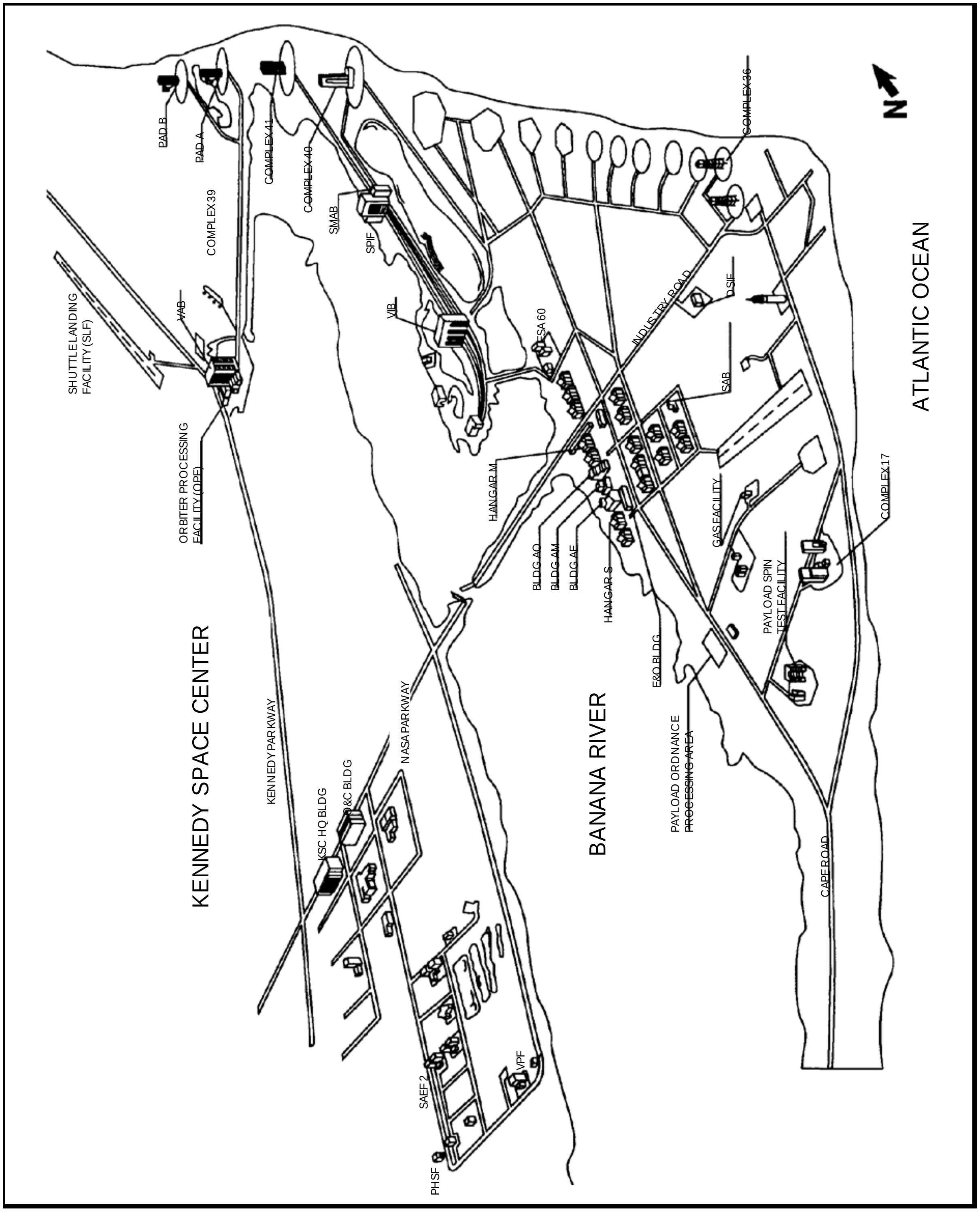
### 2.1.6 CAPE CANAVERAL AIR FORCE STATION OPERATIONS

Delta launches have occurred from CCAFS Launch Complex 17 since May of 1960, with a reliability of greater than 94 percent. During this long period of federally sponsored activities, launch preparation procedures have been well documented, standardized, and continuously reviewed. Genesis launch personnel would be trained to follow established procedures.

Safe hardware and support equipment would be used to ensure safety for both personnel and equipment during all phases of fabrication, test, and operation. The Genesis Project would prepare a Project Safety Plan (PSP) and a Missile System Pre-Launch Safety Package (MSPSP) in accordance with JPL, KSC, and Air Force Eastern and Western Range Safety Requirements (EWR 127-1). A Safety Review Panel (SRP) high-performance work team, as specified by EWR 127-1, would be convened and meet as required to review and guide the resolution of safety issues.

#### 2.1.6.1 Launch Vehicle Processing [USAF 1988, USAF 1994, MDA 1993]

The Delta II first and second stages would be initially received, inspected, and stored at Hangar M (Figure 2-6). They would then be moved to the Delta Mission Check-Out (DMCO) Building for hardware integration and systems testing. The first stage would then be transferred to the Horizontal Processing Facility (HPF) for installation of the destruct ordnance package, and prepared for erection at the launch site. The second stage would depart the DMCO Building for the Area 55 Second Stage Check-Out Building for verification




Source: [USAF 1990]

Figure 2-6. Launch Vehicle and Spacecraft Processing Areas, KSC/CCAFS of hydraulic and propulsion systems and destruct ordnance package installation. Both the first and second stages would then be transported to the launch pad for integration and testing. The GEM solid rocket motors would receive all prelaunch processing in Solid Motor Buildup Area 57 before being transported to the LC-17 launch pad and attached to the first stage. [MDA 1993]

### 2.1.6.2 Spacecraft Processing

#### 2.1.6.2.1 Planetary Protection Requirements [NASA 1999-B, NASA 1999-D]

The objective of planetary protection is to minimize the uncontrolled exchange of organic or biological material between Earth and solar system bodies on which abiotic chemical evolution could have taken place or life could exist. NASA follows established policy for the protection of planetary environments from contamination by spacecraft, and has obtained international acceptance of this policy through the Committee on Space Research (COSPAR) of the International Council of Scientific Unions. NASA implements this policy by establishing planetary protection requirements for each applicable mission.

For the proposed Genesis mission of a solar wind sample return, the planetary protection policy applies to evolved chemical material returned to Earth. The outbound mission phase covers the mission up to and through the 23-month collection period at the L1 point, during which time samples would be obtained. For this part of the mission the spacecraft has been classified as a Planetary Protection Category I mission, for which “no protection is warranted and no requirements are imposed.” [NASA 1999-D] Therefore, there are no specific requirements for clean room assembly other than those required by the necessity to control contamination of the collector materials prior to launch.

The inbound mission phase covers the mission subsequent to sample acquisition and continues through entry, descent, and aerial capture at Earth. There is little possibility of biological contamination during sample collection, and thus an insignificant chance of returning any living organism to Earth (referred to as back-contamination). Therefore, the Genesis project has requested and received certification from NASA’s Planetary Protection Officer as a Planetary Protection Category V mission, “Unrestricted Earth Return,” for this mission phase. No further planetary protection requirements would be levied on this mission. [NASA 1999-B, NASA 1999-D]

#### 2.1.6.2.2 Spacecraft Component Assembly and Test Operations

The Genesis main spacecraft bus with SRC installed, would be transported via C-17 aircraft from Lockheed Martin, Denver to KSC incased in a reusable shipping container. The main spacecraft battery would be transferred separately. The spacecraft would arrive at KSC in March 2001. At KSC's Payload Hazardous Servicing Facility (PHSF) (Figure 2-6), testing would be performed to verify spacecraft health prior to loading hydrazine into the propellant tanks. Following a spin-balance test, the spacecraft would then be mated to the upper stage. This work is performed at KSC because the requisite facilities to perform these tasks are not available at CCAFS. The following major component assembly activities would occur in the PHSF:

- Electronic ground support equipment check-out
- System test complex check-out
- Spacecraft baseline test to ensure that power, telemetry, science systems, etc., were not damaged in shipping
- Spacecraft spin balance
- Spacecraft propellant loading
- Spacecraft mating with the third stage

In late-May 2001, the spacecraft and upper stage would be transferred to CCAFS LC-17 via the Boeing Payload Transport Trailer, mated to the Delta launch vehicle, and final integrated tests with the launch vehicle would be conducted in preparation for the June 2001 launch.

#### 2.1.6.2.3 Pad Activities

The spacecraft, joined to the upper stage, would arrive at the base of the pad, be hoisted to the top of the launch tower payload level, and mated to the launch vehicle. Once mated to the launch vehicle, interface verifications with the launch vehicle, launch rehearsals, and power on/off stray voltage checks would be performed to verify spacecraft compatibility with the launch vehicle.

Integrated operations at the pad would also include:

- The upper stage/spacecraft structure would be electrically mated to the Delta II 7326 launch vehicle.
- Final spacecraft functional tests would be performed.

## 2.2 ALTERNATIVES TO THE PROPOSED ACTION

Alternatives to the proposed action that were considered included those that: (1) utilize an alternate launch vehicle/upper stage combination, (2) utilize an alternate launch site, (3) utilize an alternate recovery site, and (4) cancel the Genesis mission (the No-Action alternative).

### 2.2.1 ALTERNATE LAUNCH SYSTEMS

#### 2.2.1.1 Selection Criteria

Selecting a launch vehicle/upper stage combination (launch system) for a planetary mission largely depends on matching the payload mass and the energy required to achieve the desired trajectory to the capabilities of the prospective launch system. There is a direct correspondence between the mass of the payload, the required injection energy, and the size of the launch system, e.g., the more massive the payload and the greater the amount of energy required to achieve the trajectory, the more powerful the launch system is required to be. Normally, the most desirable launch system would meet, but would not greatly exceed, the mission's minimum launch performance requirements.

For the Genesis mission, constraints on launch system performance are the Genesis launch mass of approximately 636 kg (1400 lb) and an injection energy ($C_3$) of -0.6 $km^2/s^2$ (-10 $mi^2/s^2$). [JPL 1999-C] Other considerations that must be addressed in the selection of the launch system include reliability, cost, and potential environmental impacts associated with use of the launch system.

Feasible alternative Genesis launch systems include the Space Transportation System (STS) and various Taurus, Atlas, Delta, and Titan configurations.

#### 2.2.1.2 U.S. Launch Systems

##### 2.2.1.2.1 Space Transportation System (STS)

The STS greatly exceeds the Genesis mission requirements and would not be considered a reasonable alternative launch system.

##### 2.2.1.2.2 U.S. Expendable Launch Systems

Potential alternative U.S. expendable launch systems include the Taurus, Titan IIG/Star 48, Titan IIS/Star 48, Delta II 7425/Star 48B, Delta II 7920, Delta II 7925/Star 48B, and the Atlas IIA/Centaur.

- The payload fairings available for the Taurus are not large enough to accommodate the Genesis spacecraft.

- The Titan IIG/Star 48 does not meet the minimum mass performance criteria, and is not considered as a reasonable alternative. [AIAA 1995, MDA 1996]

- The differences between the Delta II 7425 and 7326 are the third stage and one extra GEM SRM. The Delta II 7425 has a Star 48B third stage, which contains more propellant than the Delta II 7326's Star 37FM third stage.

- The Delta II 7920 series of vehicles (7920 and 7925) would meet the minimum Genesis mission requirements. Each has nine GEMs; the 7925 has a Star 48B third stage, whereas the 7920 has no third stage. The 7326 has three GEMs and a Star 37FM third stage, which has less fuel than the Star 48B. The GEM SRMs are considered to exhaust the more potentially environmentally impacting effluents. Thus the Delta II 7920 series vehicles would contribute more potential environmental impacts than the Delta II 7326, and they are more costly; they are therefore not considered a reasonable alternative.

- The Atlas IIA launch vehicle has a booster section consisting of two liquid oxygen/kerosene booster engines, which feed the sustainer section propellant tanks. The sustainer section fuel tank contains approximately 48,988 kg (108,000 lb) of kerosene (RP-1) as compared to the 30,229 kg (66,504 lb) [USAF 1994] contained by the Delta II first stage. [AIAA 1995] The launch vehicle exhaust effluents are distributed along the trajectory for both launch vehicles. Due to it's larger mass, the Atlas II launch vehicle accelerates off the launch pad more slowly than the Delta II 7326, and thus, more of its exhaust products are ejected into the lower atmosphere. The Atlas IIA would contribute less potential environmental impacts than the Delta II 7326 because it does not have the solid rocket boosters, but it exceeds the launch capability of the Delta II 7326 by greater than 1000 kg, and would cost significantly more than the Delta II 7326.

#### 2.2.1.3 Summary

Of the launch systems examined, the Delta II 7326 is the best-suited for the Genesis mission, for the reasons listed below:

- The mass performance of the Delta II 7326 most closely matches, without exceeding, the Genesis performance requirement. [JPL 1993]

- The Delta II 7326 is the lower cost alternative launch system of those systems meeting the performance criteria. [JPL 1993, AIAA 1995]

- Of the reasonable alternative launch systems examined, all except the Atlas IIA were approximately equal in their potential environmental impacts. [DOT 1986]

### 2.2.2 ALTERNATE LAUNCH SITES

CCAFS and Vandenburg Air Force Base (VAFB) have the only currently approved facilities to launch Delta II launch vehicles. Since the Delta II 7326 is the preferred launch vehicle for the Genesis mission, alternative launch sites to CCAFS and VAFB would not be available.

The direction of launch, commonly referred to as flight azimuth, depends on range safety considerations that prohibit flying over certain land and ocean areas. Flights from VAFB must launch west and south to avoid overflying the heavily populated West Coast. This means that the launch vehicle is moving in the direction opposite to Earth's rotation. Launches from CCAFS are toward the east and in the direction of Earth's rotation, and thus do not require the extra fuel to achieve the same orbit as those originating from VAFB. Therefore, a larger launch vehicle would be required to launch Genesis onto the same trajectory from VAFB.

### 2.2.3 ALTERNATE RECOVERY SITES

Selecting a recovery operations site for a sample return mission largely depends on matching the safety and mission critical criteria to the facilities and capabilities of the prospective recovery site. Issues of concern include minimal risk to public safety and to the returned samples. Because a water recovery would most probably compromise the mission science objectives by increasing the risk of contamination of the collected samples, a recovery site on land is mandated. Moreover, in the event that an off-nominal case arises such that the helicopters are unable to fly due to weather, etc., the recovery site must be relatively free of vegetation to aid in finding the SRC after it touches down. Sites that can effectively be closed to the public minimize any chance of the reentering SRC harming individuals or their possessions within the controlled site boundary. The selection criteria for prospective recovery sites is listed below:

#### 2.2.3.1 Recovery Site Selection Criteria

Potential recovery sites investigated included Yuma Marine Corps Air Station (AZ), Luke Air Force Base (AZ), Edwards Air Force Base (CA), Chocolate Mountain Gunnery Range (CA), Twenty-Nine Palms Marine Corps Base (CA), Camp Pendleton Marine Corps

Base (CA), Fort Bliss Military Reserve (NM), White Sands Missile Range (NM), Tonopah Test Range (NV), Nellis Air Force Range (NV), China Lake/Fort Irwin (CA), Poker Flats (AK), and UTTR (Utah). These sites were evaluated against the following criteria:

- Safety
  - ⇒ site must accommodate 84 km (52 mi) downrange x 30 km (19 mi) cross range recovery footprint, (the major axis of footprint from NW to SE) (Figure 2-8.)
  - ⇒ site must have reserved air space to provide separation from commercial air traffic

- Science Return
  - ⇒ site must have a flat recovery area, free from hills or terrain features that impose side loads on the sample return capsule, should it touchdown on land
  - ⇒ site must be relatively free of vegetation for siting and off-nominal recovery operations
  - ⇒ the locale must allow prompt delivery of the samples to the JSC curatorial facility
  - ⇒ the samples must experience minimum exposure to a high-G environment
  - ⇒ the samples must experience minimum exposure to high temperature or high humidity
  - ⇒ the samples must be recovered via mid-air capture to avoid damage to the collectors and concentrator

- Land Recovery versus Water Recovery
  - ⇒ salt water is highly corrosive
  - ⇒ should the helicopters fail to capture the SRC it is at risk of sinking in a water landing
  - ⇒ there exists a risk of the SRC being carried by ocean currents if not promptly recovered

- Range Recovery Assets
  - ⇒ descent tracking capability
  - ⇒ ground recovery operations capability

- Cost
  - ⇒ Genesis is a low cost / cost-capped Discovery mission

- United States Range versus a Foreign Recovery Site
  - ⇒ time and uncertainty associated with obtaining the necessary agreements with foreign governments
  - ⇒ cost associated with forging complex agreements
  - ⇒ time to transport samples to the JSC curatorial facility, ensuring integrity, safety, and security of samples

### 2.2.3.2 Summary

The Genesis 84 km x 30 km (52 mi x 19 mi) three-sigma recovery footprint requires a large, flat, relatively unpopulated, and restricted area to ensure safety of personnel, the public, structures, and the mission science to be returned. Of the recovery sites examined, UTTR has been determined to be the best-suited potential recovery site for the Genesis mission, for the reasons listed below:

- Water recovery sites have been rejected due to unacceptable risk to the returned science, higher risk of capsule loss, and higher cost of recovery.

- U.S. recovery sites were chosen in order to ensure the integrity, safety, and security of the samples.

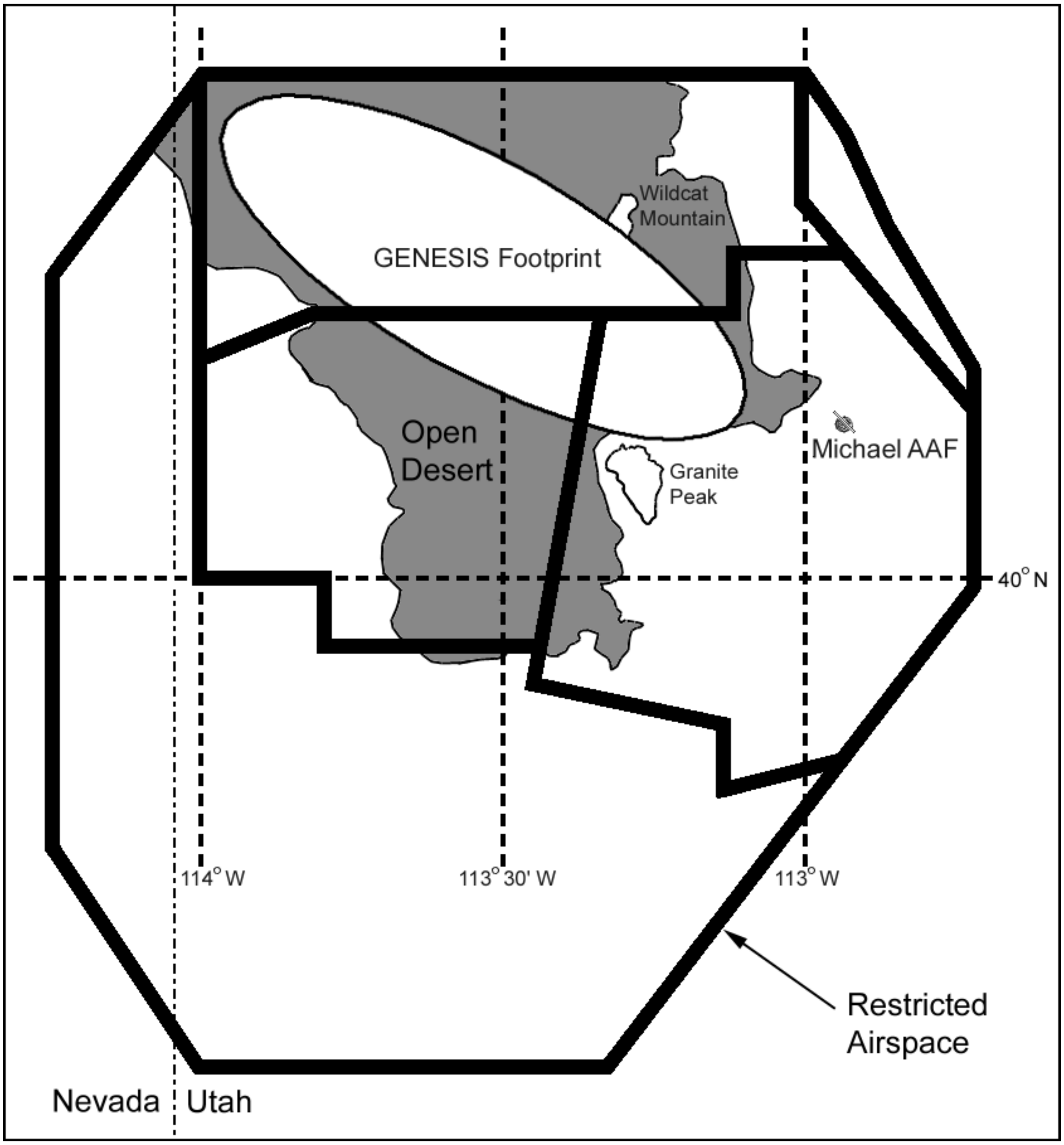
- Of the possible U. S. recovery sites considered, only Nellis Air Force Range, China Lake/Fort Irwin, Poker Flats, and UTTR meet the required footprint area. Both Nellis Air Force Range and China Lake/Fort Irwin have large areas of mountainous terrain that represent an unacceptable risk to a successful science return. Poker Flats has a very wooded terrain that would make the SRC difficult to detect should it land on the ground or in the trees.

- UTTR has the largest overland special use airspace (measured from the surface or near surface, 43,126 square (sq) km [16,651 sq mi]), as well as the largest overland contiguous block of supersonic authorized, restricted airspace in the contiguous United States (See Figure 2-7). [USAF 1997-D]

UTTR has been identified as the proposed Genesis project recovery operations site because it uniquely satisfies all of the preceding selection criteria.

### 2.2.4 NO-ACTION ALTERNATIVE

The No-Action alternative would result in termination of the Genesis mission, which would disrupt the progress of NASA’s Inner Solar System Exploration Program. While environmental impacts would be avoided by cancellation of the proposed mission, the loss of the scientific knowledge and database from carrying out the mission could be significant.




Source [JPL 1999-E]

Figure 2-7. Footprint Overlaid on Utah Test and Training Range

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# SECTION 3
# GENERAL ENVIRONMENTAL CHARACTERISTICS OF CAPE CANAVERAL AIR FORCE STATION, UTAH TEST AND TRAINING RANGE, AND SURROUNDING AREAS

## 3.1 CAPE CANAVERAL AIR FORCE STATION

Cape Canaveral Air Force Station (CCAFS) accommodates various ongoing space programs and is managed for the United States Air Force (USAF) by Patrick Air Force Base (PAFB). The cumulative environmental effects associated with these programs have been included in the baseline environmental conditions, which are detailed in the following sections. The information provided in this section is summarized from the reference documents cited in the text. Refer to those references for more complete information and maps of environmental resources, as well as for discussion of required permits and facilities issues.

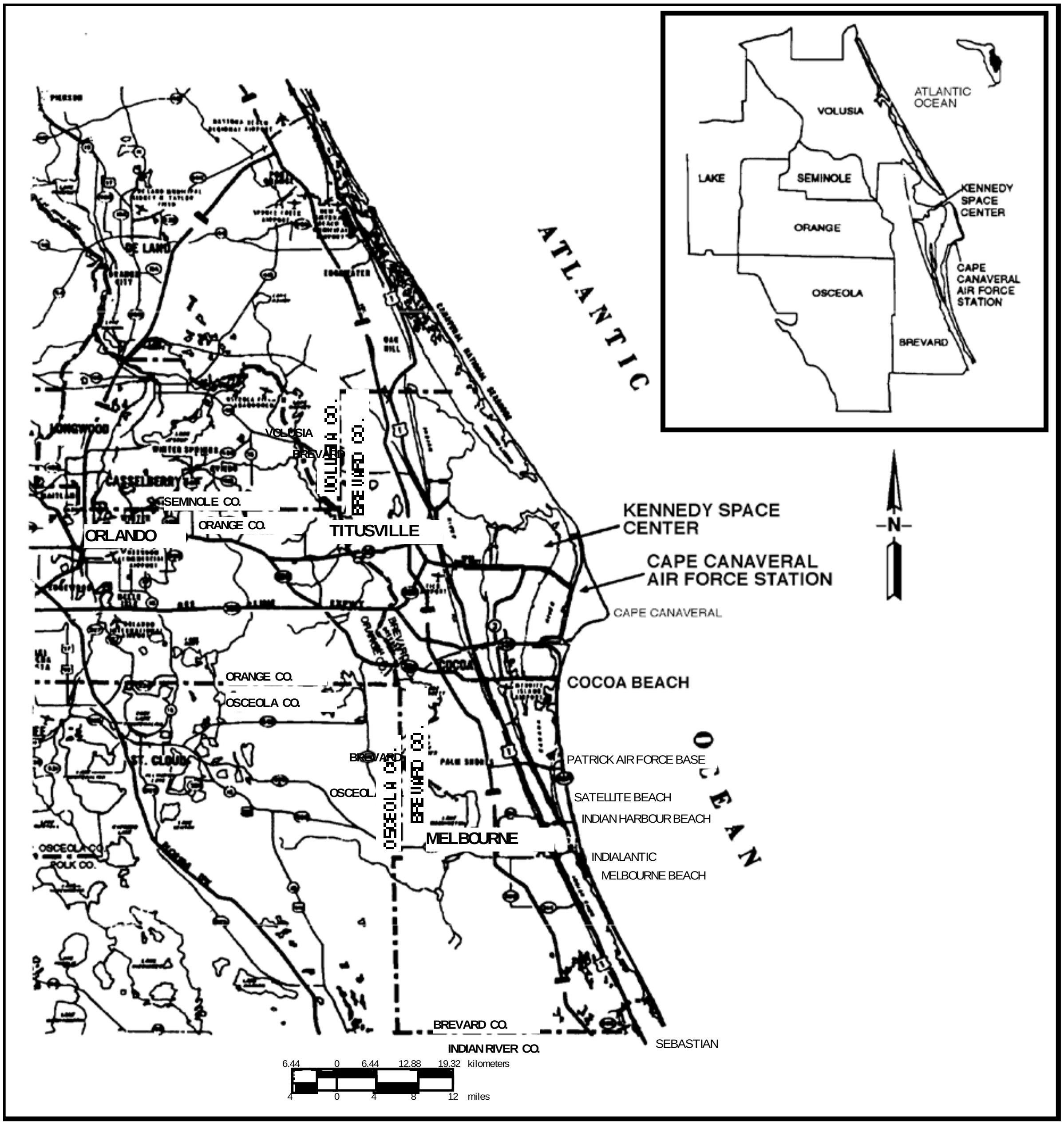
### 3.1.1 REGIONAL AND LOCAL ENVIRONMENT AROUND CCAFS

For the purposes of this document, the region of interest (Figure 3-1) consists of the six county area of Volusia, Seminole, Lake, Orange, Osceola, and Brevard counties.

CCAFS is located in Brevard County on the east coast of Florida, near the city of Cocoa Beach and 75 kilometers (km) [45 miles (mi)] east of Orlando. The station occupies nearly 65 square (sq) km (25 sq mi) of the barrier island that contains Cape Canaveral, and is adjacent to the NASA Kennedy Space Center (KSC), Merritt Island, Florida. CCAFS is bounded by KSC on the north, the Atlantic Ocean on the east, the city of Cape Canaveral on the south, and the Banana River and KSC/Merritt Island National Wildlife Refuge on the west (Figure 3-2).

#### 3.1.1.1 Population and Employment [USAF 1996-C, NASA 1999-E]

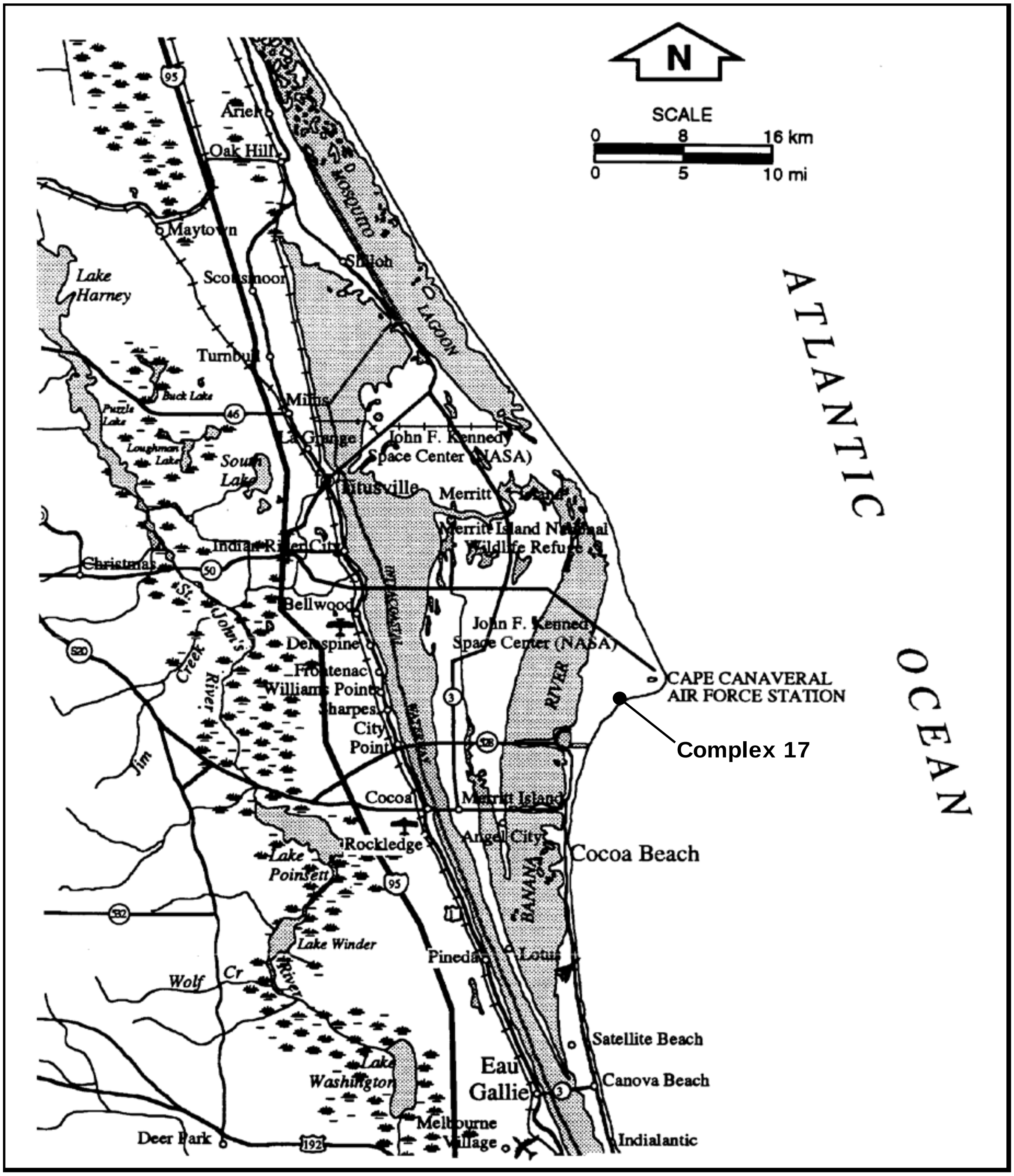
Prior to 1950 the population of Brevard County was predominantly rural. Activation of the CCAFS in the 1950s brought military personnel into the county. For the last forty years, the population and economy of Brevard County has been closely linked to the growth of the space program. There was a constant influx of aerospace contractors and military personnel from the early 1950s through the mid-1960s, such that the population grew from 23,500 to 111,500. Employment levels dropped in the late-1960s, reflecting major cutbacks in NASA operations. The local aerospace economy recovered after 1979 due to a renewed national emphasis on launch activities.




Source: [NASA 1986]

Figure 3-1. Regional Area of Interest

Within 100 km (62 mi) area around the CCAFS launch site, the 1990 population was approximately 1.8 million. About 49,000 people resided within 20 km (12 mi) of the launch site, and about 2,800 lived within a distance of 10 km (6 mi). The population within 100 km (62 mi) of the launch site is expected to grow to over 2 million by 2001, and to almost 2.2 million by 2005. Similarly, the population within 20 km (12 mi) is expected to grow to 55,000 by 2001, and to over 57,000 by 2005. By 2001 the population within 10 km (6 mi) is expected to grow to over 3,000 and to over 3,300 by 2005. [NASA 1999-E]




Source: [NASA 1986]

Figure 3-2. Location of CCAFS Relative to the Region of Interest

In 1990, minority representation within 100 km (62 mi) of the launch site was approximately 19 percent of the total population and is expected to grow to 23 percent by 2001, and to about 24 percent in 2005. Black residents constituted over half the minority population in 1990 with Hispanic residents constituting about one-third. As the general population grows through 2001 to 2005, Black and Hispanic residents are expected to dominate the minority populations, with the Hispanic segment growing to almost 50 percent of the minority population and Black representation declining to about 40 percent. Within a distance of 20 km (12 mi) of the launch site, minorities accounted for approximately nine percent of the 1990 population with Black residents accounting for almost half the minority population and Hispanics accounting for about forty percent. Minority population is expected to increase to about eleven percent of the population with 20 km (12 mi) by 2001, increasing slightly to twelve percent in 2005. Blacks and Hispanics in almost equal proportions are expected to constitute over eighty percent of the minority population. [NASA 1999-E]

Within 10 km (6 mi) of the launch site, minority groups constituted about eleven percent of the total population, and are expected to increase to about thirteen percent in 2001 and to 14 percent in 2005. Within 10 km (6 mi) Black and Hispanic residents accounted for about eighty-two percent of the minority populations in 1990, and this trend is expected to remain the same to 2005. [NASA 1999-E]

In 1990 about ten percent of the population within 100 km (62 mi) of CCAFS were below the 1990 income poverty threshold. Within 20 km (12 mi) about eight percent of the residents were below the threshold, and about eleven percent within a 10 km (6 mi) area were below the threshold. [NASA 1999-E]

Economic sectors providing significant employment in Brevard County include: services, with 58,800 employees (34.6 percent of total non-agricultural employment); retail trade, with 34,400 (20.3 percent); government, with 25,300 (14.9 percent); manufacturing, with 28,400 (16.7 percent); construction, with 8,200 (4.8 percent); wholesale trade, with 4,200 (2.5 percent); finance, insurance, real estate with 5,700 (3.4 percent); and transportation, communications, and public utilities, with 4,800 (2.8 percent). Brevard and neighboring counties exhibited little cross-commuting. Only five percent of Brevard residents traveled outside the county to work, and less than one percent of residents from Orange, Seminole or Osceola and 1.6 percent of Volusia residents worked in Brevard County in 1990. [ECFRPC 1995]

CCAFS has a work force of approximately 7,500 people, most of whom are employed by companies involved in launch vehicle testing and space launch operation. About 95 percent of the installation's military and civilian contractor personnel live in Brevard County, with the remainder residing in the surrounding counties. Major urban centers includes Titusville (20 km [12 mi] northwest, population 41,376), Cocoa (12 km [7 mi] southwest, population 17,744), Melbourne (48 km [30 mi, population 68,056)], Palm Bay (72 km [45 mi], population 78,054), and Cape Canaveral (0.8 km [0.5 mi] south, population

8,492). The nearest significant residential areas are Cocoa Beach (13 km [8 mi] south, population 12,818), and Merritt Island (population 37,521). [USAF 1996-C, EDC 1999, BC 1999] All military personnel serving at the station are assigned to Patrick Air Force Base, about 25 km (15 mi) to the south of CCAFS. [USAF 1990, USAF 1996-C]

At the beginning of 1991, 984,434 people were employed in the region (863,800 non-agricultural and 120,634 agricultural). A total of 593,796 people were employed in Orange, Seminole, and Osceola Counties, 193,321 in Brevard, 153,720 in Volusia, and 56,427 in Lake. The total labor force in Brevard County in 1993 had risen to 205,532. The unemployment rate for the region in 1993 was 7.4 percent. The 1997 annual average unemployment rate for Brevard County was 4.5 percent, as compared to 4.8 percent for the state of Florida, and 4.9 percent for the national average. [EDC 1999] The 1990 annual household income across the six-county region ranged from $7,237 to $76,232, with both ends of the range occurring in Orange County. Within 32 km (20 mi) of the launch complexes, the income ranged from $10,940 to $55,606 with most of the census tracts within this area recording median incomes in excess of $25,000. At the nearest uncontrolled population area (16 km [10 mi]) from the launch complexes, the median income was $34,000. [NASA 1995-B] The estimated average household income of Brevard Country residents in 1993 was $39,989. The 1993 estimated per capita income in Brevard County was $16,609. [USAF 1996-C]

### 3.1.1.2 Land Use

Only about 8 percent, or 1,327.42 sq km (510 sq mi), of the total region (17,000 sq km; 6,534.8 sq mi) is urbanized [ECFRPC 1992], with the largest concentrations of people occurring in three metropolitan areas:

- Orlando, in Orange County, expanding into the Lake Mary and Sanford areas of Seminole County to the north, and into the Kissimmee and St. Cloud areas of Osceola County to the south,

- the coastal area of Volusia County, including Daytona Beach, Port Orange, Ormond Beach, and New Smyrna Beach, and,

- along the Indian River Lagoon and coastal areas of Brevard County, specifically the cities of Titusville, Melbourne, and Palm Bay.

Approximately 85 percent of the region's population lives in urban areas.

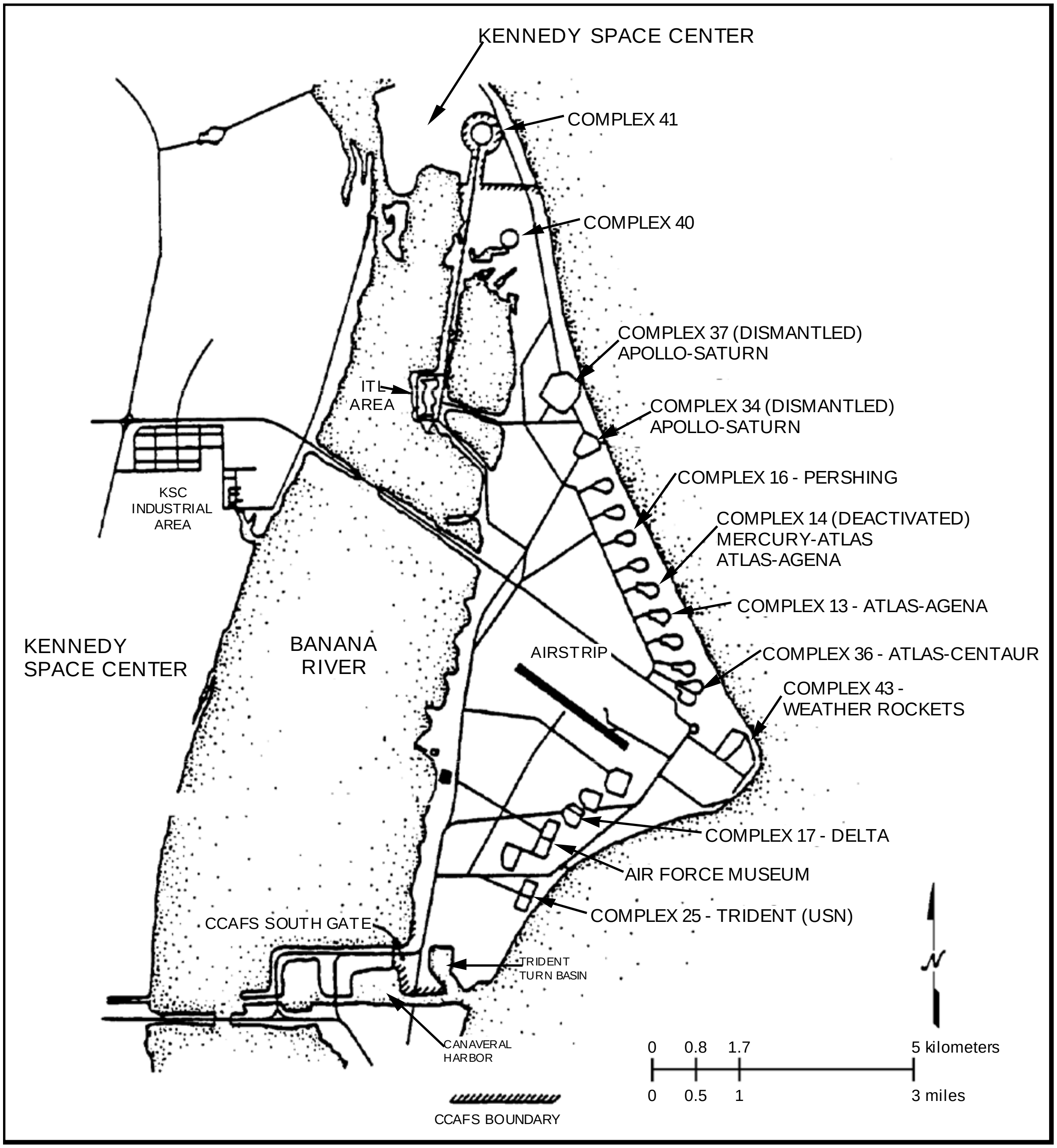
The majority of the region is considered rural, which includes agricultural lands and their associated trade and service areas, conservation and recreation lands, and undeveloped areas. About 35 percent of the regional area is devoted to agriculture, including more than 5,000 farms, nurseries, and ranches. Agricultural areas include citrus groves, winter vegetable farms, pasture land and livestock, foliage nurseries, sod farms, and dairy land.

In Brevard County, approximately 68 percent of the developed land use is agricultural, 12 percent is residential, 2 percent is commercial, 1 percent industrial, and 1 percent institutional. The remaining 16 percent is comprised of various other uses. The developed land areas are clustered in three areas in a north-south pattern along the coast and the banks of the Indian and Banana Rivers. [USAF 1990]

Land use at CCAFS is governed by the requirements to support hazardous large-scale missile test and launch activities. As of 1993, 9,068 acres were used for missile and launch support, 4,830 acres were used for restricted development, 184 acres were used for port operations, 529 acres were in use for the industrial area, and 1,193 acres were used for airfield operations. [USAF 1993-B] Approximately 30 percent of the CCAFS (about 18.8 sq km; 7.3 sq mi) is developed, and consists of launch complexes and support facilities (Figure 3-3). The remaining 70 percent is comprised of unimproved land. CCAFS also contains a small industrial area, the Air Force Space Museum, a turning basin for the docking of submarines, and an airstrip that was initially constructed for research and development in recovery operations for missile launches. Many of the hangars located on the station are used for missile assembly and testing. Future land use patterns are expected to remain similar to current conditions.

KSC occupies almost 560 sq km (216 sq mi), about 5 percent of which is developed land. Nearly 40 percent of the KSC consists of open water areas, such as portions of the Indian and Banana Rivers, Mosquito Lagoon, and all of Banana Creek. [USAF 1990, USAF 1996-C]

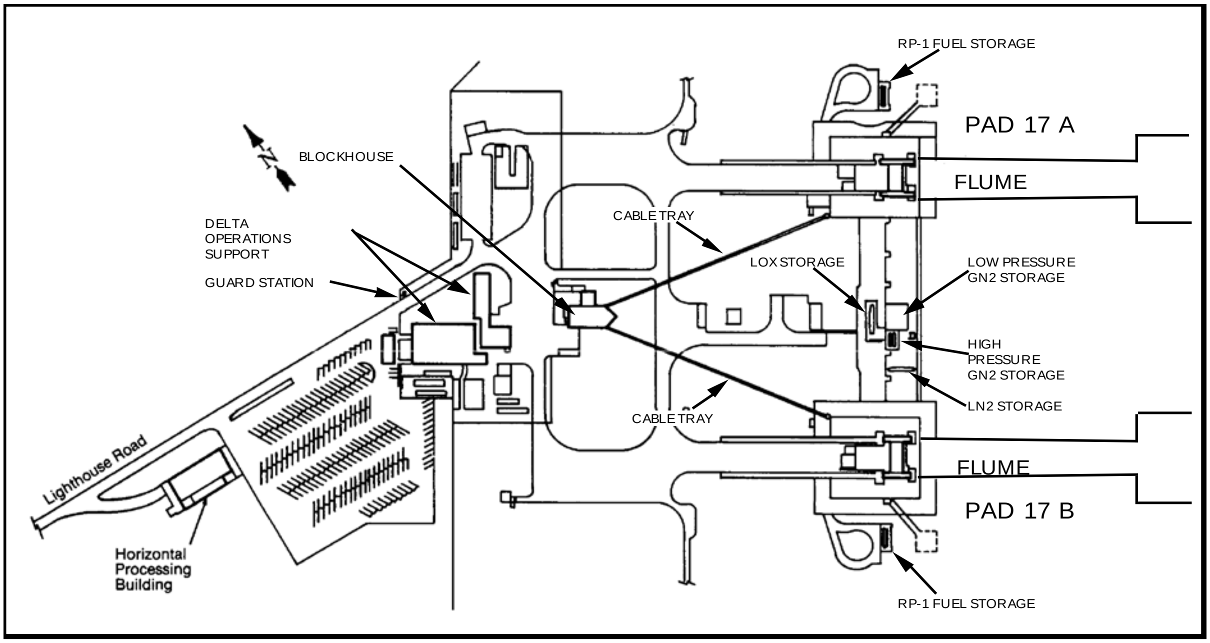
Launch Complex-17 (LC-17) (Figure 3-4) is located in the southern portion of CCAFS, approximately 0.8 km (0.5 mi) west of the Atlantic Ocean, 2.5 km (1.5 mi) east of the Banana River, and roughly 5.7 km (3.4 mi) from the station’s South Gate. The complex consists of two launch pads, 17A and 17B, each with its own Mobile Service Tower, Fixed Umbilical Tower, cable runs, and Fuel Storage Area. [USAF 1990]




Source: [NASA 1997-A]

Figure 3-3. Land Use at CCAFS

A concrete exhaust flume on each pad deflects exhaust gases away from the pad to reduce the noise and shock wave that result from ignition of solid rockets and the first stage of the launch vehicle. The noise levels of a Delta II 7326 launch do not require a water deluge system acoustic mitigation measure. [NASA 1998]




Source: [USAF 1988, USAF 1994]

Figure 3-4. Launch Complex 17

The two launch pads share common gas storage facilities, located in bunkers between the pads, and are monitored from a common blockhouse, located at a distance from the launch pads. Other miscellaneous support and service facilities are shared between them, as well. LC-17 was renovated in the late 1980s to support an upgraded version of the Delta launch vehicle.

3.1.1.2.1 Recreation

Port Canaveral has a long-established policy of providing recreational areas for the use of local residents and visitors. Three parks, plus a fourth in the planning stage, are located within the Port proper. In addition to its parks, Port Canaveral provides other recreational facilities as well. A mile and a half of bike paths run throughout the Port, from its eastern boundary at Jetty Park to Freddie Patrick Park. Jetty Park has areas for fishing, swimming, surfing, sailing snorkeling, diving and sail boarding. All boat-launching ramps located within the port are free and open to the public. It also provides a view of space launches from CCAFS.

The Disney Cruise liner docks at Port Canaveral, where passengers board and disembark from Caribbean cruises.

Launch Hazard Areas are areas restricted during launch operations to ensure public safety. All of the information is available through postings at most maritime establishments at Port Canaveral and the U.S. Coast Guard broadcasts this launch hazard information on Marine Band Channel 16. A launch would be aborted if any sea craft remain in restricted areas.

3.1.1.2.2 Infrastructure, Housing, and Emergency Services [USAF 1994, USAF 1996-C]

The city of Cocoa provides potable water, drawn from the Floridan Aquifer, to the central portion of Brevard County. The maximum capacity is 167 million liters (l) (44 million gallons [gal]) per day, and average daily consumption is about 99 million l (26 million gal) per day. CCAFS receives it water supply from the city of Cocoa and uses an average of 2.4 million l (0.64 million gal). [USAF 1996-C]

The cities of Cocoa, Cape Canaveral, Cocoa Beach, and Rockledge are each served by their own municipal sewer systems. Unincorporated areas are accommodated by several treatment plants, some of which have reached capacity.

Florida Power and Light (FPL) supplies electricity to Brevard County. CCAFS is serviced by FPL through a 240/138--kilovolt switching station. Police departments in the five municipalities of the central Brevard area have an average of one officer per 424 people, and fire protection has one full-time officer per 461 people. Health care within the area is available at 28 general hospitals, three psychiatric hospitals, and two specialized hospitals.

There were 185,150 housing units in Brevard County as of 1990. Vacancy rates over Brevard County averaged 12.2 percent, with a vacancy rate of 29.2 percent in the Cape Canaveral area. The average household in Brevard County in 1991 included 2.42 persons. There are no permanent residents at CCAFS. The nearest significant residential areas to CCAFS are Cape Canaveral, Cocoa Beach, and Merritt Island. [USAF 1996-C]

Public schools in Brevard County are part of a county-wide, single district school system with seventy-three schools and over 60,421 students in the 1992-1993 academic year. The school system has been growing since 1982, and capacity has been exceeded in some parts of central Brevard County. Growth in the district is expected to average four percent through 1996, the last year of school board projections. [USAF 1994]

Transportation in the region is served by highway, rail, airport, and harbor facilities. Federal, state and local roads provide highway service for Brevard County. Principle routes are Interstate 95, US Highway 1, and State Routes A1A, 407, 520, and 528. Bridges and causeways link the urban areas on the beaches to Merritt Island and the mainland. The Florida East Coast Railway affords rail service to the county, with a main line through the cities of Titusville, Cocoa, and Melbourne. Spur rail lines serve other parts of the county, including CCAFS. Several commercial and general aviation airports are located in the vicinity of CCAFS, the closest being Melbourne Regional Airport, approximately 30 miles south of the base. Port Canaveral, located at the southern boundary of CCAFS, is the area seaport. Industrial and commercial facilities are located at the port, and cruise ship use is increasing. [ECFRPC 1995, USAF 1996-C]

The CCAFS road system, which is linked to the regional highway system by the NASA Causeway to the west, State Route 402 to the north, the CCAFS south gate and State Highway A1A to the south, serves launch complexes, support facilities, and industrial areas. An airstrip near the center of the base is used by government aircraft and for delivery of launch vehicles and spacecraft. CCAFS is closed to the public. [USAF 1994, USAF 1996-C]

### 3.1.1.3 Regional Economic Base [NASA 1990, USAF 1996-C]

The region's economic base is tourism and manufacturing. Tourism-related employment includes most jobs in amusement parks, hotels, motels, and campgrounds, as well as many occupations in the retail trade and various types of services. Manufacturing jobs, while probably outnumbered by tourism jobs, may provide more monetary benefits to the region because of higher average wages and a larger multiplier effect.

The region's agricultural activities include citrus groves, winter vegetable farms, pastures, foliage nurseries, sod, livestock, and dairy production. In the central region, 30 percent of the land is forested and supports silviculture, including harvesting of yellow pine, cypress, sweetgum, maple, and bay trees. In Osceola County, large cattle ranches occupy almost all of the rural land. Agricultural employment declined in 1986 to just 2.2 percent of the region's employment base.

Commercial fisheries in the two counties bordering the ocean (Brevard and Volusia) landed a total of approximately 9,727 metric tons (about 21.4 million pounds) of finfish, shrimp and other invertebrates in 1988. Brevard and Volusia Counties ranked third and fourth, respectively, among the East Coast counties of Florida in total 1988 finfish landings.

### 3.1.1.4 Pollution Prevention [JG-PP 2000, USAF 2000, PPPG 1996]

The federal Pollution Prevention Act (PPA) of 1990 established pollution prevention as a national objective. As a responsible environmental steward, NASA will promote the Agency strategy of Environmental Excellence for the 21$^{st-}$ Century strategy, consistent with the requirements of Executive Order (E.O.) 12856, "Federal Compliance with Right-To-Know Laws and Pollution Prevention Requirements." It is NASA policy to prevent or reduce pollution at the source whenever possible.

The Joint Group on Pollution Prevention (JG-PP) is a partnership between various government organizations to assist in validating and implementing materials and processes that are less hazardous than those currently used in military and industrial facilities. The Joint Logistics Commanders (JLC), Military Services, Defense Logistics Agency (DLA), and NASA co-chartered JG-PP. The JG-PP's executive guidance is to continue the reduction or elimination of hazardous materials (HazMats) by establishing partnerships to foster cooperation between industry, DoD and NASA, leverage limited resources, avoid duplication of effort, and reduce total cost of ownership. This effort is expected to result in environmental compliance through pollution prevention. The JG-PP process will be used to validate changes to contractor design, manufacturing, and depot sustainment maintenance processes that are cleaner, faster, less expensive, and use less-hazardous materials and processes.

The JG-PP's working group, the Joint Acquisition-Sustainment Pollution Prevention Activity (JASPPA), is responsible for accomplishing program direction and project execution.

JASPPA provides the engineering, technical, and business services required to identify and pursue pollution prevention projects through validation of alternatives. The JASPPA facilitates projects by establishing partnerships among industry contractors; affected Army, Navy, Marine Corps, and Air Force weapon system program managers and depot process owners; NASA center and enterprise managers; and the Defense Contract Management Agency (DCMA). These participants will identify and validate alternatives to HazMat usage through the Acquisition Pollution Prevention Initiative (AP2I). Once engineering authorities have validated an alternative(s), the industry contractor utilizes the Single Process Initiative (SPI) block change process to modify contracts for implementation across all affected systems and components.

Depot sustainment maintenance activities will utilize their respective service/agency change mechanism for implementation.

The JG-PP utilizes a structured program and validated methodology to actively identify and test alternatives to HazMats and migrate new technologies across industry, the Services, and NASA. Technical information on possible alternative materials or processes are documented in the Potential Alternatives Reports (PARs). The JASPPA will prepare a cost benefit analysis (CBA) to quantify the total cost of ownership for new alternatives versus current HazMat uses. The technical stakeholders' engineering performance requirements to qualify alternatives are documented in Joint Test Protocols (JTPs). To aggregate the results of the technical and business efforts, a Statement of Task (SoT) will document the stakeholders' selection of test locations and the contracted/lab test execution. The results of all tests are documented in Joint Test Reports (JTRs), as approved by the cognizant engineering authorities. The JTR will then serve as the cornerstone for contract and maintenance process changes.

The 1996 45th Space Wing (45 SW) Pollution Prevention Program Guide (PPPG) and Pollution Prevention Management Action Plan (PPMP) satisfy requirements of the Pollution Prevention Act of 1990. The PPPG also complies with requirements in DoD Directive 4210.15, AFI 32-7080, and the Air Force Installation PPPG. The PPPG establishes the overall strategy, delineates responsibilities, and sets forth specific objectives for reducing pollution of the ground, air, surface water, and groundwater. The purpose of the PPPG is to provide sufficient guidance for pollution prevention management on Patrick AFB and CCAFS. Specific goals include implementation of management practices that eliminate or reduce the use of hazardous materials, increase efficiency in the use of raw materials, protect natural resources, and encourage source reduction through recycling, treatment, and disposal practices. [USAF 2000]

### 3.1.1.5 Environmental Justice

Executive Order (EO) 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations," focuses Federal attention on the environmental and human health conditions in minority communities and low-income communities. The NASA Environmental Justice Strategy requires the identification and consideration of disproportionately high and adverse human health or environmental effects of NASA programs on minority populations and low-income populations. (See Section 3.1.1 for a discussion of the population distribution of the region of interest.)

### 3.1.1.6 CCAFS Facilities and Services

The city of Cocoa provides potable water from the Floridian aquifer to central Brevard County. CCAFS receives its water supply from the city of Cocoa, and uses roughly 11.4 million ℓ (3 million gal) per day. To support launch facility deluge systems, the distribution system at CCAFS was constructed to provide up to 114,000 ℓ (30,000 gal) per minute for up to ten minutes. [USAF 1996-C] The largest single user of water is the deluge water system at the launch complexes, which can consume 400,000 gallons in a single launch attempt. [USAF 1993-B]

CCAFS provides for its own sewage disposal with on-site package sewage treatment plants (STPs). The LC-17 STP has a capacity of 57,000 ℓ (15,000 gal) per day and is permitted by the Florida Department of Environmental Protection (FDEP). CCAFS carries out its own sewage disposal with a consolidated wastewater treatment plant on site. [USAF 1994]

Solid waste is managed according to the nature and quantity of the waste. The CCAFS landfill located near the skidstrip accepts construction debris, demolition debris, and asbestos-containing material. Waste is segregated within the landfill according to waste type. General nonhazardous solid refuse from daily activities as CCAFS is collected by private contractor and disposed off-station at the Brevard County Landfill, which is a Class 1 landfill occupying 0.8 sq km (192 acres) near the City of Cocoa. The landfill receives between 2,000 and 2,182 metric tons (mt) [2,200 and 2,400 tons] of solid waste per day; CCAFS generated 2,615 mt (2,876 tons) of disposed solid waste and 697 mt (767 tons) of recyclable solid waste in 1992. [USAF 1994] Other non-hazardous solid wastes are usually disposed of through the Defense Reutilization and Marketing Office (DRMO). [USAF 1996-C]

The Launch Base Support Contractor (LBSC) conducts all security services on CCAFS. A mutual agreement for fire protection services exists between the city of Cape Canaveral, KSC, and the LBSC at CCAFS. The station is equipped with a dispensary under contract to NASA. The dispensary normally works on a forty-hour week basis. If medical services cannot be provided by the dispensary, hospitals at PAFB and in Cocoa, Titusville, and Melbourne are used. [USAF 1986] Disaster control is performed in accordance with 45SW OPlan 32-1, Disaster Preparedness Operations Plan. [USAF 1994]

### 3.1.1.7 Health and Safety

#### 3.1.1.7.1 Hazardous Materials and Wastes [USAF 2000]

Numerous types of hazardous materials are used to support the various missions and general maintenance operations at CCAFS. These materials range from common building paints to industrial solvents and hazardous fuels. Hazardous materials used to support current Delta II launch vehicle activities are presented in Table 3-1.

Hazardous materials management is the responsibility of each individual or organization at CCAFS. Individual hazardous materials obtained through base supply at PAFB are assigned a code which allows limited tracking of the materials and provides knowledge of hazardous materials usage for industrial hygiene and environmental compliance purposes. Currently, PAFB is developing a pharmacy-style hazardous materials acquisition system in order to improve hazardous materials tracking and reduce amounts of certain hazardous materials.

**Table 3-1. Hazardous Materials Utilized Per Delta II Launch**

| Hazardous Material | Quantity | |
|---|---|---|
| | kg | lb |
| Petroleum, oil, and lubricants | 18 | 40 |
| Volatile Organic Compound (VOC)-based primers, topcoats, and coatings | 132 | 290 |
| Non-VOC-based primers, topcoats, and coatings | 104 | 230 |
| VOC-based solvents and cleaners | 123 | 270 |
| Non-VOC-based solvents and cleaners | 241 | 530 |
| Corrosives | 2,500 | 5,500 |
| Refrigerants | 0 | 0 |
| Adhesives, sealants, and epoxies | 154 | 340 |
| Extremely hazardous substances (not otherwise included) | 0 | 0 |
| Other | 5 | 10 |
| Total | 3,277 | 7,210 |

Source: [USAF 1998]

Individual contractors at CCAFS may also obtain hazardous materials through their own supply organizations. No program has been developed at CCAFS to track these, as it is the responsibility of each contractor to provide adequate tracking and management of hazardous materials. Contractors and programs operating at CCAFS must provide the Environmental Support organization at PAFB (45 CES/CEV) and Bioenvironmental Engineering (45 AMDS/SGPB) with copies of Material Safety Data Sheets (MSDS) for all hazardous materials proposed for use. Additionally, information on hazardous materials used by contractors or programs must be provided to 45 CES/CEV in accordance with Superfund Amendments and Reauthorization Act (SARA) Title III and Clean Air Act Title V reporting requirements.

Hazardous materials, including fuel, must be handled and stored in accordance with Occupational Safety and Health Administration (OSHA), Environmental Protection Agency (EPA), Florida Administrative Code, and Air Force regulations. All hazardous wastes generated at CCAFS are managed according to the 45 SW Petroleum Products and Hazardous Waste Management Plan (OPlan 19-14). Bulk-quantity storage of hazardous materials is limited to designated storage areas at CCAFS. Smaller, shelf-life items, such as paints and varnishes, are stored in approved petroleum, oil, and lubricant storage cabinets maintained by individual contractors. Hazardous fuels are controlled by the Joint Propellants Contractor (JPC) for the 45 SW. The JPC provides for the purchase, transport, temporary storage, and loading of hazardous fuels and oxidizers.

CCAFS reported 233,412 kg (513,507 pounds) of DoD-generated hazardous waste in 1996. Typical hazardous wastes include various solvents, paints and primers, sealants, photo-developing solutions, adhesives, alcohol, oils, fuels, and various process chemicals. Hazardous wastes associated with current Delta II launch vehicle system activities are presented in Table 3-2.

**Table 3-2. Hazardous Waste Generated Per Delta II Launch**

| RCRA Hazardous Waste | Quantity | |
|---|---|---|
| | kg | lb |
| Ignitable (D001) RCRA wastes | 1,082 | 2,380 |
| Halogenated solvents (F001/F002) RCRA wastes | 0 | 0 |
| Non-halogenated solvents (F003/F004/F005) RCRA wastes | 200 | 440 |
| Toxic (D004) EPA wastes | 386 | 850 |
| Commercial chemical products | 100 | 220 |
| Corrosive (D002) RCRA wastes | 2,500 | 5,500 |
| Acutely hazardous (P) RCRA wastes | 0 | 0 |
| Reactive (D003) RCRA wastes | 5 | 10 |
| State-regulated wastes | 2,382 | 5,240 |
| Miscellaneous wastes | 986 | 2,170 |
| Total | 7,641 | 16,810 |

Source: [USAF 1998]

The Air Force, as owner of CCAFS facilities, is considered the generator of hazardous wastes at CCAFS, and is responsible for hazardous wastes physically generated by its own activities. The 45 CES/CEV at PAFB has oversight of the LBSC at CCAFS; it acts as the point of contact with regulatory agencies and informs the LBSC and JPC of new policies and policy changes concerning hazardous waste management. The LBSC provides environmental management and technical support for CCAFS, and ensures that contractors have hazardous waste management programs in place. The LBSC also reviews and inspects contractors to ascertain compliance with OPlan 19-14 and all applicable federal, state, and local regulations. Additionally, the LBSC operates the permitted hazardous waste storage areas on CCAFS, maintains records and inventories of permitted hazardous waste storage and process site accumulation areas, and maintains records pertaining to facility inspections, hazardous waste training, safety training, and other hazardous waste matters. Contractors operating at CCAFS are expected to dispose of hazardous wastes generated by their activities off-base but the USAF may provide hazardous waste disposal support on a space-available basis. As a generator of hazardous wastes at CCAFS, Boeing disposes of waste under a commercial hazardous waste generator identification number, issued by the EPA, and arranges for off-site disposal of all hazardous wastes generated during the launching of its vehicles.

The DRMO is responsible for managing and marketing excess and recoverable products and waste materials in accordance with applicable regulations. Hazardous items that cannot be marketed by the DRMO are disposed of as hazardous wastes. The DRMO is also responsible for obtaining off-site hazardous and no-hazardous wastes disposal contracts at all downrange sites.

CCAFS currently operates one hazardous waste storage facility, one PCB storage facility, and one hazardous waste treatment facility. In addition, a section of the PCB storage facility is permitted to store acids and bases. The hazardous waste storage facility is permitted to store hazardous wastes for up to one year until the waste can be disposed of by the JPC at an off-station location. It is, however, not permitted to store hydrazine, monomethyl hydrazine, or nitrogen tetroxide hazardous wastes. These wastes must be taken offsite for storage and disposal when temporary accumulation time limits have been reached. CCAFS has a Resource Conservation and Recovery Act (RCRA) permitted Explosive Ordnance Disposal (EOD) facility which provides thermal treatment of wastes generated at CCAFS & KSC, such as shavings from solid rocket motors.

Boeing maintains eight (8) satellite accumulation points and one 90-day accumulation area, which is located at Area 55, and is used as a central location for the temporary accumulation of hazardous wastes from current Delta II activities. This area receives waste directly from points of generation as well as from the eight satellite accumulation points. The JPC is responsible for collection and transportation of hazardous wastes from all accumulation sites associated with spacecraft and launch vehicle processing.

To prevent oil or petroleum discharges into U.S. waters, a Spills Prevention, Control, and Countermeasures Plan (SPCCP) is required by the EPA's oil pollution prevention regulation. A SPCCP has been integrated into the 45SW Hazardous Materials Response Plan (OPlan 32-3). Spills of oil or petroleum products that are federally listed hazardous materials will be collected and removed for proper disposal by a certified contractor according to this plan. All spills/releases will be reported to the host installation per OPlan 32-3.

#### 3.1.1.7.2 Emergency Planning and Community Right-To-Know Act

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

#### 3.1.1.8 Archeological and Cultural Resources

Within the region, there are 81 sites that are listed in the National Register of Historic Places (NRHP) [DOI 1999], and two in the National Register of Historic Landmarks.

In 1982, an archeological/historical survey of CCAFS was conducted that consisted of literature and background searches and field surveys. The survey located 32 prehistoric and historic sites and several uninvestigated historic localities. Results of the field survey indicated that many of the archeological resources had been severely damaged by the construction of roads, launch complexes, power lines, drainage ditches, and other excavation. The survey recommended 21 launch complexes for further evaluation to determine eligibility for the NRHP. [USAF 1994, RAI 1982] CCAFS is a National Historic Landmark (NHL) District, and LC-17 has been identified as potentially eligible for listing in the NRHP.

The protection and interpretation of significant resources associated with the space program are underway by the Department of the Interior, National Park Service, and USAF. Areas at CCAFS designated as landmark sites include the Mission Control Center and launch complexes 5, 6, 13, 14, 19, 26, and 34, which were used during the Mercury, Gemini, and early Apollo manned space flights. [NRHP 1999]

## 3.1.2 NATURAL ENVIRONMENT

### 3.1.2.1 Meteorology and Air Quality

#### 3.1.2.1.1 Meteorology

The climate of the region is subtropical with two distinct seasons: long, warm, humid summers and short, mild, and dry winters. [USAF 1994] Rainfall amounts vary both seasonally and yearly. Average rainfall is 128 centimeters (cm) (51 in), with about 70 percent falling during the wet season (May to October). Temperature is less variable — prolonged cold spells and heat waves rarely occur, owing to CCAFS's location adjacent to the Atlantic Ocean and the Indian and Banana Rivers. The average annual temperature at CCAFS is 22 ºCelsius (C) [71 ºFahrenheit (F)]. Average monthly temperatures range from 16 ºC (60 ºF) during January to 27 ºC (81 ºF) during July. Tropical storms, tropical depressions, and hurricanes occasionally strike the region, generally in the period starting in August and ending in mid-November. The probability of winds reaching hurricane force in Brevard County in any given year is approximately one in twenty. [USAF 1996-C] Tornadoes may occur, but are very scarce. Hail falls occasionally during thunderstorms, but hailstones are usually small and seldom cause much damage. Snow and freezing in the region are rare.  Temperature inversions are infrequent, occurring approximately two percent of the time.  [USAF 1994]

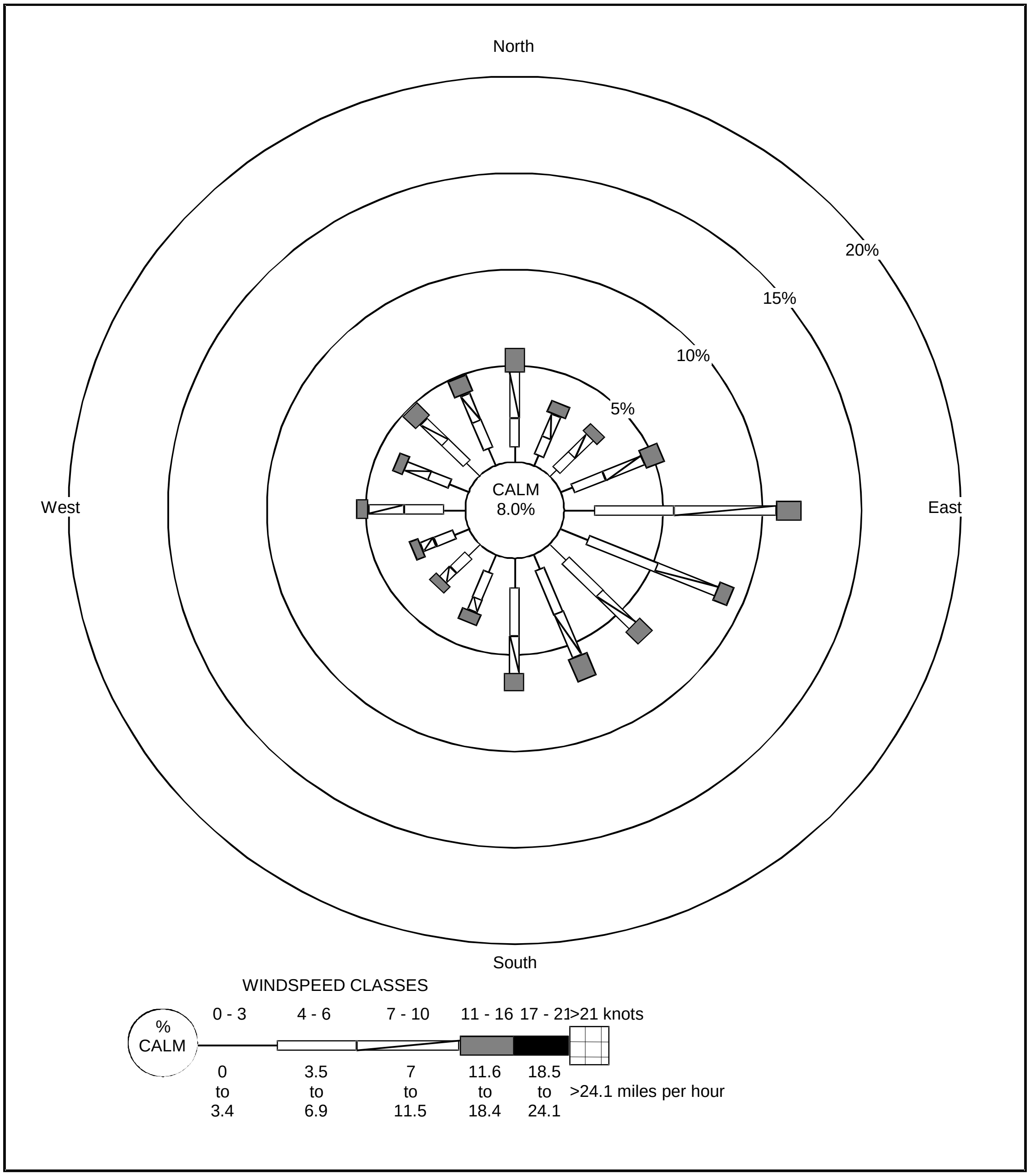
Summer weather typically lasts about nine months of the year, starting in April. The Cape Canaveral area has the highest number of thunderstorms in the United States, and one of the highest frequencies of occurrence in the world during the summer.  On average, thunderstorms occur 76 days per year at Cape Canaveral, commonly in the afternoon and usually result in lower temperatures and an ocean breeze.  Occasional cool days occur as early as November, but winter weather generally commences in January and extends through March.  [NASA 1994]  Rainfall distribution is seasonal, with a wet season occurring from May to October, while the remainder of the year is relatively dry.  Average annual rainfall for CCAFS is 123 cm (48.5 in), seventy percent of which occurs from May through October at the rate of approximately 13 cm (5 in) per month.  [USAF 1994]

The wind rose in Figure 3-5 shows the annual average frequency distribution of average wind speed and direction in the vicinity of CCAFS.  At CCAFS, winds typically come from the north/northwest from December through February, from the southeast from March through May, and from the south from June through August.  Sea breeze and land breeze phenomena occur commonly over any given 24-hour period due to unequal heating of the air over the land and ocean.  Land breeze (toward the sea) occurs at night when air over land has cooled to a lower temperature than that over the sea; sea breeze (toward the land) occurs during the day when air temperatures over the water are lower.  The sea breeze and land breeze phenomena occur frequently during the summer months, less frequently during the winter.  [USAF 1986]

#### 3.1.2.1.2 Air Quality

Air quality at CCAFS is considered good, primarily due to a predominant easterly sea breeze, (Figure 3-5).  CCAFS is located in the federally defined Central Florida Intrastate Air Quality Control Region (AQCR 48), which is classified by the EPA as an attainment area for all of the criteria pollutants.  There are no Class I or nonattainment areas for criteria pollutants (ozone [$O_3$], nitrogen oxides [$NO_X$], sulfur dioxide [$SO_2$], lead [Pb], carbon monoxide [CO], and particulates) within about 96 km (60 mi) of CCAFS.  Orange County was a nonattainment area for ozone until 1987, when it was redesignated as an ozone attainment maintenance area.  [DC 1995]

The station and its vicinity are considered to be “in attainment” or “unclassifiable” with respect to National Ambient Air Quality Standards (NAAQS) for criteria pollutants. [USAF 1990]  The criteria pollutants and the federal and state standards are listed in Table 3-3.  NAAQ primary and secondary standards apply to continuously emitting sources, while a launch is considered to be a one-time, short-term moving source; however, the standards will be used for comparative purposes throughout this EA to provide a reference, since no other, more appropriate standards exist.




Source: [USAF 1990]

Figure 3-5. Wind Rose Indicating Wind Speed and Direction — Lower Atmospheric Conditions: Cape Canaveral 1968 - 1978 Annual Averages

**Table 3-3. State and Federal Air Quality Standards**

| Pollutant | Averaging Time | State of Florida Standard | Federal Primary Standard | Federal Secondary Standard |
|---|---|---|---|---|
| Carbon Monoxide (CO) | 8-hour * | 10 $mg/m^3$ (9 ppm) | 10 $mg/m^3$ (9 ppm) | none |
| | 1-hour * | 40 $mg/m^3$ (35 ppm) | 40 $mg/m^3$ (35 ppm) | none |
| Lead (Pb) | Quarterly Arithmetic Mean | 1.5 $\mu g/m^3$ | 1.5 $\mu g/m^3$ | same as primary |
| Nitrogen Dioxide ($NO_2$) | Annual Arithmetic Mean | 100 $\mu g/m^3$ (0.05 ppm) | 100 $\mu g/m^3$ (0.05 ppm) | same as primary |
| Ozone ($O_3$) | 1-hour + | 235 $\mu g/m^3$ (0.12 ppm) | 235 $\mu g/m^3$ (0.12 ppm) | same as primary |
| Sulfur Dioxide ($SO_2$) | Annual Arithmetic Mean | 60 $\mu g/m^3$ (0.02 ppm) | 80 $\mu g/m^3$ (0.03 ppm) | none |
| | 24-hour * | 260 $\mu g/m^3$ (0.1 ppm) | 365 $\mu g/m^3$ (0.14 ppm) | none |
| | 3-hour * | 1300 $\mu g/m^3$ (0.5 ppm) | none | 1300 $\mu g/m^3$ (0.5 ppm) |
| Particulate Matter 10 (PM-10) | Annual Arithmetic Mean | 50 $\mu g/m^3$ | 50 $\mu g/m^3$ | same as primary |
| | 24-hour * | 150 $\mu g/m^3$ | 150 $\mu g/m^3$ | same as primary |
| Particulate Matter 2.5 (PM-2.5)** | Annual Arithmetic Mean | | 15 $\mu g/m^3$ | same as primary |
| | 24-hour * | | 65 $\mu g/m^3$ | same as primary |

Source: [FDEP 1999, NASA 1997-A, EPA 1999]

NOTE: $mg/m^3$ = milligrams per cubic meter
$\mu g/m^3$ = micrograms per cubic meter
ppm = parts per million
* Not to be exceeded more than once per year
+ The ozone standard is attained when the expected number of days per calendar year with maximum hourly average concentrations above the standard is less than or equal to one.
** The EPA promulgated a new standard for particulate matter with a diameter less than 2.5 microns (PM-2.5) on 18 July 1997. However, on 14 May 1999, the US Court of Appeals for the District of Columbia ruled that the EPA presented insufficient justification for the standard. The actual content of the reproposed standard, timing of the proposal, the promulgation date, and the date by which the EPA could determine those areas in compliance and those not in compliance with the standard are highly uncertain. In the 1997 proposal, the EPA expected to determine compliant and non-compliant areas of the country between 2002 and 2004. Under this timeline, controls of PM-2.5 would not be required before 2002, and they would be required after that time only in those areas determined to exceed the standard.

The daily air quality at CCAFS is chiefly influenced by a combination of vehicle traffic, maintenance activities, utilities fuel combustion, and incinerator operations. Space launches influence air quality only episodically. Two regional power plants are located within 20 km (12 mi) of the station and are believed to be the primary source of occasional elevations in nitrogen dioxide and sulfur dioxide levels. Ozone has been CCAFS's most consistently elevated pollutant. However, since January 1992, the primary standard for ozone has not been exceeded. [DC 1995]

### 3.1.2.2 Noise [USAF 1996-C]

The primary noise generators at CCAFS prelaunch processing sites are support equipment, vehicles, and air conditioners. On the whole, day-to-day operations at CCAFS would most likely approximate that of any urban industrial area, reaching levels of 60 to 80 decibels (dBA), but with a 24-hour average ambient noise level that is somewhat lower than the EPA-recommended upper level of 70 dBA. [USAF 1990, NASA 1997-A]

Occasionally, increased noise levels are experienced on a short-term basis when launches occur at one of the launch complexes. Noise is generated from the following sources: combustion noise emanating from the rocket chamber; jet noise generated by the interaction of the exhaust jet with the atmosphere; combustion noise resulting from the postburning of the fuel-rich combustion products in the atmosphere; and sonic booms. The major noise source in the immediate vicinity of the launch pad is the combination of these noises. The nature of the noise may be described as intense, of relatively short duration, composed predominantly of low frequencies, and occurring infrequently. This noise is usually perceived by the surrounding communities as a distant rumble. A concrete exhaust flume on each pad deflects exhaust gases away from the pad to reduce the noise and shock wave that result from ignition of solid rockets and the first stage of the launch vehicle. [USAF 1996-C]

Space launches also generate sonic booms during vehicle ascent and stage reentry. Launch-generated sonic booms are directed upward and in front of the vehicle and occur over the Atlantic Ocean. Stage reentry sonic booms also occur over the open ocean and do not impact developed coastal areas. [USAF 1996-C] The intensity of the sonic boom is related to vehicle size, configuration, and velocity. Some launch vehicle related noise levels measured at KSC are shown in Table 3-4.

**Table 3-4. Launch Noise Levels at Kennedy Space Center**

| SOURCE | DISTANCE FROM LAUNCH PAD | NOISE LEVEL (dBA) | REMARKS |
|---|---|---|---|
| Titan IIIC | 9,388 m (5.82 mi) | 93.7 | 21 October 1965 |
| Saturn I | 9,034 m (5.60 mi) | 89.2 | Average of 3 launches |
| Saturn V | 9,384 m (5.82 mi) | 91.0 | 15 April 1969 |
| Atlas | 4,816 m (2.99 mi) | 96.0 | Comstar |
| Space Shuttle | 9,384 m (5.82 mi) | 89.6 | Estimated |
| Delta II* | 6,452 m (4.00 mi) | 98.0 | Extrapolated from Measured Values |

Source: [NASA 1997-A, *USAF 1994]

*Launch Noise Level at CCAFS [USAF 1994]

Peak noise levels created by industrial and construction activities — mechanical equipment, such as diesel locomotives, cranes, and rail cars — could range from about 90 to 111 dBA. Vehicular traffic noise ranges from around 85 dBA for a passenger auto to about 100 dBA for a motorcycle. [NASA 1997-A]

### 3.1.2.3 Land Resources

#### 3.1.2.3.1 Geology

The region is underlain by a series of limestone formations, with a total thickness of several thousand feet. The lower formations contain the Upper Floridan Aquifer, which is under artesian pressure in the vicinity of the station. At CCAFS, the Upper Floridan Aquifer commences at a depth of about 80 m (260 ft) and is about 110 m (360 ft) thick. [USAF 1990] Beds of sandy clay, shells, and clays of the Hawthorn formation overlay the Floridan Aquifer, isolating the Floridan Aquifer from other, more shallow aquifers. The Hawthorn formation lies at a depth of about 30 m (100 ft) at CCAFS and is about 50 m (160 ft) thick. Overlying the Hawthorn formation are upper Miocene, Pliocene, Pleistocene, and recent age deposits, which form secondary, semi-confined aquifers and the Surficial Aquifer, which lay at depths up to about 30 m (100 ft).

CCAFS lies on a barrier island composed of relict beach ridges formed by wind and wave action. This island, approximately 7.5 km (4.5 mi) wide at the widest point, parallels the Florida shoreline and separates the Atlantic Ocean from the Indian River, Indian River Lagoon, and Banana River. The land surface elevation ranges from sea level to about 6 meters (20 ft) above sea level at its highest point. LC-17 is located near the southeastern shore of the station. This area is designated as above the 500-year floodplain. [USAF 1990]

#### 3.1.2.3.2 Soils

Soils on CCAFS have been mapped by the U.S. Department of Agriculture Natural Resources Conservation Service (NRCS). Soil types that have been identified by the NRCS in the vicinity of LC-17 are Canaveral Complex, Palm Beach Sand, Urban Land, and Canaveral-Urban Land Complex. These native soils are composed of highly permeable, fine-grained sediments typical of beach and dune deposits. Based on examination of well and soil borings from CCAFS, the near-surface stratigraphy is fairly uniform, consisting of Pleistocene age sand deposits that underlie the installation to depths of approximately 30 m (100 ft). [USAF 1988]

### 3.1.2.4 Hydrology and Water Quality

#### 3.1.2.4.1 Surface Waters

The station is located on Canaveral Peninsula, a barrier island that separates the Banana River from the Atlantic Ocean. The majority of ground surface at CCAFS is composed of former sand dunes. The dunes typically facilitate rapid infiltration of runoff, since the surface soils generally consist of highly permeable sand and shell. As is typical of barrier islands, the drainage divide is the dune line just inland from the ocean. Little runoff is naturally conveyed toward the ocean; most runoff percolates or flows westward toward the Banana River. The majority of storm drainage from CCAFS is collected in manmade ditches and canals and is directed toward the Banana River. None of the facilities used in prelaunch processing are within the 100-year flood plain. The North Banana River is a sanctuary for the endangered manatee.

Major inland water bodies in the CCAFS area are the Indian River (west), Banana River (immediate west), and Mosquito Lagoon (north). All three water bodies are estuarine lagoons with circulation provided mainly by wind-induced currents. These water bodies tend to be shallow except for those areas maintained as part of the Intracoastal Waterway. The Indian and Banana Rivers connect adjacent to Port Canaveral by the Barge Canal, which bisects Merritt Island; they have a combined area of 600 sq km (232 sq mi) in Brevard County and an average depth of 1.8 m (6 ft). This area receives drainage from 2,160 sq km (834 sq mi) of surrounding terrain.

Studies indicate that ambient conditions in the Banana River, Indian River, and Mosquito Lagoon are typical of estuarine waters, with the exception of some areas affected by point source loading. [FDEP 1999, BC 1999] Dissolved oxygen levels are generally higher than 6.0 milligrams per liter (mg/$\ell$) [$3.5 \times 10^{-6}$ lb/gal], and the biochemical oxygen demand is less than 3.0 mg/$\ell$ ($1.75 \times 10^{-6}$ lb/gal). Waters tend to be slightly basic, with a pH near 8.0, and have good buffering capacity as indicated by alkalines that are generally higher than 150 mg/$\ell$ ($8.74 \times 10^{-5}$ lb/gal). Nutrient and chlorophyll levels are typical of an estuarine setting. Levels of aluminum, silver, and iron have been reported in excess of state criteria, but seem to be indicative of background concentrations due to their widespread distribution as well as the high level of organic particulate matter found in the area. [BC 1999, USAF 1996-C]

Predominant ocean currents in the vicinity of CCAFS are north of the area. From the Cape Canaveral region to 26 km (16 mi) offshore, the average ocean current speed is 1.7 to 5 km per hour (kph) (1 to 3 miles per hour [mph]). Beyond about 26 km (16 mi), the system of currents becomes known as the Florida Current of the Gulf Stream. The central axis of the Gulf Stream is located approximately 83 km (50 mi) off the coast of Florida at Cape Canaveral.

#### 3.1.2.4.2 Surface Water Quality

The FDEP has classified water quality in the Middle East Coast Basin as “poor to good” based on the physical and chemical characteristics of the waters as well as whether they meet their designated use under Florida Administrative Code (FAC) 17-3. The upper reaches of the Banana River adjacent to CCAFS the lower reaches of Mosquito Lagoon have generally good water quality due to lack of urban and industrial development in the areas. Lower reaches of the Banana and Indian Rivers, the upper reaches of Mosquito Lagoon, and eastern portions of the Indian River along Merritt Island are classified as fair. Areas of poor water quality exist along the western portions of the Indian River near the City of Titusville and in Newfound Harbor near Sykes Creek in southern Merritt Island. Fair and poor areas are influenced primarily by wastewater treatment plant effluent discharges and urban runoff. [FDEP 1999] Discharge of wastewater effluent to the Banana and Indian Rivers is not permitted.

The Banana River is designated a Class III surface water, as described by the Federal Clean Water Act of 1977. Class III standards are intended to maintain a level of water quality suitable for recreation and the production of fish and wildlife communities. Several water bodies in the Middle East Coast Basin have been designated as Outstanding Florida Water (OFW) in FAC 17-3, including most of Mosquito lagoon and the Banana River, Indian River Aquatic Preserve, Banana River State Aquatic Preserve, Pelican Island National Wildlife Refuge, and Canaveral National Seashore. [FDEP 1999] An OFW is provided the highest degree of protection of any Florida surface waters, and any compromise of ambient water quality is prohibited. [NASA 1997-A] Additionally, the Indian River Lagoon System has been designated an Estuary of National Significance by the EPA. Because of these designations as well as other Florida regulations designed to minimize wastewater discharges and urban runoff in the area, water quality in the Middle East Coast Basin is expected to improve.

Surface water quality near CCAFS and KSC is monitored at 11 long-term monitoring stations that are maintained by NASA. It is also monitored by the Air Force Bioenvironmental Engineering Services on a quarterly basis at seven sites. Other monitoring stations in the general area are maintained by Brevard County, the U.S. Fish and Wildlife Service, and the FDEP. [NASA 1997-A] In general, the water quality in the monitored surface waters has been characterized as good. Both the northern and southern segments of the Banana River tend to be brackish to saline (15 to 36 parts per thousand [ppt]) at NASA Causeway East. [USAF 1990] Water quality monitoring data for the southern segment of the Banana River is summarized in Table 3-5.

**Table 3-5. Summary of Water Quality Monitoring Data for South Banana River**

| Parameter | Average Value | Range of Values | State FDEP Class III Standards |
|---|---|---|---|
| Conductivity (µmhos/cm) | 33,300 | 12,470 - 50,500 | Varies |
| Total Suspended Solids (mg/ℓ) | 32 | 1 - 143 | No standard |
| Turbidity NTU | 2.09 | 0.76 - 5.0 | 29 NTU above background |
| Oil and Grease (mg/ℓ) | 0.8 | <0.2 - 3.9 | ≤5.0; no taste or odor |
| Phenols (µg/ℓ) | 128 | 32 - 364 | < 300 |
| Alkalinity (mg/ℓ) | 130 | 109 - 168 | ≥20 (fresh water) |
| pH | 8.6 | 7.4 - 9.2 | 6.5 - 8.5 (marine water) |
| Total Kjedahl Nitrogen (mg/ℓ) | 1.96 | 0.23 - 15.00 | No standard |
| Nitrate Nitrogen (mg/ℓ) | 0.02 | <0.02 - 0.06 | No standard |
| Ortho Phosphate (mg/ℓ) | 0.032 | <0.025 - 0.08 | No standard (marine) |
| Chlorophyll A (mg/$m^3$) | 5.0 | <0.5 - 74.7 | No standard |
| Biological Oxygen Demand (mg/ℓ) | 2.5 | <1 - 7 | No standard |
| Chemical Oxygen Demand (mg/ℓ) | 712 | 478 - 1361 | No standard |
| Dissolved Oxygen (mg/ℓ) | 6.6 | 2.1 - 10.2 | ≥ 4 mg/l (marine water) |
| Total Organic Carbons (mg/ℓ) | 5.41 | 2.23 - 13.00 | No standard |
| Aluminum (mg/ℓ) | 0.62 | < 0.10 - 8.47 | ≤ 1.5 (marine water) |
| Cadmium (µg/ℓ) | 0.56 | <0.01 - 2.86 | ≤ 0.3 |
| Chromium (mg/ℓ) | 0.020 | <0.001 - 0.05 | 0.5 $Cr^{+6}$ |
| Iron (mg/ℓ) | 0.075 | <0.040 - 0.178 | 0.3 (marine water) |
| Zinc (mg/ℓ) | 0.023 | < 0.01 - 0.234 | 86 (fresh water) |
| Silver (µg/ℓ) | 17.88 | < 0.05 - 31.3 | ≤ 0.05 (marine water) |

Source: [NASA 1997-A]

NOTE: mg/ℓ = milligram per liter = 5.825 x $10^{-6}$ lb/gal
µg/ℓ = microgram per liter = 5.825 x $10^{-9}$ lb/gal
µmhos/cm = micromhos per centimeter
NTU = Nephelometric Turbidity Units

### 3.1.2.4.3 Ground Waters [USAF 1988, USAF 1994]

Ground water at the station occurs under both confined (artesian) and unconfined (nonartesian) conditions. Confined ground water is located in the Floridan Aquifer, which serves as the primary ground water source in the coastal lowlands. Recharge to the Floridan Aquifer occurs primarily in northern and central Florida.

Although good quality water may be obtained from the Floridan Aquifer throughout much of the state, water from this formation on CCAFS is highly mineralized and is not used for domestic or commercial purposes. Water for domestic and commercial purposes in this area is generally retrieved from the city of Cocoa. The water is pumped from wells in east Orange County that extract water from the Floridan Aquifer.

This unconfined surficial aquifer is composed of recent and Pleistocene age surface deposits, and is usually found up to 1.5 m (5 ft) or so below land surface. It is recharged by rainfall along the coastal ridges and dunes. The unconfined aquifer formation at CCAFS ranges in depth from about 15 m (50 ft) at the coastal ridge to less than 6 m (20 ft) in the vicinity of the St. Johns River. The unconfined aquifer beneath LC-17 is not typically used as a water source, except for residential irrigation.

#### 3.1.2.4.4 Ground Water Quality

Two aquifer systems underlie CCAFS: the surface aquifer and the Floridan aquifer. The surface aquifer system, which is composed generally of sand and marl. The water table in the surface aquifer is generally located a few feet below the ground surface and is principally recharged by precipitation. Ground water of the Floridan Aquifer at CCAFS is not used as a domestic or commercial water source. Table 3-6 summarizes the water quality characteristics of a sample collected from the Floridan Aquifer underlying the west-central portion of the station. The sample exceeded national drinking water standards for sodium, chloride, and total dissolved solids (TDS). [NASA 1997-A]

**Table 3-6. Ground Water Quality for the Floridan Aquifer at CCAFS**

| **Parameter** | **Average Value (mg/l)** | **Drinking Water Standards (mg/l)** |
|---|---|---|
| Nitrates (as Nitrogen) | < 0.01 | 10 (primary standard) |
| Chlorides | 540 | 250 (primary standard) |
| Copper | <0.01 | 1.0 (secondary standard) |
| Iron | 0.02 | 0.3 (secondary standard) |
| Manganese | <0.001 | 0.05 (secondary standard) |
| Sodium | 1400 | 160 (primary standard) |
| Sulfate | 85 | 250 (secondary standard) |
| Total Dissolved Solids | 1,425 | 250 (secondary standard) |
| pH | 7.60 | 6.5 - 8.5 (secondary standard) |
| Aluminum | | 1.5 mg/l (secondary standard) |
| Zinc | <0.01 | 5.0 (secondary standard) |
| Arsenic | <0.01 | 0.05 (primary standard) |
| Barium | 0.02 | 1.0 (primary standard) |
| Cadmium | <0.001 | 0.01 (primary standard) |
| Chromium | 0.001 | 0.05 (primary standard) |
| Lead | <0.001 | 0.05 (primary standard) |
| Silver | <0.050 | 0.05 (primary standard) |
| Mercury | 0.0005 | 0.002 (primary standard) |
| Selenium | 0.006 | 0.01 (primary standard) |

Source: [USAF 1988, NASA 1997-A]

NOTE: mg/l = milligrams per liter = 5.825 x $10^{-6}$ lb/gal
primary standard = National Interim Primary Drinking Water Regulations
secondary standard = National Secondary Drinking Water Regulations

Overall, water in the unconfined aquifer in the vicinity of KSC and CCAFS is of good quality and meets the State of Florida Class G-II (suitable for potable water use; total dissolved solids less than 10,000 mg/$\ell$ (5.825 x $10^{-2}$ lb/gal) and national drinking water quality standards for all parameters, with the exception of iron, and/or total dissolved solids. [NASA 1997-A, USAF 1990] There are no potable water wells located at LC-17 or in its vicinity.

Ground water quality in five monitoring wells at LC-17 is generally good, with some detectable quantities of trace metals and organic compounds reported in one well, and detectable zinc concentrations in another. [MDC 1990] These results suggest that soil contaminants detected by earlier studies [USAF 1988] may be relatively non-mobile under the present soil conditions.

### 3.1.2.5 Biotic Resources

Ecological resources at CCAFS are influenced by the Atlantic Ocean on the east and the Banana River on the west. Relic dunes on CCAFS have created inner-dunal swales that have been classified by the U.S. Fish and Wildlife Service as freshwater wetlands. There is also a naturally occurring pond and wetlands in the vicinity of LC-17. Vegetation communities and related wildlife habitats are representative of barrier island resources of the region. Major community types at CCAFS include beach, coastal strand and dunes, coastal scrub, lagoons, brackish marsh, and freshwater systems in the form of canals and borrow pits.

Near-natural conditions have been retained at CCAFS by restricting activities on the station. The majority of the complex consists of vegetation indigenous to the Florida coastal scrub (26 sq km) [6,400 acres], coastal strand (9 sq km) [2,300 acres], and coastal dune (3 sq km) [800 acres] plant communities. Wetlands at CCAFS represent a minor percentage of the total land area, with 0.08 sq km (20 acres) of freshwater wetlands, 2 sq km (450 acres) of mangrove swamp, and 0.6 sq km (140 acres) of salt marsh. Hammocks at CCAFS are small in size, totaling less than 0.8 sq km (200 acres, or [0.3 sq mi]). The remaining acreage is covered primarily with launch and support facilities.

In addition to communities found at CCAFS, coastal hammocks and pine flatwoods are found on KSC to the northwest and increase the ecological diversity and richness of the area. [USAF 1988] A majority of the 65 sq km (25 sq mi) complex consists of coastal scrub, woodland, strand, and dune vegetation. Coastal scrub and coastal woodland provide excellent cover for resident wildlife. The coastal scrub community is characterized by dense growths of scrub vegetation, such as myrtle oak (*Quercus Myrtifolia*), live oak (*Q. virginian*), saw palmetto (*Serenoa repens*), Chapman oak (*Q. chapmanii*), and stoppers (*Eugenia spp*.) that have developed nearly impenetrable thickets, forming clumps of vegetation separated by bare sand.

Coastal strand occurs immediately inland of the coastal dunes and is composed of dense, woody shrubs. Coastal woodland is characterized by two layers of vegetation; an upper closed canopy and a lower shrub layer. Live oak, Chapman oak, red bay (*Persea borbonia*), and Hercules club (*Zanthoxylum clave-herculis*) form the canopy and may reach heights from 5 to 15 meters (16 to 49 ft). Saw palmetto and immature oaks form the shrub layer.

Coastal dune vegetation (a single layer of grass, herbs, and dwarf shrubs) exists from the high tide point to between the primary and secondary dune crest. Known hammocks are characterized by closed canopies of tree, shrub, and herb vegetation. Most of the wildlife species resident at the station can be found in each of these vegetation communities. No federally designated threatened or endangered flora are known to exist at CCAFS. [USAF 1991, USAF 1996-C]

3.1.2.5.1 Terrestrial Biota [USAF 1988, USAF 1994]

The coastal dune community extends from the coastal strand system to the high tide line, and within the salt-spray zone. Dune systems develop on poorly consolidated, excessively drained sands that are exposed to constant winds and salt spray. This zone is delineated by the interior limit of sea oats (*Uniola paniculata*) growth, which has been listed as a state species of special concern. Florida Statute 370.41 prohibits the disturbance or removal of sea oats. The coastal dune community appears as a single layer of grass, herbs, and dwarf shrubs. In addition to sea oats, plant species commonly found in this community are sea grape (*Coccoloba uvifera*), partridge pea (*Cassia fasiculata*), and broomsedge (*Sporobolus virginicus*).

LC-17 is surrounded by coastal scrub vegetation. As a result of a recent study by the Nature Conservancy, the overgrown oak scrub has now been classified as maritime hammock. The coastal scrub community covers approximately 37.6 sq km (14.5 sq mi), or about 78 percent of the undeveloped land on CCAFS. This community is distributed on excessively drained, nutrient-deficient marine sands.

Coastal strand vegetation occurs between the coastal dune and scrub communities and lies just east of LC-17. Coastal strand communities exist on sandy, excessively drained soils dominated by shrubs and often are nearly devoid of ground cover vegetation. Coastal strand displays a single layer of vegetation that varies from one to four meters in height and includes species of cabbage palm (*Sabal palmetto*), saw palmetto, and tough buckthorn (*Bumelia tenax*). Coastal scrub and coastal woodland provide excellent cover for wildlife species such as the white-tailed deer, armadillo, beach mouse, bobcat, feral hog, Florida mouse, raccoon, rabbit, gopher tortoise, and numerous bird, lizard, and snake species.  Saw palmetto and oak species are a good foraging source when fruiting.  Mammal, reptile, and bird species that inhabit the coastal strand are about the same as those found in the coastal scrub community described earlier in this section.

CCAFS beaches are nonvegetated, but provide significant wildlife resources. The tidal zone supports a large number of marine invertebrates, as well as small fish that are food for various shorebirds.  CCAFS and KSC beaches are also important nesting areas for several varieties of sea turtles.  Sea turtles and turtle hatchlings are affected by exterior lights.  To minimize impacts to sea turtles, CCAFS has implemented a lighting policy for management of exterior lights at the installation.  The policy requires the use of low-pressure sodium lights unless prohibited by safety or security purposes.

Coastal hammocks are characterized by three layers of vegetation: a tree layer with a closed canopy, a shrub layer, and an herb layer.  The herb layer is comprised of vegetation that does not develop persistent woody tissue. Tree species of red bay, live oak, Chapman oak, and cabbage palm may reach heights from 5 to 20 meters (16 to 66 ft). Shrub species, such as saw palmetto and stopper have profiles from 0.5 to 3 meters in height in this community.  An herbaceous layer of vegetation is always present, but the extent of its development is determined by light, water, and soil conditions. Hammocks are shaded from intense insolation, and therefore retain higher levels of soil moisture than the previously described habitats.  No hammocks occur in the immediate vicinity of LC-17, the nearest one being about 3 km (1.8 mi) west of the site, adjacent to the Banana River. Hammock communities at CCAFS are inhabited by the same wildlife species associated with adjacent coastal scrub.

Wetlands within CCAFS and surrounding station facilities are important wildlife resources;  there are four isolated emergent wetlands and a major east-west drainage canal. Wetland types that are found in the area include fresh water ponds and canals, brackish impoundments, tidal lagoons, bays, rivers, vegetated marshes, and mangrove swamps.  No marsh or swamp systems occur near LC-17.  These soils are not suitable for cultivation, yet do contain swamp plants that support migratory and wading birds. [USAF 1990]

Species of plant and animal life observed or likely to occur on CCAFS are listed in references USAF 1988, USAF 1994, and USAF 1996-C.

3.1.2.5.2     Aquatic Biota  [USAF 1988]

In terms of aquatic biota, the Cape Canaveral Region is a transition zone between temperate and subtropical forms.  The northern Indian River lagoon ecosystem is a shallow system with limited ocean access, limited tidal flux, and generally mesohaline salinities.  The aquatic environment is subject to wide fluctuations in temperature and salinity due to the shallowness of the system, and the aquatic organisms that inhabit this area are generally adapted to these fluctuations.

Sea grasses are present in the Indian River system, generally found in patches in shoal areas less than 1 m (3 ft) deep and surrounded by open, sandy terrain. Benthic invertebrates found in the northern Indian and Banana Rivers include marine worms, mollusks, and crustaceans, typical of estuarine systems. Epibenthic invertebrates collected from the area included horseshoe crabs, blue crabs, and penaid shrimp.

The area is not considered an important nursery area for commercially important shrimp species. Mosquito Lagoon, north of the complex, has been considered an important shrimp nursery area. Blue crabs were determined to spawn in the area.

Few freshwater fish species inhabit the area. Many of the area's freshwater fish species are believed to have been introduced by man. Primary reasons for the low diversity in fish species are considered to be latitude, climate, low habitat diversity, and limited ocean access.

3.1.2.5.3 Launch Complex 17

A potential Region of Influence (ROI) has been identified for the proposed launches as a one-half mile radius surrounding the launch complex, based on previous launch vehicle assessments at CCAFS. Threatened or endangered species potentially occurring within the ROI are listed in Table 3-7. Preliminary review of existing vegetation mapping in the vicinity of the launch complex identified the dominant vegetation as coastal scrub community and coastal woodland community. The distinction between the two systems as previously described is a difference in the height of the vegetation and the openness of the canopy. The western portion of the ROI consists primarily of coastal woodland whereas the eastern portion of the ROI up to Pier Road supports a more open coastal scrub community. This portion of the ROI also displays signs of being recently burned. Controlled burns are implemented throughout much of CCAFS using prescribed schedules in accordance with the control-burning plan. These burns are important for improving and preserving wildlife habitat as well as for reducing the occurrence of uncontrolled fires and enhancing security visibility. The vegetation on the east side of Pier Road is characterized as coastal strand with dune vegetation along the beach interface.

The vegetative communities are partitioned into discrete units by the presence of line-of-site clear zones, roads, and widely dispersed industrial complexes. These clear zones provide an ecotone effect between the adjacent scrub/woodland community and a predominantly herbaceous grassy community. An ecotone is a transition area between the adjacent ecological communities usually containing species from both communities. Bahia grass was the dominant species bordering the road shoulder vegetation and the industrial buildings. The transition zone between the grassy community and the forested community includes wax myrtle, stoppers, groundsel, and Brazilian pepper (*Schinus tereinthifolius*). These species provide a nearly impenetrable shrub/scrub layer.

Aquatic and wetland habitats occupy a portion of the ROI. These habitats include four isolated emergent wetlands and a major east-west drainage canal. The wetlands support a wide variety of aquatic plants and animals, including the American alligator, a threatened species. The four isolated wetlands are vegetated primarily by cattails with Carolina-plains willow, wax myrtle, and groundsel bush along the edge of the system. The systems are small and appear to have originated as borrow areas for adjacent construction sites. [USAF 1994]

#### 3.1.2.5.4 Threatened and Endangered Species

The U.S. Fish and Wildlife Service (FWS), the Florida Game and Fresh Water Fish Commission (FGFWFC), and the Florida Commission on Rare and Endangered Plants and Animals (FCREPA) protect a number of wildlife species listed as endangered or threatened under Federal or State of Florida law. The presence, or potential for occurrence, of such species on CCAFS was determined from consultations with FWS, FGFWFC, and CCAFS and KSC environmental staff, and from a literature survey. Table 3-7 lists those endangered or threatened species in Brevard County residing or seasonally occurring on CCAFS and adjoining waters.

A review of the list indicates that only six species (American alligator, eastern indigo snake, southeastern kestrel, Florida scrub jay, and two species of prickly pear cactus) potentially occur in the immediate vicinity of LC-17. Three additional species may occasionally occur in wetlands on CCAFS. West Indian manatees, green turtles, and loggerhead turtles are known to occur in the Banana River, Mosquito Lagoon, and along the Atlantic Ocean beaches (see Figure 3-6). The red-cockaded woodpecker is not known to occur in the vicinity of LC-17.

**Table 3-7. Listed and Proposed Threatened and Endangered Animal Species and Candidate Animal Species In Brevard County and Their Status On CCAFS**

| SPECIES<br>Threatened/Endangered Species | Potential Occurrence[a]<br>LC-17 | STATUS[b]<br>Federal USFWS | <br>State FGFWFC | <br>Other[c] FCREPA | <br>Cape Canaveral |
|---|---|---|---|---|---|
| **REPTILES/AMPHIBIANS** | | | | | |
| American Alligator (*Alligator mississippiensis*) | X | FT (S/A) | SSC | SSC | O |
| Atlantic loggerhead turtle (*Caretta caretta caretta*) | | FT | T | T | O |
| Atlantic green turtle (*Chelonia mydas mydas*) | | FE | E | E | O |
| Leatherback turtle (*Dermochelys coriacea*) | | FE | E | R | O |
| Eastern indigo snake (*Drymarchon corais couperi*) | X | FT | T | SSC | O |
| Atlantic ridley turtle (*Lepidochelys kempi*) | | FE | E | | Offshore |
| Hawksbill sea turtle (*Eretmochelys imbricata imbricata*) | | FE | E | E | Offshore |
| Atlantic salt marash snake (*Nerodia fasciata taeniata*) | | FT | T | | n/o |
| **BIRDS** | | | | | |
| Florida scrub jay (*Aphelocoma coerulescens coerulescen*) | X | FT | T | T | O |
| Piping plover (*Charadrius melodus*) | | FT | T | SSC | O |
| Arctic peregrine falcon (*Falco peregrinus tundrius*) | | FT | T | E | O |
| Southeastern American kestrel (*Falco Sparverius paulus*) | X | UR2 | T | T | O |
| Bald eagle (*Haliaeetus leucocephalus*) | | FE | T | T | Visitor |
| Wood stork (*Mycteria americana*) | | FE | E | E | O |
| Least tern (*Sterna antillarum*) | | | T | | O |
| Kirtland's warbler (*Dendroica kirtlandii*) | | FE | E | | N/O |
| Audubon's crested caracara (*Polyborus plancus Audubonii*) | | T | T | | N/O |
| **PLANTS** | | | | | |
| Giant leather fern (*Acroatichum danaeifolium*) | | | | T-FDA | O |
| Curtis milkweed (*Asclepias curtissii*) | | | | E-FDA | O |
| Coconut palm (*Cocoa nuvifera*) | | | | T-FDA | O |
| Mosquito fern (*Azolla caroliniana*) | | | | T-FDA | O |
| Beach creeper (*Ernodea littoratis*) | | | | T-FDA | O |
| Wild coco (*Elophia alta*) | | | | T-FDA | O |
| Prickly pear cactus (*Opuntia compressa*) | X | | | T-FDA | N/O |
| Prickly pear cactus (*Opuntia stricta*) | X | | | T-FDA | O |
| Beach star (*Remirea maritima*) | | | | E-FDA,FNAI | O |
| Scaevola (*Scaevola plumeria*) | | | | T-FDA | O |
| Wildpine; air plant (*Tillandsia simulata*) | | | | T-FDA | N/O |
| **MAMMALS** | | | | | |
| Southeastern beach mouse (*Peromyscus polionotus niveiventris*) | | FT | T | | O |
| West Indian manatee (*Trichechus manuatus latriostris*) | | FE | E | T | O |
| Florida panther (*Felis concolor coryii*) | | FE | | | N/O |

Source: Adapted from [USAF 1994] and [NASA 1997-A]

[a] X = potential occurrence near LC-17
[b] FE = federally listed as endangered; FT = federally listed as threatened; S/A = similarity of appearance; UR2 = under review, but substantial evidence of biological vulnerability and or threat is lacking; F = federal species of concern (former Category 2 Candidate species) - Such species are the pool from which future candidates for listing will be drawn [Federal register Vol. 61 No. 40, PP. 7457-7463, 2/28/96]. E = state listed as endangered; T = state listed as threatened; R = rare; SSC = species of special concern; C = commercially exploited; O = observed; N/O = not observed
USFWS = U.S. Fish and Wildlife Service; FGFWFC = Florida Game and Fresh Water Fish Commission; FCREPA = Florida Commission on Rare and Endangered Plants and Animals; FDA = Florida Department of Agriculture and Consumer Services; FNAI = Florida Natural Areas Inventory
[c] listing agencies other than FCREPA are noted next to species designation

**Table 3-7. Listed and Proposed Threatened and Endangered Animal Species and Candidate Animal Species in Brevard County and Their Status on CCAFS (cont'd)**

| SPECIES | Potential Occurrence[a] | STATUS[b] | | | |
|---|---|---|---|---|---|
| Candidate Species | LC-17 | Federal USFWS | State FGFWFC | Other[c] FCREPA | Cape Canaveral |
| **REPTILES/AMPHIBIANS** | | | | | |
| Gopher tortoise (*Gopherus polyphemus*) | X | UR2 | SSC | T | O |
| Gopher frog (*Rana areolata*) | | UR2 | SSC | | N/O |
| **BIRDS** | | | | | |
| Roseate spoonbill (*Ajaia ajaja*) | | | SSC | | O |
| Snowy egret (*Egretta thula*) | | | SSC | | O |
| Louisiana heron (*Egretta tricolor*) | X | | SSC | | O |
| Little blue heron (*Florida oaerules*) | X | | SSC | | O |
| American oyster catcher (*Haematopus palliatus*) | | | SSC | | O |
| Osprey (*Pandion haliaetus*) | | | SSC | | O |
| Brown pelican (*Pelecanus occidentalis*) | | | SSC | | O |
| Reddish egret (*Egretta rufescens*) | | F | SSC | R | O |
| **Burrowing owl (*Ethene cuniculeria*)** | | | SSC | | O |
| **Florida sandhill crane (*Grus canadenis pratensis*)** | | | T | | O |
| **PLANTS** | | | | | |
| Broad-leaved spiderlily (*Hymenocallis latifolia*) | | UR2 | | UR2-FNAI | O |
| Royal fern (*Osmuda regalis var. spectabilis*) | | | | C-FDA | N/O |
| Giant wildpine; giant air plant (*Tillandsia utriculata*) | | | | C-FDA | O |
| Black mangrove (*Avicennia germinans*) | | | | SP | O |
| Dwarf redbay (*Peraea borbonia var. humilis*) | | UR2 | | UR | N/O |
| **MAMMALS** | | | | | |
| Florida mouse (*Peromyscus floridanus*) | | UR2 | SSC | T | O |
| Round-tailed muskrat (*Neofiber alleni*) | | F | | SSC | N/O |
| **Other species of interest** | | | | | |
| Finback whale (*Balaenoptera physalus*) | | FE | | | Offshore |
| Humpback whale (*Megaptera novaeangliae*) | | FE | | | Offshore |
| Right whale (*Eubalaena glacialis*) | | FE | | | Offshore |
| Sperm whale (*Physeter macrocephalus*) | | FE | | | Offshore |
| Sei whale (*Balaenoptera borealis*) | | FE | | | Offshore |

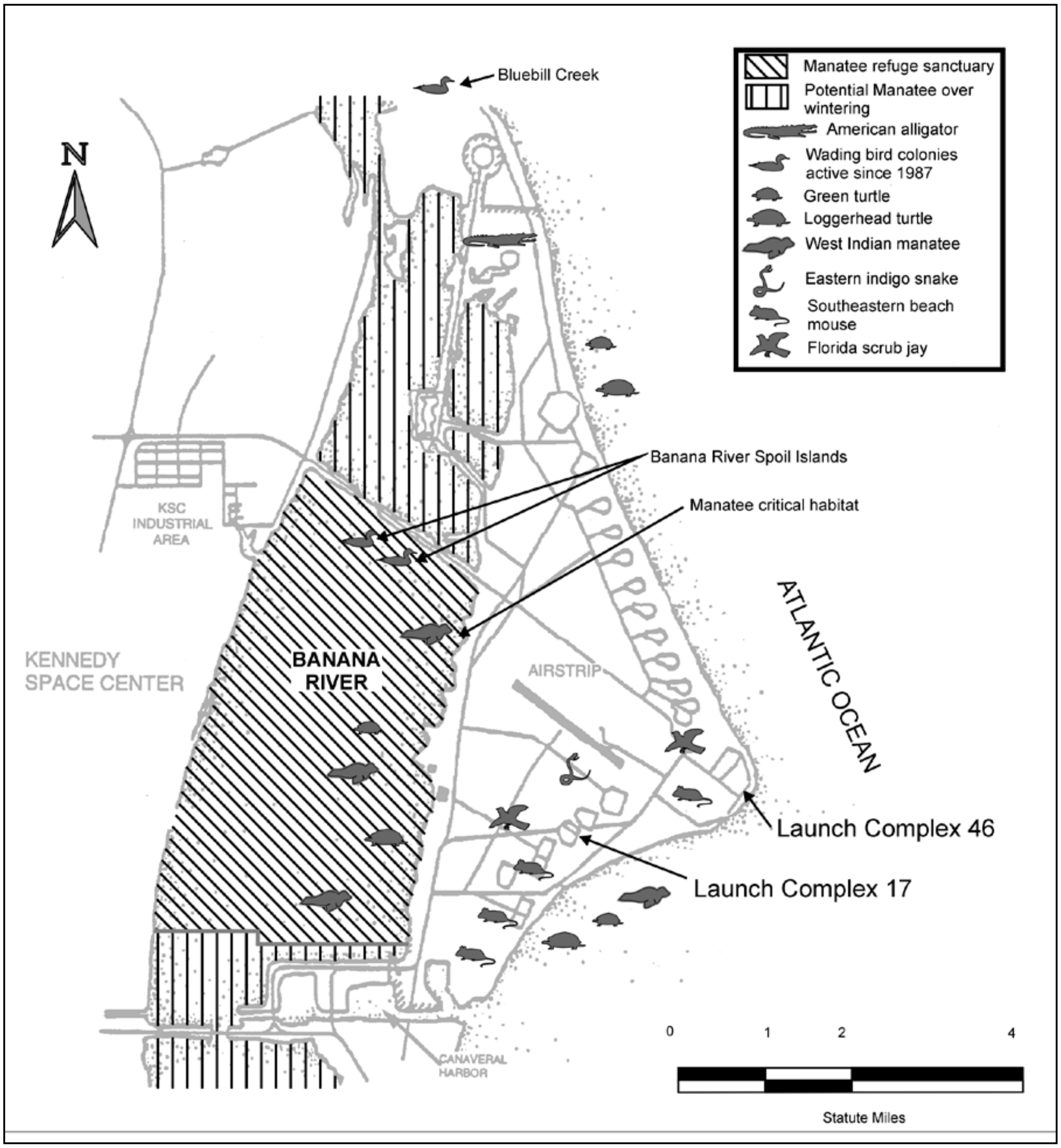
Source: Adapted from [USAF 1994] and [NASA 1997-A]

[a] X = potential occurrence near LC-17

[b] FE = federally listed as endangered; FT = federally listed as threatened; S/A = similarity of appearance; UR2 = under review, but substantial evidence of biological vulnerability and or threat is lacking; F = federal species of concern (former Category 2 Candidate species) - Such species are the pool from which future candidates for listing will be drawn [Federal register Vol. 61 No. 40, PP. 7457-7463, 2/28/96]. E = state listed as endangered; T = state listed as threatened; R = rare; SSC = species of special concern; C = commercially exploited; O = observed; N/O = not observed

USFWS = U.S. Fish and Wildlife Service; FGFWFC = Florida Game and Fresh Water Fish Commission; FCREPA = Florida Commission on Rare and Endangered Plants and Animals; FDA = Florida Department of Agriculture and Consumer Services; FNAI = Florida Natural Areas Inventory

[c] listing agencies other than FCREPA are noted next to species designation




Source: Adapted from [JPL 1996-A]

Figure 3-6 Potential Occurrence of Threatened or Endangered Species Near LC-17

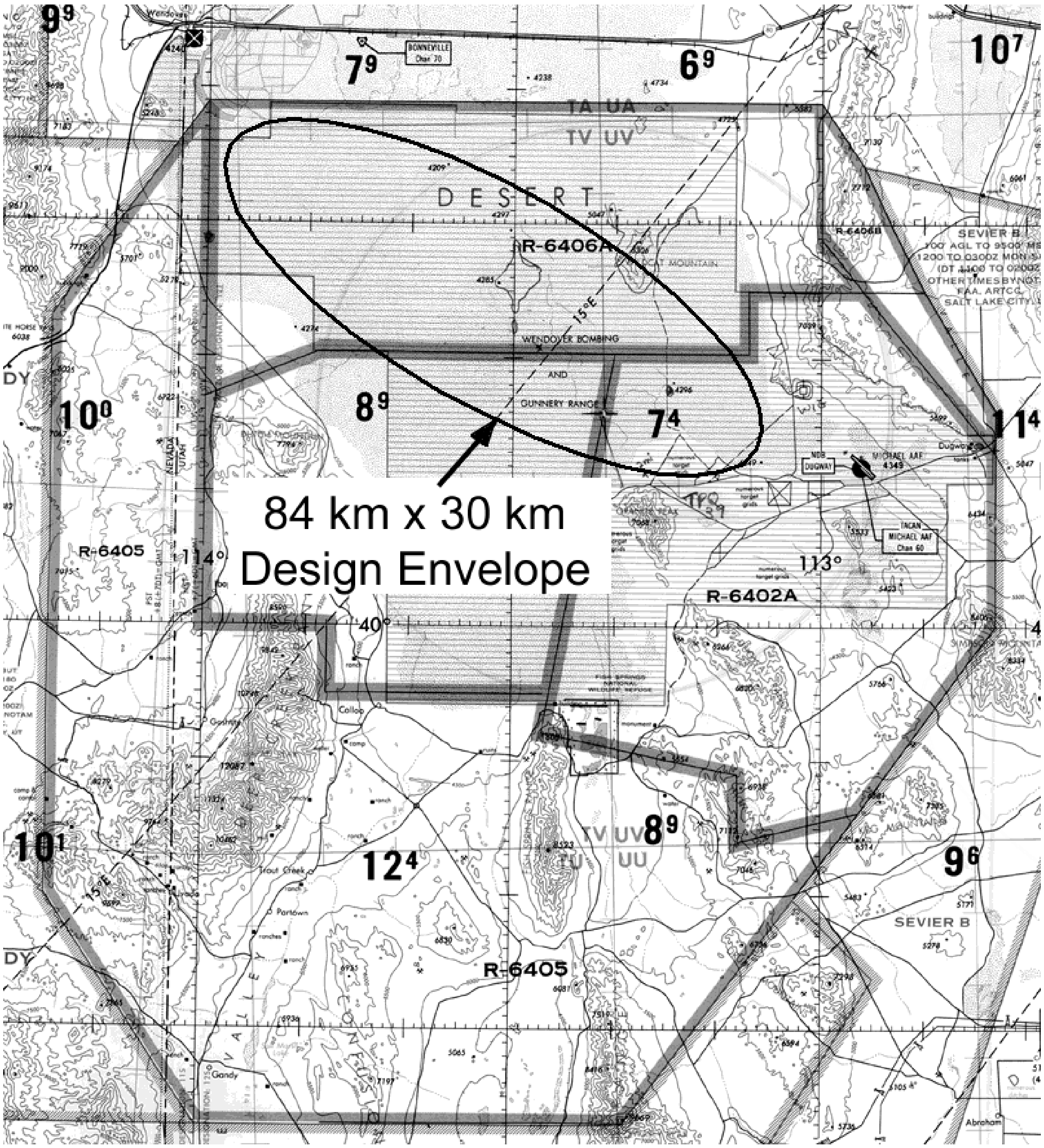
## 3.2 UTAH TEST AND TRAINING RANGE AND SURROUNDING AREA

The information provided in this section is summarized from the reference documents cited in the text. Refer to those references for more complete information and maps of environmental resources, as well as for discussion of Utah State Environmental regulations, required permits, and facilities issues. The level of detail provided herein is commensurate with the potential for impacts from the proposed action and alternatives. This document relies heavily on the following references: Final Environmental Assessment, Comet Space Vehicle Retrieval at the Utah Test and Training Range, [USAF 1993-A]; Environmental Impact Statement for Commercial Reentry Vehicles [DOT 1992]; and for in-depth information on Utah Test and Training Range (UTTR) and the surrounding area, the reader is referred to the Final Range Management Plan for the Hill Air Force Range and Wendover Air Force Range of the Utah Test and Training Range, dated 4 December 1996. [USAF 1996-A]

### 3.2.1 REGIONAL AND LOCAL ENVIRONMENT AROUND UTTR [USAF 1993-A, USAF 1996-A]

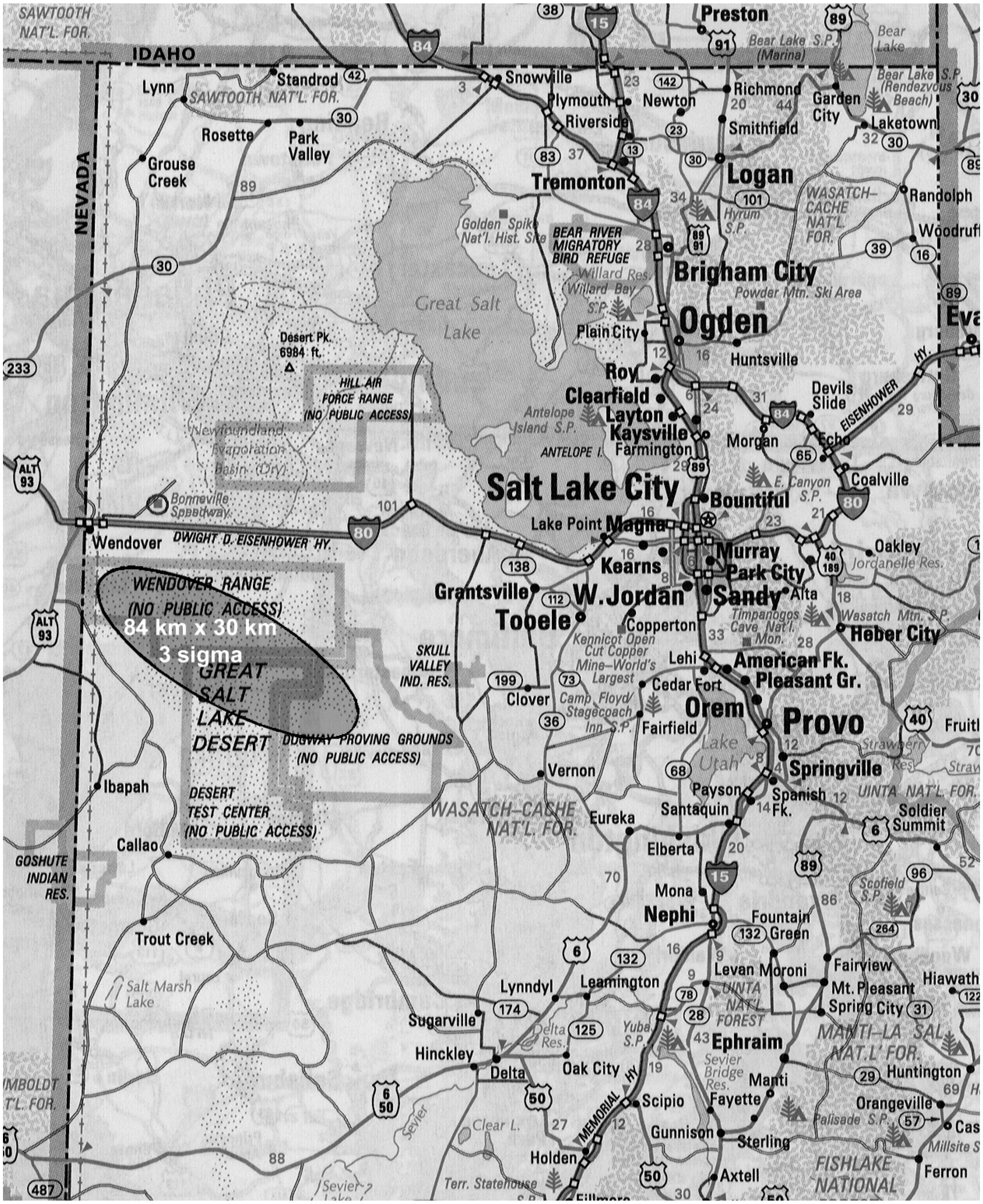
Utah Test and Training Range is in Northwestern Utah, between the Great Salt Lake and eastern Nevada, and covers an area approximately 338 km (210 mi) long and 161 km (100 mi) wide. Formerly called the Ogden Air Logistics Center (ALC) Test Range, UTTR is composed of both airspace and ground withdrawn from public use by the U.S. Department of Defense (DoD). It consists primarily of special-use airspace designated for military flight activities. The special-use airspace includes restricted areas, generally reaching to a height of 17.7 km (58,000 ft) mean sea level (MSL), and military operations areas (MOAs) varying in height from 2 km (6,500 ft) MSL up to, but not including 5.5 km (18,000 ft) MSL. Strictly defined, North UTTR (NUTTR) and South (SUTTR) refer to the UTTR airspace north and south of Interstate Highway 80 (I-80) between Salt Lake City and eastern Nevada and above the UTTR ground components managed by the U.S. Air Force (USAF or AF), as well as above Dugway Proving Ground (DPG), (managed by the U.S. Army), other nearby public lands (primarily managed by the Department of the Interior's [DoI] Bureau of Land Management [BLM]). A supersonic operating area overlies a portion of the South Range restricted area and MOAs where the proposed Genesis recovery area is located (Figures 3-7 through 3-9).

A portion of UTTR includes lands owned by the USAF and the US Army. The remainder of the land underlying the special-use airspace consists of public land administered by the BLM, and the U.S. Fish and Wildlife Service, the State of Utah, the State of Nevada, the Goshute Nation, the Skull Valley Band of Goshutes, and numerous private holdings. The land within the Region of Interest (RoI) for the proposed Genesis mission footprint is that mostly controlled by DoD. An extremely small section of land is controlled by the BLM.



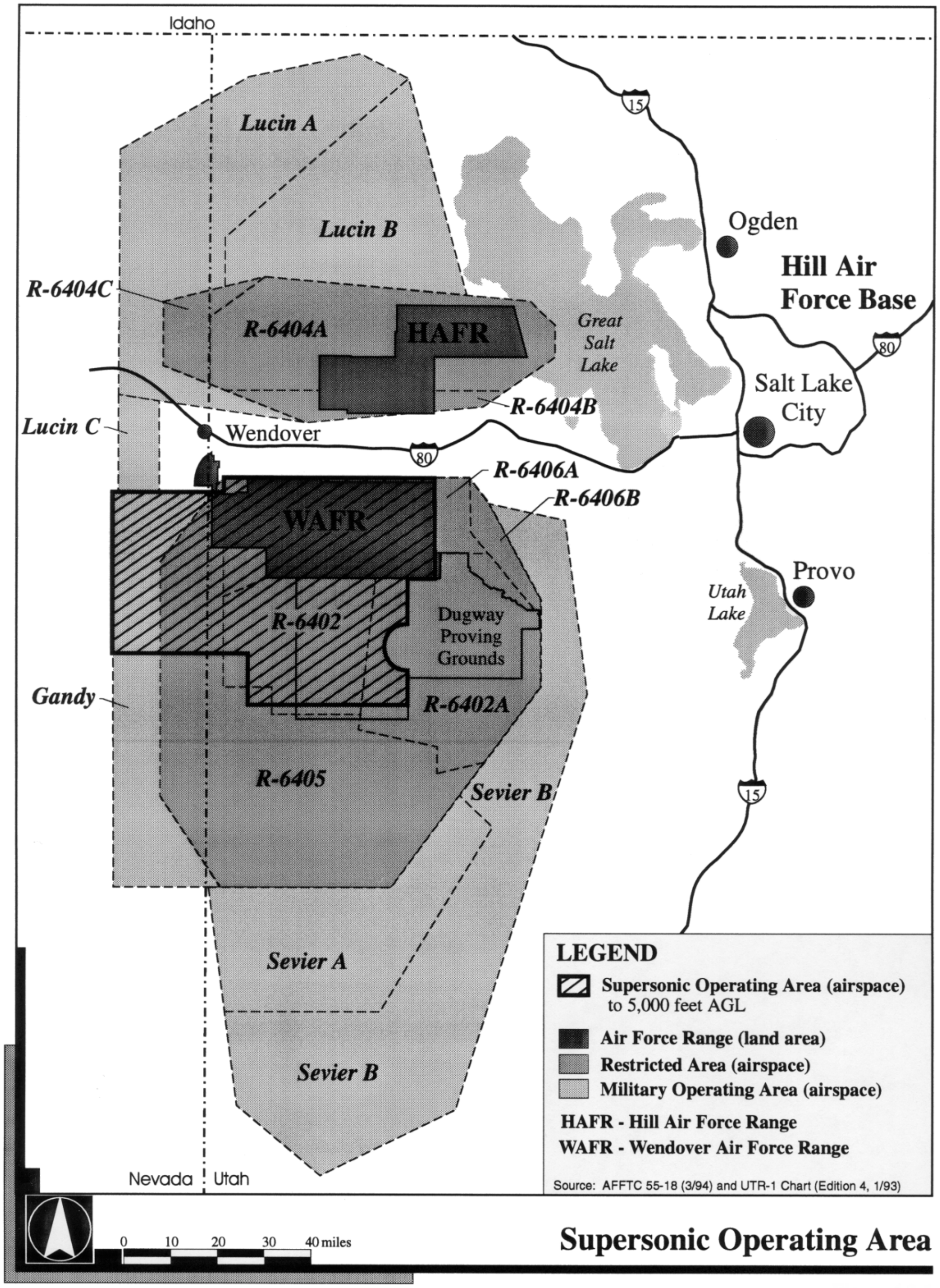

Source: [JPL 1999-E]

Figure 3-7. UTTR with Proposed Genesis 3-Sigma Recovery Footprint Superimposed




Source: [JPL 1999-E]

Figure 3-8. Location of UTTR Relative to Region of Interest - Genesis Recovery Footprint Superimposed




Source: [USAF 1996-A]

Figure 3-9. UTTR Supersonic Operating Area

Since World War II, the UTTR area has been used for military training and bombing. The North Range, previously known as Hill Air Force Range (HAFR), was consolidated with Wendover Bombing Range in the South Range to form UTTR. At the present time, UTTR supports a variety of Air Force test and training missions, including ordnance testing, air-to-ground training, air-to-air combat training, and laser targeting. Dugway Proving Ground underlying a portion of the South Range (which includes Wendover Air Force Range [WAFR]), supports a variety of Army activities, including artillery training and testing of obscurants. The safety zone area (i.e., 3-sigma recovery footprint) identified for the proposed action includes the Wildcat/Kittycat air-to-ground target complex, ordnance emergency jettison/salvo area, emergency fuel dump area, and laser training targets.

UTTR has unique characteristics, such as its large size and therefore, large safety footprint; its somewhat simplistic ecosystems and therefore, relatively diminished environmental resources to sustain impacts from range activities; and its isolation from population centers and therefore, avoidance of public annoyance and safety concerns. In this age of military base closures, it is considered extremely unlikely that all current activities would be transferred from UTTR.

### 3.2.1.1 Population Distribution and Employment [NASA 1997-C, USAF 1996-A]

There is no civilian population within the proposed Genesis recovery area. The nearest populated areas are Wendover to the northwest, Goshute and Callao to the southwest, and Dugway to the east. A total of 1,761 people live on Dugway in 471 households. Nine hundred seventy-seven of those work on the base, 418 work for the federal government, 210 work for private companies, and the remainder work for local or state Governments or are self-employed. There are 443 children between the ages of 3 and 17 enrolled in schools on the base. [NASA 1997-C] Dugway is located in Tooele County, which has a total resident population (as of 1995) of 29,263 people. The civilian labor force is 12,515 people, and the unemployment rate is 4.8 percent. Personal per capita income is just over $15,000. Based on the Environmental Justice screening analysis NASA conducted for its X-33 program using 1990 Census data, 39.7 percent of the total households in Tooele County were below the low income threshold, compared to the U.S. average of 41.8 percent, and 22.0 percent were below the very low income threshold, compared to the U.S. average of 24.3 percent. Roughly 11.3 percent of Tooele County residents qualified as persons below the poverty level, compared to the U.S. average of 12.8 percent. The minority population was 13.9 percent, compared to a U.S. average of 24.3 percent. [NASA 1997-C]

Other settlements in the area include a number of small communities near NUTTR. Although official census estimates are unavailable, population estimates are as follows: Park Valley (200), Grouse Creek (175), Lin (10), Etna (15), Montello (200), Oasis (west of Wendover, 400-500). Near SUTTR are Ibapah (100), the Goshute Indian

Reservation (100), Gold Hill (12), Callao (50), Trout Creek (35), Partoun (200), Gandy (4), Pleasant Valley (also known as Uvada, 25), and Eskdale (utopian community, 300).  There is a remote repair site for the railroad near Lakeside, therefore, on any given night, there might be up to twenty railroad people staying there for the night.  Several ranches and agricultural and mining operations may be found near these small communities.  (See Figure 3-8.)

#### 3.2.1.2 Land Use [USAF 1993-A, USAF 1996-A]

The majority of lands within the WAFR and HAFR boundaries are mud flats and sand dunes.  Approximately 98 percent of the total land base in the ranges is unimproved. WAFR includes lands west of the Cedar Mountains, north of Dugway, and generally east of the Utah-Nevada state line.  This range is mostly salt flats, which are almost completely devoid of rocks, soil, or plant life.  There are no permanently staffed facilities on WAFR.  An irregularly shaped, contiguous property parcel is attached to the main WAFR property, immediately adjacent to Wendover and extending into Nevada.  This parcel includes facilities that were historically part of Wendover Field, an installation that was extensively used during World War II, as well as Wendover Air Field, which was quit claim deeded to the City of Wendover in 1977.  The airfield has two runways and is still available for both military and commercial use; however, there are no repair or hanger facilities available.  [USAF 1996-A]

Dugway Proving Grounds consists of a total of 803,000 acres (3,264 sq km, 1256 sq mi), 300 acres (1.21 sq km, 0.47 sq mi) of which are improved land, 536 acres (2.17 sq km, 0.84 sq mi) of semi-improved land, and the remaining acreage is unimproved. The primary mission of the facility is to research, develop, test, and evaluate chemical warfare and biological defense systems; as well as flame, incendiary, and smoke obscurant systems.  Dugway is also used extensively for a wide variety of training programs.  Michael Army Airfield (MAA) is an active facility used daily for numerous landings and takeoffs by aircraft as large as or exceeding the size of a Boeing 747.  The airfield is also designated as an auxiliary landing facility for the Space Shuttle should conditions at all primary landing areas be unusable when the Space Shuttle must return.  [NASA 1997-C]

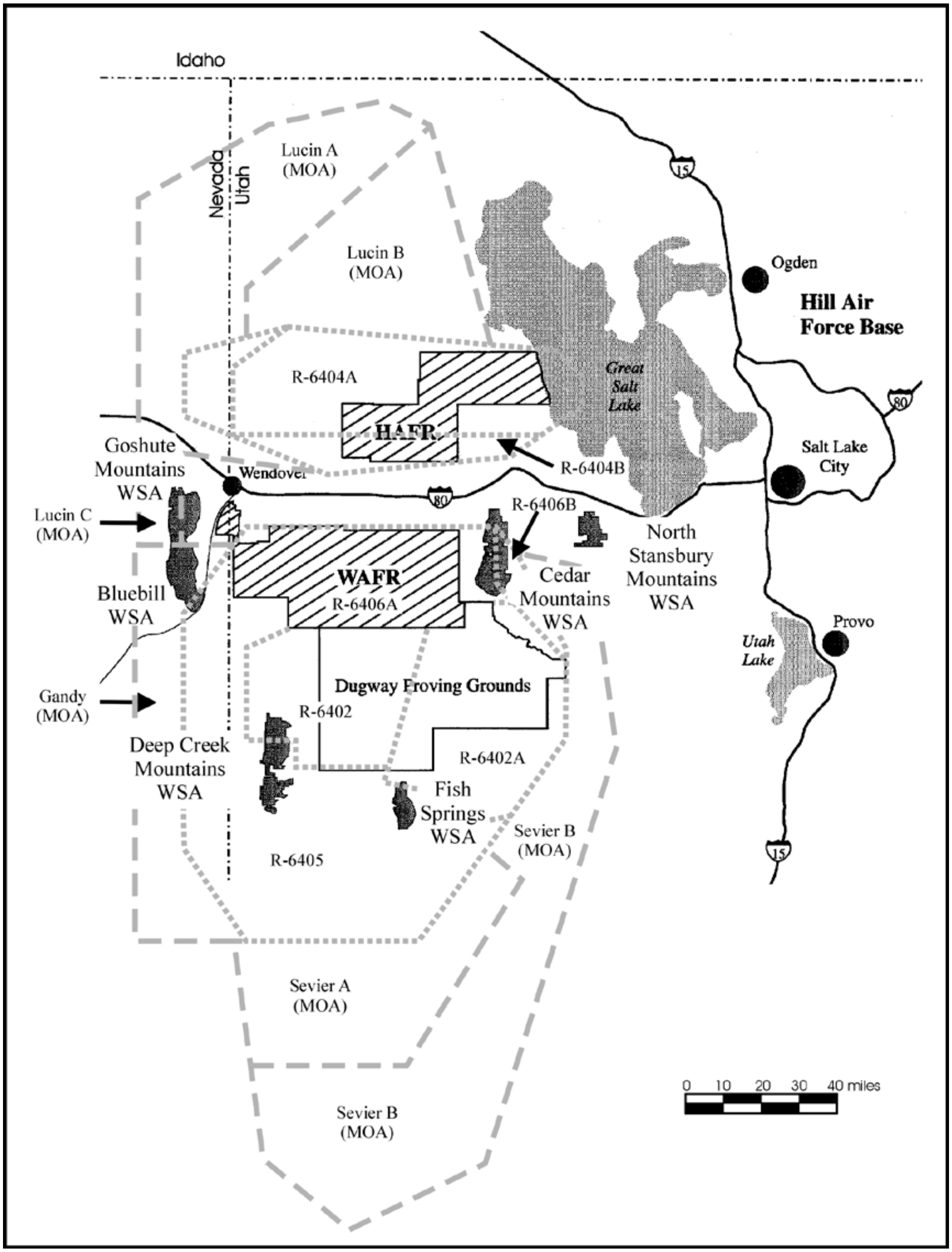
The lands adjacent to UTTR are owned by federal, state, and tribal governments and by private individuals.  They have only limited economic resources and their attractions are not readily accessible to the public. They are used to a limited extent for commercial and residential purposes and for recreation, and are supported by a limited infrastructure.  Land uses include cattle and sheep grazing, mining, and recreation.  The proposed recovery area (ROI) (oval in Figures 3-7 and 3-8) comprises DoD land used for military testing and training activities.  The land base of HAFR and WAFR is approximately 928,000 acres (3,756 sq km, 1450 sq mi) (HAFR has 351,539 acres [1,422 sq km, 549 sq mi]; WAFR has 576,157 acres [2,331 sq km, 900 sq mi]).  WAFR shares approximately 48 km (30 mi) of common boundary with DPG, which is managed by the Army.  Together with DPG, these land areas comprise over 1,700,000 acres (6,879 sq km, 2,656 sq mi), while the air space of UTTR occupies approximately 3,000,000 acres (12,141 sq km, 4,688 sq mi). No grazing occurs on DoD land in the range.

BLM lands in the vicinity of HAFR and WAFR are managed for multiple use, as directed under the Federal Land Policy and Management Act of 1976. These uses include livestock grazing, support of wildlife, dispersed and developed recreation, and mining.

Eleven parcels of federal land within Utah and within the vicinity of UTTR have been identified as Wilderness Study Areas (WSAs) for potential inclusion in the National Wilderness Preservation System. Of the 11 WSAs in the West-Central region, the 50,500-acre Cedar Mountains area approximately 8 km (5 mi) east of WAFR, the 52,500-acre Fish Springs area approximately 55 km (34 mi) south of WAFR, and the 68,910-acre Deep Creek Mountains area approximately 29 km (18 mi) south of WAFR are the closest to WAFR and are within the UTTR airspace. The Swasey Mountain, Howell Peak, Conger Mountain, Notch Peak, King Top and Wah Wah Mountain WSAs are also all within the UTTR airspace. The closest WSAs in Nevada, the Goshute Mountains WSA and Bluebell WSA, are about 97 km (60 mi) north of Ely in the Cherry Creek Mountain portion of the Egan Range, and less than 3.2 km (2 mi) west of WAFR. Other nearby areas, which were considered as WSAs in the West-Central Regional Study Group, but did not meet all of the wilderness characteristics criteria, also exhibit many wilderness qualities. These areas include the Newfoundland Mountains, the North Salt Desert, Big Creek, Dry Canyon, Big Hollow, the Onaqui Mountains, north Cedar Mountains, the Silver Island Mountains, the Dugway Mountains, and areas partially in Nevada (NV), such as Ferber Flat (Figure 3-10).

The State of Utah owns four sections of land, each one square mile, or 640 acres. These are within most of the townships of public land (BLM) in west-central Utah. These sections are known as state school lands, and they are managed by the State for the benefit of the State's public schools. In general, these sections are offered, mostly through leases, for enterprises (e.g., mining, forestry) to generate income for the State's schools. While there were state school trust inholdings on HAFR and WAFR at one time, all of the inholdings have been acquired by DoD and there are currently no school trust inholdings within the ranges. In addition, there are some State lands adjacent to the Great Salt Lake near the eastern boundary of HAFR.

In the immediate vicinity of UTTR there is little industrial, commercial, or residential development. Some industrial uses on lands adjacent to the ranges include minerals extraction and processing, mining, landfills/waste incineration, and brine shrimp collection. Mining activity occurs just south of DoD lands, and current operations include gold, silver, barite, fluospar, and beryllium. Solid waste landfill and waste incineration




Source: [USAF 1996-A]

Figure 3-10. Wilderness Study Areas Nearest UTTR facilities and a low-level nuclear waste landfill are located between HAFR and WAFR along the I-80 corridor. There are currently no producing oil or gas fields or wells in the area, and exploration activity has been sporadic.

The only significant commercial development in the immediate vicinity of UTTR is at Wendover. Casinos, hotels and motels, service stations, stores, recreational vehicle camps, and related tourist facilities are found there. Wendover is divided by the Utah-Nevada state line into Wendover, Utah (population 1,127) and West Wendover, NV (population 2,007); gambling is allowed in West Wendover. The city is mostly known for its casinos and entertainment, and much of the trade and economic activity is related to gambling.

#### 3.2.1.2.1 Recreation

Recreation on lands adjacent to and near UTTR boundaries is generally associated with the mountain ranges, springs, and seeps in the basin. The Deep Creek Mountain range, and the associated Deep Creek Mountains Wilderness Study Area, are administered by the BLM, but little has been done to facilitate recreationists. To date, there are no improvements. There are only five miles of trail in the entire range, and none of those five miles is maintained. There are no primitive or developed campgrounds, very few dirt roads to the base of the mountain, and no four-wheel drive vehicles are allowed access. The Knolls is a BLM recreational area along the north boundary of WAFR. Some encroachment of all-terrain vehicles from this area into the range occurs. There have been no major conflicts regarding the use of UTTR for recreational activities because the range is remote, the nearby population is sparse, and there are large tracts of nearby land available for public access. Specific areas that are popular for outdoor recreation, such as the Blue Lake area on the western edge of WAFR, have been separated out of the range boundaries and made available for public recreational activities. In general, however, UTTR lands have been closed to public use for decades.

Some livestock grazing occurs on adjacent BLM lands, and some roads on HAFR are used for access to these grazing allotments. No grazing, except for this limited-access use, is permitted within the range boundaries. Cattle and sheep are grazed over much of the public land in the vicinity of UTTR.

The Bonneville Salt Flats in Tooele County are also managed by the BLM. This area is internationally renown as a speedway, and numerous land speed records have been set here. The Salt Flats are found approximately nine miles southwest of HAFR (the racetrack extends even closer), and are accessed from I-80.

Hunting is a popular recreational activity in Utah, and the mountains near UTTR, such as the Stansbury and Cedar Mountains, are used very often by hunters during the October hunting season. In addition, the marshes, sloughs, and wetlands near the Great Salt Lake and the boundaries of HAFR offer opportunities to waterfowl hunters. Some upland game bird hunting may also occur near the outer fringes of the area, but this use is probably minimal. Hunting visitation for Fish Springs Northwest Reserve for the 1997 season numbered approximately 1200. Recreational visitation to the Stansbury and Deep Creek Mountain ranges and to Fish Springs would be in excess of 5,000 visits annually.

3.2.1.2.2 Infrastructure

The Salt Lake City metropolitan area is the largest populated area in the region. Denver, Colorado, is about 805 km (500 mi) east; Las Vegas, NV, is about 966 km (600 mi) south, and Boise, Idaho, is nearly 644 km (400 mi) northwest of UTTR. The Salt Lake International Airport is about 81 km (50 mi) east (by air) from the eastern boundary of HAFR. Several transportation corridors are in the area, including two railroad corridors: the Southern Pacific Lucin Cutoff railway route approaches within 5 km (3 mi) of the northern boundary of HAFR near the Lakeside Mountains, and the Western Pacific railway right-of-way about 10 km (6 mi) north of and parallel to the northern boundary of WAFR. Several county roads afford public access to BLM lands and other areas in the west desert and Great Salt Lake in the vicinity of UTTR. U.S. Highway 93 near Wendover, NV, is near the western boundary of WAFR.

The main access route to both HAFR and WAFR is I-80. On both of these ranges, improved access routes are generally utilitarian and associated with specific, frequent activities. Therefore, access is good in the eastern portion of HAFR. Primarily access is provided by a county road that runs parallel to the west side of the Lakeside Mountains and across HAFR lands and connects to a network of improved roads that link facilities in this area.

Elsewhere on the ranges, ground vehicular access is difficult because the area is isolated and undeveloped, the environment is harsh, and there has been a long-term policy of limiting public access. On the Western side of the range, access is via Nevada State Highway 93A and then county roads through BLM land to the WAFR boundary. Some of the county roads that pass through BLM lands in this area follow an abandoned railroad grade. Much of the perimeter of the range is fenced. While an unimproved road runs parallel to much of the fence line, locked gates on the roads that lead into the ranges prevent unauthorized entry.

Minimal information regarding the use of fuels and utilities by WAFR and HAFR is available. When the West Desert Pumps, found just north of HAFR, were built in 1987, a natural gas line was installed. Because of the proximity of this line to existing facilities, natural gas was provided to Oasis, and HAFR is in the process of converting some of their utility use at Oasis to natural gas. In addition, a generator station that currently uses diesel fuel, is located on the west side of the WAFR/Dugway boundary road. It provides power to the Sand Island Target Complex.

Electrical power for DPG comes solely from Utah Power and Light Company in Salt Lake City and is routed from the Tooele-Stockton Distribution Center. Transmission is over a single set of aboveground lines for 110 km (68 mi). DPG consumes less than one percent of Utah's power and light annual production. [NASA 1997-C]

The DPG telephone system is owned and operated by the Division of Information Management, Dugway, and connects with U.S. West Communications. There are 24 two-way circuits to Salt Lake City, 24 two-way circuits to Tooele, and commercial long distance. There are also 17 Defense Switch Network circuits that provide direct official communications with Defense Switch Network subscribers (both CONUS and OCONUS [continental U.S. and outside continental U.S.]) and ten federal telephone system (FTS)-2000 circuits with Integrated Services Digital Network Primary Rate Interface (ISDN PRI) capability. [NASA 1997-C]

Heat is primarily supplied to DPG with No. 2 fuel oil, although Nos. 5 and 6 fuel oils are used if there is a critical shortage of No. 2. Propane is used to ignite oil-fired boilers, heat some residences in English Village, and heat remote trailers. Generators and heavy-duty vehicles are run with diesel fuel. [NASA 1997-C]

#### 3.2.1.3 Regional Economic Base

While UTTR is fairly isolated, on-site activities do affect the economies of nearby counties. The presence of Hill Air Force Base (HAFB) and supporting facilities, including UTTR, has a dramatic socioeconomic effect on the Wasatch Front specifically, and on Utah as a whole. Because UTTR is an integral part of HAFB operations, a brief synopsis of the HAFB influence on the UTTR setting is provided here. While the impact of Dugway Proving Ground to the Utah economy is not nearly as substantial as is HAFB, it contributes significantly to Tooele County, which contains most of DPG and WAFR.

In 1990, HAFB was the largest employer in Utah, retaining approximately 5,000 military personnel and approximately 14,000 civilian personnel. The civilian workforce is primarily recruited from schools, colleges, and the general Wasatch Front population. The remainder of the workforce is comprised of civil service or other civilian employees. The annual payroll generated by HAFB is estimated to be $602,149,511 and local contracts inject more than $1.5 billion into Utah's economy. [USAF 1996-A] These wages are distributed throughout the community through local purchases of goods and services, state and local tax revenues, and personal individual contributions of time, money, and resources to the community at large. Other socioeconomic effects include the presence of retirees in the community and the multistate regional service that HAFB facilities provide.

Many of the civilian and military personnel who spent all or part of their careers at HAFB retire in the area. Estimates in 1990 placed approximately 20,000 civilian and an additional 8,000 military retirees in Utah. About half of the military retirees are estimated to reside in the economic zone of HAFB; the remainder reside in various locations throughout the state. One of the attractions for military retirees is HAFB, which includes amenities such as a base exchange, commissary, clubs, medical facilities, and golf course. Another of the many services HAFB provides to military personnel, their dependents, and military retirees is health care through an on-base hospital. The service area for this hospital includes Utah and parts of Idaho, Nevada, and Wyoming.

The HAFB runway is one of the busiest runway operations in the Air Force and is the busiest air traffic control tower in the Air Force Logistics Command (AFLC). Runway facilities there can serve almost every type of aircraft in the Air Force Inventory. A substantial number of the planes using the HAFB runways are headed for UTTR.

#### 3.2.1.4 Environmental Justice

UTTR is also under the jurisdiction of the Air Force and as such falls under its policies for environmental justice. The Genesis Mission must comply with NASA's policies as well. Please refer to section 3.1.1 for a discussion of this topic.

#### 3.2.1.5 Health and Safety [USAF 1993-A]

The primary safety issues related to the proposed recovery area concern activities at UTTR which may pose a hazard to aircraft or ground parties. These include military aircraft operations, ordnance use, and hazardous materials contained at DPG.

#### 3.2.1.5.1 Military Aircraft Operations and Ordnance Use

Hazardous military aircraft activity at UTTR is separated from civil aircraft through the designation of restricted airspace areas. These areas are under the control of UTTR air traffic control (Clover Control). Nonparticipating aircraft are restricted from flight through these areas during active periods unless clearance has been obtained from Clover Control. The proposed Genesis recovery area would be within restricted area R-6406A and sectors L, W, and 6. Use of this airspace must be scheduled through a Range Squadron within the 388th Fighter Wing.

Michael Army Airfield is currently an active military flightline with numerous military landings and departures daily. A comprehensive occupations and flight safety program managed by DPG is in place to ensure operations are conducted in a safe manner and risks are minimized. Hill AFB near Salt Lake City controls the airspace and is responsible for range safety on UTTR. There is presently sufficient fire protection and crash rescue capability at the airfield. Medical treatment is provided on Dugway by a limited medical clinic. More extensive health care services are provided by the Hill AFB Hospital approximately 161 km (100 mi) away; hospitals in Tooele, Utah, approximately 69 km (43 mi) away, and Salt Lake City approximately 137 km (85 mi) away. [NASA 1997-C]

The only proximity hazard to vehicle operations is the Carr Facility, a chemical research laboratory located 1.0 km (0.6mi) south-southeast from the runway. This lab is designated a no flyover area, and is not within the Genesis 3-sigma footprint. [USAF 1996-A]

The proposed Genesis safety zone (3-sigma footprint) contains the Wildcat and Kittycat target complexes. High explosives are delivered at Kittycat. Wildcat is used only for inert weapons. Test targets TS-1, TS-2, and TS-4 lie along the southeastern edge of the safety zone. [USAF 1996-A]

#### 3.2.1.5.2 Hazardous Materials and Hazardous Waste [NASA 1997-C]

Petroleum products are stored and handled in compliance with Dugway Standing Operating Procedures and Army Regulations. There are 131 tanks of No. 2 fuel oil with a total capacity of 4.2 million liters (ℓ) (1.1 million gallon [gal]) and 125 propane tanks. The four largest tanks have a capacity of 3.775 ℓ (997 gal) each, and the remaining have capacities of approximately 87 ℓ (23 gal) each. Seven large petroleum storage tanks are above ground and are diked to contain a total spill. Petroleum storage facilities, with the exception of three automobile gasoline tanks at the Post Exchange station, are the responsibility of the Public Works Directorate.

Other hazardous materials at DPG include boiler blowdown chemicals (caustic soda, phosphate, and tannin), chlorine used for water treatment, pesticides, and polychlorinated biphenyls (PCBs). Chemical surety materials and critical binary compounds are stored within the Carr Facility Chemical Exclusion Area. These materials include chemical agents used for test activities and unserviceable chemical munitions awaiting demilitarization.

Dugway also holds limited amounts of radioactive waste in containers stored in the East Granite Holding Area. A storage site approved by the Nuclear Regulatory Commission is not readily available. The holding area is approximately 161 acres (0.65 sq km, 0.25 sq mi) and is bounded on three sides by steep canyon walls rising 20 to 30 m (66 to 98 ft) above the canyon floor. The fourth side is cordoned off by a security fence.

Stock cultures of infectious biological agents and some toxic by-products are stored in Building 2028 and Baker Laboratory for laboratory research on biological defense and epizoological studies. These materials are stored and handled in accordance with appropriate Standard Operating Procedures for these types of materials.

Dugway Proving Grounds is classified as a large quantity hazardous waste generator (more than 1,000 kg/month [2,200 lb/month]) under the provision of the Utah Waste Management Rules. Management of hazardous wastes generated at DPG is administered by the Federal Directorate of Environmental Programs (FDEP) under the direct supervision of the installation commander. All hazardous waste generated or managed by activities on DPG is subject to and managed to achieve compliance with the Resource Conservation and Recovery Act (RCRA) of 1976, and the Hazardous and Solid Waste Amendments of 1984, as administered by the U.S. EPA, the State of Utah Department of Environmental Quality (DEQ) hazardous waste management rules, U.S. Army Regulations 200-1 and 420-74, and all other pertinent federal, state, and local laws, and Department of the Army regulations.

The Dugway Proving Ground Hazardous Waste Management Plan, completed in August 1996, prescribes policies, responsibilities, and procedures for management of hazardous wastes on Dugway. The types, quantities, and intended users of all hazardous materials that enter the installation are identified and tracked by the Compliance (Safety) Office to determine which materials are converted to hazardous waste in order to aid in their management in accordance with all applicable regulations. Material safety data sheets documenting handling and disposal information for the hazardous materials are provided and maintained in master files by the Compliance Office.

Dugway Proving Grounds presently operates two hazardous storage facilities, the Central Hazardous Waste Storage Facility located west of Fries Park, and Igloo G located in the Carr Facility. There is one hazardous waste treatment facility (the open burning/open detonation area), and 42 miscellaneous hazardous waste management units. These facilities and units would manage hazardous waste under Dugway's single, installation-wide RCRA permit issued by the Utah DEQ on 15 March 1994, once permit modification applications are approved.

### 3.2.1.6 Archeological and Cultural Resources [USAF 1993-A, USAF 1996-A]

A wide range of prehistoric, historic, and paleontological resources occurs on and near UTTR. Cultural resource surveys have resulted in the identification of more than 130 archeological sites within 48 km (30 mi) of the HAFR and WAFR boundaries. Only since 1991 have HAFR and WAFR themselves been subject to any large-scale, stratified surveys. To date, these intense, pedestrian surveys have covered 25 percent of the ranges. Seven of these higher-density areas have been recommended for nomination as National Register Districts (NRDs). All archeological sites located within an established NRD are considered contributing to that district and are therefore eligible for listing on the National Register of Historic Places (NRHP). Of the open sites located outside the boundaries of a NRD, it is likely that only those with recognizable features, diagnostic artifacts, or buried deposits will be considered eligible for inclusion on the NRHP. Proposed actions occurring within these NRDs will trigger evaluations even though they have already been surveyed. Most of the land within these districts contains no or very few resources and restricted development should be possible. Both the Wildcat and Kittycat ranges contain numerous cultural resource sites. However, most of UTTR, which consists of mud and salt flats or relatively recent eolian deposits, has virtually no potential for paleontological resources. The proposed Genesis recovery location (RoI) is in an area considered to have low potential for archaeological resources. Resources of importance to American Indians are generally coincident with high sensitivity archaeological areas.

The visual resources of the lands comprising and adjacent to UTTR are typical of the Great Salt Lake Desert. They are characterized by isolation, remoteness, expansive open space, and dramatic basin and range landforms.

## 3.2.2 NATURAL ENVIRONMENT [USAF 1993-A, USAF 1996-A]

### 3.2.2.1 Meteorology and Air Quality

#### 3.2.2.1.1 Meteorology

The climate of UTTR is characteristic of the west desert region, and is characterized by hot, dry summers, cool springs and autumns, moderately cold winters, and a general lack of year-round precipitation. The valleys of this region are considered arid. During winter, storm systems are separated by 2- to 3-week periods of stagnant high-pressure systems that tend to trap cold air in the valleys and create fog. Summer thunderstorms have the potential to cause extensive flash flooding and subsequent soil erosion. [USAF 1996-A]

The average annual precipitation, which varies significantly throughout the region due to various elevations and topography, ranges from 13 cm (5 in) in the valleys and low lying mud flats to 76 cm (30 in) in the mountains.

Temperatures in the region are highly variable, although Great Salt Lake, located to the east of UTTR at an elevation of approximately 1.3 km (4,200 ft) MSL, has a moderating effect on temperature in the area. The summers are a little cooler and the winters are a little warmer on the ranges because of the lake's presence. Average daily maximum temperatures range from -1 ºC to 10 ºC (30 ºF to 50 ºF) in January and from 27 ºC to 39 ºC (80 ºF to 100 ºF) in July, while average minimum daily temperatures range from -12 ºC to -7 ºC (10 ºF to 20 ºF) in January and from 10 ºC to 21 ºC (50 ºF to 70 ºF) in July. At DPG, in SUTTR, the daily temperature can range from below 16 ºC (60 ºF) to more than 39 ºC (100 ºF) during July and August. Records from the National Weather Service at Dugway indicate that the highest recorded temperature was 41 ºC (105 ºF) and the lowest recorded temperature was -30 ºC (-22 ºF) for a period of record from January 1951 to December 1975. For this same period of record, the average annual temperature ranged from 9 ºC to 11 ºC (48 ºF to 52 ºF). The temperature difference between winter and summer may be as much as 54 ºC (130 ºF). During the summer, temperature ranges from 27 ºC to 41 ºC (80 ºF to 105 ºF). The area averaged 151 frost-free days annually between 1951 and 1964. The relative humidity in the summer fluctuates between 13 and 50 percent. In winter, the fluctuation is from 65 to 95 percent. [USAF 1996-A]

The north-south trending Wasatch Range strongly influences the wind patterns in northern Utah and forms a barrier just to the east of the Ogden area, while the Weber River Canyon northeast of Hill Air Force Base and east of UTTR creates a predominant wind from the east-southeast throughout the year. Winds from that direction occur more than 35 percent of the time due to the strong flow of air that frequently comes down the mountain slopes and out of the canyon toward the Great Salt Lake. During the day, the return wind flow from the lake and valley floor is less unidirectional and more representative of the valley wind flow.

In the vicinity of UTTR, the general north-south orientation of the mountain ranges results in valley surface winds from the north or south. This pattern can be modified at night by downslope winds that are produced by cool, dense air flowing from higher elevations toward the valley floor. Light winds, originating locally, blow over the valley floors in a southeasterly direction by night and a northwesterly direction by day. Winds near the mountains usually have very different local effects and do not reflect the general nighttime southeast and daytime northwest patterns. The average wind speed as measured at Lakeside and Wendover Stations is 8 to 16 kilometers per hour (kph) (5 to 10 miles per hour [mph]). Spring and fall winds up to 64 kph (40 mph) and winter winds up to 80 kph (50 mph) have been recorded. Winds are from the north-northeast and south-southwest. Just south of WAFR at Dugway, wind speeds range from 3 knots in December to 6 knots from March through June. High winds are common in the area from March to June and November to December, with gusts as high as 120 kph (75 mph). [USAF 1996-A]

#### 3.2.2.1.2 Air Quality

The proposed area in the UTTR South Range is located in Tooele County. Tooele County is considered to be in attainment in that it meets the NAAQS for all pollutants regulated by the Clean Air Act (CAA) and the Utah Air Conservation Act, with the exception of sulfur dioxide ($SO_2$). Portions of Tooele County are in nonattainment for $SO_2$ primarily due to emissions from the Kennecott Corporation copper smelter near Magna. UTTR is located in the portion of Tooele County that is in attainment.

Regulations pursuant to the CAA establish air quality levels for Prevention of Significant Deterioration (PSD) in various classes of areas. Class I, or pristine, areas are the most restrictive and include national parks and wilderness areas. All other areas in the U.S. are classified as Class II. Section 169A of the CAA states that it is a national goal to prevent any further impairment of visibility in Class I areas. The nearest Class I area to the proposed recovery site is the Great Basin National Park, which is more than 161 km 100 mi) from the proposed recovery area.

### 3.2.2.2 Noise

Noise sources on UTTR include vehicle usage, military exercise, aircraft overflights and related support activities. Aircraft noise is prevalent throughout UTTR, and is the most significant source. Depending on the type of aircraft and mission, a wide range of noise levels (frequencies and loudness) can be generated, including sonic booms generated by supersonic flights (flights with maximum speeds of Mach 1 to 5). Approximately 15,000 aircraft movements were recorded in the area of the proposed action in fiscal year (FY) 1992. Average onset-adjusted day-night sound levels (Ldnmr) in the South Range are estimated to range from 50 to 64 decibels (dBA) over most of the range. Isolated areas, primarily over target complexes, are exposed to levels exceeding Ldnmr 65 dBA and, in rare cases above Ldnmr 70 dBA.

Overpressures on the ground are between 0.02 and 0.10 kiloPascals (kPa) (0.5 and 2.9 pounds per square foot [psf]), with occasional focus booms between 0.19 and 0.29 kPa (4.0 and 6.0 psf). At those higher pressures, damage to windows of conventional buildings might be expected, but not damage to walls. The nearest residential community, English Village on DPG, is 16 km (10 mi) east of Michael Army Airfield. In order to reduce potential impacts to residents, aircraft avoid flying within a 6-km (3.4-mi) radius of English Village, and the number of missions flown at night is kept to a minimum. Sustained noise levels for all types of aircraft activity, even at the highest readings, are well within established EPA noise level exposure guidelines.

### 3.2.2.3 Land Resources [USAF 1993-A]

UTTR is characterized by an arid climate, highly variable temperature, and low relative humidity. UTTR is further characterized by a basin and range physiography and by minimal, saline surface water flow (of water that has not transpired or evaporated) into an internal basin where it evaporates further.

#### 3.2.2.3.1 Geology

UTTR lies in the Great Basin region of the Basin and Range Physiographic Province, (Figure 3-11). The geography within UTTR is characterized by mountain ranges oriented in a north-south direction between the Rocky Mountains on the east and the Sierra Nevada Mountains on the west. Between the mountain range and broad flat valleys around the Great Salt Lake is a large, flat alluvial, sedimentary plain. This Province is characterized by fault-block mountain ranges that generally trend north-south and that are separated by flat desert basins. During the late Pleistocene, the area was covered by a large fresh-water lake called Lake Bonneville. At is maximum extent, Lake Bonneville covered an area of approximately 50,000 sq km (19,305 mi) and had a depth of more than 330 m (1,083 ft). [USAF 1996-A]

Land surface elevations generally vary from a high of more than 1.8 km (5,800 ft) MSL in the Lakeside Mountains to a low of about 1.3 km (4,200 ft) MSL along the Great Salt Lake. The nearby Deep Creek Mountains to the southwest and Stansbury

Mountains to the east are 3.7 km and 3.4 km (12,101 and 11,031 ft) in elevation, respectively. Most of UTTR is covered by dry mud flats, with upland areas limited to the Southern tip of the Newfoundland Mountains, northern tip of the Grassy and Lakeside Mountains on NUTTR, and Wildcat and Kittycat (Little Wildcat) Mountains of SUTTR (Figure 3-10). An upland area, called Sink Valley, occurs between the Grassy Mountains and Lakeside Mountains. Surface drainage is primarily away from the mountain areas into the mud flats, which are extremely flat with limited drainage towards the north-northeast to the Great Salt Lake.

The only rocks exposed on WAFR are the Pennsylvanian dolomite and limestone that comprise Wildcat and Kittycat Mountains. These rocks appear to be intruded by igneous rocks that are younger than Pennsylvanian. Exposed rocks are also present just west of WAFR and across the Nevada line in the Snoopy Area and in the Lead Mine Hills. The remainder of WAFR is covered by Quaternary mud flats and some eolian deposits.

3.2.3.2.2 Seismicity

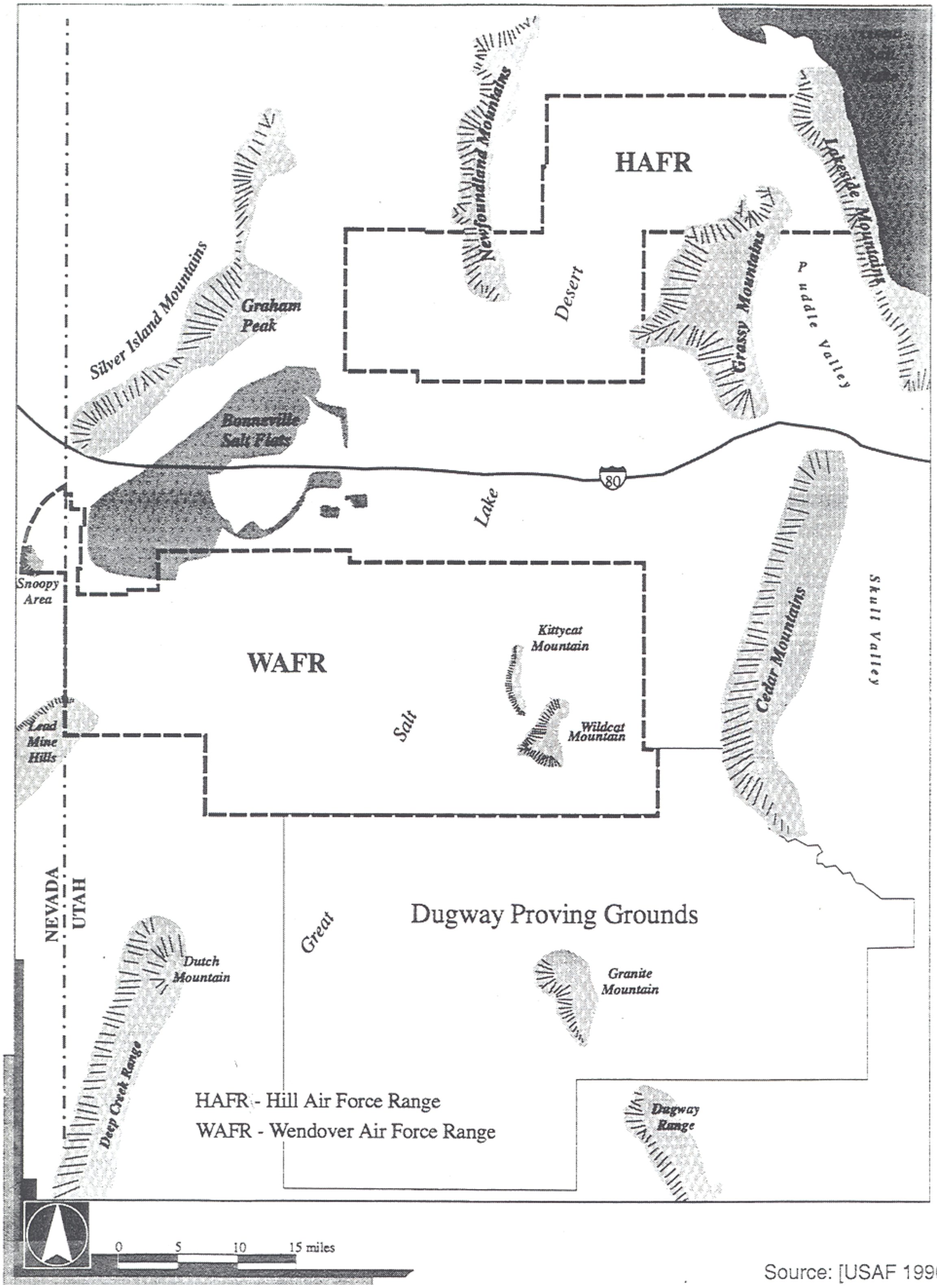
The area around UTTR is seismically active. Historically, there have been 15 earthquakes recorded in Utah that were of Richter magnitude 5.5 or greater. Of these, four have been in the vicinity of the Great Salt Lake. Of the earthquakes that measured magnitude 4.0 or greater, the west desert region had about one-third of the number that occurred east of the Great Salt Lake near HAFB.

Analysis of the northern Utah earthquakes suggest that these earthquakes are shallow seated and affect a small area. In northern Utah, no earthquake of sufficient intensity to cause extensive damage to well-constructed buildings has been recorded.

3.2.3.2.3 Soils

Most of the soils within UTTR are considered to have been deposited under the prehistoric Lake Bonneville, which is thought to have covered the area to an elevation of 1.6 km (5,150 ft). The Great Salt Lake, which comprises the remains of Lake Bonneville, still influences a large part of the soils within UTTR.

UTTR is primarily covered by Playa and Playa-Saltair Complex soils, which are found primarily in the low-lying, flat portions of the range. The playas consist of barren undrained basins that are subject to repeated inundation by salt water and salinization by evaporation of the accumulated water. The surfaces of Playas are often thinly covered by salt crystals and patterned by cracks when dry. The Playa soils have low permeability and drain slowly. Their available water capacity is very low.




Source: [USAF 1996-A]

Figure 3-11. Major Physiographic Features of UTTR

The Saltair soil is formed in alluvium and lacustrine sediments derived from mixed rock sources. The surface layer is typically very pale brown, strongly saline silt loam 20 cm (8 in) thick. The underlying material to a depth of 1.5 m (60 in) or more is white, strongly saline silt loam and silty clay loam. The Saltair soils also have low permeability and drain slowly. Their available water capacity is very low to low.

Most of the remaining soils found covering the slopes and upland areas consist primarily of silt loam, sand, gravelly-sandy loam, thin cobbly loams, and rock outcrops. Most of these soils are alkaline and covered with sparse vegetation. Very few of the soils that cover UTTR are suitable for livestock grazing, rangeland seeding, cropland, recreational uses, or homesite development, due to low forage quality, alkalinity, and frequent flooding. Less than 6 percent of the soils on HAFR are considered fair or good for livestock grazing. Less than half of a percent are fair for range seeding. Nine percent are considered suitable for irrigated crops. Less than half of a percent of the soils are considered suitable for road or building sites. All of these soils are concentrated along the slopes of the northeastern corner of HAFR. Of the soils on WAFR, less than 6 percent are considered fair or better for livestock grazing. Less than 1 percent are considered fair or better for range seeding or irrigated crops. Less than 0.01 percent of the soils are considered suitable for road or building sites. All of these soils are concentrated along the slopes and upland areas on the east and west sides of WAFR. Approximately 3.5 percent of WAFR is covered with dune sand, which occurs only in its northeast corner. [USAF 1996-A]

The soils dominating most of the UTTR area are alkali-mud/salt flats with textures that are generally saline throughout. The proposed Genesis recovery area lies primarily in the Great Salt Lake Desert. Soil materials are strongly calcareous stratified lacustrine sediments of silt, clay and sand containing sufficient amounts of salt to inhibit the growth of vegetation. Silty loam soils dominate near topographic highs within the desert and along the desert margins. Active and inactive gypsum-rich sand dunes overlie the silty loam soils in the vicinity of Dugway Proving Grounds. Near Wendover, gypsum-rich sand dunes are partially covered by the Bonneville Salt Crust.

### 3.2.2.4 Hydrology and Water Quality [USAF 1993-A]

#### 3.2.2.4.1 Surface Waters

Surface water is primarily limited to intermittent streams and drainages. No perennial streams originate on HAFR and WAFR, although there are perennial streams in the Deep Creek Mountains to the southwest. The only flows in the stream channels on the Range are found just below perennial springs and generally infiltrate within a short distance. Most of the precipitation that falls on the area is quickly discharged by evapotranspiration or is stored temporarily as soil moisture and then discharged by evapotranspiration. Some water runs off the steep consolidated-rock slopes of the mountains during and immediately after intense summer thunderstorms and during periods of rapid snow melt. Very little of this runoff reaches the basin lowland below the consolidated areas. [USAF 1996-A]

Surface water in the RoI does not support aquatic communities because it is transitory. Blue Lake and Mosquito Willy's Springs, which are on the west side of WAFR, support aquatic communities, but are not within the proposed Genesis recovery footprint. These are large springs surrounded by extensive wetlands -- the only know perennial springs on WAFR. The only significant water body within the proposed Genesis area is Blue Lake, a desert oasis on the Utah-Nevada border. It is relatively high in dissolved solids as is shown in Table 3-8.

**Table 3-8. Water Quality Data from the Blue Lake Springs Area**

| | Blue Lake Springs North | Blue Lake Springs South | Worldwide River Water Mean |
|---|---|---|---|
| Date of Collection | 10/5/77 | 10/5/77 | -- |
| Water Temperature (ºC) | 27 | 29 | -- |
| Silica – $SiO_2$ (mg/l) | 28 | 28 | 13 |
| Calcium - Ca (mg/l) | 140 | 130 | 15 |
| Magnesium – Mg (mg/l) | 60 | 56 | 4.1 |
| Sodium - Na (mg/l) | 1,400 | 1,600 | 6.3 |
| Potassium - K (mg/l) | 110 | 110 | 2.3 |
| Bicarbonate - $HCO_3$ (mg/l) | 300 | 290 | 58 |
| Sulfate - $SO_4$ (mg/l) | 240 | 250 | 11 |
| Chloride - Cl (mg/l) | 2,300 | 2,500 | 7.8 |
| Hardness as calcium carbonate ($CaCO_3$) (mg/l) (calcium, magnesium) | 600 | 560 | 55 |
| Hardness as $CaCO_3$ (mg/l) (noncarbonate) | 350 | 320 | 7 |
| Dissolved Solids (mg/l) Sum of Determined Constituents) | 4,430 | 4,820 | 90 |
| Specific Conductance (micromhos/cm @ 25ºC) | 7,920 | 8,470 | -- |
| pH | 7.7 | 7.5 | -- |
| Percent Sodium | 81 | 83 | -- |
| Sodium-Adsorption Ratio | 25 | 30 | -- |

Source: [USAF 1996-A]

3.2.2.4.2 Ground Waters [USAF 1996-A]

Groundwater occurs in both the unconsolidated and consolidated rocks beneath UTTR. The range is underlain by three primary aquifers. The shallowest, lying just below the surface, is composed of crystalline salt and lakebed deposits. The fresh-water aquifer is moderately saline but is suitable for culinary use; it lies at a depth of approximately 61 m (200 ft). The third aquifer lies at depths of 306 to 488 m (1,000 to 1,600 ft) below the surface and yields brine. Table 3-9 gives properties of the aquifers beneath HAFR and WAFR.

**Table 3-9. Properties of Aquifers Beneath the HAFR and WAFR**

| Aquifer | Transmissivity ($ft^2$/day) | Coefficient of Storage |
|---|---|---|
| Shallow-brine | 67 to 6,700 | 0.12 to 0.00005 |
| Alluvial-fan | 20,000 to 70,000 | 1 to 0.0005 |
| Basin-fill | 12,400 | 0.0004 |

Source: [USAF 1996-A]

The major groundwater reservoir is the unconsolidated to partially consolidated basin fill. This materials is more than 306 m (1,000 ft) thick, possibly ranging up to 612 m (2,000 ft) thick beneath some areas. This reservoir has been divided into three major aquifers in the region -- shallow brine, alluvial fan, and basin fill. It is best known in the vicinity of Wendover and the three aquifers defined there may be discontinuous throughout the Great Salt Lake Desert.

The shallow-brine aquifer consists of lake bed clay and silt and crystalline salt, and underlies the mud flat area of Playa soils. Although these sediments extend to a considerable depth, only the upper 7.6 m (25 ft) act as an aquifer. Brine moves through the crystalline salt and the fractures in the underlying clay. Recharge to the aquifer is primarily from infiltration of precipitation and lateral inflow from adjacent basins. Discharge from the aquifer occurs by evaporation and by flow into brine-collection ditches. Groundwater flows from the highlands into the mud flats where it evaporates. The total dissolved solids (TDS) in the water of this aquifer are generally greater than 35,000 milligrams per liter (mg/l).

The alluvial-fan aquifer consists primarily of sand and gravel. Recharge to the aquifer is primarily from infiltration of precipitation and subsurface inflow. Discharge occurs by evapotranspiration where the aquifer is shallow, by pumping and flow from wells, and by subsurface outflow. It is not known if this aquifer is present beneath HAFR or WAFR, but if so, it would be found along the flanks of the Newfoundland and Lakeside Mountains.

The basin-fill aquifer consists of older alluvial sediments that underlie most of HAFR and WAFR. These deposits consist of conglomeratic deposits of clay, sand, and gravel that are unconsolidated to well cemented. Recharge to this aquifer is probably entirely by subsurface inflow from adjacent aquifers in the alluvial fans and bedrock. Discharge is primarily from pumping wells.

Information on groundwater is provided by data from two wells completed in the basin-fill aquifer for the HAFR Oasis Complex in the northern subarea of Sink Valley. These wells were completed in the early 1960s and reach a depth of between 91 and 220 m (300 and 723 ft) below ground surface, with a depth to water at the time of drilling of 55 to 58 m (180 to 190 ft) below ground surface. When completed, the wells yielded 300 gallons per minute. Water quality analysis results from samples collected during drilling are summarized in Table 3-10. As of August 1990, the depths to water were approximately 61 m (200 ft) below ground surface and the total dissolved solids in the water ranged from 5,300 to 9,300 mg/l. The water from these potable wells is treated in reverse osmosis units prior to discharge to the water distribution system. [USAF 1996-A] The groundwater at Oasis is also monitored upgradient and downgradient of Hazardous Waste Landfill No. 5, as required by the landfill's RCRA closure permit. Monitoring wells at this location indicate that the depth to water is approximately 121 m (400 ft). Water quality data for this monitoring well are also presented in Table 3-10.

### 3.2.2.5 Biotic Resources

#### 3.2.2.5.1 Terrestrial Biota

The primary plant communities in the UTTR include salt desert shrub, Great Basin sagebrush, pinon-juniper woodland, and upper montane. Vegetation in the salt flats of the proposed recovery area is sparse to nonexistent, especially along mudflats and playas. Infrequent precipitation, occasional flooding, high salinity, and fine-grained soils limit the establishment of vegetation. Some salt-tolerant plants such as iodinebush (*Allenrolfea occidentalis*), pickelweed (*Saliconria rubra*), alkali sacaton (*Sporobolus airoides*), and saltgrass (*Distichlis spicata*) can be found in the salt flat areas.

#### 3.2.2.5.2 Wildlife

UTTR provides a wide variety and diversity of wildlife habitats, ranging from alkaline basins to alpine mountain environments. A general description of wildlife present at the range can be found in the Composite Natural Resource Plan for Hill Air Force Range, Wendover Air Force Range, and Little Mountain Test Facility. Due to lack of water, food, and cover, the salt-desert shrub area proposed for the Genesis recovery operations supports little wildlife, limited primarily to reptiles, such as lizards and snakes, and small mammals.

## Table 3-10. Water Quality Data from Oasis Complex Wells

| Constituent | Oasis Water Supply Well 1 | Oasis Water Supply Well 2 | Landfill No. 5 Monitoring Wells[1,2] |
|---|---|---|---|
| Volatile Organic Compounds (VOCs) (µg/ℓ) | - | - | ND |
| Semivolatile Organic Compounds (µg/ℓ) | - | - | ND |
| Pesticides/PCBs (µg/ℓ) | - | - | ND |
| Herbicides (µg/ℓ) | - | - | ND |
| Organophosphorus Pesticides (µg/ℓ) | - | - | ND |
| Aluminum (µg/ℓ) | - | - | ND |
| Antimony (µg/ℓ) | - | - | ND |
| Arsenic (µg/ℓ) | - | - | 6.1-26 |
| Barium (µg/ℓ) | - | - | ND |
| Beryllium (µg/ℓ) | - | - | ND |
| Cadmium (µg/ℓ) | - | - | ND |
| Chromium (µg/ℓ) | - | - | ND |
| Copper (mg/ℓ) | - | - | ND |
| Lead (µg/ℓ) | - | - | ND |
| Mercury (µg/ℓ) | - | - | ND |
| Molybdenum (µg/ℓ) | - | - | ND |
| Nickel (µg/ℓ) | - | - | ND |
| Selenium (µg/ℓ) | - | - | 5.5 |
| Silver (mg/ℓ) | - | - | ND |
| Thallium (mg/ℓ) | - | - | ND |
| Zinc (µg/ℓ) | - | - | 11 |
| Silica (mg/ℓ) | 7.8-4.7 | 22 | - |
| Iron (mg/ℓ) | 0.02-1.9 | 0 | 0.092-0.13 |
| Manganese (mg/ℓ) | 0.05-3.6 | - | 0.011-0.040 |
| Calcium (mg/ℓ) | 18-1,470 | 27 | 19.0-38.4 |
| Magnesium - Mg (mg/ℓ) | 29-2,530 | 55 | 10.7-24.5 |
| Sodium - Na (mg/ℓ) | 1,310-14,900 | 1,540 | 311-379 |
| Potassium - K (mg/ℓ) | 86 | 52 | 10.7-16.9 |
| Bicarbonate - $HCO_3$ (mg/ℓ) | 152-578 | 348 | - |
| Carbonate $CO_3$ (mg/ℓ) | 0 | 6 | - |
| Sulfate - $SO_4$ (mg/ℓ) | 245-2,350 | 457 | - |
| Chloride - Cl (mg/ℓ) | 1,600-27,800 | 2,060 | - |
| Fluoride - F (mg/ℓ) | 1.3-11 | 2.3 | - |
| Nitrate - $NO_3$ (mg/ℓ) | 17-35 | 55 | - |
| Boron - B (mg/ℓ) | 1.7 | 1.4 | - |
| Hardness as $CaCO_3$ (mg/ℓ) (Ca, Mg) | 164-9,320 | 292 | - |
| Hardness as $CaCO_3$ (mg/ℓ) (Noncarbonate) | 0-9,200 | 0 | - |
| Dissolved Solids (mg/ℓ) (Sum of Determined Constituents) | 3,550-48,100 | 4,500 | - |
| Specific Conductance (µmhos/cm @ 25ºC) | 6,140-62,700 | 7,580 | 1,630-2,070 |
| pH | 6.9-8.1 | 8.3 | 7.6-8.0 |
| Percent Sodium | 74-92 | 90 | - |
| Sodium Adsorption Ratio | 40-66 | - | - |

Source: [USAF 1996-A]

1 Well 1 water temperature was 14-18ºC when sampled from March 3, 1962 through July 8, 1993. Well 2 temperature was 17ºC when sampled on August 27, 1963.

2 Water temperature was 15-16ºC when sampled from September 28 through September 30, 1992

ND means not detected

Pronghorn range throughout the area. Birds, including several species of raptors, also utilize the area.

The proposed Genesis SRC recovery area contains little sensitive or unique wildlife habitat. The Blue Lake area at the western edge of the range provides riparian habitat for fish and migratory waterfowl. This oasis and 0.87 sq km (216 acres) of recreation land was deeded to the state of Utah in 1974. Fish Springs National Wildlife Refuge lies approximately 16 km (35 mi) south of the proposed recovery area. [USAF 1993-A]

#### 3.2.2.5.3 Threatened and Endangered Species

Two federally listed endangered species, the bald eagle (*Haliaeetus leucocephalus*) and the peregrine falcon (*Falco peregrinus*), occur within the South Range of UTTR. UTTR is a migratory route and wintering area for the bald eagle. There is a roost-tree in Skull Valley near DPG, and sightings have occurred in Snake Valley, Goshute Mountains, and the Fish Springs National Wildlife Refuge. Peregrine falcons utilize hacking towers on the perimeter of the Great Salt Lake. One tower is located at Timpie Point. Sightings have also occurred in Snake Valley, Goshute Mountains, and Fish Springs. Blue Lake is an historical nesting site for peregrine falcons. Two endangered fish species, the least chub (*lotichthes phlegethontis*) and the Bonneville cutthroat trout (Salmo Clark Utah), may occur in the area, but none have been found on UTTR property. The least chub has been found within two miles of UTTR lands.

A number of candidate plant species occur in the region. The ones most likely to occur in the proposed recovery area include the compact catseye (*Cryptantha compacta*) and sand-loving buckwheat (*Eriogonum ammophilum*). Candidate animal species in the area include western snow plover (*Charadrius alexandrinus nivosus*), long-billed curlew (*Numenuis americanus*), white-faced ibis, and ferruginous hawk (*Buteo regalis*). Tables 3-11 through 3-14 list the endangered and threatened species, as well as species of high federal concern that potentially occur in Utah.

**Table 3-11. Endangered Mammal Species, Threatened Mammal Species, and Mammal Species of High Federal Concern Potentially Occurring on UTTR Lands**

| Common Name (*Scientific Name*) | Sighted | Status |
|---|---|---|
| Utah prairie dog (*Cynomys parvidens*) | NO | FE |
| Black-footed ferret (*Mustela nigripes*) | NO | FE |
| Wolf (*Canus lupus*) | NO | FE |
| Grizzly bear (*Ursus horribilis*) | NO | EX |
| Fisher (*Martes pennanti*) | NO | EX |
| Dwarf shrew (*Sorex nanus*) | NO | SL |
| Desert shrew (*Notiosorex crawfordi*) | NO | SL |
| Ringtail (Bassariscus astutus) | NO | SL |
| Red bat (*Lasiurus borealis*) | NO | SL |
| Mexican big-eared bat (*Plecotis phyllotas*) | NO | SL |
| Spotted bat (*Euderma maculatum*) | NO | SL |
| Big free-tailed bat (*Tadarida macrotis*) | NO | SL |
| Abert squirrel (*Sciurus aberti*) | NO | SL |
| Belding ground squirrel (*Spermophilis beldingi*) | NO | SL |
| Richardson's ground squirrel *(Spermophilis richardsoni*) | NO | SL |
| Thirteen-lined ground squirrel (*Spermophilis tridecemlineatus*) | NO | SL |
| Spotted ground squirrel (*Spermophilis spilosoma*) | NO | SL |
| Yellow pine chipmunk (*Eutamias amoenus*) | NO | SL |
| Rock pocket mouse (*Perognathus intermedius*) | NO | SL |
| Wyoming pocket mouse (*Perognathus fasciatus*) | NO | SL |
| Merriam's kangaroo rat (*Dipodomys merriami*) | NO | SL |
| Desert kangaroo rat (*Dipodomys deserti*) | NO | SL |
| Cactus mouse (*Peromyscus eremicus*) | NO | SL |
| Rock mouse (*Peromyscus difficilis*) | NO | SL |
| Southern grasshopper mouse (*Onychomys torridus*) | NO | SL |
| Stephen's woodrat (*Neotoma stephansi*) | NO | SL |
| Mexican meadowmouse (*Microtus mexicanus*) | NO | SL |
| Wolverine (*Gulo gulo*) | NO | SL |
| River otter (*Lutra canadensis*) | NO | SL |
| Canada lynx (*Lynx canadensis*) | NO | SL |

Source: [USAF 1996-A]

FE = Federal Endangered
SQ = Status Questioned
ST = State Threatened
NO = Not Observed
SE = State Endangered
HFI = High Federal Interest
SL = State Limited
SD = State Declining
FT = Federal Threatened
EX = Extirpated

**Table 3-12. Reptiles, Amphibians, Insects, and Plants -- Endangered and Threatened Species, and Species of High Federal Concern Potentially Occurring on UTTR Lands**

| **Common Name (*Scientific Name*)** | **Potential Occurrence at UTTR** | **Status** |
|---|---|---|
| **Reptiles and Amphibians** | | |
| Desert Tortoise (*Gopherus agassizi*) | NO | FT |
| Gila monster (*Heloderma suspectum*) | NO | SL |
| Desert iguana (*Dipsosaurus dorsalis*) | NO | SL |
| Chuckwalla (*Sauromalus obesus*) | NO | SL |
| Desert night lizard (*Xantusia vigilis*) | NO | SL |
| Western banded gecko (*Coleonyx variegatus utahensis*) | NO | SL |
| Zebra-tailed lizard (*Callisaurus draconides*) | NO | SL |
| Many-lined skink (*Eumeces multivirgatus*) | NO | SL |
| Plateau whiptail (*Cnemidophorus velox*) | NO | SL |
| Arizona toad (*Bufo microscaphous*) | NO | SL |
| Pacific tree frog (*Hyla regilla*) | NO | SL |
| Relict leopard frog (*Rana onca*) | NO | SL |
| Speckled rattlesnake (*Crotalus mitchelli pyrrhus*) | NO | SL |
| Mojave rattlesnake (*Crotalus scutulatus scutulatus*) | NO | SL |
| Sidewinder rattlesnake (*Crotalus cerastes cerastes*) | NO | SL |
| Utah black-headed snake (*Tantilla planiceps utahensis*) | NO | SL |
| California kingsnake (*Lampropeltis getulus californiae*) | NO | SL |
| Desert glossy snake (*Arizona elegans*) | NO | SL |
| Utah blind snake (*Leptotyphlops humilis utahensis*) | NO | SL |
| Mojave patched-nose snake (*Salvadora hexalepis mojavensis*) | NO | SL |
| Arizona lyre snake (*Trimorpodon lamda*) | NO | SL |
| Utah mountain kingsnake (*Lampropeltis pyromelena*) | NO | SQ |
| Utah milk snake (*Lampropeltis triangulum*) | NO | SQ |
| Great Plains rat snake (*Elaphe guttata emoryi*) | NO | SQ |
| Western smooth green snake (*Opheodrys vernalis blanchardi*) | NO | SQ |
| Western spotted frog (*Rana pretiosa pretiosa*) | NO | SQ |
| **Insects** | | |
| Great Basin silverspot butterfly (*Speyeria nolomis nokimis*) | NO | SL |
| **Plants** | | |
| Bear poppy (*Arctomecon humilis*) | NO | FE |

Source: [USAF 1996-A]

FE = Federal Endangered
SQ = Status Questioned
NO = Not Observed
SD = State Declining
HFI = High Federal Interest
ST = State Threatened
FT = Federal Threatened

**Table 3-13. Endangered and Threatened Bird Species, and Bird Species of High Federal Concern Potentially Occurring in Utah**

| Common Name (*Scientific Name*) | Seasonal Use Status | Abundance | Status |
|---|---|---|---|
| Bald eagle (*Haliaeetus leucocephalis*) | W | FC | FE |
| Peregrine falcon (*Falco peregrinus*) | T | R | FE |
| Whooping crane (*Grus americana*) | | | FE |
| California condor (*Gymnogyps californicus*) | | | EX |
| Long-billed curlew (*Numenius americanus*) | O | | SD, HFI |
| Lewis' woodpecker (*Ansyndesmus lewis*) | T | U | SD, HFI |
| Western bluebird (*Sialia mexicana*) | O | | SD, HFI |
| Snowy plover (*Charadrius alexandrinus*) | T | | SD |
| Yellow-billed cuckoo (*Coccyzus americanus*) | | | SD |
| Osprey (*Pandion haliaetus*) | T | R | SL, HFI |
| Spotted Owl (*Strix occidentalis*) | O | | SL, HFI |
| White pelican (*Pelecanus erythrorhynchos*) | O | | SL |
| Double-breasted cormorant (*Phalacrocorax auritus*) | O | | SL |
| Caspian tern (*Hydropronge caspis*) | O | | SL |
| Purple martin (*Pronge subis*) | | | SL |
| Bell's vireo (*Vireo bellii*) | | | SL |
| Grasshopper sparrow (*Ammondramus savannarum*) | | | SL |
| Roadrunner (*Geococcyx californianus*) | | | SL |
| Great blue heron (*Ardea herodias*) | R | U | HFI, SQ |
| Pileated woodpecker (*Dendrocopus pileatus*) | | | HFI, SQ |
| Golden eagle (*Aquila chrysaetos*) | R | FC | HFI |
| Prairie falcon (*Falco mexicanus*) | R | FC | HFI |
| Ferruginous hawk (*Buteo regalis*) | R | FC | HFI |
| Merlin (*Falco columbarius*) | W | R | HFI |
| Cooper's hawk (*Accipiter cooperi*) | R | U | HFI |
| Burrowing owl (*Athene cunicularia*) | S | C | HFI |
| Flammulated owl (*Otus flammeolus*) | O | | HFI |
| Williamson's sapsucker (*Sphyrapicus thyroikeus*) | | | HFI |
| Band-tailed pigeon (*Columba fasciata*) | | | HFI |
| Sandhill crane (*Grus canadensis*) | T | U | HFI |
| Black swift (*Cypseloides niger*) | | | HFI |
| Scott's oriole (*Icterus perisorum*) | | | HFI |
| Grace's warbler (*Dendroica graciae*) | | | HFI |
| American bittern (*Botaurus lentiginosus*) | T | U | SQ |
| Western grebe (*Aechmorphus occidentalis*) | O | | SQ |

**Table 3-13. Endangered and Threatened Bird Species, and Bird Species of High Federal Concern Potentially Occurring in Utah, con'd**

| Common Name (*Scientific Name*) | Seasonal Use Status | Abundance | Status |
|---|---|---|---|
| Black-crowned night heron (*Nycticorax nycticorax*) | T | O | SQ |
| Mountain bluebird (*Sialia currocoides*) | S | FC | SQ |
| Yellow-breasted chat (*Icteria virens*) | S | FC | SQ |
| Fox sparrow (*Passerella iliaca*) | | | SQ |

Source: [USAF 1996-A]

**Table 3-14. Endangered or Threatened Fish Species, and Fish Species of High Federal Concern Potentially Occurring on UTTR Lands**

| **Common Name (*Scientific Name*)** | **Potential Occurrence at UTTR** | **Status** |
|---|---|---|
| Colorado squawfish (*Ptychocheilus lucius*) | NO | FE |
| Bonytail chub (*Gila elegans*) | NO | FE |
| Humpback chub (*Gila cypha*) | NO | FE |
| Woundfin (*Plegopterus argentissimus*) | NO | FE |
| Lahontan cutthroat trout (*Salmo clarki henhawi*) | NO | FT |
| Virgin River bonytail chub (*Gila robusta seminuda*) | NO | ST |
| June sucker (*Chasmistes liorus mictus*) | NO | ST |
| Razorback sucker (*Xyrauchen texanus*) | NO | ST |
| Least chub (*Iotichthys phlegethontis*) | NO | SD |
| Virgin River spinedace (*Lopidomeda mollispinus*) | NO | SD |
| Leatherside chub (*Gila copei*) | NO | SQ |
| Longnose dace (*Rhinichtys cataractae*) | NO | SQ |

Source: [USAF 1996-A]

All bird species in Utah are protected

FE = Federal Endangered
SQ = Status Questioned
ST = State Threatened
SE = State Endangered
HFI = High Federal Interest
SL = State Limited
SD = State Declining
FT = Federal Threatened
EX = Extirpated

Seasonal Use Status:
R= Resident
S = Summer
W = Winter
T = Transient

Abundance:
O = Occurring on or near HAFR and WAFR
C= Common, observed anytime
FC = Fairly common, observed most of the time
U = Uncommon, observed infrequently
R = Rare, observed rarely
VR = Very Rare

# SECTION 4

# ENVIRONMENTAL IMPACTS OF PROPOSED ACTION AND ALTERNATIVES

The Proposed Action is the preparation for and implementation of the Genesis mission launch from Cape Canaveral Air Force Station (CCAFS), Launch Complex 17 (LC-17), Florida, beginning in June 2001, and the proposed sample return capsule (SRC) recovery operations at Utah Test and Training Range (UTTR) forty miles from Salt Lake City, Utah, in the summer of 2004. The activities associated with completing the preparations of the Genesis spacecraft primarily involve refining the spacecraft and mission designs at Jet Propulsion Laboratory (JPL) and Lockheed Martin Astronautics (LMA), and spacecraft fabrication, assembly, and component testing at the LMA Denver facility. While such fabrication activities may generate small quantities of effluents normally associated with tooling or cleaning operations, these are well within the scope of normal activities at the fabrication/testing facilities and will produce no substantial adverse environmental consequences. The potential environmental impacts to the baseline recovery site, UTTR, are also discussed herein. Facilities at JPL, LMA, Kennedy Space Center (KSC), CCAFS, Johnson Space Center (JSC), Los Alamos National Lab (LANL), and UTTR are in compliance with all federal, state, and local regulations; therefore, the reader is referred to the environmental compliance offices of each respective facility for facilities topics not addressed herein, including the site-specific Pollution Prevention Plans and applicable permits.

Pre-launch activities (i.e., those activities occurring at the launch site) would involve integration and testing with the launch vehicle (LV) and final launch preparations, such as spacecraft and launch vehicle fueling operations, and would culminate in a successful normal launch of the Genesis spacecraft.

The following sections summarize the environmental effects of a normal Delta II 7425 launch and flight, as this launch vehicle is considered to be the bounding case for the 7300 and 7400 launch systems. The effects of possible abnormal spacecraft operations or flight conditions for the launch of the Genesis spacecraft are considered. The following sections also detail potential environmental impacts of the entry, descent, and recovery operations at UTTR.

# 4.1 ENVIRONMENTAL IMPACTS OF A NORMAL DELTA II 7326 LAUNCH AT CCAFS

## 4.1.1 AIR QUALITY

### 4.1.1.1 Emissions

For a normal Delta II launch, airborne emissions are typically generated by prelaunch, launch, and post-launch operations. Emissions resulting from Delta II operations include fuel and oxidant vapors which may escape to the atmosphere during prelaunch or post-launch operations. All CCAFS facilities involved in normal prelaunch activities have been either permitted or exempted by the Florida Department of Environmental Protection (FDEP), and will not be discussed in this document. Please refer to references USAF 1994, USAF 1996-C, USAF 1998, and USAF 2000 for further information.

The first stage of the Delta II uses RP-1 (kerosene) as a fuel and liquid oxygen as an oxidizer. The vehicle's second stage employs Aerozine 50 as a fuel and nitrogen tetroxide ($N_2O_4$) as an oxidizer. Both stages are loaded while the vehicle is on the launch pad.

Typically, RP-1 and liquid oxygen are loaded into the first stage of the launch vehicle twice during the normal sequence of prelaunch operations. Minor amounts of fuel and oxidizer are loaded approximately two weeks prior to launch to test the fuel system's integrity. Following testing, the tanks are cleaned, and loaded to full capacity several hours before launch. Any fuel spillage that occurs during the loading process is collected in sealed trenches leading from the RP-1 storage tanks to the launch pad. The RP-1 is then evacuated from these trenches into 55-gallon drums that are sealed for subsequent disposal by a certified subcontractor. Vapor losses during first stage loading are minimal, due to the low volatility of RP-1.

Aerozine 50 and $N_2O_4$ would be loaded into the second stage three days prior to the scheduled launch date. Pollution control devices are utilized to control emissions resulting from fuel and oxidizer handling operations. Chemical scrubbers are used to remove pollutants from the vapors; the scrubber solutions are then released into drums for disposal by a certified subcontractor. Spillage of Aerozine 50 or $N_2O_4$, although not expected, would be handled in accordance with 45th Space Wing (45SW) OPlan 32-3.

Nitrogen oxides ($NO_x$) may enter the atmosphere through propellant system venting, a procedure used to maintain proper operating pressures. Air emission control devices will be used to mitigate this small and infrequent pollutant source. First stage propellants will be carefully loaded using a system with redundant spill-prevention safeguards. Aerozine 50 vapors from second stage fuel loading will be processed to a level below analytical detection by a citric acid scrubber. Likewise, $N_2O_4$ vapors from second stage oxidizer loading will be passed through a sodium hydroxide (NaOH) scrubber. These scrubber wastes will be disposed of by a certified hazardous waste contractor according to the 45SW Petroleum Products and Hazardous Waste Management Plan. [OPlan 19-14] The scrubber operation is a FDEP permitted activity. Air emissions monitoring is conducted in accordance with the FDEP permit.

Emergency release could occur during the rupture of a part of the propellant loading system, mainly as a result of over pressurization of the system. Redundant flow meters and automatic shutdown devices on the propellant loading system would prevent overfilling of the propellant tanks. Automatic pressure monitoring devices on the tanks and feed system are designed to prevent over pressurization.

The majority of launch emissions are produced by the three graphite epoxy motor (GEMs) solid rockets on the Delta II 7326 vehicle and the liquid first stage of the Delta II vehicle during launch, which are ignited during lift-off. The primary products of GEM combustion are carbon monoxide (CO), carbon dioxide ($CO_2$), hydrochloric acid (HCl), aluminum oxide ($Al_2O_3$) in soluble and insoluble forms, and water. Nitrogen oxides ($NO_x$) are formed as secondary combustion by-products. Combustion products of the GEMs are listed in Table 4-1. Major exhaust products of the Delta II first stage will be CO, $CO_2$, and water. Exhaust products from the Delta II first stage are given in Table 4-2.

#### 4.1.1.2 Impacts

In a normal launch, exhaust products from the Delta II 7326 (Tables 4-1 and 4-2) are distributed along the launch vehicle's flight path (Figure 4-1). The portion of the exhaust plume that persists longer than a few minutes (the ground cloud) is emitted during the first few seconds of flight and is concentrated near the pad area. It consists of the rocket exhaust effluents and deluge water. Prior to launch all personnel are evacuated from the launch site to areas a minimal distance outside the facility perimeter until the area has been monitored and declared clear. [USAF 1988, USAF 1994]

The Air Force uses the Rocket Exhaust Effluent Diffusion Model (REEDM) to determine the concentration and areal extent of launch cloud emission dispersion from LVs. The Delta II 7425 is considered to bound the upper limit of propellants for the 7320-7420 series of Delta II launch vehicles. The 7425 differs from the 7326 in that it has an extra GEM and a Star 48 upper stage, which has 2010 kg (4422 lb) of propellant compared to the

**Table 4-1. Combustion Products for the GEM Solid Rockets**

| Combustion Product | Product Mass Fraction | Product Mass per GEM 11,870 kg | | Total Product Mass for 3 GEMs 35,610 kg | |
|---|---|---|---|---|---|
| | | kg | lb | Kg | Lb |
| aluminum chloride (AlCl) | 0.0002 | 2.4 | 5.2 | 7.1 | 15.7 |
| aluminum bichloride ($AlCl_2$) | 0.0002 | 2.0 | 4.4 | 6.0 | 13.2 |
| aluminum trichloride ($AlCl_3$) | 0.0001 | 1.0 | 2.2 | 3.0 | 6.6 |
| aluminum hypochlorite (AlClO) | 0.0001 | 1.0 | 2.2 | 3.0 | 6.6 |
| aluminum oxide ($Al_2O_3$) (soluble) | 0.2959 | 3,512.3 | 7,727.1 | 10537.0 | 23,181.4 |
| aluminum oxide ($Al_2O_3$) (insoluble) | 0.0628 | 745.4 | 1,640.0 | 2,236.3 | 4,920.0 |
| carbon monoxide (CO) | 0.2208 | 2,621.0 | 5,766.0 | 7,863.0 | 17,298.0 |
| carbon dioxide ($CO_2$) | 0.0235 | 279.0 | 613.7 | 836.8 | 1,841.0 |
| chlorine (Cl) | 0.0027 | 32.0 | 70.5 | 96.1 | 211.5 |
| hydrogen (H) | 0.0002 | 2.0 | 4.4 | 6.0 | 13.2 |
| hydrogen chloride (HCl) | 0.2109 | 2,503.4 | 5,507.4 | 7,509.0 | 16,522.3 |
| diatomic hydrogen ($H_2$) | 0.0228 | 270.6 | 595.4 | 811.9 | 1,786.2 |
| water ($H_2O$) | 0.0773 | 917.6 | 2,018.6 | 2,752.7 | 6,055.8 |
| diatomic nitrogen ($N_2$) | 0.0823 | 976.9 | 2,149.2 | 2,930.7 | 6,447.6 |
| hydroxide (OH) | 0.0002 | 2.0 | 4.4 | 6.0 | 13.2 |

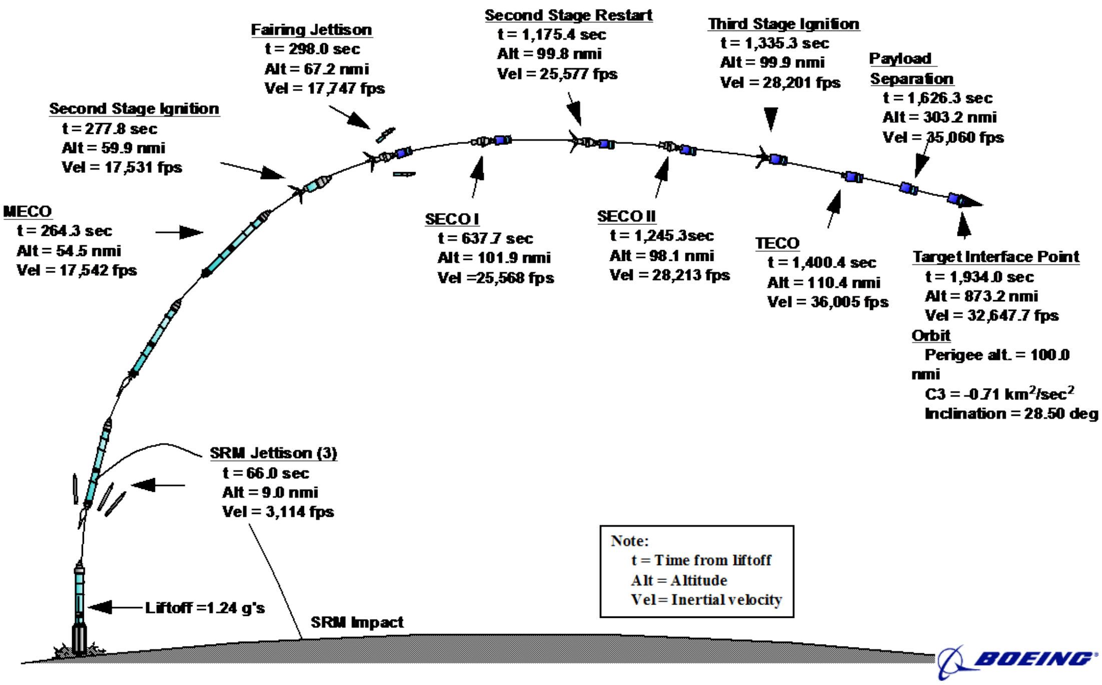
Source: Adapted from [MDSSC 1992]

**Table 4-2. Exhaust Products for the Delta II First Stage**

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

Source: Adapted from [MDSSC 1992]

Star 37 FM motor which has 1077 kg (2368 lb) of the same propellant. Using the Delta II 7425 mass fractions, data obtained during early Delta launches, and rocket engine chamber tests, REEDM was run to calculate peak ground level concentrations of various pollutants in ground clouds. For this assessment, Air Force personnel from 45SW ran REEDM for the




Source [JPL 1999-C]

Figure 4-1. Representative Launch Vehicle Flight Profile

Delta II 7425 LV nominal launch case (normal launch mode) in two different weather scenarios (2 runs). The model was also run for two failure modes (conflagration and deflagration) in two credible weather scenarios (4 runs). (A credible weather scenario is one in which launch would proceed.) The two weather scenarios include a high over the eastern US, producing easterly winds which could cause adverse inland toxic hazard corridors; the second weather case is for a cold front over southern Florida, producing northerly wind components and inversions which could also cause an adverse toxic hazard corridor toward the closest and densest population center at Port Canaveral. A total of six runs were performed. Selected output from the model runs is included in Appendix B.

For the nominal launch scenario the launch cloud was assumed to be 100 m (328 ft) in diameter at ground level. The area directly impacted by flame from the rocket exhaust would be approximately 80 m (262 ft) in diameter. The cloud height was calculated to be a minimum of 672 m (2200 ft) above the ground, with a minimum time of rise of about 450 seconds. [USAF 1996-B]

Because the cloud rises so rapidly, surface exposure to the cloud immediately after launch is assumed to occur for approximately two minutes for this analysis. Concentrations for carbon monoxide, carbon dioxide, chlorine (Cl), aluminum oxide, and hydrochloric acid were considered. The model predicted that the cloud would stabilize approximately 5 km (3 mi) from LC-17; the first concentration given below relates to this stabilization point. The second distance given relates to the position where the peak concentration is predicted to occur. For all species considered, the distance range between stabilization and peak concentration is from 5 km to 13 km (3 to 8 mi) downwind of LC-17 for the first weather scenario and 5 to 8 km (3 to 5 mi) downwind in the second weather scenario. REEDM outputs predict that the 60-minute average concentrations would be less than 0.05 ppm for all species considered for a normal launch in either of the two weather scenarios.

The Occupational Safety and Health Administration (OSHA) permissible exposure limit (PEL) for HCl is 5 ppm for an 8-hour time-weighted average. Although National Ambient Air Quality Standards (NAAQS) have not been adopted for HCl, National Academy of Sciences (NAS) developed recommended short-term exposure limits for HCl of 20 ppm for a 60-minute exposure, 50 ppm for a 30-minute exposure, and 100 ppm for a 10-minute exposure. The Short-Term Public Emergency Guidance Level (SPEGL) is the acceptable standard for public exposure and environmental protection. The SPEGL for HCl is based on a ceiling concentration level of 1 ppm. Maximum concentrations for HCl are predicted to range from 0.03 to a maximum of 0.65 ppm. The maximum one-hour average concentration for HCl was predicted by REEDM to be 0.018 ppm at 14 km (8.7 mi) downwind of LC-17.

Since the nearest uncontrolled area (i.e., general public) is approximately 4.8 km (3 mi) from LC-17, HCl concentrations are not expected to be high enough to be harmful to the general population. The maximum level of HCl expected to reach uncontrolled areas during preparation and launch of the Delta II would be well below the NAS recommended limits. Appropriate safety measures would also be taken to ensure that the permissible exposure limits defined by the OSHA are not exceeded for personnel in the launch area.

#### 4.1.1.2.1 Ozone Depletion

During the last twenty years there has been an increased concern about human activities that are affecting the upper atmosphere. Space vehicles that use SRMs have been studied concerning potential contribution to stratospheric ozone ($O_3$) depletion because of their exhaust products, with the primary depleting component being HCl. However, rockets contribute very minor amounts of HCl to the atmosphere when compared with other human-made sources. The average global depletion rates for the types of chemicals emitted were calculated as a percent $O_3$ reduction per ton of exhaust emissions. The relevant depletion rates are $3.1 \times 10^{-5}$ percent reduction for each metric ton ($2.8 \times 10^{-5}$ for each ton) of Cl emitted, 8.3 x $10^{-6}$ (7.5 x $10^{-6}$) percent reduction for each ton of $Al_2O_3$ emitted, and 1.8 x $10^{-6}$ (1.6 x $10^{-6}$) for each ton of nitrogen oxides ($NO_x$). [Jackman 1998, JPL 1998-A]

Using the bounding case of the 7420 series, there are approximately 12 metric tons (11 tons) of Cl and HCl emitted by the four GEMs during launch, which means that each launch of a Delta II 7400 vehicle would contribute an estimated 3.1 x $10^{-4}$ percent consequent global reduction in stratospheric ozone. Based on the history of twelve Delta II launches per year average for the past few years, launching twelve Delta II 7425s in a twelve-month period is extrapolated to result in a cumulative net stratospheric ozone depletion on the order of 0.0037 percent, due to HCl and Cl.

Solid rocket motors also emit $Al_2O_3$. It is not clear what will happen to the alumina particles once they are emitted into the atmosphere. If they become coated with $H_2SO_4$ (hydrogen sulfate), then they would result in a small increase in the background sulfate particle burden, a minor effect. However, if they remain uncoated, the alumina particles would have a higher potential for ozone depletion because they could promote a chlorine activation reaction ($ClONO_2 + HCl \rightarrow HNO_3 + Cl_2$). A recent analysis showed extremely small, if any, long-term impacts on stratospheric ozone from the $Al_2O_3$ emissions due to Space Shuttle and Titan operations, both of which have significantly greater alumina effluents. [Jackman 1998, JPL 1998-A] Each Delta II 7425 launch would result in 21 metric tons (19 tons) of $Al_2O_3$, which would contribute 1.4 x $10^{-4}$ percent to the cumulative net stratospheric ozone depletion. The launch scenario of twelve Delta II 7420 series launch vehicles would result in approximately 248 metric tons (225 tons) of $Al_2O_3$, which would contribute approximately 0.0017 percent to the cumulative net stratospheric ozone depletion.

The Delta II second stage is estimated to release 6.6 mt (6 tons) of $NO_2$, which would contribute 9.6 x $10^{-6}$ percent consequent global reduction in stratospheric ozone. Launching twelve Delta IIs in a twelve month period would result in a cumulative net stratospheric ozone depletion on the order of 11.5 x $10^{-5}$ percent due to $NO_x$. The cumulative net stratospheric ozone depletion caused by all three rocket exhaust effluents would be on the order of 5.5 x $10^{-3}$ percent for twelve launches during a twelve-month period.

Using the depletion rates above, estimates of peak ozone depletion per launch of the Delta II 7925, Athena 2, Taurus, Pegasus and Titan II launch vehicles were calculated (Table 4-3). The tabulated values are conservative, in that they were calculated assuming all HCl, $Al_2O_3$, and $NO_x$ would migrate to the stratosphere. Also, a study of Space Shuttle launches from KSC indicates that 28 percent of the HCl produced in the first ten seconds of launch is entrained in deluge water and/or deposited on the ground, which strongly suggests that input values for stratospheric ozone calculations and ground cloud composition be reduced by at least 20 to 30 percent. [NASA 1985] No reductions of this kind were used in calculating the ozone depletion estimates below.

**Table 4-3. Percent Stratospheric Ozone Reduction**
**(in a global annually averaged sense) per Launch**

| Launch Vehicles | HCl (tons/launch) | $Al_2O_3$ (tons/launch) | $NO_x$ (tons/launch) | Percent Ozone Depletion ($HCl + Al_2O_3 + NO_x$) |
|---|---|---|---|---|
| Delta II 7425 | 11.0 | 19.0 | 6.0 | $4.6 \times 10^{-4}$ |
| Delta II 7925 | 24.8 | 42.1 | 9.6 | $1.0 \times 10^{-3}$ |
| Athena 2 | 19.2 | 36.0 | 9.2 | $8.2 \times 10^{-4}$ |
| Taurus | 17.2 | 34.4 | 8.0 | $7.5 \times 10^{-4}$ |
| Pegasus | 3.1 | 6.4 | 1.4 | $1.3 \times 10^{-4}$ |
| Titan II | 0 | 0 | 0.6 | $9.6 \times 10^{-7}$ |

Source: Data acquired from [USAF 1989], [USAF 1995-B], [USAF 1992], [USAF 1987] and [USAF 1994]

$NO_x$ values for the Athena and Delta were extrapolated by comparing their total solid propellant quantity to that of the Taurus. Quantities are for the complete burn of all solids. Assumes all emissions migrate to the stratosphere.

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

In addition to the near-pad acidic deposition that could occur during a launch, there is a possibility of acid precipitation from naturally-occurring rain showers falling through the ground cloud shortly after launch. Since the ground cloud for a Delta II launch is predicted to be very small (diameter of about 100 m or 328 ft) [USAF 1996-B], concentrates around the launch pad, and disperses quickly, there should be no substantial amount of acidic deposition beyond the near-pad area.

During launch, gases are exhausted at temperatures ranging from 1093 to 1650 ºC (2,000 to 3,000 ºF). Most of the gases then immediately rise to an altitude of about 610 m (2,000 ft), where they are dispersed by the prevailing winds. Unprotected individuals within 100 m (327 ft) of the launch pad during a normal launch would likely be killed or injured due to heat and high levels of HCl. Prior to launch, a 2-km (6,500-ft) clear zone is established by Range Safety around the launch pad. Prior to, during, and for about twenty minutes after launch, the area within the perimeter is cleared of personnel in accordance with Range Safety practices. Additionally, an 850-m (2,780-ft) blast danger zone is established. No personnel would be in the blast area, in the event of a catastrophic launch failure. [USAF 1994, USAF 1998]

Launch cloud CO concentrations predicted by REEDM for nominal launch mode range from 0.01 to a maximum of 1.4 ppm; $CO_2$ concentrations range from 0.02 to a maximum of 0.3 ppm; and, Cl concentrations range from 0.3 to a maximum of 8.6 parts per billion (ppb). The maximum one-hour average concentrations for these exhaust effluents were predicted to be 0.085 ppm for CO, 0.018 ppm for $CO_2$, and 0.001 ppm for Cl. All maximums occurred approximately 10 km (6.2 mi) downwind of LC-17. The CO gas is expected to rapidly oxidize into $CO_2$ in the atmosphere, and therefore, CO concentrations for Delta launches are not expected to exceed the NAAQS of 35 ppm (one-hour average) beyond the immediate vicinity of LC-17.

Aluminum oxide exists as a crystalline dust in solid rocket motor (SRM) exhaust clouds, but is inert chemically and is not toxic. However, since many of the dust particles are small enough to be retained by lungs, the NAAQS for particulate matter smaller than 10 microns (PM-10) are given here for the purpose of comparison. REEDM does not currently have the capability of predicting concentrations for PM-10 or PM-2.5 particle sizes, so concentrations for all particle sizes of $Al_2O_3$ range from 0.3 to a maximum of 2.5 $\mu g/m^3$. The maximum 24-hour $Al_2O_3$ concentration beyond the distance of the nearest CCAFS property boundary predicted by the REEDM for a Delta II 7425 launch, was 3.5 $\mu g/m^3$, which is well below the 24-hour average NAAQS for PM-10 and PM-2.5 of 150 $\mu g/m^3$ and 65 $\mu g/m^3$, respectively. [USAF 1990, EPA 1999] The NAAQS for continuous emitters of particulate matter should not be exceeded by a Delta II launch due to the short nature of the launch event.

### 4.1.2 LAND RESOURCES

Overall, launching a Delta II vehicle is expected to have negligible negative effects on the land forms surrounding LC-17. [USAF 1994] However, launch activities could have some small impacts near the launch pad associated with fire and acidic deposition. Minor brush fires are infrequent by-products of Delta launches, and are contained and limited to the ruderal vegetation within the launch complexes; past singeing has not permanently affected the vegetation near the pads. Wet deposition of HCl, caused by rain falling through the ground cloud or SRM exhaust, could damage or kill vegetation. Wet deposition is not expected to occur outside the pad fence perimeter, due to the small size of the ground cloud and the rapid dissipation of both the ground cloud and SRM exhaust plume. [USAF 1990]

### 4.1.3 LOCAL HYDROLOGY AND WATER QUALITY

Water, supplied by municipal sources, is used at LC-17 for deluge water (for fire suppression), launch pad washdown, and potable water. Most of the deluge and launch pad washdown water is collected in a concrete catchment basin; however, minor amounts may drain directly to grade. The only potential contaminants used on the launch pad are fuel and oxidizer, and the only release of these substances would occur within sealed trenches and should not contaminate runoff. Any accidental or emergency release of propellants from the Delta vehicle after fueling would be collected in the flume located directly beneath the launch vehicle and channeled to a sealed concrete catchment basin. If the catchment basin water meets the criteria set forth in the FDEP industrial wastewater discharge permit, it is discharged directly to grade at the launch site. If it fails to meet the criteria, it is treated on site and disposed to grade or collected and disposed of by a certified contractor. No discharges of contaminated water are expected to result from medium launch vehicle operations at LC-17. To ensure this, the groundwater in the discharge area is monitored quarterly by Air Force Bioenvironmental Engineering Services.

The primary surface water impacts from a normal Delta II launch involve HCl and $Al_2O_3$ deposition from the ground cloud. The cloud will not persist or remain over any location for more than a few minutes. Depending on wind direction, most of the exhaust may drift over the Banana River or the Atlantic Ocean, resulting in a brief acidification of surface waters from HCl. Aluminum oxide is relatively insoluble at the pH of local surface waters and is not expected to cause elevated aluminum levels or significant acidification of surface waters. The relatively large volume of the two bodies of water compared to the amount of exhaust released is a major factor working to prevent a deep pH drop and fish kills associated with such a drop. There have been no fish kills recorded in the Atlantic Ocean or Banana River as a result of HCl and $Al_2O_3$ deposition during a normal launch. [45 AMDS/SGPB] A normal Delta II launch would have no substantial impacts to the local water quality.

### 4.1.4 OCEAN ENVIRONMENT

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

Since the first stage and GEMs will be burned to depletion in-flight, there would be relatively small amounts of remaining propellants. The release of solid propellants into the water column would be slow, with potentially toxic concentrations occurring only in the immediate vicinity of the propellant. Insoluble fractions of the first stage propellant would spread rapidly to form a localized surface film that would evaporate in several hours.

### 4.1.5 BIOTIC RESOURCES

A normal Delta II launch is not expected to substantially impact CCAFS terrestrial, wetland, or aquatic biota. The elevated noise levels of launch are of short duration and would not substantially affect wildlife populations. Wildlife encountering the launch-generated ground cloud may experience brief exposure to exhaust particles, but would not experience any significant impacts. Aquatic biota may experience acidified precipitation, if the launch occurs immediately after a rain shower. This impact is expected to be insignificant due to the brevity of the ground cloud and the high buffering ability of the surrounding surface waters to rapidly neutralize excess acidity.

### 4.1.6 THREATENED AND ENDANGERED SPECIES

Any action that may affect federally listed species or their critical habitats requires consultation with the U.S. Fish and Wildlife Service (FWS) under Section 7 of the Endangered Species Act of 1973 (as amended). The U.S. FWS has reviewed the actions which would be associated with a Delta II launch from LC-17 and has determined that those actions would have no effect on state or federally listed threatened (or proposed for listing as threatened) or endangered species residing on CCAFS and adjoining waters. [USAF 1988, NASA 1997-A]

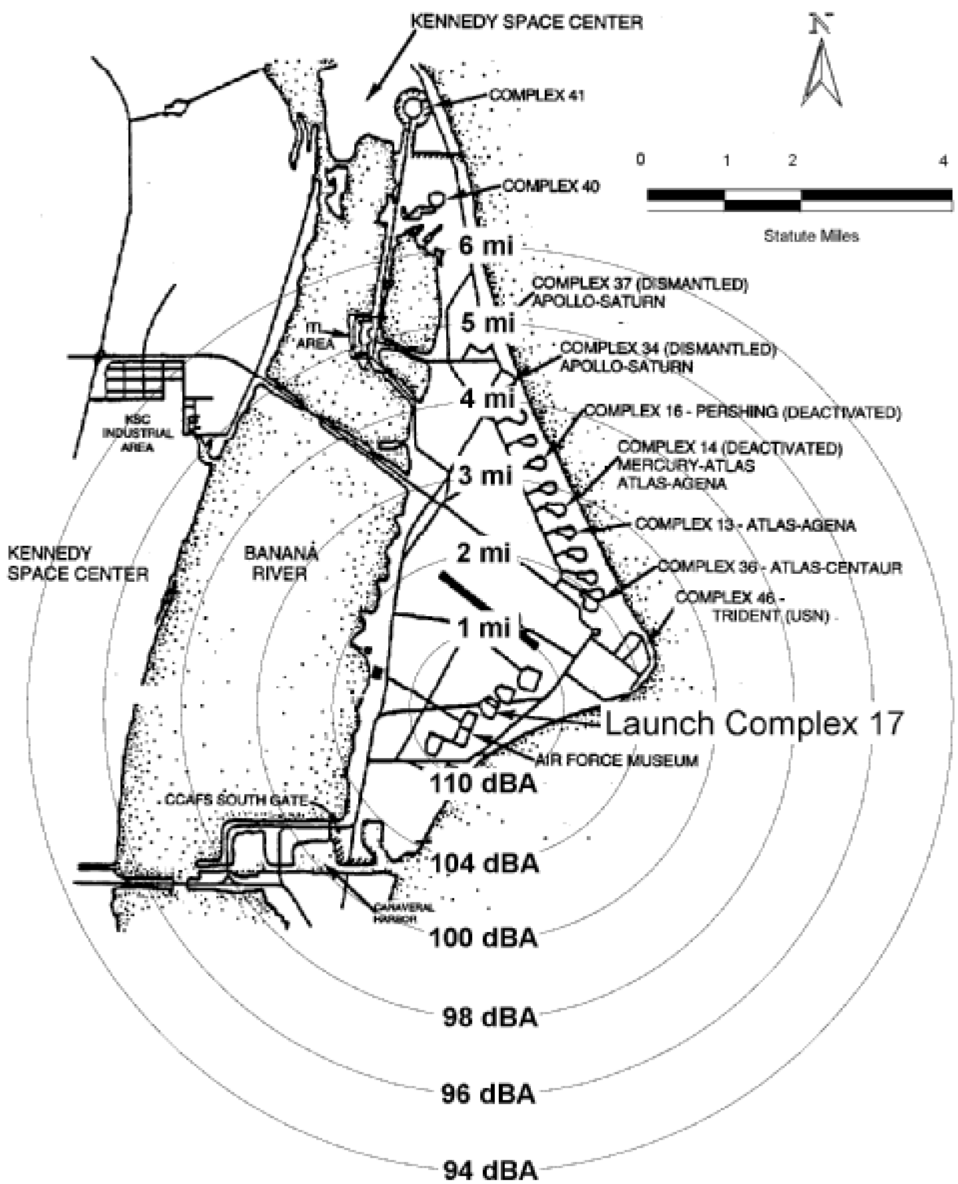
### 4.1.7 IMPACTS ON THE DEVELOPED ENVIRONMENT

#### 4.1.7.1 Population and Economics

Launching the Genesis mission would have a negligible impact on local communities, since no additional permanent personnel are expected beyond the current CCAFS staff. LC-17 has been used exclusively for space launches since the late 1950s. As such, CCAFS is a National Historic Landmark (NHL) District, and LC-17 has been identified as potentially eligible for listing in the NRHP. The Genesis mission would cause no additional adverse impacts on community facilities, services, or existing land uses.

#### 4.1.7.2 Safety and Noise Pollution

The "Medium Launch Vehicle Accident Risk Assessment Report" [MDSSC 1986] describes the launch safety aspects of the Delta II vehicle, support equipment, and LC-17 facilities. The report identifies design and operating limits that would be imposed on system elements to preclude or minimize accidents resulting in damage or injury. Normal operations at CCAFS include preventative health measures for workers such as hearing protection, respiratory protection, and exclusion zones to minimize or prevent exposure to harmful noise levels or hazardous areas or materials.




Source: Adapted from [USAF 1994]

Figure 4-2. Noise Generated by a Delta II 7925 Launch from LC-17

The engine noise and sonic booms from a Delta II launch are typical of routine CCAFS operations. To the surrounding community, noise from launch-related activity appears, at worst, to be an infrequent nuisance rather than a health hazard. In the history of the USAF space-launch vehicle operations from CCAFS, there have been no problems reported as a result of sonic booms, most probably because the ascent track of all vehicles and the planned reentry of spent suborbital stages are over open ocean, thus placing sonic booms away from land areas. Shipping in the area likely to be affected is warned of the impending launches as a matter of routine, so that all sonic booms are expected and of no practical consequence. [USAF 1988] Figure 4-2 shows the noise generated by a Delta II 7925 launch (which would bound the upper limit of noise for a Delta II 7326) from LC-17 at CCAFS.

#### 4.1.7.3 Pollution Prevention

The Joint Group on Pollution Prevention (JG-PP) is the successor to the former Joint Group on Acquisition Pollution Prevention (JG-APP). The JG-PP is a partnership between various government organizations, including the USAF and NASA, to assist in validating and implementing materials and processes that are less hazardous than those currently used in military and industrial facilities. As a NASA mission launching from CCAFS, the Genesis mission would meet JP-GG pollution prevention guidelines.

#### 4.1.7.4 Environmental Justice

EO 12898 directs Federal agencies to identify and address disproportionately high and adverse human health or environmental effects of their programs, policies, and activities on low-income populations and minority populations. Given the launch direction and trajectories of the Genesis mission, analysis indicates little or no potential of substantial environmental effects on any human populations outside CCAFS boundaries. (See Section 3.1.1 for a discussion of the population distribution in the region of interest.) The Genesis launch would not result in disproportionate adverse impacts on low-income or minority populations. [NASA 1999-E]

#### 4.1.7.5 Cultural Resources

Since no surface or subsurface areas would be disturbed, no important archaeological, historic, or other cultural sites are expected to be affected by launching the Genesis spacecraft.

### 4.1.7.6 Cumulative Impacts [USAF 1994]

CCAFS accommodates various ongoing space programs. The environmental effects associated with these programs have been included in the baseline environmental conditions described in section 3. Cumulative impacts from ozone-depleting chemicals are addressed in section 4.1.1.2.

## 4.2 ACCIDENTS AND LAUNCH FAILURES AT CCAFS

### 4.2.1 LIQUID PROPELLANT SPILL

The potential for an accidental release of liquid propellants will be minimized by strict adherence to established safety procedures. First stage propellants, RP-1 and liquid oxygen, will be stored in tanks near the launch pad within cement containment basins designed to retain 110 percent of the storage tank volumes. Post-fueling spills from the launch vehicle would be channeled into a sealed concrete catchment basin and disposed of in accordance with 45SW OPlan 32-3. Second stage propellants, Aerozine 50 and $N_2O_4$, are not stored at LC-17 and would be transported to the launch site by specialized vehicles.

The most severe propellant spill accident scenario would be releasing the entire launch vehicle load of $N_2O_4$ at the launch pad while conducting propellant transfer operations. This scenario would have the greatest potential impact on local air quality. Using the Titan REEDM predictive models and scaling for the Delta propellant loading, airborne $NO_x$ levels from this scenario should be reduced to 5 ppm within about 150 m (500 ft) and to 1 ppm within 300 m (984 ft). Activating the launch pad water deluge system would substantially reduce the evaporation rate, limiting exposure concentrations in the vicinity of the spill that are above federally established standards. Propellant transfer personnel would be outfitted with protective clothing and breathing equipment. Personnel not involved in transfer operations would be excluded from the area during such operations.

### 4.2.2 LAUNCH FAILURES

In the unlikely event of a launch vehicle destruction, either on the pad or in-flight, the liquid propellant tanks and GEM casings would be ruptured. Due to their hypergolic (ignite on contact) nature, a launch failure would result in a spontaneous burning of 10 to 30 percent of the liquid propellants, and a somewhat slower burning of GEM propellant fragments. [USAF 1997-A]

**Table 4-4. Combustion Products for Delta II 7425 GEM Failure Scenario (Conflagration)**

| Combustion Product | Product Mass Fraction | Total Propellant Mass of 47,480 kg | |
|---|---|---|---|
| | | kg | lb |
| $Al_2O_3$ | 0.1759 | 8,352 | 18,374 |
| aluminum (Al) | 0.0064 | 304 | 669 |
| carbon (C) | 0.0143 | 479 | 1,494 |
| methane ($CH_4$) | 0.0000 | 0 | 0 |
| $CO_2$ | 0.1329 | 6,310 | 13,882 |
| diatomic chlorine ($Cl_2$) | 0.0000 | 0 | 0 |
| HCl | 0.1071 | 5,085 | 11,187 |
| $H_2O$ (liquid) | 0.1274 | 6,049 | 13,307 |
| $H_2O$ (gaseous) | 0.0136 | 646 | 1,421 |
| $N_2$ | 0.4188 | 19,885 | 43,746 |
| diatomic oxygen ($O_2$) | 0.0000 | 0 | 0 |

Source: Adapted from [MDSSC 1992]

**Table 4-5. REEDM Predictions for Delta II 7425 Conflagration Chemical Species Concentrations**

| Chemical Species | Peak Concentration (ppm) | Maximum 60-Minute Mean Concentration (ppm) |
|---|---|---|
| CO | 1.80 | 0.13 |
| $CO_2$ | 0.15 | 0.01 |
| Cl | 0.062 | 0.004 |
| HCl | 0.70 | 0.05 |

Source: [USAF 1996-B]

Tables 4-4 and 4-5 define the combustion products of a Delta II 7425 GEM SRM failure (conflagration) and the corresponding REEDM predictions for the chemical species concentrations resulting from that failure mode, respectively. These maximum concentrations are predicted to occur approximately 8 km (5 mi) downwind of LC-17. The maximum 60-minute mean concentrations are predicted to occur approximately 7 km (4 mi) downwind. Tables 4-6 and 4-7 define the combustion products of a Delta II 7425 catastrophic launch pad failure (deflagration), wherein there is burning of the hypergolic propellants, and the REEDM predictions for chemical species concentrations resulting from the deflagration of a 7425, respectively. Although much of the solid and hypergolic propellants would be burned in either failure mode, emissions would include the constituents

**Table 4-6. Combustion Products for Delta II 7425 Catastrophic Failure Scenario (Deflagration)**

| Combustion Product | Product Mass Fraction | Total Propellant Mass of 151,752 kg | |
|---|---|---|---|
| | | kg | Lb |
| $Al_2O_3$ | 0.0926 | 14,052 | 30,915 |
| Al | 0.0064 | 971 | 2,136 |
| C | 0.0191 | 2,898 | 6,377 |
| $CO_2$ | 0.2514 | 38,150 | 83,931 |
| $Cl_2$ | 0.0000 | 0 | 0 |
| HCl | 0.0551 | 8,362 | 18,395 |
| $H_2O$ (liquid) | 0.1556 | 23,612 | 51,948 |
| $H_2O$ (gaseous) | 0.0141 | 2,140 | 4,707 |
| $N_2$ | 0.4051 | 61,474 | 135,244 |
| $O_2$ | 0.0000 | 0 | 0 |

Source: Adapted from [MDSSC 1992]

**Table 4-7. REEDM Predictions for Delta II 7425 Deflagration Chemical Species Concentrations**

| Chemical Species | Peak Concentration (ppm) | Maximum 60-Minute Mean Concentration (ppm) |
|---|---|---|
| CO | 12.14 | 0.27 |
| HCl | 0.19 | 0.004 |
| $Al_2O_3$ (A) | 0.15 µg/m$^3$ | 0.003 |
| unsymmetric dimethyl hydrazine (UDMH) | 0.067 | 0.001 |
| nitrogen dioxide ($NO_2$) | 1.0 | 0.022 |
| ammonia ($NH_3$) | 0.39 | 0.009 |
| hydrazine ($N_2H_4$) | 0.024 | 0.001 |
| nitric acid ($HNO_3$) | 0.002 | None |

Source: [USAF 1996-B]

(A) = aqueous

from a normal launch and dispersed propellants, including $N_2H_4$, and Unsymmetric Dimethyl Hydrazine (UDMH). Any $N_2O_4$ that does not react with other propellants is predicted by REEDM to convert to $NO_2$ in the fireball chemical reactions. The health hazard quantities of these chemicals are summarized in Table 4-8. The 24-hour average of $Al_2O_3$ resulting from this failure mode would be 4.5 µg/m$^3$, which is well below the 150 µg/m$^3$ 24-hour average federal and Florida State primary standards.  This release of pollutants would have only a short-term impact on the environment near LC-17.

For a deflagration scenario, additional species such as UDMH, nitrogen dioxide ($NO_2$), ammonia ($NH_3$), hydrazine ($N_2H_4$), nitrosodimethylamine (NDMA), formaldehyde (FDH), and nitric acid ($HNO_3$) were considered. The maximum concentrations and 60-minute mean concentrations predicted by REEDM for the deflagration mode in the worst credible weather scenario are shown in Table 4-7.  These peak concentrations were predicted to occur approximately 7 km (4 mi) downwind from LC-17.  Maximum 60-minute mean concentrations resulting from deflagration are predicted to occur approximately 8 km (5 mi) downwind.  REEDM predicted that there would be no FDH and NDMA found in the ground cloud.

Launch failure impacts on water quality would stem from unburned liquid propellant being released into CCAFS surface waters.  For most launch failures, propellant release into surface waters would be substantially less than the full fuel load, primarily due to the reliability of the vehicle destruct system.  In the event of an anomaly (accident) on the launch pad, any unburned solid-propellant dispersed by the explosion would not likely reach surface waters.  In the event of an anomaly after launch but when the launch vehicle is still near the ground, unburned propellant could fall on surface waters.  Ammonium perchlorate in the solid propellant is soluble in water, but dissolves slowly.  Trace amounts could disassociate into ammonium ions and perchlorate ions.  At low to moderate concentrations, the ammonium ion is a plant nutrient and could stimulate plant growth for a short time.  At higher concentrations, the ammonium ion is toxic to aquatic life and could cause short-term mortalities of aquatic animals.  The perchlorate ion is moderately toxic, because it oxidizes organic matter with which it comes into direct contact.  Hydroxyl-terminated polybutadiene (HTPB) could be biologically degraded over time.  Powered aluminum would rapidly oxidize to aluminum oxide, which is non-toxic at the pH that prevails in surface waters surrounding CCAFS.   [USAF 2000]

If there was an early flight termination and failure of the vehicle destruct system, it is remotely possible that the entire stage 2 propellant quantity could be released to the ocean.  Shallow or confined surface water systems, such as aquifers, ponds, etc., would receive most of the impact.  The release of the entire RP-1 fuel load in this near-pad intact vehicle impact scenario would form a very thin film (less than 0.003 cm, or 0.001 in) covering a water surface area less than 4.4 sq km (1.7 sq mi).  This film would be expected to dissipate within a few hours.  Aerozine 50 and $N_2O_4$ contaminants could exceed allowable concentrations for an approximate radius of 241 m (800 ft) in water depths exceeding 3 m (9 ft) deep.  However, the impacts to ocean systems would be localized and/or transient in nature, and expected to recover rapidly due to dispersion and buffering in such a large amount of ocean water.  [USAF 1988]

Should the second stage fail to achieve low Earth orbit and fall back into the ocean, a significant fraction of its propellant would have burned in its ascent. The second stage propellants are soluble and any remaining propellant should disperse rapidly.

Under normal or catastrophic launch scenarios, concentrations would not be hazardous except in the immediate vicinity of the launch pad; this condition would last for approximately two minutes after launch and near the centroid of the launch cloud for a short time after the launch. The launch cloud would be several hundred meters above ground level, depending on weather conditions. These hazardous concentrations near the centroid of the launch cloud would persist for an estimated ten minutes, but could occur for shorter or longer periods depending on meteorological conditions. Airplanes and boats are not allowed near the CCAFS area during launches. Prior to launch, personnel are cleared from the areas where potentially hazardous concentrations would occur, and there should be no hazard to humans associated with exhaust effluents.

For the propellants that would be dispersed to the air in the event of a catastrophic launch failure, hazardous concentrations would not occur except in the immediate vicinity of the launch complex. Since personnel will be cleared from the area prior to launch, there would be no hazard to humans from dispersed propellants in the event of a catastrophic launch failure.

Since Immediately Danger to Life or Health standards (IDLHs), Permissible Exposure Limits (PELs), Short Term Exposure Limits (STELs), and Threshold Limit Values (TLVs) are established considering potential exposure of workers, they should not be used for evaluating the potential health significance of accidental release which may impact the general population. They are, however, included here since personnel at CCAFS would be transferring and loading fuel at the pad prior to launch. The recommended guidelines used to determine safe exposure limits for the general population are the Emergency Response Planning Guidelines (ERPGs), developed by the American Industrial Hygiene Association (AIHA). The endpoint for a toxic substance is its ERPG level 2 (ERPG-2), developed by the AIHA (Section 112r of the Clean Air Act). [ERPG 1997] None of the concentrations predicted by REEDM for catastrophic launch aborts of the Delta II at CCAFS exceeded the ERPG-2 values except in the immediate vicinity of the launch pad.

A Delta II 7925 anomaly occurred on January 17, 1997 at CCAFS as a result of a GEM breaking apart during flight. When the launch vehicle exploded, approximately 2,500 pieces of solid propellant, many burning, and 2,100 fragments of the launch vehicle were scattered within a mile radius on and around LC-17. These firebrands resulted in small fires throughout the Flight Hazard Area. The airlit GEMs were not pressurized, and broke into several major pieces, which impacted intact and caused a number of secondary explosions,

**Table 4-8. Health Hazard Quantities of Hazardous Launch Emissions**

| Compound | ERPG (ppm) 1 | ERPG (ppm) 2 | ERPG (ppm) 3 | EEGL (ppm) | SPEGL (ppm) | PEL (ppm) | STEL (ppm) | TLV (ppm) | IDLH (ppm) |
|---|---|---|---|---|---|---|---|---|---|
| Dimethyl hydrazine (UDMH) | 0.03 | 8 | 80 | 0.24 for 1 hr<br>0.12 for 2 hr<br>0.06 for 4 hr<br>0.03 for 8 hr<br>0.015 for 16 hr<br>0.01 for 24 hr | 24 for 1 hr<br>1 for 24 hr | 0.5 (skin) | | 0.01 (skin) | 15 |
| Hydrazine ($N_2H_4$) | 0.03 | 8 | 80 | | 0.12 for 1 hr<br>0.06 for 2 hr<br>0.03 for 4 hr<br>0.015 for 8 hr<br>0.008 for 16 hr<br>0.005 for 24 hr | 1 (skin) | | 0.01 (skin) | 50 |
| Hydrochloric acid or hydrogen chloride (HCl) | 3 | 20 | 100 | 100 for 10 min<br>20 for 1 hr<br>20 for 24 hr | 1 (ceiling) | 5 (ceiling) | | 5 (ceiling) | 50 |
| Nitrogen tetroxide As $NO_2$ | | | | 1 for 1 hr (ceiling)<br>0.04 for 24 hr (ceiling) | 1 for 1 hr<br>0.5 for 2 hr<br>0.25 for 4 hr<br>0.12 for 8 hr<br>0.06 for 16 hr<br>0.04 for 24 hr | 5 (ceiling) | | 5 (STEL)<br>3 (TWA) | 20 |
| Ammonia ($NH_3$) | 25 | 200 | 1000 | | | 50 | 35 | 25 | |
| Nitric acid ($HNO_3$) | 4 | 10 | 100 | | | 2 | 4 | 2 | |
| Nitrogen dioxide ($NO_2$)* | | | | 1 for 1 hr (ceiling)<br>0.04 for 24 hr (ceiling) | 1 for 1 hr<br>0.5 for 2 hr<br>0.25 for 4 hr<br>0.12 for 8 hr<br>0.06 for 16 hr<br>0.04 for 24 hr | 5 (ceiling) | | 5 (STEL)<br>3 (TWA) | 20 |
| Aluminum oxide ($Al_2O_3$) | 15 $\mu g/m^3$ | 15 $\mu g/m^3$ | 15 $\mu g/m^3$ | 50 $\mu g/m^3$ for 10 min<br>25 $\mu g/m^3$ for 30 min<br>15 $\mu g/m^3$ for 60 min | | | | | |

Source: [USAF 1994]

ERPG Emergency Response Planning Guidelines - Developed by the American Industrial Hygiene Association, ERPGs are the maximum airborne concentration below which it is believed nearly all individuals could be exposed for up to 1 hour: ERPG-1 - without experiencing other than mild transient adverse health effects or perceiving a clearly defined objectionable odor; ERPG-2 - without experiencing or developing irreversible or other serious health effects of symptoms that could impair their abilities to take protective action; and ERPG-3 - without experiencing or developing life-threatening health effects.

EEGL Emergency Exposure Guidance Level - Advisory recommendations from the National Research Council (NRC) for the Department of Defense (DoD) for an unpredicted single exposure.

SPEGL Short-term Public Emergency Guidance Level - Advisory recommendations from the NRC for the DoD for an unpredicted single exposure by sensitive population.

PEL Permissible Exposure Limit - Occupational Safety and Health Administration (OSHA) standards averaged over 8-hour period, except for ceiling values which may not be exceeded in the workplace.

STEL Short Term Exposure Limit - OSHA standards averaged over 15-minute period in the workplace.

TLV Threshold Limit value - Recommendations of the America Conference of Governmental Industrial Hygienists. The TLV is the airborne concentration of the substance, which represent conditions under which it is believed nearly all workers may be repeatedly exposed to day after day without adverse effect. There are three categories of TLVs: 1) Time Weighted Average (TWA) is the concentration of a normal 8-hour work day or 40-hour week; 2) STEL is the maximum concentration to which workers can be exposed for a period of up to 15 minutes; and 3) ceiling is the concentration that should not be exceeded even instantaneously.

IDLH Immediately Dangerous to Life or Health - Air concentration at which an unprotected worker can escape without debilitating injury or health effect.

*National primary and secondary ambient air quality standard for nitrogen dioxide - annual arithmetic mean for nitrogen dioxide ($NO_2$) is 0.053.

craters, and firebrands. In addition, a cloud containing a small amount of RP-1 rocket fuel was generated. Numerous ground level secondary explosions resulted due to solid propellant and debris impacting the ground. Range radar reported tracking debris in the local area for nearly 30 minutes after the explosion. All debris impacted within predefined areas. [USAF 1997-B] The vast bulk of the plume generated by the explosion was out over water; and maximum concentrations of HCl and $NO_2$ were both 1 to 2 ppm. A slight wisp at the surface may have blown on-shore at concentrations below detection. A large buoyant and visible plume covered much of southern Brevard County and Indian River County at high altitude. No aspect of this plume was hazardous. The Flight Termination Systems (FTSs) proved able to prevent a hazard to the public. [USAF 1997-A, USAF 1997-B]

As a result of this launch accident, CCAFS has implemented the following new policies: there will be a Brevard County Emergency Management Center (BEMC) representative at the launch console two hours before launch, to provide county officials with immediate access to information about the content of clouds and their direction; and the Air Force has installed direct audio and video communications lines from its control center to BEMC, to ensure open communication lines to the Rockledge emergency bunker, the site from which county officials broadcast emergency alerts. The Air Force has also installed a direct emergency phone line to the Florida State Emergency Response Center.
[USAF 1997-A, USAF 1997-B]

## 4.3 ENVIRONMENTAL IMPACTS OF RECOVERY OPERATIONS AT UTTR [USAF 1993-A, USAF 1996-A]

Impacts are described for the environmental resource areas presented in Section 3. The level of treatment given each resource area is related to the potential for environmental impacts. The primary areas of concern are effects on the physical environment and health and safety. Air quality considerations and potential impacts on biological and cultural resources are also identified. Other resources are treated more briefly.

### 4.3.1 AIR QUALITY

Emissions of criteria pollutants would occur as a result of helicopter and ground vehicle activity during Genesis SRC recovery operations. The SRC itself would not generate any air pollutants in the lower atmosphere (the area subject to NAAQS), nor is it expected that it would contain any chemicals or substances that could emit hazardous air pollutants regulated under National Emission Standard for Hazardous Air Pollutants (NESHAPs). Given that the Genesis mission is a single sample return, the quantities of helicopter emissions would be extremely small. Furthermore, when affected sectors would be scheduled for the Genesis recovery operation, other aircraft would be curtailed, thereby resulting in lower short-term emission levels. It is unlikely that overall emissions in the area would be greater during Genesis recovery operations than under baseline conditions. The proposed action is not expected to result in any violations of the NAAQS or to interfere with Tooele County's ability to reach or maintain attainment.

NAAQS and effects on the air quality of the UTTR area relate to the lower atmosphere. Upper altitude emissions associated with reentry of the SRC would include ablation products of the thermal protection system (TPS) on the forebody. Six hours prior to reentry, the spacecraft would orient to the reentry attitude; two hours later the SRC would separate from the spacecraft bus. Entry into Earth's atmosphere would decelerate the SRC from 11 km/s (36,091 ft/s) to 50 m/s (154 ft/s), with the aid of a drogue chute deployed at 33 km (108,000 ft) altitude. At an altitude of 6.7 km (22,000 ft) above mean sea level (MSL), a lifting parachute would further slow the SRC, providing a vertical descent rate of 4.6 m/s (15 ft/s) and a forward rate of 15.6 m/s (51ft/s). At an altitude of 2.8 km (9200 ft) MSL, a recovery helicopter would intercept the SRC and initiate a mid-air retrieval operation above the UTTR surface altitude of 1.3 km (4265 ft) MSL. The intercept altitude would permit multiple passes, if necessary, to effect capture, and a back-up helicopter provides redundant capability. [JPL 1999-G]

Most of the deceleration of the SRC (from 11 km/sec to 0.4 km/sec) would occur due to aerodynamic drag on the capsule, before the drogue parachute is deployed. Thus, the SRC would require a forebody heatshield that could survive the extreme reentry-heating environment. The temperature of the material structure must be kept low enough to prevent structural degradation, and the sample canister containing the captured solar wind samples must not exceed 54 ºC (129 ºF) during any portion of the reentry. The material baselined to be used for the forebody heatshield is a carbon-carbon (C-C) composite recently developed at LMA. The insulation mass requirements for a heatshield utilizing C-C are comparable to a segmented PICA (phenolic impregnated carbon ablator) as was used for the Stardust forebody heatshield. The C-C heatshield has been baselined on the basis of cost, schedule, and risk due to possible eroding of exposed bonds along the segments.

During the descent of the SRC the C-C material comprising its forebody heatshield would ablate due to frictional heating. The peak heating would occur at approximately 60 seconds after reentry begins, which corresponds to an altitude of approximately 60 km (196,860 ft) above the earth. The ablation would continue for about twenty seconds. Models conservatively predict that less than five percent of the total C-C material would ablate during reentry. The total mass of the C-C material would be about 40.32 kg (88.7 lb); of this a maximum of 2.05 kg (4.5 lb) would be ablated during reentry. The chemical species that would be produced during ablation of the C-C material are shown in Table 4-9. These chemical species would be dissipated in the shock wave behind the SRC.

**Table 4-9. Chemical Species Produced During Ablation of Carbon-Carbon Heatshield**

| Chemical Species | Total Mass of Species Produced During Ablation (g) | Total Amount of Species Produced During Ablation (lb) |
|---|---|---|
| carbon dioxide ($CO_2$) | 62.7 | $1.380 \times 10^{-1}$ |
| carbon monoxide (CO) | 2337.7 | 5.143 |
| cyanato (NCO) | $3.50 \times 10^{-4}$ | $7.706 \times 10^{-8}$ |
| ketenylidene ($C_2O$) | $3.63 \times 10^{-2}$ | $7.994 \times 10^{-5}$ |
| carbon (C) | 1.9 | $4.177 \times 10^{-3}$ |
| cyanide (CN) | 53.0 | $1.167 \times 10^{-1}$ |

Source: [JPL 1999-A]

The ablation process and thus the production of these species would cease at 48 km (157,500 ft) above the earth. Therefore, these concentrations would disperse in the large volume of air in the upper atmosphere and would not constitute a danger to health or life on earth. The SRC heatshield would be rapidly cooling during the subsonic portion of the descent, and would not be emitting into the lower atmosphere. [JPL 1999-G]

The SRC would be entering Earth's atmosphere from space and repressurizing as it nears the surface of the earth. The SRC would be traveling at supersonic velocity during the ablation of the heatshield. A flow field analysis of the heatshield radiation and ablation has demonstrated that only a minimal amount of ablation products would gain access to the interior of the SRC through the vents located on the sides of the backshell. Most of the repressurization of the SRC would occur below 10 km (6.2 mi) MSL, during the subsonic portion of the reentry. A test would be performed by Safety personnel to ascertain if a potentially harmful amount of cyanide gas might be present in the SRC after landing. If the test so indicates, personnel opening the SRC to retrieve the sample canister would be required to wear appropriate personal protective equipment (PPE) to preclude potential health hazards. [JPL 1997-B]

The Super Lightweight Ablator (SLA-561V) material comprising the TPS of the backshell portion of the SRC undergoes far less heating during reentry than does the C-C material on the forebody. Of the 4.98 kg (10.96 lb) of SLA-561V comprising the backshell heatshield, approximately 0.27 kg (0.6 lb) would be lost during reentry. Table 4-10 gives the amounts of the predominant species produced during reentry peak heating.  There are no toxic species produced from this heatshield material.  [JPL 1996-B]

**Table 4-10.  Chemical Species Produced During Ablation of SLA-561V Heatshield**

| Chemical Species | Total Mass of Species Produced During Ablation (g) | Total Amount of Species Produced During Ablation (lb) |
|---|---|---|
| $H_2O$ | $1.22 \times 10^{+1}$ | $2.69 \times 10^{-2}$ |
| CO | $4.40 \times 10^{-2}$ | $9.70 \times 10^{-5}$ |
| $CH_4$ | $1.02 \times 10^{+2}$ | $2.25 \times 10^{-1}$ |
| $CO_2$ | $1.91 \times 10^{-0}$ | $4.21 \times 10^{-3}$ |
| methyl alcohol ($CH_3OH$) | $1.07 \times 10^{-7}$ | $2.35 \times 10^{-10}$ |
| silicon dioxide ($SiO_2$) | $9.57 \times 10^{-4}$ | $2.11 \times 10^{-6}$ |
| $H_2$ | $1.22 \times 10^{-0}$ | $2.69 \times 10^{-3}$ |
| silicon oxide (SiO) | $1.18 \times 10^{+2}$ | $2.60 \times 10^{-1}$ |
| silane ($SiH_4$) | $1.89 \times 10^{-3}$ | $4.16 \times 10^{-6}$ |
| tetramethyl silane ($SiC_4H_{12}$) | $3.67 \times 10^{+1}$ | $8.08 \times 10^{-2}$ |

Source: [JPL 1996-B]

## 4.3.2 LAND RESOURCES

The proposed action would disturb soils in the location of the SRC touchdown and the immediate vicinity where helicopters or a land vehicle would recover the SRC. Helicopter landings are currently common on UTTR and should have no additional effect. The SRC would have a diameter of 1.52 m (60 in) and would weigh approximately 225 kg (495 lb).  It would have a parachute system that would slow its velocity to approximately 4.6 m/s (15 ft/s).  The area affected would measure only a few meters. Any disturbance to the surface could easily be recovered if desired.  Due to the single event nature of this recovery operation, the resulting impact would be negligible.  The SRC would contain no propellant, except for the mortar charge (0.75 gram) that would expel the drogue chute, and this would be expended at 33 km (108,000 ft) altitude.

## 4.3.3 BIOTIC RESOURCES

The SRC landing and recovery operations would affect vegetation in the immediate vicinity of the touchdown.  Individual plants within a localized area could be crushed. The impact to plant communities in the area would be insignificant. Ground disturbance could increase the potential for invasive species like halogeton to establish in the area, but the small size of the area disturbed would not increase this effect noticeably above the baseline conditions. The proposed Genesis impact area does not contain any sensitive habitats that could be affected by recovery operations.

### 4.3.4 THREATENED AND ENDANGERED SPECIES

No threatened or endangered species are expected to be affected by the proposed action. The probability of a collision between the SRC or a helicopter and a bald eagle or Peregrine falcon in the area is extremely remote -- raptors have a very low incidence of airstrike. It is highly unlikely that any candidate species that could be affected occur in the project area.

### 4.3.5 DEVELOPED ENVIRONMENT

#### 4.3.5.1 ECONOMICS

The proposed action would not affect demographics, housing, or the structure of the economy in the region. The Genesis recovery operations would be compatible with the purpose and use of UTTR and the DoD land in the proposed impact area.

There is a possibility that the SRC, if it' parafoil is carried by wind and it is not recovered by the helicopters in mid-air over UTTR, could land on public lands administered by the BLM just outside the safety zone. The BLM lands involved are along the outside edges of the impact area, so the probability of a landing occurring on BLM land is less than one in a million. This would not adversely affect the land or grazing if the touchdown occurred as planned and there was no mishap. Combined with the low probability of mishap, the risk of an incident involving BLM land is extremely remote, and the resulting impacts even in the event of an incident would not be significant. Emergency response procedures would be required as part of the Site Safety Plan for the project. These would ensure adequate response and remediation of any lands adversely affected. In the event the SRC should touch down on BLM land within the confines of UTTR airspace, the Air Force would use approved procedures for recovery contained in an existing Memorandum of Agreement between the USAF and the BLM. [USAF 1997-C]

Recovery could be hampered if the SRC landed in the Cedar Mountains. Based on the six-degree of freedom Monte Carlo analysis run by NASA Langley Research Center, the probability of such an occurrence is less than 3 in 1,000. [JPL 1999-G] This area lies outside the designated impact area. Given the low probability of this event, the proposed action is not expected to adversely affect the Cedar Mountains WSA.

### 4.3.5.2 Safety and Noise Pollution [USAF 1996-A]

#### 4.3.5.2.1 Noise

Noise from helicopter operations would not differ from baseline conditions and is therefore not anticipated to have any impact on local wildlife. The sonic boom from the SRC reentry would not have any impact due to its high altitude. The recovery area is overlain by the Gandy Supersonic Operating Area, which experiences sonic booms at lower altitudes and higher overpressures than those that would be created by the Genesis SRC.

Numerous studies have been conducted on the sensitivity of wildlife to noise and sonic boom, including studies of big horn sheep, pronghorn, and elk at UTTR. A literature survey of studies on effects of supersonic and subsonic aircraft noise on animals conducted by the USAF in 1986 revealed few effects from sonic booms. These same studies have shown that there is more potential for effects from subsonic aircraft operations, especially helicopters, and indicated that wildlife acclimated to recurring events. In any case, the proposed project area does not include sensitive wildlife species likely to be adversely affected, and any wildlife in the area is likely already acclimated to the on-going range operations.

#### 4.3.5.2.2 Health and Safety

There would be three areas of concern with respect to health and safety during the entry, descent, and landing phase of the mission. The first involves range safety considerations; the second is concerned with SRC recovery safety issues; and the third is the inadvertent reentry of the spacecraft.

##### 4.3.5.2.2.1 UTTR Range Safety Considerations

Scheduling procedures for use of UTTR would preclude any risk of flight hazards involving other aircraft in the area. This is a negligible risk of mishap involving helicopters should they be used in the SRC recovery operations. This risk would be comparable to currently on-going risks at the range. In the event of a helicopter accident, there are no inhabited areas in the proposed recovery area that would be exposed to hazardous conditions. The airspace above the range is under positive control at all times. During the recovery period, Range Control would grant access only to aircraft participating in the recovery. Therefore, potential for adverse effect to personnel or the public is considered insignificant.

The Monte[1] Carlo analysis performed by NASA's Langley Research Center for the Genesis project shows that the risk of casualty from the SRC reentry is no greater than one in a million ($1 \times 10^{-6}$). [JPL 1999-G]

The SRC would not be released from the spacecraft if NASA determined that it would not land within its safety zone (also known as the 3-sigma landing footprint - see figures 4-1 and 4-2), on UTTR. However, it would have the potential for landing anywhere within the designated safety zone, which includes targets and areas that may contain unexploded ordnance. In the event that the SRC landed on a target, there is a chance it could initiate an explosion. This could destroy the SRC and result in a release of any materials contained within it. The highest probability is that the experimental materials would be destroyed in the mishap. The risk of this occurrence is substantially less than the risk of a military aircraft crashing on unexploded ordnance on the range. [USAF 1993-A] To reduce the possibility of the SRC triggering an explosion upon landing, the AF would search out and explode any undetonated munitions in the proposed recovery site prior to the expected date of reentry.

#### 4.3.5.2.2.2 SRC Recovery Safety Considerations [JPL 1997-B]

The SRC would be captured via helicopter mid-air to protect its fragile collectors from ground impact. In the event that the SRC should impact the ground, it would weigh approximately 225 kg (495 lb), and would be touching down at 4.6 m/s (15 ft/s). This is comparable in mass to one of the 500-pound inert bombs the range typically drops in this area during bombing exercises, but would land at a much lower velocity. Therefore, it would pose no additional risk to personnel or structures.

Four potential hazards in handling the SRC once it has been recovered have been identified. They include safing of potential unfired parachute deployment ordnance; lithium battery faults such as the production of sulfur dioxide ($SO_2$), or a lithium fire should the battery be damaged during landing; RF emissions from the Global Positioning System

[1] A Monte Carlo analysis is a numerical method that evaluates the properties of complex, many-body systems, as well as non-deterministic processes, and is used routinely in many diverse fields to simulate complex physical phenomena. Monte Carlo methods are used to simulate problems that have an enormous number of dimensions or a process that involves a path with many possible branch points, each of which is governed by some fundamental probability of occurring.

(GPS) transmitter and the very high frequency (VHF) beacon; and handling of the SRC. These will be discussed in detail in the following paragraphs.

4.3.5.2.2.2.1 Ordnance Safing

There are redundant NASA Standard Initiators (NSIs) in the SRC to fire the mortar and deploy the drogue chute. The drogue mortar would not be a handsafe pyrotechnic (pyro) device. In the nominal recovery scenario, i.e., the parachute deploys as engineered, it would indicate that at least one NSI fired, but would not provide information that the redundant NSI also fired. Therefore, it is possible that there would be an unfired NSI within the drogue mortar. If the Deployable Aft Conical Section (DACS) separation and main parafoil deployment occur as intended, the mortar canister would remain with the DACS, and be separated from the SRC. Genesis plans to recover the drogue/DACS assembly, and to engage a UTTR Explosive Ordinance Disposal (EOD) expert to isolate and remove the parachute initiator NSIs in an electrostatic discharge control area. The second NSI on the parachute mortar would be designed to be directed toward the center of the parachute canister and parallel to the DACS surface, so that if it discharged upon recovery of the DACS, it would not pose a safety hazard to personnel. Unexpended NSIs would be disposed of at UTTR. Procedural methods are planned to minimize personnel exposure to an unfired NSI in the mortar.

There would be three (3) dual bridgewire devices connected to the three separation bolts, which would all have to fire to release the DACS, and deploy the main parafoil. All three separation bolts must operate for nominal reentry. If a bolt failed to operate, the main parafoil would not deploy, and there is a possibility of unfired ordnance. The separation bolts are not hand safe. The end of the bolt is ejected upon firing which could pose a hazard to personnel. Landing within the 3-sigma footprint is not dependent upon drogue chute or parafoil deployment.

The drogue pyro cable cutter would be initiated by a single dual bridgewire device located on the parachute deck. The drogue cable cutter must operate to permit full release of the DACS from the SRC. Failure to operate may result in mission loss, but the device remains handsafe in the unfired state.

The parafoil brake cutters would be mechanically actuated devices packed in the main parafoil compartment. Due to redundant cutters, one device could fail to be expended upon recovery. The parafoil brake cutters are handsafe ordnance devices.

Off-nominal recovery conditions would be addressed by the recovery team. All potentially unfired ordnance devices would be isolated and removed by certified ordnance handlers.

#### 4.3.5.2.2.2.2 Lithium Battery Faults

The SRC would contain twin 7.5-amp hour lithium sulfur dioxide ($LiSO_2$) battery, comprised of eight (8) cells each. These batteries would provide power to: sequence timers for SRC post separation events, the NSI firing of the drogue parachute deployment, the bridgewire firing of the cutter severing the drogue-mortar NSI wires, the bridgewire firing of the DACS separation bolts, activation of a VHF beacon, and activation of radio frequency (RF) descent transponder. These lithium cells would be about the size of a commercial “D” cell. These cells would be used only for the SRC return and are diode-protected from reverse charging. Potential hazardous characteristics resulting from damaged batteries would be lithium fire, and $SO_2$ production. The recovery team would include a safety inspector, who would perform a test to verify the absence of airborne toxins before the SRC is declared safe for human handling. The battery case has been designed to leak before bursting and the cables would be protected at possible abrasion points.

#### 4.3.5.2.2.2.3 RF Emissions from the GPS Transmitter and the VHF Beacon

The batteries would provide power to operate the GPS transmitter and the VHF beacon for a minimum of 3 hours. The GPS transmitter emits a 100 ms pulse at 384 MegaHertz (MHz) every second with a maximum output power of 5 Watts. The whip antenna for this GPS transmitter is sewn into a parafoil riser. The VHF beacon antenna is a wire approximately 10 inches long sewn into a parachute riser. The average transmitting power is 100 mW at 242.000 MHz, with a duty cycle of 3 seconds on, 5 seconds off. The American Conference of Government Industrial Hygienists (ACGIH) allows exposure to antennas radiating 7 Watts or less at frequencies between 100 kHz to 450 Mhz., since these devices would not be attached to a human body on a continual basis. Best practices mandate minimizing exposure to RF radiation, which would be satisfied by requiring that recovery personnel be only briefly exposed to the RF emanations resulting from SRC handling and disassembly.

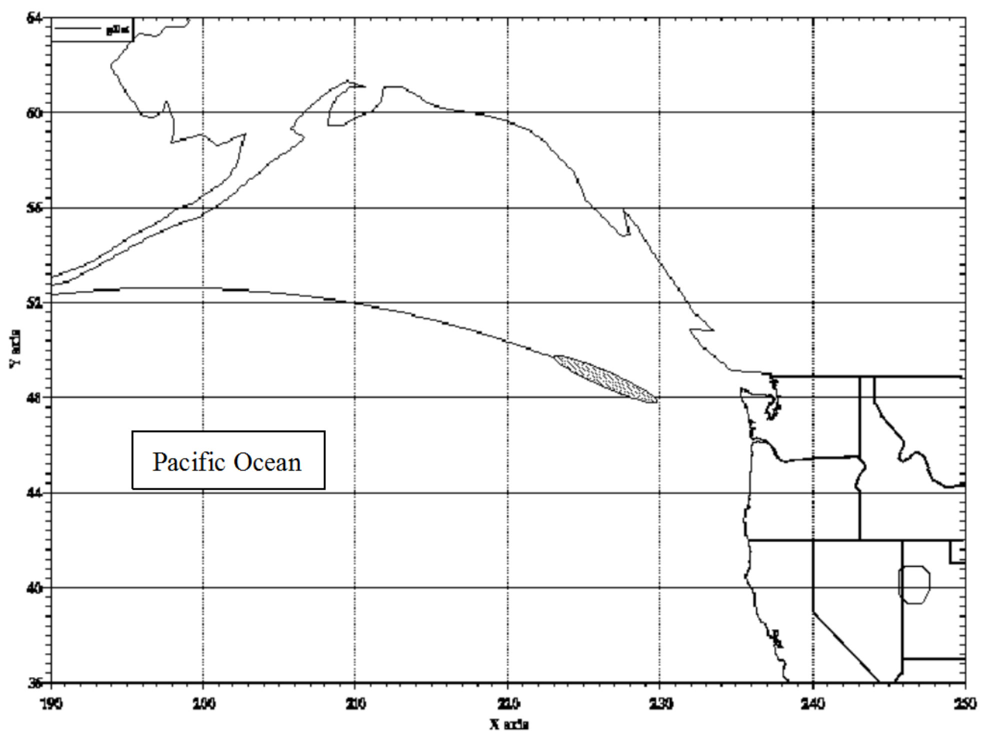
#### 4.3.5.2.2.2.4 SRC Handling

The primary method of handling would be via helicopter suspension, except when it is secured in its handling fixture. Gloves would be used for all handling of SRC ablated surfaces, and would also protect the teams from the hot surface.

The SRC thermal control system design calls for two ablative materials in the heatshields. On the backshell would be the SLA-561V, which is a combination of RTV 663 mixed with silica fibers, treated cork, phenolic microballoons, and silicon microspheres packed into a phenolic honeycomb. This material is currently used on the Shuttle, and requires no special safety handling procedures. On the forebody would be the carbon-carbon (C-C) material, which is composed of a carbon over fiberform. It is baked out to minimize volatile materials.

### 4.3.5.3 Reentry of the Spacecraft

Current plans call for performing a controlled deboost maneuver on the spacecraft approximately one hour after releasing the SRC. This would result in the spacecraft entering the upper atmosphere high above the Pacific Ocean, where it would burn up due to atmospheric friction. Figure 4-3 shows the spacecraft entry groundtrack. The proposed Genesis deboost maneuver would comply with the guideline for footprint clearance of land masses (45 km [28 miles] from US soil, 370 km [230 miles] from any non-US land mass).




Source: [JPL 2000-A]

Figure 4-3. Proposed Genesis Spacecraft Reentry Groundtrack

Based on the Genesis Spacecraft Breakup Analysis, the main spacecraft composite structure is conservatively predicted to break apart at altitudes above 68 km (223,108 ft). Even in the most conservative case wherein the spacecraft bus would reenter the atmosphere along the same trajectory as the SRC, all components would burn up above 47 km (154,000 ft). The small quantities of gases produced during burnup of the Genesis spacecraft are left at these extreme altitudes. Table 4-11 lists the predominant species that would be generated during spacecraft reentry.

#### 4.3.5.4 Pollution Prevention [JG-PP 2000]

Recently the Joint Logistics Commanders and NASA formally approved the Joint Group – Pollution Prevention (JG-PP) as the single agency responsible for pollution prevention for the Military Services. The JG-PP combines the pollution prevention mission of the depot maintenance and acquisition communities. The JG-PP includes NASA and strengthens the link with Single Process Initiative (SPI). It does this by providing military depots, acquisition programs, NASA centers and defense contractors with an accessible means to improve depot maintenance and manufacturing processes by reducing total ownership costs, eliminating emissions of hazardous materials, and minimizing the use of multiple material specifications. Direction and execution of the JG-PP initiative is provided by the Joint Acquisition Sustainment Pollution Prevention Activity (JASPPA). [JG-PP 2000]

#### 4.3.5.5 Environmental Justice

EO 12898 directs Federal agencies to identify and address disproportionately high and adverse human health or environmental effects of their programs, policies, and activities on low-income populations and minority populations. NASA conducted a preliminary Environmental Justice screening analysis for its X-33 Program to ensure that the NEPA process was fully utilized to address concerns identified by Indian tribes, enhance protection of the tribal environments and resources, and identify Native American lands that might be affected by the proposed action. Given the characteristics of the SRC that is to land at UTTR and that its footprint is well inside restricted territory, analysis indicates little or no potential of substantial environmental effects on any human populations outside UTTR boundaries. (See Section 3.2.1.1 for a discussion of the population distribution around UTTR.)

#### 4.3.5.6 CULTURAL RESOURCES [USAF 1996-A]

In the event that the helicopter does not succeed in the five mid-air retrieval attempts and touches down on UTTR, there are no extant historic or other cultural resources in the 84 km x 30 km 3-sigma safety footprint area that could be affected by Genesis

**Table 4-11. Chemical Species Produced during Spacecraft Reentry**

| Chemical Species | Total Mass* of Species Produced During Ablation (g) | Total Weight of Species Produced During Ablation (lb) |
|---|---|---|
| aluminum (Al) | $6.971 x10^{4}$ | 153.36 |
| carbon dioxide ($CO_2$) | $4.664 x10^{4}$ | 102.61 |
| titanium (Ti) | $2.804 x10^{4}$ | 61.69 |
| copper (Cu) | $2.237 x10^{4}$ | 49.21 |
| iron (Fe) | $1.590 x10^{4}$ | 34.98 |
| tungsten (W) | $7.318 x10^{3}$ | 16.10 |
| nickel (Ni) | $5.603 x10^{3}$ | 12.33 |
| chromium (Cr) | $4.628 x10^{3}$ | 10.18 |
| water ($H_2O$) | $2.231 x10^{3}$ | 4.91 |
| zinc (Zn) | $1.795 x10^{3}$ | 3.95 |
| carbon monoxide (CO) | $1.790 x10^{3}$ | 3.94 |
| platinum (Pt) | $1.550 x10^{3}$ | 3.41 |
| magnesium (Mg) | $1.005 x10^{3}$ | 2.21 |
| diatomic hydrogen ($H_2$) | $9.473 x10^{2}$ | 2.09 |
| carbon tetrafluoride ($CF_4$) | $9.096 x10^{2}$ | 2.01 |
| dihydrogen sulfide ($H_2S$) | $7.589 x10^{2}$ | 1.67 |
| manganese (Mn) | $6.413 x10^{2}$ | 1.41 |
| tin (Sn) | $4.612 x10^{2}$ | 1.01 |
| cobalt (Co) | $4.132 x10^{2}$ | 0.91 |
| lead (Pb) | $2.900 x10^{2}$ | 0.64 |
| beryllium (Be) | $1.915 x10^{2}$ | 0.42 |
| molybdium (Mo) | $1.589 x10^{2}$ | 0.35 |
| niobium (Nb) + tantalum (Ta) | $1.536 x10^{2}$ | 0.34 |
| gold (Au) | 94.77 | 0.21 |
| amidogen ($NH_2$) | 71.71 | 0.16 |
| methane ($CH_4$) | 45.11 | 0.10 |
| freon ($C_2F_6$) | 0.448 | $9.88 x10^{-4}$ |
| ammonia ($NH_3$) | $1.876 x10^{-2}$ | $4.14 x10^{-5}$ |
| carbon disulfide ($CS_2$) | $1.744 x10^{-2}$ | $3.85 x10^{-5}$ |
| hydrazine ($N_2H_4$) | $5.396 x10^{-4}$ | $1.19 x10^{-6}$ |
| hydrogen sulfide (HS) | $2.567 x10^{-7}$ | $5.66 x10^{-10}$ |
| hydrogen cyanide (HCN) | $2.402 x10^{-7}$ | $5.30 x10^{-10}$ |
| tetrafluorethene ($C_2F_4$) | $9.255 x10^{-8}$ | $2.04 x10^{-10}$ |
| formaldehyde ($CH_2O$) | $4.672 x10^{-8}$ | $1.03 x10^{-10}$ |
| cyanic acid (HNCO) | $2.539 x10^{-9}$ | $5.60 x10^{-12}$ |
| sulfur dioxide ($SO_2$) | $1.428 x10^{-9}$ | $3.15 x10^{-12}$ |

Source [JPL 1999-E]

*2.2 pounds per 1,000 grams

operations. As this area is an active bombing range, there are no sites listed on the NRHP within the proposed Genesis recovery footprint area. The proposed recovery area is considered to have a low level of sensitivity for significant archaeological resources; hence, the probability of the SRC landing on an NRHP-eligible site is extremely remote. The Genesis SRC recovery could have the potential for affecting cultural resources if it should impact outside the safety footprint. In the off-nominal case of the SRC landing outside the safety footprint and coincidentally on an archaeological site, the level of ground disturbance would be slight and unlikely to affect buried materials, except in the event of a mishap with the parafoil deployment. Therefore, the potential risk of adverse effect is considered remote and, in any event, would be insubstantial.

### 4.3.6 BACK CONTAMINATION

Genesis would journey 1.5 million km (930,000 mi) beyond Earth to the L1 Sun-Earth libration point where it would remain for a period of two years before returning to Earth. The mission would be focused on the collection and return of matter emitted by the Sun at this distance. Ions would be captured in nearly ultrapure silicon collector arrays, and the electrostatic concentrator would concentrate the elements hydrogen, helium, lithium, beryllium, boron, carbon, nitrogen, oxygen, fluorine, and neon. Sample collection would only occur at L1 with the sample collection system sealed at all other times. The samples would be returned to Earth in a sealed reentry capsule for study by the international science community.

The trajectory and associated halo orbit assures that the space vehicle would not travel near any extraterrestrial body. During the journey Genesis would be impacted by high velocity (1 km/sec [3,274 ft/s] or greater) interplanetary dust, in addition to solar wind. The dust is not a science objective and would be destroyed by vaporization upon impact with temperatures exceeding 500 ºCelsius. There would also be a possibility of capturing low velocity dust, primarily in near-Earth transit. This low velocity dust accumulation would be equivalent to that commonly experienced during Space Shuttle missions and U2 flights. Furthermore, the background radiation environment at the L1 point is extremely high, and the general consensus of the science community is that no organism would be able to sustain life in such a harsh environment. For these reasons, there is very little probability that back contamination of the Earth could occur due to the sample return. [JPL 1998-B] The Genesis project has requested and received classification from NASA’s Planetary Protection Officer as a Planetary Protection Category V mission, “Unrestricted Earth Return,” for this mission phase. No further planetary protection requirements would be levied on this mission. [NASA 1999-B, NASA 1999-D]

## 4.4 ENVIRONMENTAL IMPACTS OF ALTERNATIVES

### 4.4.1 ALTERNATIVE LAUNCH VEHICLES

Of the alternate launch vehicle systems available, all greatly exceed the Genesis mission requirements. The Atlas II would contribute less potential environmental effects; however, its cost to launch would prohibit the launch of this cost-capped Discovery mission. All other launch vehicle alternatives would contribute potentially comparable environmental impacts.

### 4.4.2 ALTERNATIVE LAUNCH SITES

CCAFS and Vandenburg Air Force Base (VAFB) have the only currently approved facilities to launch Delta II launch vehicles. Since the Delta II is the preferred launch vehicle for the Genesis mission, alternative launch sites to CCAFS and VAFB would not be available.

### 4.4.3 ALTERNATIVE RECOVERY SITES

Of the potential recovery sites reviewed for the Genesis mission, all would have the same environmental impacts, due to the ablation of the C-C heatshield in the upper atmosphere, and the recovery of the SRC over land. Analysis of possible trajectories for Genesis to land at other ranges shows that only choosing UTTR would allow the SRC to enter Earth's atmosphere directly over the range and into restricted airspace. The sparse human population surrounding UTTR adds a measure of personnel safety not readily achievable at other potential recovery sites. Therefore, recovering the SRC at the other sites reviewed would entail greater safety risks to commercial air traffic and to surrounding human populations, as well as risk to the science in the off-nominal case of the SRC landing in the mountainous or forested regions bordering the other locations.

### 4.4.4 NO-ACTION ALTERNATIVE

The No-Action alternative would result in termination of the mission, which would disrupt the progress of NASA's Solar System Exploration program. While environmental impacts would be avoided by cancellation of this proposed single mission, the loss of the scientific knowledge and database from carrying out the mission could be substantial.

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# SECTION 5
# REGULATORY REVIEW

## 5.1 CAPE CANAVERAL AIR FORCE STATION (CCAFS)

### 5.1.1 AIR QUALITY

The Florida Department of Environmental Protection (FDEP) regulates air pollutant emission sources in Florida and requires permits for the construction, modification, or operation of potential air pollution sources [FDEP 1999]. Emissions from mobile sources, such as aircraft and space launch vehicles, do not require a permit. This exception does not include support facilities, such as propellant loading systems.

Stationary, ground-based sources associated with space vehicle launches are subject to FDEP review. Because no new stationary sources would be constructed for the Genesis launch, there is no requirement for new air quality permits.

The Delta II oxidizer and fuel vapor air pollution control devices at CCAFS are in compliance with NAAQS standards and FDEP regulations. The citric acid scrubber for Delta II propellants is probably one level of control beyond that required by the FDEP.

### 5.1.2 WATER QUALITY

#### 5.1.2.1 Stormwater Discharge

Florida's stormwater discharge permitting program is designed to prevent adverse effects on surface water quality from runoff. A discharge permit will not be required for Genesis because the launch would not increase stormwater runoff rates or reduce the quality of the existing runoff.

#### 5.1.2.2 Sanitary and Industrial Wastewater Discharge

LC-17 and the Genesis spacecraft and launch vehicle assembly facilities have potable water and sanitary waste disposal permits. No new permits will be required for the Genesis assembly or launch.

Wastewater from LC-17 would include deluge and pad washdown water discharged during Genesis launch activities. An application has been filed with the FDEP to permit discharge from LC-17. The permit will be issued based on demonstration that discharge would not significantly degrade surface or ground water.

#### 5.1.2.3 Floodplains and Wetlands

LC-17 is not located on a floodplain. Impacts to wetlands from the launch of the Genesis would not exacerbate impacts from other CCAFS activities or launches. Therefore, no new permits would be required for the Genesis launch.

### 5.1.3 HAZARDOUS WASTES

CCAFS was issued a Resource Conservation and Recovery Act (RCRA), Part B Hazardous Waste Operations permit in January 1986 [USAF 1986]. All hazardous wastes generated at CCAFS will be managed according to the 45th Space Wing (45SW) Petroleum Products and Hazardous Waste Management Plan (OPlan 19-14). Hazardous wastes produced during processing and launch operations will be collected and stored in hazardous waste accumulation areas before being transferred to a hazardous storage area. These wastes will eventually be transported to an off-station licensed hazardous waste treatment/disposal facility.

### 5.1.4 SPILL PREVENTION

To prevent oil or petroleum discharges into U.S. waters, a Spills Prevention, Control, and Countermeasures Plan (SPCCP) is required by the Environmental Protection Agency's oil pollution prevention regulation. A SPCCP has been integrated into the 45th SW Hazardous Materials Response Plan (OPlan 32-3). Spills of oil or petroleum products that are federally listed hazardous materials will be collected and removed for proper disposal by a certified contractor according to 45SW OPlan 19-14. All spills/releases will be reported to the host installation per OPlan 32-3.

### 5.1.5 COASTAL MANAGEMENT PROGRAM

The Federal Coastal Zone Management Act of 1972 established a national policy to preserve, protect, develop, restore, and/or enhance the resources of the nation's coastal zone. The Act requires federal agencies that conduct or support activities directly affecting the coastal zone, to perform these activities in a manner that is, to the maximum extent practicable, consistent with approved state coastal zone management programs.

Delta II launches from LC-17 have been demonstrated to be consistent to the maximum extent practical with the State of Florida's Coastal Management Program, based on compatible land use, absence of significant environmental impacts and compliance with applicable regulations. [USAF 1986] Genesis mission processing and launch would add no substantial impact beyond those determined to be associated with the Delta II.

### 5.1.6 CULTURAL RESOURCES

In accordance with 36 CFR Part 800, the Florida Department of State, Division of Historical Resources, will review the planned Genesis launch for possible impact to archaeological and historical sites or properties listed, or eligible for listing, in the National Register of Historic Places (NRHP).

## 5.2 UTAH TEST AND TRAINING RANGE (UTTR) [USAF 1996-A]

Management of UTTR has included and will include compliance with many federal laws and regulations, State of Utah Department of Environmental Quality (DEQ) regulations, Utah environmental statues, and local environmental requirements to ensure that human health and the environment are protected. The Utah State DEQ implements and enforces most of the environmental laws and regulations promulgated in Utah. Utah has been designated by EPA to administer, implement, and enforce most of the federal environmental programs and laws.

### 5.2.1 AIR QUALITY

Activities at UTTR are governed by the federal Clean Air Act (CAA), which is largely implemented through the Utah Air Conservation Act (Title 19, Chapter 2, U.C.A.) and Air Conservation Regulations (R307-1 U.A.C.), and by any portions of the federal regulations that have not been adopted by the State. The State of Utah has been designated by EPA for implementation and enforcement of the CAA regulations. The State implementation plan contains emission controls to ensure that State air quality control areas meet National Ambient Air Quality Standards (NAAQS). UTTR is located within a Class II attainment area; therefore, it is subject to regulations designed for prevention of significant deterioration (PSD) of air quality.

Potential pollutants of concern at UTTR for which federal or state ambient air quality standards have been established include ozone ($O_3$), carbon monoxide (CO), nitrogen dioxide

($NO_2$), sulfur dioxide ($SO_2$), total suspended particulates (TSP), particulate matter less than 10 microns in aerodynamic diameter (PM-10), and lead.

The draft CAA Title V operating permit has been completed for UTTR. It provides information on UTTR emission sources, actual emissions, potential emissions, and other pertinent permitting data.

Air emissions from ground transport to and from off-range facilities (e.g., the facilities at HAFB), from overflying aircraft, from target detonation, from the Thermal Treatment Unit (TTU), from missile and other testing, and from other miscellaneous transient sources have been modeled in previous NEPA compliance documentation and the Title V permit application.

## 5.2.2 WATER QUALITY

Control of water quality at UTTR includes regulation of water discharges under the Clean Water Act (CWA) and under the Utah Water Quality Act (Title 19, Chapter 5, U.C.A.), Utah Pollutant Discharge Elimination System Rules (R317-8 U.A.C.) and Utah Underground Injection Control Program Rules (R317-7 U.A.C.). The State of Utah has been designated by EPA to implement and enforce the CWA in Utah. The Utah Ground Water Quality Protection Rules (R317-6 U.A.C.) do not formally apply at UTTR because the ground water there is classified as nonpotable brine. Nonetheless, UTTR personnel do take steps to comply with the spirit of these rules and file Nature of Groundwater Discharge Notification Forms when appropriate.

### 5.2.2.1 Stormwater Discharge

There are no stormwater discharges on UTTR; therefore a stormwater management Plan is not required. The reverse-osmosis water treatment plant on HAFR uses HTH chlorine (A high-test calcium hypochlorite product), antiscalant, and pH-adjusting chemicals such as sulfuric acid and potassium permanganate for treatment. The plant operates continuously and periodically discharges wastewater through a French drain system to a ditch that is approximately 300 yards east of the plant. A Nature of Groundwater Discharge Notification Form was submitted to the Utah Division of Water Quality (DWQ) on January 26, 1995, for *de minimus* (i.e., too small for regulation based on numerous situation-specific considerations) discharges from the treatment plant. The DWQ has indicated that continued discharge is acceptable unless they send formal notification to the contrary.

#### 5.2.2.2 Sanitary and Industrial Wastewater Discharge

The wastewater treatment system on HAFR consists of a total containment evaporation pond that is east of the drinking water treatment plant. This is an injection well at the Eagle Tower Range maintenance facility that was once considered a de minimus discharge facility. This discharge is no longer regulated and discharges into a drain field. It is standard procedure to test wastewater prior to discharge. If the water contains plastic Kevlar chips, it is considered nonhazardous and is discharged to the wastewater treatment pond. If the water contains propellant, it is drummed and sent off-site for disposal.

#### 5.2.2.3 Underground Storage Tanks (range [USAF 1996-A]

Underground storage tanks (USTs) and their associated piping are regulated by the RCRA UST regulations. These regulations require states to develop programs covering UST design, construction, installations, operation release reporting, and corrective action. The Utah Sate Underground Storage Tank Act and the Underground Storage Tank Rules (Title 311, Rules 200-212 U.A.C.) specify notification requirements for tanks and leaks from tanks, leak detection, spill and overfill protection, installation, removal, closure, and corrective action requirements. The Utah DEQ manages the UST compliance program, under which USTs that store hazardous chemicals or wastes are required to have secondary containment.

There are two permitted USTs at HAFR. Twenty-five USTs were removed in January 1994. Three additional tanks had been removed by April 1996. There are eleven tanks that are not regulated.

Facilities that have the potential to discharge harmful quantities of oil into or on bodies of water are required by the Oil Pollution Act, which supersedes certain sections of the CWA, to prepare a Spill Prevention Control and Countermeasure (SPCC) plan. The final HAFB SPCC plan was combined with the facilities response plan (FRP) in a single document. The SPCC/FRP details prevention and response measures to ensure that oil and hazardous material spills do not reach navigable waters. It also provides the spill prevention training requirements and the responsibilities of the hazardous materials (HAZMAT) Team with regard to spills of hazardous materials. Emergency response (ER) and the spill response plan mission on HAFR and WAFR are performed by the 75th RANS (Range Support Squadron) HAZMAT Team, which has been certified by the National Fire Protection Association.

### 5.2.3 HAZARDOUS WASTES

HAFR is considered to be a small-quantity waste generator, and has an EPA identification number. Hazardous waste generated on HAFR includes ash residue from the

TTU and other open burning/open detonation activities, and various wastes generated in the vehicle maintenance shops and batter storage facility. Hazardous wastes that are shipped off-site are handled in accordance with DoT requirements. The DoT regulations must be applied to transportation of hazardous materials and wastes on public roads, including those on HAFR.

WAFR has no EPA identification number since hazardous waste is not generated there.

There are three RCRA-permitted activities at HAFR -- the TTU, the closure of the hazardous waste landfill (Landfill No. 5), and the Lithium Battery Facility (research, development, and disposal).

### 5.2.4 NOISE

The Noise Control Act (NCA) requires measures to reduce emissions. Generally, federal agencies whose activities result in increased environmental noise in the surrounding community are responsible for compliance with state and local environmental noise requirements. However, the NCA exempts military weapons or equipment for combat use from environmental noise requirements. The State of Utah has no noise control regulations, although State Code 10-8-16 gives cities the authority to develop noise control regulations or standards. The Tooele County Planning Division has performance standards that regulate the sound pressure level radiated by the facilities in the county; the Box Elder County Zoning Department has no noise abatement requirements and places HAFR in zone MU-160, where most uses are permitted by a conditional permit.

The existing noise environment on UTTR consists primarily of aircraft flight activity. This includes subsonic activity on low-level training flights and high-altitude missions and supersonic events in the Supersonic Operating Area (SOA) about 1.5 km (5,000 ft) above ground level (AGL). The SOA is in SUTTR and covers all of WAFR and Dugway generally west of Granite Mountain, as well as extending into Nevada. Sonic booms generated outside the SOA and capable of generating overpressure between one and four pounds per square foot occur infrequently.

### 5.2.5 CULTURAL RESOURCES

Data on the cultural resources identified at HAFR and WAFR to date by surveys are on file at HAFB, but are only available on a “need to know” basis. Information on cultural resources is typically not made available to the general public in order to protect the sites from potential “pot hunters.” However, there are no sites listed on the NRHP within the proposed Genesis recovery footprint area. Because the Genesis recovery is planned as a mid-air retrieval, there is a very small probability that the SRC would actually land on the ground. The proposed impact area is considered to have a low level of sensitivity for significant archaeological resources; therefore, the probability of landing on a NRHP-eligible site is remote. In the event that the SRC is not caught during one of the five planned helicopter passes and did land on an archaeological site, the level of ground disturbance would be slight and unlikely to affect buried materials. Therefore, the risk of adverse effect is considered insignificant. There are no extant historic or other cultural resources in the impact area that could be affected by Genesis operations.

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# SECTION 6

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# APPENDIX A
# CORRESPONDENCE WITH STATE AND FEDERAL AGENCIES

NOTE:

While preparing this Environmental Assessment, NASA solicited comments from a range of Federal and State Agencies. A distribution list may be found at the end of the NASA Letter to Concerned Agencies dated 29 March 1999. There will be formal correspondence with Patrick Air Force Base, Air Combat Command, Kennedy Space Center, and Utah Test and Training Range.

This appendix contains the comments received from the following State Agencies:

Florida State Clearinghouse
State of Florida Department of Community Affairs (Florida Coastal Management Program)
Florida Department of Environmental Protection
Florida Game and Fresh Water Fish Commission
Florida Office of Tourism, Trade, and Economic Development (OTTED)
Florida Bureau of Historic Preservation
St. John's River Water Management District
Florida Office of Planning and Budgeting, Environmental Policy Unit
East Central Florida Regional Planning Council

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# APPENDIX B

## Selected REEDM Outputs for:

Normal Launch Mode

Conflagration Mode Failure

Deflagration Mode Failure

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