RA

APR 2 8 1999

Office of Cultural Affairs
Attn: Ms. Lynne Sebastian
Division Director
Historic Preservation Division
228 East Palace Avenue
Santa Fe, NM 87501

Subject: NASA White Sands Test Facility (WSTF) Historic Preservation Issues at the Proposed Plume-Front Groundwater Remediation System

NASA intends to implement a pump and treat groundwater remediation system to prevent further migration of contaminated groundwater caused by historical site operations. This interim remedy will pump groundwater from six extraction wells, treat the groundwater using ultraviolet/oxidation and air stripping technologies, and reintroduce treated groundwater into the aquifer through a network of four injection wells. The proposed project would be located in sections 31 and 32 of T20S, R3E, and sections 4, 5, 6, and 9 of T21S, R3E.

This letter addresses historic preservation issues associated with the proposed plume-front groundwater remediation system. Historic preservation surveys were performed at WSTF by Batcho & Kauffman Associates in the early 1990's. The Environmental Assessment has considered historic preservation issues, and the proposed project will avoid areas of significance. NASA concludes that the proposed project will have no effect on historic preservation and requests your concurrence. Supportive information is provided in the Environmental Assessment. Section 3.4 (Cultural Resources) and Appendix B (A Final Report of the Archaeological Mitigation of Site BK 337 on State Land Adjacent to the NASA White Sands Test Facility) provide specific historic preservation information.

If you have any questions or comments concerning this submittal, please call me at (505) 524-5517.

Original Signed By:

David A. Amidei
Environmental Program Manager

Enclosure

bc:
ATSC Team/P. H. Pache

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White Sands Test Facility
P.O. Drawer MM
Las Cruces, NM 88004

ENCLOSURE

Environmental Assessment for the Plume-Front Remediation System

White Sands Test Facility

Issued: 4/2/99
Expires: N/A

ENVIRONMENTAL ASSESSMENT FOR THE PLUME-FRONT REMEDIATION PLAN

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NASA

ENVIRONMENTAL ASSESSMENT FOR THE PLUME-FRONT REMEDIATION SYSTEM WHITE SANDS TEST FACILITY LAS CRUCES, DOÑA ANA COUNTY NEW MEXICO

Lead Agency:
National Aeronautics and Space Administration (NASA)
White Sands Test Facility
Las Cruces, New Mexico

Proposed Action:
Fabrication and operation of a plume-front pump and treat groundwater remediation system to prevent further migration of contaminated groundwater.

For Further Information:
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Date: April 2, 1999

Abstract:
NASA White Sands Test Facility (WSTF) intends to implement a pump and treat groundwater remediation system to prevent further migration of contaminated groundwater caused by historic site operations. This interim remedy will pump groundwater from six extraction wells, treat the groundwater using ultraviolet/oxidation and air stripping technologies, and reintroduce treated groundwater into the aquifer through a network of four injection wells. System construction is expected to commence in the summer of 1999 and is anticipated to operate 24 hours per day following an initial start-up phase. Approximately 1,000 gallons per minute will be treated and injected during the operational life of the system. WSTF expects the system to be operational in the year 2000. Contaminant treatment standards for the injected water have been developed following standards and guidelines from Federal and State regulatory sources. WSTF is located approximately 16 miles northeast of Las Cruces, New Mexico. The proposed project's location is in Sections 31 and 32 of T20S, R3E and Sections 4,5,6, and 9 of T21S, R3E in Doña Ana County, NM.

This Environmental Assessment examines the proposed project effects on the natural habitat and evaluates alternatives. These alternatives include monitored natural attenuation, full-scale groundwater remediation, land acquisition and control, remediation system options, and a no-action option.

EXECUTIVE SUMMARY

An Environmental Assessment (EA) is designed by the Federal Government to investigate proposed projects and their effects on the natural environment. The National Aeronautics and Space Administration (NASA) has prepared an EA for this project based on Section 3.6.1 of the *NASA Procedures and Guidelines for Implementing the National Environmental Policy Act and Executive Order 12114.* This EA analyzes the plume-front stabilization proposal on NASA, Bureau of Land Management (BLM), and State of New Mexico (NM) land adjacent to the NASA White Sands Test Facility (WSTF). WSTF intends to implement a pump and treat groundwater remediation system to prevent further migration of contaminated groundwater caused by historic site operations. This interim remedy will pump groundwater from six extraction wells, treat the groundwater using ultraviolet/oxidation and air stripping technologies, and reintroduce treated groundwater into the aquifer through a network of four injection wells. System construction is expected to commence in the summer of 1999 and is anticipated to operate 24 hours per day following an initial start-up phase. Approximately 1,000 gallons per minute will be treated and injected during the operational life of the system. WSTF expects the system to be operational in the year 2000. Contaminant treatment standards for the injected water have been developed following standards and guidelines from Federal and State regulatory sources. The proposed location is in Sections 31 and 32 of T20S, R3E and Sections 4,5,6, and 9 of T21S, R3E in Doña Ana County, NM.

This analysis evaluates the environmental effects of the proposed project and determines if an Environmental Impact Statement should be prepared. The EA is designed to present information sufficient to determine if there are significant impacts which merit a more detailed study, analysis and public input. An Environmental Impact Statement, if necessary, presents the results of the detailed study and analysis, and attempts to rigorously measure and present the nature and level of potential significance.

Alternatives Considered

NASA has considered the alternatives of Monitored Natural Attenuation, Full-Scale Groundwater Remediation, Land Acquisition and Control, Remediation System Options, and No-Action. These alternatives are not technically or financially feasible at this time. In addition, these alternatives are not currently acceptable by State and Federal regulatory agencies. The EA provides detailed information concerning each alternative.

Environmental Aspects

Environmental aspects were examined pertaining to the following areas: geology and soils; air; water; cultural resources; biological resources; noise; land use; energy; services; and socioeconomic issues. The following section summarizes the conclusions for relevant environmental issues:

Land use - Regulatory officials would need to concur pertaining to the proposed activities. Additional roads, pipes, and powerlines with poles would be needed to support this proposal. These actions would be minimized by using existing facilities where applicable.

Energy - Energy consumption would increase at WSTF. The worst-case usage estimation would result in an approximate 73% annual increase of electrical energy consumption at WSTF when compared to fiscal year 1998 (FY98).

Groundwater Quality - Groundwater quality at the project area will be significantly enhanced. Groundwater pump and treat remediation will remove contaminant mass, reduce potential ecological risks and prevent continued plume migration.

Biological resources - The proposed project area has no habitat critical to the survival or reproduction of any listed species of plant or animal. This was observed during a threatened and endangered species survey. Additionally, there are no areas nearby that are considered highly sensitive or moderately sensitive that could be affected by the proposed action. However, wells, well pads, roads, pipes, and powerlines with poles would be needed to support this proposal. These actions would be minimized by using existing facilities in all applicable instances.

Cultural resources - During the implementation phase, there is a possibility of unearthing archaeological resources. An archeological survey has been completed for the affected area. If any undiscovered archeological site is uncovered during construction, site construction would cease until historic preservation issues are resolved.

Noise - Construction activities are expected to be done intermittently over a two year period. Fifteen wells would be drilled; each lasting approximately 10 days. The remedial air stripping noise levels have been estimated at 95 decibels (dB(A)) at 5 feet. Ecological impacts from well installation activities and remedial system construction are expected to be negligible.

Geology and soils - A minor concern exists with an increase of wind or water erosion of soils during the construction phase. This is unlikely to transform the topographic conditions within the proposed area.

If an accident or mishap occurs as a result of this project there may be a minor environmental impact. All necessary precautions will be taken to ensure that operations are performed under the safest conditions possible to minimize any impact on public health and employee safety as well as the natural environment.

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INDEX OF ACRONYMS AND ABBREVIATIONS

3DSWB	Three-Dimensional Site-Wide Bedrock
bgs	below ground surface
BLM	Bureau of Land Management
CFR	Code of Federal Regulation
CMS	Corrective Measures Study
dB(A)	decibel, A-weighted
DMN	N-nitrodimethylamine
EA	Environmental Assessment
EJ	Environmental Justice
EPA	Environmental Protection Agency
FBR	Flow-Banded Rhyolite
ft	feet
FY98	Fiscal Year 1998
gpm	gallons per minute
hr	hour
HRMB	Hazardous and Radioactive Materials Bureau
JDMB	Jornada del Muerto Basin
km	kilometers
lpm	liters per minute
m	meters
mi	miles
MPCA	Mid-Plume Constriction Area
mph	miles per hour
NARA	National Archives and Records Administration
NASA	National Aeronautics and Space Administration
NDMA	N-nitrosodimethylamine
NM	New Mexico
NMAC	New Mexico Administrative Code
NMED	New Mexico Environment Department
NMSLO	New Mexico State Land Office
PCE	Perchloroethene
PFE	Plume-Front Extraction
PFI	Plume-Front Injection
Plan	Plume-Front Stabilization Work Plan
ppm	parts per million
ppmw	parts per million by weight
PSL	Physical Science Laboratory
RCRA	Resource Conservation and Recovery Act
RFI	Resource Conservation and Recovery Act Facility Investigation
TCE	Trichloroethene
TDS	Total Dissolved Solids
TX	Texas
WBFZ	Western Boundary Fault Zone
WSMR	White Sands Missile Range
WSTF	White Sands Test Facility

1.0 PURPOSE AND NEED

WSTF is located in south central New Mexico (Figures 1-3). Groundwater contamination is present at WSTF due to historical operations utilizing hypergolic propellants and industrial cleaning solvents. The proposed groundwater pump and treat plume-front containment project is intended to control threats to human health and/or the environment at the westernmost extent of a groundwater contaminant plume within the WSTF aquifer. The contaminants of concern at the plume-front include N-nitrosodimethylamine (NDMA), N-nitrodimethylamine (DMN) and several volatile organic compounds. The volatile organic compounds of concern are perchloroethene (PCE), trichloroethene (TCE) and several Freons. The WSTF groundwater contamination plume is approximately 6,095 meters (m) (20,000 feet (ft)) in length, 2,440 m (8,000 ft) in width (at the plume-front) and 215 m (700 ft) in depth. The plume outer boundaries are presented in Figure 4. Investigations indicate that the contamination has an elongated east to west pattern. This is caused by a strong east to west hydraulic gradient between the San Andres Mountains recharge areas (east) and the Jornada del Muerto Basin (JDMB) (west). The groundwater plume consists of three general areas: the source areas; mid-plume constriction area; and the plume-front area (Figure 5).

The WSTF plume-front area is hosted within a transitional hydrogeological zone between the western San Andres Mountains fractured bedrock pediment slope and the alluvial filled JDMB (Figure 5). This transitional zone is referred to as the Western Boundary Fault Zone (WBFZ), and comprises an area of pronounced half-graben bedrock faulting related to Tertiary Basin and Range extension. Groundwater at the plume-front area occurs at an approximate depth of 130 m (420 ft) below ground surface (bgs), with low-concentration groundwater contamination confined to the upper 185 m (600 ft) of the aquifer.

NASA maintains administrative control over all lands underlain by groundwater contamination (Figure 6). These lands include parcels owned by the U.S. Department of Defense, BLM, the State of New Mexico, and NASA. NASA's ownership or co-use control of these lands precludes water extraction for the purpose of domestic or commercial use. The parcels of land the Plan encompasses include Sections 31 and 32 of T20S, R3E; and Sections 4, 5, 6, and 9 of T21S, R3E. The WSTF buffer zone (approximately ten square miles west of the industrial facility) has isolated the facility from potential receptors of groundwater contamination. However, NASA proposes to institute this plume-front containment project to effectively mitigate plume migration and minimize risks to potential receptors.

FIGURE 1
COUNTRY LOCATION

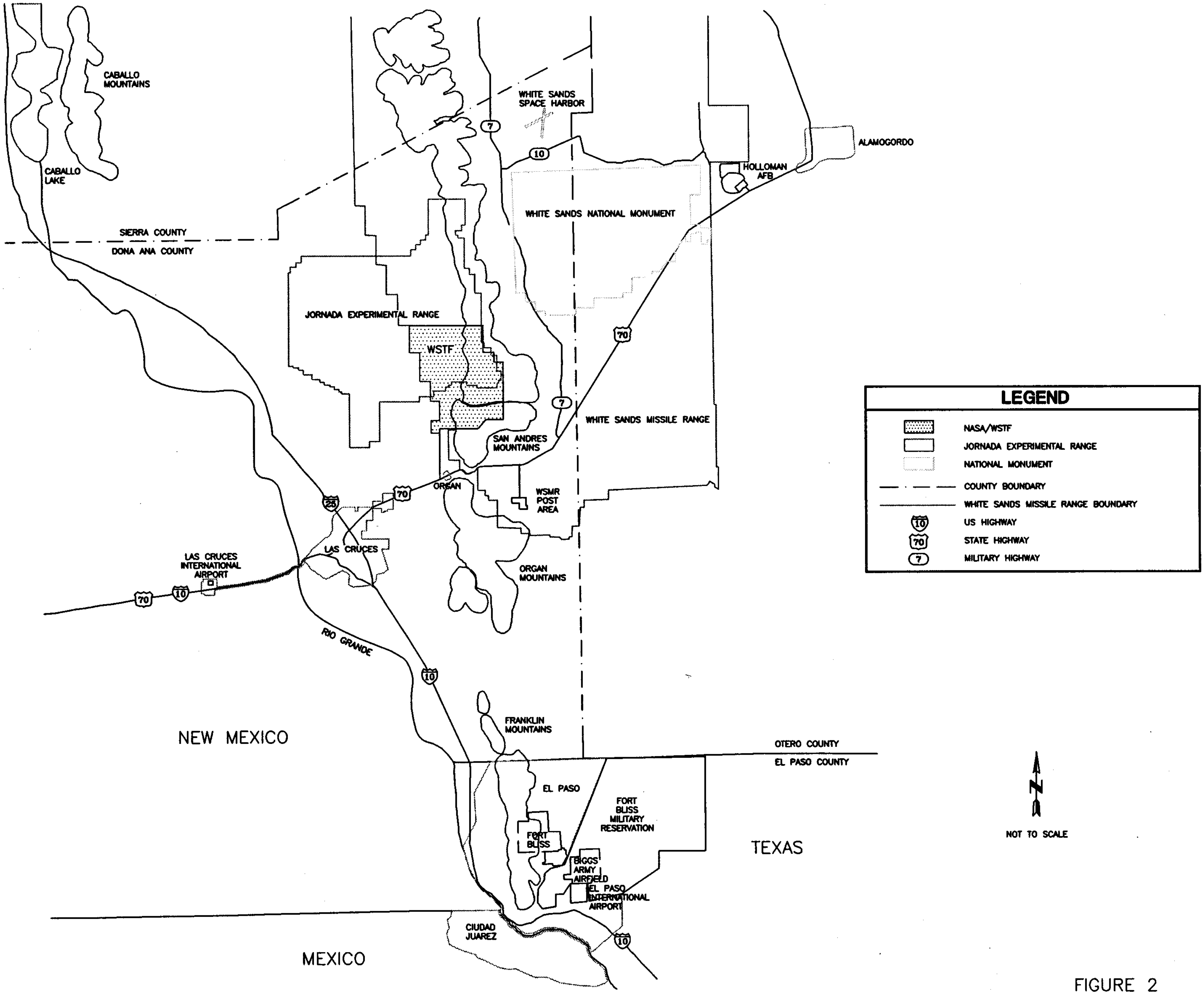

FIGURE 2
COUNTY VICINITY

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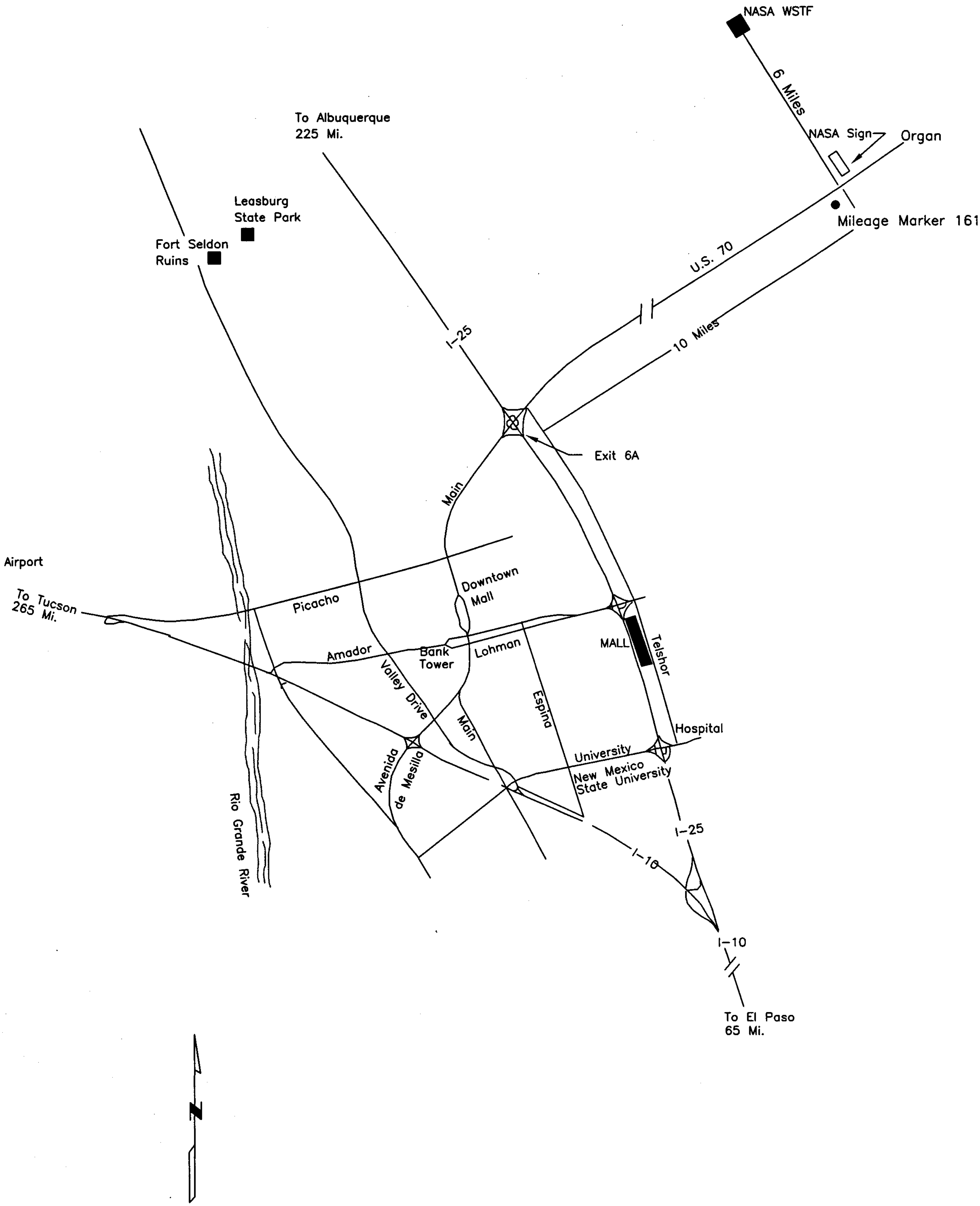

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FIGURE 3
MUNICIPAL AREA

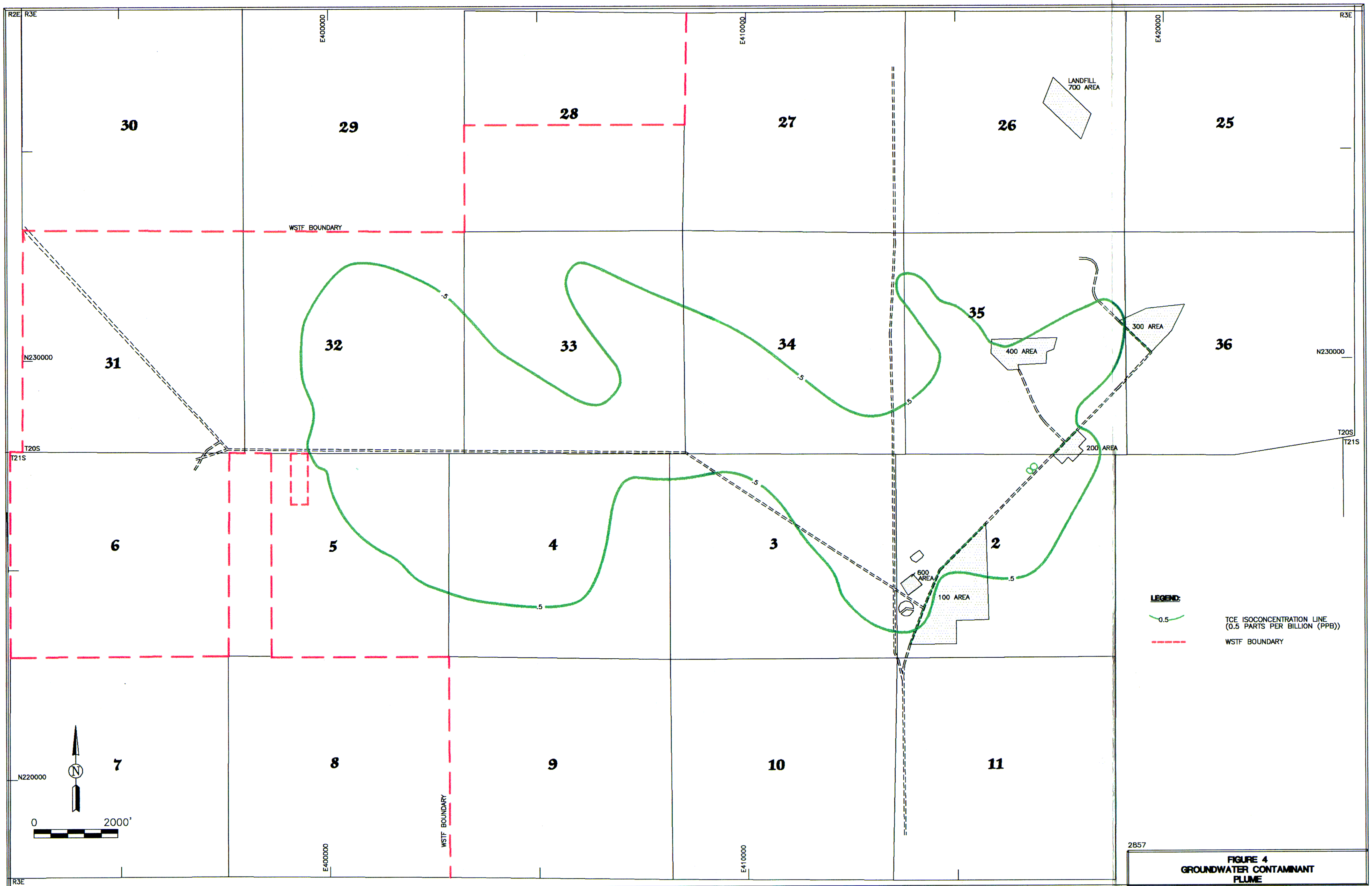

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FIGURE 4
GROUNDWATER CONTAMINANT PLUME

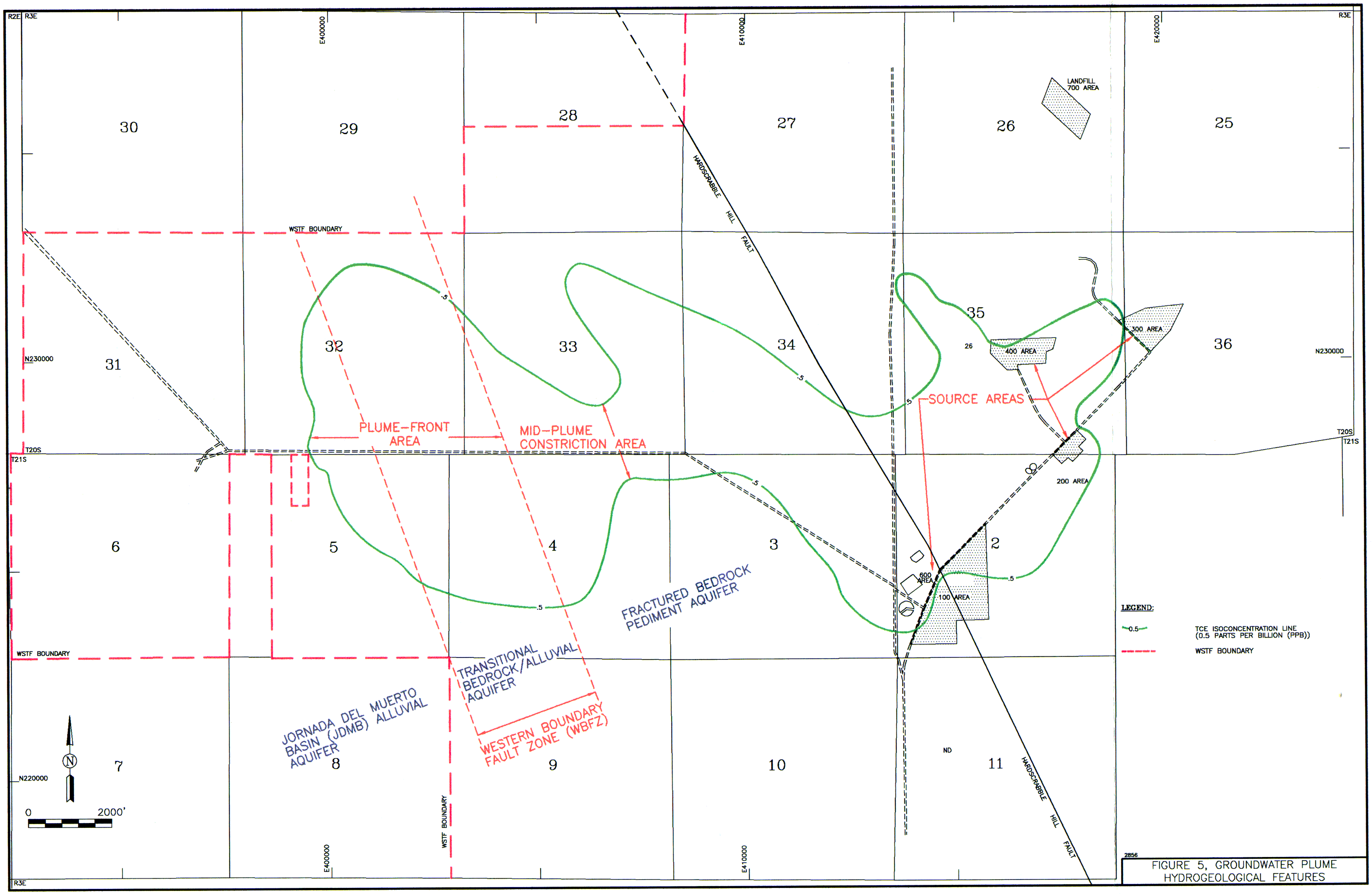


FIGURE 5, GROUNDWATER PLUME HYDROGEOLOGICAL FEATURES

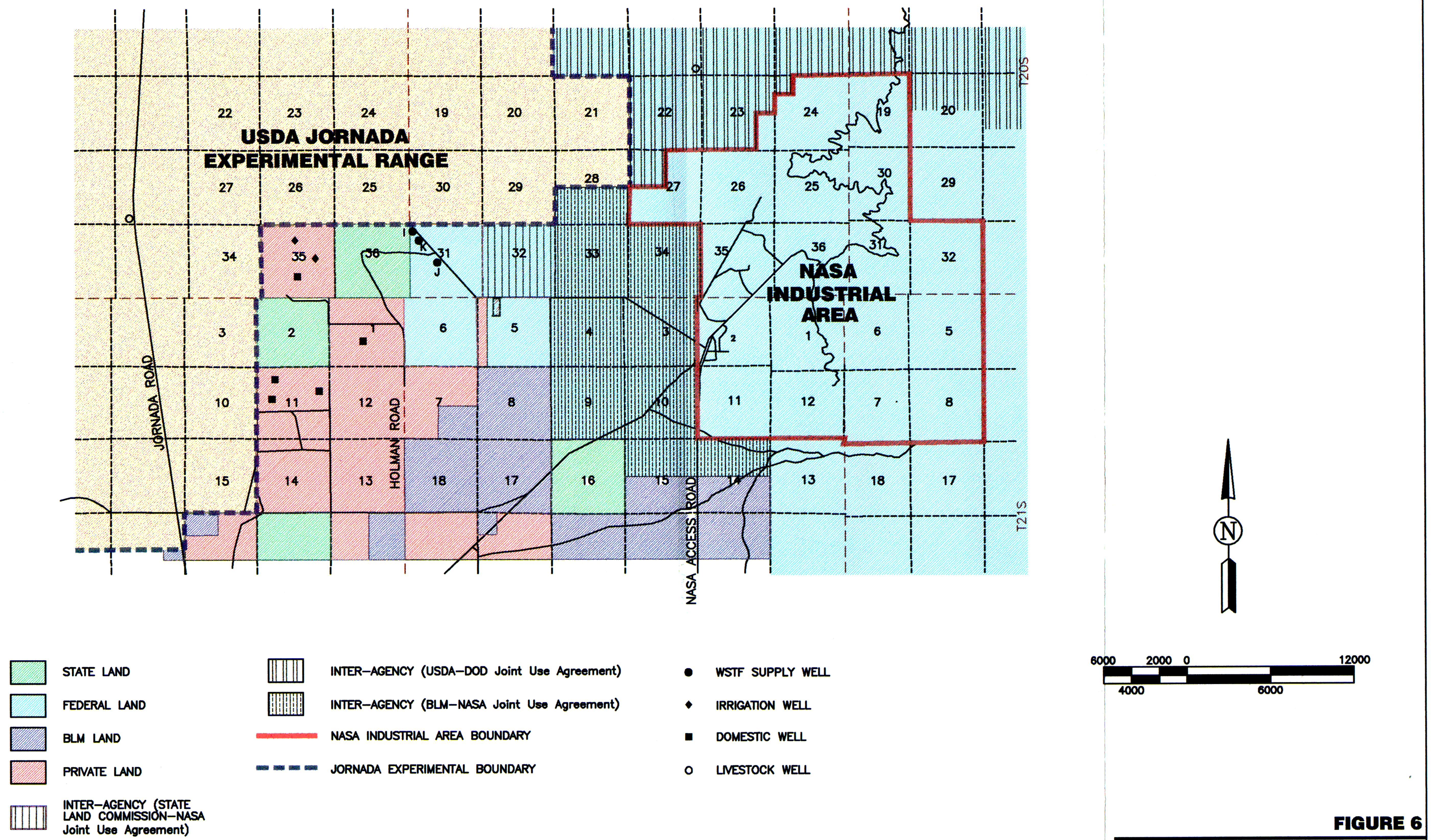


FIGURE 6

ADMINISTRATIVE CONTROL

2.0 DESCRIPTION OF PROPOSED ACTION AND ALTERNATIVES

2.1 Proposed Action

The Plume-Front Stabilization Work Plan (Plan) describes a plume-front containment presumptive remedy for contaminated groundwater at WSTF. NASA proposes an ex-situ pump and treat groundwater remediation system to address plume-front stabilization and contaminant mass treatment activities. This system will consist of five additional groundwater monitoring wells (WW-2, ST-7, JP-3, PL-8 and BLM-37). These wells enhance plume-front monitoring capabilities and monitor the effectiveness of the stabilization system.

The plume-front stabilization proposal will utilize six plume-front extraction (PFE) and four plume-front injection (PFI) wells (Figure 7). The three-dimensional site-wide bedrock (3DSWB) model was utilized to simulate contaminant plumes for NDMA, PCE and TCE. Parameters generated from the 3DSWB model wells were used for the plume-front stabilization well designs.

Extraction wells PFE-1 through PFE-6 will remain within, or on the eastern boundary, of the WBFZ. Three high-volume extraction wells (PFE-1 through PFE-3) and one lower volume extraction well (PFE-4) will specifically address the TCE contamination, which extends furthest west. This will also effectively contain the PCE plume. Extraction wells PFE-1 through PFE-4 will utilize an estimated combined flow rate of 3,065 liters per minute (lpm) (810 gallons per minute (gpm)). Extraction wells PFE-5 and PFE-6, with an estimated combined flow rate of 760 lpm (200 gpm), specifically address NDMA/DMN plume-front containment. In the plume-front vicinity, the DMN plume has a similar extent to the NDMA plume. To ensure stabilization of the NDMA/DMN plume-front, which does not extend as far west as the TCE plume, wells PFE-5 and PFE-6 will be positioned to stabilize NDMA/DMN plume-front concentrations east of the TCE target wells. The estimated total system flow rate will be 3,825 lpm (1,010 gpm).

Groundwater contaminant destruction will be performed using a groundwater treatment system. The groundwater from the extraction well system will be pretreated as necessary, and remediated by an ultraviolet/oxidation unit (primarily for NDMA and DMN) and an air-stripper unit (for the volatile organic compounds). Contaminant treatment standards for the injected water have been developed

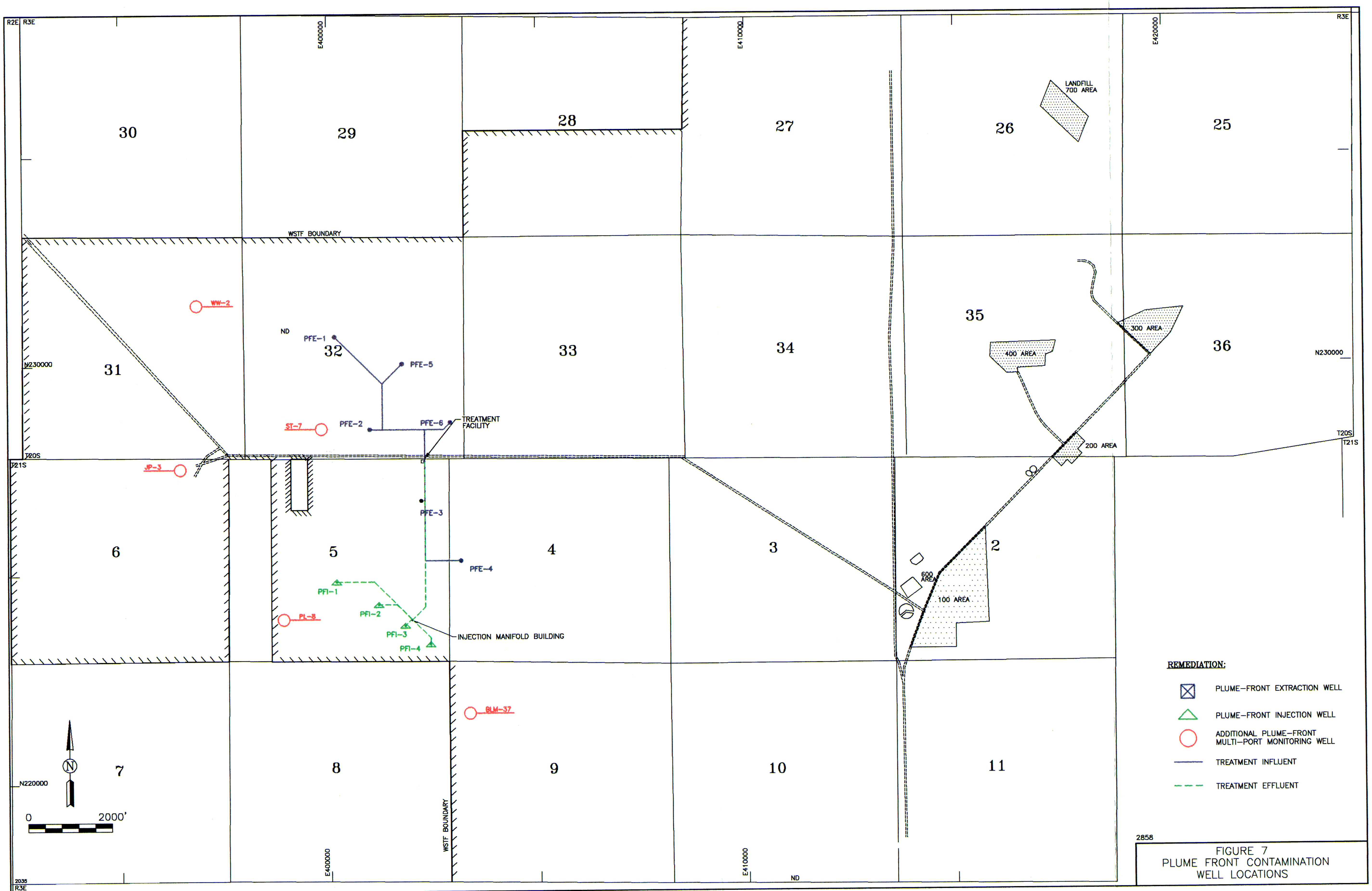


FIGURE 7
PLUME FRONT CONTAMINATION
WELL LOCATIONS

following standards and guidelines from multiple Federal and State regulatory sources. Remediated groundwater injection will be accomplished by four injection wells (PFI-1 through PFI-4) located to the west and south of the contaminant plume. The injection well locations are designed to contain the southern migration of the plume by creating a localized groundwater mound. The remedial system location relative to existing wells and the plume boundaries is provided in Figure 8.

The Plan addresses the stabilization and mass removal of low-concentration groundwater contamination encountered at the leading (westernmost) edge of the WSTF contaminant plume (referred to as the plume-front). This Plan presents an ex-situ groundwater pump and treat remediation and plume containment system. This proposal is the most technically and economically desirable alternative based on the following:

- the remediation system is a proven technology treatment;
- the system will remove contaminant mass and effectively contain plume-front contaminant migration;
- electrical power and water can be extended from existing WSTF systems located less than one mile from the site (Figures 9 and 10);
- construction of the proposed project utilizes land agreements with the State of New Mexico and BLM which allows NASA to construct and operate with minimal inter-government agency interaction; and,
- the remediation facility will be remote and not accessible to the general public.

2.2 Other Alternatives

2.2.1 Monitored Natural Attenuation

NASA has examined the alternative of monitored natural attenuation for plume-front groundwater contamination. Monitored natural attenuation allows for the natural degradation of groundwater contamination over time utilizing native microbes, bacteria, and enzymes. As part of a monitored natural attenuation program, facilities perform rigorous groundwater monitoring activities to evaluate the process and determine the extent of contaminant degradation and plume migration. From a State and Federal regulatory perspective, this procedure is not an acceptable alternative to active remediation when computer modeling and groundwater data indicates even minimal plume movement. In addition, regulatory agencies disapprove of monitored natural attenuation when contaminants are recalcitrant to natural degradation processes. The monitored natural attenuation option does not provide for active plume-front contamination containment, does not prevent plume migration, does not remove contaminant mass, and is not protective of human health or the environment.

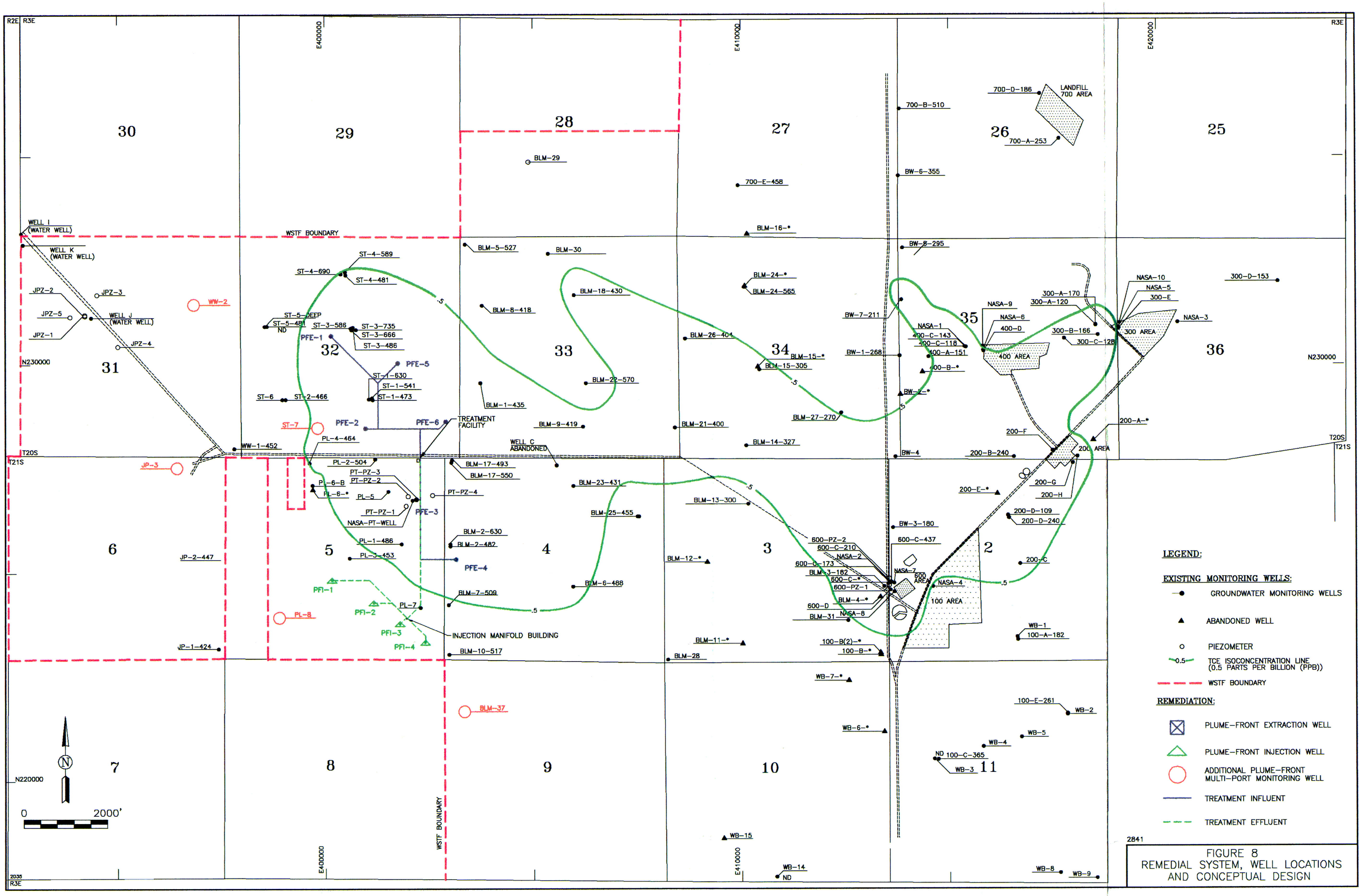
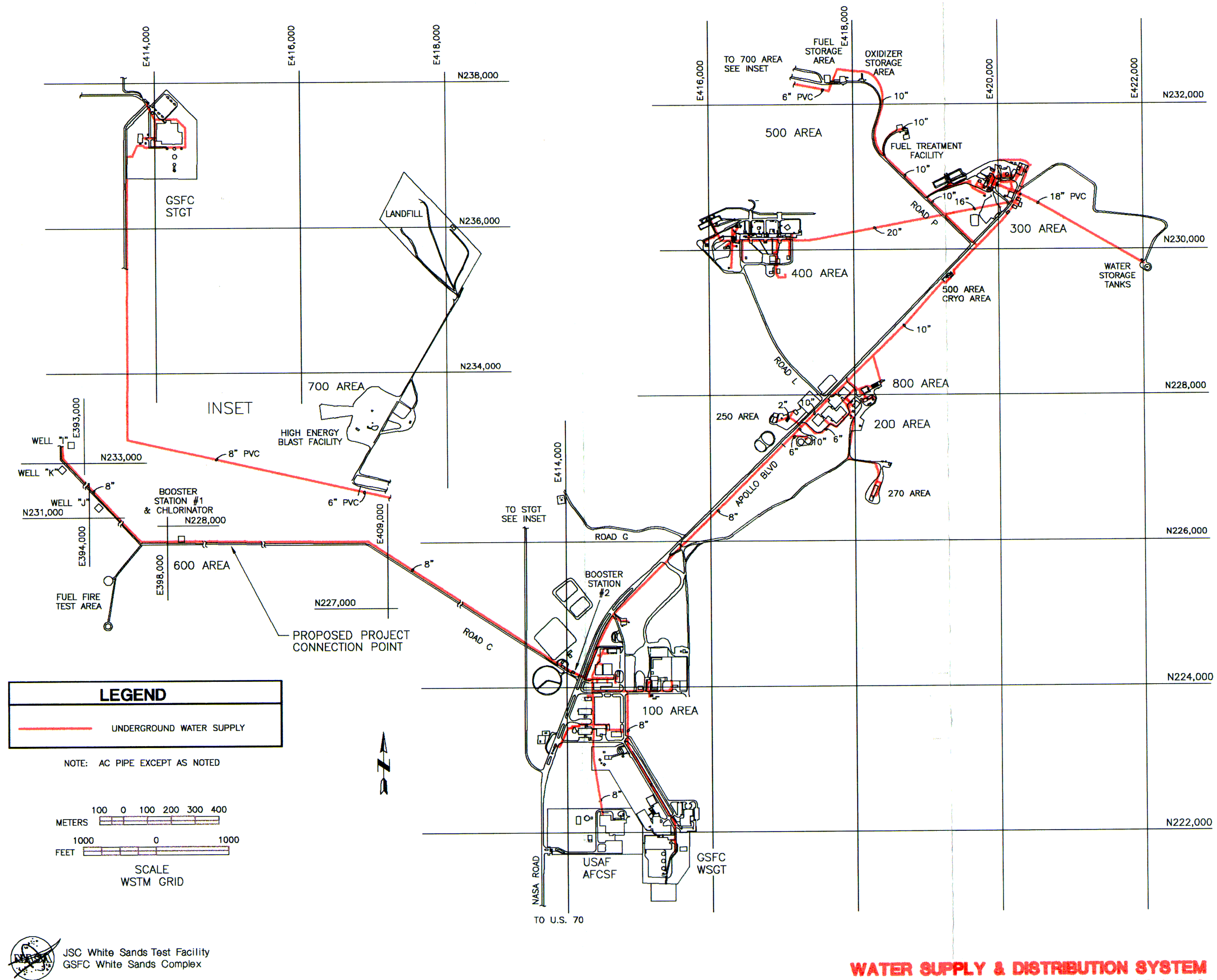
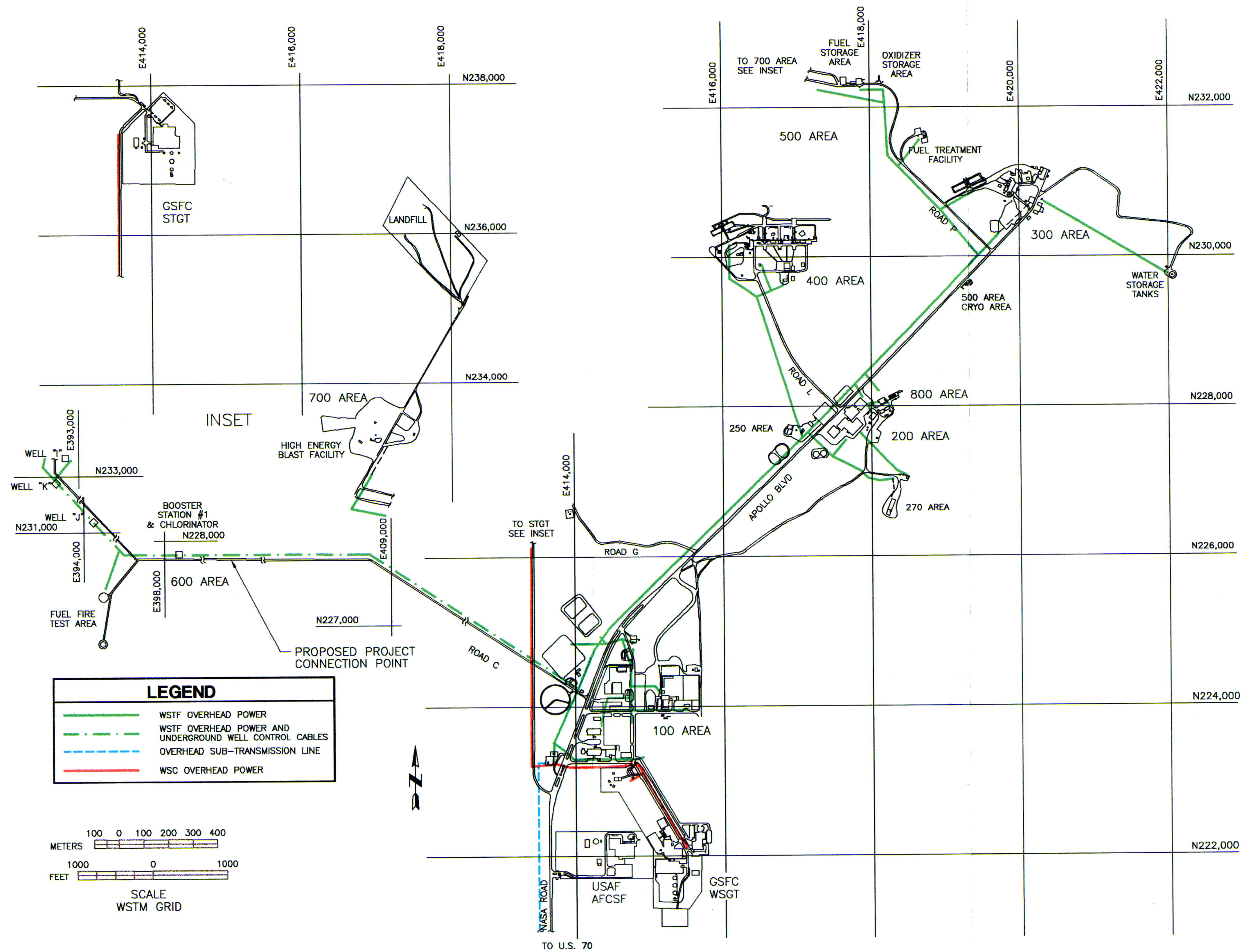


FIGURE 8
REMEDIAL SYSTEM, WELL LOCATIONS
AND CONCEPTUAL DESIGN



WATER SUPPLY & DISTRIBUTION SYSTEM
FIGURE 9

2842



JSC White Sands Test Facility
GSFC White Sands Complex

ELECTRICAL DISTRIBUTION SYSTEM
FIGURE 10

2843

2.2.2 Full-Scale Groundwater Remediation

NASA has determined that performing full-scale groundwater remediation activities is not currently a feasible alternative to plume-front containment. As an integral part of compliance with an Environmental Protection Agency (EPA) issued §3008(h) Administrative Order on Consent, NASA has prepared a preliminary Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) and Corrective Measures Study (CMS). These reports provide several options for full-scale remediation activities. At this time, State and Federal regulatory agencies have not approved the final RFI and CMS. The alternative of full-scale remediation is not currently technically or financially viable due to the extensive groundwater contamination plume and hydrogeological concerns regarding remediation in fractured bedrock and the mid-plume constriction zone. However, full-scale remediation may eventually be phased-in over time at several specific areas (source areas, mid-plume constriction zone) as part of an approved CMS and with full regulatory concurrence. Plume-front containment operations will be included in a final CMS full-scale groundwater remediation proposal.

2.2.3 Land Acquisition And Control

The alternative of land acquisition and control involves the purchase of land and water rights to prevent exposure to groundwater contamination. NASA could also enter into land use agreements with other agencies or private parties to control access and limit risks to human health or the environment. The current buffer zone properties could be supplemented through land acquisition and public access could be denied using site-specific security procedures. This alternative would not control plume-front contaminant migration, would not remove contaminant mass at the plume-front area, and is not protective of human health and the environment. In addition, land acquisition and control as a remedial alternative is not acceptable to State and Federal regulatory agencies.

2.2.4 Remediation System Options

NASA has performed on-site and off-site studies of alternative remediation systems. Bench-scale testing of proprietary bioremediation materials was performed on-site to determine the viability of using specialized microbes, enzymes, nutrients, and filter materials to destroy site-specific groundwater contamination. The short and long-term test protocol's results were analyzed and contaminant destruction to acceptable regulatory levels was not conclusively demonstrated. In addition, a separate study on the viability of bioremediation materials was conducted through the local university and was also inconclusive concerning contaminant destruction.

NASA contracted an off-site laboratory to perform test procedures to determine the viability of using steam injection to remediate specific contaminants in-situ. Analytical data were reviewed from this study and it was determined that, although a viable treatment technology for some volatile organic constituents, the technology was not capable of destroying the more recalcitrant contaminant of concern.

As part of the preliminary CMS, several remediation technology alternatives were examined. These include air sparging, soil vapor extraction, granular activated charcoal, and ultraviolet photocatalysis. These alternatives have not been considered at this time; however, they may be initiated, in conjunction with the implementation of proven technology, after regulatory approval of the CMS. At this time, an effective, proven technology remediation system is necessary to ensure plume-front containment.

2.3 No-Action

NASA has evaluated the No-Action alternative. With the No-Action alternative, the groundwater contamination would continue to exist and plume migration would not be prevented. State and Federal regulatory requirements have mandated that contamination plumes be contained to ensure the protection of human health and the environment. If the No-Action alternative were selected, the current aggressive groundwater monitoring program would continue and the plume-front containment objectives of NASA and the State and Federal regulatory agencies would not be achieved. Therefore, the No-Action alternative is not a viable alternative.

3.0 EXISTING ENVIRONMENT

WSTF operates as a field test installation under the NASA Lyndon B. Johnson Space Center, Houston, Texas (TX). Its primary purpose is to provide testing services to NASA for the United States space program. However, it also provides test service and support for the Department of Defense, Department of Energy, private industry, and foreign government agencies. The primary WSTF mission is to develop, qualify and test the limits of spacecraft propulsion systems and subsystems.

WSTF is located 26 kilometers (km) (16 miles (mi)) northeast of Las Cruces, New Mexico (NM), and 104 km (65 mi) north of El Paso, TX. Geographic coordinates of WSTF are 32°30'30" north latitude and 106°36'30" west longitude. The installation occupies over 250 km^2 (60,000 acres) along the western flank of the San Andres Mountains, one of the most prominent north-south ranges in southwestern New Mexico. Figures 1 through 3 show the general location of the facility. The following sections detail environmental information associated with the proposed plume-front groundwater remediation project. Additional information can be found in the WSTF Environmental Resources Document (RD-WSTF-0025), the WSTF Master Plan (1994), and the Plume-Front Stabilization Work Plan.

3.1 Geology and Soils

The proposed site is located in the Mexican Highland Section of the Basin and Range Province within a major tectonic feature referred to as the Rio Grande Rift Zone. This extensional rift zone, which extends from southern Colorado to northern Mexico, is characterized by north-trending mountain ranges separated by intermontane basins.

The area soils are primarily the sandy to silty, loamy soils of the Doña Ana-Regan associations (United States Department of Agriculture, Soil Conservation Service classification). These soils are typically assorted with alluvial fan deposits. The surface in the proposed area has abundant shallow, hidden arroyos.

3.1.1 Stratigraphy

Bedrock locally crops-out adjacent and east of the WSTF industrial test areas (the primary sources for groundwater contamination). Bedrock stratigraphic units include Pennsylvanian to Permian-age limestone, sandstone, siltstone, and shales to the east within the WSTF test areas, and Tertiary volcanic rocks to the west. The two bedrock lithologies are juxtaposed in the subsurface along the regional northwest-trending Hardscrabble Hill Fault formed as a result of Tertiary Basin and Range extensional tectonics. Bedrock is covered with a veneer of alluvium, which increases in thickness to the west from a few feet in the vicinity of the test areas to over 120 m (400 ft) near the WBFZ. This alluvium consists of Quaternary alluvial fan deposits of the Santa Fe Group derived from the San Andres Mountains to the east.

The Santa Fe Group alluvium is consolidated to unconsolidated, poorly sorted gravel with a matrix of sand, silt and clay. Surface geology in the plume-front area consists of Quaternary mid-to-distal alluvial fan Santa Fe Group deposits made up of limestone, siltstone, shale, rhyolite, andesite, and granite clasts. The thickness of the alluvial deposits in the plume-front vicinity increases from approximately 120 m (400 ft) on the bedrock pediment to in excess of 760 m (2,500 ft) within the JDMB (NASA, 1996).

Tertiary volcanic bedrock units within the plume-front area consist of variable acidic volcanic rocks. Rhyolitic tuffs predominate and consist of crystal-vitric-lithic ash-flow tuffs. Correlative lithologies have been reported in association with the Organ Mountains Intrusive Complex (Seager, 1981). The flow-banded rhyolite (FBR) volcanic unit represents the most texturally distinct lithology of the west pediment area. The FBR forms a distinct hydrostratigraphic unit that is fundamental in creating a hydrogeological feature referred to as the mid-plume constriction area (MPCA).

3.1.2 Structure

Two types of geologic deformation are recognized within WSTF boundaries. The oldest and least prevalent deformation consists of west to northwest-trending folding and faulting associated with the Late Cretaceous to Early Tertiary Laramide Orogeny. This compressional deformation type is confined to the western San Andres Mountains, and is exposed within the Bear Peak Fold and Thrust Zone (Seager, 1981).

The second deformation type consists of Late Tertiary Basin and Range normal faulting and is significant relative to the plume-front stabilization activities. East-west extensional forces resulted in the formation of north-trending structural depressions and adjacent fault-bound mountains from the Oligocene period to present. Numerous subsurface Basin and Range-related normal faults have been inferred from seismic and well log data throughout the site, including the Hardscrabble Hill Fault (NASA, 1996). The most significant expression of normal faulting at WSTF is the WBFZ, which is coincident with the plume-front area. The WBFZ is a north-northwest trending, regional-scale series of normal half-graben faults that offset the top of the bedrock by greater than 610 m (2,000 ft) over a width of 610 m (2,000 ft). Each normal fault within the series dips steeply to the west.

3.2 Climate and Air

The area is in a predominantly Chihuahuan Desert Grassland climate. This climate is characterized by abundant sunshine, low humidity, slight rainfall, and a large day-to-night temperature variance. The mountainous terrain in the area influences the climate by blocking the incursion of moisture laden maritime air masses. Cold air drainage down-slope causes a wide variation in the minimum temperatures experienced in the area. Precipitation, greatest in July and August, averages 25.4 centimeters (10 inches) annually. The growing season is about 200 days per year.

A predominant factor causing wind variability in the area lies in the effects of the mountain ranges. Daily up-slope and nocturnal drainage winds of less than 24 km/hr (hour) (15 miles per hour (mph)), due to thermal gradients, are common on the slopes of the mountain's arid foothills. These diurnal winds are caused by cooling of the upper atmosphere in the mountains at night. While in the basin, air is warmed by the temperature of the earth, resulting in surface air movements from the mountain and foothill areas to the valley floor. During daylight hours, the opposite occurs: the sun warms the air over the mountains resulting in surface air movement from the valley floor to the mountain and foothill areas. The winds may reach velocities as high as 65 km/hr (40 mph) when a pressure gradient and a thermal gradient lie in the same direction.

The ambient air quality and weather conditions in this area are excellent. The atmospheric visibility "seeing" conditions are in the 80-160 km (50-100 mi) range. Doña Ana County, in which the proposed project is located, has been designated as an Air Quality Maintenance Area for carbon monoxide and total suspended particulate matter. Although the county itself is lightly populated and relatively pollution free, air quality is affected by the southern cities of El Paso, TX and Juarez, Mexico.

The New Mexico Environment Department (NMED) Air Quality Bureau does not regulate emissions from air stripping operations during remediation activities. These emissions are considered RCRA-related emissions that could be regulated under Subpart AA, BB and CC of 40 Code of Federal Regulation (CFR) §264 (National Archives and Records Administration (NARA)). The following discussion addresses each of the three subparts.

3.2.1 Subpart AA

EPA has established air emissions standards which apply to owners and operators of facilities that treat, store or dispose of hazardous waste (NARA, 1998). These standards apply to process vents associated with various treatment processes, including air stripping, that manage hazardous waste with organic concentrations of at least 10 parts per million by weight (ppmw). Subpart AA standards apply to operations that are conducted in units subject to the permitting requirements of 40 CFR §270, or in hazardous waste recycling units that are located at RCRA-permitted facilities. The plume-front remediation system will not manage groundwater with 10 ppmw concentrations of regulated contaminants.

3.2.2 Subpart BB

The Subpart BB standards apply to equipment leaks that contain or contact hazardous waste with organic concentrations of at least 10% by weight. These standards apply to operations that are conducted in units subject to the permitting requirements of 40 CFR §270, or in hazardous waste recycling units that are located at RCRA-permitted facilities. The remediation system will not manage groundwater with this concentration of organics.

3.2.3 Subpart CC

The Subpart CC air emissions standards for units that treat groundwater with tanks, surface impoundments, or containers do not apply. Regulations (40 CFR §264.1080) state that a waste management unit that is used solely for on-site treatment or storage of hazardous waste that is generated as the result of implementing remedial activities is exempt from Subpart CC requirements (NARA, 1998).

3.3 Water

WSTF's drinking water and sewage systems are upgraded as the site requirements change or additional facilities are required. To ensure that the system is operating properly, and in compliance with all applicable regulations, WSTF has several on-going monitoring programs. Drinking water analyses are performed for lead, copper, synthetic organic compounds, coliform, nitrate, nitrite, volatiles, fluoride, sulfate, cyanide, and metals. Sewage systems are sampled and analyzed as required by NMED-issued Discharge Plans. In addition, WSTF utilizes over 100 monitoring wells in its groundwater monitoring program. The proposed remediation project will comply with all requirements of the New Mexico Water Quality Control Regulations (20 NMAC 6.2). A discharge plan application package has been submitted to NMED to obtain a permit for the injection of remediated groundwater. This permit will be obtained prior to system start-up and will provide an operational plan, sampling and analysis schedules, recordkeeping and reporting requirements, and discharge limitations on injection quantity and contaminant concentrations.

NASA will obtain all required well construction permits from the State Engineer Office (SEO). The SEO has numerous stipulations for permit requirements dependent on the type of well being drilled (e.g., pilot boreholes, extraction wells, injection wells, monitoring wells). Permit information required by the SEO can include: the need for pollution control or recovery operations; withdrawal and discharge points; the maximum annual water withdrawal; the underground water source; the amount, method, and type of discharge; the estimated project completion time; and borehole records after the conclusion of drilling activities.

The site access and NASA well roads are subject to flooding at arroyo crossings. Culverts are not placed at the smaller arroyos, and the runoff from heavy thunderstorms results in a swift, shallow flow across the road surface which quickly subsides after the storm passes. There are few definite stream channels which extend from the west mountainside onto the alluvial plain. Much of the runoff from the west mountain basin begins to infiltrate the coarse alluvial plain deposits within a mile of the slope break. Only very heavy rainfall causes the runoff to extend beyond the mountainside. Stream floods typically remain within the semi-permanent channels on the west mountain flank and then tend to flow as a sheet-flood onto the alluvial plain.

3.3.1 Aquifer Description

Groundwater below the WSTF test areas and west to the WBFZ is hosted within a fractured bedrock aquifer at depths which increase from approximately 30 m (100 ft) to 120 m (400 ft) bgs. Within and west of the WBFZ, groundwater is located within the JDMB alluvial aquifer at a depth of approximately 130 m (420 ft) bgs. The alluvial aquifer has a thickness in excess of 760 m (2,500 ft) toward the center of the JDMB (Maciejewski, 1996) where it yields relatively large quantities of potable water. Within the WBFZ area, the plume-front is hosted within a transitional alluvium/bedrock aquifer, with the thickness of saturated alluvium increasing to the west.

Two hydrogeologic groundwater flow barriers have been identified on the WSTF pediment slope within the mid-plume, semi-confined, fractured bedrock aquifer. Secondary porosity consisting of fractures with dips ranging from 45 to 65 degrees with minor separation predominates with the aquifer. These barriers combine to form the narrow MPCA. To the north, the northwest-southeast trending FBR unit with low permeability and transmissivity restricts groundwater flow. Groundwater sample analyses within the FBR indicate no detectable contaminant concentrations. To the south, a second flow barrier is created by andesite that has been altered to impermeable clay, promoting low hydraulic conductivities and no detectable contaminant concentrations. The barriers result in a natural confining area to contaminant flow both to the north and south. In the MPCA, groundwater occurs at a depth of 90 m (300 ft) bgs and is coincident with bedrock. An MPCA interim measure evaluation is currently in progress within this area to determine if mid-plume interception and treatment of the groundwater contamination is feasible.

Aquifer conditions in the vicinity of the plume-front vary from unconfined to leaky confined. Leaky confined conditions are generally prevalent within, and to the west, of the WBFZ. Discontinuous confining layers are interpreted to comprise clay or cemented alluvial horizons. Hydraulic conductivity and transmissivity values for the alluvial aquifer are typically several orders of magnitude greater than for the fractured bedrock aquifer.

3.3.2 Groundwater Movement

East to west groundwater flow within the fractured bedrock aquifer below WSTF is generated as a result of San Andres Mountain-front recharge and subsequent infiltration downgradient into the JDMB. Horizontal hydraulic gradients at WSTF are relatively steep within the pediment area 75 m/km (250 ft/mi) and decrease west of the WBFZ within the alluvial aquifer to 0.36 m/km (1.1 ft/mi). Localized bedrock variations and alluvial lithologies influence the groundwater flow direction. Within the Tertiary volcanic pediment region of the bedrock aquifer (within and west of the WBFZ), small-scale, interconnected fractures are interpreted to promote localized irregular downgradient groundwater movement. The fracture matrix density is generally high enough to approximate a porous flow environment.

3.3.3 Groundwater Recharge/Discharge

The San Andres Mountains provide recharge to the bedrock and alluvial aquifers through the infiltration of precipitation into exposed bedrock fractures and faults. Mountain-front recharge is estimated to be 61,675 m^3 to 246,700 m^3 (50 to 200 ac-ft/mi) of mountain front annually (Wilson et. al. 1981; Geoscience Consultants, Ltd. 1995; NASA, 1997).

The nearest perennial surface water is the Rio Grande, located 24 km (15 mi) to the west within the Mesilla Bolson. Direct recharge by infiltration into the JDMB is low as a result of high evaporation, low precipitation, significant depths to groundwater, and the presence of thick lacustrine clays, which inhibit percolation. Minor point recharge areas are present on the pediment slope where WSTF has discharged excess water relatively continuously over the last 30 years. Approximately 90% of the groundwater utilized by WSTF is used for testing in the 300 and 400 Areas. The uncontaminated, spent test water is then discharged to grade and percolates into the adjacent arroyo to recharge the groundwater. A total of 111,010 m^3 (90 ac-ft) annually is estimated to recharge the aquifer over a distance of 215 m (7,000 ft) downgradient of the 300 Area.

The current total groundwater discharge/pumpage of the JDMB aquifer is approximately 4,540 lpm (2,000 ac-ft per annum or 1,200 gpm). Approximately 55% of the withdrawn water is used by small independent users, 33% by local water companies, 9% by WSTF, and 3% by the City of Las Cruces. Conservative over-estimates predict future JDMB water usage/pumpage to total 39,470,100 m^3 (32,000 ac-ft) per annum by the year 2026, of which 55% will be used by the City of Las Cruces, 28% by local water companies, and 17% by small independent users (of which 2% will be used by WSTF). The JDMB aquifer is not currently significantly stressed; however, the future population growth and expanded JDMB groundwater usage are anticipated to result in significant groundwater drawdown (NASA, 1996).

3.3.4 General Groundwater Quality

WSTF groundwater is classified as fresh to slightly saline and is characterized by elevated levels of sodium, sulfate and bicarbonate (Wilson et. al. 1981; NASA, 1996). Total dissolved solids (TDS) concentrations range from 490 to 1,230 parts per million (ppm). Fluoride, iron and manganese levels are generally low. Water hardness ranges from 24 to 320 ppm, and water pH values are slightly alkaline with values ranging from 7.2 to 8.3. Sulfate is the most abundant anion, with concentrations ranging from 185 to 600 ppm. Chloride and bicarbonate concentrations range from 15 to 126 ppm and 89 to 376 ppm, respectively. Nitrate levels are generally below 10 ppm. Concentrations of fluoride are usually less than 2 ppm. Dominant cations comprise the metals calcium, iron, magnesium, potassium, and sodium. Calcium concentrations range from 22 to 179 ppm. Magnesium and sodium concentrations range from 13 to 84 ppm and 28 to 500 ppm, respectively. Iron and potassium occur in trace amounts to 0.8 ppm and 9 ppm, respectively. Concentrations of sodium range from 30 to 157 ppm.

3.3.5 Background Metals' Concentrations

Volume Four, Chapter Two, of the Draft RFI Report (NASA, 1996) provides discussions concerning observed concentrations of RCRA regulated metals in groundwater samples. This chapter includes discussions of observed metals' concentrations such as barium, lead and selenium, which are indicative of naturally occurring levels in the JDMB. In addition, chromium detections are discussed and attributed to either naturally occurring levels or to published leaching problems associated with stainless steel casing. EPA and NMED comments to the Draft RFI Report (EPA) requested additional evaluations concerning these metals.

These comments have resulted in additional data evaluations and have supported the original RFI Report determinations. Final evaluations and statistical analyses will be presented with the revised Draft RFI Report. Data collected from the plume-front wells do not indicate that metals' concentrations are associated with groundwater contamination.

3.4 Cultural Resources

NASA ensures that early consideration is given to the protection of historic and archeological resources in the planning of any project. WSTF has contracted several cultural resources studies by qualified professionals (Batcho & Kauffman Associates) from January 27, 1987 to August 30, 1994. These studies were carried out to satisfy the requirements of Sections 106 and 110 of the National Historic Preservation Act of 1966 (as amended). Section 110 requires that Federal agencies assume responsibility for the preservation of historic properties which are owned or controlled by such agencies. Section 106 of the Act requires a Federal agency head with jurisdiction over a Federal, federally assisted or federally licensed undertaking to take into account the effects of the agency's undertakings on properties included in, or eligible for, the National Register of Historic Places.

Furthermore, this account is taken to afford the Advisory Council on Historic Preservation a reasonable opportunity to comment on the undertaking prior to approval. The results of the surveys and all related investigations are reported to the New Mexico State Historic Preservation Officer and tracked by the WSTF contractor Environmental Department.

Archeological investigations at WSTF have found evidence of historical and pre-historical habitation, encampment and subsistence. These sites have been recorded, inventoried and mapped to prevent disturbance or destruction. The data suggest that most prehistoric archeological resources represent the remains of limited-use hunting, gathering and processing camps. These sites are generally small and have a limited number of recognizable surface features.

One archeological site located near the proposed project has been identified as BK 337. A proposed road, located in Section 32, will come within a quarter-mile from BK 337. However, the proposed project will not disturb BK 337. On September 17 and 18, 1992, archeologists performed a testing and data recovery program at BK 337. A single radiocarbon sample was recovered during excavation, and dated the hearth to 2860 ±90 years old. No macrofloral remains were identified in the flotation samples that were recovered from the hearth fill. No associated extramural features were discovered through shovel scraping of the disturbed area surrounding the hearth, or through test excavations placed in undisturbed peripheral areas. No artifacts were discovered during the testing or data recovery. The data recovery excavations described in this report were guided by a research design and scope of work submitted to the New Mexico State Land Office (NMSLO) and the State Historic Preservation Office in August 1992. No further data are contained within the prehistoric site, and it was recommended that data recovery was sufficient to satisfy the requirements for a determination of no adverse effect. Additional information can be found in Appendix B (A Final Report of the Archaeological Mitigation of Site BK 337 on State Land Adjacent to the NASA WSTF).

3.5 Biological Resources

3.5.1 Naturally Occurring

The biotic resources on the proposed section are typical of that found in the arid southwest, a desert area with low rainfall and sparse vegetation. This area receives an average of 25.4 centimeters (10 inches) of rain per year, making it difficult to suffice for agriculture; hence, as with all deserts and semi-arid areas, the overall species diversity is low.

Major vegetation within the area include a combination of woody shrubs and grasses characteristic of the Chihuahuan Desertscrub Biotic Community. The proposed project's location is a xeric, poorly drained and vegetatively homogenous area. Numerous well developed arroyos are present, but hidden from sight, within the low profile topography and vegetation. Water flows in a westward direction towards the Jornada Basin. Plant species richness is low relative to better drained upland slopes. Shrubs provide a microhabitat for warm season grasses and herptiles.

The project area is found on the alluvial fan along the west side of the San Andres Mountains. This vegetation group contains burro grass (*Scleropogon brevifolius*), yucca (*Yucca* spp.), snakeweed (*Xanthocephalum sarothrae*), sagebrush (*Artemisia* spp.), and honey mesquite (*Prosopis glanulosa*). While not as common, these areas may include patches of various grama grasses (*Bouteloua* spp.). Dominant plant species are tarbush (*Flourensia cernua*), creosotebush (*Larrea tridentata*), Russian thistle (*Salsola kali*), lotebush (*Ziziphus obtusifolia*), Morman tea (*Ephedra trifurca*), littleleaf sumac (*Rhus microphylla*), night shade (*Solanum eleagnifolium*), narrow leaf globemallow (*Sphaeralcea angustiforlim*), Western pink verbena (*Verbena ambrosifollia*), soaptree yucca (*Yucca elata*), and the desert Christmas cactus (*Opuntia leptocaulis*). The most abundant species of grasses are fluff grass (*Erioneuron pulchellum*), tobosa grass (*Hilaria mutica*) and alkali sacaton (*Sporobolus airoides*). Ball cacti (*Coryphantha vivipara*) are on slopes with limestone gravel. These cacti have not been seen in bloom (the most characterizing feature) to assist in differentiating between subspecies.

The project area is considered to be a low affectability area. This area (Sections 31 and 32 of T20S, R3E and Sections 4,5,6, and 9 of T21S, R3E) receives little use by wildlife species because it has been physically altered by human disturbance or overgrazing, and provides reduced topographic relief and vegetation diversity associated with food and cover. However, this area may be a suitable foraging area for various species (e.g., deer, mice, song birds, and hunting raptors). The activities associated with past and current uses, and ecological make-up, limits its suitability as nesting or roosting habitat except for more common rodents, lizards, etc., that have adapted to the present habitat conditions.

3.5.2 Endangered Species

WSTF contracted the Physical Science Laboratory (PSL) to perform a Threatened and Endangered Species Survey in 1996. This survey also included a follow-up survey which assisted in identifying species that were dormant or absent when the initial survey took place. This report is attached as Appendix C (Threatened and Endangered Species Survey of the National Aeronautics and Space Administration's White Sands Test Facility, New Mexico).

Specimens of the Texas horned lizard (*Phrynosoma cornutum*) have been found in this area. This lizard is a Federal Candidate 2 species. Currently, this species has no State of New Mexico status. It is common in desert areas throughout southern and central New Mexico. These horned lizards live in shrubland, desert grassland and associated juniper woodland.

The WSTF site survey included eight raptorial bird species which were observed during PSL's biologic field survey. Although several pairs of raptors were observed nesting in the area, there was no clearly defined raptor use area or ecological habitat associated with the proposed property. Golden eagles (*Aquila chrysaetos*) are generally associated with lowland areas and are present in the proposed area. Canyons, drainages and other upland areas in the nearby foothills of the San Andres Mountains likely provide nest sites that are suitable for use by golden eagles and other large raptors. Lowland desert grasslands and shrub vegetation provide important hunting areas for small to medium-sized mammalian prey items. Most observations of Swainson's (*Buteo swainsoni*) and red-tailed hawks (*Buteo jamaicensis*) are associated with power poles along the WSTF road system. These birds perch on electrical power poles while feeding on prey, searching the desert floor and scrub habitat below for insects or small vertebrates or while sunning during the early morning hours.

During the biological survey, large stick nests were found in the proposed project area. All nests were in relatively good structural condition and were located in sandy/clay swales and playas within Chihuahuan Desert Shrub macro habitat. The primary nest-tree species were honey mesquite (*Prosopis glandulosa*) and desert sumac (*Rhus microphyllum*).

Although testing and new construction activity at the project area will cause some degree of noise and run-off disturbance, these impacts will be temporary. Well placements will be chosen away from open grasslands or densely vegetated plots if practical. If anticipated noise levels associated with this project are maintained into the future, no adverse threat to populations of wildlife or their habitats are anticipated. Due to the findings of the threatened and endangered species survey, sensitive species will not be impacted by the proposed project.

3.6 Noise

The proposed area is surrounded by a buffer zone that consists of State of New Mexico, BLM and NASA lands. There is a one mile buffer zone between the proposed project and the nearest private home. The closest WSTF facilities are two water supply wells, located approximately one mile from the proposed site. This buffer distance effectively eliminates any hazard or discomfort to off-site interests. An on-going hearing conservation program is in effect at WSTF which includes noise studies and subsequent reports, recommendations for engineering control, the provision of periodic audiometric testing, and the use of ear plugs and muffs. Noise generated by project operations can be attributed to three principle sources: vehicular traffic; project operations; and heavy equipment during construction.

There are expected to be potential noise impacts during the construction phase. Construction activities needed to facilitate monitor/extraction/injection wells at the proposed site are expected to be done intermittently over a two year period. These noises will have minimal impacts. Fifteen wells will be drilled; each lasting approximately 10 days. Noise levels during construction may, at times, reach levels harmful to field personnel. The remedial air stripping noise levels have been estimated at 95 dB(A) at 5 feet. Building layout and silencers will be utilized to assist with reducing these sound levels. For individual protection, all personnel are required to use appropriate protective hearing devices if 84 dB(A) are surpassed. The following table lists common noise sources and their decibel levels:

Common Noise Sources

dB(A) Level	Source
60	Speech at 3 ft
70	Normal street traffic
90	Operating a lawn mower
100	Operating a chain saw
140	Jet airplane takeoff at 50 ft

3.7 Land Use

The general pattern of WSTF land usage follows planning concepts and objectives that were established when the installation was initially conceived, designed and constructed. The fundamental guideline for orderly growth and development at WSTF is to continually review, utilize and/or extend these basic ideas with respect to frequently changing conditions. The current WSTF Master Plan (1994) satisfies all foreseeable major functional requirements and relationships. For example, it protects off-site adjacent land usage from objectionable or hazardous influence, and incorporates flexibility to accommodate current long-range planning goals and objectives.

WSTF has utilized the proposed area as a safety buffer zone. Agreements between NASA and NMSLO have limited activity on this property. NASA has groundwater wells, drinking water pipes and utility lines located within the proposed sections. A chlorinating booster station for WSTF's drinking water is located in the southwestern corner of Section 32. Additionally, private individuals lease land within the proposed area for cattle grazing. Due to this proposed project, the number of vehicular trips will rise, but the WSTF access road and the WSTF well road will be used to alleviate impacts.

3.8 Energy

WSTF energy consumption will increase with the implementation of the proposed project. Total electrical usage at WSTF for FY98 was 12,134,800 kilowatt-hours at a cost of $854,200. The maximum expected additional usage and annual cost, due to operation of a plume-front groundwater remediation system, will be approximately 8,900,000 kilowatt-hours and $500,000. This worst case usage estimation will result in an approximate 73% annual increase of electrical energy consumption at WSTF when compared to FY98.

Roads, pipes, powerlines, and power poles will be branched off from the areas and systems previously presented on Figures 8, 9 and 10. These actions will be minimized by using existing facilities in all applicable instances. Additionally, the remediation system will operate 24 hours per day. Manufactured lighting will be installed, but the use of natural light (sky lights) will assist with decreasing energy consumption during daylight hours.

3.9 Services

WSTF is restricted to authorized personnel. Barbed wire fence is used to define the borders along BLM, Jornada Experimental Range (United States Department of Agriculture) and the White Sands Missile Range (WSMR) properties. The proposed project will include the following WSTF services:

- a 24-hr surveillance system to provide safety and security (security guards and firemen make regularly scheduled patrols throughout the active portion of WSTF);
- NASA and the site contractor's safety and health program ensures that the site meets the Federal and State safety and health regulations;
- emergency medical facilities (the dispensary is staffed during normal work hours by a nurse; weekly visits are made by a contracted doctor who oversees the dispensary and examines site personnel; and after normal work hours, dispensary operations are handled by firemen trained as Emergency Medical Technicians); and,
- several levels of fire protection for personnel, facilities, and surrounding areas at WSTF (these include fire resistant construction and wide spacing of buildings and test facilities; automatic fire detection and alarm systems; automatic suppression system in selected locations; Level 3 hazardous material response team; fire extinguishers and hose racks; and a 24-hr fire department).

3.10 Socioeconomic

Environmental Justice (EJ) is an active part of WSTF's National Environmental Policy Act requirements. In compliance with Executive Order 12898, *Federal*

Actions to address Environmental Justice in Minority Populations and Low-Income Populations, NASA has an Environmental Justice Implementation Plan. This Executive Order requires Federal agencies to identify and address the potential for their programs, policies and actions to have disproportionately high and adverse human health or environmental effects on minority or low-income populations. The companion Presidential Memorandum, signed February 11, 1994, directs Federal agencies to include (within their National Environmental Policy Act documents) an analysis of the effects of their actions on minority and low-income communities, along with mitigation measures for significant and adverse effects.

Each NASA Center and field installation is responsible for developing its own EJ Implementation Plan; taking into account the activities conducted at each facility and their associated environmental impacts, its organizational structure and existing processes, the nature of the surrounding community, and the most effective means of communication with external shareholders. Analysis of the demographics of Doña Ana County indicate that this project will not disproportionately affect low income and/or minority populations.

The proposed project will be located in Doña Ana County, NM, lying outside of the city limits of Las Cruces (population over 70,000). The economic stability of the area is a result of the two major employers: WSMR and New Mexico State University. Together, these two institutions employ over 40% of the labor force of Las Cruces and Doña Ana County. This growth is largely attributable to the establishment and rapid growth of the high technology space and defense industries.

Considerations have been taken with socioeconomic data, accidental environmental catastrophes, and distance between the site and a given population. The proposed project has encouraged public participation throughout the proposal process. A summary of the EA will be published in the local paper (in both English and Spanish), posted in local public places, and copies will be made available to area citizens.

4.0 ENVIRONMENTAL IMPACTS OF ALTERNATIVES

4.1 Proposed Action

4.1.1 Land Use

The NMSLO and BLM will need to concur pertaining to the activities occurring in this location. These agreements will include grazing rights. Additionally, wells, well pads, roads, pipes, and powerlines with power poles will be needed to support this proposal. These actions will be kept to a minimum by using existing facilities in all applicable instances.

4.1.2 Energy

Energy consumption will increase at WSTF. Total electrical usage at WSTF for FY98 was 12,134,800 kilowatt-hours at a cost of $854,200. The worst case additional usage and annual cost, due to operation of a full-scale plume-front groundwater remediation system, will be approximately 8,900,000 kilowatt-hours and $500,000. This worst case usage estimation will result in an approximate 73% annual increase of electrical energy consumption at WSTF when compared to FY98.

4.1.3 Groundwater Quality

Groundwater quality at the project area will be significantly enhanced. Groundwater pump and treat remediation will remove contaminant mass, reduce potential ecological risks, and prevent continued plume migration.

4.1.4 Biological Resources

During the threatened and endangered species survey it was recognized that impacts to vegetation and wildlife species are considered adverse if: (1) pre-existing wildlife cannot be supported following removal or alteration of vegetation from the property; (2) project associated disturbance such as habitat destruction, noise, human presence, project operation, pollution, etc., results in long-term wildlife population decreases that are greater than one breeding season; and, (3) severe erosion occurs from removal of vegetation or other disturbance resulting in irreversible effects to the surrounding habitat. Also, the loss of vegetation along arroyos can result in a loss of soil stability causing adverse erosion problems.

Direct impacts are those actions that have a direct and often immediate effect upon the resource. These conspicuous actions primarily include ground conversion activities (e.g., construction, chemical spills, etc.). The following minor impacts are expected to occur during the proposed project:

> **Surface Disturbances** - Surface disturbances can include a wide range of activities such as road or site facility construction, installation of utilities, or any other action that removes the existing plant and animal communities. Effects of surface disturbance range from immediate and total removal of the organism, to temporary removal or disturbance.
>
> **Rural Fugitive Dust** - Construction activities, dirt roads, or any other activity that results in dust generation can result in damage to the local

flora. Rural fugitive dust is often deposited on the leaf surfaces of plants adjacent to the dust source. The resulting coating of dust can reduce the photosynthetic capacity of the plant and potentially leave it in a stressed condition.

Impacts from both surface disturbances and rural fugitive dust will be abated by the utilization of existing roads where applicable. In addition, new roads will be constructed using techniques to assist in minimizing disturbances (such as wetting of dirt).

Irrespective of the specifics of the environmental setting, plant and wildlife species can be adversely affected by a potentially large number of extraneous factors associated with construction activity, including: (1) human disturbance (noise, human presence, power line, and fence entanglement); (2) pollution; (3) direct loss of habitat; and, (4) indirect loss of habitat associated with habitat fragmentation.

Adverse impacts on species of raptors and songbirds in the local area surrounding the site could result from the effects of noise and other disruptive activity if elevated noise levels occur during the breeding or nesting periods. For example, project activities could cause raptors and other groups of birds to abandon their nests or young. In addition, these kinds of man-made disturbances may function as a deterrent to foraging activity during critical periods of the breeding and nesting cycles, as well as interfering with the raising of young to the fledgling stage.

Several species that are protected by the State of New Mexico (but not listed) or protected by the Federal Migratory Bird Treaty were observed during the 1996 Threatened and Endangered Species Survey; most of these taxa included primarily small-to-large sized raptorial birds species: Cooper's hawk (*Accipiter cooperii*); golden eagle (*Aquila chrysaetos*); red-tailed hawk (*Buteo jamaicensis*); Swainson's hawk (*Buteo swainsoni*); turkey vulture (*Cathartes aura*); northern harrier (*Circus cyaneous*); loggerhead shrike (*Lanius ludovicianus*); American kestrel (*Falco sparverius*); and western burrowing owl (*Speotyto cunicularia hypugea*).

NOTE: All wild birds in the United States, except resident game birds (i.e., pheasant, grouse, quail, etc., which are managed by the respective State, and the English sparrow, starling, and feral pigeon) are protected by the Migratory Bird Treaty Act (16 United States Code 703-711). Although Federal Category 2 Candidate species are not specifically protected under the Endangered Species Act, an increase in threats from habitat destruction could cause them to be proposed for listing.

The project area is considered to be a low affectability area. This area receives little use by wildlife species because it has been physically altered by human disturbance or overgrazing, and provides reduced topographic relief and vegetation diversity associated with food and cover.

4.1.5 Cultural Resources

During the implementation phase, there is a possibility of unearthing archeological resources. The project area has been previously surveyed for archeological resources by a qualified cultural resources subcontractor. If any undiscovered archeological site is uncovered during construction, site construction will cease at this specific location until historic preservation issues are resolved.

4.1.6 Noise

Construction activities at the proposed site are expected to be done intermittently over a two year period. Construction related noise from well drilling and remedial system installation is expected to have minimal impacts. Fifteen wells will be drilled; each lasting approximately 10 days. The remedial air stripping noise levels have been estimated at 95 dB(A) at 5 feet, but will be mitigated by building design, arrangement, and composition.

4.1.7 Geology and Soils

A minor issue exists with an increase of wind or water erosion of soils during the construction phase. This is unlikely to transform the topographic conditions within the proposed area. Engineering practices to control erosion will be initiated during construction when appropriate.

4.2 Other Alternatives

4.2.1 Monitored Natural Attenuation

Ecological impacts from this alternative would be minimal; limited to on-going groundwater monitoring activities. However, groundwater contamination would continue to exist at present levels, contaminant mass would not be removed and plume migration would not be prevented.

4.2.2 Full-Scale Groundwater Remediation

Ecological consequences of full-scale remediation could be extensive, with the installation of a large network of groundwater monitoring, injection, and extraction wells, and the construction of several treatment facilities and extensive infrastructure.

4.2.3 Land Acquisition And Control

Ecological impacts from this alternative would be minimal; limited to on-going groundwater monitoring activities. However, groundwater contamination would continue to exist at present levels, contaminant mass would not be removed and plume migration would not be prevented.

4.2.4 Remediation System Options

Ecological impacts from using an alternative technology could vary significantly depending on the chosen treatment method. Infrastructure requirements and peripheral support requirements (roads, power, etc.) could be extensive.

4.3 No-Action

There are no site-specific ecological consequences with selecting the No-Action alternative. However, groundwater contamination would continue to exist at present levels, contaminant mass would not be removed and plume migration would not be prevented.

5.0 AGENCIES AND INDIVIDUALS CONSULTED

The following lists agencies and individuals contacted and consulted during the EA preparation (this list does not include entities within NASA or under contract to NASA):

Federal
Tom Custer - BLM (505) 525-4328
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APPENDICES

Appendix A. Public Comment on the Environmental Assessment for the Plume-Front Remediation System

Appendix B. A Final Report of the Archaeological Mitigation of Site BK 337 on State Land Adjacent to the NASA White Sands Test Facility

Appendix C. Threatened and Endangered Species Survey of the National Aeronautics and Space Administration's White Sands Test Facility, New Mexico

Appendix A

Public Comment on the Environmental Assessment for the Plume-Front Remediation System

There were no inquiries or concerns expressed during the public comment period (including the public meeting held at the Branigan Library on May 6, 1999).

Appendix B

A Final Report of the Archaeological Mitigation of Site BK 337 on State Land Adjacent to the NASA White Sands Test Facility

Batcho & Kauffman Associates

A FINAL REPORT OF THE ARCHAEOLOGICAL MITIGATION
OF SITE BK337 ON STATE LAND
ADJACENT TO THE NASA WHITE SANDS TEST FACILITY

by

Barbara E. Kauffman

Performed Under State Blanket Permit No. 92-035

A REPORT PREPARED BY BATCHO & KAUFFMAN ASSOCIATES AND SUBMITTED
TO LOCKHEED ENGINEERING AND SCIENCES COMPANY, INC.
LAS CRUCES, NEW MEXICO

BATCHO AND KAUFFMAN ASSOCIATES
CULTURAL RESOURCES REPORT NO. 154

JANUARY 4, 1993

ABSTRACT

On September 17 and 18, 1992, archeologists from Batcho & Kauffman Associates carried out a testing and data recovery sprogram at site BK337, an isolated buried hearth on State Trust land adjacent to the NASA White Sands Test Facility near Las Cruces, New Mexico. The project area is located in central Doña Ana County, approximately 7 miles north of Organ, New Mexico. The isolated hearth was exposed during blading for a groundwater monitoring well in Section 32, Township 20 South, Range 3 East. A total of 2 field days were spent testing the site.

A single radiocarbon sample was recovered during excavation and dated the hearth to 2860 +/- 90 years B.P. (1371 - 830 B.C.). No macrofloral remains were identified in the flotation samples that were recovered from the hearth fill. No associated extramural features were discovered through shovel scraping of the disturbed area surrounding the hearth or through test excavations placed in undisturbed peripheral areas. No artifacts were discovered during the testing or data recovery.

The data recovery excavations described in this report were guided by a research design and scope of work submitted to the State Land Office and the State Historic Preservation Office in August 1992. No further data is contained within the prehistoric site, and it is recommended that data recovery has been sufficient to satisfy the requirements set forth in the research design and scope of work for a determination of no adverse effect.

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INTRODUCTION

Project Background

On September 17 and 18, 1992, archeologists from Batcho & Kauffman Associates carried out a testing and data recovery program at site BK337, an isolated buried hearth on State Trust Land adjacent to the NASA White Sands Test Facility (NASA-WSTF) in Doña Ana County near Las Cruces, New Mexico (Figure 1). The feature was exposed during blading for the construction of a groundwater monitoring well pad.

NASA-WSTF has been engaged in a program of constructing a series of groundwater monitoring wells on WSTF and adjacent lands. In compliance with both Federal and State requirements, archaeological surveys of all affected lands were conducted between 1986 and 1989 by Batcho & Kauffman Associates. All areas with known archaeological remains are strictly avoided when planning the location of groundwater monitoring wells. During 1988, the State Land section where site BK337 is located was surveyed for cultural resources (Michalik 1988). No sites were discovered in the section during that survey.

Site BK337 was discovered in April 1992 during blading for the construction of a well pad. A heavy equipment operator employed by Lockheed Engineering and Sciences Co. (LESC) noted a dark stained area containing blackened rock approximately 20 cm below the ground surface. Work was immediately stopped in the feature area, and the discovery was reported to the LESC Environmental Division. Archaeologists from Batcho & Kauffman Associates visited the site the following day with LESC personnel to assess its significance. Based on the consultants' initial observations that the hearth appeared to contain datable materials and was relatively intact, NASA-WSTF determined that the site was potentially eligible for listing on the National Register of Historic Places, and asked for concurrence from the State Historic Preservation Office (SHPO). Following SHPO concurrence, a research design and scope of work was prepared to guide testing and data recovery operations.

Project Location

Site BK337 is located on State Trust Land adjacent to NASA-WSTF on the west side of the San Andres Mountains, approximately 7 miles north of Organ, New Mexico in east-central Doña Ana County. The site is located in Section 32, Township 20 South, Range 3 East, on the Taylor Well 7.5'topographic quadrangle (Figure 1).

ENVIRONMENTAL SETTING

The project area is in the Mexican Highland section of the Basin and Range Physiographic Province. The site is located within the Bear Creek drainage system at the base of a broad

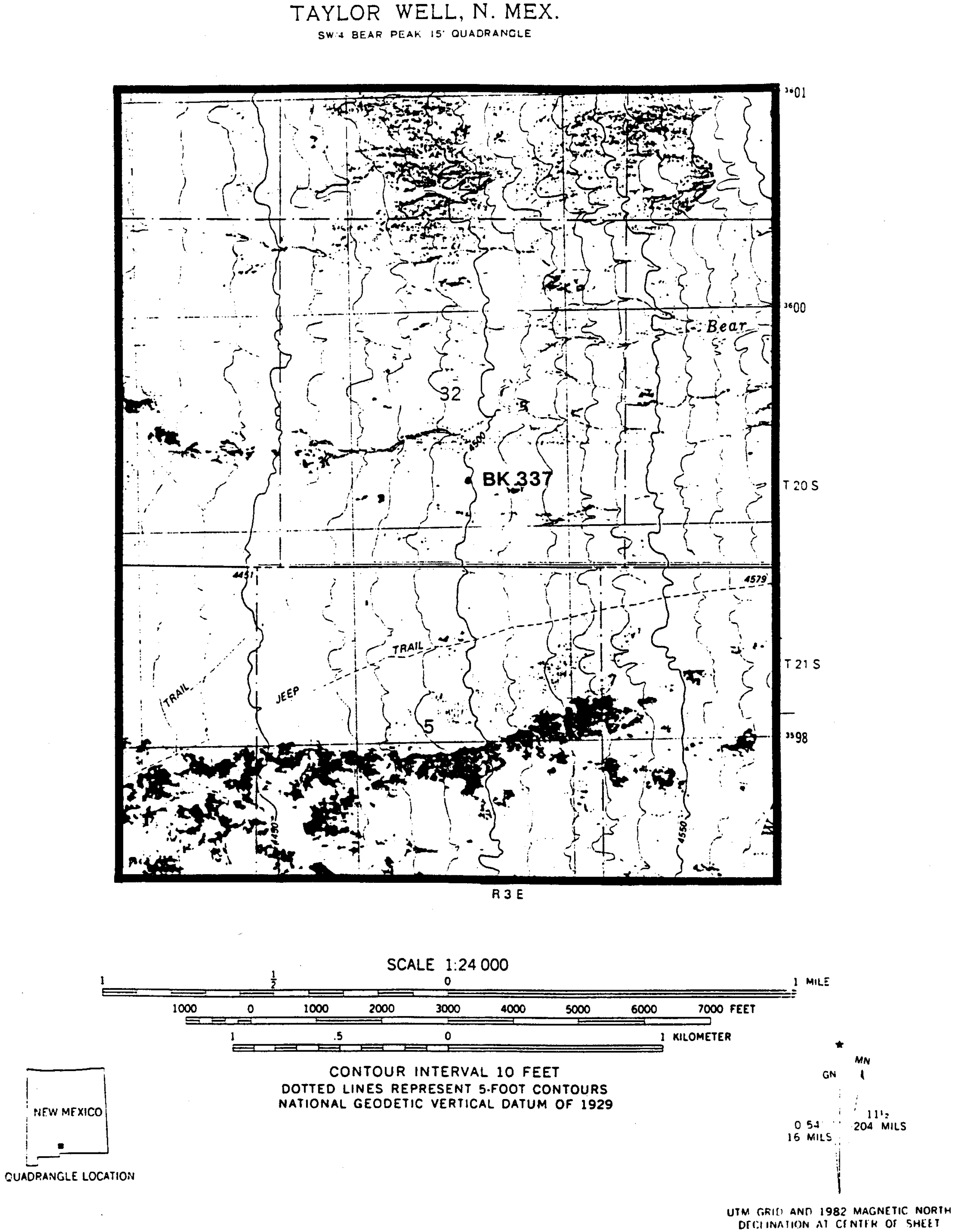

Figure 1. Site location.

alluvial fan extending westward from the foothills of the San Andres Mountains. The topography in the immediate site vicinity is relatively flat, with a slope of less than 2 degrees to the west. The Bear Creek drainage system at this point consists of a series of very shallow, west-trending rills. The hearth was probably buried by low-energy colluvial (slopewash) action, which served to cover the feature with sediment while causing little erosional damage. The site is within an area where the Jornada II and Organ morphostratigraphic units mix or coalesce (Gile et al. 1981). The Jornada surface is a well-stabilized early Pleistocene alluvial fan surface with a dense covering of gravel to cobble-sized detritus derived from the mountains to the east. The Organ surface dates from approximately 6400 to 1100 B.P., and is the result of a series of cut and fill sequences that deposited finer, sandier sediments over the earlier Jornada surface. Soils on the site belong to the Doña Ana-Reagan Association (Bulloch and Neher 1980).

A detailed study of the geomorphology of the project area has been produced by Gile, Hawley, and Grossman (1981), and is important to an understanding of prehistoric land use. Lithic raw materials are abundant in the fan sediments and arroyo bottoms, and were used extensively for tool manufacture by the prehistoric populations. These materials include siltstone, sandstone, chert, chalcedony, quartzite, and limestone/dolomite.

Vegetation in the vicinity of the site is characterized by a dense covering of creosote and various grasses. Other vegetation present in the area includes tarbush, mesquite, four-wing saltbush, soaptree yucca, cholla, and snakeweed. The faunal community includes a wide variety of bird species, including raptors, as well as snakes, lizards, a variety of rodents, rabbits and hares, mule deer, mountain sheep, and antelope. All of these species may have been economically significant to the prehistoric inhabitants of the area.

REGIONAL CULTURAL HISTORY

Previous archeological research in southern New Mexico indicates a record of aboriginal human activity dating to the end of the Pleistocene and continuing through approximately A.D. 1500, a span of some 12,000 years. During this period, several different cultural systems utilizing various adaptive strategies were present at one time or another within southern New Mexico and its environs. Some periods of use, such as the Paleoindian, Early Archaic, and late prehistoric or protohistoric, are poorly documented and understood.

Although there has been some reconsideration in the past several years, there has long been a tendency to hypothesize an unbroken evolutionary progression from simple mobile hunting and gathering strategies to complex sedentary agricultural systems. This is approached through the use of an over-simplified phase system that equates time of occupation with a specific adaptive strategy, thereby ignoring the possibility that groups following diverse adaptive strategies occupied southern New Mexico contemporaneously. For present purposes, culture periods will serve as a general chronological framework for the following brief overview of the prehistory of the area.

Paleoindian

The earliest record of human occupation in the southern New Mexico region is the sporadic occurrence of distinctive projectile point types such as Folsom, Plainview and Clovis, which date from approximately 10,000 to 6,000 B.C. These points are generally found as isolated occurrences, although they have sometimes occurred in excavation context with extinct Pleistocene megafauna. There are no confirmed reports of the occurrence of these point types with evidence for habitation structures in the area, nor have many been located in context with independently datable hearth remains.

The Paleoindian era is generally thought to have been characterized by a highly mobile, hunting and gathering way of life, although much of the reconstruction is based heavily on inference from better dated contexts elsewhere in North America. The base of a Folsom point was collected from the Vista Hills site in southeast El Paso, Texas in 1978 by archaeologists from Commonwealth Associates (Anderson and Carter 1980), and Kauffman (1984) later recovered 13 pieces of obsidian from the same site which yielded hydration dates between 5,000 and 7,000 B.C. While Kauffman's obsidian hydration dates were not tightly clustered, they do record human use of the area during this early time period.

Archaic

Traditionally, the Archaic period dates between approximately 6,000 B.C. and A.D. 200 in the region. Once again, the human occupation of the area is poorly understood during this period, most inferences having been drawn from well-preserved materials in cave sites, and more thoroughly studied areas elsewhere in the Southwest.

In general, the Archaic period is viewed as a continuation of the previous mobile hunter-gatherer way of life, coupled with an increased emphasis on plant foods and smaller game species, and a trend toward decreasing group mobility through the era. Some of the changes in adaptive strategy have been linked to changes in climate and vegetation throughout the region. Several different site types have been dated to the Archaic period, including cave and rockshelter sites, burned rock loci, lithic scatters, and isolated hearths. Many more sites have been attributed to the Archaic period on the basis of "negative" information such as the absence of ceramics, or by recourse to poorly dated and apparently long-lived projectile point styles.

Formative

According to the generally used local phase system, beginning around A.D. 200 there was a shift away from the subsistence and settlement patterns that define the Archaic, toward a more sedentary life style and an apparent shift to more intensive cultivation of maize, beans, and squash. The all-inclusive nature of this adaptive strategy is beginning to be questioned, however, by various researchers (e.g., Carmichael 1985; Kauffman and Batcho 1983; Plog and Green 1983; Stuart and Gauthier 1981; Upham 1984). In the El Paso/Las Cruces area, the Formative period has been further subdivided into three phases: the Mesilla, Dona Ana, and El Paso, which are said to reflect observable trends in the direction of increased sedentism and social complexity.

Charred food remains indicate that while hunting and wild plant collecting were still a major part of the subsistence routine, at least some groups had begun to practice, and possibly emphasize, farming. Common elements of the material culture complex of the period include recognizable structures, grinding tools, pottery, and smaller projectile points, the morphology of which suggests their use as arrow points. Habitation sites increase in size and complexity through the Formative, although they are greatly outnumbered by smaller, diffuse sites that have been interpreted as temporary hunting and gathering camps, presumably linked with permanent residential settlements. Pottery styles progress from plain brownwares to polychrome painted vessels, with an increase in imported styles (Beckes 1977:174-184; Beckett and Wiseman 1979:397-401; Stuart and Gauthier 1981:210-221; Whalen 1977).

The Formative period comes to an end around A.D. 1350 to 1400, when the area is hypothesized to have been abandoned by sedentary agriculturalists. Most authors have theorized a climatic shift toward a more arid environment that made farming an untenable strategy (Kelley 1952), although this is not well documented. Stuart and Gauthier (1981:216-218) rework the climatic shift hypothesis somewhat, and instead of an abandonment _per se_, they see a change in adaptive strategy (to a more _extensive_ use of the environment, i.e., hunting and gathering) as a result of a drying trend in the late 1200s. When the area was explored by the Spanish in the 16th and 17th centuries, it was apparently occupied by small groups of mobile hunter-gatherers. The advent of the Spanish marks the end of the prehistoric period and the beginning of the Historic period.

Historic

The Historic period in New Mexico can be divided into the Spanish (1540-1821), Mexican (1821-1846), and Anglo periods (1846-present). During the Spanish period southern New Mexico was primarily used as a trade route between Chihuahua and Santa Fe. This route became known as the "camino real" and followed the Rio Grande River from the El Paso area to Santa Fe (Jenkins and

Schroeder 1974). The first known Spanish settlement in the area, El Paso Del Norte, was established when the Spanish retreated from northern New Mexico during the pueblo revolt (Ellis 1971). Some Piro and Tiwa Indians accompanied the Spanish and settled in the El Paso area. Use of desert mesa region, was probably marginal during this period.

In 1821 Mexico, which includes present day New Mexico, gained independence from Spain (Jenkins and Schroeder 1974). During the short span of Mexican control in New Mexico, several communities were established in the southern portions of the Rio Grande River valley. Land use in the desert areas surrounding the present project area was probably limited to stock grazing and exploration during the Mexican period. Possible sites of this period would therefore be restricted to wagon roads and campsites.

In 1846 New Mexico was peacefully invaded by American forces (ibid). The Territory of New Mexico was created by the U.S. Congress in 1850 and the present Mexico-United States border was established in 1853 with the Gadsden Purchase. The Anglo period is characterized by an increase in activity in the southern regions of New Mexico. During this period American forts were established to protect settlers from Indian attacks and the Butterfield Stage route was established. Ranching activity, which probably represents the most extensive use of the study area, also increased during this period. In 1881 the Southern Pacific Railroad line between El Paso and San Francisco was established. Ranching and recreational use of the study area has continued to the present.

RESEARCH GOALS

Three research goals were considered for the data recovery program: (1) to record the site; (2) to salvage the remains of the disturbed hearth; and (3) to test the immediate area around the hearth in order to determine if the feature was more likely an isolated manifestation or part of a larger site.

Research problem domains for the NASA area have been discussed in detail by Batcho & Kauffman (1986) and Miller and Stuart (1991). Due to the apparently small size and limited nature of the remains at site BK337, it was expected that chronometric and, perhaps, subsistence concerns could be addressed. Dating the site would add to our growing concepts of the time frame in which prehistoric people most actively utilized the NASA area. Subsistence information could be used in comparison with the data recovered from the extensively excavated sites, BK4 and BK5, just east of BK337.

Previous research at hearth sites on the NASA facility have yielded significant chronological and subsistence data (Almarez 1990; Miller and Stuart 1991; Stuart 1988b) that have broadened our understanding of the prehistoric settlement system recorded through extensive survey of the facility and adjacent areas. The excavation and dating of site features has also been useful in formulating general predictive models of site visibility based on local geomorphology that are important for the management of cultural resources on the facility (Miller and Stuart 1991).

TESTING AND DATA RECOVERY PROGRAM

Methods

Four 1 by 1 meter test units were excavated just outside of the bladed area surrounding the hearth (Figure 2). The primary purpose of these units was to determine if there were any indications that the exposed hearth was part of a larger site. The units were excavated to a depth of 30 cm or to caliche, whichever was shallower. All materials excavated from these units were screened through 1/4 inch mesh hardware cloth. No features or artifacts were discovered in any of the test units.

An area of approximately 6 square meters surrounding the hearth (Feature 1) was shovel scraped to define the boundaries of the feature and to search for associated features. The area had previously been bladed, so shovel scraping served mainly to create a clean surface to examine the feature context. Soil removed during shovel scraping was also screened through 1/4 inch mesh. No extramural features or artifacts were discovered during this operation.

Feature 1 was completely excavated by hand in order to maximize the recovery of radiocarbon and macrofloral remains, and to determine hearth morphology. Approximately 50% of the hearth fill (14 liters) was recovered for flotation analysis. A unit datum was set up at the southwest corner of the 2 by 2 meter excavation unit surrounding the hearth, in order to maintain vertical control. The feature was drawn in planview, bisected, the southern half excavated, and profiled prior to the excavation of the northern half of the feature. Black and white and color photographs were also taken to document the feature excavation. Feature fill that was not recovered for flotation analysis or radiocarbon dating was screened through 1/8 inch mesh. No artifacts were discovered in the feature fill. A single radiocarbon sample was recovered and submitted to Beta Analytic Inc. for dating.

Results

Feature 1 consisted of a roughly circular arrangement of mostly limestone cobbles, measuring approximately 180 by 150 cm by 20 cm deep (Figure 3). The hearth pit was dug into the caliche substrate, roughly rock-lined, and filled with burned rock and ashy soil. Some small pockets of charcoal remained, but the hearth had been disturbed by a creosote bush and rodent burrow. Over 450 fist-sized limestone cobbles were removed from the feature fill. Except for the root and rodent disturbance in

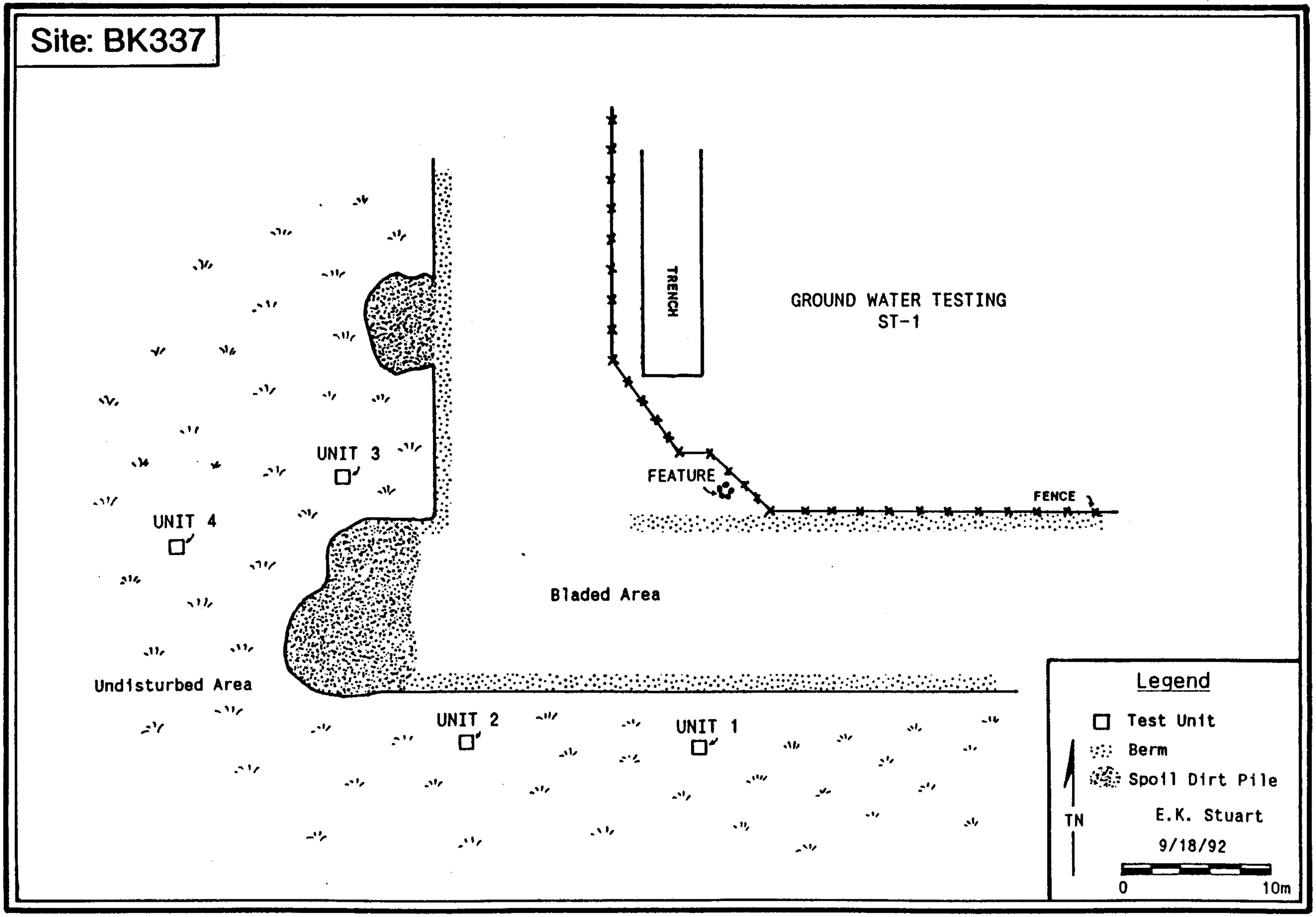

FIGURE 2: AREA TESTED AT SITE BK337

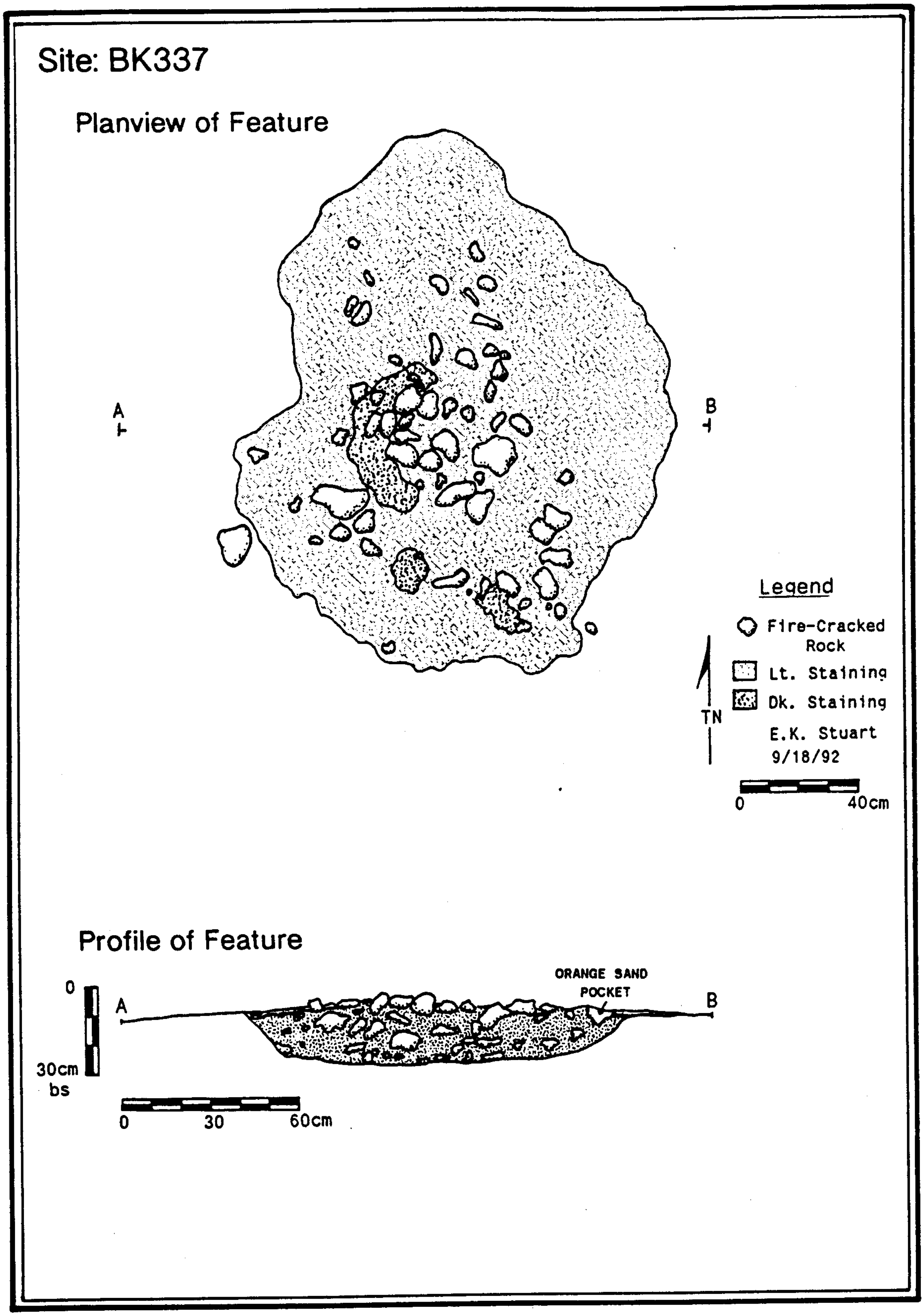

FIGURE 3: FEATURE 1 PLANVIEW AND PROFILE

the northeast portion of the feature, the hearth appeared to be relatively intact. Blading appears to have just removed the overlying sediments, doing little damage to the feature itself. Since the hearth was constructed in a basin which was partially excavated into the caliche substrate, original hearth dimensions and morphology were readily apparent. The hearth pit itself was oxidized and reddish from burning. No artifacts were recovered from the feature or the surrounding area.

RADIOCARBON DATING AND FLOTATION RESULTS

One radiocarbon sample and two flotation samples collected from site BK337 were processed and analyzed. The radiocarbon sample, analyzed by Beta Analytic, yielded a C13/C12 corrected date of 2860 +/- 90 years B.P. (Beta Sample # 58741; Appendix I).

The 10 year decadal calibration (Stuiver and Becker 1986) of this date indicates a range of use of the feature at site BK337 sometime between 1371 and 830 B.C. with a 95% confidence level. This places the Feature 1 cultural component in stratigraphic context within the Organ I strata which has been previously radiocarbon dated to between 2,200 and 6,400 yrs. B.P. (Gile et al. 1981).

Flotation analysis yielded no charred floral or faunal remains (Appendix II). The hearth fuel was identified as mesquite (*Prosopis*), and due to the lack of charred seed remains recovered, it has been suggested that the hearth was probably used for warming rather than cooking.

DISCUSSION AND CONCLUSIONS

Three research goals were outlined in the scope of work for the excavations of BK337. These problem domains consist of 1) dating the site, 2) obtaining subsistence information from the disturbed hearth feature, and 3) determining whether the feature was part of a larger site. The single radiocarbon sample obtained from the feature dated to the late Archaic period. No subsistence data were recoverable from the feature, and testing suggests that the feature is isolated, and not part of a larger buried site.

Several Archaic dates were obtained from buried hearths along Gardner Spring Arroyo as part of the Desert Project (Gile et al. 1981). These hearths were sampled in order to date alluvial deposits and were not excavated by archaeologists. Other sites in the vicinity of the NASA White Sands Test Facility have been tentatively identified as dating to the Archaic period based on projectile point morphology and characteristics of their lithic assemblages (Stuart 1988a).

Several sites on or near the NASA facility which have been excavated in the past few years have been dated to the Archaic period. One of these sites (BK84) is very similar to site BK337

(Stuart 1988b). It consisted of a single isolated hearth, buried approximately 20 cm below the present ground surface, with no surface manifestation and few associated artifacts. Like site BK337, it was uncovered during blading. Radiocarbon samples from this isolated hearth have been dated to the late Archaic period (800 - 415 B.C.).

Site BK229, consisting of two buried ash and charcoal stains in Gardner Spring Arroyo, approximately 3 miles east of site BK337, also dated to the Archaic period (Almarez 1990). Radiocarbon dates from the two features average between 3778 and 3370 B.C. Like the hearth on site BK84, very few artifacts (all lithics) were recovered in association with the features.

Archaic dates have also been obtained from hearths at site BK4, an excavated site with both Formative and Archaic occupations (Miller and Stuart 1991). One of these hearths, Feature 7, was completely excavated while the other hearth, Feature 9, was only sampled. The two dates from these hearths were averaged and indicated use between 2900 and 2470 B.C.

While several Archaic occupational episodes have been documented through radiocarbon dating of sites and features at NASA-WSTF, subsistence remains from this period are largely absent. The apparent intact nature of these buried Archaic hearths, along with the low recovery of subsistence remains, can suggest either a limited and/or very short-term use of these features or a poor state of preservation for Archaic subsistence remains. However, it must also be noted that excavated features from the Formative occupations at sites BK4 and BK5, east of site BK337 on the NASA facility, yielded large samples of floral remains, indicating that preservation of more recent remains in the area is good (Miller and Stuart 1991).

Since little or no subsistence remains have been recovered from Archaic hearths in the NASA White Sands Test Facility area, interpretations regarding the function of these features must rely on the overall morphological characteristics of the hearths themselves. Several researchers in the Jornada Mogollon area have provided extensive descriptions and comparisons of features from the area (Whalen 1977; O'Laughlin 1980; Hard 1983; Carmichael 1985). These studies have noted an apparent dichotomy between hearth features based on size. This dichotomy consists of small, fire-cracked rock features and large, fire-cracked rock features. Even though there is currently some disagreement regarding the function of these features, most researchers agree that small hearths were "general purpose" features used by small groups such as nuclear families or task groups while the larger hearths were specialized, communally used processing features such as roasting pits.

The researchers noted above dealt specifically with fire-cracked rock features. While fire-cracked rock has been rare in the previously excavated Archaic features on the facility, it was abundant in the feature at BK337. The variable of hearth size can be used to compare the BK337 Archaic feature with others excavated in the general Jornada Mogollon region. Carmichael (1985) found that fire-cracked rock features from Keystone sites 36 and 37 could be grouped into two categories. Small fire-cracked rock features ranged in size from 0.5 to 1.7 square meters, whereas large fire-cracked rock features ranged in size from 2.1 to 14.8 square meters. The hearth excavated at site BK84 and Feature 7 at site BK4 measured 1.19 square meters and 1.23 square meters respectively, placing them in Carmichael's small feature category. The remains of the hearth at BK229 had been extensively impacted by the excavation of a backhoe trench, and it was difficult to determine its size category. Based on the apparent size of the remaining portion of the feature, however, it was estimated to fall within the small hearth feature size range. If the dichotomy discussed above can be applied to the NASA area, then the hearths at BK84, BK4, and BK229 can be classified as general purpose hearths used by small groups.

In contrast, the hearth at BK337 measures 2.7 square meters and falls in the large feature category. It also differs from the previously excavated Archaic period features at NASA by its abundant fire-cracked rock. Prior to excavation, it was hoped that this morphological difference might denote that the feature was more similar to the Formative period features excavated at sites BK4 and BK5. Large quantities of carbonized plant remains were recovered from those features. Unfortunately, this was not the case.

The hypothesized dichotomy in hearth size and function is not supported by the BK337 flotation analysis. The model discussed above suggests that as a large hearth, the feature was a specialized food processing feature. The lack of charred plant remains, however, argues against this interpretation. The large amount of fire-cracked rock in the BK337 feature, in contrast to the other Archaic hearths in the area, also cannot be explained in terms of differences in feature function, because of the paucity of macrofloral data available. The absence of associated artifacts likewise suggests that the feature was not communally used.

RECOMMENDATIONS

The testing and data recovery excavations described in this report have served to mitigate the adverse effects of the monitoring well pad construction on site BK337, and to salvage all available data from the site. It is recommended that the data recovery program has been sufficient to satisfy the requirements set forth in the research design and scope of work for a determination of no adverse effect.

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APPENDIX I:

RADIOCARBON DATING RESULTS

BETA ANALYTIC INC.

JERRY J. STIPP, PH.D.
MURRY A. TAMERS, PH.D.
CO-DIRECTORS

4985 S.W. 74 COURT
MIAMI, FLORIDA
33155 U.S.A

December 3, 1992

Ms. Barbara Kauffman
Batcho and Kauffman Associates
755 Telshor, Suite 13E
Las Cruces, New Mexico 88001

Dear Ms. Kauffman:

Please find enclosed our result on the charcoal sample (BK337-01) that you recently sent for radiocarbon dating and carbon-13/12 ratio analysis.

As with your previous charcoal samples, this one also was thoroughly pretreated, both physically and chemically, for the removal of any intrusive rootlets (a few present initially), carbonate or humic acid contaminants. The clean charcoal was then synthesized to benzene and counted for radiocarbon content. The charcoal was of good quality and adequate quantity, and all analytical steps proceeded normally.

This analysis was paid for in advance, thank you. And as always, please call us at any time you have questions or would like to discuss the date. With best regards I remain

Sincerely,

Jerry J. Stipp

TELEPHONE: 305-667-5167 / FAX: 305-663-0964 / BITNET: XNRBET22@SERVAX

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(305) 667-5167
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P.O. BOX 248113
CORAL GABLES, FLA. 33124

REPORT OF RADIOCARBON DATING ANALYSES

FOR: Barbara Kauffman
Batcho & Kauffman Associates

DATE RECEIVED: November 9, 1992
DATE REPORTED: December 3, 1992
SUBMITTER'S PURCHASE ORDER #

OUR LAB NUMBER	YOUR SAMPLE NUMBER	C-14 AGE YEARS B.P. ± 1σ	C13/C12 per mil	C-13 adjusted C-14 age
Beta-57841	BK 337-01	2,870 +/- 90	- 25.3	2,860 +/- 90

These dates are reported as RCYBP (radiocarbon years before 1950 A.D.). By international convention, the half-life of radiocarbon is taken as 5568 years and 95% of the activity of the National Bureau of Standards Oxalic Acid (original batch) used as the modern standard. The quoted errors are from the counting of the modern standard, background, and sample being analyzed. They represent one standard deviation statistics (68% probability), based on the random nature of the radioactive disintegration process. Also by international convention, no corrections are made for DeVries effect, reservoir effect, or isotope fractionation in nature, unless specifically noted above. Stable carbon ratios are measured on request and are calculated relative to the PDB-1 international standard; the adjusted ages are normalized to -25 per mil carbon 13.

APPENDIX II:

FLOTATION ANALYSIS

Flotation Analysis at
BK337

Submitted by:
Johna Hutira
Northland Research, Inc.
Flagstaff, Arizona

Flotation Analysis

Introduction

Fourteen liters of soil taken from a hearth at BK337 were examined for plant remains. The soil did not yield identifiable seed remains. However, several pieces of charcoal were identifiable.

Methodology

The soil samples were floated using a device similar to that utilized by the Black Mesa Archaeological Project (described in Hutira 1989). Poppy seed tests (after Wagner 1982) were performed throughout the water separation procedure to monitor the effectiveness of the system. The fourteen liters were submitted in three lots (two of five liters, one of four liters). One bag was salted with 50 poppy seeds. Forty-seven were recovered in that sample during analysis. The remaining three were not recovered from the other samples. The gravel portion that remained in the bottom of the screened insert was quickly examined for artifactual and other biofactual materials.

The dried light fractions were sorted using a series of screens that facilitated identification of seeds and plant parts. Each subset was examined under a variable 10-30x power light microscope. Identification of remains was aided by the use of seed manuals (Martin and Barkley 1961) and the author's modern reference collection.

Technically, the term "seed" refers to a matured ovule, consisting of an embryo and its coats, and a supply of food (Harrington and Durrell 1957: 186). For the purposes of this report, the term "seed" will include not only true seeds, but equivalent structures that look and function like seeds: achenes, caryopses, nuts, and other disseminules.

Results

No carbonized seed remains were recovered from the sample. There was a small amount (approximately 10% of the light fraction) of charcoal noted in the samples, of which, five pieces were identifiable as mesquite (*Prosopis*). Because mesquite is usually available in larger pieces, thus more likely to yield pieces big enough to identify, an identification bias in hearth sediments is introduced. For example Minnis (1987:122) cautions the specimens smaller than $4mm^2$ do not provide enough area to determine if resin ducts (absent in Juniper wood, present in pines) are present. Furthermore, a piece of charcoal must be large enough to break and produce a cross-section. Tangential and radial sections are also necessary for positive identification (Bohrer 1986). Creosotebush (*Larrea tridentata*) was probably used in the hearth as well but as it and other shrubby taxa burn more completely, and fragment easier, are less likely to produce identifiable specimens, particularly in flotation samples.

The lack of charred seed remains suggests the hearth was used for warmth rather than cooking. Furthermore, the lack of even the usually ubiquitous cheno-ams may indicate that the hearth may represent a single use episode.

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APPENDIX III:

LABORATORY OF ANTHROPOLOGY SITE FORM

LA/Field No. ____________

LABORATORY OF ANTHROPOLOGY, MUSEUM OF NEW MEXICO
ARCHAEOLOGICAL SITE SURVEY FORM

LA No. ________ **Site Name** ____________ **Other Inst.#** BR537 I.O.

MNM Proj. # **UTM: Zone** 13

E 344540 N 3588220
E ______ N ______
E ______ N ______
E ______ N ______

Legal Desc. T 20 N/(S) R [illegible] (E)/W Sec. 32

NW 1/4 of the SW 1/4 of the SE 1/4

Unplatted **Grant** **Owner & Address:** State of New Mexico

***Map Reference:** Taylor Well **Date:** 1982 **Scale:** 1:24000

County Dona Ana **Nearest Named Drainage:** Bear Creek Arroyo
Distance/Direction: 500 ft. NE

State New Mexico **Nearest Water:** Gardner Spring
Distance/Direction: 3.5 miles east

Locational Desc.: Recognized Landmarks site is located at the base of a broad, gently sloping alluvial fan extending west from the base of the San Andres Mountains

Site Type: isolated buried hearth

Site Size: Length 1.5m **Width** 1.8m **Average Elevation (# of feet)** 4500
Square Meters 2.7 **Elevation Range:** ______

Topographic Setting (Location & Access): go 2.5 miles west of the NASA White Sands Test Facility on Well Road, then 1/2 mile north on two-track water monitoring well road to site

arroyo/wash	flood plain/	✓plain/flat
base of cliff	valley bottom	playa
bench	hill top	ridge
blowout	hill slope	saddle
canyon rim	low rise	base talus slope
cave	mesa	terrace
cliff/scarp	mountain	other (specify)
constricted cyn	mt. front/foothill	slope: 2%
dune	open canyon floor	aspect: open
		exposure: open

Local Vegetation: creosote 75%, tarbush 10%, grasses 5%, saltbush 5%, mesquite 5%

Ecological Zone: forest ____ woodland ____ scrubland ____ grassland ____ desertscrub X ____ marshland ____ other (specify) ______

***Form must by accompanied by photocopy portion of USGS map showing T., R., scale and quad name.**

LA/Field No. BK007

Soil Type: rocky ____ gravelly X sandy ____ clayey ____ other ____

Local Outcrops: sandstone ____ shale ____ limestone ____ basalt ____ tuff ____
other (specify) none

Nature and Depth of Fill: gravelly colluvium to ca. [illegible] cm

Arch. Status: Amount and Type of Work Past and Present

Site record, maps, photographs, excavation of feature, C14 and flotation samples taken and processed

National and/or State Register Status:

____ On State Register
____ On National and State Register
____ Recommended for National by State, on State Register
____ Recommended for National and State Register
____ In District, National and State
____ In District, National
____ In District, State
____ Recommended and rejected
____ Insufficiently evaluated, potential unknown
____ Not nominated

Condition of Site: intact ____ grazed ____ eroded ____ mech. disturbance X
vandalized ____ other excavated

Mitigation: avoid ____ monitor ____ test X excavate X not required ____

Surveyed for NASA White Sands Test Facility

Record Form: Surv. Forms X Excav. Forms X Sketch Map X Photos X

Loc. of Forms, Maps, Photos Batcho & Kauffman Associates, Las Cruces

Surface and/or Subsurface Collections: yes X no ____ **Strategy** C14 and flotation samples taken, no artifacts

Location of Collected Artifacts N/A

Previous Collections? no **When** ____ **Repository** ____

Is there another site close by? no **LA or Field Identif.#** ____

Artifact Density: (0), 10's, 100's, 1000's.

Time Diagnostic Artifacts: none

LA/Field No. BK[illegible]

No. of Temporal Components 1

(Earliest to Latest)

Temporal Component (1)

Features Isolated buried FCR hearth, 1.5 by 1.8 m by 20 cm deep

Culture Desert Archaic Period Late Archaic Phase

Site Function: temp. camp Best Date 1371 to 830 BC

Method of Date: single radiocarbon sample, date is 2860 +/- 90 BP, decadal calibration date as above per Stuiver & Becker 1986

Temporal Component (2)

Features

Culture Period Phase

Site Function: Best Date

Method of Date:

Temporal Component (3)

Features

Culture Period Phase

Site Function: Best Date

Method of Date

Additional Temporal Components

LA/Field No. BK337

Published Reference:

Date 1993

Institution Batcho & Kauffman Associates, Las Cruces, NM

Author and Title B. Kauffman, Batcho & Kauffman Cultural Resources Report No. 154

Remarks: Site BK337 is an isolated buried FCR hearth discovered ca. 20 cm below the surface during blading to construct a water monitoring well drill pad by NASA-WSTF. No artifacts are associated with the feature. The hearth was completely excavated and measured 1.8 x 1.5 x 0.2 m. The feature was roughly oval in shape, consisting of ca. 450 fist-sized pieces of limestone FCR in a shallow pit partially dug into the caliche substrate. The feature fill was ashy with some small charcoal pieces, but was disturbed by root and rodent activity.

A single radiocarbon sample was recovered & dates the use of the hearth to the Late Archaic period from 1371 and 830 BC (decadally corrected). Flotation samples yielded no charred seeds, but fuelwood charcoal was identified as mesquite (Prosopis). Flotation analyst suggested hearth was used for warming since no seeds were recovered, but abundant FCR may suggest otherwise.

In addition to excavating the hearth, four 1 x 1 m test units were excavated in undisturbed areas surrounding the feature to search for evidence that the feature was part of a larger site. No artifacts or features were discovered during that testing.

Field Recorder E. K. Stuart **Date** 9/18/92

Lab Recorder B. Kauffman **Date** 9/20/92

Appendix C

Threatened and Endangered Species Survey of the National Aeronautics and Space Administration's White Sands Test Facility, New Mexico

Threatened and Endangered Species Survey Of the National Aeronautics and Space Administration's White Sands Test Facility (WSTF), New Mexico

Prepared by:

Dr. Robert M. Sullivan and Deborah L. Houde-Nethers
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Submitted to:

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July 1, 1996

NEW MEXICO STATE UNIVERSITY
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Threatened and Endangered Species Survey Of the National Aeronautics and Space Administration's White Sands Test Facility (WSTF), New Mexico

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REPORT SUMMARY

This report provides results of a detailed biological field survey of Threatened and Endangered species of plants and animals found on the National Aeronautics and Space Administration's (NASA) White Sands Test Facility (WSTF), Doña Ana County, New Mexico (Figure 1). The biological survey was conducted on more than 13 sections of land and along approximately 52 km (32 mi) of right-of-way and fire fighting dirt roadways. Field work was conducted from 12 June through 5 September 1995. A supplemental rare plant survey was conducted during the spring flowering season of 1996. Industrial areas surveyed were divided into eight land use areas generally according to function. Because geographic boundaries of these land use and test areas are loosely defined, each area was referenced in the biological survey in relation to the particular section of land surveyed. A 100 percent pedestrian survey was conducted of all Threatened, Endangered, and Sensitive species of plants and diurnal animals, which included all connecting roadways, powerlines, and arroyos within the affected area.

Five rare plant species were documented within the primary study area. These taxa included: Ball Cactus (*Coryphantha vivipara*- no Federal status; State of New Mexico "Plant Taxa Considered, But Not Included", L4); Barrel Cactus (*Ferocactus wislizenii*-no Federal status; State of New Mexico, "Plant Taxa Considered, But Not Included", L4); **Night-blooming Cereus** (*Peniocereus greggii* var. *greggii*—Federal status [C2]; State of New Mexico Endangered [Status L1C, R-E-D Code: 1-3-1]); **White-flowered Visnagita** (*Neolloydia intertexta* var. *dasyacantha*—no Federal status; delist in 1995 from State of New Mexico Endangered to "Plant Taxa Considered, But Not Included" [Status L4-1, R-E-D Code: 1-1-1]); and the **Zephyr Lily** (*Zephyranthes longifolia*—no Federal status; State of New Mexico "Plant Taxa Considered, But Not Included" [Status L4-1). Thirteen animal species were documented within the primary study area; these taxa included primarily small- to large-sized raptoral birds species: **Coopers Hawk** (*Accipiter cooperii*—no Federal status; State of New Mexico [Protected]); **Golden Eagle** (*Aquila chrysaetos*—Federal Endangered Species; State of New Mexico [Protected]); **Koch's Snail** (*Ashmunella kochi kochi*—no Federal status; State of New Mexico [Sensitive]); **Red-tailed Hawk** (*Buteo jamaicensis*—no Federal status; State of New Mexico [Protected]); **Swainson's Hawk** (*Buteo swainsoni*—no Federal status; State of New Mexico

[Protected]); **Turkey Vulture** (*Cathartes aura*—no Federal status; State of New Mexico [Protected]); Northern **Harrier** (*Circus cyaneous*—Federal status [none]; State of New Mexico [Protected]); **Loggerhead Shrike** (*Lanius ludovicianus*—Federal [Candidate]; State [none]); **American Kestrel** (*Falco sparverius*—no Federal status; State of New Mexico [Protected]; **Pale Townsend's Big-eared Bat** (*Plecotus townsendii pallescens*—Federal [Candidate]; State of New Mexico [Protected]; **Texas Horned Lizard** (*Phrynosoma cornutum*—Federal [Candidate]; State of New Mexico [Protected]); **Short-horned Lizard** (*Phynosoma douglassi*—no Federal status; State of New Mexico [Protected]); and **Western Burrowing Owl** (*Speotyto cunicularia hypugea*—Federal [Candidate]; State of New Mexico [Protected]).

Fragmentation of native habitat represents a direct and observable loss of wildlife resources and may increase the level of predation on native wildlife species. These resources may include watering areas, foraging areas, travel corridors, and cover, nesting, and bedding sites. Fragmentation of native habitat, therefore generally results in an overall decrease in species density and richness. Fragmentation and resulting loss of natural habitat associated with new testing and construction activities can cause adverse impacts to wildlife habitat in the local area. Although this loss may not be immediately apparent, overtime it will have an accumulative negative effect on local plant and animal species diversity and density—which will be difficult, as well as expensive, to reclaim once lost. These areas on the WSTF site include: (1) ecotones between arroyo and scrub vegetation associated with both minor and major drainages; (2) the ecotones between arroyo vegetation and woodland vegetation at the eastern boundary of the property at the base of the San Andres Mountains; and (3) areas of great natural topographic diversity. No habitat critical to the survival or reproduction of any listed species of plant or animal was observed on the WSTF property.

Regions of high sensitivity habitat included: (1) the upper reaches of the Bear Canyon drainage, which drains east to west; (2) mesic woodland and arroyo vegetation associated with the Love Ranch area; and (3) the mesic woodland habitat associated with the northeast foothills of Quartzite Mountain and the San Andres Mountain Range. These areas are rich in biodiversity of both plants and animals, topographic relief, and provides natural water catchments and cover for wildlife. Areas of moderate sensitivity include desert grassland and associated shrubby vegetation lying at the base of the foothills of Quartzite Mountain and the San Andres Mountain Range, including the primary WSTF testing areas and the western boundary of the property. Areas considered to be of low sensitivity encompassed the remaining habitat, including most of the roadways to the north that boarder or are contained within the Jornada Experimental Range.

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EXECUTIVE SUMMARY

This report provides results of a detailed biological field survey of Threatened and Endangered species of plants and animals found on the National Aeronautics and Space Administration's (NASA) White Sands Test Facility (WSTF), Doña Ana County, New Mexico (Figure 1). The biological survey was conducted on more than 13 sections of land and along approximately 52 km (32 mi) of right-of-way and fire fighting dirt roadways. Field work was conducted from 12 June through 5 September 1995. A supplemental rare plant survey was conducted during the Spring flowering season of 1996. Industrial areas surveyed were divided into eight land use areas generally according to function. Area number designations are as follows: 100 Area, 200 Area, 300 Area, 400 Area, 500 Area, 600 Area, 700 Area, and the 800 Area. Because geographic boundaries of these land use and test areas are loosely defined, each area was referenced in the biological survey in relation to the particular section of land surveyed.

A 100 percent pedestrian survey was conducted of all Threatened, Endangered, and Sensitive species of plants and diurnal animals. In addition to the 100 percent surveys of each area for species of special concern, the line-intercept sampling technique also was employed. Objectives of the line-intercept sampling were to determine species composition of major plant taxa in a given habitat, and identify quantitatively any community transition or ecological gradient that might exist in the specific study area.

Major vegetation within the area included a combination of woody shrubs and grasses characteristic of the Chihuahuan Desertscrub Biotic Community (Brown and Lowe 1982). Vegetation communities found within the designated study area included: Chihuahuan Broadleaf Deciduous Desert Scrub; Chihuahuan Foothill-Piedmont Desert Grassland; Chihuahuan Broadleaf Evergreen Desert Scrub; Rocky Mountain Montane Scrub and Interior Chaparral; and Rocky Mountain-Great Basin Open Conifer Woodland.

Of 36 plant species of special concern potentially occurring throughout Doña Ana County, New Mexico, 5 taxa (7.2%) were documented within the primary study area. These taxa included: **Ball Cactus** (*Coryphantha vivipara*- no Federal status; State of New Mexico "Plant Taxa Considered, But Not Included", L4); **Barrel Cactus** (*Ferocactus wislizenii*-no Federal status; State of New

Mexico, "Plant Taxa Considered, But Not Included", L4); **Night-blooming Cereus** (*Peniocereus greggii* var. *greggii*—Federal status [C]; State of New Mexico Endangered [Status L1C, R-E-D Code: 1-3-1]); **White-flowered Visnagita** (*Neolloydia intertexta* var. *dasyacantha*—no Federal status; delist in 1995 from State of New Mexico Endangered to "Plant Taxa Considered, But Not Included" [Status L4-1, R-E-D Code: 1-1-1]); and the **Zephyr Lily** (*Zephyranthes longifolia*—no Federal status; State of New Mexico "Plant Taxa Considered, But Not Included" [Status L4-1).

Of 39 animal species of special concern potentially occurring throughout Doña Ana County, New Mexico, 5 taxa (7.4%) were documented within the primary study area. In addition, several additional species that are protected by the State of New Mexico (but not listed) or protected by the Federal Migratory Bird Treaty also were observed; most these taxa included various raptoral birds species: **Coopers Hawk** (*Accipiter cooperii*—no Federal status; State of New Mexico [Protected]); **Golden Eagle** (*Aquila chrysaetos*—Federal Endangered Species; State of New Mexico [Protected]); **Koch's Snail** (*Ashmunella kochi kochi*— no Federal status; State of New Mexico [Sensitive]); **Red-tailed Hawk** (*Buteo jamaicensis*—no Federal status; State of New Mexico [Protected]); **Swainson's Hawk** (*Buteo swainsoni*—no Federal status; State of New Mexico [Protected]); **Turkey Vulture** (*Cathartes aura*—no Federal status; State of New Mexico [Protected]); **Northern Harrier** (*Circus cyaneous*—Federal status [none]; State of New Mexico [Protected]); **Loggerhead Shrike** (*Lanius ludovicianus*—Federal [Candidate]; State [none]); **American Kestrel** (*Falco sparverius*—no Federal status; State of New Mexico [Protected]; **Pale Townsend's Big-eared Bat** (*Plecotus townsendii pallescens*—Federal [Candidate]; State of New Mexico [Protected]; **Texas Horned Lizard** (*Phrynosoma cornutum*—Federal [Candidate]; State of New Mexico [Protected]); **Short-horned Lizard** (*Phynosoma douglassi*—no Federal status; State of New Mexico [Protected]); and **Western Burrowing Owl** (*Speotyto cunicularia hypugea*—Federal [Candidate]; State of New Mexico [Protected]).

Mammalian species richness was high throughout the study area, depending upon local topography and vegetation complexity. This pattern of species richness is the result of significant topographic relief and geologic structural complexity, vegetation and ecotonal diversity, and the abundance of large arroyos, which are often obscured in lowland flat areas. Out of 548 mammal observations, the most common species included the Desert Cottontail (*Sylvilagus* *auduboni*, 34%), Blacktailed Jackrabbit (*Lepus californicus*, 20%), White-throated Woodrat (*Neotoma albigula*, 16%), Mule Deer (16%), and the Banner-tailed Kangaroo Rat (*Dipodomys spectablis*, 7%). Mule deer were abundant on the WSTF site, as evidenced by frequent observation of individual deer and groups of as many as 12 individuals. Foraging and bedding areas, travel corridors, antler castings, tracks, and feces also were common in the study area. Areas of high concentrations of deer exist throughout much of the area associated with the foothills of the San Andres Mountains, along major west draining arroyos (Bear Canyon), artificial watering areas, and most well developed and densely vegetated bajadas. Drainages and adjacent low-land slopes associated with grassland-scrub habitat and arroyo vegetation function as important travel corridors, bedding sites, and foraging areas for deer and many other medium to small-sized mammals, particularly in areas that are not disturbed by human activity.

The most common bird species observed (n= 428) were the Black-throated Sparrow (*Amphispiza bilineata*, 21%), Mourning Dove (*Zenaida macroura*, 13.5%), Northern Mockingbird (*Mimus polyglottos*, 7%), White-winged Dove (*Zenaida asiatica*, 6%), and the Western Kingbird (*Tyrannus vociferans*, 5%). Eight species of raptorial bird species were observed, including the: Coopers Hawk (*Accipiter cooperii*), Golden Eagle (*Aquila chrysaetos*), Red-tailed Hawk (*Buteo jamaicensis*), Swainson's Hawk (*Buteo swainsoni*), Turkey Vulture (*Cathartes aura*), Northern Harrier (*Circus cyaneous*), American Kestrel (*Falco sparverius*), and the Western Burrowing Owl (*Speotyto cunicularia hypugea*). Although several pairs of raptors were observed nesting in the general area, there was no clearly defined raptor use area or ecological region associated with the property. However, all upland shrub habitat and the ecotone between shrub and desert grassland habitats associated with the foothills of Quartzite Mountain and the San Andres Mountains function as a primary nesting area for large populations of the Black-throated Sparrow (*Amphispiza bilineata*), Northern Mockingbird (*Mimus polyglottos*), Lesser Nighthawk (*Chordeiles acutipennis*), White-winged Dove (*Zenaida asiatica*), and Mourning Dove (*Zenaida macroura*).

The largest densities of reptiles occurred in desert grassland and scrub habitat associated with Section 1 (19% of the total number of individuals observed, n=503), Section 36 (17%), Section 12 (9.3%), Section 11 (8%), and Section 32W (8%). The most common species of herptile was the Side-blotched Lizard (*Uta stansburiana*, n=133 individuals observed) followed by the Grassland Whiptail (*Cnemidophorus uniparens*, n=94), Western Whiptail (*Cnemidophorus tigris*, n=89), and Checkered Whiptail (*Cnemidophorus tesselatus*, n=43). Four specimens of the Texas Horned Lizard (*Phrynosoma cornutum*) were found in Section 1 and Section 36. This taxon is a Federal Candidate species. In addition, 12 specimens of the Short-horned Lizard (*Phrynosoma douglassi*) also were found. This species appears abundant and widespread in desert grassland and shrubland habitat, particularly at low elevations. All species of horned lizards are protected in New Mexico.

Because of the lack of ponds, streams, and wetland habitat, the number of species of amphibians was low. Man-made watering areas associated with Section 25 and 26 (Water Tower and 200 Area), and Section 2 (Sewage Lagoons [Nos. 640 and 136]) provide extremely limited access to perennial free water for amphibians. A large earthen tank (Section 31W) used for watering cattle contain 1,000s of Western Spadefoot Toad (*Scaphiopus hammondi*) tadpoles.

The primary source of free water for wildlife derives from numerous arroyos and several larger drainages associated with the foothills of the San Andres Mountains, which receives runoff and has natural, but ephemeral, water catchments. There are no perennial stream flows in the area, and deeply incised arroyos typically contain debris-laden flow during and shortly following summer storms. Gardner Springs Arroyo trends west through the facility near the 500 Area and 200 Area. One of its branches is close to the expansive Bear Creek canyon area, which is the primary arroyo to the north. The Bear Creek canyon drainage receives the largest amount of runoff during the monsoon season and is an important ephemeral source of free water for wildlife during the summer months. Limestone and igneous bedrock collects and pools water in depressions that can be used by wildlife as a annual source of water, which lies adjacent to vegetative cover. This drainage probably receives the largest amounts of use by wildlife following periods of summer and early fall precipitation. In addition, shrubs provide cover and perching substrates for a variety of passerine birds. Water will remain for longer periods of time if shrubs and trees remain undisturbed, because they provide shading, thus increasing the quality of this arroyo as important wildlife habitat.

Fragmentation of native habitat represents a direct and observable loss of wildlife resources and may increase the level of predation on native wildlife species. These resources may include watering areas, foraging areas, travel corridors, and cover, nesting, and bedding sites. Fragmentation of native habitat, therefore generally results in an overall decrease in species density and richness. Fragmentation and resulting loss of natural habitat associated with new testing and construction activities can cause adverse impacts to wildlife habitat in the local area. Although this loss may not be immediately apparent, overtime it will have an accumulative negative effect on local plant and animal species diversity and density—which will be difficult, as well as expensive, to reclaim once lost. These areas primarily include: (1) ecotones between arroyo and scrub vegetation associated with both minor and major drainages; (2) the ecotones between arroyo vegetation and woodland vegetation at the eastern boundary of the property at the base of the Quartzite Mountain and San Andres Mountains; and (3) areas of great natural topographic diversity.

No habitat critical to the survival or reproduction of any listed species of plant or animal was observed on or in the immediate vicinity of the WSTF property. Regions of high sensitivity habitat included: (1) the upper reaches of the Bear Creek Canyon drainage, which drains east to west; (2) mesic woodland and arroyo vegetation associated with the Love Ranch area; and (3) the mesic woodland habitat associated with the northeast foothills of Quartzite Mountain and the San Andres Mountain Range. These areas are rich in biodiversity of both plants and animals, topographic relief, and provides natural water catchments and cover for wildlife. Areas of moderate sensitivity were associated with desert grassland and associated shrubby vegetation lying at the base of the foothills of Quartzite Mountain and the San Andres Mountain Range, including the primary WSTF testing areas and the western boundary of the property. Areas considered to be of low sensitivity encompassed the remaining habitat, including most of the roadways to the north that boarder or are contained within the Jornada Experimental Range.

1 INTRODUCTION

1.1 PURPOSE OF BIOLOGICAL ASSESSMENT

This report provides results of a detailed biological field survey of Threatened and Endangered species of plants and animals found on the National Aeronautics and Space Administration's (NASA) White Sands Test Facility (WSTF), Doña Ana County, New Mexico (Figure 1). The biological survey was conducted on more than 13 sections of land and along approximately 52 km (32 mi) of right-of-way and fire fighting dirt roadways. Specific tasks completed included:

1. Survey and identify all Threatened, Endangered, and Sensitive species of plants and animals that occur or have the potential to occur within the boundaries of the specific study area.

2. Catalog all species identified during the biological survey and publish and submit to AlliedSignal Technical Services Corporation (ATSC) a detailed report concerning results of the survey, including:

   - a detailed description of the survey area and associated GIS products;
   - a detailed description of all biological survey methodologies used;.
   - a list of all Threatened, Endangered, and Sensitive species identified;
   - a discussion of all critical habitats, topography, substrates, drainage patterns, unique biological communities, and other factors of significance to the biological regime;
   - discussions and recommendations concerning the findings of the biological survey;
   - discussions and recommendations of site activities potentially impacting sensitive species and their critical habitats.

1.2 INSTALLATION DESCRIPTION

1.2.1 Location

WSTF is located 32 km (20 mi) northeast of Las Cruces, New Mexico, and 105 km (65 mi) north of El Paso, Texas. Geographic coordinates of WSTF are 106°36'30" W longitude, 32°30'30" N latitude. The installation occupies approximately 245 km^2 (60,500 acres) along the western flank of the San Andres Mountains in southwestern New Mexico.

1.2.2 Geology

WSTF is in the Mexican Highland Section of the Basin and Range Province and within a major tectonic feature—the Rio Grande Rift. This rift, which extends from southern Colorado to northern Mexico, is characterized by north-trending mountain ranges and intermontane basins. WSTF is located along the western flank of the San Andres Mountains. This range extends from San Augustine Pass at the southern border (near the WSTF access road entrance from U.S. Highway 70) to Mockingbird Gap, White Sands Missile Range on the north, a distance of 120 km (75 mi). Elevation of the adjacent plains to the west is about 1,300 m (4,200 ft) above mean sea level. This area is part of the Jornada del Muerto, a broad, dry basin on the west side of the San Andres Mountains. Considered part of the Rio Grande Rift, along with the San Andres Mountains, the basin measures 191 km (120 mi) in length and 24 to 48 km (15-30 mi) wide with elevation ranging from 1,432 to 1,554 m (4,700 - 5,100 ft). Higher peaks of the mountains to the east of the WSTF site are from 2,100 to 2,700 m (7,000 - 9,000 ft) in elevation. Quartzite Mountain, just east of WSTF along Bear Creek canyon, reaches 2,100 m (6,800 ft), whereas elevations of most WSTF industrial sites range from 1,460 to 1,520 m (4,800 - 5,000 ft).

1.2.3 General Soil Conditions

Uppermost alluvial layers associated with the WSTF site consist of silt, sand, gravel, boulders, and locally cemented conglomerates. Alluvium ranges from 10 to 99 m (35 - 325 ft) thick, adjacent to the mountains, to greater than 610 m (2,000 ft) thick in the basin floor. The surface of the uppermost alluvial layer is a sandy silt containing some gravel and occasional boulders, and the gravel and boulder content gradually increase with depth.

1.2.4 Hydrology

The primary water supply in the area is from underground water resources immediately adjacent to the Rio Grande. In the WSTF area, all water is from an underground source, a groundwater aquifer of the Jornada Del Muerto Basin. Recharge of the groundwater aquifer comes primarily from the adjacent San Andres Mountains. Because of the relatively impervious geological structure of these mountains and the drainage gradients, runoff is approximately 75 percent of the total rainfall. Runoff that does not evaporate or transpire after reaching the alluvial fans at the base of the mountains infiltrates the ground and constitutes groundwater recharge. Although sporadic and of a small volume, it is important as a continuing source of recharge.

1.2.5 Meteorology

The WSTF site is in a predominantly Chihuahuan Desert Grassland climate, which is characterized by abundant sunshine, low humidity, slight rainfall, and a large day-to-night temperature variance. Average annual temperature is 62°F (17 °C). The mountainous terrain influences the climate by blocking the incursion of moisture-laden maritime air masses, and cold air draining down slopes causes a wide variation in minimum temperatures. There is also more precipitation in the mountains than in the basin. Although nighttime temperatures usually fall below freezing, average highs near 60°F (16°C) prevail during the coldest months, December and January. Spring, March and April, is the driest time of year. Dust storms caused by long-sustained winds are common. Summer weather, with an average maximum temperature of 94°F (34°C), begins in May and lasts through September. The highest temperatures, near and occasionally over 100°F (40°C), usually occur in late June, but through out the summer the temperature may drop 30°F (17°C) or more after sundown because of the clear skies and elevation.

1.3 SURVEYED LAND USE AREAS

Industrial areas surveyed are divided into eight land use areas generally according to function. Area number designations are: 100 Area, 200 Area, 300 Area, 400 Area, 500 Area, 600 Area, 700 Area, and the 800 Area. Because geographic boundaries of these land use and test areas are loosely defined, each area was referenced in the biological survey in relation to the particular section of land surveyed. All section corners and test areas were verified and mapped by use of U.S. Geological Survey (USGS) topographic maps and a Trimble Pathfinder Global Positioning Systems (GPS).

1.3.1 100 Area

The 100 Area contains office facilities for administrative, management, and engineering activities, food service facilities, vehicle and facility maintenance, trade shops, emergency medical, fire fighting, and warehousing functions. The propellant transport parking area, an isolated area off the main thoroughfare and north of the 100 Area perimeter, is a holding area for trucks loaded with hazardous materials awaiting inspection and proper escort to offloading destinations. Two in-ground and three above-ground magazines for explosives and detonators are located in an isolated area northwest of the 100 Area. The "borrow" area, a mile south of the 100 Area, is an archaeologically safe source of gravel.

1.3.2 200 Area

The 200 Area contains laboratories and support facilities for propulsion system testing and components testing. The 250 and 270 Area test facilities were constructed to perform hazardous testing of hardware safely but with access to needed utilities and control facilities. Natural earthen barricades, a concrete retaining wall, and manmade structures protect the immediate areas. The 200 Area also contains covered hazardous waste evaporation tanks that exclude wildlife. Also open sewage lagoons are present and serve as a source of free water to numerous species of birds and other local wildlife.

1.3.3 300 and 400 Areas

The 300 and 400 Areas contain facilities and systems necessary to perform cold flow and static hot fire testing of propulsion systems. Rocket fuels and oxidizers are stored, pressurized, and transferred here. Within each area are four test stands, a control blockhouse, equipment and support buildings, instrumentation bunkers, and small office buildings. The site water storage facility, consisting of two above-ground tanks, is adjacent to the 300 Area.

1.3.4 500 Area

The 500 Area contains three separate areas: the fuel treatment facility, the propellant storage area, and the cryogenic and inert gas storage area (cryo area). The propellant storage area is restricted to facilities for storing and transferring propellants (oxidizers and fuels). At the cryo area are storage and distribution systems for liquid oxygen (inactive) and liquid and gaseous nitrogen.

1.3.5 600 Area

The three water supply wells, the two water booster stations, and the water treatment facilities are located along the well road in the 600 Area. The remote Large-Scale Fuel Fire Test Area is located near the wells, 4 mi (6.4 km) from the 100 Area.

1.3.6 700 Area

The 700 Area contains the remote High-Energy Blast Facility, the Landfill, and the open detonation unit where waste explosives are detonated.

1.3.7 800 Area

The 800 Area, adjacent to the 200 Area, contains facilities for performing tests on a wide variety of materials for ignition and combustion characteristics in various liquid and gaseous atmospheres at a wide range of temperatures and pressures. Facilities include a control building and reinforced concrete test cells.

2 METHODS

2.1 GENERAL SAMPLING METHODS

The biological field survey was conducted from 12 June through 5 September 1995 and April through May 1996. Because field work was conducted at the end of the flowering and growing seasons (Summer), the survey period was not seasonally timed to allow observation of the presence of some potential species of special concern, or to ensure complete coverage of all species in the affected area. However, the survey was seasonally timely enough to allow observations of most species of special concern, and to determine general habitat characteristics of taxa associated with different plant communities, elevations, topography, and drainage basin conditions within the local area.

Lists of plant and animal taxa occurring and potentially occurring within the project area were compiled from direct observation during pedestrian surveys of the affected area, and from recent literature detailing the surrounding biotic communities. Lesser game and nongame species of wildlife were recorded by visual observation and by the presence of tracks, scat, burrow systems, and nests—bones in carnivore scat and those found associated with woodrat nests are particularly good indicators of species richness of the small vertebrate community in the local area.

2.2 COMPLETE SURVEY METHOD (100 PERCENT)

A 100 percent pedestrian survey was conducted of all Threatened, Endangered, and Sensitive species of plants and diurnal animals, and included all connecting roadways, powerlines, and arroyos within the affected area (Figure 2). Surveys were conducted in each of the 13.5 sections of land, including all designated fire fighting access roadways (40.2 km [25 mi]) and the first 10.5 km (6.5 mi) of the NASA Road from Highway 70 to the entrance of the main WSTF facility (100 Area). An area of 45.7 meters (m) (150 feet [ft]) on both sides of all fire fighting and access roadways (1.146 acres) also was sampled 100 percent by walking.

One-hundred percent surveys of all flowering plants were conducted using parallel transects walked back and forth across survey areas by four qualified biologists and botanists.

A 100 percent survey was necessary to determine the presence, distribution, and critical habitat[1] characteristics of all species of special concern listed by the Federal and State of New Mexico environmental resources agencies (i.e., U.S. Fish and Wildlife Service [USFWS], U.S. Forest Service [USFS], State of New Mexico Forestry Division [NMFD], New Mexico Department of Game and Fish [NMDGF]).

2.3 PLANT TRANSECTS

In accordance with recommendations of the NMDGF, all major wildlife communities within the proposed survey area were determined, including the presence and distribution of lesser faunal and floral species and their sensitive habitats, including travel corridors, foraging areas, nesting sites, etc. (NMDGF, 1991, 1992). In addition to the 100 percent surveys of each area for species of special concern, the line-intercept sampling technique also was employed. Objectives of the line-intercept sampling were two-fold: (1) determine species composition of major plant taxa in a given habitat, and (2) identify quantitatively any community transition or ecological gradient that might exist in the specific study area.

Data were tabulated on the basis of plants lying on a straight line cutting across different regions of the study area. Because a specific unit of area (i.e., square meter [m^2]) was not being sampled, only species composition and relative estimates of density can be calculated from these data. Surveys were stratified by habitat type and eight transects, totaling 1,600 m (5,250 ft) in length, were walked within each section of land. Starting points and orientation of transect locations were randomly selected. Samples were taken at 5 m (16.4 ft) intervals (40 individual data points per 200 m [656 ft] transect). Plants were counted if they were physically touched by the line-intercept transect vector or if their aerial foliage overlay the line-intercept transect vector.

The line-intercept method has been used extensively in studies of woodland, desertscrub, and desert grassland biotic communities, because true estimates of absolute density either cannot be

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1 The Endangered Species Act (ESA) (1993 §§ 2-19, 16 U.S.C.A.) defines critical habitat as that geographic area within the area occupied by the species at the time of its listing that the U.S. Fish and Wildlife Service (USFWS) determines to be essential to the conservation of the species and requiring special management consideration or protection.

made or are difficult to interpret due to the problem of distinguishing between individual grass plants. In situations where relative estimates are sufficient, line-intercept transects may efficiently obtain them. In addition, this survey technique gives rapid, accurate, and objective information on relative frequency, density, and cover (dominance) of wildlife species, and is recommended by the NMDGF (NMDGF, 1992).

3 RESULTS

3.1 BIOLOGICAL RESOURCES

3.1.1 Vegetation Communities

Major vegetation within the area included a combination of woody shrubs and grasses characteristic of the Chihuahuan Desertscrub Biotic Community (Brown and Lowe 1982). Figure 4 shows the major vegetation communities found within the designated boundaries of the WSTF site and the associated fire roadways; these plant communities include Chihuahuan Broadleaf Deciduous Desert Scrub (4222); Chihuahuan Foothill-Piedmont Desert Grassland (5221); Chihuahuan Broadleaf Evergreen Desert Scrub (4221); Rocky Mountain Montane Scrub and Interior Chaparral (4110); and Rocky Mountain-Great Basin Open Conifer Woodland (3122). All vegetation designations follow data compiled by the New Mexico Gap Analysis Project (GAP), which currently resides in the PSL GIS Computer Database.

3.2 DESCRIPTION OF SPECIFIC SITES SURVEYED

Complete lists of all Threatened, Endangered, and Sensitive species of plants and animals potentially occurring within the project area are provided in Appendices A and B. Criteria for listing these plants and animals are presented in Appendix C. Plant species not detected in the line-transects because they are relatively rare in the area surveyed are provided in Appendix D1, D2, and D3—these species were observed during the 100 percent pedestrian surveys. Animal species observed and expected during the biological survey of the each section are shown in Appendix E1, E2, and E3.

3.2.1 Sections 11 and 12

3.2.1.1 Section 11

Section 11 is located along the southwest border of the WSTF facility. The northern boarder of Section 11 lies adjacent to the 100 Area (Section 2), which includes the Goddard Space Flight

Center (GSFC), Tracking and Data Relay Satellite Station (TDRSS) facility, U.S. Air Force Communications Support Facility (ASCFS), and the main gate along NASA Road. Dominate soil types were sandy/loam (1.6%), sandy gravel (27.8%), and boulders (5.0%). Dominant shrub species included Louisiana White Sage (*Artemisia ludoviciana*, 6.9%), Feather Plume (*Dalea formosa*, 3.8%), Tarbush (*Flourensia cernua*, 15.6%), Broom Snakeweed (*Gutierezia sarothrae*, 3.8%), Creosotebush (*Larrea tridentata*, 10.6%), Honey Mesquite (*Prosopis glandulosa*, 10.0%), and Lotebush (*Ziziphus obtusifolia*, 1.3%). The most common species of grasses were Side-Oats Grama Grass (*Bouteloua curtipendula*, 2.5%), Fluff Grass (*Erioneuron pulchellum*, 6.9%), and Alkali Sacaton (*Sporobolus airoides*, 4.4%). Alkali Sacaton is an indicator of saline soil.

<u>No Threatened, Endangered, or Sensitive species of plants were observed in the area surveyed.</u>

3.2.1.2 Section 12

Section 12 is located along the southeast border of the WSTF facility and does not include any testing facilities. The newly constructed fire break corridor is along its western boundary. Elevation gradually increases moving east and upslope toward the northwest escarpment of Quartzite Mountain. Dominate soil types were sandy loam (1.6%), sandy gravel (27.8%), and boulders (5.0%). Dominant shrub species included Louisiana White Sage (*Artemisia ludoviciana*, 6.9%), Feather Plume (*Dalea formosa*, 3.8%), Tarbush (*Flourensia cernua*, 15.6%), Broom Snakeweed (*Gutierezia sarothrae*, 3.8%), Creosotebush (*Larrea tridentata*, 10.6%), Honey Mesquite (*Prosopis glandulosa*, 10.0%), and Lotebush (*Ziziphus obtusifolia*, 1.3%). The most common species of grasses were Side-Oats Grama Grass (*Bouteloua curtipendula*, 2.5%), Fluff Grass (*Erioneuron pulchellum*, 6.9%), and Alkali Sacaton (*Sporobolus airoides*, 4.4%).

<u>No Threatened, Endangered, or Sensitive species of plants were observed in the area surveyed.</u>

3.2.2 Sections 1 and 2

Sections 1 and 2 are located directly north of, and adjacent to, Sections 11 and 12, which lie at the southwest and southeast borders of the WSTF facility. NASA Road lies at the extreme western boundary of Section 2; whereas the newly constructed fire break corridor lies along the western boundary of Section 1. Several testing areas are included within the boundaries of these two areas.

In both sections, Ball cacti (*Coryphantha vivipara*) were observed growing on slopes with limestone gravel. This cactus was not in bloom and the subspecies was not positively identified. However, two subspecies - *C.v.* var. *bisbeeana* and *C.v.* var. *radiosa* are on the State of New Mexico "Plant Taxa Considered, But Not Included", L4.

3.2.2.1 Section 1

Section 1 does not include any testing facility, only the newly constructed fire break corridor along its western boundary. Elevation gradually increases moving east and upslope toward the northwest escarpment of Quartzite Mountain. Dominate soil types in this area included sandy loam (1.6%), sandy gravel (27.8%), and boulders (5.0%). Dominant shrub species included Louisiana White Sage (*Artemisia ludoviciana*, 6.9%), Feather Plume (*Dalea formosa*, 3.8%), Tarbush (*Flourensia cernua*, 15.6%), Broom Snakeweed (*Gutierezia sarothrae*, 3.8%), Creosotebush (*Larrea tridentata*, 10.6%), Honey Mesquite (*Prosopis glandulosa*, 10.0%), and Lotebush (*Ziziphus obtusifolia*, 1.3%). The most common species of grasses were Side-Oats Grama Grass (*Bouteloua curtipendula*, 2.5%), Fluff Grass (*Erioneuron pulchellum*, 6.9%), and Alkali Sacaton (*Sporobolus airoides*, 4.4%).

3.2.2.2 Section 2

Section 2 includes the **100 Area**, three sewage treatment lagoons, the **600 Area**, the **272 Area** and part of the **200 Area**. This section of land includes a high density of buildings and storage areas for surplus materials (pipes, vehicles, etc.). Disturbed areas are vegetated by common weedy plants, such as Russian Thistle (*Salsola australis*). The sewage treatment lagoons are denuded of vegetation and provide water and forage for a variety of bird species such as Spotted Sandpiper (*Actitis macularia*), Killdeer (*Charádrius vociferus*), Cactus Wren (*Campylorhynchus brunneicapillus*), American Kestrel (*Falco sparverius*), Roadrunner (*Geococcyx californianus*), Cliff Swallows (*Petrochélidon pyrrhonóta*), Curved-bill Thrasher (*Toxostoma curvirostre*), and Yellow-headed Blackbirds (*Xanthocéphalus xanthocéphalus*).

Topography in this section was mostly flat with a few rolling hills sloping up towards Quartzite Mountain. The lower end of Gardner Springs Arroyo flows south on the western side of the areas listed above. A series a small limestone outcrops separate the facilities from the fire brake at the base of Quartzite Mountain. These limestone hills have been coined "Ocotillo Ridge" by NASA employees. Dominate soil types were sandy loam (1.6%), sandy gravel (27.8%), and boulders (5.0%). Dominant shrub species included Louisiana White Sage (*Artemisia ludoviciana*, 6.9%), Feather Plume (*Dalea formosa*, 3.8%), Tarbush (*Flourensia cernua*, 15.6%), Broom Snakeweed (*Gutierezia sarothrae*, 3.8%), Creosotebush (*Larrea tridentata*, 10.6%), Honey Mesquite (*Prosopis glandulosa*, 10.0%), and Lotebush (*Ziziphus obtusifolia*, 1.3%). The most common species of grasses were Side-Oats Grama Grass (*Bouteloua curtipendula*, 2.5%), Fluff Grass (*Erioneuron pulchellum*, 6.9%), and Alkali Sacaton (*Sporobolus airoides*, 4.4%). An existing burrow pit in section 2 was uncovered during excavation in 1993; and an archaeological survey was performed at this time by Batcho and Kauffman Associates (Stuart, 1994).

3.2.3 Sections 31W, 32W, 6, and 5

Sections 31W, 32W, 6, and 5 constitute four sections of lowland, which encompasses the most xeric, poorly drained, and vegetatively homogeneous area on the WSTF property. Numerous well developed arroyos were present but hidden from sight within the low profile topography and vegetation. Water flows in a westward direction towards the Jornada Basin. Plant species richness is low relative to better drained upland slopes. Vegetation is sparse between shrub species such as Creosotebush (*Larrea tridentata*), Tarbush (*Flourensia cernua*), and Honey Mesquite (*Prosopis glandulosa*). Shrubs provide a microhabitat for warm season grasses and herptiles. Natural habitat of this area also has been adversely impacted by cattle grazing.

3.2.3.1 Section 31W

Dominate soil types associated with Section 31W were desert pavement (2.2%) and sandy loamy soil (36.3%). Dominant shrub species included Tarbush (*Flourensia cernua*, 5.9%), Broom

Snakeweed (*Gutierezia sarothrae*, 5.6%), Creosotebush (*Larrea tridentata*, 10.6%), and Honey Mesquite (*Prosopis glandulosa*, 3.1%); whereas the most abundant species of grasses were Fluff Grass (*Erioneuron pulchellum*, 8.4) and Alkali Sacaton (*Sporobolus airoides*, 27.8%).

No Threatened, Endangered, or Sensitive species of plants were observed in the area surveyed.

3.2.3.2 Section 32W

The dominate soil type associated with Section 32W was sandy/loamy soil (60.9%). Dominant shrub species were Tarbush (*Flourensia cernua*, 10.0%), Creosotebush (*Larrea tridentata*, 6.3%), Russian Thistle (*Salsola kali*, 5.6%), Lotebush (*Ziziphus obtusifolia*, 1.9%); and the most abundant species of grasses were Fluff Grass (*Erioneuron pulchellum*, 10.6%) and Alkali Sacaton (*Sporobolus airoides*, 4.7%).

Ball cacti (*Coryphantha vivipara*) were observed growing on slopes with limestone gravel. This cactus was not in bloom and the subspecies was not positively identified. However, two subspecies - *C.v.* var. *bisbeeana* and *C.v.* var. *radiosa* are on the State of New Mexico "Plant Taxa Considered, But Not Included," L4.

3.2.3.3 Section 5

The dominate soil type associated with Section 5 was sandy loam soil (41.3%). Dominant shrub species included Mormon-tea (*Ephedra trifurca*, 7.5%), Tarbush (*Flourensia cernua*, 70.0%), Broom Snakeweed (*Gutierezia sarothrae*, 23.8%), Creosotebush (*Larrea tridentata*, 40.0%), Desert Christmas cactus (*Opuntia leptocaulis*, 5.0%), Honey Mesquite (*Prosopis glandulosa*, 8.8%), Soaptree Yucca (*Yucca elata*, 5.0%), and Lotebush (*Ziziphus obtusifolia*, 21.3%). The most common grasses were Fluff Grass (*Erioneuron pulchellum*, 10.0%) and Alkali Sacaton (*Sporobolus airoides*, 43.8%).

No Threatened, Endangered, or Sensitive species of plants were observed in the area surveyed.

3.2.3.4 Section 6

The dominate soil type associated with Section 6 was sandy loam (28.4%). Dominant shrub species included Tarbush (*Flourensia cernua*, 5.0%), Creosotebush (*Larrea tridentata*, 11.9%), Honey Mesquite (*Prosopis glandulosa*, 12.5%), Littleleaf Sumac (*Rhus microphylla*, 2.5%), Night Shade (*Solanum eleagnifolium*, 3.1%), Narrow Leaf Globemallow (*Sphaeralcea angustifolia*, 3.8%), Western Pink Verbena (*Verbena ambrosifollia*, 2.2%), and Lotebush (*Ziziphus obtusifolia*, and 2.5%). The most common species of grasses were Fluff Grass (*Erioneuron pulchellum*, 12.5%), Tobosa Grass (*Hilaria mutica*, 1.6%), and Alkali Sacaton (*Sporobolus airoides*, 14.1%).

<u>No Threatened, Endangered, or Sensitive species of plants were observed in the area surveyed</u>.

3.2.4 Sections 23 and 26

Sections 23 and 26 encompass the **700 Area** (High Energy Blast Facility, Landfill, Open Burn/Open Detonation Unit) and the 40 acre Second TDRSS Ground Terminal (STFT), located approximately 4.8 km (3 mi) north of the main WSTF gate-- TDRSS is the GSFC Tracking and Data Relay Satellite Station; whereas GSFC is the Goddard Space Flight Center. The northern one half of Section 23 boarders the Jornada Experimental Range and associated access roads.

3.2.4.1 Section 23

The dominant soil type associated with Section 23 was sandy gravel (45.0%). Dominant shrub species included Louisiana White Sage (*Artemisia ludoviciana*, 2.5%), Four-wing Saltbush (*Atriplex canescens*, 1.3%), Feather Plume (*Dalea formosa*, 2.5%), Broom Snakeweed (*Gutierezia sarothrae*, 8.8%), Curlycup Gumweed (*Grindelia squarrosa*, 1.3%), Creosotebush (*Larrea tridentata*, 13.1%), Purple Prickly Pear (*Opuntia violaceae*, 1.3%), Desert Holly (*Perezia nana*, 2.2%), Paperflower (*Psilostrophe tagetna*, 0.6%), Honey Mesquite (*Prosopis glandulosa*, 2.5%), and Banana Yucca (*Yucca baccata*, 1.6%). The most common species of grasses were Fluff Grass (*Erioneuron pulchellum*, 13.4%), Bush Muhly (*Muhlenbergia porteri*, 1.9%), and Alkali Sacaton (*Sporobolus airoides*, 2.2%).

No Threatened, Endangered, or Sensitive species of plants were observed in the area surveyed.

3.2.4.2 Section 26

Section 26 is mostly flat to the west, but to the east there is a series of rolling hills near the 400 Area. Numerous arroyos are hidden from sight within the low profile of the topography. Bear Creek drains into this area providing enough flow during heavy floods to create deeply entrenched arroyos. Topography slopes gently upwards to the San Andres Mountains. A sewage treatment lagoon west of the STFT security gate provides water for wildlife. Banks of the lagoon lack vegetation, however a few plant species were starting to grow. Most sprouts were common roadside weeds such as Russian Thistle (*Salsola australis*) and one Rush-like sprout (*Juncus* sp.).

The dominate soil types associated with Section 26 were desert pavement/gravel (5.0%), limestone cobble (1.6%), and sand (1.9%). The more heterogeneous soils were a reflection of the proximity to better drained upland topography at the eastern boundary of Section 26 and the western boundary of Section 25. Increased topographic relief also affected greater plant species richness. Dominant species of shrubs were Louisiana White Sage (*Artemisia ludoviciana*, 2.8%), Desert Willow (*Chilopsis linearis*, 2.2%), Feather Plume (*Dalea formosa*, 1.9%), Turk's Cap (*Echinocactus horizonthalonius*, 0.6%), Mormon-tea (*Ephedra trifurca*, 0.9%), Tarbush (*Flourensia cernua*, 2.5%), Ocotillo (*Fouquieria splendens*, 0.6%), Broom Snakeweed (*Gutierezia sarothrae*, 2.5%), Curlycup Gumweed (*Grindelia squarrosa*, 6.3%), Creosotebush (*Larrea tridentata*, 8.1%), Purple Prickly Pear (*Opuntia violaceae*, 2.8%), Desert Holly (*Perezia nana*, 0.9%), Paperflower (*Psilostrophe tagetna*, 7.5%), Honey Mesquite (*Prosopis glandulosa*, 3.8%), Twist Flower (*Streptanthus arizonicus*, 0.3%), Banana Yucca (*Yucca baccata*, 0.9%), and Soaptree Yucca (*Yucca elata*, 0.6%). The most abundant species of grasses were Fluff Grass (*Erioneuron pulchellum*, 9.4%), Bush Muhly (*Muhlenbergia porteri*, 2.8%), Alkali Sacaton (*Sporobolus airoides*, 1.6%), and Purple Three Awn (*Aristida purpurea*, 0.6%).

Two specimens of the Night-blooming Cereus (*Peniocereus greggii* var. *greggii*) were observed on the east side of the Landfill, approximately 1.3 km (2 mi) west of Bear Canyon (Figure 3) at an elevation of 1,600 m (5,250 ft). One specimen was located along a utility access road in the shade of a Creosotebush (*Larrea tridentata*), and within the alluvial fan of Bear Canyon. The other specimen was located approximately 300 m (1,000 ft) north of the first specimen. This specimen was located during a spring 1996 rare plant survey. This second cactus was growing under the canopy of a Creosotebush, and smaller than the first cactus. *P. g. var. greggii* is a State Endangered and Federal Candidate species.

3.2.5 Section 25

The southern one-half of Section 25 was surveyed in conjunction with Sections 30E and 36. Section 25 encompasses the largest area of arroyo habitat associated with the mouth of the Bear Creek and its westward drainage. Virtually the entire topographic aspect of Section 25 has a southern exposure, which is vividly reflected in its plant species composition. Dominate soil types were desert pavement/gravel (5.0%), limestone cobble (1.6%), and sand (1.9%). Dominant species of shrubs were Louisiana White Sage (*Artemisia ludoviciana*, 2.8%), Desert Willow (*Chilopsis linearis*, 2.2%), Feather Plume (*Dalea formosa*, 1.9%), Turk's Cap (*Echinocactus horizonthalonius*, 0.6%), Mormon-tea (*Ephedra trifurca*, 0.9%), Tarbush (*Flourensia cernua*, 2.5%), Ocotillo (*Fouquieria splendens*, 0.6%), Broom Snakeweed (*Gutierezia sarothrae*, 2.5%), Curlycup Gumweed (*Grindelia squarrosa*, 6.3%), Creosotebush (*Larrea tridentata*, 8.1%), Purple Prickly Pear (*Opuntia violaceae*, 2.8%), Desert Holly (*Perezia nana*, 0.9%), Paperflower (*Psilostrophe tagetna*, 7.5%), Honey Mesquite (*Prosopis glandulosa*, 3.8%), Twist Flower (*Streptanthus arizonicus*, 0.3%), Banana Yucca (*Yucca baccata*, 0.9%), and Soaptree Yucca (*Yucca elata*, 0.6%). Common grasses were Fluff Grass (*Erioneuron pulchellum*, 9.4%), Bush Muhly (*Muhlenbergia porteri*, 2.8%), Alkali Sacaton (*Sporobolus airoides*, 1.6%), and Purple Three Awn (*Aristida purpurea*, 0.6%).

In addition, several Zephyr Lilies (*Zephryanthus longifolia*) were observed scattered throughout the section, flowering in sandy arroyos. This species is a State List 4 plant and is not protected (Appendix C).

3.2.6 Section 27

Section 27 lies west and adjacent to Section 26. Topography is mostly flat with numerous arroyos hidden below the line of sight. Dominate soil types associated with Section 27 includes boulders

(1.3%), gravel (22.5%), desert pavement (1.3%), sandy loam (4.7%), sandy gravel (33.8%), and arroyo cobble (2.2%). Dominant shrub species included Louisiana White Sage (*Artemisia ludoviciana*, 2.5%), Desert Willow (*Chilopsis linearis*, 2.5%), Tarbush (*Flourensia cernua*, 1.3%), Broom Snakeweed (*Gutierezia sarothrae*, 1.9%), Curlycup Gumweed (*Grindelia squarrosa*, 1.3%), Creosotebush (*Larrea tridentata*, 12.8%), Desert Holly (*Perezia nana*, 1.3%), Paperflower (*Psilostrophe tagetna*, 1.3%), and Honey Mesquite (*Prosopis glandulosa*, 1.3%). The most common species of grass was Fluff Grass (*Erioneuron pulchellum*, 8.4%). An archeological survey of this area was conducted in Section 27 and adjacent Section 3 (Miller and Stuart, 1991).

<u>No Threatened, Endangered, or Sensitive species of plants were observed in the area surveyed</u>.

3.2.7 Section 30E

Section 30E contains the Love Ranch site and lies along the northern fork of Bear Creek at the mouth of the Bear Creek canyon. Section 30E consists predominantly of topography associated with more xeric southern exposures. Dominate soil types were boulders (1.3%) and rocky habitat (31.9%). Dominant shrub species included White Thorn (*Acacia constricta*, 4.7%), Louisiana White Sage (*Artemisia ludoviciana*, 1.9%), Wooly Lipfern (*Cheilanthes tomentosa*, 0.6%), Sotol (*Dasylirion wheeleri*, 2.5%), Feather Plume (*Dalea formosa*, 8.8%), Mormon-tea (*Ephedra trifurca*, 2.2%), Tarbush (*Flourensia cernua*, 5.0%), Ocotillo (*Fouquieria splendens*, 3.4%), Broom Snakeweed (*Gutierezia sarothrae*, 5.0%), and Purple Prickly Pear (*Opuntia violaceae*, 2.5%). The most common species of grasses were Tobosa Grass (*Hilaria mutica*, 2.8%) and Alkali Sacaton (*Sporobolus airoides*, 27.5%).

Numerous individuals of the White-flowering Visnagita (*Neolloydia intertexta* var. *dasyacantha*) cactus were observed scattered on limestone hillsides (Figure 3). This species was listed was a State Endangered (L1C) plant, however, in 1995 it was delist to "Plant Taxa Considered, But Not Included [Status L4-1]. These cacti were associated with dropseed grasses (*Sporobolus* spp.).

3.2.8 Section 31E

Section 31E represents the most highly diverse ecological zone, containing large segments of arroyo topography and vegetation, northern mesic and xeric southern uplands and associated plant communities. Section 31E lies directly south of Section 30E, and includes the west draining mouth of the Bear Creek canyon at the northern-most extension of Quartzite Mountain. Bear Creek is the largest canyon draining the WSTF site. Bear Creek cuts through the San Andres Mountains and is characterized by small limestone, siltstone, and sandstone hills. Smaller tributaries originate within these hills and flow into the valley bottom. Lower elevations, closer to the creek, contain both low and high west gravel ridges. Immediately adjacent to Bear Creek are broad, alluvial terraces or benches that widen near the mouth of the canyon. Slopes in this mountain zone range from 8 to 50 percent and elevation ranges from 1,640 to 1,797 m (5,000 - 5,480 ft) (Kauffman and Wright, 1987; Kauffman and Howell. 1987; and Stuart, 1988).

Dominant soil types consisted of a combination of limestone cobble (talus, 14.1%), rock (limestone bedrock, 20.9%), and sand (2.5%). The predominant species of shrubs were Agave (*Agave palmeri*, 2.5%), Louisiana White Sage (*Artemisia ludoviciana*, 2.5%), California Brickel Bush (*Brickelia californica*, 1.3%), Two-leaf Sena (*Cassia bauhiniodes*, 4.7%), Mountain Mahogany (*Cerocarpus montanus*, 1.3%), Sotol (*Dasylirion wheeleri*, 2.5%), Feather Plume (*Dalea formosa*, 7.2%), Turk's Cap (*Echinocactus horizonthalonius*, 1.3%), Tarbush (*Flourensia cernua*, 3.4%), Ocotillo (*Fouquieria splendens*, 3.8%), Broom Snakeweed (*Gutierezia sarothrae*, 2.5%), Creosotebush (*Larrea tridentata*, 5.6%), Desert Four O'clock (*Mirabilis multiflora*, 1.3%), Beargrass (*Nolina microcarpa*, 2.5%), Pancake Prickly Pear (*Opuntia phaeacantha*, 1.3%), Purple Prickly Pear (*Opuntia violaceae*, 0.9%), Honey Mesquite (*Prosopis glandulosa*, 2.5%), Squaw Bush (*Rhus trilobata*, 1.3%), and Banana Yucca (*Yucca baccata*, 1.9%). The most common species of grasses were Six Weeks Grass (*Bouteloua barbata*, 1.9%) and Alkali Sacaton (*Sporobolus airoides*, 10.6%).

In addition, White-flowering Visnagita (*Neolloydia intertexta* var. *dasyacantha*), State of New Mexico "Plant Taxa Considered, But Not Included" (L4-1) was observed in this section (Figure 3). Most individual plants were observed on the lower northeast facing slope of Quartzite Mountain in limestone soil, associated with Alkali Sacaton (*Sporobolus airoides*).

This area was surveyed again during the spring 1996 in attempts to identify threatened or endangered plant species that flower in the spring. No new taxa of were observed during this survey. Growth or flowering of annual plants was suppressed due to drought-like conditions.

No Threatened, Endangered, or Sensitive species of plants were observed in the area surveyed.

3.2.9 Section 25

Section 25 is composed of several short hills that roll west out of the mouth of Bear Creek. These hills are oriented in a north-south pattern parallel to the San Andres Mountains. This area is a transition zone between the valley and Bear Canyon. Dominate soil type was sandy/gravel (21.9%) and rock (limestone bedrock, 8.8%). Dominant shrub species included Sotol (*Dasylirion wheeleri*, 1.9%), Feather Plume (*Dalea formosa*, 8.8%), Tarbush (*Flourensia cernua*, 2.5%), Broom Snakeweed (*Gutierezia sarothrae*, 2.5%), Curlycup Gumweed (*Grindelia squarrosa*, 8.8%), Creosotebush (*Larrea tridentata*, 5.0%), and Night Shade (*Solanum eleagnifolium*, 2.5%). The most common species of grasses were Alkali Sacaton (*Sporobolus airoides*, 25.0%) and Fluff Grass (*Erioneuron pulchellum*, 12.5%).

No Threatened, Endangered, or Sensitive species of plants were observed in the area surveyed.

3.2.10 Section 35

Section 35 includes part of the **200 Area, 272 Area, 800 Area,** and all of the **400 Area.** Facility structures for the **200** and **272** areas, and **800 Area** on the east side of NASA road. The **200** and **800 areas** are separated from the **272 Area** by Gardner Springs Arroyo, which drains in a southern direction parallel with Quartzite Mountain. Along both sides of NASA Road are drainage ditches. These ditches harbor a dense and lush population of common roadside weeds, and plants that grow in disturbed areas.

3.2.10.1 400 Area

The **400 Area** is the propulsion test area, which is directly across from **200 Area** and west of NASA Road. This area is used for the performance of cold flow and hot firing static testing of propulsion system. Facility structures include two vertical down-firing altitude simulation and one vertical down-firing atmospheric static test stands; two test stand support buildings, a control building and miscellaneous support facilities (Condon et al., 1980).

The **400 area** gently slopes towards the Second TDRSS access road. Other than a major arroyo draining in the northwest exposure, the topography of this region is generally flat. White Thorn Acacia (*Acacia constricta*) was the predominate shrub on west facing arroyos, whereas short, weather beaten Creosotebush (*Larrea tridentata*) was more common on the flats. Dominate soil types were boulders (0.6%), desert pavement/gravel (10.6%), sandy/loamy soil (7.5%), sandy/gravel (14.1%), and wood (0.3%). Dominant species of shrubs were White Thorn(*Acacia constricta*, 1.9%), Louisiana White Sage (*Artemisia ludoviciana*, 2.2%), Feather Plume (*Dalea formosa*, 4.1%), dead forb (spp., 0.6%), Tarbush (*Flourensia cernua*, 2.5%), Broom Snakeweed (*Gutierezia sarothrae*, 2.2%), Curlycup Gumweed (*Grindelia squarrosa*, 20.3%), Creosotebush (*Larrea tridentata*, 7.2%), Pancake Prickly Pear (*Opuntia phaeacantha*, 1.9%), Mariola (*Parthenium incanum*, 1.3%), Paperflower (*Psilostrophe tagetna*, 0.6%), Honey Mesquite (*Prosopis glandulosa*, 2.5%), and Lotebush (*Ziziphus obtusifolia*, 1.6%). Common grasses were Alkali Sacaton (*Sporobolus airoides*, 7.2%) and Fluff Grass (*Erioneuron pulchellum*, 10.9).

A few scattered White-flowered Visnagita (*Neolloydia intertexta* var. *dasyacantha*) were observed on the northeastern side of the **400 Area** along the facility fence line (Figure 3).

3.2.11 Section 36

Section 36 includes part of the **200, 272, 300, 500,** and **800** areas. Facility structures for the **200, 272,** and **800** areas in Section 35. Facility structures for the 300 and 500 areas are in Section 36. This Section is located on the western side of Quartzite Mountain. Topography is mostly flat with a gradual slope upward toward the base of Quartzite Mountain. A small limestone ridge separates the firebreak from the facilities. The ridge top is dominated by a line of Ocotillo

(*Fouquieria splendens*), hence the local name of "Ocotillo Ridge." Gardner Springs Arroyo separates Ocotillo Ridge from facility structures. This arroyo begins shortly south of Bear Canyon and flows south in the direction of Highway 70. Southeast of the 800 Area is Gardner Spring, which is approximately 0.6 km northeast of Quartzite Mountain. In 1990 an archaeological survey in this area was conducted by Batcho and Kauffman Associates (Almarez, 1990).

A small population of Zephyr Lily (*Zephryanthes longifolia*) was observed on Ocotillo Ridge; and several individuals of the White-flowering Visnagita (*Neolloydia intertexta* var. *dasyacantha*) were observed in the **800 Area** (Figure 5).

3.2.11.1 200 Area

The **200 Area** contains a set a general laboratories, data reduction, analysis facilities and modification, checkout and preparation facilities for propulsion system testing. This area has a dominate soil type of sandy/gravel (21.9%) and rock (limestone bedrock, 8.8%). Dominant shrub species in this area included Sotol (*Dasylirion wheeleri*, 1.9%), Feather Plume (*Dalea formosa*, 8.8%), Tarbush (*Flourensia cernua*, 2.5%), Broom Snakeweed (*Gutierezia sarothrae*, 2.5%), Curlycup Gumweed (*Grindelia squarrosa*, 8.8%), Creosotebush (*Larrea tridentata*, 5.0%), and Night Shade (*Solanum eleagnifolium*, 2.5%). The most common species of grasses were Alkali Sacaton (*Sporobolus airoides*, 25.0%) and Fluff Grass (*Erioneuron pulchellum*, 12.5%).

No Threatened, Endangered, or Sensitive species of plants were observed in the area surveyed.

3.2.11.2 300 Area

The **300 Area** is a propulsion test area. It accommodates cold flow and hot firing static testing of propulsion systems. Facilities in the area include: atmospheric, down-firing static test stand, an altitude simulation down-firing test stand, a below grade structure for instrumentation and control signal conditioning equipment, a test center, a remote command building and miscellaneous support facilities (Condon et al., 1980). Dominate soil type was sandy/loamy soil (15.9%), desert pavement/gravel (14.4%), and rock (limestone bedrock, 1.9%). Dominant shrub species included Louisiana White Sage (*Artemisia ludoviciana*, 2.2%), Feather Plume (*Dalea formosa*, 1.9%), dead forb (spp.,0.6%), Tarbush (*Flourensia cernua*, 2.8%), Broom Snakeweed

(*Gutierezia sarothrae*, 1.3%), Curlycup Gumweed (*Grindelia squarrosa*, 15.0%), All Thorn (*Koeberlinia spinosa*, 0.6%), Stickseed (*Lappula redowskii*, 0.6%), Creosotebush (*Larrea tridentata*, 10.6%), Purple Prickly Pear (*Opuntia violaceae*, 1.6%), Paperflower (*Psilostrophe tagetna*, 1.5%), Honey Mesquite (*Prosopis glandulosa*, 1.3%), Littleleaf Sumac (*Rhus microphylla*, 1.6%), Western Pink Verbena (*Verbena ambrosifollia*, 1.3%), Banana Yucca (*Yucca baccata*, 1.6%), Soaptree Yucca (*Yucca elata*, 1.6%), and Lotebush (*Ziziphus obtusifolia*, 1.3%). Common grasses included Fluff Grass (*Erioneuron pulchellum*, 5.6%), and Alkali Sacaton (*Sporobolus airoides*, 14.1%), and Purple Three Awn (Aristida purpurea, 0.6%).

<u>No Threatened, Endangered, or Sensitive species of plants were observed in the area surveyed</u>.

3.2.11.3 800 Area

The **800 Area** is a material test area. This facility is used to test a wide variety of materials for ignition and combustion under various temperatures and pressure, and in various liquids and gaseous atmosphere (Condon et al., 1980). The dominate substrates in the **800 Area** were: boulders (8.8%), sandy/loamy soil (25.0%), sandy/gravel (52.5%), and Rock (limestone bedrock, 6.3%). Vegetation composition is Louisiana White Sage (*Artemisia ludoviciana*, 12.5%), Four-wing Saltbush (*Atriplex canescens*, 6.3%), Sotol (*Dasylirion wheeleri*, 6.3%), Feather Plume (*Dalea formosa*, 18.8%), New Mexico Rainbow Cactus (*Echinocereus viridiflours*, 6.3%), Tarbush (*Flourensia cernua*, 31.3%), Broom Snakeweed (*Gutierezia sarothrae*, 18.8%), Curlycup Gumweed (*Grindelia squarrosa*, 25.0%), Creosotebush (*Larrea tridentata*, 43.8%), Bush Muhly (*Muhlenbergia porteri*, 6.3%), Honey Mesquite (*Prosopis glandulosa*, 12.5%), and Littleleaf Sumac (*Rhus microphylla*, 6.3%). The most common species of grasses were Side-Oats Grama Grass (*Bouteloua curtipendula*, 10.0%), Fluff Grass (*Erioneuron pulchellum*, 56.3%), and Alkali Sacaton (*Sporobolus airoides*, 56.3%).

One individual Zephyr Lily (*Zephryanthes longifolia*) was observed on top of Ocotillo Ridge (Figure 3). Several White-flowered Visnagita (*Neolloydia intertexta* var. *dasyacantha*) were observed within a half mile radius from the **800 Area**, on the up slope toward Quartzite Mountain. Individuals were sparse within the area; they were found in associated with Alkaline Sacaton (*Sporobolus airoides*), Creosotebush (*Larrea tridentata*), and limestone soil.

4 SPECIFIC SURVEYS FOR WILDLIFE

4.1 MAMMALS

Mammalian species richness was naturally high throughout the study area, depending upon local topography and vegetation complexity. This pattern of species richness was associated primarily with significant topographic relief (e.g., rock outcrops, cliffs, etc.), vegetation and ecotonal diversity, and the abundance of large arroyos, which are often obscured in lowland flat areas. North- and east-facing slopes of the San Andres Mountains in the vicinity of Bear Creek canyon and the Love Ranch provide abundant local mesic microclimates for numerous species of plants and invertebrate animals, including sensitive species of terrestrial snails. In contrast, well drained limestone soils and rock outcrops found on south- and west-facing slopes in the same general area harbor a distinctly arid Chihuahuan desertscrub plant community.

The most common species of mammals included the Desert Cottontail (*Sylvilagus auduboni*, 34%, of the total number of mammals observed [n = 548]), Blacktailed Jackrabbit (*Lepus californicus*, 20%), White-throated Woodrat (*Neotoma albigula*, 16%), Mule Deer (16%), and the Banner-tailed Kangaroo Rat (*Dipodomys spectablis*, 7%) (Appendix E). Blacktailed Jackrabbits were especially abundant throughout Creosotebush (*Larrea tridentata*) scrub habitat, whereas cottontails were primarily restricted to brushy low lying areas along the roadways and sandy Honey Mesquite (*Prosopis glandulosa*) thickets or hummocks. Mule Deer (*Odocoileus hemionus*) were particularly abundant throughout the entire survey area, as evidenced by numerous sightings of live animals, bones, and antler castings in arroyos and near artificial watering areas. Numerous individual Coyotes (*Canus latrans*) were observed throughout the entire survey area, along with tracks and scat. Several individual Gray Fox (*Urocyon cinereoargenteus*) were observed, along with abundant scat and tracks, primarily at low elevations (Appendix E).

4.2 BIRDS

The most common species of birds observed in the WSTF site were the Black-throated Sparrow (*Amphispiza bilineata*, 21%, n= 428 total birds observed), Mourning Dove (*Zenaida macroura*, 13.5, Northern Mockingbird (*Mimus polyglottos*, 7%), White-winged Dove (*Zenaida asiatica*, 6%), and the Western Kingbird (*Tyrannus vociferans*, 5%) (Appendix E).

4.3 REPTILES

The largest densities of reptiles occurred in desert grassland and scrub habitat associated with Section 1 (19% of the total number of individuals observed, n=503), Section 36 (17%), Section 12 (9.3%), Section 11 (8%), and Section 32W (8%) (Appendix E). The most common species of herptiles was the Side-blotched Lizard (*Uta stansburiana*, n=133 individuals observed) followed by the Grassland Whiptail (*Cnemidophorus uniparens*, n=94), Western Whiptail (*Cnemidophorus tigris*, n=89), and Checkered Whiptail (*Cnemidophorus tesselatus*, n=43) (Appendix E).

Four specimens of the Texas Horned Lizard *(Phrynosoma cornutum)* were found in Section 1 (n=2) and Section 36 (n=2). This species is a Federal Candidate species. Currently, this species has no State of New Mexico status; however, all species of horned lizards are protected. In New Mexico specific permits are required to collect these animals. The Texas Horned Lizard is common in desert areas throughout southern and central New Mexico. These horned lizards live in shrubland, desert grassland, and associated juniper woodland. They feed mostly on ants, and occur in areas where ants, particularly seed harvester ants belonging to the genus *Pogonomyrmex*, are abundant.

Twelve specimens of the Short-horned Lizard *(Phrynosoma douglassi)* also were found. This species appears abundant and widespread in desert grassland and shrubland habitat (Appendix E), particularly at low elevations. Currently this species has no Federal or State of New Mexico status.

4.4 AMPHIBIANS

Because of the lack of ponds, streams, and wetland habitat, the number of species of amphibians was low. Man-made watering areas associated with Section 25 and 26 (Water Tower and the 200 Area), and Section 2 (Sewage Lagoons [Nos. 640 and 136; Figure 3]) provide extremely limited access to perennial free water for amphibians. A large earthen tank (Section 31W) used for watering cattle contain 1000's of western spadefoot tadpoles. Several species of amphibians that potentially may occur in temporary rain pools in the project area include the Tiger Salamander (*Ambystoma tigrinum*), Woodhouse Toad (*Bufo woodhousei*), Great Plains Toad (*Bufo cognatus*), and Red-spotted Toad (*Bufo punctatus*).

5 LISTED SPECIES OF PLANTS AND ANIMALS

From information collected by the PSL biologic team, NASA's White Sands Test Facility has the potential to support 36 species of plants and 39 species of animals, which are listed as Threatened, Endangered, or Sensitive by various Federal or State of New Mexico resource agencies (Appendix A and B). These lists were compiled after extensive biologic field surveys of the nearby Southwest Regional Spaceport site by PSL staff biologists/botanists (Sullivan and Nethers, 1995), and after consultation with appropriate resource agencies (e.g., New Mexico State University Agricultural Experimental Station [Jornada Range], U.S. Fish and Wildlife Service (USFWS), White Sands Missile Range (WSMR), and the New Mexico Division of Forestry (NMDF). Appendix C provides criteria for listing plant and animal species of special concern by the State of New Mexico and Federal resource agencies.

Note: Our definition of the term "sensitivity" is not intended as a NEPA term or as having a NEPA equivalent term "sensitive resources" (see §§10 CFR 1021.410(b)(1)(iii) and (b)(2) of the proposed bill as condition b.(4) in the final rule--pg. 15133, Part II Department of Energy). Instead and herein, sensitivity refers to a term developed specifically by us to indicate the susceptibility of a species or area to future human-induced degradation. Future actions within a sensitive area, as defined above, may or may not affect sensitive resources (i.e. NEPA term) found within or outside the designated study area.

5.1 LISTED SPECIES—PLANTS

The WSTF property provides habitat for a variety of native species of plants. Appendix D.1-D.3 provides a list of plant species observed during the biological survey. Of 36 plant species of special concern potentially occurring throughout Doña Ana County, New Mexico, 5 taxa (7.2%)

were documented within the primary study area. These taxa included: Ball Cactus (*Coryphantha vivipara*- no Federal status; State of New Mexico "Plant Taxa Considered, But Not Included", L4); Barrel Cactus (*Ferocactus wislizenii*-no Federal status; State of New Mexico, "Plant Taxa Considered, But Not Included," L4); Night-blooming Cereus (*Peniocereus greggii* var. *greggii*—Federal status [C]; State of New Mexico Endangered [Status L1C, R-E-D Code: 1-3-1]); White-flowered Visnagita (*Neolloydia intertexta* var. *dasyacantha*—no Federal status; delisted in 1995 from State of New Mexico Endangered to "Plant Taxa Considered, But Not Included" [Status L4-1, R-E-D Code: 1-1-1]); and the Zephyr Lily (*Zephyranthes longifolia*—no Federal status; State of New Mexico "Plant Taxa Considered, But Not Included" [Status L4-1).

5.1.1 Ball Cactus [*Coryphantha vivipara* var. *bisneeana* (Orcutt) Benson and *Coryphantha vivipara* var. *radiosa* (Engelm.) Backeb.]

Status: Federal (None); State of New Mexico "Considered but not included" (Status L4).

Habitat: Chihuahuan Desert Scrub: Hot, dry plains with widely scattered shrubs typically of Honey Mesquite (*Prosopis glandulosa*), and various species of yucca (*Yucca* spp.) with warm season grasses, forbs and cacti in shrub interspaces. Range extends from Arizona east through New Mexico.

Sensitivity: Low (relatively common; three sections, 1, 2, and 32W were documented harboring individuals)

Additional Information: Several varieties occur through out the southwestern United States. Flowers of these varieties are the distinguishing characteristics.

5.1.2 Barrel Cactus [*Ferocactus wislizenii* (Engelm) Britt. & Rose]

Status: Federal (None); State of New Mexico "Considered but not included" (Status L4).

Habitat: Chihuahuan Desert Scrub: Hot, dry plains with widely scattered shrubs typically of Honey Mesquite (*Prosopis glandulosa*), and various species of yucca (*Yucca* spp.) with warm season grasses, forbs and cacti in shrub interspaces. Range extends from Arizona east through southern New Mexico into El Paso County, Texas.

Sensitivity: Low (relatively common; eight individual were documented in Section 1, 2, 12, 23, 25, 27, 30E, and 36.)

Additional Information: Commonly occurs on slight slopes with rocky soil providing good drainage. Largest cactus in our area, truly resembling a barrel. Once used for food and making candy. Now becoming rare due to over collection and slow regeneration.

5.1.3 Night-blooming Cereus (*Peniocereus greggii* (Engelm) Britt & Rose var. *greggii*)

Status: Federal (C); State of New Mexico Endangered (Status L1C, R-E-D Code: 1-3-1).

Habitat: Chihuahuan Desert Scrub: Hot, dry plains with widely scattered shrubs typically of Cresote bush (*Larrea tridentata*), Tarbush (*Flourensia cernua*), Honey Mesquite (*Prosopis glandulosa*), and various species of yucca (*Yucca* spp.) with warm season grasses, forbs and cacti in shrub interspaces. Widespread throughout southern New Mexico, usually at elevations below 1,524 m (5,000 ft).

Sensitivity: High (rare; two individual were discovered in Section 26 adjacent [15 m] to the eastern boundary of the Landfill. One was within about 0.3 m [1ft] of an existing dirt road and the other was about 300 m [1,000 ft] to the north; many historical populations of this cactus have already been extirpated by collection [Sivinski and Lightfoot 1994]).

Additional Information: Night-blooming Cereus is a species that inhabits slopes and alluvial fans ranging from 1,200 to 1,600 m (3,937-5,240 ft). Typically it is associated with a nursery plant such as Creosotebush (*Larrea tridentata*). Many historical populations of this unique cactus have been extirpated by collection. Populations vary from a solitary individual to several specimens. This cactus has slender erect stems that are usually dark in color with 3 to 6 vary string ribs. Along the edge of each rib is a short (1/8-1/4 inch) spine. The fruit is a bright red, ovoid in shape with a beaked tip. The root is a potato like tuber that can weigh 5-15 lbs. The flower is typically pink to white, short-lived, and blooms only at night.

5.1.4 White-flowered Visnagita (*Neolloydia intertexta* var. *dasyacantha* (Engelm.) L. Benson)

Status: Federal (None); delisted in 1995 from State of New Mexico Endangered (Status L1C, R-E-D Code: 1-1-1) to State of New Mexico "Plant Of Considered, But Not Included" (Status L4-1, R-E-D Code: 1-1-1).

Habitat: Chihuahuan Desert Scrub: Hot, dry plains with widely scattered shrubs typically of Creosotebush (*Larria tridentata*), Tarbush (*Flourensia cernua*), Honey Mesquite (*Prosopis *glandulosa*), acacia (*Acacia* spp.), various species of yucca, warm season grasses, forbs, and cacti in shrub interspaces. Widespread throughout southern New Mexico, usually at elevations below 1,524 m (5,000 ft). Semidesert Grasslands: Hot, dry plains of warm season grasses such as grama (*Bouteloua* spp.), dropseed (*Sporobolus* spp.), Tobosa Grass (*Hilaria mutica*), and Burro Grass (*Scleropogon brevifolius*). Mesquite and Soaptree Yucca (*Yucca elata*) also occur and may become dominant when continuously grazed by livestock.

Sensitivity: Moderate (locally abundant; scattered on limestone slopes throughout the WSTF area [Sections 30E and 31E]; however the majority of individuals observed were in areas that would not be affected by normal activities).

Additional: This cactus is much more abundant and less threatened then suspected when listed. It has been delisted from the state endangered species list (Sivinski and Lightfoot, 1995). Now this cactus is a List 4 species. This species is not protected by the New Mexico Endangered Plant Species Act (9-10-10 NMSA). White-flowered Visnagita inhabits grassy limestone slopes at elevations from about 1200 to 1600 m (3937-5240 ft), and within juniper and piñon-juniper woodland. It is a rounded columnar medium sized cactus that normally has a solitary stem densely covered with interwoven spines. It usually ranges from 2.5 to 18 cm (1-7 inches) tall, but specimens > 0.4 m (1 ft) in height have been recorded (Sullivan and Smartt, 1994). It normally has 3 or 4 pinkish central spines and from about 16 to 25 radial spines per areole. Each of these spines can range from 1 to 1.5 cm (0.4-0.6 inches) long. Its white to pale pink flowers open in April with a small greenish-tan fruit appearing in late spring and often persisting into early summer. The *N. intertexta* normally occurs on coarse soils or rocky slopes, often on soils derived from rhyolite or volcanic materials.

5.1.5 Zephyr Lily (*Zephyranthes longifolia* Hemsl)

Status: Federal (None); State of New Mexico (L4-1).

Habitat: Chihuahuan Desert Scrub: Hot, dry plains with widely scattered shrubs typically of Creosotebush (*Larria tridentata*), Tarbush (*Flourensia cernua*), Honey Mesquite (*Prosopis glandulosa*), acacia (*Acacia* spp.), various species of yucca, warm season grasses, forbs, and cacti in shrub interspaces. Widespread throughout southern New Mexico, usually at elevations below 1,524 m (5,000 ft). Semidesert Grasslands: Hot, dry plains of warm season grasses such as grama (*Bouteloua* spp.), dropseed (*Sporobolus* spp.), Tobosa Grass (*Hilaria mutica*), and Burro Grass (*Scleropogon brevifolius*). Mesquite and Soaptree Yucca (*Yucca elata*) also occur and may become dominant when continuously grazed by livestock.

Sensitivity: Low (locally abundant in gravelly arroyos, and on limestone soils with good drainage such as Bear Canyon [sections 25 and 35]).

Additional: List 4 species are those species that were considered for listing but because of one reason or other they were not listed. This species is not protected by the New Mexico Endangered Plant Species Act (9-10-10 NMSA). The Zephyr Lily is a small (6 inch) herbaceous plant that has a large solitary flower. The flower is usually white or tinged with pink. It occurs in gravelly arroyos, and on limestone soils with good drainage. Typically it occurs between 1219 to 1829 m (4000 - 6000 ft). Flowering occurs during the summer monsoon rains.

5.2 LISTED—ANIMALS

The WSTF property provides habitat for a variety of small vertebrates. Appendix E provides a list of animal species observed during the biological survey, as well as those taxa expected to occur at the site, but which were not observed during the 100 percent pedestrian survey. Of 39 animal species of special concern potentially occurring throughout Doña Ana County, New Mexico, 4 taxa (9.7%) were documented within the primary study area. In addition, several additional species that are protected by the State of New Mexico (but not listed) or protected by the Federal Migratory Bird Treaty also were observed; most of these taxa include primarily small- to large-sized raptoral birds species: Coopers Hawk (*Accipiter cooperii*); Golden Eagle (*Aquila chrysaetos*); Koch's Snail (*Ashmunella kochi kochi*); Red-tailed Hawk (*Buteo jamaicensis*); Swainson's Hawk (*Buteo swainsoni*); Turkey Vulture (*Cathartes aura*); Northern Harrier (*Circus cyaneous*); Loggerhead Shrike (*Lanius ludovicianus*); American Kestrel (*Falco sparverius*); Texas Horned Lizard (*Phrynosoma cornutum*); Short-horned Lizard (*Phynosoma douglassi*); and Western Burrowing Owl (*Speotyto cunicularia hypugea*).[2]

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[2] In addition, all wild birds in the United States, except resident game birds (i.e., pheasant, grouse, quail, etc., which are managed by the respective States, and the English sparrow, starling, and feral pigeon) are protected by the Migratory Bird Treaty Act (16 USC 703-711). Although Federal Category 2 Candidate species are not specifically protected under the Endangered Species Act, an increase in threats from habitat destruction could cause them to be proposed for listing before or during construction of future facilities.

5.2.1 Cooper's Hawk (*Accipiter cooperii*)

Status: No Federal status; State of New Mexico (Protected)[3].

Habitat: Wide-ranging and breeds in riparian areas, montane forests, woodland habitat at mid-elevations.

Sensitivity: Low (2 individual birds observed in piñon-juniper habitat associated with the Love Ranch and Bear Canyon areas [sections 30E and 31E; Appendix E]). Sensitivity of this species is considered to be low because: (1) of the small number of birds observed on the property; (2) the general lack of diagnostic habitat for the species except where habitat merges with the mesic upland and canyon habitat of the San Andres Mountains; and (3) low probability of disturbance to the ecology in these areas from ongoing and future testing activity; and (4) the fact that similar test and construction activities in north and south-central New Mexico historically have not resulted in documented adverse affects on the biology, reproduction, or ecology of this species or similar species (Sullivan and Knight, 1994; Sullivan and Smartt, 1991*a*, 1991*b*, 1991*c*, 1994)[4].

5.2.2 Golden Eagle (*Aquila chrysaetos*)

Status: Federal Protected Species; State of New Mexico (Protected).

Habitat: Open and tilted landscapes, Chihuahuan Desert scrub (Creosotebush [*Larrea tridentata*], Tarbush [*Flourensia cernua*], Honey Mesquite [*Prosopis glandulosa*]), desert-grassland-juniper habitat, montane woodland and forests, deeply cut by streams and canyons, and rising to open or sparsely treed mountain slopes and rock crags—all elevations; hunts small

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Further, because the cumulative impacts associated with the proposed construction could include future major development in the area surrounding the proposed corridor, we recommend that all candidate species be included in surveys and project evaluations once full disclosure of land conversion is made public (pers. comm. USFWS, 1995).

[3] All raptors are protected by the State of New Mexico. In addition, the Golden Eagle is a fully Federally protected species under Public Law 93-205 and Title 16 USC, Subchapter II-Protection Of Bald and Golden Eagles Part 668*a* (16 USC §668*a*), which designated the Bald Eagle and Golden Eagle as Threatened or Endangered species.

[4] Also see "Department of the Army White Sands Missile Range Aerial Cable Capability final environmental impact statement. 10 October 1991. 292 pp.

mammals (ground squirrels, prairie dogs, rabbits, hares); high cliff ledges or faces are favored substrates for nest construction, also nests in trees associated with precipitous, rock cliff terrain.

Sensitivity: Low (8 individual birds observed in the primary study area associated with sections 5, 6, 11, 27, and 30E, 31E; [Appendix E]). Sensitivity of this species is considered to be low because: (1) of the relatively small number of birds observed in the project area; (2) the larger area surrounding WSTF also is abundant with the Blacktailed Jackrabbit (*Lepus californicus*) and other small to medium-sized mammalian prey species; (3) low probability of disturbance to existing preferred nesting and roosting habitat (upper elevations of San Andres Mountains) from ongoing and future testing activity; and (4) the observation that similar test and construction activities in north and south-central New Mexico historically have not resulted in documented adverse affects on the biology, reproduction, or ecology of this species or similar species (Sullivan and Knight, 1994; Sullivan and Smartt, 1991*a*, 1991*b*, 1991*c*, 1994).

Additional Information: The Golden Eagle inhabits open tilted landscapes, desert-grassland-juniper habitat, montane woodland and forests, and deeply cut streams and canyons that rise to open or sparsely treed mountain slopes and rock crags. Range of this species covers all elevations in North America. High cliff ledges or faces are favored substrates for nest construction, but in areas where this type of habitat is unavailable they will also construct nests in trees associated with precipitous, rock cliff terrain. This species is commonly observed in the nearby San Andres Mountains.

5.2.3 Koch's Land Snail (*Ashmunella kochi kochi*)

Status: Federal (none); State of New Mexico (Sensitive).

Habitat: Talus slopes at higher, more mesic, elevations within the piñon-juniper woodland macrohabitat; dominant topography consists of rock seams in steep canyons and cliffs; in order of occurrence, dominant plant species were silk-tassel, Gamble's oak, mountain mahogany, one-seed juniper, tree cholla, purple prickly pear, banana yucca, ephedra, beargrass, soto, and cliff rose; 40 percent overstory cover; dominant substrate consisted of igneous and rock; this species of snail is an excellent indicator of natural biodiversity and quality of natural habitat; these populations should be monitored by a qualified biologists.

Sensitivity: Low (numerous individuals observed in talus habitat associated with the northeast exposure of Quartzite Mountain--Section 31E, 6,600 ft; [Appendix E]). Sensitivity of this species is considered to be low because of: (1) the relatively large number of individuals observed in the area; (2) the fossorial nature of the species; and (3) because of the remote location of populations on the WSTF site, which are well away from and potential testing and construction activities.

5.2.4 Red-tailed Hawk (*Buteo jamaicensis*)

Status: Federal (none); State of New Mexico (Protected).

Habitat: Plains, open spaces, deserts, woodlands, riparian areas, sagebrush, forests.

Sensitivity: Low (18 individuals observed soaring above or feeding in the primary project area [sections 2, 5, 6, 27, 30, 31E, 31W] or perched on one of several power-poles along NASA Road [Appendix E]). Sensitivity of this species is considered to be low because of: (1) the relatively large number of birds observed on of the property; (2) the larger area surrounding WSTF also is abundant with the Blacktailed Jackrabbit (*Lepus californicus*) and other small to medium-sized mammalian prey species; (3) low probability of disturbance to individual birds or their preferred habitat from ongoing and future testing activity, and (4) similar test and construction activities in north and south-central New Mexico historically have not resulted in documented adverse affects on the biology, reproduction, or ecology of this species or similar species of raptors (Sullivan and Knight, 1994; Sullivan and Smartt, 1991*a*, 1991*b*, 1991*c*, 1994).

Additional Information: Although *B. jamaicensis* is neither a Federal nor State of New Mexico endangered, or sensitive species, all raptors are fully protected by the State of New Mexico. This species is the most common and wide spread buteo in North America. The Red-tailed Hawk is a bird of both open and wooded areas, particularly wooded edges, and often perch conspicuously on a treetops, a telephone poles, or other lookouts while hunting. Prey species includes mainly rodents but also insects and their larvae, fish, and larger mammals, such as rabbits and squirrels. They often pursue prey into dense brush, pirate prey from other raptors, and eat carrion. At WSTF, this species frequents power poles adjacent to NASA Road, where mortality to hares and rabbits from automobiles is quite high. Presumably this species, along with eagles, benefit from this fresh source of food.

5.2.5 Swainson's Hawk (*Buteo swainsoni*)

Status: Federal (none); State of New Mexico (Protected).

Habitat: Plains, open spaces, deserts, woodlands, riparian areas.

Sensitivity: Low (9 individual birds observed soaring overhead or perched along access roads associated with sections 2, 5, 6, 11, 31W, and 32 [Appendix E]). Sensitivity of this species is considered to be low because of: (1) the relatively large number of birds observed on or in the vicinity of the property; (2) the larger area surrounding WSTF is abundant with the Blacktailed Jackrabbit (*Lepus californicus*) and other small to medium-sized mammalian prey species; (3) low probability of disturbance to individual birds or their preferred habitat from ongoing and future testing activity, and (4) similar test and construction activities in north and south-central New Mexico historically have not resulted in documented adverse affects on the biology, reproduction, or ecology of this species or similar species of raptors (Sullivan and Knight, 1994; Sullivan and Smartt, 1991*a*, 1991*b*, 1991*c*, 1994).

Additional Information: The Swainson's Hawk is neither a Federal nor State of New Mexico endangered, or sensitive species; however, all raptors are fully protected by the State of New Mexico. This species is a common inhabitant of the Great Plains and relatively arid areas of grassland in the West, including plains, open spaces, deserts, woodlands, and riparian areas. It builds flimsy nests in shrubs and trees along wetlands and drainages, and in windbreaks in fields around farmsteads. Prey consists of small mammals, birds, large insects, and reptiles that it hunts primarily from perches such as fence posts, low trees, or from elevated vantage points on the ground. This species moves in response to locally high concentrations of prey more than most other species of raptors.

5.2.6 Turkey Vulture (*Cathartes aura*)

Status: No Federal status; State of New Mexico (Protected).

Habitat: Widely distributed in western North America; inhabits a wide variety of habitats in Southwest.

Sensitivity: Low (35 individual birds observed feeding or soaring overhead in most of the primary study area [Appendix E]). Sensitivity of this species is considered to be low because of: (1) the relatively large number of birds observed in the project area and the ubiquitous nature of the species throughout the Southwest—this species primarily is tied to the area because of the abundance of carrion associated with the cattle grazing industry; and (2) similar construction activities in north and south-central New Mexico historically have not resulted in documented adverse affects on the biology, reproduction, or ecology of this species or similar species (Sullivan and Knight, 1994; Sullivan and Smartt, 1991*a*, 1991*b*, 1991*c*, 1994).

5.2.7 Northern Harrier (*Circus cyaneous*)

Status: Federal (none); State of New Mexico (Protected).

Habitat: Plains, open spaces, grasslands, woodlands, riparian areas, sagebrush.

Sensitivity: Low (4 individuals observed soaring low over desert grassland and scrub habitat of sections 2, 5, 27, 31W, and 32W [Appendix E]). This species may move into the area from more riparian habitat as far away as the Rio Grande. Sensitivity of this species is considered to be low because of: (1) the relatively small number of birds observed in the project area; (2) the species is relatively wide ranging throughout the area; and (3) similar testing and construction activities in north and south-central New Mexico historically have not resulted in documented adverse affects on the biology, reproduction, or ecology of this species or similar species (Sullivan and Knight, 1994; Sullivan and Smartt, 1991*a*, 1991*b*, 1991*c*, 1994).

Additional Information: The Northern Harrier has no Federal status, but is a State of New Mexico protected raptor. It inhabits plains, fields, open spaces, grasslands, woodlands, and riparian areas. This species nests on the ground in dense cover, however, it may occasionally construct nests in association with deep or shallow marsh habitat. The northern harrier preys on a variety of animals and regularly detects prey solely by means of its keen hearing. This species was most commonly observed during the quiet early morning hours gliding or hovering at low altitude over desert grassland and scrub habitat and associated dirt roads.

5.2.8 American Kestrel (*Falco sparverius*)

Status: Federal (none); State of New Mexico (Protected).

Habitat: Power lines, fence lines/posts, sagebrush, grassland habitat.

Sensitivity: Low (8 birds observed during the biological survey [sections 2, 6, 11, and 5]; Appendix E). This species tends to be locally abundant in the area. Sensitivity of this species is considered to be low because: (1) the relatively large number of birds associated with the surrounding area; and (2) similar construction activities in north and south-central New Mexico historically have not resulted in documented adverse affects on the biology, reproduction, or ecology of this species or similar species (Sullivan and Knight, 1994; Sullivan and Smartt, 1991*a*, 1991*b*, 1991*c*, 1994).

Additional Information: Although *F. sparverius* is neither a Federal nor State of New Mexico Endangered, or Sensitive species, all raptors are fully protected by the State of New Mexico. The American Kestrel is the smallest North American flacon and one of the most common. This species is usually seen hovering or sitting on exposed perches, such as poles, fence lines, wires, or treetops, where it hunts for rodents, insects, birds, lizards, or snakes. American Kestrels nest in tree cavities but will readily use holes in cliffs and crevices in buildings as well as nest boxes. This species is a common inhabitant of the Southwest and relatively arid grassland regions of New Mexico, including plains, open spaces, deserts, woodlands, and riparian habitats.

5.2.9 Loggerhead Shrike (*Lanius ludovicianus*)

Status: Federal (Candidate); State (none).

Habitat: Plains, grasslands, deserts, woodlands, sagebrush, riparian areas. Preferred habitat is open country with scattered shrubs or small trees such as shelter-belts, cemeteries, farmsteads, and hedge-rows. In the west they breed in savanna, chaparral, or pine-oak woodland and prefer open stands. This species eats mostly grasshoppers and crickets, but also a variety of other insects, small mammals, birds, and reptiles.

Sensitivity: Low (17 birds observed during the biological survey [sections 1, 2, 5, 11, 12, 25, 26, 30E, 31W, 32W, 35, and 36]; Appendix E). This species is common along fenced access roads. Sensitivity of this species is considered to be low because: (1) the relatively large number of birds observed in the project area; and (2) similar construction activities in north and south-central New Mexico historically have not resulted in documented adverse affects on the biology, reproduction, or ecology of this species or similar species (Sullivan and Knight, 1994; Sullivan and Smartt, 1991*a*, 1991*b*, 1991*c*, 1994).

Additional Information: Although the Loggerhead Shrike is a Federal Candidate species, its status is classified as unknown (U), indicating that additional survey work is required to determine its current distribution, abundance and population trends. This species inhabits open spaces, grasslands, deserts, woodlands, and riparian areas. Birds are commonly observed perch-hunting from fences that overlook grassland and sagebrush habitat, and from taller shrubs (*Atriplex*) that occur along roadways. The cause of the logger head shrike population declines may involve more efficient farming practices and increased use of pesticides along roadways and on farmlands. Location of hedge-rows, short shade trees, thorny vegetation, and reduction in native pasture-lands are probably the most important environmental factors associated with this species decline (Hunter, 1990).

5.2.10 Texas Horned Lizard (*Phrynosoma cornutum*)

Status: Federal (Candidate); State of New Mexico (Protected).

Habitat: Open bare ground, desert grassland, sagebrush, Chihuahuan Desert scrub (creosotebush [*Larrea tridentata*], Tarbush [*Flourensia cernua*], and Honey Mesquite [*Prosopis glandulosa*]).

Sensitivity: Low (4 individuals observed [sections 1 and 36]; Appendix E). Sensitivity of this species is considered to be low because of the small number of animals observed in the project area; however, *P. cornutum* is common in all surrounding areas, particularly White Sands Missile Range (R. M. Sullivan, pers. obs.). In addition, there was no evidence of mortality along the main paved or dirt roadways servicing the area, despite relatively heavy vehicular traffic. Lack of evidence of mortality of herptiles in an area can be a crude indication of the relative abundance of a particular herptile species in the affected area. Occasional loss of some reptiles and other small animals will likely result during and after construction of various projects and roadways associated with the WSTF facilities. Some mortality is inevitable given the affinity that most species of reptiles have for warm roadways during the early morning and evening hours. For example, resident populations of reptiles exhibiting normal daily and seasonal movements associated with feeding and reproductive behavior will be subject to occasional mortality by vehicular traffic, particularly along NASA Road.

Additional Information: The Texas horned lizard is common in desert areas throughout southern and central New Mexico. These horned lizards live in shrubland, desert grassland, and associated juniper woodland. They feed mostly on ants, and occur in areas where ants, particularly seed harvester ants belonging to the genus *Pogonomyrmex*, are abundant. Currently, this species has no State of New Mexico status; however, all species of horned lizards are protected in New Mexico and specific permits are required from the NMDGF to collect these lizards. Techniques used during the wildlife survey were adequate to assess the presence of this diurnal species under normal conditions. Hibernation generally occurs in September or early October, with the first cold weather. It emerges during the following spring in mid-April or early May.

5.2.11 Round-tailed Horned Lizard (*Phrynosoma modestum*)

Status: Federal (none); State of New Mexico (Protected).

Habitat: Open bare ground, desert grassland, sagebrush, Chihuahuan Desert scrub (creosotebush [*Larrea tridentata*], Tarbush [*Flourensia cernua*], and Honey Mesquite [*Prosopis glandulosa*]).

Sensitivity: Low (12 individuals observed [sections 1, 2, 5, 25, 26, 27, 30E, 31W, 32W, and 36]; Appendix E). Sensitivity of this species is considered to be low because of the relatively small number of animals observed in the project area; however, *P. cornutum* is common in all surrounding areas, particularly White Sands Missile Range (R. M. Sullivan, pers. obs.). In addition, there was no evidence of mortality along the main paved or dirt roadways servicing the area, despite relatively heavy vehicular traffic.

Additional Information: Although *P. modestum* has no Federal status, all species of horned lizards are protected in New Mexico. Round-tailed horned lizards are common in desert areas throughout southern and central New Mexico. These horned lizards live in Chihuahuan Desert shrubland, desert grassland, and associated juniper woodland. They feed mostly on ants, and occur in areas where ants, particularly seed harvester ants belonging to the genus *Pogonomyrmex*, are abundant.

5.2.12 Pale Townsend's (Western) Big-eared Bat (*Plecotus townsendii pallescens*)

Status: Federal (Candidate); State of New Mexico (Protected).

Habitat: This species is found from low desert habitats up to the fir habitat zones. The presence of this species may be more a function of suitable shelters than specific ecological habitat type per se. *P. t. pallescens* will roost in caves, mines, and manmade structures that are abandoned or have low disturbance levels.

Sensitivity: Low (2 individual bats observed in the roofing panels of the Love Ranch house). Sensitivity of this species is considered to be low because the Love Ranch house is in an undisturbed area that is well away from any testing or construction activity. This area and historical structures associated with the ranch house should be protected.

5.2.13 Western Burrowing Owl (*Speotyto cunicularia*)

Status: Federal (Candidate); State of New Mexico (Protected).

Habitat: Bare ground, open desert, grassland-juniper habitat, Chihuahuan Desert scrub (Creosotebush [*Larrea tridentata*], Tarbush [*Flourensia cernua*], Honey Mesquite [*Prosopis glandulosa*]); nests in abandoned rodent burrows.

Sensitivity: Low (3 birds was observed in section 27). Sensitivity of this species is considered to be low because of the general lack of birds, active burrows, or evidence of old burrow systems in the immediate vicinity of the property, particularly disturbed areas. Trenching or other ground disturbing activities through occupied burrowing owl habitat should be avoided. If necessary, work should only proceed if owls have vacated the site on their own volition.

Additional Information: Western Burrowing Owls nest and feed within abandoned rodent burrows that have been modified by digging and scraping with the beak, wings, and feet. Western Burrowing Owls also frequent disturbed or man-made embankments, and along fence lines (Sullivan and Knight, 1994; R. M. Sullivan, pers. obs.).

5.2.14 Northern Aplomado Falcon (*Falcon femoralis septentrionalis*)

Status: Federal (Endangered); State of New Mexico (Endangered Group 1).

Habitat: *F. f. septentrionalis* has been documented in a variety of open woodland, savanna, and grassland habitats (Hector 1981, USFWS 1990). Within the Chihuahuan desert, *F. f. septentrionalis* typically occur in open grasslands with scattered mesquite and or yuccas (Ligon 1981, Montoya and Zwank 1995). Montoya and Zwank (1995) found in home ranges of *F. f. septentrionalis* in Chihuahua, Mexico, woody vegetation densities varied from 12.1 to 151.3 plants per hectare and ground cover ranged from 28.9% to 69.5%. There was no significant difference between nesting and non-nesting territories (means equalled 49.9% versus 37.8%, respectively). Home-range estimates varied from 2 to 22 square kilometers (0.5-8.5 square miles). Range of juvenile dispersal is uncertain at this time, but may range as far as 140 km (85 mi). Preferred habitat generally occurs below 2,000 m (6,500 ft) in lightly forested or open country from the southwestern border of U.S., where it is nearly extinct, south to southern Mexico and suitable areas throughout South America. It is migratory at the northern and southern extremes of its range.

Recent confirmed sightings of *F. f. septentrionalis* on WSMR have heightened interest in this species. Several areas currently are being considered for designation as potential "critical habitat" set-a-sides for *F. f. septentrionalis* (Daisan E. Taylor and David Holderman, WSMR Directorate of Environment and Safety, Environmental Services Division [DES-E], pers. comm., and WSMR 1996); these areas include grassland-yucca-scrub and yucca-grassland habitats. Currently, the USFWS and WSMR DES-E are updating their survey methodology for *F. f. septentrionalis* in New Mexico (Leal et al. 1996[5]). In addition, WSMR is in the process of developing survey procedures and schedules that will accommodate the needs of potential contractors/customers regarding access or use of areas that potentially fall within critical habitat set-a-sides for *F. f. septentrionalis* (David Holderman, WSMR DES-E, pers. comm.); these recommendations may be useful to WSTF.

Sensitivity: Low—no individuals of this species were observed during biological inventories of the WSTF facility; however, recent sightings suggest that *F. f. septentrionalis* may be expanding its range into southern New Mexico (USFWS pers. comm. 1995).

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5 *Note:* The Leal et al., document recommends that system-wide surveys of the Northern Aplomado Falcon and its "critical habitat" should be conducted on a year-round basis; however, the majority (approximately ⅔) of all system-wide surveys should be conducted between 1 February and 31 August.

Additional Information: *F. f. septentrionalis* often is seen perched on conspicuous snags, telephone wires, or on the ground. In the Southwest, it breeds in association with desert grassland habitats where pairs use abandoned nests of other raptors (Swainson's Hawks, Chihuahuan Ravens [*Corvus cryptoleucus*]) situated more than 2 m above the ground (range 3-8 m). Nests are usually in forks of yuccas or in tops of mesquite and other cacti (Bailey 1928; Bent 1938; NMDGF 1991). Eggs are laid from March until June, primarily in mid-April. Incubation lasts from 31 to 33 days. Both sexes participate in incubation and young fledge approximately 35 days after hatching. Fledglings may remain in the vicinity of the nest for at least a month after fledging (Hector 1981).

Research conducted by Hector (1981), Jiménez (1993), and Montoya and Zwank (1995) show a wide array of birds, insects, mammals, and reptiles that have been documented in diets of Aplomado Falcons. In eastern Mexico, birds comprised 94% of individual prey items and 35% of prey items that were observed being captured, while insects comprised approximately 65% of prey items seen captured (Hector 1985). Hector (1981) determined that birds composed 97% of the prey biomass. Montoya and Zwank (1995) found a similar preference for avian prey items with meadowlark (*Sturnella neglecta* and *S. magna*), common nighthawk (*Chordeiles minor*), and mourning dove (*Zanaida macroura*) the most frequently taken avian species in northern Chihuahua. Prey includes such rapid fliers as parrots, snipe, doves, and pigeons. Prey items may be caught on the ground or in the air. Pairs often hunt together, frequently late in the day after sunset. Pairs may cooperate in catching birds.

F. f. septentrionalis was widespread and common in deserts of the southern quarter of New Mexico during late 19th and early 20th centuries (Hector 1987; NMDGF 1991). Several breeding records and specimens were taken from the Jornada del Muerto desert that spans parts of Doña Ana, Sierra, and Socorro counties. The northernmost historical record for this region is from 40 km (64.4 mi) north of Engle, New Mexico, and 70 km (112.7 mi) north of Alamogordo (Hector 1987). Confirmed observations of single birds have been made recently on the Jornada del Muerto and in the Tularosa Basin. A small breeding population is known in the Mexican state of Chihuahua (NMDGF 1991).

5.2.15 White Sands Woodrat (*Neotoma micropus leucophaea*)

Status: Federal (Candidate); State of New Mexico (Sensitive).

Habitat: The endemic White Sands woodrat (*Neotoma micropus leucophaea*) may live around the bases of cholla or in burrows along the sides of arroyos or at the bases of shrubs. However, in situations where *N. micropus* and the White-throated woodrat (*N. albigula*) occur together, *N. micropus* generally occupies open grassland and arroyo-side situations, whereas *N. albigula* is found in rocky foothill habitats.

Sensitivity: Low—this species was not observed, and typical habitat for this species was, in most situations, well away from existing facilities. Determination of the presence of this species in the project area would require extensive live-animal trapping of typical habitat. Typical habitat, consisting of sand dunes and associated vegetation, was not observed except in small regions along the southeast border of the WSTF facility.

6 SENSITIVE HABITAT AREAS

6.1 RAPTOR USE AREAS

Eight species of raptorial bird species were observed during the biologic field survey (i.e., Coopers Hawk [*Accipiter cooperii,* 2 individuals], Golden Eagle [*Aquila chrysaetos,* 8 individuals], Red-tailed Hawk [*Buteo jamaicensis,* 18 individuals], Swainson's Hawk [*Buteo swainsoni,* 9 individuals], Turkey Vulture [*Cathartes aura,* 39 individuals], Northern Harrier [*Circus cyaneous,* 7 individuals], American Kestrel [*Falco sparverius,* 8 individuals], and Western Burrowing Owl [*Speotyto cunicularia hypugea,* 1 individual]) (Appendix E). Although several pairs of raptors were observed nesting in the area, there was no clearly defined raptor use area or ecological region/habitat associated with the property. All upland shrub habitat and the ecotone between shrub and desert grassland habitats associated with the foothills of Quartzite Mountain and the San Andres Mountains, however, function as a prime nesting area for the large populations of the Black-throated Sparrow (*Amphispiza bilineata*), Northern Mockingbird (*Mimus polyglottos*), Lesser Nighthawk (*Chordeiles acutipennis*), White-winged Dove (*Zenaida asiatica*), and Mourning Dove (*Zenaida macroura*).

All sightings of Cooper's Hawks were made within mesic upland vegetation and piñon pine-juniper woodland found within foothills of the San Andres Mountain Range, Bear Creek Canyon, and the Love Ranch areas. These wooded areas provide abundant cover, nesting and perching sites, and ephemeral sources of free water. In addition, there was generally a large prey-base of perching birds associated with various canyons and arroyos in this area. This kind of habitat provides an ideal habitat for the Cooper's Hawk, which is a medium-sized bird-eating species.

Golden Eagles were generally associated with lowland areas at the western boundary of the WSTF property (Sections 5, 6, 11, 27, 30, 31E). These birds were observed soaring overhead in the early morning hours. Canyons, drainages, and other upland areas in the nearby foothills of the San Andres Mountains likely provide nest sites suitable for use by golden eagles and other large raptors, whereas lowland desert grasslands and scrub vegetation provide important hunting areas for small to medium-sized mammalian prey items.

Most observations of Swainson's and Red-tailed hawks were associated with the line of power poles along NASA Road from Highway 70 to the main WSTF Gate. These birds perch on electrical power-poles, while feeding on prey, searching the desert floor and scrub habitat below for insects or small vertebrates, or while sunning during the cool early morning hours.

During the biological survey, 8 large stick nests were found within Sections 5, 6, 31W and 32W (Figure 3). All nests were in relatively good structural condition and were located in sandy clay swales and playas within Chihuahuan desertscrub vegetation. The primary nest-tree species were Honey Mesquite and Desert Sumac. Six nests contained young Chihuahuan Ravens (*Corvus cryptoleucus*), whereas two nests contained chicks of the Swainson's Hawk (*Buteo swainsoni*). A spring follow-up raptor survey should be conducted throughout all low lying habitat to determine the percent use and fledgling success rate of desert-scrub habitat by raptors on all low-lying WSTF property. In addition, every effort should be made to avoid impacting raptor nests or disturbing nesting and fledgling raptor chicks.

6.2 FORAGING AREAS

Mule deer were abundant on the WSTF site, as evidenced by frequent observation of individual deer and groups of as many as 12 individuals. Foraging and bedding areas, travel corridors, antler castings, tracks, and feces also were common. Areas of high concentrations of deer exist throughout much of the area associated with the foothills of the San Andres Mountains, along major west drainages (Bear Canyon), artificial watering areas, and most well developed and densely vegetated arroyos. Drainages and adjacent low-land slopes associated with grassland-scrub habitat and arroyo vegetation function as important travel corridors, bedding sites, and foraging areas for deer and many other medium to small-sized mammals in the project area.

Mule deer sign was also common along virtually all slopes and ridgetops in the project area, where mule deer browse on saltbush (*Atriplex*), mountain mahogany (*Cerocarpus*), Apache plume (*Fallugia*), winterfat (*Ceratoides*), and squawbrush (*Rhus*). Additionally, cover provided by vegetation in these areas contributes to the well-being of mule deer by providing shelter, increasing their chances of escape from predators, and fostering a sense of security—a number of studies indicate that the latter factor may be highly significant in maintaining mule deer in good physical condition (Dasmann 1971). Critical cover must alleviate to tolerable limits the cold, wetness, and snow depths of winter, heat and insect annoyance of summer, and harassment by predators and humans.

The biologic unit (territory occupied by an individual mule deer herd) for mule deer over much of its range in New Mexico consists of a winter range, or a group of related winter ranges, and their complementary spring, summer, and fall ranges where the majority of the animals that use the winter range spend the balance of the year. Ungrazed grassland and scrub vegetation associated with the foothills surrounding the project area is an important winter range for mule deer. In the project area, the winter range occupies a more limited area than the summer range—animals that wander over several thousand acres in the warmer months usually concentrate in a much smaller territory because of unfavorable conditions during the winter. Because home ranges of mule deer must offer food, water, and cover, any additional disturbances (particularly to the winter range) that create less closer combinations of these three essential elements will tend to decrease mule deer numbers in the general area. Therefore, maintenance of existing levels of natural vegetation is critical to habitat management of mule deer on the WSTF site.

6.3 EPHEMERAL WATER SOURCES

Average annual precipitation at WSTF is about 36 cm (14 in). Most precipitation occurs in the summer and an average of about 1.3 cm (0.5 in) occurs each month from January through May. Although intense summer thunderstorms frequently release heavy but brief rainfalls over a restricted geographical area, there are no natural sources of perennial free water on the WSTF property. Gardner Spring was once a natural source of water, however overtime it has become ephemeral. Several man-made watering areas associated with Section 25 and 26 (Water Tower and 200 Area), and Section 2 (Sewage Lagoons [Nos. 640 and 136; Figure 3]), but these sources provide the only significant perennial sources of free water and foraging areas for a variety of wildlife species.

The primary source of free water for wildlife derives from numerous arroyos and several larger drainages associated with the foothills of the San Andres Mountains, which receives runoff and has natural, but ephemeral, water catchments. The western flank of the San Andres Mountains drains into the Jornada del Muerto Basin, but this watershed is relatively small in total area (8.5 km^2 [2.3 sq mi]). There are no perennial stream flows in the area, and deeply incised arroyos typically contain debris-laden flow during and shortly following summer storms. Gardner Arroyo trends west through the facility near the 500 Area and 200 Area. One of its branches is very close to the expansive Bear Creek canyon area, which is the primary arroyo to the north.

The Bear Canyon drainage receives the largest amount of runoff during the monsoon season and is an important ephemeral source of free water for wildlife during the summer months. Limestone and igneous bedrock collects and pools water in depressions that can be used by wildlife as a annual source of water, which lies adjacent to vegetative cover. This drainage probably receives the largest amounts of use by wildlife following periods of summer and early fall precipitation. In this drainage various shrubs provide cover and perching substrates for a variety of passerine birds. In this drainage, water will remain for longer periods of time if shrubs and trees remain undisturbed, because they provide shading, thus increasing the quality of this arroyo as important wildlife habitat.

7 PROJECTED BIOLOGICAL IMPACTS

It is assumed that this report will be used for current and future operation and construction activities at the WSTF site. Thus this report will provide a baseline planning document for future testing and construction projects. This section, therefore, emphasizes those areas that have been identified as potentially sensitive habitat or important wildlife use sites. Impacts to vegetation and wildlife species are considered adverse if: (1) preexisting wildlife cannot be supported following removal or alteration of vegetation from the property; (2) project-associated disturbance such as habitat destruction, noise, human presence, project operation, pollution, etc., results in long-term wildlife population decreases that are greater than one breeding season; and (3) severe erosion occurs from removal of vegetation or other disturbance resulting in irreversible effects to the surrounding habitat.

7.1 VEGETATION

Loss of vegetation along arroyos can result in a loss of soil stability causing adverse erosion problems. Absence of grazing by livestock and the relative lack of human disturbance to vegetation and edaphic conditions within the WSTF area has allowed the site to remain in a relatively natural state; however, disturbance to slopes and foothills of the San Andres Mountains and the banks of arroyos will cause errosion, habitat deterioration, and overall loss of biological diversity and species richness of local plants and animals.

7.2 WILDLIFE

Plant and wildlife inventories are time specific. Species composition and patterns of distribution observed during one sampling period are biased and likely to change on a seasonal as well as a yearly basis. Moreover, irrespective of the specifics of the environmental setting, plant and wildlife species can be adversely affected by a potentially large number of extraneous factors associated with construction activity, including: (1) human disturbance (noise, human presence, powerline and fence entanglement); (2) pollution; (3) direct loss of habitat; (4) and indirect loss of habitat associated with habitat fragmentation. In addition, any decrease in species diversity tends to also decrease the stability of the ecosystem, both ecologically and energetically. Further, any decrease in stability increases the danger of fluctuations in populations of economically important species in the immediate area.

7.3 NOISE EFFECTS

Although testing and new construction activity at WSTF will cause some degree of noise disturbance, most of these impacts should be temporary or infrequent. Therefore, if current levels of noise associated to ongoing testing are maintained into the future, no adverse threat to populations of wildlife or their critical habitats would be anticipated.

However, adverse impacts on species of raptors and songbirds in the local area surrounding the site could result from the effects of noise and other disruptive activity if elevated noise levels occur during the breeding or nesting periods. For example, these man-made activities could cause raptors and other groups of birds to abandon their nests or young. In addition, these kinds of man-made disturbances may function as a deterrent to foraging activity during critical periods of the breeding and nesting cycles, as well as interfering with the raising of young to the fledgling stage.

From a resource management perspective, therefore, it is recommend that testing and construction activities be conducted in accordance with a policy for coexistence with the environment and conservation of biotic diversity. Minimal impact on nesting passerine birds and raptors found or potentially occurring in the area would result from testing or construction activities and noise if the following measures were implemented: (1) biological surveys of sensitive species should be performed prior to any planned construction activity or project; (2) large-scale construction activities that result in considerable noise should be curtailed during breeding and nesting activity if future biological surveys of each affected area show the presence of sensitive species; and (3) all generators and other on-site equipment should be equipped with muffling devices to assure that noise levels are reduced to minimum levels consistent with efficient operation; and (4) vehicles and other mobile equipment should be maintained in accordance with accepted maintenance practices to assure that operating equipment is free of defects that could contribute to excessive noise levels (Skaggs, 1990; Cunniff et al., 1991*a*; 1991*b*; 1991*c*).

7.4 POLLUTION

Toxic chemicals and other hazardous materials can spill into arroyos, drainages, and other low lying areas on the site where water collects in shallow depressions. This kind of man-made pollution can have adverse environmental consequences that may result in negative direct or indirect to impacts on the survival or reproduction of plants and wildlife that rely on arroyo topography and vegetation for food, cover, or dispersal corridors into and out of the area. In the study area all natural free water sources are ephemeral—restricted to low lying and temporary pools of rain water, and arroyo flow. These sources of free water, therefore may not be continuously flushed (= cleaned) by natural precipitation, which can cause them to be highly susceptible to pollution. Effects of pollution on survival and reproduction of local wildlife should be continuously monitored in association with the four primary WSTF hazardous waste management units, including: (1) container storage unit, (2) hazardous waste evaporation tank system, (3) open detonation unit, and (4) fuel treatment units.

7.5 LOSS OF HABITAT AND HABITAT FRAGMENTATION

Fragmentation of native habitat represents a direct and observable loss of wildlife resources and may increase the level of predation on native wildlife species. These resources may include watering areas, foraging areas, travel corridors, and cover, nesting, and bedding sites. Fragmentation of native habitat, therefore generally results in an overall decrease in species density and richness. Fragmentation and resulting loss of natural habitat associated with new testing and construction activities can cause adverse impacts to wildlife habitat in the local area. Although this loss may not be immediately apparent, overtime it will have an accumulative negative effect on local plant and animal species diversity and density—which will be difficult, as well as expensive, to reclaim once lost. These areas primarily include: (1) ecotones between arroyo and scrub vegetation associated with both minor and major drainages; (2) the ecotones between arroyo vegetation and woodland vegetation at the eastern boundary of the property at the base of the Quartzite Mountain and the San Andres Mountains; and (3) areas of great natural topographic diversity.

8 GENERAL AREAS OF SENSITIVITY

Following completion of the biologic field survey, literature review, and consultation with State and Federal agencies, varying levels of sensitivity were placed on different regions of the project area based on our previous experience with similar actions. Levels of sensitivity were based on the ability of a particular area to support: (1) unique or Endangered species of plants and animals, (2) a high diversity of wildlife species, and (3) habitat attributes critical to species survival and reproduction of wildlife populations (i.e., foraging and watering areas, travel corridors, display and nesting sites, and breeding territories, etc.). Sensitivity levels also were based on the current distribution of highly disturbed sites. Direct observation suggested that those areas that had historically sustained the largest amount of habitat disturbance, also had the fewest native plant and animal species, and were in the poorest condition relative to more undisturbed habitat (i.e., arroyo vegetation).

Consultation with State of New Mexico and Federal resource agencies will be necessary, and is recommended, for future projects at the WSTF site to obtain updated information on species of special concern, and because in many instances the information from different Federal and State of New Mexico agencies is not consistent. The following sensitivity levels have been assigned to specific regions in the WSTF testing area.

8.1 CRITICAL

No habitat critical to the survival or reproduction of any listed species of plant or animal was observed on or in the immediate vicinity of the WSTF property. The term "critical habitat" for a Threatened or Endangered species means:

(i) the specific areas within the geographic area occupied by the species at the time it is listed in accordance with provisions of section 4 of the ESA, on which are found those physical or biological features essential to conservation of the species and, which may require special management considerations or protection and;

(ii) the specific areas outside the geographical area occupied by the species at the time it is listed in accordance with the provisions of section 4 of ESA, upon determination by the Secretary of the Interior that such areas are essential for the conservation of the species.

8.2 HIGH

High sensitivity areas were identified as having a combination of three or more of the following occurring in association with one another—ephemeral water sources, travel corridors, bedding areas, cover, and foraging areas. High sensitivity is also based on the amount of habitat available to wildlife in the vicinity of the project area, and on the areas potential to support sensitive species. Loss or disturbance of high sensitivity areas will likely result in long-term or permanent alterations in population sizes and reproductive potential in the vicinity of the project area, or use of the general area by wildlife.

On the WSTF site, regions of high sensitivity include: (1) the upper reaches of the Bear Canyon drainage, which drains east to west; (2) mesic woodland and arroyo vegetation associated with the Love Ranch area; and (3) the mesic woodland habitat associated with the northeast foothills of Quartzite Mountain and the San Andres Mountain Range. These areas are rich in biodiversity of both plants and animals, topographic relief, and provides natural water catchments and cover for wildlife.

8.3 MODERATE

Areas of moderate sensitivity were identified as having a combination two of the following occurring in association with one another—travel corridors, bedding areas, cover, and foraging areas. Areas of moderate sensitivity also receive consistent use by wildlife, although the amount of use is generally less than in highly sensitivity areas. This rating also is based on the amount of this habitat available to wildlife and on the ability of habitat to support sensitive species. Further, loss of moderate sensitivity areas can result in short-term impacts like temporary avoidance by wildlife that could result in long-term impacts to wildlife use areas if construction of a large number of projects caused fragmentation of habitat in the vicinity of proposed site.

On the WSTF site, regions of moderate sensitivity are associated with desert grassland and associated shrubby vegetation lying at the base of the foothills of Quartzite Mountain and the San Andres Mountain Range, including the primary WSTF testing areas and the western boundary of the property.

8.4 LOW

Areas considered to be of low sensitivity receive little use by wildlife species, because they have been physically altered by human disturbance or overgrazing (Sections 31, 32, 6, 5), and which provide reduced topographic relief and vegetation diversity associated with food and cover. Within the WSTF property these areas primarily included all remaining habitat, including most of the roadways to the north that boarder or are contained within the Jornada Experimental Range.

Note: *The definition of the term "sensitivity" is not intended as a NEPA term or as having a NEPA equivalent term (see 10 CFR 1021, Appendix B Point 4), "sensitive resources"). Instead, sensitivity refers to a term developed specifically by us to illustrate zones or areas on WSTF modeled in section 9.0 above. Future actions within any sensitive area, as defined above, may or may not affect sensitive resources (i.e., NEPA term) found within or outside the designated area.*

9 OVERALL IMPACTS TO BIOLOGIC RESOURCES

A variety of potential impacts could affect sensitive biologic resources such as endangered plants and animals, or unique plant communities on the site. These impacts can be classified into three broad categories: (1) direct impacts, (2) indirect impacts, and (3) cumulative impacts. These categories are defined in the following sections.

9.1 DIRECT IMPACTS

Direct impacts are those actions that have a direct and often immediate effect upon the resource. These conspicuous actions primarily include ground conversion activities (e.g., construction, fire, chemical spills, etc.). Once identified, direct effects are often easily mitigated.

9.1.1 Surface Disturbance Impacts

Surface disturbance can include a wide range of activities such as road or site facility construction, installation of utilities, or any other action that removes the existing plant and animal communities. Such activities can have devastating effects on rare plants and animals. Effects of surface disturbance range from immediate and total removal of the organism, to partial removal or disturbance.

Surface disturbance impacts are evident throughout much of the WSTF property, primarily in association with existing dirt roadways, Landfill, and existing test sites.

9.1.2 Fire

Most plants that exist in grassland and shrubland environments have evolved mechanisms for dealing with periodic natural fires. However, there was no clearly visible evidence of natural or man-made fires at the site. The relatively dense shrubland habitat associated with the eastern boundary of the WSTF site is a potential fire hazard, particularly in the Love Ranch area.

9.1.3 Deposition of Debris, Garbage, or Chemical Spills

Disposal of unwanted waste can often severely impact the area immediately around a disposal site; this is particularly true with chemical spills. Chemical materials can leach into the soil and kill vegetation in the surrounding area and can potentially poison native herbivores. Deposition of man-made debris, garbage, and discarded building materials were evident throughout much of the WSTF, particularly the Landfill area.

9.1.4 Pesticide and Herbicide Spraying

Pesticides and herbicides are often used to control insect infestations as well as the spread of unwanted weeds. These agents can often have adverse effects upon rare plants; and direct application of herbicides can result in the immediate death of the plant. Further, use of pesticides near rare plant sites can result in a reduction of pollinators that can lead to lack of pollination and failure of fruit set. There was no evidence of pesticide or herbicide spraying at the WSTF site.

9.1.5 Rural Fugitive Dust

Construction activities, dirt roads, or any other activity that results in dust generation can result in damage to the local flora. Rural fugitive dust is often deposited on the leaf surfaces of plants adjacent to the dust source. The resulting coating of dust can reduce the photosynthetic capacity of the plant and potentially leave it in a stressed condition. The northern-most dirt roadways that are shared with the Jornada Experimental Range exhibited some evidence of fugitive dust on vegetation.

9.1.6 Soil Deflation

Soil deflation can result in loss of all topsoil down to the hardpan layer. Soil deflation exposes root systems of plants and in many cases desiccation and death of plants. Except for the Landfill and the area around the 700 Area, there was no evidence of soil deflation.

9.2 INDIRECT IMPACTS

Indirect impacts include activities that are remote from a site but have the ability to significantly impact the site. It is suggested that the potential for indirect impacts be considered in WSTF resource management plan. Although there were few potential indirect impacts apparent, the effects of remote construction activities that may result in downstream flooding or sediment distribution seem to apply to the property.

For example, remote construction activities can often have subtle and damaging effects upon rare plants and animals. Any construction in the upper portion of Bear Creek Canyon watershed can alter the flow of storm water runoff, resulting in flooding or sediment deposition at a downstream location that would not normally be affected by such events.

9.3 CUMULATIVE IMPACTS

Cumulative impacts include activities that, by themselves, may not have a significant impact but, by interacting with other factors/impacts, can have dramatic effects[6]. These are the most difficult to identify and usually the most difficult to control. One of the more obvious cumulative impacts can result from habitat fragmentation. Activities that by themselves may not affect an animal or plant often become significant factors when the habitat of that animal or plant is fragmented or reduced in size. The number of cumulative impacts is almost infinite and the chance combination of events that can lead to significant effects from cumulative impacts often relies on factors that happen as chance events over time. Generally, any factor that alters the natural habitat of a plant or animal can contribute to cumulative impacts on that species. Therefore, it is suggested that the potential for cumulative impacts be considered in the WSTF environmental resource management plan. What follows is a general discussion of some of the potential problems that could arise from cumulative impacts at the site.

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[6] In 1978, the Council on Environmental Quality (CEQ) defined cumulative impacts as: "the incremental impact of the action when added to past, present, and reasonably foreseeable future actions. Cumulative impacts result from individually minor but collectively significant actions taking place over a period of time."

Construction of buildings and roads can cause fragmentation and loss of valuable travel corridors, cover, and foraging habitat. Moreover, the combination of separate, yet ongoing, projects in the immediate vicinity of the property can result in cumulative impacts to plants, animals and wildlife habitat through increases in noise and human presence, as well as habitat alteration. Construction of buildings and roads can cause fragmentation and loss of valuable travel corridors, cover, and foraging habitat. This combination of separate and ongoing projects nearby, together with WSTF activities can result in cumulative impacts to wildlife through increases in noise and human presence, as well as habitat alteration and pollution.

Because some of the area surrounding WSTF has been disturbed by past activities, including overgrazing along the western border (sections 5, 6, 31W, 32W), serious consideration should be given to the overall ecological consequences to plant species diversity and wildlife resulting from loss of habitat in this region. Future projects should consider using previously disturbed areas on the property or minimizing the amount of impact on the site by limiting the amount of permanent disturbances, and through specific and immediate habitat rehabilitation following completion of a particular project.

10 MITIGATION OF BIOLOGIC CONSEQUENCES

Many species that inhabit the WSTF area are not restricted to jurisdictional lines on a map. Because State and Federal resource agencies are the best sources of information regarding the management of biological resources. It is recommended that construction and operational activities be conducted in accordance with recently proposed national forest land and resource management plans[7], as a baseline for affective management of the biological resources. These forest management plans provide for coexistence with the environment, preservation of sensitive species, maintenance of historical levels of biologic diversity, conservation and sustained use of other wildlife species, protection of vegetation, and wise use or protection of other natural resources on land withdrawn from the general public or private use.

Previous sections of this report summarized possible impacts that could affect plant and animal species and wildlife habitats that occur or potentially occur in the area. In order to avoid these effects, a variety of resource management policies can be enacted. These management prescriptions vary depending upon the sensitivity of habitat within an area. However, overall management prescriptions apply to all areas irrespective of whether rare plants or animals, or unique biological communities have been located at the site. It is recommended that the following measures be taken to reduce or avoid potential significant biological and ecological impacts associated with the project area, and that these recommendations be incorporated into current and future resource management plans. The following measures should be taken to reduce or avoid potential significant environmental impacts associated any planed construction of habitat modification.

10.1 Future Construction Projects

Future construction projects in the general vicinity of a site should be restricted to the maximum extent possible to previously disturbed portions of the property.

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7 For example—Cibola National Forest Land and Resource Management Plan (1991—Changing Forest Landscapes: Five Years of Progress, Cibola National Forest Land and Resource Management Plan 1986-1990, U.S. Department of Agriculture, Southwestern Region, 85 pp.).

10.2 Future Buildings and Facilities

Future buildings and facilities should be constructed in close proximity to one another (clustered) to minimize the potential of further degradation of natural habitat and biodiversity.

10.3 Future Disturbance

If future disturbance is necessary, construction activities should be minimized during the nesting or breeding season of sensitive species of raptors or passerine birds that have been documented on the property.

10.4 Loss of Vegetation, Habitat Fragmentation, and Edge Effect

Habitat fragmentation should be avoided whenever possible. The effects on both rare and common plant communities are more pronounced when communities are cut up into small islands of native habitat. Fragmentation can be reduced by clustering facilities to previously disturbed sites. If clustering is not possible the next best management tool would be placement of facilities at the edge of large tracts of natural habitat, rather than in the center.

In the short-term, clearing natural vegetation along proposed construction corridors may result in loss of soil stability, excessive dust, erosion, and minor watershed alteration. Over the long-term, plant communities and ecological process may change substantially as a result of "edge effects" caused by fragmentation of wildlife habitat and associated man-made barriers. The outer boundary of any habitat is not a line but rather a "zone of influence" that varies in width depending on what is measured. Sunlight and wind impinge upon a patch of woodland from the edge and alter the local microclimate. Edge zones, which can change the entire species composition of a local plant community, are usually drier and less shady than natural shrub/woodland interiors, thus favoring shade-intolerant, xeric plants over typical native species.

Edges can cause some wildlife species to use less suitable travel corridors and foraging areas, thus increasing the potential risk of predation. In some instances, passerine birds are attracted to edges, which function as ecological traps. Further, birds nesting near the edge, may suffer high rates of nest predation, thus greatly reducing fledgling success. Increased rates of nest predation by opportunistic predators may extend up to 600 m from an edge into a woodland interior.

10.5 Topographic Relief

Destruction of rocky ledges and hilly habitat associated natural desert shrub vegetation (i.e., sumac, piñon-juniper-oak woodland, etc.) should be avoided.

10.6 Natural Drainages

Future construction and access roads should not be built within 30 m (100 ft) of either side of existing natural drainages or arroyos; and erosion control measures should be installed on structures and roads built along the length of arroyos. Around construction sites and roads, runoff should continue to be directed by way of ditches and grading to natural drainage channels (arroyos).

10.7 Construction Debris

Strict standards should be imposed to prevent dirt, loose rock, brush, human refuse, or other debris resulting from construction activities from being deposited into arroyos or canyons.

10.8 Vehicular Traffic

Vehicular traffic outside immediate construction sites and designated access roads should be prohibited, particularly within areas of natural vegetation. Restriction should include all staff, transient test observers, construction personnel, and equipment operators. Vehicles should be restricted to designated access routes only. If access to these areas is unavoidable, users should be specifically briefed by a qualified staff biologist/environmental scientist as to the location of any managed/sensitive biological areas/resources.

10.9 Trenching

Open trenches, splice pits, and ditches can trap small vertebrates and cause injury to large mammals. Periods of highest activity for many nocturnal and crepuscular species include warm summer months and wet weather. Loss of wildlife can be minimized by implementing the following recommendations (see Trenching Guidelines, New Mexico Department of Game and Fish, November 1994): (1) Minimize the amount of open trenches at any given time by keeping trenching and back-filling crews close together. (2) Trench during cooler months (October-March); however, there may be exceptions (e.g., critical wintering areas) that need to be assessed on a site-specific basis. (3) Avoid wetland and riparian areas. (4) Avoid leaving trenches open overnight. Where trenches cannot be back-filled immediately, escape ramps should be constructed at least every 90 m. State-wide there are 41 threatened, endangered or sensitive species potentially at risk by trenching operations. Risk to these species depends upon a wide variety of conditions at the trenching site, such as trench depth, side slope, soil characteristics, season, and precipitation events.

10.10 Hazardous and Toxic Materials

Hazardous and toxic materials should be stored on a level concrete pad away from all arroyo drainages, catchment basins, and low-lying grassland habitat. Any chemical spills or excess concrete should be cleaned up immediately, and not dumped in drainages. Fuels, oils, or other chemicals must not be poured or drained onto ground surfaces, and containment devices should be placed around these materials in the event of spills. Any dumping of human refuse or building debris should be prohibited in and around the vicinity of the property and along existing roadways. All dumping and storage of trash, garbage, metal, bottles, and other man-made waste should be strictly prohibited within the property at all times.

10.11 Recyclable Waste

All recyclable waste from previous activity and tests should be collected and disposed of in accordance with the facility recycling plan. This action also will help prevent small unwanted animal "pests" (rodents, arthropods, poisonous snakes, etc.) from taking shelter near testing facilities, particularly in areas where discarded/old equipment and buildings materials are stored adjacent to test area buildings.

10.12 Fire Control

Fire control and suppression equipment should be in place at all times of the year. This is particularly important around Love Ranch and Bear Creek Canyon where there is extensive scrubland vegetation and unique habitat types. A coordinated fire suppression program (if not already in place) could be organized among these neighboring agencies.

10.13 Water Sources

Natural watering areas, arroyos, sewage lagoons, and artificial water pooling areas (e.g., water tanks, evaporative cooling run off, etc.) provide a source of free water for wildlife in the surrounding area. These areas also have a high species richness and diversity. Every effort, therefore, should be made to restrict access and human disturbance to these areas of high biological diversity.

10.14 Noxious and Exotic Weeds

Under guidance from Section 15 of the 1990 Farm Bill (Management of Undesirable Plants on Federal Lands), the Federal Noxious Weed act of 1974, and Executive Order 11897 (Exotic Organisms), WSTF has responsibilities to control noxious weeds in the installation. To help in this effort, WSTF should consider exotic and noxious weed control in all areas affected by future proposed construction until native vegetation has been reestablished, depending upon the extent of disturbance and the size of the affected area. Various control measures include hand weeding and/or limited herbicide use in specific target areas, based on herbicide trials with African rue (*Pegunum harmala*). Specific guidelines regarding weed control and a list of southwestern noxious weeds include: leafy spurge (*Euphorbia escula*), yellow star thistle (*Centaurea solstitialis*), diffuse napweed (*Centaurea diffusea*), Russian knapweed (*Centaurea repens*), spotted knapweed (*Centaurea maculosa*), dalmatian toadflax (*Linaria genistifolia dalmatica*), yellow toadflax, (*Linaria vulgaris*), African rue (*Pegunum harmala*), halogenton (*Halogenton* *glomeratus*), bull thistle (*Cirsium vulgare*), Canada thistle (*Cirsium arvense*), musk thistle (*Carduus nutans*), Russian thistle (*Salsoa iberica*), Scotch thistle (*Onopordum acanthium*), salt cedar (*Tamarisk spp.*).

10.14.1 Background on African Rue

African rue is an introduced plant species from North Africa that has invaded 1000's of acres on White Sands Missile Range (WSMR) and Holloman Air Force Base (HAFB). This species is extremely drought tolerant, tolerates saline and alkaline soils, and is toxic to ungulates, because it contains allelopathic chemical compounds that retard and prevent growth of native vegetation. For example, on HAFB African rue is displacing native vegetation and is spreading along all roadways, native dune areas, and around Lake Holloman. Removal of native vegetation through blading, chemical measures, and other means has allowed for rapid infestation of African rue and other weeds onto barren soil. Blading and mowing of highway shoulders, fields, etc., also has served to spread seed over wider areas. Construction of pipelines, sewer lines, power lines, blasting activities, etc., are factors that have encouraged heavy infestation rates.

Aggressive native plant restoration and re-vegetation efforts are typically required in areas that incur severe ground disturbance. Control measures to reduce the likelihood of African rue invasion at all future proposed construction sites include: (1) immediate seeding with native plant seed mixtures at 2–3 times greater than normal application rates; (2) covering seeded areas with erosion control material/mats so rue seed can not get established; (3) watering to encourage sprouting of native vegetation; (4) re-vegetating areas with plants instead of seeds; and/or (4) physically removing any African rue plants (by hand) until native vegetation becomes re-established.

Mechanical removal of plants and roots by digging will work in areas with only a few isolated plants. Routine mowing and blading activities should be minimized or discontinued where appropriate. In areas of gravel or bare soil re-vegetation efforts with appropriate native plants may be a viable option for contractors. All such activities adopted by WSTF should be coordinated with a qualified member of the WSTF environmental resource staff.

10.14.2 Trenching

Open trenches, splice pits, and ditches can trap small vertebrates and cause injury to large mammals. Periods of highest activity for many nocturnal and crepuscular species include warm summer months and wet weather. Loss of wildlife can be minimized by implementing the following recommendations (NMDGF 1994; WSMR 1995a):

- Minimize the number of open trenches at any given time by keeping trenching and back-filling crews close together.

- Trench during cooler months (October-March); however, there may be exceptions (e.g., critical wintering areas) that need to be assessed on a site-specific basis.

- Avoid wetland and riparian areas.

- Avoid leaving trenches open overnight. Where trenches cannot be back-filled immediately, escape ramps should be constructed at least every 90 m (27 ft). State-wide there are 41 threatened, endangered or sensitive species potentially at risk by trenching operations. Risk to these species depends upon a wide variety of conditions at the trenching site, such as trench depth, side slope, soil characteristics, season, and precipitation events.

10.14.3 Sand Dune Habitat

Construction requiring operation of heavy-duty trenching or digging equipment (i.e., track or rubber vehicles, etc.) should follow in previously disturbed routes and avoid, to the maximum extent possible, all sand dune habitat. In the event that natural dune habitat is destroyed by construction activities, plantings of native shrubs, forbs, grasses, etc., should be applied by the contractor to ensure that the natural vegetative cover is reestablished, and the natural dune ecosystem is not degraded. Mats or other stabilizing materials may need to be applied to ensure that native vegetation gets reestablished; these activities should be coordinated with a qualified biologist.

10.14.4 Wetland and Riparian Areas

Because a large number of construction projects (i.e., roads, bridges, trenching cables, etc.) disturb small areas of aquatic, wetland, or riparian habitat, these activities have a significant potential cumulative impact on these habitats. The following recommendations were developed with the intent of avoiding or minimizing adverse effects of such projects on fragile and limited aquatic, riparian, and wetland habitats (see 1994 NMDGF recommendations for *Bridge and Road Construction/Reconstruction Guidelines for Wetland and Riparian Areas*). Depending upon the full extent of disturbance and mitigation, these recommendations will be particularly relevant to areas of future construction activity located along the Bear Creek drainage.

10.14.4.1 Historical Perspective and Extent of the Problem in New Mexico

Of 867 species of vertebrates known to occur in New Mexico, approximately 479 (55%) rely wholly, or in part, on aquatic, wetland, or riparian habitat for their survival[8]—439 species of vertebrates are known to occur in the vicinity of WSTF and the adjacent WSMR (WSMR 1995a).

A majority of the 96 species that are listed by the State of New Mexico as endangered or threatened are associated with these habitats (51 species, or 53% of the total). Surface water comprises only 0.2% (141,440 acres) of the surface area of New Mexico[9]. Wetlands and riparian areas comprise another 0.6% (481,900 acres)[3]. It is estimated that one-third of the wetlands that once existed in New Mexico have been lost[10]. On the main stem of the Rio Grande, the situation is worse—an 87% decrease in wetland acreage occurred along this river from 1918 to 1982[11]. The

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[8] New Mexico Department of Game and Fish. 1994. *Biota Information System of New Mexico (BISON-M)*, Version 2.5. Santa Fe, New Mexico.

[9] U.S. Department of the Interior, Geological Survey. 1970. *The National Atlas of the United States of America.* Washington, D.C. 417 pages.

[10] Dahl, T.E. 1990. *Wetlands Losses in the United States, 1780s to 1980s.* U.S. Department of the Interior, Fish and Wildlife Service, Washington, D.C. 21 pages.

[11] Hink, V.C. and R.D. Ohmart. 1984. *Middle Rio Grande Biological Survey.* Report submitted to the U.S. Army Corps of Engineers, Albuquerque, New Mexico. Contract Number DACW47-81-C-0015. 58 pages.

quality of these habitats also has been diminished. Of the 6,000 miles of streams in New Mexico, approximately 3,226 miles (54%) are impaired to some degree by water pollution[12].

10.14.4.2 Recommendations

10.14.4.2.1 Minimum Notice

A minimum notice of 30 days is requested by the NMDGF prior to the planning deadline for the project. This lead time is necessary for any habitat evaluation or biological inventory that may be required to collect information for project scoping and to establish baseline conditions.

10.14.4.2.2 Comprehensive On-Site Supervision

Comprehensive on-site supervision of the project contractor should be conducted by the project sponsor to ensure that specifications are followed. Post-construction mitigation likewise should be monitored to ensure that agreed-upon measures are implemented successfully. The NMDGF requests notification upon project initiation and completion, as well as implementation and completion of mitigation measures.

10.14.4.2.3 Minimize Impacts on Vegetation

Efforts must be made during construction to minimize impacts on vegetative communities. Existing roads and rights-of-way should be used for all transportation. Off-road driving should be avoided. Staging areas should be located in previously disturbed sites, where possible, and kept as small as possible. Road realignments should be designed to minimize the amount of construction in previously undisturbed areas.

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[12] Water Quality Control Commission. 1992. *Water Quality and Water Pollution Control in New Mexico, 1992*. A report prepared for submission to the Congress of the United States by the State of New Mexico pursuant to Section 305(b) of the Federal Clean Water Act. NMED/SWQ-92/1. New Mexico Environment Department, Santa Fe, New Mexico. 263 pages.

10.14.4.2.4 Topsoil Removal

All topsoil removed for construction should be stockpiled and used as surface fill in reclamation of the project area. Following construction, disturbed areas should be revegetated using native species that approximate predisturbance plant community composition or native plant communities likely to be found in the area, whichever is more beneficial to wildlife. Other plant species may be used to provide quick establishment of ground cover on highly erodible areas. A revegetation plan must be included as a component of the project mitigation plan. The revegetation plan should specify: (1) areas to be planted; (2) species to be planted in each area; (3) quantity of species (e.g., pounds of seed per acre, number of poles, number of saplings) to be planted at each location; and (4) monitoring and maintenance (e.g., protection of the plantings).

10.14.4.2.5 Tree Replacement

All trees that are removed that are greater than six inches diameter at breast height should be replaced, at a suitable location near the site, at a 4:1 ratio. The project proponent should guarantee to monitor and maintain the plantings over a four-year period to ensure at least 80% survival at the end of that period in each planting area. This guarantee should be specified in the mitigation plan. If monitoring and maintenance cannot be guaranteed, trees should be replaced at a 10:1 ratio with cottonwood poles, saplings, or appropriate native tree species. All other woody vegetation should be replaced on an acre-by-acre basis with native species.

10.14.4.2.6 On-Site Revegetation

If possible, revegetation should be conducted on the disturbed site. If no suitable areas occur on-site (e.g., native riparian forest already exists, stocking level precludes planting additional trees, land ownership problems, etc.), where possible, revegetation plots should be located in the immediate vicinity of the impacted site. Consideration should be given to restoring areas dominated by non-native species such as salt-cedar, Russian olive, and Siberian elm.

10.14.4.2.7 Erosion Control

Erosion control measures must be implemented during construction to prevent introduction of sediment-laden runoff into surface waters (e.g., hay bales, silt screens, settling basins, sediment traps). No material excavated for bridge approaches may be introduced into the stream. Exposed soils, particularly on slopes, must be stabilized with vegetation as soon as possible to prevent excessive erosion.

10.14.4.2.8 Drainage Control

Drainage control features of the project must be designed to prevent soil erosion and impacts to surface-water quality. These measures should include, but not be limited to, the following: (1) culvert inverts should be level with existing channel bottom at inflow and outflow; (2) slope of culvert should match the gradient of the stream channel; (3) in watercourses with high stream flow velocity, the outlet of the culvert should be armored to prevent stream-bed degradation; (4) bar ditches and roadside drainage features should be designed to prevent excessive flow velocity and gully formation through consideration of slope and incorporation of energy dissipation features; (5) settling basins should be installed in areas where runoff contains high sediment loads to prevent sedimentation of receiving waters; (6) based on site-specific conditions, raised culverts at road crossings of ephemeral streams may be employed to raise the water table upgradient and promote development of mesic or wetland habitat. The NMDGF should be consulted during the planning stage to determine if a raised culvert is appropriate.

10.14.4.2.9 Net Loss of Wetland Habitat

No net loss of wetland habitat quantity or quality should occur. If losses are unavoidable, mitigation should be designed to replace lost area and value through in-kind (i.e., same type of wetland habitat type), on-site measures. The next option is to mitigate in-kind, off-site, preferably at an existing wetland where the result of mitigation would be expansion or enhancement.

10.14.4.2.10 Wetland Creation, Restoration, Enhancement Plan

A wetland creation/restoration/enhancement plan should be included as a component of the project mitigation plan if wetland impacts are unavoidable. This plan should include the following features, which will provide information necessary to evaluate the potential for success: (1) a description of desired biological and hydrological values and functions of the wetland creation/restoration/enhancement is necessary to establish objectives of the mitigation; (2) scale plans that describe location, configuration, aerial extent, side slopes and depth contours of proposed wetland creation/restoration sites; (3) profiles of proposed wetland creation/restoration sites, including adjacent river bed elevation (where applicable), should be provided to allow for assessment of the capacity of the proposed wetland to accommodate fluctuations in size (i.e., expansion and contraction) that may result from fluctuating hydrologic conditions; (4) characterization of groundwater hydrology and quality at wetland creation/restoration sites, including temporal variations in groundwater level and relationships between river stage (where applicable) and groundwater level; (5) a presentation of soil characteristics (e.g., salinity, permeability, organic matter content) at proposed wetland creation/restoration sites; (6) a description of proposed plantings, including quantities and locations, should be presented along with the proposed sources of the plants or plant propagules; (7) a monitoring and maintenance program, which includes consideration of trash removal, human-use monitoring and control, and vegetation management to maintain the stated wetland function and value goals.

This information should be used as the basis for wetland mitigation design. It will also enable reviewing agencies to adequately evaluate the mitigation plan.

10.14.4.2.11 Boulders and Rootwads

Boulders and rootwads dislodged during project activities should be placed within the stream to provide fish habitat. This activity should be planned and coordinated with the NMDGF and other natural resource agencies to maximize effectiveness and prevent detrimental impacts, such as accelerated bank erosion and channel destabilization.

10.14.4.2.12 In-stream Equipment

In-stream equipment activity is to be minimized, with no refueling, maintenance, or cleaning of equipment (e.g., cement trucks) in or near the watercourse. All construction equipment shall be inspected daily to ensure that leaks or discharges of lubricants, fuels, or hydraulic fluids do not occur. All fuels, lubricants, and hydraulic fluids must be stored and dispensed at least 200 feet away from the stream bank or outside of the 100-year floodplain. Any poured concrete shall be contained in forms and uncured concrete shall be prevented from being introduced into surface waters. The NMDGF must be notified in the event of any spills of toxic material into the stream or if sediments above State Water Quality Standards levels are introduced into the stream.

When in-stream equipment activity cannot be avoided, it is recommended this activity take place during low flow in the fall and winter months. This is generally when the least amount of biological damage to the system will be incurred. However, scheduling may be affected by the presence of spawning fish or wintering wildlife (e.g., bald eagles, waterfowl, wading, and shorebirds) or site-specific environmental constraints. The NMDGF should be contacted for recommendations under these circumstances.

10.14.4.2.13 Disturbance to Stream Substrate

Minimize disturbance of stream substrate to only that necessary for placing abutments or pilings. To preserve channel equilibrium and stability, stream channels should not be realigned, constricted, widened, changed in bed elevation, or otherwise altered.

10.14.4.2.14 Cofferdams

Cofferdams should be constructed of material that cannot be brought into suspension by flowing water (e.g., water bag barriers, concrete highway dividers). All in-stream work should be conducted "in the dry."

10.14.4.2.15 Use of Gravel

Gravel for surfacing, riprap, and other bank stabilizing materials, including all temporary and permanent structures placed into the watercourse, must be free of fines and chemical contaminants.

10.14.4.2.16 Catchment Devices

Tarpaulins or other catchment devices should be slung under the bridge in order to prevent debris, wastes, and toxic compounds from entering the stream. The New Mexico Environment Department must be notified for disposal of any toxic compounds.

10.14.4.2.17 Sandblasting

Sandblasting operations should include vacuum systems, or the bridge should be completely "bagged" to ensure collection of all lead paint and concrete debris.

10.15 PLANTS AND WILDLIFE

Biological surveys of the WSTF site observed four species of special concern. In addition, a discussion of one species (Northern Aplomado Falcon) is included that was not observed. It is recommended that consideration of all of these taxa be made in any future management plan. Recommendations for mitigation of environmental effects and management of these protected species are discussed below.

10.15.1 Night-blooming Cereus

Night-blooming Cereus is an extremely rare species in the southwestern United States. Few populations have been observed in the wild. Moreover, this species is highly sought after for commercial and personal use. A very small population (n= 2 individuals) was discovered in Section 26 adjacent (15 m) to the eastern boundary of the Landfill, and within about 0.3 m (1ft) of an existing dirt road. One individual is in danger of being crushed from vehicular traffic, which has been subsequently blocked, used in maintenance of the road and near by powerline. In fact, this particular plant exhibits scaring characteristic of previous encounters with vehicles. WSTF management has blocked traffic away from this area since the discovery of the first individual. The other individual was discovered in the spring 1996 survey. It is approximately 300 m (1,000 ft.) north from the first individual parallel with the powerline. This individual is safe from most unnatural disturbances, such as traffic or road maintenance activities. Because of the rarity of these species, it is recommended that WSTF continue to restrict access to this area. However, in the event that construction or testing must occur near by, it is suggested that this individual be transplanted to a alternate site with a similar microhabitat, after consultation with the appropriate State of New Mexico resource agency.

10.15.2 Koch's Land Snail (*Ashmunella kochi kochi*)

Koch's land snail inhabits higher, more mesic, elevations within the piñon-juniper woodland macrohabitat. Dominant topography consists of rock seams in steep canyons and cliffs associated with mesic vegetation and abundant shade. Because this species is an excellent indicator of biodiversity and quality of natural habitat, it is recommended that these populations be monitored on a yearly basis. Because of the isolated nature of these populations, it not anticipated that future development in areas of critical habitat will occur. A primary concern would be construction of an access road or facilities on top of Quartzite Mountain that would result in rock-roll and deposition of earth and construction material over the edge and down slope into areas inhabited by snails.

10.15.3 Texas Horned Lizard (*Phrynosoma cornutum*)

The Texas horned lizard is a diurnal species that inhabits arid and semi-arid open country with sparse plant growth of grass, cactus, juniper, acacia, and mesquite. *P. cornutum* prefers areas with some loose soil; therefore, soil compaction should be avoided in all areas known to provide habitat for this species. In addition, construction activities in areas where Texas horned lizards have been observed should be avoided during the egg laying and hatching periods of April to July. Although some individuals of this species potentially would be impacted by construction activities (physical and noise) associated with any proposed Action, such activities would not result in a trend to Federal listing or loss of viability.

Although elimination of all potential adverse impacts to horned lizards is difficult because they live in underground burrows, several measures can be enacted to reduce the number of horned lizards lost due to testing an construction activities. Testing and construction activities where horned lizards are known to occur should be avoided, if possible, during the egg laying and hatching period from April to July. This would allow young lizards time to hatch and disperse throughout the local area.

10.15.4 Northern Aplomado Falcon (*Falcon femoralis septentrionalis*)

Although the northern *F. f. septentrionalis* is not known to nest on WSTF, recent sightings suggest that this species may be expanding its range into southern New Mexico (USFWS pers. comm. 1995). The area along the western base of the foothills of Quartzite Mountain at the eastern corner of the WSTF property is considered potential "critical habitat" for the Northern Aplomado Falcon, particularly in areas dominated by mesquite and yucca. The Environmental Services Branch of the USFWS is currently updating the recommended survey methodology for *F. f. septentrionalis* in New Mexico (Leal et al. 1996). This document should be consulted if surveys by the contractor are requested. Otherwise, surveys should be performed by a qualified biologist.

10.15.5 Loggerhead Shrike (*Lanius ludovicianus*)

Although this taxon is a Federal Candidate species, its status is classified as unknown (U), indicating that additional survey work is required to determine its current distribution, abundance population trends, and ultimate listing. This species inhabits open spaces, grasslands, deserts, woodlands, and riparian areas. Individual birds and pairs of birds commonly are observed perch-hunting from fences that overlook grassland and sagebrush habitat and from taller shrubs (mesquite, saltbush) that occur along roadways.

The biological surveys of the WSTF facility recorded numerous individuals of this species in shrubland and mesquite sand dune habitat throughout the study area. However, because most projects are temporary and do not adversely affect or reduce feeding or nesting habitat, no significant impact is expected for this species from most proposed actions. However, because of the general lack of quantitative information on the species, nests and characteristic habitat for *L. ludovicianus* should be avoided during all phases of any construction activity, particularly during the nesting season.

10.16 Species/Biological Diversity

Topographic heterogeneity and species diversity of plant and animals surrounding the Love Ranch and lower Bear Canyon areas represent the most unique and relatively undisturbed natural habitat found on the WSTF property. Bear Canyon encompasses a unique local composite of both mesic and xeric habitats found within the San Andres Mountains. Several biotic communities that contribute to the overall uniqueness of the San Andres Mountains are restricted to this area, including land snails and numerous species of cacti.

As stewards of the land it is recommended that this area be protected from short and long term disturbance. If disturbance is unavoidable, users should be specifically briefed by a qualified staff biologist/environmental scientist as to the location of sensitive species any managed biological areas/resources. Specific areas of potential disturbance should be surveyed during the spring, summer, and fall flowering, breeding, and migratory seasons for plants and birds. Many plant and avian species have seasonally restricted reproductive periods. Disturbance during this time may adversely affect the ability to detect the presence of a species of special concern, or terminate the reproductive cycle (i.e., abandon a nest).

Application of the above biological and ecological mitigation recommendations should reduce to insignificance the potential impacts to all plant and animal species, and to any Threatened and Endangered taxon that might be found in the project area in the future.

11 RECOMMENDATIONS FOR ENVIRONMENTAL RESTORATION

- Qualified members of the environmental staff should conduct a pre-site survey to identify existing site conditions prior to initiation of testing and construction activities. These surveys will serve as a benchmarks for restoration of any areas disturbed by construction activities to as near its original condition as possible. In addition, it is recommended that photographic points be established throughout the area. Each point should include as many features of the landscape as possible, including close photo-documentation, aerial photographs, and photographs of disturbed and undisturbed areas. Photographs taken once every 1-3 years is recommended. These photographs become a source of baseline information, and can be used to detect trends that may not be readily apparent to the casual observer.

- Once operations within a particular project area are completed, or when project needs for a particular area have been terminated, all disturbed areas that are no longer required for testing/operations should be immediately returned to its original native condition. This may include immediately seeding and revegetating with native vegetation, and recontouring the land to predisturbance topographic relief.

- Any native landscape features scarred or damaged by construction equipment or maintenance operations should be restored, as nearly as possible, to its original condition pursuant to WSTF's resource management plan. This also may include immediately seeding and revegetating with native vegetation, and recontouring the land to predisturbance topographic relief.

- Recontouring and reseeding of sites is recommended as part of any site abandonment. A 1:1 in-kind replacement of acreage through re-vegetation should take place when projects result in a loss of grassland-shrub species, particularly in grassland-juniper and arroyo vegetation zones. Further, species of plants (grass and shrubs) should be seeded/planted from genetic stocks endemic to the local area.

- Regarding temporary site facilities, the contractor should be required to obliterate all signs of temporary construction facilities. In addition, the contractor should take all reasonable steps to restore areas occupied by temporary construction facilities to near natural conditions.

- All hazardous materials and excess concrete should be removed from the construction site and properly disposed of. All metal, man-made materials, building debris, and trash that has accumulated in the project area should be collected and recycled, or disposed of in accordance with the WSTF recycling plans. A grass/shrub seed mixture for the WSTF site is indicated below.

Table 1. Grass/shrub Seed Mixture Recommended for Potential Trenching and Fiber Optic Cable Feeder Lines

Common Name	Species Name	Minimum Standards			
		Lbs/Acre	Purity %	Germination %	Pure Live Seed %
Alkali Sacaton	*Sporobulus airoides*	3 lbs/acre	85%	80%	75%
Giant Dropseed	*Sporobulus giganteus*	2 lbs/acre	85%	80%	75%
Indian Rice Grass	*Oryzopsis humenoides*	3 lbs/acre	90%	90%	80%
Blue Grama	*Bouteloua gracilis*	3 lbs/acre	95%	90%	95%
Little Bluestem/New Mexico Blue Stem	*Andropogon scoparius* var. *neomexicanus*	2 lbs/acre	95%	90%	95%
Four-wing Saltbush	*Atriplex canescens*	2 dewinged or 4 winged lbs/acre	—	75%	75%

Note: Total mixture is about 15 lbs/acre. Mixture can be drilled (1/4" depth) or broadcast by individuals with experience in seeding projects. If using a drill, one may need to use a seed box because of the fine seeds of Alkali Sacaton. Because it is not a pure sacaton mixture, the bulk of the other seed sizes may prevent sacaton seeds from setting to the bottom or running out too rapidly from the seed box. Seed source should be from stock as locally adapted as possible Seed must be able to grow in this environment (i.e., seeds from other parts of the West may be better adapted to higher rainfall amounts or warm winter temperatures).

- The open air sewage treatment lagoons are being used by a high diversity of wildlife species. During the biological survey WSTF management expressed concern that biological survey team stay away from the lagoons, due to safety concerns. However, if these areas are considered hazardous to humans, then they also are likely to be unsafe for numerous species (and hundreds of individual) of animals that drink and forage in the effluent.

Although not planned for such purposes, construction of sewage-treatment plants often creates wildlife habitat for a number of aquatic species. For water fowl and shorebirds, lagoons are unusual habitat because the water is often deep and the edges lack emergent vegetation and in fact, may be covered with rock, rubber, or other hard-surfaced materials (Swanson 1977). Instead, the attractive component seems to be the abundance of invertebrate food supplies available in nutrient-enriched ponds, and in arid environments abundant free water. Uhler (1956, 1964) perhaps was the first to describe waterfowl use and production on sewage lagoons, underscoring the abundance there of midge larvae and other invertebrates—more so than in natural wetlands. Midges are particularly well-known sources of protein required by nesting hens and ducklings; McKnight and Low 1969), and in sewage-treatment lagoons in Missouri, there numbers—sometimes exceeding 16 per cm^{2-}made up more than 94 percent of the total insect population (Kimerle and Enns 1968). Maxson (1981) recorded waterfowl use of a sewage lagoon in North Dakota and noted that this habitat served migrating and premolting birds as well as those raising broods, More that 60 waterfowl broods were recorded on the 263-ha lagoon each year—one brood per 183 m of shoreline.

However, sewage environments may promote avian diseases feather-wetting from detergent accumulations (Choules et al. 1978), or poisoning from Blue-green algal toxins (Olson 1964). Therefore, within the confines of their primary purpose, sewage lagoons may pose a variety of management concerns for wildlife resources on WSMR. These concerns need to be identified and evaluated relative to the overall affect of sewage lagoons on survival and reproduction of local and migratory wildlife.

Therefore, it is recommended that measures be taken to insure that these lagoons are safe for animals to use, both as a free water source and as a foraging area. This can be done by using permaculture techniques and converting ponds into natural wetlands.

- The NASA Johnson Space Center (JSC) White Sands Test Facility (WSTF) Facilities Master Plan (FMP) expresses a concern for fostering a stewardship management and conservation of natural resources and natural landscaping. The WSTF policy is to employ corrective or safeguard measures that minimize the evidence of human activities on the natural environment.

A prerequisite for reaching this goal is to maintain natural floristic and faunistic densities and species compositions at levels prior to the onset of any proposed testing or construction activities—where ever and when ever possible. For example, where dense populations of cacti occur in an area scheduled for disturbance, transplanting these cacti would foster a stewardship management practice consistent with the FMP, even in situations where a no action management approach may be taken without legal consequences. This kind of proactive approach to resource management issues also would be politically popular. In addition, continued natural landscaping around facilities also is a positive strategy for minimizing impact and alteration of the natural arid-land ecosystem found at the WSTF site, and should be encouraged.

12 ADDITIONAL RECOMMENDATIONS FOR RESOURCE MANAGEMENT

12.1 NESTING RAPTOR SURVEY

A spring follow-up raptor survey should be conducted throughout all low lying habitat to determine the percent use and fledgling success rate of desert-scrub habitat by raptors on all low-lying WSTF property. The significance of the WSTF property as a nesting area and breeding area for local and migratory raptors is extremely important indicator of local biodiversity and ecosystem health.

12.2 NEOTROPICAL AND MIGRATORY BIRD SURVEYS

The Rio Grande Valley is a major thoroughfare for the migrating birds through New Mexico. Various species migrate along this corridor to feeding grounds in the south and nesting areas in the north. Therefore, a survey for avian species during at least one of these seasons (usually spring or fall) is recommended. Sampling techniques such as mist netting would provide an accurate assessment of species composition in the local WSTF area.

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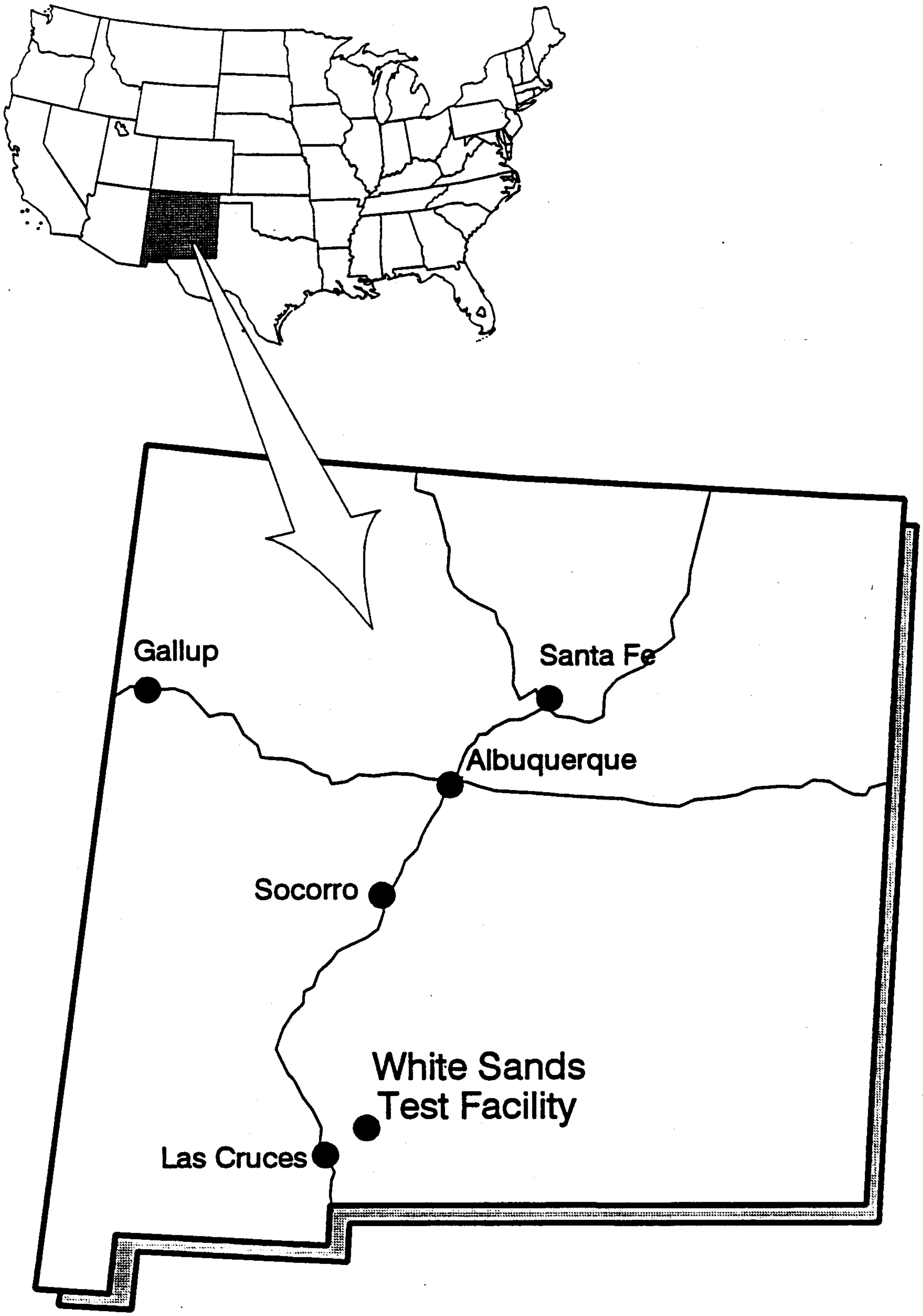

Figure 1. General Location of the White Sands Test Facility

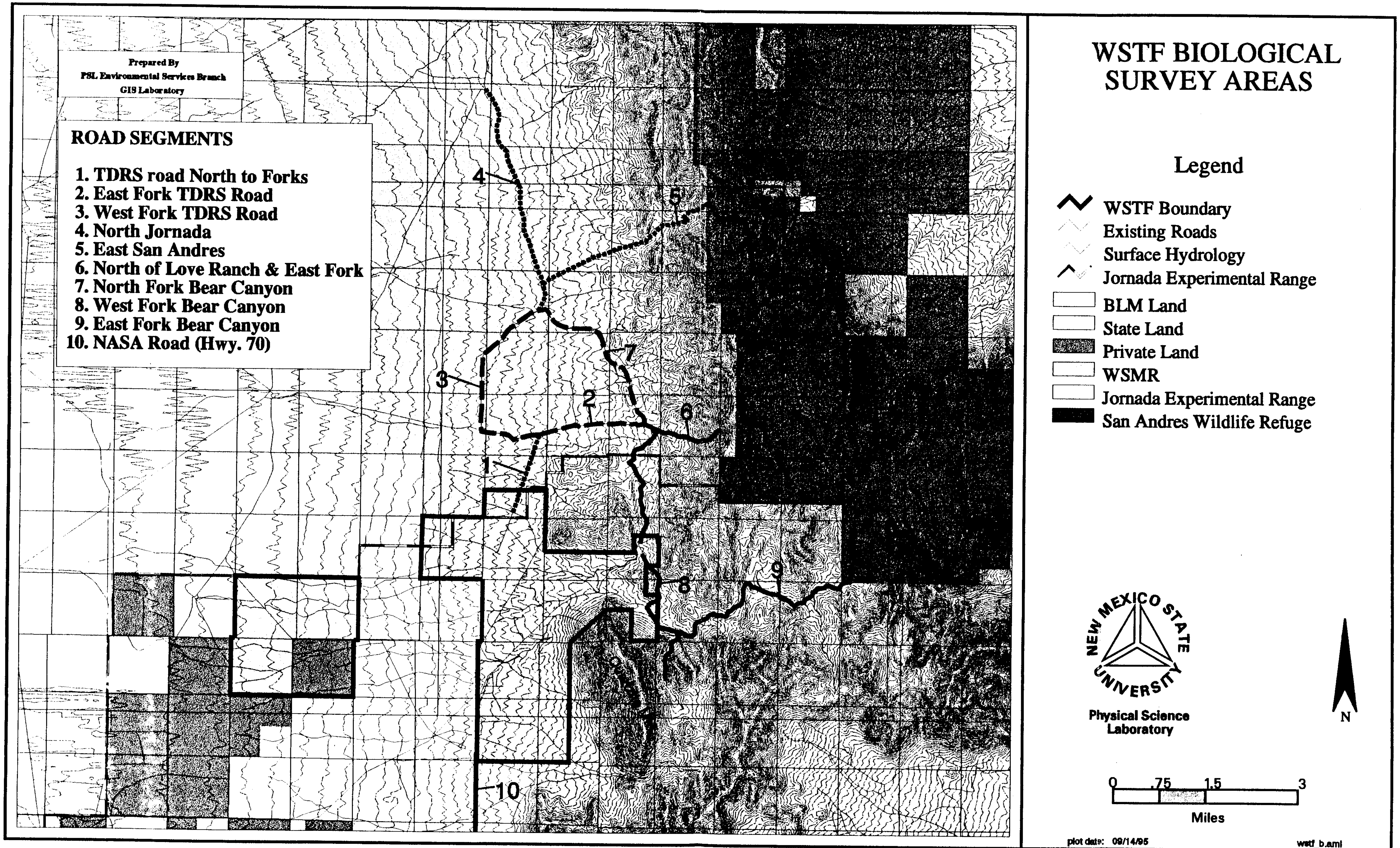

Figure 2. General locations of the White Sands Test Facility Study Area and associated roadways.

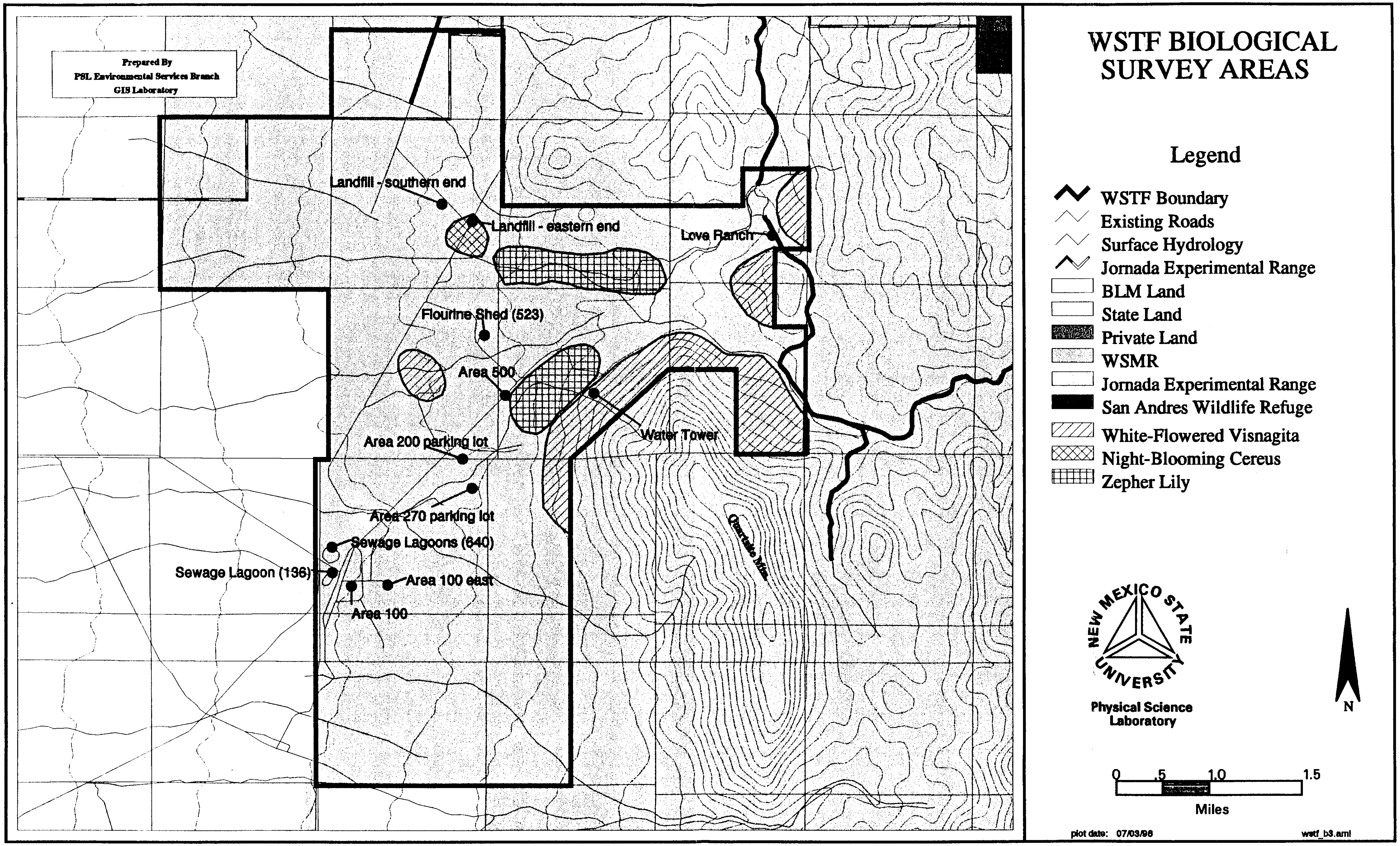

Figure 3. Distribution of Listed Species of Plants.

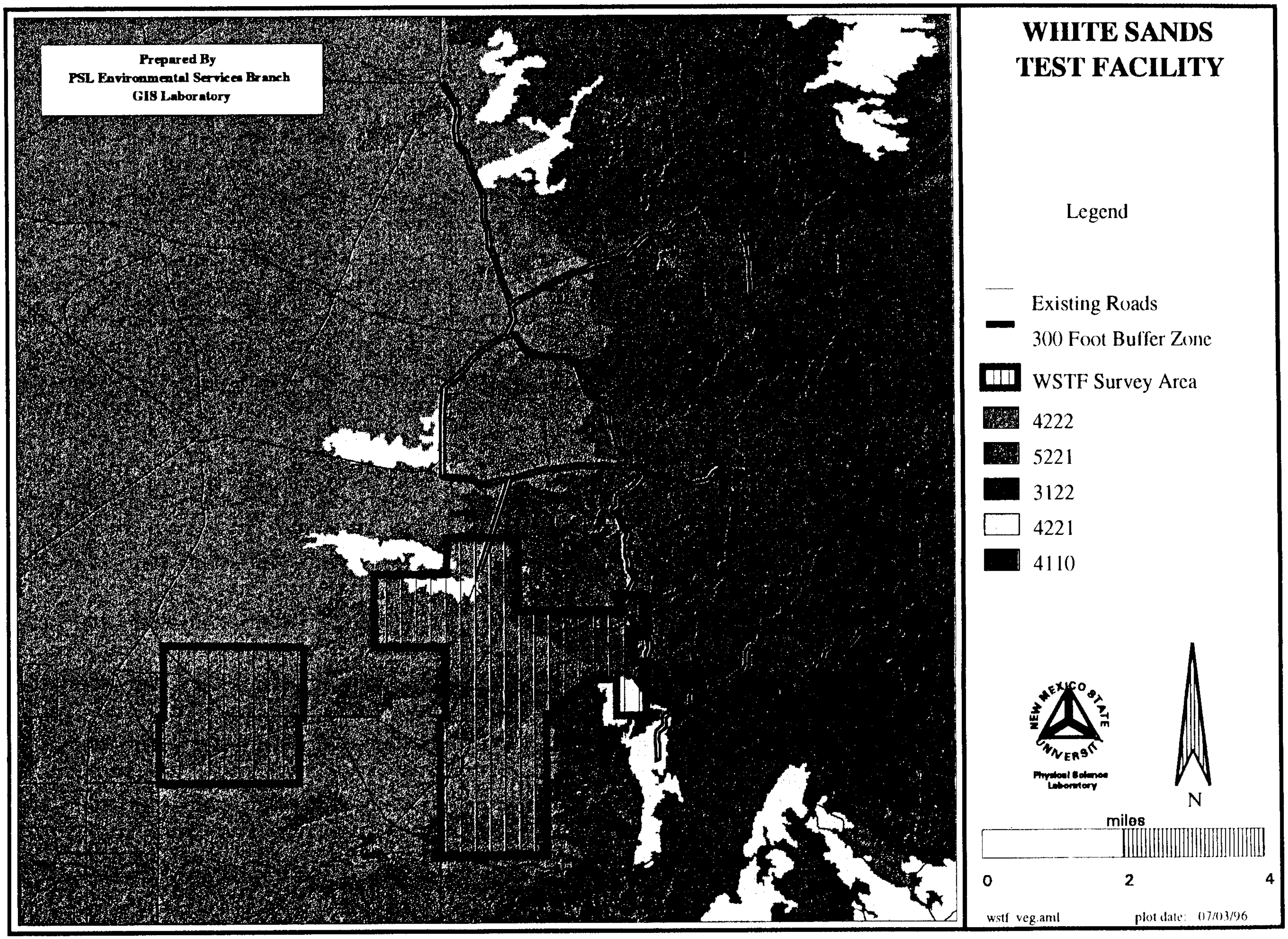

Figure 4. Major Vegetation Communities Found Within the WSTF Boundaries and Fire Roadways

APPENDICES

Appendix A. List of plant species of special concern potentially found at WSTF, Doña Ana County, New Mexico. State of New Mexico and Federal criteria for listing are provided in Appendix C. [CHIHUAHUAN DESERT SCRUB: Hot, dry plains with widely scattered shrubs typically Cresote bush, Tarbush, Mesquite, Acacia, Yucca and warm seasoned grasses at about 5,500 ft elevation. INTERIOR CHAPARRAL: Relatively dense shrub associated on desert mountain slopes including live Oak, Manzanita, Mountain Mahogany, Silktassel, Sotol, and Catclaw. MADREAN EVERGREEN WOODLAND: A mild winter-wet summer woodland of Mexican Oaks and Pines. PLAINS & GREAT BASIN GRASSLANDS: Mostly short-grass plains of Grama, Wheatgrass, Three-awn, Muhly, and Buffalograss. GREAT BASIN CONIFER WOODLAND: Cold adapted evergreen woodland at intermediate elevations, below 7,500 ft. Includes mostly piñon-juniper. ROCKY MOUNTAIN MONTANE CONIFER FOREST: Mountain forests represent Merriam's Transitional Zone (ponderosa pine) and Canadian Zone (Douglas fir-white fir). Gamble oak and New Mexico locust are also important. Elevation ranges around 7,500 to 10,000 ft. SUBALPINE GRASSLAND: Cold, high elevation (7,500 to 12,000 ft) grasslands that occupy valleys, slopes and ridges within montane and subalpine conifer forests. SEMIDESERT GRASSLANDS: Hot, dry plains of warm season grasses such as black Grama, Dropseed, Tobosa, and burro grass, mesquite and Soaptree yucca.(Sivinski and Lightfoot, 1994 and 1995)]

Family	Scientific Name	Common Name	State Index	Status		Distribution outside NM	Habitat Type	Remarks
				NM	Federal			
Amarillidaceae	*Zephryanthes longiflolia*	Zephry Lily	None	L4	None	Arizona, Texas, Mexico	Chihuahuan desert scrub, Great basin conifer woodland, Interior chaparral	Not Listed as a protected species, too common.
Asteraceae	*Brickellia lemmonii var. wootonii*	Wooton's Bricklebush	?-?-?	L3	None	Mexico	Interior chaparral	More Information needed on distrubution
Asteraceae	*Hymenoxya quinquesquamata*	Five Scale Bitterweed	1-1-2	L2	None	Arizona	Great basin conifer woodland	None
Asteraceae	*Hymenoxys vasseyi*	Vassey's Bitterweed	3-1-3	L2	None	Arizona, Texas	Great basin conifer woodland, Interior chaparral	None
Asteraceae	*Perityle cernua*	Nodding Cliff Daisy	2-1-3	L2	C	Endemic	Interior chaparral, igneous cliffs	Narrow endemic of the Organ Mts.

Family	Scientific Name	Common Name	State Index	Status		Distribution outside NM	Habitat Type	Remarks
				NM	Federal			
Brassicaceae	*Draba standleyi*	Standley's Whitlow Grass	2-1-2	L2	C	Arizona, Texas, Mexico	Interior chaparral, Rocky Mountain Subalpine Conifer Forest, cliffs & crevices	Presently known only form the Organ Mts, Davis Mts (Tx), Chiricahua Mts (Az).
Cactaceae	*Coryphantha scheeri var. uncinata*	Scheer's Pincushion Cactus	2-2-2	L1	None	Arizona, Texas, Mexico	Chihuahuan desert scrub, Semidesert Grassland	Most common SHeer's cactus in NM
Cactaceae	*Coryphantha scheeri var. valida*	Scheer's Pincushion Cactus	1-2-1	L4	None	Texas, Mexico	Chihuahuan desert scrub	Barely enters NM, along the Rio Grande Valley along the TX border
Cactaceae	*Epithelantha micromeris*	Button Cactus	1-2-1	L4	None	Arizona, Texas, Mexico	Chihuahuan desert scrub, Semidesert Grassland, Interior chaparral, limestone	None
Cactaceae	*Escobaria orcuttii*	Orcutt's Pincushion Cactus	1-2-2	L3	None	Arizona, Mexico	Chihuahuan desert scrub, Interior chaparral	None
Cactaceae	*Escobaria organensis*	Organ Mt. Pincushion Cactus	1-2-3	L1B	None	Endemic	Great basin conifer woodland, Interior chaparral	None
Cactaceae	*Escobaria sandbergii*	Sandberg's Pincushion Cactus	2-2-3	L2	None	Texas, Mexico	Chihuahuan desert scrub, Interior chaparral, Great basin conifer woodland, limestone	Known only from the shouthern end of the San Andres Mts.
Cactaceae	*Esobaria sneedii var. sneedii*	Sneed's Pincushion Cactus	2-2-2	L1	LE	Texas	Interior chaparral, limestone	Occasionally common within habitat

Family	Scientific Name	Common Name	State Index	Status		Distribution outside NM	Habitat Type	Remarks
				NM	Federal			
Cactaceae	*Mammillaria wrightii var. wrightii*	Wright's Pincushion Cactus	1-2-2	L4	None	Arizona, Texas	Great basin conifer woodland, Plains & great basin grasslands, Semidesert Grassland	Proposed for delisting
Cactaceae	*Neolloydia intertexta var. dasyacantha*	White-flowered Visnagita	1-1-1	L4	None	Texas, Mexico	Semidesert Grassland, Chihuahuan desert scrub	Proposed for delisting
Cactaceae	*Neolloydia intertexta var. intertexta*	Early Bloomer	1-1-1	L4	None	Arizona, Texas, Mexico	Semidesert Grassland, Chihuahuan desert scrub	Proposed for delisting
Cactaceae	*Opuntia arenaria*	Sand Prickly Pear	2-2-2	L1B	C	Texas, Mexico	Semidesert Grassland, sand	Narrow distrubution along the Rio Grande
Cactaceae	*Opuntia wootonii*	Wooton's Prickly Pear	?-?-3	L3	None		Semidesert Grassland, Chihuahuan desert scrub	Not a well understood species
Cactaceae	*Pediocactus papyracanthus*	Grama Grass Cactus	1-2-2	L4	C	Arizona, Texas	Semidesert Grassland, Great basin conifer woodland, Plains & great basin grasslands, sandy or gypseous soil	Very cryptic
Cactaceae	*Peniocereus greggii var. greggii*	Night-blooming Cereus	1-3-1	L1C	C	Texas, Mexico	Chihuahuan desert scrub	Many historical populations have been extirpated

Family	Scientific Name	Common Name	State Index	Status		Distribution outside NM	Habitat Type	Remarks
				NM	Federal			
Caryophllaceae	*Silene planki*	Plank's cactshfly	1-1-2	L2	C	Texas	Semidesert Grassland, P&GBrl, wetlands, wet meadows	None
Cucurbitaceae	*Sicyos glaber*	Smooth Cucumber	1-1-2	L2	None	Texas	Semidesert Grassland, Plains & great basin grasslands, Riparian, wetlands, alkaline soils	None
Dryopteridaceae	*Phanerophlebia auriculata*	Mexican Ear Fern	?-1-1	L3	None	Arizona, Texas, Mexico	Great basin conifer woodland, Interior chaparral, cliffs, crevices	Very Rare in NM & Tx
Fabaceae	*Astragalus castetteri*	Castetter's milkvetch	1-1-3	L2	C		Interior chaparral, Great basin conifer woodland, limestone	Occasionally common within its range
Gentinaceae	*Eustoma exaltatum*	Catchfly gentian	1-2-1	L2	None	Florida, Californa, Mexico to Belize	Semidesert Grassland, Plains & great basin grasslands, wetlands, wet meadows	None
Gentinaceae	*Eustoma russellianum*	Prairie gentian	1-2-2	L2	None	Colorado, Nebraska, Oklahoma,Texas, Mexico	Semidesert Grassland, Plains & great basin grasslands, riparian, wetlands, alkaline soils	None
Lamiaceae	*Agastache pringlei var. verticillata*	Whorled Giant Hyssop	?-?-3	L2	None		Interior chaparral	Information needed

Family	Scientific Name	Common Name	State Index	Status		Distribution outside NM	Habitat Type	Remarks
				NM	Federal			
Lamiaceae	*Agastache cana*	Mosquito Plant	1-1-2	L2	None	Texas	Great basin conifer woodland	Recorded from the headwaters of the Pecos
Malvaceae	*Sphaeralcea wrightii*	Wright's Globemallow	?-1-?	L3	None	Mexico	Chihuahuan desert scrub	Information needed
Onagraceae	*Oenothera organensis*	Organ Mt. Evening Primrose	2-2-3	L2	C	Endemic	Madrean evergreen woodland, riparian	Endemic to Organ Mts
Polygalaceae	*Polygala rimulicola var. mescalerorum*	Mescalero milkwort	3-3-3	L1B	C	Endemic	Interior chaparral, limestone cliffs	Endemic to WSMR, San Andres Mts. Known from 173 individuals
Portulacaceae	*Talinum longipipes*	Long-Stemmed Flame Flower	1-1-3	L2	C		Chihuahuan desert scrub, limestone	None
Scrophulariaceae	*Castilleja organorum*	Organ Mt. Paintbrush	1-1-3	L3	None		Great basin conifer woodland, Rocky Mountain Subalpine Conifer Forest	None
Scrophulariaceae	*Penstemon ramosus*	Branching Penstemon	2-1-2	L2	None	Arizona	Interior chaparral	None
Scrophulariaceae	*Scrophulariaceae*	Smooth Figwort	1-2-2	L2	C		Great basin conifer woodland, Rocky Mountain Subalpine Conifer Forest, moist canyons	Endemic to the Organ Mta. Flowers mostly red, but may vary with amounts of green
Scropulariaceae	*Penstemon alamosensis*	Alamo Beardtongue	2-1-2	L2	C		Inteior chaparral, Great basin conifer woodlandl, limestone slopes, cliffs	Numerous plants in the San Andres Mts on WSMR

Appendix B. List of animal species of special concern potentially found in the vicinity of WSTF, Doña Ana County, New Mexico. Federal and State of New Mexico criteria for Endangered, threatened, and sensitive species are listed in Appendix C.

Family	Scientific Name	Common Name	Status	
			NM	Federal
GASTROPODS				
Polygyridae	*Ashmunella koci kochi*	Koch's Land Snail	S	n/a
REPTILES				
Helodermatidae	*Heloderma suspectum*	Gila Monster	1	n/a
BIRDS				
Accipitridae	*Buteogallus anthracinus*	Common Black Hawk	2	n/a
Accipitridae	*Falco peregrinus*	Peregrine Falcon	1	Endangered
Accipitridae	*Haliaeetus leucocephalus*	Bald Eagle	2	Endangered
Accipitridae	*Ictinia mississippiensis*	Mississippi Kite	2	n/a
Caprimulgidae	*Caprimulgus ridgwayi*	Buff-Collared Nightjar	1	n/a
Columbidae	*Columbina passerina*	Common Ground-Dove	1	n/a
Emberizinae	*Ammodramus bairdii*	Baird's Sparrow	2	n/a
Emberizinae	*Passeria versicolor*	Varied Bunting	2	n/a
Falconidae	*Falco femoralis septentrionalis*	Northern Aplomado Falcon	1	Endangered
Falconidae	*Falco peregrinus anatum*	American Peregrine Falcon	1	Endangered
Gruidae	*Grus americana*	Whooping Crane	2	Endangered
Lanidae	*Lanus ludovicianus*	Loggerhead Shrike	S	Candidate
Laridae	*Sterna antillarum athalassos*	Interior Least Tern	1	Endangered
Phalacrocoracidae	*Phalacrocorax olivaceus*	Olivaceous Cormorant	2	n/a
Strigidae	*Speotyto cunicularia hypugea*	Western Burrowing Owl	n/a	Candidate
Strigidae	*Strix occidentalis lucida*	Mexican Spotted Owl	2	n/a
Trochilidae	*Calypte costae*	Costa's Hummingbird	2	n/a
Trochilidae	*Cynanthus latirostris*	Broad-Billed Hummingbird	2	n/a
Tyrannidae	*Empidonax traillii extimus*	Southwestern Willow Flycatcher	2	Endangered
Vireonidae	*Vireo vicinior*	Gray Vireo	2	n/a

Family	Scientific Name	Common Name	Status	
			NM	Federal
Vireonidae	*Vireo bellii*	Bell's Vireo	2	n/a
REPTILES				
Iguanidae	Phrynosoma cornutum	Texas Horned Lizard	S	Candidate
MAMMALS				
Bovidae	*Ovis canadensis*	Bighorn Sheep	1	n/a
Geomyidae	*Geomys arenarius*	Desert Pocket Gopher	n/a	Candidate
Geomyidae	*Thomomys umbrinus emotus*	Southern Pocket Gopher	2	n/a
Molossidae	*Eumops perotis californicus*	Greater Western Mastiff Bat	S	Candidate
Molossidae	*Myotis ciliolabrum*	Small-footed Myotis	n/a	Candidate
Molossidae	*Myotis thysanodes*	Fringed Myotis	n/a	Candidate
Molossidae	*Myotis volans*	Long-legged Myotis	n/a	Candidate
Molossidae	*Myotis yumanensis*	Yuma Myotis	n/a	Candidate
Molossidae	*Nyctinomops/Tadarida macrotis*	Big Free-tailed Bat	n/a	Candidate
Cricetidae	*Neotoma micropus leucophaeus*	White Sands Woodrat	S	Candidate
Mustelidae	*Mustela nigripes*	Black-footed Ferret	1	Endangered
Sciuridae	*Cynomys ludivicianus arizonensis*	Arizona Black-tailed Prairie Dog	S	Candidate
Sciuridae	*Tamias quadrivittatus australis*	Colorado Chipmunk	2	n/a
Vespertilionidae	*Euderma maculatum*	Spotted Bat	2	Endangered
Vespertilionidae	*Plecotus townsendii pallescens*	Pale Townsend's Big-Eared Bat	n/a	Candidate
* New Mexico Department of Game and Fish, *Handbook of Species Endangered in New Mexico.*				

Appendix C. Federal and State of New Mexico criteria for threatened, endangered, and sensitive species of plants and animals. Currently, Threatened, Endangered, and Sensitive of plants and animals in New Mexico are classified within various jurisdictional frameworks, including the USFWS Endangered Species Act, New Mexico Endangered Plant Species Act, and the USFS Sensitive Species list. Each agency maintains its own list that it considers important for protection or review. Each list has categories distinct from one another. The following is a brief discussion of these categories as they relate to both plant and animal species of special concern that potentially could be in the biological survey area (Sivinski and Lightfoot, 1995).

FEDERAL STATUS

U.S. Fish and Wildlife List:

The USFWS maintains lists for species that it considers Endangered, Threatened, proposed endangered, proposed threatened, Candidate, 3A, 3B and 3C. Species potentially occurring in the biological survey area are Category C2 and 3C; legal designations are as follows:

LE: Listed as Endangered by the USFWS under the ESA

LT: Listed as Threatened by the USFWS under the ESA

PE: Proposed by the USFWS to be listed as endangered under the ESA

PT: Proposed by the USFWS to be listed as threatened under the ESA

Candidate (C1).—Category 1 candidates are species for which there is enough substantial information on biologic vulnerability and threats(s) to support proposals to list them as endangered or threatened.

Category 2 Candidate (C2).—Category 2 candidates are species for which additional information is needed to support a proposal to list as threatened or endangered.

Note: These species receive no protection under the ESA unless they become listed as threatened or endangered.

Category 3 Species.—Category 3 taxa are those species that were once considered for listing as endangered or threatened, but are not currently receiving such consideration. These taxa include the 3A, 3B and 3C designations.

Category 3A Species.—Category 3A designation comprises taxa for which the USFWS has persuasive evidence of extinction. If rediscovered, however, such taxa might warrant high priority for additions to the Endangered Species List.

Category 3B Species.—Category 3B designation comprises names that on the basis of current taxonomic understanding, usually as represented in published revisions and monograph do not represent taxa meeting the legal definition of a species as defined in the ESA.

Category 3C Species.—Category 3C designation is applied to those taxa that have proven to be more abundant or widespread than previously believed and have no identifiable threats.

FFS.—U.S. Forest Service Sensitive Species List (USFS). The USFS sensitive rare plant species are those considered sensitive to land use practices within each specific National Forest. Potential impacts to these species on USFS land are regulated by USFS management policies. Collection of these species requires a permit issued by the USFS. Lists are specific to each National Forest.

NEW MEXICO STATUS

State of New Mexico Plant Lists:

The New Mexico Forestry and Resources Conservation Division, Energy, Minerals, and Natural Resources Department (NMFD) maintains four lists in an effort to categorize degrees of concern. There is a potential that New Mexico endangered and sensitive plants could occur within the biological survey area.[1] Legal designations are:

List 1. Plant Species Endangered in New Mexico

L1A The taxon is listed as threatened or endangered under the provisions of the ESA (16 U.S.C. Sections 1531 et seq.); or

L1B The taxon is so rare across its entire range and of such limited distribution and population size that unregulated collection could jeopardize its survival in New Mexico; or

L1C The taxon may be widespread in adjacent states or Mexico, but its numbers are being significantly reduced to such a degree that within the foreseeable future the survival of the taxon within New Mexico is jeopardized.

List 2. New Mexico Rare and Sensitive Plant Species

This list contains taxa that are considered to be rare because of restricted distribution or low numerical density. They need not be endemic to New Mexico, but must be regionally endemic or rare throughout their range. Since they are rare, these species are sensitive to long-term or cumulative land use impacts and are vulnerable to biological or climatic events that could eventually threaten them with extinction or extirpation. List 2 is monitored by the State of New Mexico to determine if they should ever be elevated to List 1—they are not protected by state statute or policy.

List 3. New Mexico Rare Plant Review List

Species on the New Mexico Rare Plant List are plants about which more information is needed. All are under consideration for Lists 1 or 2, but data are lacking to either list or reject them. Species on this list are taxonomically questionable or poorly understood as to distribution and endangerment. They are not protected by the state statute or policy. Some of these plants, however, are in need of prompt attention. Placement on the Review List should not diminish the concern for their continued survival in New Mexico.

List 4. Plant Species Considered, But Not Included

This list contains all taxa occurring on the 1985 New Mexico Heritage Program Element List that were considered, but not included on Lists 1, 2, or 3. It also contains species rejected during a 1991 interagency review and taxa originally included on Lists 2 and 3 in 1992, but were later determined to be too abundant to retain.

The R-E-D Code

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1 The 32 taxa presently on the list are protected from unauthorized collection or take under the New Mexico Endangered Plant Species Act (9-10-10 NMSA) and attendant regulation NMFRCD Rule No. 91-1. Taxa on this list are included for any one of the L1A, L1B, L1C criteria.

The R-E-D Code is used in by the State of New Mexico for developing an inventory of plants with regard to: rarity, endangerment, and distribution. Each code is divided into three classes or degrees of concern, represented by the number 1, 2, or 3. In each instance, the higher the number, the more critical the concern. This R-E-D system code is defined as follows:

R (Rarity index): (1) rare, but found in sufficient numbers and distributed widely enough that the potential for extinction is low; (2) occurrence confined to several populations or to one extended population; (3) occurrence limited to one or a few highly restricted populations, or present in such small numbers that it is seldom reported.

E (Endangerment index): (1) not endangered, (2) endangered in a portion of its range, (3) endangered throughout its range.

D (Distribution index): (1) more or less widespread outside New Mexico, (2) rare outside New Mexico, (3) endemic to New Mexico.

Example: The Santa Fe Milkvetch (*Astragalus feensis*) M. E. Jones--is designated by the State of New Mexico as a Rare and Sensitive Species (Code 1-1-3). For this specific code, the first digit is the Rarity index ("rare, but found in sufficient numbers and distributed widely enough that the potential for extinction is low for the foreseeable future"), the second digit represents Endangered index ("not endangered"), and the third digit is the Distribution index ("endemic to New Mexico").

State of New Mexico Animal Lists:

Listing of animals as Endangered by the State of New Mexico is the function of the New Mexico Department of Game and Fish (NMDGF), as approved by the State Game Commission. This authority is granted under the Wildlife Conservation Act (NMSA 17-2-37 through 17-2-46, 1978 compilation, which became effective on 1 July 1974. Under the Wildlife Conservation Act, and Endangered species is defined as one "*whose prospects of survival or recruitment within the state are in jeopardy or a likely within the foreseeable future to become so*" (Section 17-2-38). The phrase within the state means that the NMDGF must base its determination of endangerment solely on the basis of a species' status inside New Mexico, regardless of what the status might be beyond the boundaries of the state. The NMDGF has chosen to divide species into two categories, based on the two categories above (Handbook of Species Endangered in New Mexico, 1991):

Endangered (group 1): Species whose prospects of survival or recruitment within the state are in jeopardy.

Endangered (group 2): Species whose prospects of survival or recruitment within the state are likely to become jeopardized in the foreseeable future.

Appendix D-1. List of plant species observed at the White Sands Test Facility (WSTF) during the biological survey. Plants were keyed out using Allred (1988), Kearney and Peebles (1951), and Weniger (1991) An X represents observed taxa, and highlighted text indicates threatened, endangered, or protected taxa.

Family/Scientific Name	Common Name	Square Mile Section															
		1	2	5	6	11	12	23	25	26	27	30E	31E	31W	32W	35	36
Agavaceae																	
Agave palmeri Eng	Agave												X			X	X
Dasylirion wheeleri Wats	Sotol	X	X			X	X	X	X	X		X	X			X	X
Nolina microcarpa Wats	Beargrass	X	X			X	X	X	X	X		X	X			X	X
Yucca baccata (Eng) Trel	Banana Yucca	X	X		X	X	X	X	X	X	X	X	X	X		X	X
Yucca elata Eng	Soaptree Yucca	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Amarillidaceae																	
Zephryanthes longifolia Hemsl	Zephry-lily								X								X
Anacardiaceae																	
Rhus microphylla Eng	Littleleaf Sumac	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Rhus trilobata Nutt	Squaw Bush											X	X				
Asclepiadaceae																	
Asclepias brachstephana Eng	Short-crowned Milkweed													X		X	X
Asteraceae																	
Aphanostephus ramosissimus DC	Lazy Daisy											X	X			X	X
Artemisia ludoviciana Nutt	Louisiana White Sage	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Family/Scientific Name	Common Name	Square Mile Section*															
		1	2	5	6	11	12	23	25	26	27	30E	31E	31W	32W	35	36
Baileya multiradata Harv & Gray	Marigold							X		X	X			X		X	X
Baccharis glutinosa Pers	Seep Willow			X													X
Bahia oblongifolia Gray	Bahi							X		X							
Brickellia californica (Torr & Gray) Gray	California Brickel Bush												X				
Brickellia lacinata Gray	Cutleaf Brickellbush	X	X	X		X	X				X		X				X
Cirsium ochrocentrum Gray	Yellow Spine Thistle			X												X	X
Conzya couteri Gray	Mare's Tail													X			X
Asteraceae																	
Dyssodia acerosa DC	Prickleaf Dogwood							X		X							
Erigeron bellidiastrum Nutt	Western Fleabane	X	X					X		X	X	X	X			X	X
Flourensia cernua DC	Tarbush	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Grindelia squarrosa (Pursh) Dun	Curlycup Gumweed	X	X			X	X	X		X	X	X	X		X	X	X
Gutierrezia sarothrae (Pursh) Britt & Rusby	Broom Snakeweed	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Hymenoxys odorata (DC) Kuntz	Fragrant Bitterweed																X

Family/Scientific Name	Common Name	Square Mile Section															
		1	2	5	6	11	12	23	25	26	27	30E	31E	31W	32W	35	36
Machaeranthera tanacetifolia (HBK) Nees	Tahoka Daisy					X	X										X
Parthenium incanum HBK	Mariola	X	X			X	X	X		X				X			X
Perezia nana Gray	Desert Holly	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Psilostrophe tagetna (Nutt) Greene	Paper Flower	X	X			X	X	X		X	X		X			X	X
Stephanomeria pauciflora (Torr) Nels	Few Flower Wire-lettuce												X				
Zinnia acerosa (DC) Gray	Desert Zinnia										X		X				
Berberidaceae																	
Berberis haematocarpous Wooton	Bayberry											X					
Bignoniaceae																	
Chilopsis linearis (Cav) Sweet	Desert Willow					X	X	X	X	X	X	X	X				X
Maurandya wisilizenii Eng	Net Cup Snapdragon Vine	X	X														
Boraginaceae																	
Lappula redowskii (Hornem) Greene	Stickseed					X	X								X	X	X
Brassicaceae																	
Dithyrea wislizenii Eng	Spectacle-pod					X	X	X		X	X						X
Draba cuneifolia Nutt	Whitlow Grass			X	X	X	X	X	X	X	X	X	X		X	X	X
Lepidium montanum Nutt	Pepper Grass					X	X										

Family/Scientific Name	Common Name	Square Mile Section															
		1	2	5	6	11	12	23	25	26	27	30E	31E	31W	32W	35	36
Lesquerella gordonii (Gray) Wats	Bladderpod				X	X	X	X		X	X					X	X
Nerisyrenia camporum (Gray) Greene	Bicolored Mustard											X	X				
Streptanthus arizonicus Wats	Twist Flower							X		X	X						X
Cactaceae																	
Coryphantha macromeris (Eng) Lem	Long Mamma			X				X	X	X		X	X				X
Coryphantha sulcata Eng	Finger Cactus												X				
Coryphantha vivipara (Eng) L. Benson	Ball Cactus	X	X												X		
Echinocereus chloranthus (Eng) Rumpl	Green Flowered Torch Cactus	X	X			X	X	X	X	X		X	X		X	X	X
Echinocereus fendleri Eng	Strawberry Cactus	X	X	X				X		X		X				X	X
Echinocactus horizonthalonius Lem	Turk's Head	X	X			X	X	X	X	X		X	X			X	X
Echinocereus triglochidiatus Eng	Claret cup Cactus	X	X		X	X	X	X	X	X	X	X	X			X	X
Echinocactus uncinatus var. *wrightii* Eng	Brown Flowered Hedgehog								X								
Echinocereus viridiflorus Eng	Spiny Wax Candle Cactus	X	X			X	X	X		X		X	X		X	X	X
Ferocactus wislizenii (Eng) Britt & Rose	Barrel Cactus	X	X			X	X	X		X		X					X

Family/Scientific Name	Common Name	Square Mile Section															
		1	2	5	6	11	12	23	25	26	27	30E	31E	31W	32W	35	36
Mammillaria microcarpa Eng	Pincushion Cactus	X	X														
Mammillaria tuberculosa Eng	Tube Cactus												X				X
Neolloydia intertexta var. *dasyacantha* (Eng) L. Bens	White-Flowered Visnagita											X	X				X
Opuntia imbricata (How) DC	Tree Cholla	X	X	X	X	X	X	X		X	X	X	X		X	X	X
Opuntia leptocaulis DC	Desert Christmas Cactus	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Opuntia phaeacantha Eng	Pancake Prickly-pear	X	X		X	X	X	X		X	X	X	X			X	X
Opuntia violacea Eng	Purple Prickly-pear	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Peniocereus greggii (Eng) B & R var. greggii	Night Blooming Cereus									X							
Chenopodiaceae																	
Atriplex canescens (Pursh) Nutt	Four-wing Salt Bush	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Ceratoides lanata (Pursh) How	Winter Fat											X	X				
Chenopodium incanum (Wats) Heller var. *elatum* Crawford	Gray Goosefoot					X	X	X	X	X	X					X	X
Salsola australis R. Brown	Russian Thistle	X	X	X	X	X	X	X		X	X	X		X	X	X	X
Convolvulaceae																	
Convolvulus equitans Benth	Hairy Bindweed											X					

Family/Scientific Name	Common Name	Square Mile Section															
		1	2	5	6	11	12	23	25	26	27	30E	31E	31W	32W	35	36
Evolvulus alsinoides L	False Morning Glory											X					
Cucurbitaceae																	
Cucurbita digitata Gray	Coyote-melon							X		X				X			
Cucurbita foetidissima HBK	Buffalo Gourd			X	X	X	X							X	X	X	X
Ibervillea tenuisecta (Gray) Small	Globe Berry											X		X			
Cupressaceae																	
Juniperus deppeana Steud	Alligator Juniper												X				
Juniperus monosperma (Eng) Sarg	One-seed Juniper	X	X									X	X				X
Ephederaceae																	
Ephedra trifurca Torr	Mormon-Tea	X	X	X	X	X	X	X		X	X	X	X		X	X	X
Euphorbiaceae																	
Euphorbia sprout (*E. fendeleri* Torr & Gray?)	Milk Spurge															X	X
Euphorbia albomarginata Torr & Gray	Rattlesnake Weed											X	X				
Fabaceae																	
Acacia constricta Benth	White Thorn	X	X		X	X	X	X		X	X	X	X				X
Acacia greggi Gray	Catclaw							X		X							X
Astragalus allochrous Gray	Hassayampa Milkvetch				X									X			

Family/Scientific Name	Common Name	Square Mile Section															
		1	2	5	6	11	12	23	25	26	27	30E	31E	31W	32W	35	36
Astragalus mollissimus Torr	Woolly Loco				X												
Cassia bauhiniodes Gray	Two-leaf Sena	X	X								X	X	X			X	X
Ceasilipinia gilliesii Wall	Bird of paradise											X					
Dalea formosa Torr	Feather Indigo Bush	X	X		X	X	X	X		X	X	X	X			X	X
Hoffmanseggia glauca (Ort) Eifert	Hog Potato			X										X	X		
Prosopis glandulosa Torr	Honey Mesquite	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X
Quercus turbinella Greene	Oak											X	X				
Fouquieriaceae																	
Fouquieria splendens Eng	Ocotillo	X	X			X	X	X		X	X	X	X			X	X
Garryaceae																	
Garrya wrightii Torr	Silk Tassel											X	X				
Hydrophyllaceae																	
Phacelia congesta Hook	Tight Phacellia	X	X					X		X	X	X	X				
Juncaceae																	
Juncucs sp.	Rush										X						
Koeberliniaceae																	
Koeberlinia spinosa Zucc	All Thorn	X	X		X	X	X	X		X	X	X	X	X		X	X
Laminaceae																	
Hedeoma nanum (Torr) Briq	False Pennyroral												X				

Family/Scientific Name	Common Name	Square Mile Section															
		1	2	5	6	11	12	23	25	26	27	30E	31E	31W	32W	35	36
Liliaceae																	
Allium macropetalum Rydb	Onion	X	X														X
Loasaceae																	
Mentzillia albicaulis (Hook) Torr & Gray	White Tack Stem																X
Malvaceae																	
Hibiscus denudatus Benth	Pale Hibiscus															X	X
Sida leprosa (Ort) K. Schum	Scurfy Sida					X	X										
Sphaeralcea angustifolia (Cav) G. Don	Narrow Leaf Globemallow					X	X							X		X	X
Sphaeralcea subhasts Coult	Wrinkled Globemallow				X			X		X	X	X	X			X	X
Martynigiaceae																	
Proboscidea altheaefolia (Woot) Woot & Standl	Devil's Claw										X						
Moraceae																	
Morus microphylla Buckl	Texas Mulberry																X
Nyctaginaceae																	
Acleisanthes longiflora Gray	Angle Trumpets														X		
Mirabilis multiflora (Torr) Gray	Desert Four O'clock										X		X				

Family/Scientific Name	Common Name	Square Mile Section															
		1	2	5	6	11	12	23	25	26	27	30E	31E	31W	32W	35	36
Oleaceae																	
Menodora scoparia Eng	Menodora											X					
Pinaceae																	
Pinus edulus Eng	Piñon Pine											X	X				
Plantaginaceae																	
Plantage patagonica Jacq	Wooly Indian Wheat	X	X	X											X		
Poaceae																	
Aristida purpurea Nutt	Purple Three-awn	X	X	X	X			X		X			X	X			
Aristida sp.	Three-Awn											X					
Bouteloua barbata Lag	Six-week Grama	X	X		X	X	X				X	X	X				
Bouteloua curtipendula (Michx) Torr	Side Oats Grama	X	X					X		X	X		X			X	X
Chloris virgata Swartz	Feather Fingergrass										X	X					
Distichlis spicata L.Greene var. *stricta* (Torr) Beetle	Inland Salt Grass													X	X		
Erioneuron pulchellum (HBK) Takeoka	Fluff Grass	X	X	X	X	X	X				X	X	X	X	X	X	X
Hilaria mutica (Buckl) Benth	Tobosa Grass			X	X						X	X	X	X	X	X	X
Muhlenbergia arenacea (Buckl) Benth	Ear Muhly				X	X	X					X	X		X	X	X

Family/Scientific Name	Common Name	Square Mile Section															
		1	2	5	6	11	12	23	25	26	27	30E	31E	31W	32W	35	36
Muhlenbergia porteri Scribn	Bush Muhly	X	X	X	X						X	X	X	X	X	X	X
Scleropogon brevifolius Phil	Burro Grass	X	X									X	X				
Sporobolus airioides (Torr) Torr	Alkali Sacaton Dropseed	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X
Sporobolus cryptandrus (Torr) Gray	Sand Dropseed	X	X	X		X	X	X		X	X	X	X	X	X	X	X
Sporobolus flexuosus (Thurb) Rybd	Meas Dropseed	X	X									X					
Polemoniaceae																	
Eriastrum diffusum (Gray) Mason	Miniature Wooly-star													X			
Ipomopsis longiflora (Torr) V. Grant	Blue Trumpets			X													
Phlox multifloa Nels	Multi-flowered phlox											X					
Phlox longiflolia Nutt	Long-flowered phlox											X					
Polygonaceae																	
Eriogonum abertianum Torr	Abert's Buckwheat	X	X	X													
Eriognum deflexum Torr	Skeleton Buckwheat	X	X			X	X				X			X	X	X	X
Eriogonum hieracifolium Benth	Eriogonum								X			X	X				
Rumex mexicanus Mesin	Mexican Doc							X		X	X		X				X

Family/Scientific Name	Common Name	Square Mile Section															
		1	2	5	6	11	12	23	25	26	27	30E	31E	31W	32W	35	36
Portulaceae																	
Portulaca sp.	Portulaca	X	X			X	X									X	X
Rhamnaceae																	
Ceonothus greggi Gray	Desert Ceonothus												X				
Condalia warnockii MC Johnst	Crucillo			X								X					X
Microrhamnus ericoides Gray	Javelina Bush	X	X	X	X	X	X	X		X		X	X	X	X	X	X
Ziziphus obtusifolia (Torr & Gray) Gray	Lotebush	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X
Rosaceae																	
Cerocarpus montanus Raf	Birchleaf Mountain Mahogany											X	X				
Fallugia paradoxa (D. Don) Endl	Apache Plume	X	X			X	X	X		X	X		X			X	X
Saliaceae																	
Salix exigua Nutt	Sandbar Willow	X	X														
Scrophulariaceae																	
Castilleja lanata Gray	Indian Paint-Brush												X				X
Penstemon barbatus (Cav) Roth	Penstemon												X				
Sinopteridaceae																	

Family/Scientific Name	Common Name	Square Mile Section															
		1	2	5	6	11	12	23	25	26	27	30E	31E	31W	32W	35	36
Cheilanthes tomentosa Link	Wooly Lipfern	X	X									X	X			X	X
Notholaena standleyi Maxon	Standley's Cloakfern														X		
Solanceae																	
Chamaesaracha sordida (Dun) Endl	Dingy Chamaesaracha															X	X
Datura quercifolia HBK	Thorn Apple										X				X		
Lycium pallidum Miers	Pale Stem Wolfberry											X	X				X
Physalis hederaefolia Gray	Ground Cherry											X		X			
Solanum eleagnifolium Cav	Bull-nettle	X	X	X	X	X	X	X		X	X		X	X	X	X	X
Tamariaceae																	
Tamarix ramosissima Pall	Salt Cedar																X
Typhaceae																	
Typha latifolia L	Cattails																X
Verbenaceae																	
Glandularia bipinnatida Nutt	Dakota Vervain														X		
Verbena ambrosifolia Rydb	Western Pink Verbena					X	X				X						X
Zygophyllaceae																	
Larrea tridentata (DC) Cov	Creosote Bush	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X

Family/Scientific Name	Common Name	Square Mile Section															
		1	2	5	6	11	12	23	25	26	27	30E	31E	31W	32W	35	36
Tribulus terrestris L	Puncture Vine			X													
Total number of taxa observed per area		60	59	36	36	54	54	55	22	57	54	73	76	37	38	59	86

Appendix D-2. List of plant species observed at various test areas on the White Sands Test Facility (WSTF) during the biological survey. Plants were keyed out using Allred (1988), Kearney and Peebles (1951), and Weniger (1991) An X represents observed taxa, and highllighted text indicats threatened, endangered, sensitive, or protected taxa.

Family/Scientific Name	Common Name	Facility							
		100	200	300	400	500	600	700	800
Agavaceae									
Agave palmeri Eng	Agave								X
Dasylirion wheeleri Wats	Sotol	X	X	X		X	X	X	X
Nolina microcarpa Wats	Beargrass	X	X	X	X	X	X	X	X
Yucca baccata (Eng) Trel	Banana Yucca	X	X	X	X	X	X	X	X
Yucca elata Eng	Soaptree Yucca	X	X	X	X.	X	X	X	X
Amarillidaceae									
Zephryanthes longifolia Hemsl	Zephry-lily					X			X
Anacardiaceae									
Rhus microphylla Eng	Littleleaf Sumac	X	X	X	X	X	X	X	X
Asclepiadaceae									
Asclepias brachstephana Eng	Short-crowned Milkweed		X						
Asteraceae									
Aphanostephus ramosissimus DC	Lazy Daisy					X	X		X
Artemisia ludoviciana Nutt	Louisiana White Sage	X	X	X	X	X	X	X	X
Baileya multiradata Harv & Gray	Marigold		X	X	X			X	
Baccharis glutinosa Pers	Seep Willow				X	X	X		X
Bahia oblongifolia Gray	Bahi		X					X	
Brickellia lacinata Gray	Cutleaf Brickellbush	X	X						
Cirsium ochrocentrum Gray	Yellow Spine Thistle		X		X				
Conzya couteri Gray	Mare's Tail		X						
Dyssodia acerosa DC	Prickleaf Dogwood							X	
Erigeron bellidiastrum Nutt	Western Fleabane	X	X	X		X	X	X	X
Flourensia cernua DC	Tarbush	X	X	X	X	X	X	X	X

Family/Scientific Name	Common Name	Facility							
		100	200	300	400	500	600	700	800
Grindelia squarrosa (Pursh) Dun	Curlycup Gumweed	X	X	X		X	X	X	X
Gutierrezia sarothrae (Pursh) Britt & Rusby	Broom Snakeweed	X	X	X	X	X	X	X	X
Machaeranthera tanacetifolia (HBK) Nees	Tahoka Daisy				X	X	X		X
Parthenium incanum HBK	Mariola	X		X	X	X	X	X	X
Perezia nana Gray	Desert Holly	X	X	X	X	X	X	X	X
Psilostrophe tagetna (Nutt) Greene	Paper Flower	X	X		X	X	X	X	X
Stephanomeria pauciflora (Torr) Nels	Few Flower Wire-lettuce			X	X				
Bignoniaceae									
Chilopsis linearis (Cav) Sweet	Desert Willow			X	X	X	X	X	X
Maurandya wisilizenii Eng	Net Cup Snapdragon Vine	X							
Boraginaceae									
Lappula redowskii (Hornem) Greene	Stickseed		X	X	X				
Brassicaceae									
Dithyrea wislizenii Eng	Spectacle-pod					X	X	X	X
Draba cuneifolia Nutt	Whitlow Grass		X	X		X	X	X	X
Lepidium montanum Nutt	Pepper Grass			X					
Lesquerella gordonii (Gray) Wats	Bladderpod		X	X				X	
Streptanthus arizonicus Wats	Twist Flower				X	X	X	X	X
Cactaceae									
Coryphantha macromeris (Eng) Lem	Long Mamma			X		X	X	X	X
Coryphantha vivipara (Eng) L. Benson	Ball Cactus	X							
Echinocereus chloranthus (Eng) Rumpl	Green Flowered Torch Cactus	X	X	X	X	X	X	X	X
Echinocereus fendleri Eng	Strawberry Cactus	X	X		X	X	X	X	X

Family/Scientific Name	Common Name	Facility							
		100	200	300	400	500	600	700	800
Echinocactus horizonthalonius Lem	Turk's Head	X	X	X	X	X	X	X	X
Echinocereus triglochidiatus Eng	Claret cup Cactus	X	X	X	X	X	X	X	X
Echinocereus viridiflorus Eng	Spiny Wax Candle Cactus	X	X	X		X	X	X	X
Ferocactus wislizenii (Eng) Britt & Rose	Barrel Cactus	X						X	
Mammillaria microcarpa Eng	Pincushion Cactus	X							
Mammillaria tuberculosa Eng	Tube Cactus					X	X		X
Neolloydia intertexta var. *dasyacantha* (Eng) L. Bens	White-Flowered Visnagita				X				X
Opuntia imbricata (How) DC	Tree Cholla	X	X	X	X	X	X	X	X
Opuntia leptocaulis DC	Desert Christmas Cactus	X	X	X	X	X	X	X	X
Opuntia phaeacantha Eng	Pancake Prickly-pear	X	X	X	X	X	X	X	X
Opuntia violacea Eng	Purple Prickly-pear	X	X	X	X	X	X	X	X
Chenopodiaceae									
Atriplex canescens (Pursh) Nutt	Four-wing Salt Bush	X	X	X	X			X	
Ceratoides lanata (Pursh) How	Winter Fat			X					
Chenopodium incanum (Wats) Heller var. *elatum* Crawford	Gray Goosefoot	X	X	X				X	X
Salsola australis R. Brown	Russian Thistle	X	X	X	X			X	
Convolvulaceae									
Convolvulus equitans Benth	Hairy Bindweed				X				
Cucurbitaceae									
Cucurbita digitata Gray	Coyote-melon							X	
Cucurbita foetidissima HBK	Buffalo Gourd		X	X					

Family/Scientific Name	Common Name	Facility							
		100	200	300	400	500	600	700	800
Cupressaceae									
Juniperus monosperma (Eng) Sarg	One-seed Juniper	X		X		X	X		X
Ephederaceae									
Ephedra trifurca Torr	Mormon-Tea	X	X	X	X	X	X	X	X
Euphorbiaceae									
Euphorbia sprout *(E. fendeleri* Torr & Gray ?)	Milk Spurge		X						X
Euphorbia albomarginata Torr & Gray	Rattlesnake Weed				X				
Fabaceae									
Acacia constricta Benth	White Thorn	X		X	X	X	X	X	X
Acacia greggi Gray	Catclaw			X		X	X	X	X
Prosopis glandulosa Torr	Honey Mesquite	X	X	X	X	X	X	X	X
Fouquieriaceae									
Fouquieria splendens Eng	Ocotillo	X	X	X	X	X	X	X	X
Hydrophyllaceae									
Phacelia congesta Hook	Tight Phacellia	X			X			X	
Koeberliniaceae									
Koeberlinia spinosa Zucc	All Thorn	X	X	X	X	X	X	X	X
Liliaceae									
Allium macropetalum Rydb	Onion	X				X	X		X
Loasaceae									
Mentzillia albicaulis (Hook) Torr & Gray	White Tack Stem			X	X				
Malvaceae									
Hibiscus denudatus Benth	Pale Hibiscus		X						
Sphaeralcea angustifolia (Cav) G. Don	Narrow Leaf Globemallow		X	X	X				
Sphaeralcea subhasts Coult	Wrinkled Globemallow		X					X	
Moraceae									
Morus microphylla Buckl	Texas Mulberry			X		X	X		X

Family/Scientific Name	Common Name	Facility							
		100	200	300	400	500	600	700	800
Nyctaginaceae									
Acleisanthes longiflora Gray	Angle Trumpets			X					
Plantaginaceae									
Plantage patagonica Jacq	Wooly Indian Wheat	X							
Poaceae									
Aristida purpurea Nutt	Purple Three-awn	X		X	X			X	
Bouteloua barbata Lag	Six-week Grama	X		X					
Bouteloua curtipendula (Michx) Torr	Side Oats Grama	X	X	X		X	X	X	X
Chloris virgata Swartz	Feather Fingergrass				X				
Erioneuron pulchellum (HBK) Takeoka	Fluff Grass	X	X	X	X	X	X		X
Hilaria mutica (Buckl) Benth	Tobosa Grass		X			X	X		X
Muhlenbergia arenacea (Buckl) Benth	Ear Muhly		X		X	X	X		X
Muhlenbergia porteri Scribn	Bush Muhly	X	X		X	X	X		X
Scleropogon brevifolius Phil	Burro Grass	X							
Sporobolus airioides (Torr) Torr	Alkali Sacaton Dropseed	X	X	X	X	X	X	X	X
Sporobolus cryptandrus (Torr) Gray	Sand Dropseed	X	X	X	X	X	X	X	X
Sporobolus flexuosus (Thurb) Rybd	Meas Dropseed	X							
Polygonaceae									
Eriognum deflexum Torr	Skeleton Buckwheat	X	X	X					
Rumex mexicanus Mesin	Mexican Doc					X	X	X	X
Portulacaeae									
Portulaca sp.	Portulaca	X	X			X	X		X
Rhamnaceae									
Condalia warnockii MC Johnst	Crucillo					X	X		X

Family/Scientific Name	Common Name	Facility							
		100	200	300	400	500	600	700	800
Microrhamnus ericoides Gray	Javelina Bush	X	X	X		X	X	X	X
Ziziphus obtusifolia (Torr & Gray) Gray	Lotebush	X	X		X	X	X	X	X
Rosaceae									
Fallugia paradoxa (D. Don) Endl	Apache Plume	X	X	X	X	X	X	X	X
Salicaceae									
Salix exigua Nutt	Sandbar Willow	X							
Scrophulariaceae									
Maurandya wislizenii Eng	Net-cup Snapdragon Vine					X	X		X
Sinopteridaceae									
Cheilanthes tomentosa Link	Wooly Lipfern								X
Solanaceae									
Chamaesaracha sordida (Dun) Endl	Dingy Chamaesaracha		X		X				
Datura quercifolia HBK	Thorn Apple				X				
Solanum eleagnifolium Cav	Bull-nettle	X	X	X	X	X	X	X	X
Tamaricaceae									
Tamarix ramosissima Pall	Salt Cedar				X				
Typhaceae									
Typha latifolia L	Cattails				X	X	X		X
Verbenaceae									
Verbena ambrosifolia Rydb	Western Pink Verbena			X		X	X		X
Zygophyllaceae									
Larrea tridentata (DC) Cov	Creosote Bush	X	X	X	X	X	X	X	X
Total number of taxa observed per facility test area:		57	57	56	54	59	58	54	64

Appendix D-3. List of plant species observed at the White Sands Test Facility. Ten sections of road where surveyed, which include: 1) TDRS road north to Forks; 2) East Fork TDRS road; 3) West Fork TDRS road; 4) North Jornada; 5) East San Andres; 6) North of Love Ranch and East Fork; 7) North Fork Love Ranch; 8) West Fork Bear Canyon; 9) East Fork Bear Canyon; 10) NASA Road. An X represents observed taxa, and highlighted text indicates threatened, endangered, or sensitive taxa.

Family/Scientific Name	Common Name	Roadway									
		1	2	3	4	5	6	7	8	9	10
Agavaceae											
Agave palmeri Eng	Agave					X			X	X	
Dasylirion wheeleri Wats	Sotol		X			X	X	X	X	X	
Nolina microcarpa Wats	Beargrass		X			X	X	X		X	
Yucca baccata (Eng) Trel	Banana Yucca	X	X	X	X	X	X	X	X	X	X
Yucca elata Eng	Soaptree Yucca	X	X	X		X	X	X			X
Amaranthaceae											
Amaranthus palmeri Wats	Pigweed										X
Anacardiaceae											
Rhus microphylla Eng	Littleleaf Sumac	X	X	X	X		X	X	X	X	X
Rhus trilobata Nutt	Squaw Bush								X	X	X
Asteraceae											
Artemisia ludoviciana Nutt	Louisiana White Sage	X	X	X	X	X	X	X	X	X	X
Baileya multiradata Harv & Gray	Marigold	X									X
Bahia absinthifolia Benth	Sageleaf Bahia				X						
Bahia pedata Gray	Bahi								X		X
Brickellia californica (Torr & Gray) Gray	California Brickel Bush						X		X		
Brickellia lacinata Gray	Cutleaf Brickellbush	X		X			X	X	X	X	X
Cirsium ochrocentrum Gray	Yellow Spine Thistle			X					X		X
Conzya couteri Gray	Mare's Tail				X						
Erigeron bellidiastrum Nutt	Western Fleabane				X		X	X		X	
Flourensia cernua DC	Tarbush	X	X		X	X	X	X	X	X	X
Grindelia squarrosa (Pursh) Dun	Curlycup Gumweed	X	X	X	X	X		X			X
Gutierrezia sarothrae (Pursh) Britt & Rusby	Broom Snakeweed	X	X	X	X	X	X	X	X	X	X

Family/Scientific Name	Common Name	Roadway									
		1	2	3	4	5	6	7	8	9	10
Helianthus ciliaris DC	Blueweed										X
Hymenoxys odorata (DC) Kuntz	Fragrant Bitterweed								X		X
Melampodium leucanthum Torr & Gray	Blackfoot Daisy									X	
Perezia nana Gray	Desert Holly	X	X	X			X	X		X	X
Psilostrophe tagetna (Nutt) Greene	Paper Flower	X	X	X			X	X		X	
Tessaria sericea (Nutt) Shinner	Arrow-weed										X
Viquiera dentata (Cav) Spreng var. *dentata*	Golden-eye										X
Xanthium strumarium L	Cocklebar										X
Berberidaceae											
Berberis haematocarpous Wooton	Bayberry						X		X	X	
Bignoniaceae											
Chilopsis linearis (Cav) Sweet	Desert Willow	X					X	X	X	X	X
Brassicaceae											
Draba cuneifolia Nutt	Whitlow Grass	X	X				X	X	X		X
Erysimum capitatum (Doug) Greene	Douglas Wallflower				X				X	X	X
Lepidium montanum Nutt	Pepper Grass	X									X
Lesquerella gordonii (Gray) Wats	Bladderpod								X	X	X
Neriyrenia camporum (Gray) Greene	Bicolor Mustard									X	
Cactaceae											
Coryphantha macromeris (Eng) Lem	Long Mamma				X			X			
Coryphantha sulcata Eng	Finger Cactus								X		
Echinocereus chloranthus (Eng) Rumpl	Green Flowered Torch Cactus		X				X	X	X		
Echinocereus fendleri Eng	Strawberry Cactus				X		X				

Family/Scientific Name	Common Name	Roadway									
		1	2	3	4	5	6	7	8	9	10
Echinocactus horizonthalonius Lem	Turk's Head		X					X			
Echinocereus triglochidiatus Eng	Claret cup Cactus	X	X	X		X	X	X			
Echinocereus viridiflorus Eng	Spiny Wax Candle Cactus					X	X	X	X		X
Opuntia imbricata (How) DC	Tree Cholla	X	X	X	X			X	X	X	X
Opuntia leptocaulis DC	Desert Christmas Cactus		X	X			X	X			X
Opuntia phaeacantha Eng	Pancake Prickly-pear				X	X	X	X	X	X	X
Opuntia violacea Eng	Purple Prickly-pear	X	X	X	X	X	X	X		X	X
Chenopodiaceae											
Atriplex canescens (Pursh) Nutt	Four-wing Salt Bush	X		X	X	X	X	X			X
Ceratoides lanata (Pursh) How	Winter Fat					X	X			X	
Chenopodium incanum (Wats) Heller var. *elatum* Crawford	Gray Goosefoot	X	X	X	X						
Salsola australis R. Brown	Russian Thistle	X		X	X			X	X	X	X
Commelinaceae											
Commelina erecta L var. *angustifolia* (Michx) Fern	Narrowleaf Dayflower										X
Convolvulaceae											
Convolvulus equitans Benth	Hairy Bindweed									X	
Evolvulus alsinoides L	False Morning Glory								X		
Cucurbitaceae											
Cucurbita digitata Gray	Coyote-melon			X	X						
Cucurbita foetidissima HBK	Buffalo Gourd								X	X	X
Cupressaceae											
Juniperus deppeana Steud	Alligator Juniper								X		
Juniperus monosperma (Eng) Sarg	One-seed Juniper					X	X	X	X	X	

Family/Scientific Name	Common Name	Roadway									
		1	2	3	4	5	6	7	8	9	10
Ephederaceae											
Ephdera torreyana Wats	Torrey's Ephedra						X				
Ephedra trifurca Torr	Mormon-Tea		X			X	X	X	X		X
Euphorbiaceae											
Euphorbia albomarginata Torr & Gray	Rattlesnake Weed										X
Fabaceae											
Acacia constricta Benth	White Thorn		X			X	X	X	X		
Acacia greggi Gray	Catclaw								X		
Cassia bauhiniodes Gray	Two-leaf Sena	X			X		X	X	X		X
Ceasilipinia gilliesii Wall	Bird of paradise										X
Dalea formosa Torr	Feather Indigo Bush	X	X	X			X	X	X		X
Hoffmanseggia glauca (Ort) Eifert	Hog Potato								X		
Medicago polymorpha L	Burclover										X
Prosopis glandulosa Torr	Honey Mesquite	X	X	X	X	X	X	X	X	X	X
Fagaceae											
Quercus turbinella Greene	Oak								X		
Fouquieriaceae											
Fouquieria splendens Eng	Ocotillo		X			X	X	X	X	X	
Garryaceae											
Garrya wrightii Torr	Silk Tassel						X		X		
Hydrophyllaceae											
Phacelia congesta Hook	Tight Phacellia					X					
Koeberliniaceae											
Koeberlinia spinosa Zucc	All Thorn					X	X	X		X	X
Laminaceae											
Hedeoma nanum (Torr) Briq	False Pennyroral						X		X		
Liliaceae											
Allium macropetalum Rydb	Onion								X	X	

Family/Scientific Name	Common Name	Roadway									
		1	2	3	4	5	6	7	8	9	10
Loasaceae											
Mentzilia albicaulis (Hook) Torr & Gray	Whitestem Stickleaf										X
Malvaceae											
Sphaeralcea angustifolia (Cav) G. Don	Narrow Leaf Globemallow						X		X	X	X
Sphaeralcea subhasts Coult	Wrinkled Globemallow						X				X
Nyctaginaceae											
Mirabilis multiflora (Torr) Gray	Desert Four O'clock								X	X	
Oleaceae											
Menodora scoparia Eng	Menodora				X				X		X
Papaveraceae											
Argemone pleiacantha Greene	Prickly Poppy										X
Pinaceae											
Pinys edulus Eng	Piñon Pine						X		X		
Poaceae											
Aristida purpurea Nutt	Purple Three-awn	X			X						
Andropogon gerardii Vitm	Blue Stem				X						X
Bouteloua barbata Lag	Six-week Grama									X	
Bouteloua curtipendula (Michx) Torr	Side Oats Grama	X							X	X	X
Chloris virgata Swartz	Feather Fingergrass						X		X		
Erioneuron pulchellum (HBK) Takeoka	Fluff Grass	X	X	X	X	X	X	X	X	X	X
Eragrostis curvula (Schrad) Ness	Weeping Lovegrass										X
Hilaria mutica (Buckl) Benth	Tobosa Grass			X	X		X	X	X	X	
Muhlenbergia arenicola Buckl	Sand Muhly										X
Muhlenbergia porteri Scribn	Bush Muhly	X	X	X	X	X	X	X		X	X

Family/Scientific Name	Common Name	Roadway									
		1	2	3	4	5	6	7	8	9	10
Sporobolus airioides (Torr) Torr	Alkali Sacaton Dropseed	X	X	X	X	X	X	X	X	X	X
Sporobolus cryptandrus (Torr) Gray	Sand Dropseed						X	X	X	X	
Stipa eminens Cav	Southwestern Neddlegrass										X
Polemoniaceae											
Ipomopsis longiflora (Torr) V. Grant	Blue Trumpets									X	
Phlox longiflolia Nutt	Long-flowered phlox								X		X
Polygonaceae											
Eriognum deflexum Torr	Skeleton Buckwheat							X			X
Eriogonum hieracifolium Benth	Eriogonum					X	X			X	
Portulaceae											
Portulaca umbraticola HBK	Chinese Hat										X
Rhamnaceae											
Condalia warnockii MC Johnst	Crucillo							X			
Microrhamnus ericoides Gray	Javelina Bush	X	X	X	X	X	X	X		X	X
Ziziphus obtusifolia (Torr & Gray) Gray	Lotebush						X	X	X	X	
Rosaceae											
Cerocarpus montanus Raf	Birch-leaf Mountain Mahogany									X	
Fallugia paradoxa (D. Don) Endl	Apache Plume					X	X	X	X	X	X
Salicaceae											
Salix exigua Nutt	Sandbar Willow						X				
Scrophulariaceae											
Castilleja lanata Gray	Indian Paint-brush								X		
Maurandya wislizenii Eng	Net-cup Snapdragon Vine								X	X	X

Family/Scientific Name	Common Name	Roadway									
		1	2	3	4	5	6	7	8	9	10
Penstemon barbatus (Cav) Roth	Penstemon						X				
Solanaceae											
Chamaesaracha sordida (Dun) Endl	Dingy Chamaesaracha								X		X
Datrua wrightii Regel	Thornapple										X
Physalis hederaefolia Gray	Ground Cherry								X		
Solanum eleagnifolium Cav	Bull-nettle	X			X		X		X	X	X
Tamaricaceae											
Tamarix ramosissima Ledeb	Salt-Cedar										X
Ulmaceae											
Celtis reticulata Torr	Netleaf Hackberry									X	
Verbenaceae											
Glandularia bipinnatida Nutt	Dakota Vervain								X	X	
Viscaceae											
Phoradendron villosum (Nutt) Nutt subsp *coryae* (Trel) Wiens	Fuzzy Mistletoe								X	X	
Zygophyllaceae											
Larrea tridentata (DC) Cov	Creosote Bush	X	X	X	X	X	X	X	X	X	X
Total number of taxa observed per road segment:		32	29	26	31	29	53	45	61	52	65

Appendix E-1. Animal Species Observed and Expected in the WSTF Biological Survey Area.

Common Name	Scientific Name	Expected	Specific Survey Areas															
			1	2	5	6	11	12	23	25	26	27	30E	31E	31W	32W	35	36
MAMMALS:																		
Antelope Ground Squirrel	*Ammospermophilus interpres*	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pronghorn	*Antilocapra americana*	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Coyote	*Canus latrans*	X	-	-	X	-	X	X	-	-	-	-	-	-	X	-	X	-
Merriam's Kangaroo Rat	*Dipodomys merriami*	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ord's Kangaroo Rat	*Dipodomys ordii*	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Banner-tailed Kangaroo Rat	*Dipodomys spectabilis*	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Porcupine	*Erithizon dorsatum*	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Blacktailed Jackrabbit	*Lepus californicus*	X	X	X	X	X	X	X	X	-	X	X	-	-	X	X	X	X
White-throated Woodrat	*Neotoma albigula*	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mule Deer	*Odocoileus hemionus*	X	X	X	X	-	X	X	X	X	X	X	X	X	-	-	X	X
Northern Grasshopper Mouse	*Onychomys leucogaster*	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Silky Pocket Mouse	*Perognathus flavus*	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Deer Mouse	*Peromyscus maniculatus*	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rock Squirrel	*Spermophilus variegatus*	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Common Name	Scientific Name	Expected	Specific Survey Areas															
			1	2	5	6	11	12	23	25	26	27	30E	31E	31W	32W	35	36
Desert Cottontail	*Sylvilagus auduboni*	X	X	X	X	-	X	X	X	X	X	X	X	X	-	X	X	X
Gray Fox	*Urocyon cinereoargenteus*	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BIRDS:																		
Cooper's Hawk	Accipiter cooperi	x	-	-	-	-	-	-	-	-	-	-	X	X	-	-	-	-
Cassin's Sparrow	*Aimophila cassinii*	X	-	-	-	X	-	-	-	-	-	-	-	-	-	-	X	-
Rufous-crowned Sparrow	*Aimóphila rúficeps*	X	-	-	-	-	X	X	-	-	-	-	-	-	-	-	X	-
Sage Sparrow	*Amphispiza belli*	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Black-throated Sparrow	*Amphispiza bilineata*	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Golden Eagle	*Aquila chrysaetos*	X	-	-	X	-	X	X	-	-	-	X	-	X	-	-	-	-
Great-horned Owl	*Búbo virginiánus*	X	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-
Red-tailed Hawk	*Buteo jamaicensis*	X	-	X	X	X	-	-	-	X	-	X	X	X	X	-	-	-
Ferruginous Hawk	*Buteo regalis*	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Swainson's Hawk	*Buteo swainsoni*	X	-	X	X	X	X	-	-	-	-	-	-	-	X	X	-	-
Lark Bunting	*Calamospiza melanocorys*	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gambel's Quail	*Callipepla gambelii*	X	X	X	-	-	X	X	-	-	-	-	-	X	-	-	X	X
Scaled Quail	*Callipepla squamata*	X	X	X	-	-	X	X	X	-	X	X	-	-	-	-	X	X
Whip-poor-will	*Caprimulgus vociferus*	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Common Name	Scientific Name	Expected	Specific Survey Areas															
			1	2	5	6	11	12	23	25	26	27	30E	31E	31W	32W	35	36
Cactus Wren	*Campylorhynchus brunneicapillus*	X	X	X	-	X	X	X	X	-	X	X	-	-	-	-	X	X
Housefinch	*Carpodacus mexicanus*	X	X	X	X	X	-	-	-	-	-	-	-	-	-	-	X	X
Killdeer	*Charadrius vociferus*	X	-	-	X	-	-	-	-	-	-	-	-	-	-	-	X	-
Green-tailed Towee	*Chlorúra chlorúra*	X	-	-	-	-	X	X	-	-	-	-	-	-	-	-	X	-
Lesser Nighthawk	*Choirdeiles acutipénnis*	X	X	X	X	X	X	X	X	X	X	X	X	-	X	X	X	X
Common Nighthawk	*Choirdeiles minor*	X	X	-	-	-	-	-	-	X	-	-	X	-	X	-	-	X
Lark Sparrow	*Chondestes grammacus*	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Northern Harrier	*Circus cyaneus*	X	-	X	X	-	-	-	-	-	-	X	-	-	X	X	-	-
Rock Dove	*Columba livia*	X	X	X	-	-	-	-	-	-	-	-	-	-	-	-	X	X
Chihuahuan Raven	*Corvus cryptoleucus*	X	X	-	X	X	-	-	X	-	X	X	-	-	X	X	X	X
Ladderback Woodpecker	*Dendrócoposa scaláris*	X	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-
Western Flycatcher	*Empidonax difficilis*	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Horned Lark	*Eremophila alpestris*	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
American Kestrel	*Falco sparverius*	X	-	X		X	X	-	-	-	-	-	-	-	-	-	X	-
Roadrunner	*Geococcyx californianus*	X	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-
Barn Swallow	*Hirúndo rústica*	X	X	X	-	-	X	X	X	-	X	X	-	-	-	-	X	X
Scott's Oriole	*Icterus pasisorum*	X	X	X	X	X	X	X	-	-	X	-	-	-	-	X	X	X

Common Name	Scientific Name	Expected	Specific Survey Areas															
			1	2	5	6	11	12	23	25	26	27	30E	31E	31W	32W	35	36
Loggerhead Shrike	*Lanius ludovicianus*	X	X	X	X	-	X	X	X		X	-	X	-	X	X	X	X
Song Sparrow	*Melospiza melodia*	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Northern Mockingbird	*Mimus polyglottos*	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Brown-headed Cowbird	*Molothrus ater*	X	-	-	-	X	X	X	X	-	X	-	-	-	X	X	-	-
Ash-throated Flycatcher	*Myiarchus cinerâscens*	X	X	X	X	-	X	X	X	X	X	X	X	-	-	X	X	X
Sage Thrasher	*Oreoscoptes montanus*	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Harris's Hawk	*Parabuteo unicinctus*	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
House Sparrow	*Passer domesticus*	X	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	X
Savannah Sparrow	*Passerculus sandwichensis*	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cliff Swallow	*Petrochélidon pyrrhonóto*	X	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-
Phainopepla	*Phainopepla nitens*	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Poor-will	*Phalaenóptilus núttailii*	X	X	X	X	-	-	-	-	-	-	X	-	X	-	-	-	X
Brown Canyon Towhee	*Pipilo fuscus*	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rufous-sided Towhee	*Pipilo erythropthalmus*	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Blue-gray Gnatcatcher	*Polióptila coerúlea*	X	X	-	-	-	-	-	-	-	-	-	-	X	-	-	-	X
Black-tail Gnatcatcher	*Polióptila melanúra*	X	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-
Vesper Sparrow	*Pooecetes gramineus*	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pyrrhuloxia	*Pyrrhulóxia sinuáta*	X	-	-	-	-	X	X	X	-	X	-	-	-	X	-	-	-

Common Name	Scientific Name	Expected	Specific Survey Areas															
			1	2	5	6	11	12	23	25	26	27	30E	31E	31W	32W	35	36
Common Grackle	*Quiscalus quiscula*	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bank Swallow	*Riparia riparia*	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rock Wren	*Salpinctes obsoletus*	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Says Phoebe	*Sayórnis sáya*	X	X	X	-	-	-	-	-	X	-	-	X	-	-	-	X	X
Western Burrowing Owl	*Speotyto cunicularia*	X	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-
Goldfinch	*Spinus tristis*	X	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-
Clay-colored Sparrow	*Spizella pallida*	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chipping Sparrow	*Spizella passerina*	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Western Meadowlark	*Sturnella neglecta*	X	-	-	-	X	-	-	X	-	X	-	-	-	X	-	X	-
Bronzed Cowbird	*Tangávius aéneus*	X	-	-	X	X	-	-	-	-	-	-	-	-	X	X	-	-
Curve-billed Thrasher	*Toxóstoma curviróstre*	X	X	X	X	-	X	X	X	-	X	-	-	-	-	X	X	X
Brown Thrasher	*Toxostoma rufum*	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Western Kingbird	*Tyránnus verticális*	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Cassin's Kingbird	*Tyránnus vociferans*	X	-	-	X	X	X	X	-	-	-	-	-	-	-	X	X	-
Barn Owl	*Týto álba*	X	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	X
Hummingbird spp.	unknown spp.	X	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-
White-winged Dove	*Zenáida asiática*	X	X	X	-	-	X	X	-	-	-	-	-	-	-	-	-	X
Mourning Dove	*Zenaida macroura*	X	X	X	X	-	X	X	X	X	X	X	X	X	X	X	X	X

Common Name	Scientific Name	Expected	Specific Survey Areas															
			1	2	5	6	11	12	23	25	26	27	30E	31E	31W	32W	35	36
REPTILES:																		
Chihuahuan Spotted Whiptail	*Cnemidophorus exsanguis*	X	X	-	-	-	-	-	-	X	-	-	X	-	-	-	-	X
Little Striped Whiptail	*Cnemidophorus inornatus*	X	X	-	-	-	-	-	-	X	-	-	X	X	-	-	-	X
New Mexico Whiptail	*Cnemidophorus neomexicanus*	X	-	-	X	-	-	-	-	X	-	-	X	X	-	-	-	-
Checkered Whiptail	*Cnemidophorus tesselatus*	X	X	-	X	X	X	X	X	-	X	X	-	-	X	X	X	X
Western Whiptail	*Cnemidophorus tigris*	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Grassland Whiptail	*Cnemidophorus uniparens*	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Western Diamondback Rattlesnake	*Crotalus atrox*	X	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	X
Prairie Rattlesnake	*Crotalus viridis viridis*	X	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-
Collared Lizard	*Crotaphytus collaris*	X	-	-	-	-	-	-	X	-	X	-	-	-	-	X	-	-
Leopard Lizard	*Crotaphytus wislizenii*	X	X	X	-	-	X	X	-	-	-	-	-	-	-	X	X	X
Northern Ringneck Snake	*Diadophis punctatus edwardsi*	X	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-
Lesser Earless Lizard	*Holbrookia maculata*	X	X	X	-	-	X	X	-	-	-	-	-	-	-	-	-	X
Greater Earless Lizard	*Holbrookia texana*	X	X	-	X	-	X	X	X	-	X	-	-	-	-	-	X	X
Coachwhip	*Masticophis flagellum*	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bullsnake	*Pituophis melanoleucus*	X	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-

Common Name	Scientific Name	Expected	Specific Survey Areas															
			1	2	5	6	11	12	23	25	26	27	30E	31E	31W	32W	35	36
Texas Horned Lizard	*Phrynosoma cornutum*	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X
Round-tailed Horned Lizard	*Phrynosoma douglassi*	X	X	X	X	-	-	-	-	X	X	X	X	-	X	X	-	X
Round-tailed Horned Lizard	*Phrynosoma modestum*	X	X	X	X	-	-	-	X	X	X	X	X	-	X	X	-	X
Patch Nose Snake	*Salvadora grahamiae lineata*	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X
Desert Spiny Lizard	*Sceloporus magister*	X	-	-	-	-	X	X	-	-	-	-	-	-	-	-	-	-
Eastern Fence Lizard	*Sceloporus undulatus*	X	X	-	X	-	-	-	X	-	X	-	-	-	-	-	-	X
Western Box Turtle	*Terrapene ornata*	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tree Lizard	*Urosaurus ornatus*	X	-	-	-	X	-	-	X	-	X	-	-	-	-	-	-	-
Side-blotched Lizard	*Uta stansburiana*	X	X	X	X	X	X	X	X	X	X	-	X	-	-	X	X	X
AMPHIBIANS:																		
Tiger Salamander	*Ambystoma tigrinum*	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Great Plains Toad	*Bufo cognatus*	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Red-spotted Toad	*Bufo punctatus*	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Texas Toad	*Bufo speciosus*	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Woodhouse Toad	*Bufo woodhousei*	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Couch's Spadefoot Toad	*Scaphiopus couchi*	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Common Name	Scientific Name	Expected	Specific Survey Areas															
			1	2	5	6	11	12	23	25	26	27	30E	31E	31W	32W	35	36
Western Spadefoot Toad	*Scaphiopus hammondi*	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Spadefoot Tadpoles	Unknown spp.	X			X													
MOLLUSCA																		
Koch's Land Snail	Ashmunella kochi kochi	X	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-

Appendix E-2. List of animal species observed at the White Sands Test Facility (WSTF) during the biological survey.

Scientific Name	Common Name	Square Mile Section																
		1	2	5	6	11	12	23	25	26	27	30E	31E	31 W	32W	35	36	Total
MAMMALS:																		
Ammospermophilus interpres	Antelope Ground Squirrel	-	-	-	-	1	-	-	-	-	-	-	-	-	1	2	2	6
Antilocapra americana	Pronghorn	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	2
Canus latrans	Coyote	-	2	3	-	-	1	-	1	-	-	2	-	1	-	1	-	11
Dipodomys ordii	Ord's Kangaroo Rat	-	1	-	-	1	-	1	-	-	-	-	-	-	-	-	-	3
Dipodomys spectabilis	Banner-tailed Kangaroo Rat	8	4	1	-	14	7	5	-	-	-	-	-	-	-	-	-	39
Erithizon dorsatum	Porcupine	-	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-	2
Lepus californicus	Blacktailed Jackrabbit	7	5	7	5	4	9	9	4	18	3	2	5	12	8	6	5	109
Neotoma albigula	White-throated Woodrat	3	4	8	7	7	6	5	5	9	4	3	2	12	2	5	8	90
Odocoileus hemionus	Mule Deer	12	1	5	5	5	3	5	9	4	3	2	1	7	3	8	12	85
Oryx gazella	African Oryx	-	-	-	-	-	-	2	-	-	-	-	-	1	1	-	-	4
Peromyscus spp.	Deer Mice	1	-	-	-	1	1	1	-	-	-	-	-	-	-	-	-	4
Spermophilus variegatus	Rock Squirrel	-	-	-	-	-	-	-	-	-	-	-	1	1	1	-	1	4
Sylvilagus auduboni	Desert Cottontail	33	33	8	7	4	5	4	6	12	8	6	4	9	2	12	33	186
Urocyon cinereoargenteus	Gray Fox	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	1	3
	Total Mammals:	64	51	33	24	38	32	35	25	43	18	15	13	43	18	34	62	548

Scientific Name	Common Name	Square Mile Section																
		1	2	5	6	11	12	23	25	26	27	30E	31E	31 W	32W	35	36	Total
BIRDS:																		
Accipiter cooperi	Cooper's Hawk	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	2
Actitis macularia	Spotted Sandpiper	-	12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	12
Aimophila cassinii	Cassin's Sparrow	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1	-	2
Aimóphila rúficeps	Rufous-crowned Sparrow	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1	-	2
Amphispiza bilineata	Black-throated Sparrow	51	51	6	41	15	36	12	11	31	5	11	9	20	16	62	51	428
Aquila chrysaetos	Golden Eagle	-	-	1	1	1	-	-	-	-	1	2	2	-	-	-	-	8
Búbo virginiánus	Great-horned Owl	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1
Buteo jamaicensis	Red-tailed Hawk	-	4	2	-	6	-	-	-	-	1	2	1	2	-	-	-	18
Buteo swainsoni	Swainson's Hawk	-	2	2	1	2	-	-	-	-	-	-	-	1	1	-	-	9
Calamospiza melanocorys	Lark Bunting	-	-	2	1	-	-	-	-	-	-	-	-	-	-	-	-	3
Callipepla gambelii	Gambel's Quail	7	5	-	-	2	6	4	-	-	-	-	3	-	-	4	7	38
Callipepla squamata	Scaled Quail	8	3	-	-	-	1	-	-	10	2	-	-	-	-	5	8	37
Campylorhynchus brunneicapillus	Cactus Wren	3	1	2	2	7	6	4	5	3	1	12	11	1	1	2	3	64
Carpodacus mexicanus	Housefinch	17	7	1	1	2	-	2	-	-	-	9	1	1	1	3	17	62
Cathartes aura	Turkey Vulture	2	5	4	-	-	-	-	1	-	5	1	-	16	3	-	2	39
Charadrius vociferus	Killdeer	-	9	6	-	-	-	-	-	-	-	-	-	-	-	3	-	18
Chlorúra chlorúra	*Green-tailed Towee*	-	-	-	-	7	4	-	-	1	-	-	4	-	-	-	-	16

Scientific Name	Common Name	Square Mile Section																
		1	2	5	6	11	12	23	25	26	27	30E	31E	31 W	32W	35	36	Total
Chordeiles acutipénnis	Lesser Nighthawk	5	19	5	1	8	16	5	1	7	5	1	-	1	2	10	5	91
Choirdeiles minor	Common Nighthawk	1	5	-	-	-	-	-	2	-	-	2	-	1	-	-	1	12
Circus cyaneus	Northern Harrier	-	1	2	-	-	-	-	-	-	1	-	-	1	2	-	-	7
Columba livia	Rock Dove	5	1	1	2	5	-	-	-	-	-	-	-	-	-	6	5	25
Corvus cryptoleucus	Chihuahuan Raven	1	-	1	9	-	-	-	-	13	9	-	-	2	2	2	1	40
Dendrócoposa scaláris	Ladderback Woodpecker	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	2
Eremophila alpestris	Horned Lark	-	4	5	-	-	-	-	-	-	-	-	-	-	-	-	-	9
Falco sparverius	American Kestrel	-	2	-	1	2	-	-	-	-	-	-	-	-	-	3	-	8
Geococcyx californianus	Roadrunner	-	2	-	-	2	1	-	-	1	-	-	-	-	-	-	-	6
Hirúndo rústica	Barn Swallow	25	4	-	-	3	1	2	-	8	5	-	-	-	-	14	25	87
Icterus pasisorum	Scott's Oriole	1	1	1	2	4	3	2	-	1	-	-	-	-	3	5	3	26
Lanius ludovicianus	Loggerhead Shrike	1	1	3	-	2	3	2	3	1	-	3	-	1	3	3	1	27
Mimus polyglottos	Northern Mockingbird	15	15	17	6	5	5	7	5	6	3	5	6	5	7	8	15	130
Molothrus ater	Brown-headed Cowbird	2	5	3	2	-	1	1	-	2	-	-	-	2	1	-	-	19
Myiarchus cineráscens	Ash-throated Flycatcher	11	4	2	-	5	8	5	6	4	3	6	-	-	1	2	11	68
Passer domesticus	House Sparrow	10	10	-	-	-	-	-	-	-	-	-	-	-	-	-	10	30
Petrochélidon pyrrhonóto	Cliff Swallow	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	4
Phainopepla nitens	Phainopepla	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1

Scientific Name	Common Name	Square Mile Section																
		1	2	5	6	11	12	23	25	26	27	30E	31E	31 W	32W	35	36	Total
Phalaenóptilus núttailii	Poor-will	3	1	1	-	-	-	-	-	-	1	-	3	-	-	-	3	12
Pipilo fuscus	Brown Canyon Towhee	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	2
Pipilo erythropthalmus	Rufous-sided Towhee	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	2
Polióptila coerúlea	Blue-gray Gnatcatcher	1	-	-	-	1	-	-	-	-	-	-	2	-	-	-	1	5
Polióptila melanúra	Black-tail Gnatcatcher	-	-	-	-	2	-	3	-	-	-	-	-	-	1	-	-	6
Pyrrhulóxia sinuáta	Pyrrhuloxia	2	2	-	-	4	5	1	-	1	-	-	-	2	-	-	-	17
Riparia riparia	Bank Swallow	-	5	-	-	1	-	1	-	-	-	-	-	-	-	2	-	9
Salpinctes obsoletus	Rock Wren	-	-	-	-	-	-	-	-	-	-	1	3	-	-	-	1	5
Sayórnis sáya	Says Phoebe	1	1	-	-	-	-	-	2	-	-	2	-	-	-	2	1	9
Speotyto cunicularia	Western Burrowing Owl	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1
Spinus tristis	Goldfinch	1	2	-	-	-	-	-	-	-	-	1	-	-	-	-	-	4
Sturnella neglecta	Western Meadowlark	-	-	5	3	4	-	1	-	2	-	-	-	1	-	2	-	18
Tangávius aéneus	Bronzed Cowbird	-	-	4	7	-	-	-	-	-	-	-	-	2	1	-	-	14
Toxóstoma curviróstre	Curve-billed Thrasher	8	3	2	1	4	5	2	-	1	2	2	2	4	1	2	3	42
Tyránnus verticális	Western Kingbird	7	4	15	14	7	3	5	2	5	1	2	2	7	6	15	7	102
Tyránnus vociferans	Cassin's Kingbird	-	-	1	2	-	1	-	-	-	-	-	-	-	1	2	-	7
Týto álba	Barn Owl	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1	3
unknown spp.	Hummingbird spp.	-	-	-	-	-	-	-	-	-	-	-	5	-	-	-	2	7

Scientific Name	Common Name	Square Mile Section																
		1	2	5	6	11	12	23	25	26	27	30E	31E	31 W	32W	35	36	Total
Xanthocephalus xanthocephalus	Yellow-headed Blackbird	-	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7
Zendida asiática	White-winged Dove	14	8	7	5	14	9	9	6	6	7	9	2	2	1	2	14	115
Zenaida macroura	Mourning Dove	30	30	4	7	9	11	6	23	38	3	33	4	4	2	42	30	276
	Total Birds:	**233**	**226**	**109**	**110**	**124**	**126**	**76**	**67**	**141**	**56**	**105**	**60**	**78**	**56**	**203**	**230**	**2,000**
REPTILES:																		
Cnemidophorus exsanguis	Chihuahuan Spotted Whiptail	4	-	-	-	-	-	-	5	-	-	5	-	-	-	-	4	18
Cnemidophorus inornatus	Little Striped Whiptail	6	-	-	-	2	3	-	1	-	-	1	1	-	-	-	6	20
Cnemidophorus neomexicanus	New Mexico Whiptail	-	-	1	-	-	-	-	1	-	-	1	1	-	-	-	-	4
Cnemidophorus tesselatus	Checkered Whiptail	4	-	7	2	5	5	-	-	3	3	-	-	1	6	3	4	43
Cnemidophorus tigris	Western Whiptail	9	1	9	6	12	16	-	1	3	3	1	1	5	13	6	3	89
Cnemidophorus uniparens	Grassland Whiptail	15	1	5	6	-	3	-	4	14	4	4	1	4	12	6	15	94
Crotalus atrox	Western Diamondback Rattlesnake	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-	2	5
Crotalus viridis viridis	Prairie Rattlesnake	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1
Crotaphytus collaris	Collared Lizard	-	-	-	-		-		-	1	-	-	-	-	1	-	-	2
Crotaphytus wislizenii	Leopard Lizard	1	1	-	-		1		-	-	-	-	-	-	1	3	1	8
Diadophis punctatus edwardsi	Northern Ringneck Snake	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1
Holbrookia maculata	Lesser Earless Lizard	5	5	-	-	3	2	2	-	-	-	-	3	-	-	-	5	25

Scientific Name	Common Name	Square Mile Section																
		1	2	5	6	11	12	23	25	26	27	30E	31E	31 W	32W	35	36	Total
Holbrookia texana	Greater Earless Lizard	1	-	1	-	4	3	4	-	1	-	-	-	-	-	2	1	17
Pituophis melanoleucus	Bullsnake	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1
Phrynosoma cornutum	Texas Horned Lizard	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	4
Phrynosoma modestum	Round-tailed Horned Lizard	1	1	1	-	-	-	-	1	1	3	1	-	1	1	-	1	12
Salvadora grahamiae lineata	Patch Nose Snake	1	-	-	-	-	-		-	-	-	-	-	-	-	-	1	2
Sceloporus magister	Desert Spiny Lizard	-	-	-	-	-	1		-	-	-	-	-	-	-	-	-	1
Sceloporus undulatus	Eastern Fence Lizard	1	-	1	-	-	-	-	-	3	-	-	-	-	-	-	1	6
Urosaurus ornatus	Tree Lizard	-	-	-	1	5	7	3	-	1	-	-	-	-	-	-	-	17
Uta stansburiana	Side-blotched Lizard	42	1	4	1	8	6	4	2	4	2	2	-	-	3	12	42	133
	Total Reptiles:	94	11	29	16	39	47	13	15	31	15	17	7	11	38	32	88	503
AMPHIBIANS:																		
Unknown spp	Spadefoot Tadpoles	-	-	99	-	-	-	-	-	-	-	-	-	-	-	-	-	99
MOLLUSCA																		
Ashmunella kochi kochi	Koch's Land Snail	-	-	-	-	-	-	-	-	-	-	-	30	-	-	-	-	30

Appendix E-3. List of animal species observed at the White Sands Test Facility (WSTF) during the biological survey of dirt roads.

Scientific Name	Common Name	Roadway										
		1	2	3	4	5	6	7	8	9	10	Total
MAMMALS:												
Ammospermophilus interpres	Antelope Ground Squirrel	-	-	-	-	-	1	-	1	-	-	2
Antilocapra americana	Pronghorn	2	-	-	-	-	-	-	-	-	-	2
Dipodomys ordii	Ord's Kangaroo Rat	1	-	-	-	-	-	-	-	-	-	1
Dipodomys spectabilis	Banner-tailed Kangaroo Rat	-	-	-	-	-	-	-	-	-	1	1
Lepus californicus	Blacktailed Jackrabbit	9	1	1	-	2	1	-	-	-	6	20
Neotoma albigula	White-throated Woodrat	3	-	-	-	-	1	4	-	-	-	8
Neotoma mexicana	Mexican Woodrat	-	-	-	-	-	-	-	-	-	5	5
Odocoileus hemionus	Mule Deer	5	-	-	-	-	-	-	10	-	7	22
Oryx gazella	African Oryx	2	-	-	2	-	-	-	-		-	4
Sylvilagus audubonii	Desert Cottontail	6	1	1	-	-	2	1	3	-	3	17
	Total Mammals:	**28**	**2**	**2**	**2**	**2**	**5**	**5**	**14**	**0**	**22**	**82**
BIRDS:												
Actitis macularia	Spotted Sandpiper	-	-	-	-	-	-	-	-	-	8	8
Amphispiza bilineata	Black-throated Sparrow	6	-	4	-	-	-	-	-	-	10	20
Aquila chrysaetos	Golden Eagle	-	-	-	-	1	-	-	-	-	-	1
Buteo jamaicensis	Red-tailed Hawk	-	-	-	1	-	-	-	1	-	3	5
Buteo swainsoni	Swainson's Hawk	-	-	-	-	-	1	-	-	-	-	1
Callipepla gambelii	Gambel's Quail	4	-	-	-	-	-	-	-	-	2	6
Campylorhynchus brunneicapillus	Cactus Wren	4	-	-	-	-	-	1	-	-	1	6
Carpodacus mexicanus	Housefinch	2	-	-	-	-	-	-	-	-	2	4
Cathartes aura	Turkey Vulture	-	-	-	-	-	-	-	3	1	-	4
Chordeiles acutipénnis	Lesser Nighthawk	2	-	-	-	1	-	-	-	-	2	5
Corvus cryptoleucus	Chihuahuan Raven	-	1	1	1	2	-	-	-	-	2	7
Falco sparverius	American Kestrel	-	-	-	-	-	-	-	-	-	1	1

Scientific Name	Common Name	Roadway										
		1	2	3	4	5	6	7	8	9	10	Total
Geococcyx californianus	Roadrunner	-	-	-	1	1	-	-	-	-	1	3
Gymnorhínus cyanocéphalus	Piñon Jay	-	-	-	-	-	-	-	2	-	-	2
Hirúndo rústica	Barn Swallow	2	-	-	-	-	-	-	-	-	12	14
Lanius ludovicianus	Loggerhead Shrike	1	-	-	-	-	-	-	1	-	3	5
Mimus polyglottos	Northern Mockingbird	2	1	2	-	-	-	-	-	-	3	8
Myiarchus cineráscens	Ash-throated Flycatcher	1	-	-	1	-	-	1	-	-	-	3
Selàsphorua platycércus	Broad-Tailed Hummingbird	-	-	-	-	-	-	-	-	1	-	1
Sturnella neglecta	Western Meadowlark	1	-	-	-	-	-	-	-	-	-	1
Toxóstoma curviróstre	Curve-billed Thrasher	-	-	-	-	-	-	-	4	-	-	4
Toxóstoma longiróstre	Long-billed Thrasher	-	-	-	-	-	3	-	-	-	1	4
Tyránnus verticális	Western Kingbird	-	-	2	-	-	-	2	-	-	2	6
Xanthocephalus xanthocephalus	Yellow-headed Blackbird	-	-	-	-	-	-	-	-	-	5	5
Zenáida asiática	White-winged Dove	6	-	-	5	-	-	-	-	-	-	11
Zenaida macroura	Mourning Dove	4	2	3	-	-	5	-	3	1	4	22
	Total Birds:	35	4	12	9	5	9	4	14	3	54	149
REPTILES:												
Cnemidophorus inornatus	Little Striped Whiptail	-	-	-	-	1	-	-	-	-	-	1
Cnemidophorus tigris	Western Whiptail	-	-	-	-	-	-	-	-	-	10	10
Cnemidophorus uniparens	Grassland Whiptail	-	1	-	-	-	-	-	2	-	3	6
Crotalus atrox	Western Diamondback Rattlesnake	-	-	-	-	-	-	-	1	-	-	1
Crotaphytus collaris	Collared Lizard	-	-	-	-	-	1	-	-	-	-	1
Holbrookia maculata	Lesser Earless Lizard	-	-	-	-	-	1	-	-	-	1	2
Phrynosoma cornutum	Texas Horned Lizard	-	-	-	-	-	-	-	-	-	1	1
	Total Reptiles:	0	1	0	0	1	2	0	3	0	15	22

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

National Environmental Policy Act; Finding of No Significant Impact

AGENCY:
National Aeronautics and Space Administration (NASA)
White Sands Test Facility
Las Cruces, New Mexico

ACTION:
Fabrication and operation of a plume-front pump and treat groundwater remediation system to prevent further migration of contaminated groundwater.

SUMMARY:
Based on the Environmental Assessment of the Plume-Front Stabilization Work Plan, an Environmental Impact Statement is not required.

DATE:
April 2, 1999

RESPONSIBLE OFFICIAL:
Joseph Fries
Manager
NASA White Sands Test Facility

ADDRESS:
NASA White Sands Test Facility
P.O. Box 20
Las Cruces, New Mexico 88004

FOR FURTHER INFORMATION CONTACT:
David A. Amidei
Environmental Program Manager
NASA White Sands Test Facility
(505) 524-5517
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BACKGROUND AND DESCRIPTION OF PROPOSED ACTION:
NASA White Sands Test Facility (WSTF) intends to implement a pump and treat groundwater remediation system to prevent further migration of contaminated groundwater caused by historic site operations. This interim remedy will pump groundwater from six extraction wells, treat the groundwater using ultraviolet/oxidation and air stripping technologies, and reintroduce treated groundwater into the aquifer through a network of four injection wells. System construction is expected to commence in the summer of 1999 and is anticipated to operate 24 hours per day following an initial start-up phase. Approximately 1,000 gallons per minute will be treated and injected during the operational life of the system. WSTF expects the system to be operational in

the year 2000. Contaminant treatment standards for the injected water have been developed following standards and guidelines from Federal and State regulatory sources. WSTF is located approximately 16 miles northeast of Las Cruces, New Mexico. The proposed project's location is in Sections 31 and 32 of T20S, R3E and Sections 4,5,6, and 9 of T21S, R3E in Doña Ana County, NM.

ALTERNATIVES CONSIDERED:
As part of the Environmental Assessment, NASA has considered the alternatives of Monitored Natural Attenuation, Full-Scale Groundwater Remediation, Land Acquisition and Control, Remediation System Options, and No-Action. These alternatives are not technically or financially feasible at this time. In addition, these alternatives are not currently acceptable by State and Federal regulatory agencies.

POTENTIAL ENVIRONMENTAL EFFECTS:
Environmental aspects were examined pertaining to the following areas: geology and soils; air; water; cultural resources; biological resources; noise; land use; energy; services; and socioeconomic issues. The following section summarizes the conclusions for relevant environmental issues:

Land use - Additional roads, pipes, and powerlines with poles will be needed to support this proposal. These actions would be minimized by using existing facilities where applicable.

Energy - Energy consumption will increase at WSTF. The worst-case usage estimation will result in an approximate 73% annual increase of electrical energy consumption at WSTF when compared to Fiscal Year 1998.

Groundwater Quality - Groundwater quality at the project area will be significantly enhanced. Groundwater pump and treat remediation will remove contaminant mass, reduce potential ecological risks, and prevent continued plume migration.

Biological resources - The proposed project area has no habitat critical to the survival or reproduction of any listed species of plant or animal. This was determined from a Threatened and Endangered Species Survey.

Cultural resources - During the implementation phase, there is a possibility of unearthing archeological resources. Soil disturbance will be minimized due to this possibility; therefore, a negligible impact to archeological sites is expected. An archeological survey was completed for the affected area by a qualified subcontractor. If any undiscovered archeological site is uncovered during construction, site construction would cease until historic preservation issues are resolved.

Noise - Construction activities needed to facilitate monitoring, extraction and injection wells at the proposed site are expected to be done intermittently over a two year period. Ecological concerns regarding noise are expected to be negligible.

Geology and soils - A minor concern exists with an increase of wind or water soil erosion. During the construction phase, erosion control procedures will be implemented when appropriate.

PUBLIC COMMENT:
An Environmental Assessment that supports the Finding of No Significant Impact is available for public review at the Branigan Library (200 East Picacho Avenue, Las Cruces, NM; Reference Desk). A public meeting is scheduled for May 6th, 1999, from 5 p.m. to 7 p.m. in the Dresp B room of the Branigan Library. All comments are invited for consideration by the NASA Environmental Program Manager within forty-five calendar days of this notice. Address all correspondence to:

> **NASA White Sands Test Facility**
> **Attn: David A. Amidei**
> **P.O. Box 20**
> **Las Cruces, NM 88004**

Publish: April 11, 1999

ADMINISTRACIÓN NACIONAL AERONAÚTICA Y ESPACIAL (*NASA*)

Acto Nacional Ambiental Político (*National Environmental Policy Act*); Hallazgo de no impacto significativo

AGENCIA:
National Aeronautics and Space Administraion (*NASA*)
Administración Nacional Aeronaútica y Espacial
White Sands Test Facility, New Mexico

ACCIÓN:
Fabricación y operación de un sistema de bomba-y-tratamiento de remediación del agua subterranea para prevenir aún más la migración de la contaminación del agua subterranea.

SUMARIO:
Basado en la evaluación ambiental del Plan de Trabajo de la Estabilización del Penacho (*Plume-Front Stabilaztion Work Plan)*, no se requiere una declaración del Impacto al Ambiente.

FECHA:
2 de abríl 1999

OFICIAL RESPONSIBLE:
Joe Fries
Manager
NASA White Sands Test Facility

DIRECCIÓN:
NASA WSTF
P.O. Box 20
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PARA INFORMACIÓN ADICIONAL PÓNGASE EN CONTACTO CON:
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ANTECEDENTES DISCRIPCIÓN DE LA ACCIÓN PROPUESTA:
NASA White Sands Test Facility (WSTF) intenta llevar acabo un sistema de remediación del agua subterranea de bomba-y-tratamiento para prevenir aún más la migración de la contaminación del agua subterranea causada por operaciones históricas del sitio. Este remedio interino bombeará agua suberranea de seis posos de extracción, tratará el aqua subterranea usando tecnologías ultravioletas/oxidantes y eliminantes aero-ventiladoras, y introducirá de nuevo a la capa acquífera el agua subterrania tratada a traves de una red de cautro pozos de inyección. La construción del

sistema se espera comenzar en el verano de 1999 ye se anticipa operar 24-horas al día después de la fase inicial de lanzamiento. Aproximadamente 1,000 galones por minuto serán tratados e inyectados durante the vida operacional del sistema. *WSTF* espera que el sistema sea operacional en el año 2000. Las normas de la contaminación para el tratamiento del aqua de inyección han sido desarrolladas sigiendo las normas y las pautas de fuentes federales y estatales. *WSTF* está localizado aproximadamente 16-millas al noreste de Las Cruces, Nuevo Méjico. El projecto popuesto esta localizado en *Sections 31 and 32 of T20S, R3E* y *Sections 4,5,6*, y *9* de *R3E* del condado de Doña Ana.

ALTERNATIVOS CONSIDERADOS:
De parte de la valoración ambiental, NASA a considerado los alternativos de *Monitored Natural Attenuation* (Monitoriar Atenuación Natural), Remediación Total del Agua Subterrania, Adquisición de Terrenos y Control, Operación del Sistema de Remediación, y de no tomar acción. Estos alternativos no son técnicamente o económicamente factibles al la actualidad. Adicionalmente, estos alternativos no son, por lo presente, aceptados por las agencias estatatales y federales.

EFECTOS AMBIENTALES POTENCIALES:
Fueron examinados aspectos ambientales perteneciendo a las siguientes areas: geología y tierra, aire, agua, recursos culturales, recursos biológicos, ruido, uso de terrenos, energía, servicios, y cuestiones socioeconómicas. La siguiente sección resume las conclusiones pertinentes ambientales:

Uso de terrenales - Caminos adicionales, tubería, y postes y lineas de fuerza eléctrica serán necesarias para soportar este propuesto. En dónde sean áplicas, estas acciones serían minimizadas usandos faciladades exsistas.

Energia - El consume de la energía aumentará en *WSTF*. En el peor de los casos, el presupuesto resultará en aproximadamente un 73-por ceinto aumento del consumo de energía eléctrica en *WSTF* caundo comparada al año físico de 1998.

La calidad del agua subterranea - La calidad del agua subterranea en la area del projecto será realzada significativamente. La remediación del agua subterranea de bomba-y-tratamiento sacará masa contaminada, reducirá el riesgos ambiental potenciales, y prevenirá la migración del penacho.

Recursos biológicos - La area del proyecto propuesto no tiene habitante crítico a la supervivencia o la reproducción de caulquier especie enlistado de planta o animal. Esto fué determinado por un estudio de la lista de *Threatened and Endagered Species* (Especies Amenacados o Arriesgados.)

Recursos culturales - Durante la fase de implantación, habrá la posabilidad de desenterrar recurosos arqueológicos. Debido a esto, perturbación del terreno será minimizada, por lo tanto, se espera impacto mínimo a los sitios arqueológicos. Un estudio arqueológico del area fúe cumplido por un sub-contratista competente. Si un sitio arqueológico no aún discubrido se encuentre durante la construcción, la construcción del sitio será suspendida hasta que questiones de la preservación hisótorica sean resolvadas.

Ruido - Sobre un periodo de dos años, se espera hacer actividades intermitentes de construcción necesarias para faciltar monitoriar, posos de extracción e inyección en los sitios propuestos. Asuntos ecológicos conciente al ruido se esparan ser desdeñable.

Geologia y tierra - Un asunto menor existe debido al aumento de la erosión por aire o tierra durante la fase de construcción. Cuando sean apropiados durante la fase de construccion, procedimientos serán implantados contra la erosión.

COMENTARIO PÚBLICO:

La Evaluación Ambiental que soporta este "Hallazgo de no Impacto Significativo" es disponible para revisa pública en la biblioteca *Branigan Library (200 East Picacho Avenue, Las Cruces, NM; Reference Desk)*. Una reunion pública ha sido programada el seis de mayo, 1999, de las 5:00 p.m. – 7:00 p.m. en el cuarto *Dresp B* de la biblioteca *Branigan.* Todos comentarios son invitados para consideración por el **Gerente del Programa Ambiental (Environmental Program Manager)** dentro de 45-dias calendarios de esta noticia. Dirija toda correspondencia a:

NASA White Sands Test Facility
Attn: David A. Amidei
P.O. Box 20
Las Cruces, NM 88004

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