



**FINAL
REVEGETATION ACTION PLAN
FOR
KIRTLAND AIR FORCE BASE**

SEPTEMBER 2004

ACRONYMS AND ABBREVIATIONS

AFB	Air Force Base
AMAFCA	Albuquerque Metropolitan Arroyo Flood Control Authority
ATVs	all-terrain vehicles
BNRI	Baseline Natural Resources Inventory
°F	degrees Fahrenheit
INRMP	Integrated Natural Resources Management Plan
IPM	Integrated Pest Management
NRCS	Natural Resources Conservation Services
PLS	pure live seed
USACE	US Army Corps of Engineers
USAF	US Air Force
USDA	US Department of Agriculture
USFS	US Forest Service
USGS	US Geological Survey

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ALBUQUERQUE, NEW MEXICO**

TABLE OF CONTENTS

<u>Section</u>	<u>Page</u>
SECTION 1 INTRODUCTION	1-1
SECTION 2 PURPOSE AND NEED.....	2-1
SECTION 3 EXISTING ENVIRONMENT.....	3-1
3.1 GEOLOGY/TOPOGRAPHY.....	3-1
3.2 SOILS	3-1
3.3 CLIMATE.....	3-4
3.4 HYDROLOGY.....	3-5
3.5 PLANT COMMUNITIES ON KIRTLAND AFB.....	3-5
3.5.1 Sagebrush Steppe Community	3-6
3.5.2 Grassland Community.....	3-6
3.5.3 Juniper Woodland Community	3-6
3.5.4 Pinyon-Juniper Woodland Community.....	3-8
3.5.5 Ponderosa Pine Woodland Community	3-8
3.5.6 Riparian/Wetland/Arroyo Community.....	3-8
3.6 SITES IDENTIFIED FOR POTENTIAL REVEGETATION.....	3-8
SECTION 4 APPROACH AND METHODOLOGY	4-1
4.1 COMPONENTS OF REVEGETATION	4-1
4.1.1 Soil and Plant Salvage.....	4-1
4.1.1.1 Topsoil	4-1
4.1.1.2 Cryptogamic Soils	4-2
4.1.1.3 Plants.....	4-2
4.1.2 Seed Collection and Purchase	4-3
4.1.2.1 Bulk vs. Pure Live Seed.....	4-3
4.1.3 Primary Species Descriptions.....	4-4
4.1.3.1 Primary Seed Mix Species.....	4-4
4.1.3.2 Primary Tree Species.....	4-6
4.1.3.3 Specialty Area Species	4-6
4.1.4 Plant Acquisition	4-7
4.2 GENERAL SITE METHODS – GRASSLANDS	4-7
4.2.1 Site Preparation	4-7
4.2.1.1 Large Areas.....	4-8
4.2.1.2 Small Areas.....	4-8
4.2.2 Seed Application	4-8

4.2.2.1 Large Areas.....	4-9
4.2.2.2 Small Areas.....	4-10
4.2.3 Planting Techniques.....	4-10
4.2.3.1 Large Areas.....	4-10
4.2.3.2 Small Areas.....	4-10
4.3 GENERAL SITE METHODS – PINYON-JUNIPER.....	4-11
4.3.1 Site Preparation.....	4-11
4.3.1.1 Large Areas.....	4-11
4.3.1.2 Small Areas.....	4-11
4.3.2 Seed Application.....	4-11
4.3.2.1 Large Areas.....	4-12
4.3.2.2 Small Areas.....	4-12
4.3.3 Planting Techniques.....	4-12
4.3.3.1 Large Areas.....	4-12
4.3.3.2 Small Areas.....	4-12
4.4 GENERAL SITE METHODS – PONDEROSA PINE.....	4-12
4.4.1 Site Preparation.....	4-12
4.4.1.1 Large Areas.....	4-13
4.4.1.2 Small Areas.....	4-13
4.4.2 Seed Application.....	4-13
4.4.2.1 Large Areas.....	4-13
4.4.2.2 Small Areas.....	4-13
4.4.3 Planting Techniques.....	4-13
4.4.3.1 Large Areas.....	4-14
4.4.3.2 Small Areas.....	4-14
4.5 SPECIFIC SITE METHODS.....	4-14
4.5.1 Tijeras Arroyo.....	4-14
4.5.2 Prairie Dog Control Zones and Areas Previously Occupied by Prairie Dogs.....	4-15
4.5.2.1 Enhanced, Improved, or Semi-Improved Grounds.....	4-15
4.5.2.2 Unimproved Grounds.....	4-15
4.5.2.3 Inactive Prairie Dog Towns Outside of Control Zones.....	4-15
4.5.3 Burned Areas.....	4-16
4.6 WEED CONTROL.....	4-16
SECTION 5 MONITORING.....	5-1
5.1 DATA COLLECTION.....	5-1
5.1.1 Photographic Documentation.....	5-1
5.1.2 Growth and Survival.....	5-1
5.1.3 Determining Vegetation Composition.....	5-2
5.2 REPORTS.....	5-2
SECTION 6 LIST OF PREPARERS.....	6-1
SECTION 7 REFERENCES AND BIBLIOGRAPHY.....	7-1
SECTION 8 PERSONS AND AGENCIES CONTACTED.....	8-1

APPENDIX A SOIL SERIES	A-1
APPENDIX B GRASSLAND COMMUNITY.....	B-1
APPENDIX C JUNIPER WOODLAND COMMUNITY	C-1
APPENDIX D PINYON-JUNIPER COMMUNITY	D-1
APPENDIX E PONDEROSA PINE WOODLAND COMMUNITY.....	E-1
APPENDIX F RIPARIAN/WETLAND/ARROYO COMMUNITY	F-1
APPENDIX G NATIVE SEED DISTRIBUTORS AND WHOLESALE NURSERIES AS OF JULY 2004.....	G-1
APPENDIX H SEEDING PARAMETERS	H-1
APPENDIX I DEVELOPING A REVEGETATION CONTINGENCY PLAN	I-1

LIST OF FIGURES

<u>Section</u>	<u>Page</u>
Figure 3-1. Kirtland AFB Soils	3-3
Figure 3-2. Vegetation Communities on Kirtland AFB and the Withdrawal Area	3-7

LIST OF TABLES

<u>Section</u>	<u>Page</u>
Table 3-1. Albuquerque, New Mexico Average High/Low Temperatures and Precipitation by Month (1914 – 2003).....	3-4
Table 3-2. Potential Sites Identified for Revegetation or Monitoring	3-9
Table A-1. Soil Series.....	A-1
Table B-1. Grassland Species in the Kirtland Air Force Base Region.....	B-1
Table C-1. Juniper Woodland Species in the Kirtland Air Force Base Region.....	C-1
Table D-1. Pinyon-Juniper Woodland Species in the Kirtland Air Force Base Region.....	D-1
Table E-1. Ponderosa Pine Woodland Vegetation Species in the Kirtland Air Force Base Region.....	E-1
Table F-1. Riparian/Wetland/Arroyo Community Species in the Kirtland Air Force Base Region.....	F-1
Table H-1. Seeding Parameters	H-1

SECTION 1 INTRODUCTION

Kirtland Air Force Base (AFB) is located just southeast of Albuquerque, New Mexico at the foot of the Manzanita Mountains. These mountains rise to over 10,000 feet and define the eastern boundary of an area locally known as the East Mesa. Elevations at Kirtland AFB range from 5,200 feet to nearly 8,000 feet above mean sea level (US Geological Survey [USGS] 1990 a, b, c; 1991 a, b, c). Land use for areas adjacent to the base includes Cibola National Forest to the northeast and east, the Isleta Pueblo Indian Reservation to the south, and residential and business areas of the City of Albuquerque to the west and north.

The United States Air Force (USAF) owns most of the land at Kirtland AFB, but several other ownerships and leases apply. The eastern portion of Kirtland AFB is primarily Cibola National Forest land. These lands have been withdrawn from public use and are known as the Withdrawal Area.

Kirtland AFB is the third largest USAF facility in the world, occupying over 52,000 acres in south central New Mexico. Originally established in the late 1930s as a training base for the Army Air Corps, the base now supports approximately 200 tenant organizations. Kirtland AFB serves as a center for research and development for Air Force Research Laboratory (formerly Phillips Laboratory) and Sandia National Laboratories. The base functions as a test and evaluation center for the Space and Missile Systems Center and Air Force Operational Test and Evaluation Center, and is the headquarters for operational organizations including the Air Force Inspection Agency, and Albuquerque Operations Office for the Department of Energy.

Kirtland AFB also functions as a training base for the 58th Special Operations Wing of Air Education and Training Command's 19th Air Force. The 150th Fighter Group of the New Mexico Air National Guard is stationed at the base and flies F-16 aircraft from the base airfield. Kirtland AFB's host and associated units comprise the largest single employer in New Mexico, employing over 24,000 people (USAF 2003a).

SECTION 2 PURPOSE AND NEED

Under Air Force Instruction 32-7064 Section 2.2.1, the USAF must maintain or restore remaining native ecosystems types whenever feasible and or practicable and consistent with the mission. Revegetation is important because it can help to restore damaged lands that are important for wildlife, erosion control, water conservation, and aesthetic value. A Final Revegetation Plan for Kirtland AFB was completed in August 2000. This update to the original plan is needed for two reasons: advances in techniques for restoration have occurred; and a 2001 Baseline Natural Resources Inventory (BNRI) for Kirtland AFB have been used to provide a list of sites on base that are in need of environmental restoration.

The purpose of this revegetation plan update is to help Kirtland AFB personnel properly and effectively revegetate disturbed areas using native plant species. Revegetation techniques and procedures are discussed for each of the vegetation communities as well as for small and large disturbed areas, potential road closures, vacant prairie dog towns, and brush control areas. This plan also identifies areas of the base that are in need of revegetation.

This plan is intended to be used as a tool by Kirtland AFB personnel to help them determine the appropriate methods, species, and techniques to revegetate each of the primary plant communities. This plan gives general rather than site specific information, since numerous factors influence the success of a restoration project, as discussed in Section 4.1.

SECTION 3 EXISTING ENVIRONMENT

Kirtland AFB is located southeast of Albuquerque, New Mexico. It lies at the intersection of four major North American physiographic and biotic provinces: the Great Plains, Great Basin, Rocky Mountains, and Chihuahuan Desert. Vegetation and wildlife found within Kirtland AFB are influenced by each of these provinces, the Great Basin being the most dominant. USAF training and testing are the primary disturbances, however, large areas of Kirtland AFB remain unaltered by these actions.

3.1 GEOLOGY/TOPOGRAPHY

Kirtland AFB is situated in the eastern portion of the Albuquerque Basin, one of the region's largest north-south-trending basins, measuring 90 miles long and 30 miles wide (Fenneman 1931). The basin extends from the gently sloping area near the Rio Grande River to the steep foothills and slopes of the Sandia and Manzano Mountains. The basin is demarcated to the south by the Socorro Channel, to the north by the Nacimiento Uplift, to the west by the Puerco Plateau and Lucero Uplift, and to the east by the Sandia and Manzano Mountains. The Albuquerque Basin is at its widest point in the Kirtland AFB area and tapers off at its north and south ends. Large-scale faulting which occurred between 11.2 and 5.3 million years ago deepened the basin and tilted the local mountains. As a result, basin deposits (and those at Kirtland AFB) are a mixture of volcanic and sedimentary rocks (Energy Research and Development Administration 1977). Different landforms within the basin include mesas, benches, stream terraces, low hills, ridges, and graded alluvial slopes (Lozinsky et al. 1991; Kelley 1977; Kelley and Northrup 1975). Elevations at Kirtland AFB range from 5,200 feet in the west to nearly 8,000 feet in the Manzano Mountains. Several canyons are found within the Withdrawal Area including, Sol se Mete, Lurance, Bonito, Otero, and Madera Canyons.

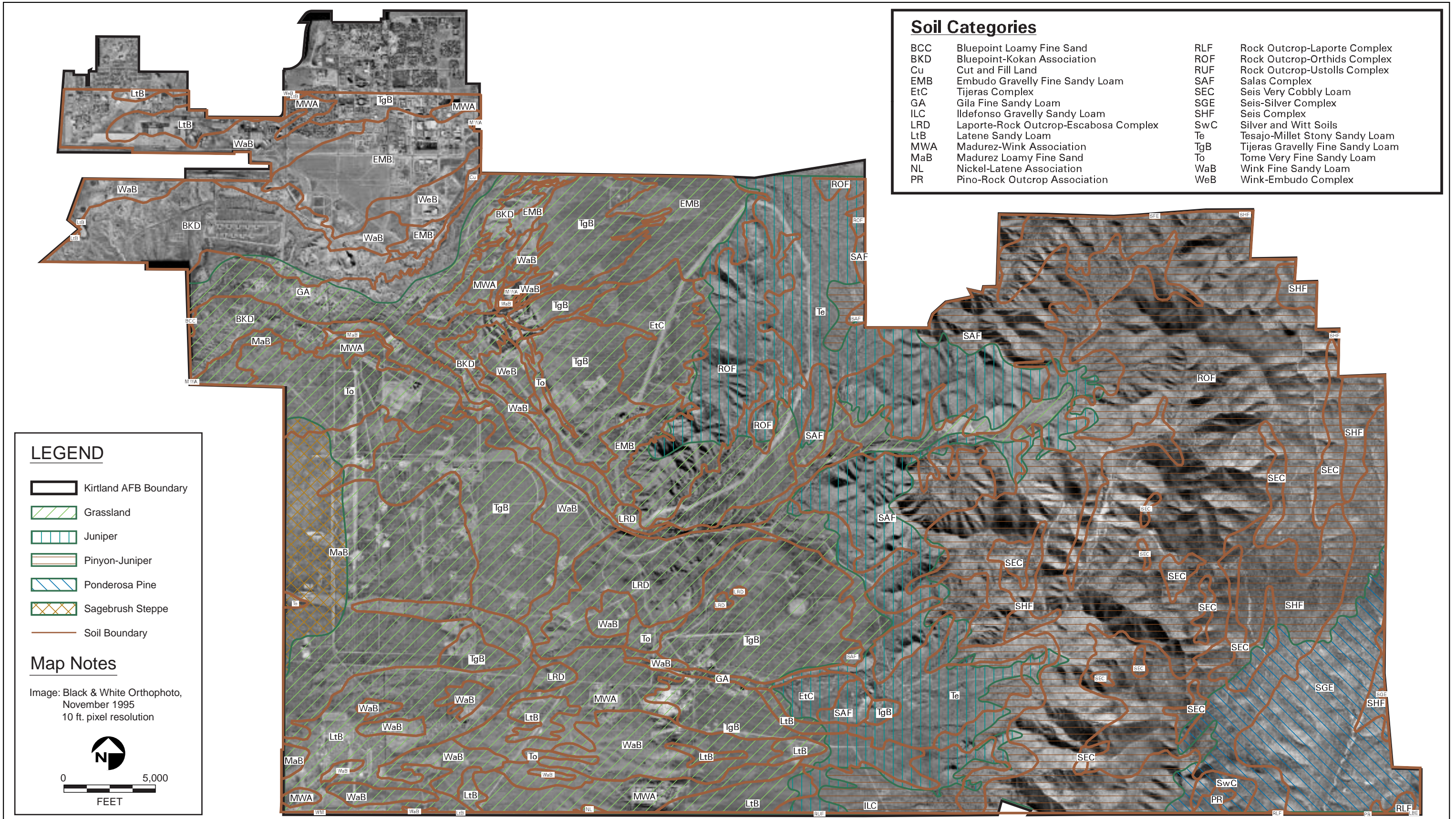
Much of the Albuquerque Basin consists of poorly consolidated sediments that eroded from the surrounding mountains following previous faulting and geologic activity. These sediments, known as the Santa Fe Group, are overlain in places by the 5.3 to 1.6-million-year-old Ortiz Gravel deposits. In certain places, Rio Grande River and volcanic deposits are interspersed.

3.2 SOILS

The dominant soils of the Albuquerque Basin are well drained and loamy. Minor amounts of gravelly and stony soils are found along the mountains and arroyos. A variety of soil associations are present on Kirtland AFB: Gila-Vinton-Brazito association, Bluepoint-Kokan association, Madurez-Wink association, Tijeras-Embudo association, Sies-Orthids association, and Kolob-Rock outcrop association (US Department of Agriculture [USDA] 1977). Gila-Vinton-Brazito and Bluepoint-Kokan associations are deep soils on floodplains and dissected terraces. The Gila-Vinton-Brazito association consists of level or nearly level, well drained, loamy soils mostly on the floodplain of the Rio Grande. The Bluepoint-Kokan association is composed of nearly level to steep,

somewhat excessively drained or excessively drained, sandy and gravelly soils on dissected terraces and alluvial fans. Madurez-Wink and Tijeras-Embudo associations are deep soils on alluvial fans, mesas, and piedmonts. The Madurez-Wink association is composed of level to moderately sloping, well drained, loamy soils on piedmonts. The Tijeras-Embudo association consists of level to moderately sloping, well drained, loamy and gravelly soils on alluvial fans. Sies-Orthid and Kolob-Rock outcrop associations are shallow to deep soils that occur on mountains and foot slopes. The Sies-Orthid association is composed of shallow or moderately deep, level to very steep, well drained, very cobbly, stony, and very stony loamy soils. The Kolob-Rock outcrop soils are deep, moderately steep to very steep, well drained, loamy and stony soils and rock outcrops (USDA 1977). Each association contains several specific soil series that differ in composition and individual characteristics. Individual soil series found at Kirtland AFB are listed in Appendix A.

The predominant soil series found in the developed area of Kirtland AFB are Tijeras gravelly fine sandy loam, Madurez-Wink association, and Embudo gravelly fine sandy loam (USDA 1977). Madurez loamy fine sand is the major soil association in the sagebrush steppe. The dominant soil types present in the western grasslands are Madurez loamy fine sand, Tijeras gravelly fine sandy loam, Madurez-Wink association, and Wink fine sandy loam. Tijeras gravelly fine sandy loam, Tesajo Millet sandy loams, Salas Complex, and Rock-outcrop-Orthids complex soils occur in the juniper woodland community. Soil series found in the pinyon-juniper hills include Rock-outcrop-Orthid complex, Tesajo-Millet sandy loams, and Salas complex. Soils found in the ponderosa regions of the Withdrawal Area include Rock-outcrop-Orthid complex, Seis complex, Seis-silver complex, and Seis very cobbly loam (USDA 1977). The locations of individual soil series are detailed in Figure 3-1.



Kirtland AFB Soils

FIGURE

3-1

3.3 CLIMATE

The climate in the Albuquerque area can be described as mild, sunny, and dry. During the summer, temperatures in the vicinity of Kirtland AFB average 90 degrees Fahrenheit (°F) for a high with low temperatures averaging around 62°F. The winter months (October to April) are much cooler, with an average daily low of 32°F and an average daily high of 58°F. The higher elevations of the Withdrawal Area are generally a few degrees cooler than the adjacent Albuquerque Basin. Large diurnal and annual ranges of temperature occur in the area, which is characteristic of a continental climate. Sunshine occurs nearly 3,400 hours a year and is evenly distributed in all seasons (USDA 1977). Annual precipitation is variable in the vicinity of Kirtland AFB. The average annual precipitation in Bernalillo County ranges from 8 inches in the county's arid valley and mesa areas to 30 inches in the Sandia Mountains east of Albuquerque. Precipitation occurs primarily in the summer months with more precipitation falling at higher elevations. Half of the average annual precipitation events occur from July to October, with an average of 44 heavy thunderstorms occurring each year (USDA 1977). Annual snowfall averages range from approximately 10 inches in the valley to 3 feet in the foothills. In the higher mountains, snowfall averages can reach as high as 10 feet. In the valley, which has an elevation similar to much of Kirtland AFB, the snow season extends from November to early April, but snow seldom stays on the ground for more than a day (USDA 1977). Table 3-1 shows the average high/low temperatures and precipitation in Albuquerque by month.

Table 3-1. Albuquerque, New Mexico Average High/Low Temperatures and Precipitation by Month (1914 – 2003)

Month	High/Low	Precipitation
January	47/23	0.4
February	53/28	0.4
March	61/33	0.5
April	70/41	0.5
May	79/50	0.6
June	89/59	0.6
July	92/65	1.3
August	89/63	1.5
September	82/56	1.0
October	71/44	0.9
November	57/31	0.4
December	48/25	0.5

Source: New Mexico Climate Center 2004.

Prevailing winds in the area are from the north in the winter and from the south along the river valley in the summer. The average annual wind speed is 9 miles per hour, with the windy season occurring in the spring. Gusts up to 50 miles per hour can occur in Tijeras Canyon from the release of heavy cold air held back by the Sandia and Manzano Mountains (USDA 1977).

3.4 HYDROLOGY

The Rio Grande River is the major surface hydrologic feature in central New Mexico. It flows north to south through Albuquerque, approximately 5 miles west of Kirtland AFB. The East Mesa, on which Kirtland AFB is located, has a west-southwestward ground surface slope ranging from 250 feet per mile near the mountains to 20 feet per mile near the Rio Grande River. The mesa's width is variable, ranging from 3 miles across in its northern section to 9 miles across in its southern section. Small wetlands, such as Coyote Springs and Sol se Mete Spring, constitute minor surface water bodies on the East Mesa.

Surface water occurs in the form of stormwater sheet flows that drain into small gullies during a precipitation event. Tijeras Arroyo, which is dry for most of the year, is the primary surface channel that drains surface water from Kirtland AFB to the Rio Grande River. These sheet flows reach Tijeras Arroyo through a series of storm drains, flood canals, and small unnamed arroyos. Surface water enters Tijeras Arroyo where it crosses the northeast corner of Kirtland AFB and then flows south of Albuquerque International Sunport draining eventually into the Rio Grande River (USAF 1991). Tijeras Arroyo flows intermittently during heavy thunderstorms and spring snowmelt (US Army Corps of Engineers [USACE] 1979a). However, nearly 95 percent of the precipitation that flows through Tijeras Arroyo evaporates before it reaches the Rio Grande River. The remaining 5 percent is equally divided between groundwater recharge and runoff (USAF 1991). Vegetation can encroach on the Tijeras Arroyo channel and obstruct the flow of water; this obstruction can cause flooding, especially during high intensity thunderstorms between May and October (USACE 1979b). Although they occur infrequently, Tijeras Arroyo floods are characterized by high peak flows, small volumes, and short duration.

Kirtland AFB is located within the limits of the Rio Grande Underground Water Basin, which is defined as a natural resource area and is designated a "declared underground water basin" by the State of New Mexico. It is regulated by the state as a sole source of potable water. The average depth to groundwater beneath Kirtland AFB ranges from 450 to 550 feet. The Rio Grande Underground Water Basin is fed by the Santa Fe Aquifer, which has an estimated 2.3 billion acre-feet of recoverable water. This aquifer is most likely recharged east of the installation in the Manzano Mountains where the sediment material favors rapid infiltration (USAF 1991).

3.5 PLANT COMMUNITIES ON KIRTLAND AFB

The vegetation scheme observed during field investigations at Kirtland AFB consists of six main plant communities: Sagebrush steppe, grassland, juniper woodland, pinyon-juniper woodland, ponderosa pine woodland, and riparian/wetland/arroyo. These vegetative communities correspond closely with the accepted US Forest Service (USFS) plant community descriptions. Transitional areas are found between these communities and contain a mixture of representative species. The pinyon-juniper woodland and grassland vegetation communities are the most common at Kirtland AFB. The riparian/wetland/arroyo community is confined to isolated areas inundated by surface water during at least some part of the year. The five primary vegetative plant

communities on Kirtland AFB and the Withdrawal Area are presented on Figure 3-2. Due to the limited occurrence of the riparian/wetland/arroyo community it is not considered a primary vegetative plant community.

3.5.1 Sagebrush Steppe Community

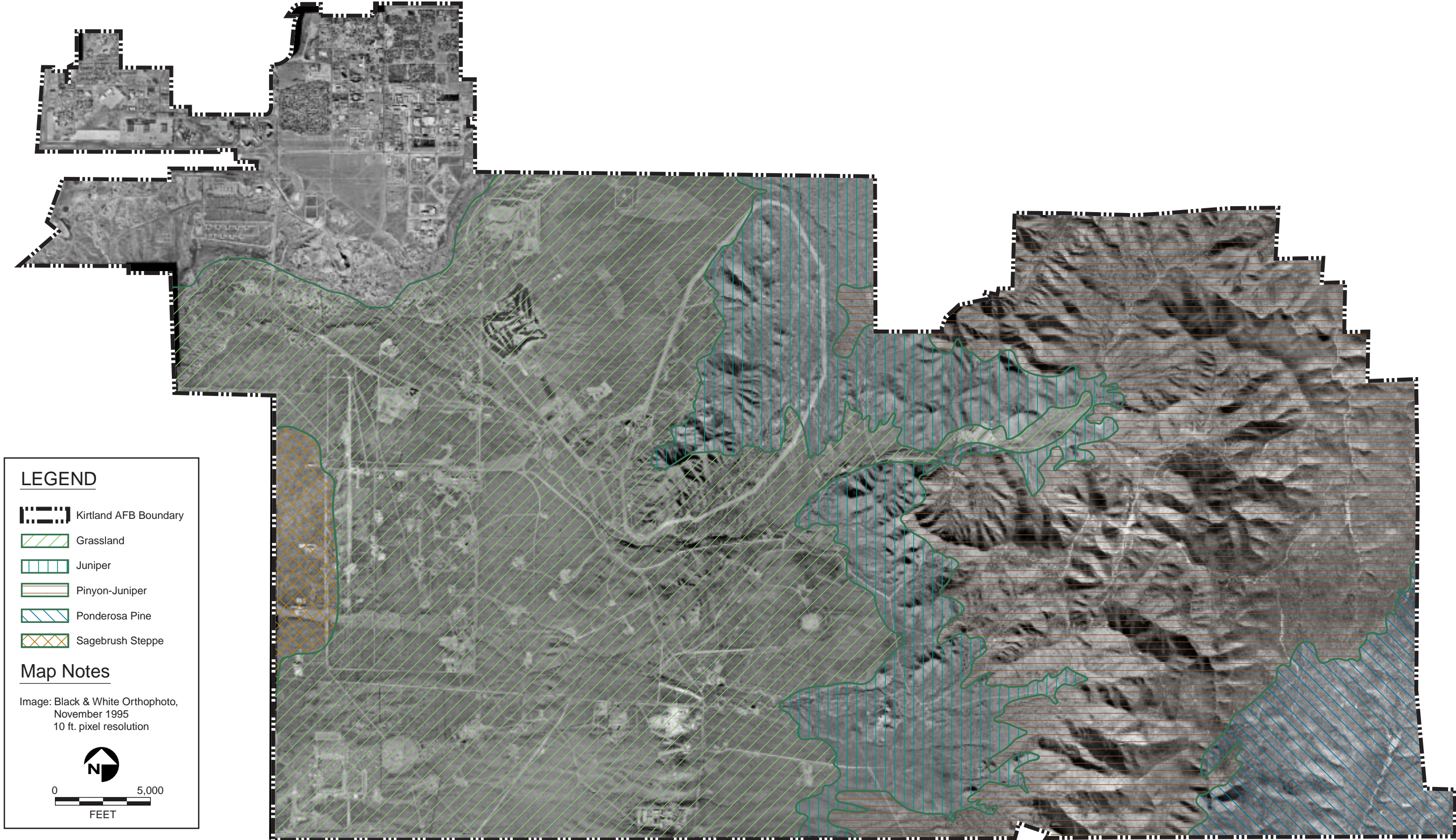
This community occupies a small portion of the base along the south west boundary of the installation. It is dominated by sand sagebrush (*Artemisia filifolia*), with scattered grasses such as black grama and spike dropseed (*Sporobolus contractus*). Other species include galeta, ring muhly (*Muhlenbergia torreyi*), broom snakeweed, and Great Plains yucca (*Yucca glauca*). Cryptogamic crust is common in this vegetation community.

3.5.2 Grassland Community

The grassland community is the most wide-spread vegetation complex at Kirtland AFB. This community generally occurs between elevations of 5,200 and 6,000 feet in the southwestern portion of Kirtland AFB. Near the Manzano Base, these grasslands are found as high as 6,900 feet. Primary grass species include ring muhly, Indian ricegrass, black grama, blue grama and spike dropseed (USAF 1991). Sand sagebrush is the most common shrub in this community, but apache plume (*Falugia paradoxa*) and four-wing saltbush (*Atriplex canescens*) are also present. Other species found in Kirtland AFB's grasslands include red three-awn (*Aristida purpurea* var. *longiseta*), purple three-awn (*Aristida purpurea* var. *purpurea*), six-weeks three awn (*Aristida adscensionis*), hairy grama, mesa dropseed (*Sporobolus flexuosus*), and scorpionweed (*Phacelia integrifolia*). Plains prickly pear cactus (*Opuntia polyacantha*) is also found, as well as Great Plains yucca. Appendix B lists plant species found in the grassland community.

3.5.3 Juniper Woodland Community

The juniper woodland community is a transitional zone between the grassland and pinyon-juniper woodland vegetation types and ranges in elevation from 5,800 to 6,800 feet. As a result, most of the vegetation present in the juniper woodland community is representative of these two bordering communities. One seeded juniper (*Juniperus monosperma*) is the main shrub component, forming a savanna type of habitat. Plant species found more commonly here than in the other two associations include clarets cup cactus (*Echinocereus triglochidiatus*), nolina (*Nolina microcarpa*), indigo bush (*Dalea formosa*), bush muhly (*Muhlenbergia porteri*), side oats grama (*Bouteloua curtipendula*), wavy leaf oak (*Quercus x pauciloba*), gray oak (*Quercus turbinella*), tree cholla (*Opuntia imbricata*), and squawbush (*Rhus trilobata*). A few Colorado pinyon pine (*Pinus edulis*) may be found in the upper elevations. Appendix C lists plant species found in the juniper woodland community.



Vegetation Communities on Kirtland AFB and the Withdrawal Area

FIGURE

3-2

3.5.4 Pinyon-Juniper Woodland Community

Pinyon-juniper woodlands at Kirtland AFB range in elevation from 6,300 to 7,700 feet. This plant community is composed of Colorado pinyon pine and one-seeded juniper, with an understory of shrubs and grasses. At most elevations, this community consists of open woodland with blue grama and, to a lesser degree, side-oats grama dominating the understory. Other species associated with this plant community are threadleaf groundsel, alderleaf mountain mahogany (*Cercocarpus montanus*), hop-tree (*Ptelea trifoliata*), New Mexican locust, and banana yucca (*Yucca baccata*). This plant community occurs primarily in the eastern portions of Kirtland AFB and is in good condition due to the lack of disturbance and habitation. Appendix D lists plant species found in the pinyon-juniper community.

3.5.5 Ponderosa Pine Woodland Community

The ponderosa pine woodland community is found at elevations ranging from 7,500 - 7,988 feet, but may occur lower in north facing canyons (USGS 1991c). Common species found in this community include the Ponderosa pine (*Pinus ponderosa*) and the Colorado pinyon pine. Gambel oak (*Quercus gambelii*) is common in some locations, providing islands of important pine-oak woodlands. Intermingled with these species are creeping barberry, New Mexican locust, snowberry (*Symphoricarpus rotundifolius*), Rocky Mountain juniper and Kentucky bluegrass (*Poa pratensis*). This community occurs primarily within the Manzano Mountains and is restricted to higher elevations. It is relatively undisturbed, although small logging operations do occur within the Withdrawal Area. Appendix E lists plant species found in the ponderosa pine woodland community.

3.5.6 Riparian/Wetland/Arroyo Community

The riparian/wetland/arroyo community consists of species that have a greater moisture requirement than species common to the other communities. These plant communities are found along Tijeras Arroyo, Arroyo del Coyote, and the various springs found on Kirtland AFB, where sufficient moisture occurs during at least some part of the year. Species associated with the riparian/wetland/arroyo community include salt-cedar (*Tamarix chinensis*), yerba mansa (*Anemopsis californica*), three-square bulrush (*Scirpus americanus*), and cattail (*Typha latifolia*). The small, scattered wetlands on Kirtland AFB are in good to fair condition. The Coyote Springs wetland complex is the largest wetland on base and has been used as a recreation area in the past. Because of past disturbance, this wetland is in fair condition, although several recent projects (tamarisk removal) have focused on restoring the wetland. Appendix F lists plant species found in the riparian/wetland/arroyo community.

3.6 SITES IDENTIFIED FOR POTENTIAL REVEGETATION

A BNRI was conducted in September 2001 and included in the 2001 Integrated Natural Resources Management Plan (INRMP). This survey identified many sites, large and

small, that have been disturbed and could benefit from revegetation efforts. Table 3-2 identifies these sites as they appear in the 2001 BNRI. Several of the sites are currently used for military training/operations and therefore, would not be candidates for revegetation. However, they are listed in the event that training or operations change, allowing some sites to be revegetated. Sites identified with an “M” and shaded in grey in the table are sites that may not need revegetation, but should be monitored to ensure that the site is recovering (i.e. revegetating naturally).

Table 3-2. Potential Sites Identified for Revegetation or Monitoring

Identification Number	UTM Location		Approx. Acreage	Description of Site
	Northing	Easting		
1	3869000	358385	10	Ground is generally bare with existing vegetation comprised of weedy species.
2M	3868291	358211	Unknown	Active training site. Exposed ground and some weedy species.
3	3868366	359060	5	Located at the Chestnut Site Hazard Zone. Sizable invasion of Russian thistle and mustards exist.
4	386916	358707	40 +	Large area at Chestnut Site Hazard Zone has several Russian thistle and mustard invasion.
5	3869352	365327	3-4	Sandia National Laboratory Restoration Site # 71 has areas of bare ground and Russian thistle.
6M	3869251	366416	NA	Large swath of vegetation removed. Appears to be active as the site is graded regularly and tire tracks were present, therefore the site should be monitored for long-term environmental issues.
9	3870228	365379	1/3	Appears to be a place where fire engines turned around in an area that recently burned. Due to the proximity of an adjacent arroyo, some sediment has entered the arroyo.
17	3870529	369183	7-10	Area heavily dominated by cheatgrass and Russian thistle. May be an active training location as many "foxholes" are present.
21	3870939	370629	Unknown	An old road leading to the summit of Sol se Mete Mountain has been abandoned. As a result, gullies have formed in the middle of the road. Natural vegetation is slowly invading. No major weed invasions.
22	3870503	370864	Unknown	An abandoned road has gullies forming in the middle of it. Should be revegetated if not in use.
23	3871245	368000	Unknown	Many weedy species such as mustards and Russian thistle are located at the HERTF site. An obvious attempt at revegetation was made, as vegetative matting was present. However, this effort appears unsuccessful.
24	3870120	373070	Unknown	Road leading to Manzano Lookout has gullies eroding the center of the road. Civilians recreating were observed four-wheeling up the road. Should be revegetated if not in use.

Table 3-2. Potential Sites Identified for Revegetation or Monitoring (continued)

Identification Number	UTM Location		Approx. Acreage	Description of Site
	Northing	Easting		
49	3872700	364700	Unknown	A borrow pit is located north of the road leading to Coyote Springs. Road leading to the pit directs water and sediment into Arroyo del Coyote. If it is still in use, then no other environmental recommendations are suggested. If no longer in use, then control weeds or revegetate the site.
52	3872250	364410	Unknown	A gravel pad is heavily invaded by Russian thistle. Site is located near Building 29094 FCDSWA Thermal Radiation Source.
54	3873740	365900	1	It is recommended that the parking area at Coyote Springs be revegetated.
56	3874050	365860	2	Just north of Coyote Springs is an area that is heavily disturbed. Russian thistle and mustards dominate the site. Benches are located at one end. Surface water runoff from this site is causing erosion into Arroyo del Coyote.
57	3874820	366050	Unknown	Sandia National Laboratory Restoration Project #8 was revegetated in the past, but many weedy species still exist.
58	3874910	366200	Unknown	On the opposite side of the road from 57 is another site that contains many weedy species including Russian thistle and mustards. Some areas have asphalt that is crumbling. Road leading into the site from the north also contains large numbers of weedy species.
60M	3878760	363550	2	Small two-acre fire burned along the northern fence line. An apparent firebreak surrounds the site. Natural revegetation is taking place; therefore, the site should be monitored to ensure that natural revegetation of the site continues.
61	3878800	362450	Unknown	Area around the water towers near the northern fence line is invaded by Russian thistle, mustards and other weedy species.
64	3875000	361420	Unknown	The equestrian stables are dominated by mustards. Mustards extend north of the stables into a riding area, as well as the Crash Test Site Laboratory. Revegetation north of the stables is recommended.
65	3877450	361270	3/4	Near the southeast corner of the landfill there is a denuded area, approximately 3/4 acre in size. Monitoring wells were installed at this location. Site was originally suggested for revegetation, but a pair of burrowing owls now inhabit the site. Revegetation should only occur if owls abandon the area.
66	3875780	360920	Unknown	The Peace Keeper Challenge Competitors Physical Fitness Course is virtually bare of vegetation except for mustards and few shrubs. It is recommended that the site be revegetated where possible.

Table 3-2. Potential Sites Identified for Revegetation or Monitoring (continued)

Identification Number	UTM Location		Approx. Acreage	Description of Site
	Northing	Easting		
67	3876210	361140	Unknown	The road surrounding the Tijeras Golf Course has some weed invasion issues. The road on the east side of the golf course shows the greatest amount of mustards and Russian thistle. A few small borrow pits are located on the northern segment of the road.
68	Tijeras Arroyo Floodplain		640	The entire Tijeras Canyon and Tijeras Arroyo complex located at KAFB is a major weed issue. Mustards and Russian thistle form large monocultures in the complex, especially downstream from Pennsylvania Blvd. The area north of the road is in better condition, but large areas of weeds exist.
69	3876500	359900	4-5	Site contains bare ground and mustards. Four yellow posts are labeled with signs reading "Caution-Non-Potable Water line".
74	3873100	370400	Unknown	The Cable Site located in the Withdrawal Area has Russian thistle invading the edges. It appears to be restricted only to disturbed areas. Recommend that the Russian thistle be managed to prevent its spread to the surrounding environment.
75	3878590	358490	Unknown	Two monitoring wells were installed recently. Area has been denuded of vegetation.
76	3874420	372740	Unknown	Located in the Withdrawal Area southeast of the Burn Site is an old 4x4 road. The middle of the road has eroded in some places. What appear to be erosion gauges were observed. At the roads terminus, surface water from the road has created a large gully down the southeast side of the mountain. The gully is approximately 12 feet wide and extends several hundred feet down hill. Little vegetation is present in the gully and it should be stabilized and revegetated.

Source: BNRI 2001 from Appendix AA of the INRMP 2001.

SECTION 4 APPROACH AND METHODOLOGY

This chapter contains information needed by land managers to revegetate various sites on Kirtland AFB. Section 3.1 describes the components of revegetation: soil and plant salvage, seed collection and purchase, primary species to be used, and plant acquisition. General methods (site preparation, seed application, and planting techniques) are described for the major habitat types (grassland, pinyon-juniper, and ponderosa pine) and the size of area to be revegetated (large vs. small). Revegetation plans for certain sites (Tijeras Arroyo, prairie dog control zones, and burned areas) and weed control procedures are also discussed.

4.1 COMPONENTS OF REVEGETATION

Revegetation involves restoring disturbed or altered areas back to a more natural state that supports native plants in patterns that resemble the native landscape. Revegetation efforts at Kirtland AFB will involve site preparation, seed application, and planting. Site preparation involves improving the soil and growing conditions so native seeds can germinate and planted species can survive. Seed application consists of planting seeds for grasses and other species on sites that have been prepared. Planting includes placing seedlings and saplings on prepared sites. Seedlings are young plants (e.g., shrubs) that have been grown from seed while saplings refer to young trees. Other practices associated with revegetation efforts include plant and topsoil salvage, seed collection and preparation, and plant propagation. These practices may be employed to varying degrees during revegetation efforts at Kirtland AFB.

Several limiting factors influence the success rate of revegetation projects at Kirtland AFB including: extended dry periods, monsoon rains, temperature extremes, poor soils, and high winds. Species and methods must be carefully chosen to overcome as many of these obstacles as possible. Reducing a limiting factor can sometimes be as effective as removing it all together, as long as it is reduced to a level where native vegetation can take hold at a site and out-compete undesirable species.

4.1.1 Soil and Plant Salvage

Salvage refers to the removal of useful soil and plant resources from an area that would otherwise be destroyed. These soils and plants are then transplanted to an area being restored.

4.1.1.1 Topsoil

Topsoil is often referred to as “living soil” as it contains organic material, bacteria, fungus, seeds, and other useful organisms necessary for plant growth. As a guideline it only refers to the top 12-24 inches of the soil, as soils found deeper contain little if any of these beneficial components. When areas containing topsoil are slated for disturbance, the topsoil should be removed and placed in areas being restored. Transplanting topsoil

has been proven effective in restoring native ecosystems and should be performed at Kirtland AFB whenever possible.

4.1.1.2 Cryptogamic Soils

Cryptogamic soils are sometimes referred to as “microbiotic crust.” These soils consist of living organisms (e.g., algae, cyanobacteria, mosses, lichens) and their by-products which form a crust of soil particles bound together by organic materials. This crust makes soils less susceptible to wind and water erosion, improves water infiltration, reduces weed invasions, and enhances plant germination. Studies have shown that cryptogamic soils are higher in nutrient content than non-crust-covered soil (USGS 2003).

Restoring cryptogamic crust takes many years (the science of such restoration is still in its infancy) but, certain techniques are known to promote crust growth. The following five factors have been shown to increase soil moisture and, therefore, encourage crust development (City of San Diego 2002):

1. Closely spaced plants;
2. Flat areas (depositional rather than erosional surfaces);
3. Some surface rocks, roots, or plant litter (to slow water and wind erosion);
4. Highly stable soils; and
5. Stable microhabitats (under shrubs, away from small drainages).

Soil crust organisms can also be relocated from impact areas by cutting squares of crust (about the size of a greenhouse flat) using hand tools. These squares are then placed into flats for transport or temporary storage. When soils at the revegetation site are moist, the crust can be planted into shallow holes that are flush with, or slightly below, the surrounding soil surface. Crust redevelopment of a site is often more species diverse when intact microbiotic crust has been translocated to the disturbed area (City of San Diego 2002).

New crust organisms have been grown on a small scale by placing salvaged native topsoil in greenhouse flats, which are then kept continually moist in a shaded growing structure. Salvaged brush also has been used to promote crust growth. Branches are placed on open ground after weeds have been controlled. These branches alter the soil conditions by reducing evaporation. Mosses and algae have been observed growing under this condition within 1 year (City of San Diego 2002). Due to the benefits provided from cryptogamic soils and the need to preserve them, these soils should be salvaged and used in revegetation efforts at Kirtland AFB whenever possible.

4.1.1.3 Plants

Plant salvage involves removing native plants from sites scheduled for construction or other disturbance and replanting this vegetation in areas needing restoration. These

plants (primarily small trees, shrubs, and some bunch grasses) are often repotted and stored for later use at a holding facility where seedlings and saplings may be propagated from these individuals. This provides easy access to native vegetation, often at a low cost. If available, salvaged native vegetation should be used whenever practical at Kirtland AFB. If salvaged saplings are used, they should be planted within 500 feet of the elevation in which they were originally collected to ensure the best survival and growth rates (Morris 2000).

4.1.2 Seed Collection and Purchase

Seed can be collected from native vegetation or purchased from a dealer. Native seed collection is time consuming, but reduces the possibility of weedy species entering the seed mixture. Additionally, seed collection requires cleaning and some seeds require certain preparation efforts to improve their chances of germination; this process is often labor intensive and time consuming. Collection, cleaning, and preparation would likely be the responsibility of personnel associated with revegetation projects at Kirtland AFB.

Purchasing native seed from dealers eliminates the time required to collect and prepare native seed, but does not ensure control of undesirable or weedy species in the mix. Purchased seeds grown and harvested within 200 miles of the site in which they will be sown have the highest survival and growth rates, therefore, the source should be considered during purchasing (Morris 2000).

Seed mixes sold by dealers require testing to ensure species composition, seed viability, and other factors. Federal seed laws require that testing analysis be no older than 5 months for seeds shipped interstate and no older than 9 months for seeds shipped intra-state. According to federal seed laws and New Mexico Department of Agriculture labeling laws, each bag of seed sold by a dealer must be sealed and labeled with variety, kind of seed, lot number, purity, germination, percent crop, percent inert, percent weed (including noxious weeds), origin, test data, and net weight.

4.1.2.1 Bulk vs. Pure Live Seed

Seed is usually sold either in “bulk” or “pure live seed” (PLS) quantities. Bulk seed is sold at a lower cost; however, these seeds are not cleaned nor are their purity or germination rates determined. By performing a few simple calculations, it is easy to determine which seed mix is more economical.

The percentage of PLS is determined by multiplying the percentage of purity by the percentage of germination and often represents a more exact quantity (and more accurate depiction of cost), as shown in the example below.

- Seed Mix “A” is labeled 98 percent pure with a 95 percent germination.
- Seed Mix “B” is labeled 89 percent pure with a 92 percent germination.

First, the PLS is determined for each seed mixture.

- Seed Mix A: $.98 \times .95 = .931$ PLS in 1 bulk pound of seed
- Seed Mix B: $.89 \times .92 = .819$ PLS in 1 bulk pound of seed

To determine the PLS cost, the seed cost is divided by the PLS percentage:

- Seed Mix A: $\$5.00 / .931 = \5.37 per PLS pound
- Seed Mix B: $\$4.75 / .819 = \5.80 per PLS pound

Seeds with higher PLS values often have more vigorous, healthy seed than those with lower PLS values (Wind River Seed Inc. 2003). Another factor to consider is shipping cost. These calculations and considerations are necessary to determine which is the best seed mix for the money.

Appendix G contains a list of local native seed distributors and wholesale nurseries where plants can be purchased. Some of the distributors that have websites provide prices and reclamation information on their websites or have catalogs available. Prices are subject to change and therefore, are not provided in this plan.

4.1.3 Primary Species Descriptions

The following is a discussion about the primary species to be used in revegetation efforts in the three primary habitat types on Kirtland AFB: grassland (including the sagebrush steppe and juniper woodlands), pinyon-juniper woodland, and ponderosa pine woodland. Some of the common species, such as one-seeded juniper and Rocky Mountain juniper, are not discussed since they readily reinvade sites with little human intervention. Therefore, only species that are recommended for inclusion in seed mixtures or plantings are discussed.

4.1.3.1 Primary Seed Mix Species

Blue grama (*Bouteloua gracilis*) - This native perennial is the state grass of New Mexico. This grass is also the most widespread of the grama grasses in the western US and is the most economically important of its genus. It is found in all types of habitats, from arid grasslands to ponderosa pine forests. Blue grama grows in patches and forms sod, depending on the amount of moisture available. In the southwest, it tends to grow in large patches, with individual plants growing up to 2½ feet high. This species is known to form a good ground cover and has high soil protective value. Once established, blue grama limits the effects of erosion caused by high winds and monsoon rains, thereby increasing the chance of survival for other species. Blue grama is a fast-growing species, maturing in about 60 to 70 days, with growth usually beginning after the initiation of summer rains. This characteristic allows it to cover the ground during winter and spring and provide protection for native grasses that have spring growth periods. The species is drought-resistant, becoming dormant during dry portions of the growing season. As soon as moisture becomes available, this species resumes growth. Blue grama is a good fall and winter forage plant, although it produces slightly less forage in spring and summer (USDA 1988). It has no known serious pests, which further increases its chances of

survival. This species is recommended for inclusion in the seed mixture for all habitat types at Kirtland AFB.

Indian ricegrass (*Achnatherum hymenoides*) - Indian ricegrass is one of the most important forage grasses in western and semi-desert ranges. This grass was once so prevalent in the west that it is said to have grown like fields of grain. The Zuni grind the seed into meal or flour to make highly prized bread (USDA 1988). Indian ricegrass is a hardy, densely tufted perennial and is one of the most drought-tolerant native grasses. This species grows in grasslands, on high plains, in pinyon-juniper woodlands, and on mountain areas above 10,000 feet. Growth begins in early spring and large plump seeds that resemble common rice are produced by summer. Spring growth of Indian ricegrass helps to limit weed species from establishing during cooler months. This plant is recommended for inclusion in the seed mixture for the grassland and pinyon-juniper habitats.

Galleta (*Pleuraphis jamesii*) - This grass is widespread in the western US, but is probably most common in New Mexico and Arizona, where it grows in the high plains and lower limits of the ponderosa pine belt. This species has a tough, woody rootstock that facilitates reproduction and increases its effectiveness as a soil binder. Galleta is very drought-resistant and does well on arid ranges. It is a warm season grass that is very tolerant of grazing. Under favorable conditions it grows in bunches, forming a sod (USDA 1988). This protective sod will limit the hardness associated with caliche soils. Galleta is also used as a good cover species for watershed protection (USAF 1998). This species is recommended for inclusion in the seed mixture for grassland habitat.

Side-oats grama (*Bouteloua curtipendula*) - In the southwest, this native perennial grass is typically found on plains, prairies, grasslands, woodlands, forest openings, dry slopes, ridges, and rocky hillsides. Side-oats grama grows vigorously on well-drained soils. It rises from rootstocks on leafy stems 1 to 4 feet high (USDA 1988). It is good forage for all classes of wildlife throughout summer and fall and is an important host plant for several species of butterflies (USAF 1998). This plant is recommended for inclusion in the pinyon-juniper and ponderosa pine woodland habitats seed mixture.

Scarlet globemallow (*Sphaeralcea coccinea*) - This native perennial forb grows in a broad range of soils and is found on plains, prairies, hills, mesas, along roadsides, and on rangeland. It also grows well in valleys, foothills, and waste areas. Scarlet globemallow reproduces from seed and is extremely drought resistant, actually increasing in abundance during dry periods. This species grows rapidly, with the main growth periods occurring in spring and summer (USDA, Natural Resources Conservation Services [NRCS] 2000). Scarlet globemallow establishes itself especially well on disturbed sites and is an excellent soil stabilizer, reducing wind and water erosion. It is also excellent forage for deer and pronghorn (USAF 1998). This species is recommended for inclusion in the seed mixture for native grasslands.

Southwestern penstemon (*Penstemon barbatus*) - This native forb species belongs to the snapdragon family (*Scrophulariaceae*) and is common to well-drained soils in mountains.

It can also be found on dry, rocky slopes in open forests. Southwestern penstemon grows up to 3 feet tall and blooms from June to October (USAF 1998). This species is recommended for inclusion in the seed mixture used for establishing herbaceous vegetation in ponderosa pine habitats.

4.1.3.2 Primary Tree Species

Pinyon pine (*Pinus edulis*) - The pinyon pine is one of the main components of the pinyon-juniper habitat type. It can be found growing on mountain slopes, mesas, plateaus, and in foothills, but is most abundant on dry and rocky soils. This species reaches a maximum height of 50 feet, although it is often shorter when associated with juniper. Pinyon pine seeds provide food for songbirds, quail, squirrels, chipmunks, black bears, mule deer, bighorn sheep, and mountain goats (USAF 1998). Due to its high value for wildlife and because it requires less water than junipers, pinyon pine has been favored over juniper during most revegetation efforts in the vicinity of Kirtland AFB (Haines 2000).

Ponderosa pine (*Pinus ponderosa*) - The ponderosa pine is a large tree that can grow up to 200 feet high. It grows on rocky hillsides, mesas, mountains, and plateaus. This species can grow on moist or dry sites and does well across a wide range of soil types. It is a good tree for wildlife because the seeds are eaten by several bird and small mammal species and the foliage is browsed by deer, bighorn sheep, and mountain goats (USAF 1998).

4.1.3.3 Specialty Area Species

Apache plume (*Fallugia paradoxa*) - Apache plume is a native perennial shrub common to arroyos, foothills, plains, mesas, hills, slopes, canyon bottoms, alluvial plains, dry rocky slopes, and washes. In the southwest, it is found from deserts and chaparral to open pine forests. Apache plume usually grows to about 3 feet tall, but is known to reach heights up to 8 feet. It grows rapidly, with the main growth occurring in spring and summer. Apache plume is also highly drought-resistant (USDA, NRCS 2000). This species provides important browse for deer and other wildlife, especially during winter. It is also a valuable aid in erosion control (USAF 1998). Apache plume is recommended for revegetation efforts on or near Manzano Mountain, where it is abundant.

Gambel oak (*Quercus gambelli*) - This native oak grows as a shrub or small tree and is common to valleys, canyons, foothills, stream margins, and lower mountain slopes. It usually grows in dense thickets. In the southwest it is abundant in upper woodlands and in association with ponderosa pine. Gambel oak is a good soil builder and usually supports an understory of palatable herbaceous vegetation. Oaks provide shelter and food for many species of wildlife (USAF 1998). Gambel oak is recommended for planting in open areas within the ponderosa pine habitat.

Rubber rabbitbrush (*Ericameria nauseosus*) - This is a gray-green shrub, attaining heights of 6 feet, but generally is two to four feet tall. It has bright yellow flowers that

bloom from June to September. This species of rabbitbrush contains a high grade rubber called chrysil (USFS 1988). It is a deep rooted, perennial shrub that is found in both the grasslands and pinyon juniper habitats at Kirtland AFB. Its forage value is considered fair for deer on winter range.

Kochia (*Kochia americana*) - Also known as red sage, this native perennial deciduous shrub grows to about 1½ feet tall with multi-branched woody stems. This plant reproduces from seed and flowers in late summer. It grows in desert valleys, flats, marshes, roadsides, and foothills, usually in areas with alkaline soils. This species provides good forage for deer, and contains high protein in fall (Stubbendieck et al. 1992). This species is able to flourish in caliche soils; therefore, it is recommended for seeding in grassland areas with caliche soils and high alkalinity.

Fourwing saltbush (*Atriplex canescens*) – This is a grayish-white shrub that branches freely from the ground, averaging 3-5 feet in height. It is found in dry, moderately saline or alkaline soils on plains and foothills. It often occurs in gravel washes, mesas, and along ridge tops (USFS 1988). It is important wildlife forage during the winter since it is an evergreen and has a high nutrient value. Fourwing saltbush should be used in grassland and pinyon-juniper habitats when possible.

4.1.4 Plant Acquisition

Plant propagation is not expected to be a major part of revegetation efforts at Kirtland AFB. Some plant propagation occurs at Tijeras Golf Course and, if space is available, some sensitive species may be propagated in support of revegetation efforts associated with this plan. For the most part, plants will either be transplanted from on-base salvage operations or purchased.

4.2 GENERAL SITE METHODS – GRASSLANDS

Although general revegetation methodology is presented in Section 3.1, this section explains techniques that should be used to restore grassland habitat in particular. Procedures specific to large and small areas are also described in this section.

4.2.1 Site Preparation

The first step in restoring a grassland area is to determine whether eroded areas need repair or if the site should be recontoured. If deemed necessary, either or both of these activities should be completed prior to employing other site-preparation methods.

If available, salvaged topsoil or cryptogamic soils should be placed on the site prior to seeding. If these soils are not available, however, the site must be prepared to make the existing soil favorable for seed germination. Grassland areas in need of revegetation often have impermeable soils from disturbance and loss of native vegetation. Wind and water can erode topsoil and associated nutrients from the site. Erosion also causes many areas to become compacted or hard and therefore, resistant to seed germination. These

compact soils act as a barrier, preventing nutrients and water from being absorbed into the soil. Once an area becomes compacted, water drains away instead of being absorbed by the soil. As time passes, this condition increases until the soil is eventually unable to support plant growth. In these areas, soil must be loosened to allow the infiltration of water and seed germination. Soil preparation methods are described below. For the purpose of this plan, “large areas” are those considered too extensive to be worked using manual labor.

4.2.1.1 Large Areas

Traditional agricultural methods, such as a disc and harrow, could be used to loosen soil in large areas. Areas of more severe compaction may require chiseling, ripping, or gouging if a disc will not prepare the seedbed to an appropriate depth. Gouging is the preferred method of the three since it digs a series of small depressions across the landscape and doesn’t leave a “cultivated” look to the germinating vegetation (Munshower 1994). Large clods or stones expected to affect seeding should be removed. One disadvantage to this method of site preparation is that the dirt is as receptive to wind-borne weed seeds as it is to preferred species.

Land imprinting is another way to prepare large grassland areas for revegetation. This technique involves shaping the seedbed into a series of V-shaped imprints with a specially constructed machine and creates a look similar to gouging. Seeds are deposited at the same time by the imprinter. The V-shaped imprints funnel seed, rainwater, eroded soil, and plant litter together where these resources can work in concert to germinate seeds and establish seedlings. Land imprinting has been used to successfully establish vegetation on degraded land areas where annual precipitation ranges from 3 to 14 inches (Dixon and Carr 1998). This method has proven more successful in ecological restoration primarily due to greater control of rainwater at the soil surface. On favorable soils, failures with imprinting are often attributed to poor imprints from faulty machines and use of poor seed stock (Dixon and Carr 1998). In the vicinity of Kirtland AFB, the imprinting method is not recommended in grassland areas where soils are sandy and silty. High winds quickly shift fine-textured soils and imprints are lost before any benefit can be obtained (Morris 2000). Imprinting should not be employed in areas where fine-soil conditions exist and where traditional methods would be more effective.

4.2.1.2 Small Areas

Principals of site preparation that apply to large areas often apply to small areas too, except that large machinery cannot access the site. All-terrain vehicles (ATVs) can be used to pull site-preparation machinery. Hand tools or gas-powered rototillers could be used to prepare the site if ATV use is impracticable or ineffective.

4.2.2 Seed Application

Seed should be applied using traditional agricultural methods (i.e. drill seeding). The seeding mix recommended for each acre of grassland to be revegetated as follows:

- Blue grama – recommended 3 lbs/acres
- Indian ricegrass – recommended 2.5 lbs/acre
- Galleta – recommended 2.5 lbs/acre
- Scarlet globemallow – recommended ½ lb/acre

In caliche soils, species such as kochia (2 lbs/acre) can be added. Seeds should be planted in June or July prior to the July and August monsoons.

4.2.2.1 Large Areas

When possible, seeds should be applied with a drill seeder that plants seeds in a zigzag pattern, in order to avoid a furrowed look. A drill seeder allows seed to be planted to a desired depth and facilitates intimate seed-to-soil contact, minimizing the effects of wind and water erosion. (Seeding parameters for recommended seeds are provided in Appendix H.) Drill seeders may be used only on slopes less than 30 percent and in areas that are not extremely rocky (Steinbacher 2000). It may be possible to plant grasses and forbs together using a Great Plains native grass seed drill. This drill has three separate seed boxes, allowing different seed types (i.e. sizes) to be planted at the same time (Gourd 2004).

A rangeland drill seeder with packer wheels could be used to revegetate large grassland sites or areas where the soil is rocky or contains other large debris. Rangeland drill seeders do not require soil alteration before use and can be used on hard or crusty soils. These seeders plant and cover the seed without disking or harrowing, thus limiting the amount of soil exposed to erosion or to the invasion of weedy species. The packer wheels pack the dirt back into place, increasing the soil-to-seed contact. Unfortunately, rangeland drill seeders are difficult to obtain. If rangeland drill seeders are unavailable, seeding should be performed with a traditional drill seeder. Use of a traditional drill seeder requires site preparation, thereby increasing the risk of erosion. Application of mulch after seeding protects the soil surface from erosion and can help prevent seed from being washed away by monsoon rains. Mulch should be applied loosely. The use of mulch mats is not recommended because they are expensive and can entangle wildlife. Due to the arid climate at Kirtland AFB, loose mulch should consist of straw hay. Wheat hay mulches are less desirable than oat hay mulches since wheat grows better in arid climates and may compete with the seeded species. Some species used for mulch are grown specifically for this purpose and are harvested prior to seeds becoming mature. These seed-free mulches are expensive and may not be economically feasible for large areas on Kirtland AFB. Loose mulching of large remote areas can have high transportation costs since mulches are light and bulky. Rather than hauling organic matter to isolated areas, it may be cheaper to transport shredding devices to the site and mulch organic products available there (Munshower 1994).

Mulches can be spread by hand or with shredders. Loose mulch should be crimped into the surface of the soil or sprayed with a tackifier to hold it in place. A hydromulch spray can also be used, but this should be done after seeding. Hydromulches do not work well

in windy situations since the dried material peels up and rolls back in the wind. On extreme slopes or where wind or water erosion is a concern, jute netting can be placed over the mulch and tacked down. Jute netting is expensive and labor intensive to install, so this should be reserved only for problem areas. Considering the relative harsh environmental factors at Kirtland AFB, mulch should be used when feasible.

In some cases, it may be impractical to use the machinery described in this section. Some irregularly shaped sites or steep slopes may be inaccessible to large machinery. In those cases, techniques described in section 3.2.2.2 can be used.

4.2.2.2 Small Areas

It is often cost-prohibitive to use large machinery to revegetate small or irregularly shaped areas or sites on a steep slope. In these cases, seed can be planted by broadcast seeding followed by hand raking. Broadcast seeding applies seed to the surface (not directly into the soil) with a mechanical seeder or by hand. Hand raking or pulling a panel of chainlink fence behind an ATV may be necessary to ensure seeds are covered and evenly distributed. Rolling the area with a water-filled roller will help ensure good seed-to-soil contact. Broadcast seeding requires much more seed than drill seeding to ensure a high yield. Birds and insects also have access to seeds spread by this method, further reducing overall yield. Mulch should be applied after seeding to limit erosion, to prevent seed from being eaten by birds, and to keep seed from being swept away by wind or heavy rain.

4.2.3 Planting Techniques

Although seedlings or saplings would be planted primarily in pinyon-juniper and ponderosa pine habitat, some native shrubs may be planted in grassland areas. Species that may be planted include fourwing saltbush (*Atriplex canescens*) and rubber rabbitbrush (*Ericameria nauseosa* var. *nauseosa*).

4.2.3.1 Large Areas

Shrubs can be re-established by planting salvaged vegetation or seedlings in grasslands. Traditional planting methods (i.e., shovels) should be used to plant native shrubs, although use of mechanized equipment such as a gas-powered post-hole digger, could facilitate large-scale planting efforts.

4.2.3.2 Small Areas

Traditional planting methods used to plant or transplant shrubs in large areas also apply to small areas. Use of mechanized equipment, however, is probably not cost-effective for planting shrubs in smaller grassland sites.

4.3 GENERAL SITE METHODS – PINYON-JUNIPER

Although general revegetation methodology is described in Section 3.1, this section discusses techniques specific to pinyon-juniper restoration. Revegetation efforts in pinyon-juniper habitat would focus on establishing pinyon pine and juniper trees. Because pinyon pine is more valuable to wildlife (for cover and food) and is less water intensive, it is preferred over juniper for revegetation efforts (Haines 2000).

4.3.1 Site Preparation

As described in Section 3.2.1, before further restoration occurs, eroded areas should be repaired. Next, hard soils should be broken up; however, less alteration is required to restore pinyon-juniper habitat than is necessary to revegetate native grassland (Haines 2000).

4.3.1.1 Large Areas

Light discing or the use of a harrow will adequately break up hard soils in pinyon-juniper habitat. Juniper will re-establish itself without assistance as long as grass comprises less than 30 percent of the total vegetation cover and a seed source is present (Haines 2000). Pinyon pines must be planted and grasses kept away from the seedlings. In order for pinyon pines to survive, grasses should be cleared at least eighteen inches around the seedling in order to reduce competition.

4.3.1.2 Small Areas

Principles of site preparation that apply to large areas often apply to small areas as well. ATVs can be used to pull machinery to help break up the soil. Hand tools or gas-powered rototillers could also be used to prepare the site.

4.3.2 Seed Application

The seeding mix recommended for each acre of pinyon-juniper revegetation is as follows:

- Blue grama – 2.5 lb
- Indian ricegrass – 3 lb

Additional species could be added including 1 lb/acre Apache plume or 50 seedlings (NM Forestry Division 2004) and 2 lbs/acre four-wing saltbush or 50 seedlings (NM Forestry Division 2004) in areas where those species are present in the surrounding communities. Seeds should be planted in June or July prior to the July and August monsoons.

4.3.2.1 Large Areas

To revegetate large areas in pinyon-juniper habitat, seeding should occur before trees are planted. The presence of the new trees will limit the effectiveness of a drill seeder on these sites. Areas seeded with grasses and forbs should be mulched to improve success.

4.3.2.2 Small Areas

Small areas should be seeded using the broadcast seed method. The site should be prepared, as necessary, using hand tools or gas-powered rototillers before seeding attempts are made.

4.3.3 Planting Techniques

In pinyon-juniper habitat, pinyon pine seedlings should be planted where grassland cover has been removed from a 1-foot diameter area (NM State Forestry Division 2004). These seedlings must be watered when planted and then monitored and watered as needed. Watering on an as-needed basis should occur for at least 1 year (Haines 2000). Watering could be done by back-pack sprayers or the use of watering pellets such as those sold by the Dry Water Company.

4.3.3.1 Large Areas

Trees and shrubs should be re-established by planting salvaged vegetation or seedlings in this habitat. Plantings should occur after seeding procedures have been completed. Traditional planting methods (i.e., shovels) should be used to plant native trees and shrubs although mechanized equipment such as a gas-powered post-hole digger could facilitate larger planting efforts.

4.3.3.2 Small Areas

Traditional planting methods used to plant or transplant trees and shrubs in large areas often apply to small areas. Use of mechanized equipment, however, is probably not cost-effective for planting trees and shrubs in smaller pinyon-juniper sites.

4.4 GENERAL SITE METHODS – PONDEROSA PINE

Although general revegetation methodology is described in Section 3.1, this section explains techniques used to restore ponderosa pine habitat in particular. Revegetation efforts in ponderosa pine habitat will focus on seeding first with herbaceous plants and then planting ponderosa pine saplings.

4.4.1 Site Preparation

Prior to restoring a site, any eroded areas should be repaired. Where necessary, hard soils should be broken up to improve seeding success.

4.4.1.1 Large Areas

Any crusted areas should be broken up with traditional agricultural tools, where possible. All-terrain vehicles (ATVs) may be used to bring machinery to the site if mature trees and shrubs make the area inaccessible to larger vehicles or machinery. If the site is inaccessible to larger equipment, hand tools or gas-powered rototillers could be used to prepare the site.

4.4.1.2 Small Areas

For smaller areas, ATVs can be used to pull machinery to the site. Hand tools or gas-powered rototillers could be used to prepare the site prior to revegetating with herbaceous species.

4.4.2 Seed Application

The seeding mix recommended for each acre of ponderosa revegetation is as follows:

- Blue grama – 1.5 lb (Plants of the Southwest 2004)
- Side-oats grama – 4.5 lb (Plants of the Southwest 2004)
- Southwestern penstemon – 1 lb (Plants of the Southwest 2004)

4.4.2.1 Large Areas

To revegetate large areas of this habitat type, seeding should occur before ponderosa pines are planted. The soil should be loosened as necessary and seeding should be conducted using a drill seeder, imprinter, or gouger. If the presence of mature trees limit the effectiveness of the drill seeder, it may be necessary to manually broadcast seed and hand rake the site. Mulch could be applied to limit the effects of erosion and to prevent seeds from being washed away by monsoon rains.

4.4.2.2 Small Areas

The same principles applied to seeding large areas of ponderosa pine habitat can be applied to small areas, except that hand-seeding should be used.

4.4.3 Planting Techniques

Ponderosa pine saplings are recommended for this vegetative community. Gamble oak acorns can also be planted where this species is part of the surrounding community. A power auger can be used to dig the hole for the transplanted pine sapling; this keeps the sides of the hole from becoming compacted and allows the roots to penetrate the soil (Atwell 2000). The saplings should be planted at the times and depths recommended by the USFS. A manual post-hole digger could be used in areas inaccessible to a power auger. Ponderosa pines used for revegetation should be three years old (two years in a seedbed and one year in a transplant bed). Using saplings of this age provides a higher

survival rate following the transplant into native habitat (Atwell 2000). If possible, transplanted ponderosa pine saplings should be planted within 500 feet of the elevation from which they were harvested. This has been proven to increase their survival and growth rates (Morris 2000). Oak acorns may be gathered on site and planted in conjunction with the ponderosa pine sapling planting effort.

4.4.3.1 Large Areas

Trees and shrubs should be re-established by planting salvaged vegetation, seedlings, or saplings in this habitat. Traditional planting methods (i.e., shovels) should be used to plant native trees and shrubs. Mechanized equipment, such as a gas-powered post-hole digger, could facilitate large-scale planting efforts.

4.4.3.2 Small Areas

Traditional planting methods used to plant or transplant trees and shrubs in large areas often apply to small areas. However, it is probably not cost-effective to use mechanized equipment to plant trees and shrubs in smaller sites.

4.5 SPECIFIC SITE METHODS

Kirtland AFB contains several areas that have special revegetation needs: Tijeras Arroyo, prairie dog control zones, and areas that have burned. These sites, which range in size from about 1/3 area (a burned area) to approximately 1 square mile (the Tijeras Canyon and Arroyo complex) are described in Kirtland AFB's BNRI (USAF 2001a). This section addresses how each of these areas should be treated.

4.5.1 Tijeras Arroyo

Revegetating an arroyo is a very complex, difficult, and expensive process. The soil must be somewhat stabilized to allow desirable plants to take hold. Banks that are eroding or particularly susceptible to erosion may be stabilized by placing rip-rap, gabions (chunks of concrete or rocks held in place by wire mesh), or paving blocks on the side slopes (Funk 1996). However, this can cause erosion problems on the opposite bank (Lovato 2003). While test plots are often used to determine which revegetation techniques/species work best in a particular area, this is not recommended for an arroyo because a seeding plan that works in one location may not work in other areas of the same arroyo (Lovato 2003). Due to budget constraints, a complete arroyo revegetation plan is not possible. However, a few things can be done to improve the habitat along Tijeras Arroyo. Weedy species are prevalent along portions of the arroyo; however, according to Kirtland AFB's Pest Management Plan, tolerable weeds may be essential for soil stabilization (USAF 2003b). The Albuquerque Metropolitan Arroyo Flood Control Authority (AMAFCA) recommends leaving all existing vegetative growth in place. Removing plants, even weeds, can cause more problems than are solved. Broadcast seeding the arroyo with a seed mix that allows for early germination will add more native vegetation to the area. Such a seed mix is available through AMAFCA (Lovato 2003).

4.5.2 Prairie Dog Control Zones and Areas Previously Occupied by Prairie Dogs

This section describes revegetation plans for prairie dog control zones. By definition, prairie dog control zones consist of those areas on base where prairie dogs are determined to adversely affect human health, human safety, or a mission to the extent that they will be removed and kept from reinvading these areas (USAF 2003c). Some of these control zones are in housing areas, athletic fields and other maintained (enhanced, improved, or semi-improved) grounds. Other control zones are in areas where land maintenance activities are minimal (unimproved grounds). This section also addresses revegetation protocol for areas previously occupied by prairie dogs, therefore not in a control zone.

4.5.2.1 Enhanced, Improved, or Semi-Improved Grounds

Enhanced, improved or semi-improved grounds previously occupied by prairie dogs should be repaired according to methods described in Kirtland AFB's Grounds Maintenance Plan and Pest Management Plan (USAF 2001b; USAF 2003b).

4.5.2.2 Unimproved Grounds

Some areas previously occupied by prairie dogs may contain enough native vegetation to preclude the need for reclamation. These sites should be allowed to revegetate naturally, but should be monitored to ensure conditions do not deteriorate. Other areas that should not be actively revegetated include those sites containing nesting burrowing owls. It may be desirable to provide artificial nests for owls in these locations. This may be done by trenching a 4-foot deep L-shaped burrow, lining the burrow with 6-inch black corrugated drain pipe, and attaching the pipe to a 5-gallon covered bucket at the below-ground end.

If bare ground exists in areas previously occupied by prairie dogs, seeding may be necessary to reduce erosion and prevent invasion by weedy species. To improve seeding success, the site should be prepared as described in Section 3.2.1. If weedy species have already invaded an area, they may be removed or killed before seeding is done. Weeds may be managed using biological, mechanical, or chemical methods (USAF 2003b). A seed mix containing sideoats grama, blue grama, Indian ricegrass, and galleta grass may be used to increase successful restoration. The area should be seeded using a grass drill (Buckner 2003).

4.5.2.3 Inactive Prairie Dog Towns Outside of Control Zones

Prairie dog colonies usually become inactive following an outbreak of disease (primarily plague). These areas will probably become re-colonized within several years. In most cases, it is best to leave these areas as they are and let them revegetate naturally. Native grasses generally need to establish for at least 5 years to withstand grazing by prairie dogs and, since prairie dogs often return in less than 5 years, revegetation efforts are generally unsuccessful.

For areas that are highly degraded, however, it may be preferable to conduct some revegetation. Planting grasses (i.e., sideoats grama, purple-three-awn, and ring muhly) and forbs (i.e., scarlet globemallow, tansy aster) that are less attractive or palatable to prairie dogs may delay their return. Also, if prairie dogs return to an area before 5 years have passed, it may help to “distract” them by seeding wheat or oats so native plants receive less defoliation and have a better chance of becoming established (Buckner 2003).

4.5.3 Burned Areas

Fire is a natural and important component of the habitats found on Kirtland AFB. For this reason, areas that burn from either natural or human-caused means should be allowed to revegetate naturally. A more aggressive approach may be needed in areas where natural revegetation is not likely to be successful (e.g., steep hillsides or highly erodable soils). In these cases, Kirtland AFB personnel may implement revegetation or erosion-control measures. All burned sites should be monitored to ensure vegetation is successfully establishing.

4.6 WEED CONTROL

The Integrated Pest Management (IPM) program at Kirtland AFB controls weeds through biological, horticultural, mechanical, and chemical means. All other IPM control alternatives should be considered before using chemical methods (USAF 2003b). Weed control is usually accomplished by allowing native vegetation to out-compete weedy species. Weeds often grow in areas re-seeded with native vegetation, but after a few years these weeds die off, giving way to native grassland species (Morris 2000). The selected seed mixes (Sections 3.2.2, 3.3.2, and 3.4.2) provide a cover of at least one native grass during spring and summer. The presence of these grasses reduces the chance that weeds will take root during the cooler months and the main growing season. Where practicable, native grasses should be allowed to naturally control weed populations at revegetation sites at Kirtland AFB.

If an area has a weed problem, and the weeds that are present will likely out-compete native grasses, a variety of weed control methods may be considered. Weeds may be pulled by hand; this is labor intensive and time consuming, but may be the preferred method for small isolated invasions. Weeds may be removed through mechanical methods (e.g., a disc and harrow can be used to rip up weeds and prepare the soil for seeding). Black plastic may be laid down to “suffocate” weeds. Or, a non-selective herbicide, such as “Roundup”, may be applied prior to seeding (Morris 2000). Roundup has been proven effective in weed control because it affects only the species it makes contact with and breaks down quickly in the environment. Roundup is recommended for the upland areas on Kirtland AFB when herbicide use is necessary. Since it is non-selective, care should be taken around turf and other desirable plant life to avoid unwanted die-offs.

SECTION 5 MONITORING

Areas that are revegetated should be monitored to ensure and document the success of the revegetation effort. At a minimum, revegetated sites should be monitored annually for a period of five years. Ideal times for monitoring would coincide with the end of the monsoon season (late August – September). The following describes a monitoring program that would provide valuable information concerning the success of the revegetation effort. Results and information from the monitoring program can be used to alter and direct the site being restored or can be used in future revegetation programs.

5.1 DATA COLLECTION

Initial data collection should occur prior to any revegetation efforts. This is necessary in order to gather a “baseline” of previous conditions to determine the success or failure of revegetation efforts. Data collection should include photographic documentation, vegetation growth and survival, and vegetation structure and composition. Gathering vegetation growth and survival data is not necessary before the restoration of a site where the existing vegetation would be.

5.1.1 Photographic Documentation

Photographic documentation should be conducted so that a visual record will exist for future use and comparison. The number and placement of photographic points (locations where photographs are taken annually) needed for a site being revegetated is dependent on the size of the area being restored, topography, and site vegetation (topography and vegetation will limit the viewable area captured by photography). The number of photographic points should be enough to give an overall view of the area. Rebar or T-post can be used to establish permanent photo point locations. Photographs should be taken from these established points at least annually, with the camera facing the same direction, angle, and height each time. Information such as date, time, weather, and direction should be recorded for each photograph. Additionally, photographs should be taken as close to the same date each year as possible, so that accurate comparisons between photographs can be made. If trees and shrubs are part of the revegetation effort, a range pole should be included in the photograph to show the amount of annual growth.

5.1.2 Growth and Survival

Growth and survival should be noted while photographic documentation of the site is being conducted. Survival or germination can be determined by counting the number of grasses and forbs in a meter plot. Several plots should be done per site with each of these plots randomly selected to avoid human bias. These meter square plots should be permanently fixed to the site. Plastic pipe can be used to create these plots with “V” shaped stakes attaching them to the ground. Plant growth can be determined by measuring the height and circumference of grasses, shrubs, and trees. Careful note taking is important, and each plot should be identified with a unique number or code in order to

avoid the mixing of data. Measuring the survival and growth of plants each year will help base personnel determine if goals of the restoration effort are being met.

5.1.3 Determining Vegetation Composition

Vegetation composition consists of percent cover and diversity. Percent cover is the amount of vegetation when viewed from above that covers the ground surface. Diversity is the number of different species occupying the site. Many methods have been developed to determine percent cover. Most of these require guessing to determine the data. The following method does not involve guess work, but actually measures percent cover.

A 100-foot long measuring tape should be stretched along a representative portion of the restoration site. Percent cover is measured by adding up the total area that plants occupy under the tape when viewed from the top. For example, if 300 inches of vegetation can be viewed along 100 feet of tape (1,200 inches) the percent cover would be 25 percent (300 inches/1,200 inches). Only live vegetation should be counted and gaps between branches or leaves should not. Only actual live vegetation that is obscured by the tape needs to be added up. Percent cover can be determined for all vegetation or separated out by grasses, shrubs, weeds, or by species. To determine diversity, simply count the number of different species inhabiting the site. Notes should reflect if the species was part of the restoration effort (i.e. seeded or planted) or if it invaded the site on its own.

5.2 REPORTS

Reports should be written annually after field data have been gathered. These reports should include the information gathered from the past field season and if possible compared to previous years' data. Before comparing data, define what the goal of the restoration project is. An area that was originally bare of all vegetation, but now consists of 5 percent cover could be considered successful. It is also important to remember that weedy species should be expected to reinvade a site that has been disced, harrowed, or altered in some other manner. Weedy species can be useful in the restoration effort (as long as they are native species and non-noxious) as they tend to invade areas with open mineral cycles. As these weedy species begin to close these open cycles they become a smaller component of the restored site. Success of a restoration project can only be determined by looking at it over time. As long as the site is moving toward the desired goal, then the restoration project should be considered a success. In the event that the revegetation efforts have failed, a contingency planned has been prepared as Appendix I.

**SECTION 6
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This report was prepared for and under the direction of the 377th Air Base Wing Command of Kirtland AFB by the LOPEZGARCIA GROUP. The members of the professional staff of the LOPEZGARCIA GROUP who participated in the development and technical review of this document are listed below.

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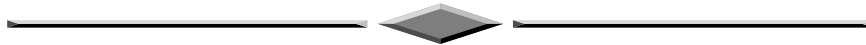
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**SECTION 8
PERSONS AND AGENCIES CONTACTED**

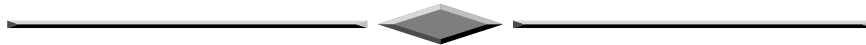
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APPENDIX A

SOIL SERIES



**APPENDIX A
SOIL SERIES**

Table A-1. Soil Series

Soil series	Native Vegetation	Location on Kirtland AFB	Slope	Runoff	Water Erosion	Wind Blowing	Potential Revegetation Sites
Bluepoint Loamy Fine Sand	Perennial grass: Indian ricegrass, black grama, giant dropseed, bush muhly, galleta, sand dropseed, mesa dropseed, spike dropseed, sand bluestem, little bluestem, blue grama, and three-awn. The dominant shrub for these soils is sand sagebrush. Other less abundant shrubs include four-wing saltbush, Mormon-tea, wolfberry rubber, rabbitbrush, winterfat, broom dalea, broom snakeweed, and bush mint. Also present in these soils are the cholla cactus, pricklypear cactus, and small soapweed. Annual plants: jimsonweed, fiddleneck, daisy, verbena, tansymustard, aster, lambsquarters, and six-weeks grama.	Northwest corner	Level to moderate sloping	Slow	N/A	Severe	N/A
Bluepoint-Kokan Association	Perennial grass: Indian ricegrass, black grama, giant dropseed, bush muhly, galleta, sand dropseed, mesa dropseed, spike dropseed, sand bluestem, little bluestem, blue grama, and three-awn. The dominant shrub for these soils is sand sagebrush. Other less abundant shrubs include four-wing saltbush, Mormon-tea, wolfberry rubber, rabbitbrush, winterfat, broom dalea, broom snakeweed, and bush mint. Also present in these soils are the cholla cactus, pricklypear cactus, and small soapweed. Annual plants: jimsonweed, fiddleneck, daisy, verbena, tansymustard, aster, lambsquarters, and six-weeks grama.	Primarily on hilly gravelly ridges; western portion of installation in Tijeras Canyon and Arroyo area	Hilly to steep	Slow	Moderate to severe	N/A	68

Table A-1. Soil Series (continued)

Soil series	Native Vegetation	Location on Kirtland AFB	Slope	Runoff	Water Erosion	Wind Blowing	Potential Revegetation Sites
Cut and Fill Land	N/A	Residential areas in northwest corner	Level to moderately steep	Slow to very rapid	Slight to severe	N/A	N/A
Embudo gravelly fine sandy loam	Grasses: sand dropseed, mesa dropseed, galleta, three-awn, blue grama, alkali sacaton, bush muhly, Indian ricegrass, and fluffgrass. Black gram is the primary grass. Other native vegetation for these soils include broom snakeweed, broom dalea, pricklypear cactus, small soapweed, cholla cactus, winterfat, catclaw mimosa, and range ratany. Apache-plume is the dominant shrub.	Northern boundary	Level to gently sloping	Medium	Moderate	N/A	60, 61, and 65
Embudo-Tijeras Complex	Grasses: sand dropseed, mesa dropseed, galleta, three-awn, blue grama, alkali sacaton, bush muhly, Indian ricegrass, and fluffgrass. Black gram is the primary grass. Other native vegetation for these soils include broom snakeweed, broom dalea, pricklypear cactus, small soapweed, cholla cactus, winterfat, catclaw mimosa, and range ratany. Apache-plume is the dominant shrub.	Occurs in drainageways and depressions as well as low ridge in narrow undulations. This soil is located in the north-central	Level to moderately sloping	Medium	Moderate	N/A	N/A
Gila Fine Sandy Loam	Grasses: sand dropseed, mesa dropseed, galleta, three-awn, blue grama, alkali sacaton, bush muhly, Indian ricegrass, and fluffgrass. Black gram is the primary grass. Other native vegetation for these soils include broom snakeweed, broom dalea, pricklypear cactus, small soapweed, cholla cactus, winterfat, catclaw mimosa, and range ratany. Apache-plume is the dominant shrub.	South central	Level or nearly level soils in the mouth of the Tijeras Arroyo	Slow and flooding is a hazard	Moderate	Moderate	N/A

Table A-1. Soil Series (continued)

Soil series	Native Vegetation	Location on Kirtland AFB	Slope	Runoff	Water Erosion	Wind Blowing	Potential Revegetation Sites
Ildefonso gravelly sandy loam	Primarily pinyon pine and oneseed juniper. Oakbrush is the dominant shrub. Also present in these soils, but not as abundant are big sagebrush, rubber rabbitbrush, mountain mahogany, winterfat, fourwing saltbush, skunkbush sumac, and Apache-plume. Side-oats grama and blue grama are abundant. Less abundant grasses consist of western wheatgrass, black grama, galleta, bottlebrush squirreltail, needle-and-thread, New Mexico feathergrass, wolftail, and sand dropseed, alkali sacaton, and bluegrass. Small soapweed, cholla cactus, pricklypear cactus, and agave occur as well.	Southwestern corner and south central	Nearly level to moderately sloping	Medium	Moderate	Moderate	1, 2, 3, 4, 5, 6, and 8
Laporte-Rock-Outcrop-Escabosa Complex	Primarily pinyon pine and oneseed juniper. Oakbrush is the dominant shrub. Also present in these soils, but not as abundant are big sagebrush, rubber rabbitbrush, mountain mahogany, winterfat, fourwing saltbush, skunkbush sumac, and Apache-plume. Side-oats grama and blue grama are abundant. Less abundant grasses consist of western wheatgrass, black grama, galleta, bottlebrush squirreltail, needle-and-thread, New Mexico feathergrass, wolftail, and sand dropseed, alkali sacaton, and bluegrass. Small soapweed, cholla cactus, pricklypear cactus, and agave occur as well.	Coyote Springs area	Gentle to moderately steep	Laporte - moderate Rock-Outcrop – Rapid Escabosa – moderate	Laporte - moderate Rock-Outcrop – Slight Escabosa - Moderate	N/A	49 and 52

Table A-1. Soil Series (continued)

Soil series	Native Vegetation	Location on Kirtland AFB	Slope	Runoff	Water Erosion	Wind Blowing	Potential Revegetation Sites
Latene Sandy Loam	Grasses: sand dropseed, mesa dropseed, galleta, three-awn, blue grama, alkali sacaton, bush muhly, Indian ricegrass, and fluffgrass. Black grama is the primary grass. Other native vegetation for these soils include broom snakeweed, broom dalea, pricklypear cactus, small soapweed, cholla cactus, winterfat, catclaw mimosa, and range ratany. Apache-plume is the dominant shrub.	Southwestern corner as well as the south central portion	Nearly level to gently sloping	Medium	Moderate	Moderate	1, 2, 3, 4, 5, 6, and 8
Madurez-Wink Association	Grasses: sand dropseed, mesa dropseed, galleta, three-awn, blue grama, alkali sacaton, bush muhly, Indian ricegrass, and fluffgrass. Black gram is the primary grass. Other native vegetation for these soils include broom snakeweed, broom dalea, pricklypear cactus, small soapweed, cholla cactus, winterfat, catclaw mimosa, and range ratany. Apache-plume is the dominant shrub.	Northwest corner as well as southwest near the south boundary	Gently sloping	Slow	Slow	Moderate to severe	69, and 70
Madurez loamy fine sand	Indian ricegrass is the dominant grass, as well as some black grama, sand dropseed, spike dropseed, mesa dropseed, giant dropseed, bush muhly, New Mexico feathergrass, and galleta. Major shrubs for this soil include fourwind saltbush, winterfat, wolfberry and Mormon-tea.	Western boundary	Gently undulating	Slow	Slow	Severe	N/A
Nickel-Latene Association	Grasses: sand dropseed, mesa dropseed, galleta, three-awn, blue grama, alkali sacaton, bush muhly, Indian ricegrass, and fluffgrass. Black gram is the primary grass. Other native vegetation for these soils include broom snakeweed, broom dalea, pricklypear cactus, small soapweed, cholla cactus, winterfat, catclaw mimosa, and range ratany. Apache-plume is the dominant shrub.	Southwest corner along the southern boundary	Gently rolling an hilly on alluvial fans	Rapid	Moderate to severe	N/A	N/A

Table A-1. Soil Series (continued)

Soil series	Native Vegetation	Location on Kirtland AFB	Slope	Runoff	Water Erosion	Wind Blowing	Potential Revegetation Sites
Pino-Rock Outcrop Association	Ponderosa pine, pinyon pine and oneseed juniper. Grasses include blue grama and side-oats grama.	Southeast corner of the installation along the southern boundary	Gently sloping to moderately steep	Medium	Moderate	N/A	N/A
Rock outcrop-Laporte Complex	Primarily pinyon pine and oneseed juniper. Oakbrush is the dominant shrub. Also present in these soils, but not as abundant are big sagebrush, rubber rabbitbrush, mountain mahogany, winterfat, fourwing saltbush, skunkbush sumac, and Apache-plume. Side-oats grama and blue grama are abundant. Less abundant grasses consist of western wheatgrass, black grama, galleta, bottlebrush squirreltail, needle-and-thread, New Mexico feathergrass, wolftail, and sand dropseed, alkali sacaton, and bluegrass. Small soapweed, cholla cactus, pricklypear cactus, and agave occur as well.	Southeast corner along the boundary of the installation	Moderately steep to very steep	Rapid	Slight to severe	N/A	N/A
Rock Outcrop-Orthids Complex	Primarily pinyon pine and oneseed juniper. Oakbrush is the dominant shrub. Also present in these soils, but not as abundant are big sagebrush, rubber rabbitbrush, mountain mahogany, winterfat, fourwing saltbush, skunkbush sumac, and Apache-plume. Side-oats grama and blue grama are abundant. Less abundant grasses consist of western wheatgrass, black grama, galleta, bottlebrush squirreltail, needle-and-thread, New Mexico feathergrass, wolftail, and sand dropseed, alkali sacaton, and bluegrass. Small soapweed, cholla cactus, pricklypear cactus, and agave occur as well.	Northeast corner, southeast and northwest	Moderate to very steep	Rapid	Moderate	N/A	57, and 76

Table A-1. Soil Series (continued)

Soil series	Native Vegetation	Location on Kirtland AFB	Slope	Runoff	Water Erosion	Wind Blowing	Potential Revegetation Sites
Salas Complex	Primarily pinyon pine and oneseed juniper. Oakbrush is the dominant shrub. Also present in these soils, but not as abundant are big sagebrush, rubber rabbitbrush, mountain mahogany, winterfat, fourwing saltbush, skunkbush sumac, and Apache-plume. Side-oats grama and blue grama are abundant. Less abundant grasses consist of western wheatgrass, black grama, galleta, bottlebrush squirreltail, needle-and-thread, New Mexico feathergrass, wolftail, and sand dropseed, alkali sacaton, and bluegrass. Small soapweed, cholla cactus, pricklypear cactus, and agave occur as well.	North and south central and northeast	Moderate slope to very steep	Rapid	Moderate	N/A	6, 49, 54, 56, 57, 58, and 59
Seis Very Cobbly Loam	Primarily pinyon pine and oneseed juniper. Oakbrush is the dominant shrub. Also present in these soils, but not as abundant are big sagebrush, rubber rabbitbrush, mountain mahogany, winterfat, fourwing saltbush, skunkbush sumac, and Apache-plume. Side-oats grama and blue grama are abundant. Less abundant grasses consist of western wheatgrass, black grama, galleta, bottlebrush squirreltail, needle-and-thread, New Mexico feathergrass, wolftail, and sand dropseed, alkali sacaton, and bluegrass. Small soapweed, cholla cactus, pricklypear cactus, and agave occur as well.	Eastern portion	Level to moderately steep	Medium	Moderate	N/A	17, 22, 21, 24, 74, 76

Table A-1. Soil Series (continued)

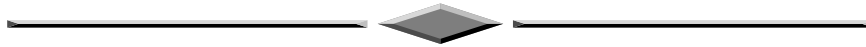
Soil series	Native Vegetation	Location on Kirtland AFB	Slope	Runoff	Water Erosion	Wind Blowing	Potential Revegetation Sites
Seis-Silver Complex	Primarily pinyon pine and oneseed juniper. Oakbrush is the dominant shrub. Also present in these soils, but not as abundant are big sagebrush, rubber rabbitbrush, mountain mahogany, winterfat, fourwing saltbush, skunkbush sumac, and Apache-plume. Side-oats grama and blue grama are abundant. Less abundant grasses consist of western wheatgrass, black grama, galleta, bottlebrush squirreltail, needle-and-thread, New Mexico feathergrass, wolftail, and sand dropseed, alkali sacaton, and bluegrass. Small soapweed, cholla cactus, pricklypear cactus, and agave occur as well.	East of Manzanita mountains, southeast	On alluvial fans	Rapid	Severe	N/A	24
Seis Complex	Primarily pinyon pine and oneseed juniper. Oakbrush is the dominant shrub. Also present in these soils, but not as abundant are big sagebrush, rubber rabbitbrush, mountain mahogany, winterfat, fourwing saltbush, skunkbush sumac, and Apache-plume. Side-oats grama and blue grama are abundant. Less abundant grasses consist of western wheatgrass, black grama, galleta, bottlebrush squirreltail, needle-and-thread, New Mexico feathergrass, wolftail, and sand dropseed, alkali sacaton, and bluegrass. Small soapweed, cholla cactus, pricklypear cactus, and agave occur as well.	Eastern half	Moderate sloping to very steep	Rapid	Moderate	N/A	23

Table A-1. Soil Series (continued)

Soil series	Native Vegetation	Location on Kirtland AFB	Slope	Runoff	Water Erosion	Wind Blowing	Potential Revegetation Sites
Silver and Witt Soils	Grasses including blue grama, western wheat grass, galleta, and black grama are dominant. Three-awn, ring muhly, sand dropseed, sideoats grama, Indian ricegrass, needleandthread, and bottlebrush squirreltail are less abundant. Broom snakeweed, small soapweed, cholla cactus, pricklypear cactus, winterfat, rubber rabbitbrush, and Russian-thistle are also common	Southeastern corner near border	Gentle to moderately sloping	Rapid	Moderate to severe	N/A	N/A
Tesajo-Millett Stony	Mixture of trees, shrubs, and understory plants. Oneseed juniper and oakbrush are dominant. Less abundant shrubs that may occur include skunkbush sumac, sacahuista, range ratany, feather dalea, and rubber rabbitbrush. Apache-plume, small soapweed, broom snakeweed, cholla cactus, and pricklypear cactus. Dominant Grass: Black grama. Less abundant grasses that may occur are blude grama, hairy grama, bush muhly, bluegrass, New Mexico feathergrass, sand dropseed, three-awn, and bottlebrush squirreltail. Perennial forbs: globemallow, groundsel, and brikellbush. Annual plants: Indian paintbrush, bladderpod, cheatgrass, six-weeks grama, labmsquarters, and fiddleneck.	Southeast portion	Undulating to hilly	Medium	Moderate	N/A	N/A
Tijeras Gravelly Fine Sandy Loam	Grasses: sand dropseed, mesa dropseed, galleta, three-awn, blue grama, alkali sacaton, bush muhly, Indian ricegrass, and fluffgrass. Black gram is the primary grass. Other native vegetation for these soils include: broom snakeweed, broom dalea, pricklypear cactus, small soapweed, cholla cactus, winterfat, catclaw mimosa, and range ratany. Apache-plume is the dominant shrub.	Western part of installation	Gently sloping on old alluvial fan on E. Mesa	Moderate	Moderate	N/A	66, 67

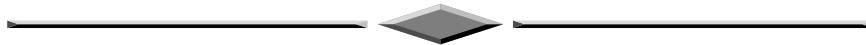
Table A-1. Soil Series (continued)

Soil series	Native Vegetation	Location on Kirtland AFB	Slope	Runoff	Water Erosion	Wind Blowing	Potential Revegetation Sites
Tome Very Fine Sandy Loam	Grasses: sand dropseed, mesa dropseed, galleta, three-awn, blue grama, alkali sacaton, bush muhly, Indian ricegrass, and fluffgrass. Black gram is the primary grass. Other native vegetation for these soils include broom snakeweed, broom dalea, pricklypear cactus, small soapweed, cholla cactus, winterfat, catclaw mimosa, and range ratany. Apache-plume is the dominant shrub.	Along Western perimeter	Level or nearly level	Medium	Moderate	N/A	N/A
Wink Fine Sandy Loam	Grasses: sand dropseed, mesa dropseed, galleta, three-awn, blue grama, alkali sacaton, bush muhly, Indian ricegrass, and fluffgrass. Black gram is the primary grass. Other native vegetation for these soils include broom snakeweed, broom dalea, pricklypear cactus, small soapweed, cholla cactus, winterfat, catclaw mimosa, and range ratany. Apache-plume is the dominant shrub.	Western Portion	Gently sloping on mesas	Medium	Slight to moderate	Moderate	1, 2, 4, 64
Wink Embudo	Grasses: sand dropseed, mesa dropseed, galleta, three-awn, blue grama, alkali sacaton, bush muhly, Indian ricegrass, and fluffgrass. Black gram is the primary grass. Other native vegetation for these soils include broom snakeweed, broom dalea, pricklypear cactus, small soapweed, cholla cactus, winterfat, catclaw mimosa, and range ratany. Apache-plume is the dominant shrub.	Northwest Portion	Level to gently sloping	Medium	Moderate	N/A	N/A



APPENDIX B

GRASSLAND COMMUNITY



**APPENDIX B
GRASSLAND COMMUNITY**

Table B-1. Grassland Species in the Kirtland Air Force Base Region

Name	Duration, Life Cycle *	Characteristics/Soils	Wildlife/Livestock Use
AGAVACEAE			
Great Plains yucca (<i>Yucca glauca</i>)	P	Grows in dry, well-drained soils	Deer forage on these plants
ASCLEPIADACEAE			
Antelopehorn milkweed (<i>Asclepias asperula</i>)	P	Sandy soils, in pinyon juniper areas	Forage for hummingbirds and monarch butterflies
Poison milkweed (<i>Asclepias subverticillata</i>)	P	Sandy, clayey, or gravelly soils	Poisonous to livestock, especially sheep
Broadleaf milkweed (<i>Asclepias latifolia</i>)	P	Found on sandy or gravelly soils.	Flowers provide food for butterflies.
ASTERACEAE			
Desert Marigold (<i>Baileya mulriviata</i>)	P	Sandy and rocky slopes	Not identified as important for forage
Navajo tea (<i>Thelesperma filifolium</i>)	P	Calcareous soils dry plains and hills	Not identified as important for forage
Tansy aster (<i>Machaeranthera tanacetifolia</i>)	A,B	Grows in a variety of soils, abundant in open fields, along roadsides and ditches	Fair to poor forage for livestock, fair for sheep and goats
Prickly-leaf dogweed (<i>Dyssodia acerosa</i>)	P	Sandy soil, drought tolerant	Not identified as important for forage
Short-rayed coneflower (<i>Ratibida tagetes</i>)	P	Plains and prairies	Not identified as important for forage
Salsify (<i>Tragopogon dubius</i>)	A	Semi-desert, foothills, opening and city lots, roadsides, fields, meadows, and other waste sites.	Not identified as important for forage
Alkali Yellowtop (<i>Flaveria campestris</i>)	P	Plains, prairies and disturbed sites	Not identified as important for forage
Prickly leaf lettuce (<i>Lactuca serriola</i>)	A, P	Found along roadsides, pastures, streams; yards, and gardens	Not identified as important for forage
Perennial goldenweed (<i>Isocoma spinulos</i>)	P	Grows in any soil type. Drought tolerant	Not identified as important for forage
Mexican hat (<i>Ratibida columnifera</i>)	P	Light sandy, medium loamy, heavy clay, well-drained soils	Some game animals including deer
Carruth's sagewort (<i>Artemisia carruthii</i>)	P	Open slopes or canyons. Dry plains, open prairies in full sun.	Good forage for sheep, poor to fair for cattle. Important to deer and elk.
Baby aster (<i>Chaetopappa ericoides</i>)	P	Dry open areas	Not identified as important for forage
Mesa daisy (<i>Aphanostephus ramosissimus</i>) [syn. <i>Aphanostephus arizonicus</i>]	A	Sandy or silty areas; washes	Not identified as important for forage

Table B-1. Grassland Species in the Kirtland Air Force Base Region (continued)

Name	Duration, Life Cycle *	Characteristics/Soils	Wildlife/Livestock Use
ASTERACEAE (continued)			
Sand sagebrush <i>(Artemisia filifolia)</i>	P	Indicator of sandy soil	Forage for pronghorn and deer; rarely grazed if other forages are present
Cudweed sagewort <i>(Artemisia ludoviciana)</i>	P	Dry, open sites	Not identified as important for forage
New Mexico thistle <i>(Cirsium neomexicanum)</i>	B,P	Roadsides	Goldfinches feed on the seeds
Yellowspine thistle <i>(Cirsium ochrocentrum)</i>	B,P	Occurs in open disturbed sites; found in dry sandy and gravelly soil	Not identified as important for forage
Rubber rabbitbrush <i>(Ericameria nauseosa</i> var. <i>nauseosa)</i> [syn. <i>Chrysothamnus nauseosus</i>]	P	Roadsides and waste areas; inhabits dry, sandy, gravelly, or heavy clayey and alkali soils; thrives on poor soil; indicator that the land is poor, eroded, overgrazed, or otherwise neglected; vigorously invades disturbed sites; excellent for controlling erosion	Foliage and seeds serve as a reserve food for antelope, jackrabbits, mountain sheep, and mule deer; an important winter browse for elk
Broom snakeweed <i>(Gutierrezia sarothrae)</i>	P	Very aggressive; invades areas where the climax vegetation has been depleted by fire, grazing, or drought; excellent indicator of range deterioration (one of the first plants to invade ranges where better forage has been overgrazed; protects the soil against wind and water erosion; adapted to a broad range of soils but apparently does not occur on saline or alkaline soils)	Unpalatable to deer; causes cattle and sheep abortions; most toxic during leaf formation
Prairie sunflower <i>(Helianthus petiolaris)</i>	A	Waste areas	Not identified as important for forage
Fendler's dandelion <i>(Malacothrix fendleri)</i>	A	Common on dry rocky slopes and mesas, often on limestone	Not identified as important for forage
Blackfoot daisy <i>(Melampodium leucanthum)</i>	P	Rocky soil	Not identified as important for forage
Common dandelion <i>(Taraxacum officinale)</i>	P	Fields, pastures, and roadsides	Spring and summer food for Canada geese and ruffed grouse; also used by deer, elk, and bears
Prairie zinnia <i>(Zinnia grandiflora)</i>	P	Dry slopes and mesas	Not identified as important for forage
BORAGINACEAE			
Stickseed <i>(Lappula occidentalis)</i>	A,B	Dry to moderately moist sites, along roadsides or overgrazed ranges	High in palatability, and fair forage for sheep and goats, otherwise poor for livestock

Table B-1. Grassland Species in the Kirtland Air Force Base Region (continued)

Name	Duration, Life Cycle *	Characteristics/Soils	Wildlife/Livestock Use
BRASSICACEAE			
Tansy mustard (<i>Descurainia sophia</i>)	A,B	Grows in a variety of soils, abundant in open fields, along roadsides and ditches	Fair to poor forage for livestock, fair for sheep and goats
Spectacle pod (<i>Dimorphocarpa wislizeni</i>) [syn. <i>Dithyrea wislizenii</i>]	A	Open ground in grasslands, and pinyon/juniper woodlands	Not identified as important for forage
Western wallflower (<i>Erysimum capitatum</i>)	B,P	Found in coniferous forests at higher altitudes, rarely below 7,000 feet	Not identified as important for forage
Western peppergrass (<i>Lepidium montanum</i>)	B,P	Dry, open slopes and disturbed ground	Not identified as important for forage
Fendler's bladderpod (<i>Lesquerella fendleri</i>)	P	Rocky or sandy soil, especially soils formed from limestone	Not identified as important for forage
CACTACEAE			
Cylinder bells (<i>Echinocereus viridiflorus</i>) [syn. <i>Echinocereus chloranthus</i>]	P	Dry rocky areas, and sandy plains	Not identified as important for forage
Club cholla (<i>Opuntia clavata</i>)	P	Sandy or gravelly soils	Not identified as important for forage
Tree cholla (<i>Opuntia imbricata</i>)	P	Sandy or gravelly soils	Not identified as important for forage
New Mexican prickly pear (<i>Opuntia phaeacantha</i>)	P	Dry, rocky areas	Not identified as important forage
Plains prickly pear (<i>Opuntia polyacantha</i>)	P	Dry sandy or gravelly soils	Not identified as important for forage
Grama grass cactus (<i>Sclerocactus papyracanthus</i>) [syn. <i>Pediocactus papyracanthus</i>]	P	Dry open areas	Not identified as important for forage
CAPPARIDACEAE			
Clammy weed (<i>Polanisia dodencandra</i>)	A	Sandy soils, open areas, along roadsides, or in alluvium near streams	Not identified as important for forage
CHENOPODIACEAE			
Four-wing saltbush (<i>Atriplex canescens</i>)	P	Common in many different soil types; one of the most important shrubs to rehabilitate depleted rangelands and stabilize soil	Good forage for deer; furnishes valuable browse in winter; fruits and seeds are consumed by birds and small animals; pronghorn and rabbits occasionally feed on this plant
Gray goosefoot (<i>Chenopodium incanum</i>)	A	Dry hills and plains, especially in prairie dog towns	Not identified as important for forage

Table B-1. Grassland Species in the Kirtland Air Force Base Region (continued)

Name	Duration, Life Cycle *	Characteristics/Soils	Wildlife/Livestock Use
CHENOPODIACEAE (continued)			
Russian thistle (<i>Salsola tragus</i>) [syn. <i>Salsola iberica</i>]	A	Overgrazed pastures, roadsides, waste areas, disturbed sites; in nearly all soil types	Not identified as important for forage
CONVOLVULACEAE			
Field bindweed (<i>Convolvulus arvensis</i>)	P	Introduced from Europe, weedy species, occurs in disturbed sites	Not identified as important for forage
CUCURBITACEAE			
Buffalo gourd (<i>Cucurbita foetidissima</i>)	P	Dry or sandy soil	Not identified as important for forage
ELAEAGNACEAE			
Russian olive (<i>Elaeagnus augustifolia</i>)	P	Occurs in waste areas	Fruits eaten by songbirds, pheasants, and quail
EPHEDRACEAE			
Mormon tea (<i>Ephedra trifurca</i>)	P	Most abundant in gravelly or sandy soils, but occasionally in clays	Browsed by bighorn sheep and jackrabbits; cones are eaten by scaled quail
FABACEAE			
Mottled locoweed (<i>Astragalus lentiginosus</i> var. <i>diphysus</i>)	P	Plains and mesas, usually in sandy soils	Not identified as important for forage
Missouri locoweed (<i>Astragalus missouriensis</i>)	P	Plains prairies and dry open slopes	Harmful to livestock
Hogpotato (<i>Hoffmanseggia glauca</i>)	P	Roadsides and ditchbanks; large colonies grow in alkaline soil	Small swellings on roots provide good nourishment for many animals
Yellow sweet clover (<i>Melilotus officinalis</i>)	A,B,P	Waste and cultivated areas; roots are host to nitrogen-fixing bacteria and quickly add organic matter to deficient soils	Sometimes used as forage
HYDROPHLLACEAE			
Scorpion weed (<i>Phacelia integrifolia</i>) [syn. <i>Phacelia hastate</i>]	P	Sand to rocky soils. Found on steep slopes or along roadsides	Not identified as important for forage
LINACEAE			
Flax (<i>Linum lewisii</i>)	P	Grassy trails and meadows Open meadows, dry plains, hills and open ridges, often among sagebrush.	Not identified as important for forage
Plains flax (<i>Linum puberulum</i>)	A	Plains and mesas, mostly in sandy soils	Not identified as important for forage

Table B-1. Grassland Species in the Kirtland Air Force Base Region (continued)

Name	Duration, Life Cycle *	Characteristics/Soils	Wildlife/Livestock Use
LOASACEAE			
Blazing star (<i>Mentzelia albicaulis</i>)	B,P	Roadsides; sandy places	Not identified as important for forage
MALVACEAE			
Scarlet globemallow (<i>Sphaeralcea coccinea</i>)	B,P	Roadsides, waste areas; adapted to a broad range of soils; increases in abundance with overgrazing and during dry periods; considerable drought resistance; establishes well on disturbed sites; excellent soil stabilization species on harsh sites	Excellent forage for deer and pronghorn
Wrinkled globemallow (<i>Sphaeralcea hastulata</i>) [syn. <i>Sphaeralcea subhastata</i>]	P	Sometimes in saline soil	Not identified as important for forage
MIMOSACEAE			
Honey mesquite (<i>Prosopis glandulosa</i>)	P	Dry sandy or gravelly soils, found on the plains and prairies. Abundant in areas where fire is controlled.	Poor to good forage for livestock, deer. Seeds are good for wildlife.
ONAGRACEAE			
Hartweg's sundrop (<i>Calylophus hartwegii</i>)	P	Dry open areas	Not identified as important for forage
Prairie evening primrose (<i>Oenothera albicaulis</i>)	A	Sandy soil; disturbed ground	Not identified as important for forage
Scarlet gaura (<i>Gaura coccinea</i>)	P	Roadsides; sandy soils; noxious weed in some states	Not identified as important for forage
Velvety gaura (<i>Gaura mollis</i>)	A,P	Waste ground, roadsides	Not identified as important for forage
POACEAE			
Windmill grass (<i>Chloris verticillata</i>)	P	Plains and hills; waste areas, prairies, pastures, lawns, and roadsides.	Livestock such as cattle will not consume
Spike bent grass (<i>Agrostis exarata</i>)	P	Found along streams, moist parks, meadows, and in aspen stands and semi-shaded woodlands	Important forage for livestock, cattle and to wildlife including elk
Green bristle grass (<i>Setaria viridis</i>)	A	Found in waste places, well-drained soil	
Fringed brome (<i>Bromus ciliatus</i>)	P	Fine and coarse soils, moist, saline, and dry soils	Highly palatable for grazings, seedheads good for livestock
Fluff Grass (<i>Dasyochloa pulchella</i>)	P	Dry mesas and hills. Sites of low productivity, often rocky soils, among desert shrubs on very open sites from foothills to flats.	low forage

Table B-1. Grassland Species in the Kirtland Air Force Base Region (continued)

Name	Duration, Life Cycle *	Characteristics/Soils	Wildlife/Livestock Use
POACEAE (continued)			
Barley (<i>Hordeum jubatum</i>)	P	Plains, foothills, moist ditches, meadows, roadsides, and waste areas. Grows in moist saline and dry soils.	Fair to fairly good forage for livestock
Bush muhly (<i>Muhlenbergia porteri</i>)	P	Sand, Sandy loam, clay and clay loam	Highly palatable for all livestock
Cane bluestem (<i>Bothriochloa barbinodis</i>)		Silty or clayey soils	Good forage for large herbivores
Cheatgrass (<i>Bromus tectorum</i>)	A	Deep, loamy or coarse textured soils, sandy soils, found in valley bottoms	Harmful to livestock. Stiff awns can injure the mouths of livestock and wildlife
Indian ricegrass (<i>Achnatherum hymenoides</i>)	P	Disturbed sites; usually on dry sandy soils but will occur on well-drained silty and limey soils; moderately salt and alkali tolerant; one of the most drought tolerant native range grasses	Grazed by many types of livestock
Six-weeks three-awn (<i>Aristida adscensionis</i>)	A	Occurs in disturbed sites	Awns catch in fur and may injure soft tissue of grazing animals
Red three-awn (<i>Aristida purpurea</i> var. <i>longiseta</i>)	A,P	Aggressively invades denuded areas and recently disturbed soils; indicator of range deterioration	Poor forage value for wildlife; grazed only before awn development; invades eyes and nostrils of grazing animals; penetrates wool of sheep
Purple three-awn (<i>Aristida purpurea</i> var. <i>purpurea</i>)	A,P	Abundant on abused rangeland; indicator of range deterioration	Low forage value but sometimes used for grazing; awns may injure soft tissue of grazing animals
Black grama (<i>Bouteloua eriopoda</i>)	P	Seldom grows in fine-textured soils; occurs on dry, gravelly, or sandy soils	Excellent forage for all classes of wildlife throughout the year; intolerant of heavy grazing
Blue grama (<i>Bouteloua gracilis</i>)	P	Not found in wet, poorly drained soils; grows in all soil textures, but most abundant in sandy or gravelly soils; drought-resistant; goes dormant during drought, greens up after moisture is available	Good for all classes of wildlife; highest quality when green, but retains much of its value when dry and furnishes fall and winter grazing
Hairy grama (<i>Bouteloua hirsuta</i>)	P	Most abundant on dry, loose sands and neutral to slightly calcareous soils	Fair wildlife forage; most palatable late in the growing season; winter forage when not snow-covered
Squirreltail (<i>Elymus elymoides</i>) [syn. <i>Elymus longifolius</i>]	P	An important, persistent grass in erosion-control seedings; grows chiefly on dry, gravelly soils or in saline situations, but also occurs in deep or alkaline soils; susceptible to ergot infestation	Not identified as important for forage

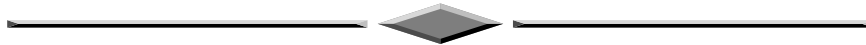
Table B-1. Grassland Species in the Kirtland Air Force Base Region (continued)

Name	Duration, Life Cycle *	Characteristics/Soils	Wildlife/Livestock Use
POACEAE (continued)			
Needle-and-thread (<i>Hesperostipa comata</i>) [syn. <i>Stipa comata</i>]	P	Common on dry, sandy or gravelly soils	Extensively used by elk in winter and deer in spring; awns can injure grazing animals
Ring muhly (<i>Muhlenbergia torreyi</i>)	P	Prefers sandy or clay loams, but will grow on coarse gravelly or rocky sites; usually an indicator of range deterioration; may partially substitute as a protective soil cover in absence of better grasses	Used as forage
Galleta (<i>Pleuraphis jamesii</i>)	P	Most abundant on fine-textured soils, but will occur on coarse-textured soils; good cover species for watershed protection; very drought-resistant; susceptible to ergot infestation	Used as forage by many types of livestock
Kentucky bluegrass (<i>Poa pratensis</i>)	P	Best-suited to well-drained or clay loams with high organic matter content; sod is resistant to heavy use; planted as a lawn grass; susceptible to ergot infestation	Excellent forage for a wide variety of animals including elk, deer, horses, cattle, and sheep
Spike dropseed (<i>Sporobolus contractus</i>)	P	Sandy soils	Not identified as important for forage
Sand dropseed (<i>Sporobolus cryptandrus</i>)	P	Disturbed sites; most common on sandy soils, but grows well on other soils (not tolerant of wet soils); increases with abusive grazing or after drought; extremely drought-tolerant	Used for forage and is palatable to some livestock
Mesa dropseed (<i>Sporobolus flexuosus</i>)	P	Sandy soils	Not identified as important for forage
Canaigre (<i>Rumex hymenosepalus</i>)	P	Common and conspicuous in sandy stream beds and fields	Not identified as important for forage
PLANTAGINACEAE			
Woolly plaintain (<i>Plantago patagonica</i>)	A	Sandy soils, prairies, pastures, waste places, and roadsides	Good forage for sheep, fair to poor for cattle and wildlife
ROSACEAE			
Apache plume (<i>Fallugia paradoxa</i>)	P	A valuable aid in erosion control	Important browse for deer and possibly other big game; more valuable winter forage when other browse becomes scarce; chief value is on winter ranges
SCROPHULARIACEAE			
Southwestern paintbrush (<i>Castilleja integra</i>)	P	Dry rocky slopes	Good source of forage for livestock
Mullein (<i>Verbascum thapsus</i>)	P	Dry, sandy soils, well drained. Found along roadsides, fields, vacant lots	Not good forage, irritant to most animals
James penstemon (<i>Penstemon jamesii</i>)	P	Sandy soils, grassland areas	Not identified as important for forage

Table B-1. Grassland Species in the Kirtland Air Force Base Region (continued)

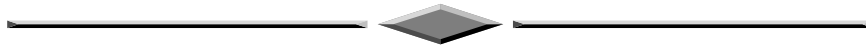
Name	Duration, Life Cycle *	Characteristics/Soils	Wildlife/Livestock Use
SIMAROUBACAE			
Tree of Heaven <i>(Ailanthus altissima)</i>	A	Found in alleys, sidewalks, parking lots, streets, roadsides, forest openings	Not identified as important for forage
SOIANACEAE			
Southwestern thorn apple <i>(Datura wrightii)</i>	A,P	Noxious weed; occurs in loose sand	Poisonous to livestock
SOLANACEAE			
Silverleaf nightshade <i>(Solanum elaeagnifolium)</i>	P	Old lots, along roads, waste areas; grows in dry soil	Berries and foliage are poisonous to livestock
ULMACEAE			
Siberian elm <i>(Ulmus pumila)</i>	P	Roadsides, pastures; resistant to Dutch elm disease	Not identified as important for forage
VERBENACEAE			
Western pink vervain <i>(Glandularia bipinnatifida)</i>	A,P	Weedy fields	Not identified as important for forage
ZYGOPHYLLACEAE			
Goathead <i>(Tribulus terrestris)</i>	A	Disturbed ground, pastures, waste areas, along roadsides	Hard spiny burs damage wool and injure livestock

* A-Annual, B-Biennial, P-Perennial



APPENDIX C

JUNIPER WOODLAND COMMUNITY



**APPENDIX C
JUNIPER WOODLAND COMMUNITY**

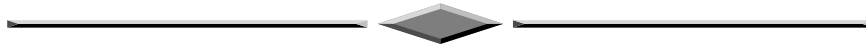
Table C-1. Juniper Woodland Species in the Kirtland Air Force Base Region

Name	Duration, Life Cycle*	Characteristics/Soils	Wildlife/Livestock Use
ASTERACEAE			
Bigelow sagebrush (<i>Artemisia bigelovii</i>)	P	Well-drained, sandy or gravelly soils, One of the most drought-tolerant sagebrushes in North America	Provides valuable winter and spring forage for wildlife and livestock
Fringed sagebrush (<i>Artemisia frigida</i>)	P	Dry, coarse, shallow to deep soils, well-drained	Good forage for cattle, domestic sheep, horses and large game
Lyreleaf green eyes (<i>Berlandiera lyrata</i>)	P	Common along roadsides	Not identified as important for forage
New Mexico thistle (<i>Cirsium neomexicanum</i>)	B, P	Roadsides	Goldfinches feed on the seeds
Hopi tea (<i>Thelesperma megapotamicum</i>)	P	Grassy plains, mesas, and open woodlands	Not identified as important for forage
CACTACEAE			
Claret cup cactus (<i>Echinocereus triglochidiatus</i>)	P	Rocky or gravelly slopes, often among pinyons or junipers	Fruits edible
Englemann cactus (<i>Opuntia engelmannii</i>)	P	Well-drained soils, dry rocky flats and slopes	Good forage for cattle, sheep and other livestock
Wright's fishhook cactus (<i>Mammillaria wrightii</i>)	P	Barren, alkaline soils, vary from clay to sandy soils	Not identified as important for forage
CUPRESSACEAE			
One-seed juniper (<i>Juniperus monosperma</i>)	P	Adapted to a broad range of soil types	Fruits are eaten by deer, quail, fox, chipmunks, squirrels, songbirds, and coyotes
EURPHORBIACEAE			
Fendler spurge (<i>Chamaesyce chaetocalyx</i>)	A, P	Dry hills and mesas	Toxic to cattle when dry in hay, fresh plants rarely eaten by cattle
FABACEAE			
Indigobush (<i>Dalea formosa</i>)	P	Abundant in coarse soils; highly drought tolerant	Provides forage for deer and seeds for kangaroo rats
FAGACEAE			
Wavyleaf oak (<i>Quercus undulata</i>)	P	Dry, sandy soils to Medium loamy and heavy clay soils	Not identified as important for forage
LAMIACEAE			
False pennyroyal (<i>Hedeoma drummondii</i>)	P	Dry hills and plains	Not identified as important for forage

Table C-1. Juniper Woodland Species in the Kirtland Air Force Base Region (continued)

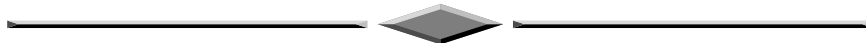
Name	Duration, Life Cycle*	Characteristics/Soils	Wildlife/Livestock Use
NYCTAGINACEAE			
Four-o'clock <i>(Mirabilis multiflora)</i>	P	Sandy or rocky soils	Not identified as important for forage
POLYGONACEAE			
Simpson's buckwheat <i>(Eriogonum microthecum spp simpsonii)</i>	P	Dry plains and hills	Not identified as important for forage

*A-Annual, B-Biennial, P-Perennial
[] Former name



APPENDIX D

PINYON-JUNIPER COMMUNITY



APPENDIX D
PINYON-JUNIPER COMMUNITY

Table D-1. Pinyon-Juniper Woodland Species in the Kirtland Air Force Base Region

Name	Duration, Life Cycle*	Characteristics/Soils	Wildlife/Livestock Use
ANACARDIACEAE			
Squawbush (<i>Rhus trilobata</i>)	P	Common in slopes and in canyons	Birds and small animals eat the berries; rabbits eat the bark; pronghorn, deer, moose, and bighorn sheep browse the twigs and foliage
ASCLEPIADACEAE			
Poison milkweed (<i>Asclepias subverticillata</i>)	P	Sandy, clayey, or gravelly soils	Poisonous to livestock, especially sheep
AGAVACEAE			
Banana yucca (<i>Yucca baccata</i>)	P	High drought tolerance, found in dry rocky soils	Large fleshy fruits are edible
APIACEAE			
Mountain parsley (<i>Pseudocymopterus montanas</i>)	P	Found on foothills and meadows, damp woods, and rocky cliffs	Not identified as important for forage
ASTERACEAE			
Easter daisy (<i>Townsendia exscapa</i>)	P	Found along roadsides, plains and mesas	Not identified as important for forage
Short-rayed cone flower (<i>Ratibida tagetes</i>)	P	Plains and prairies	Not identified as important for forage
Salsify (<i>Tragopogon dubius</i>)	A	Semi-desert, foothills, opening and city lots roadsides, fields, meadows, and other waste sites	Not identified as important for forage
Prickly leaf lettuce (<i>Lactuca serriola</i>)	A, P	Found along roadsides, and also in pastures	Not identified as important for forage
Gumweed (<i>Grindelia nuda</i>)	A,P	Sandy light and medium soils, well drained, can grow in nutritionally poor soil	Unpalatable to all livestock.
Cudweed sagewort (<i>Artemisia ludoviciana</i>)	P	Dry, open sites	Not identified as important for forage
Desert marigold (<i>Baileya multiradiata</i>)	A,B,P	Sandy plains and mesas, especially along roadsides	Not identified as important for forage
Lyreleaf green eyes (<i>Berlandiera lyrata</i>)	P	Dry, limestone soil; common along roadsides	Not identified as important for forage
Brickellbush (<i>Brickellia grandiflora</i>)	P	Occurs in rich soils, mainly in coniferous forests	Not identified as important for forage

**Table D-1. Pinyon-Juniper Woodland Species in the Kirtland Air Force Base Region
(continued)**

Name	Duration, Life Cycle*	Characteristics/Soils	Wildlife/Livestock Use
ASTERACEAE			
Yellowspine thistle (<i>Cirsium ochrocentrum</i>)	B,P	Found in dry sandy and gravelly soil	Not identified as important for forage
Reddome blanketflower (<i>Gaillardia pinnatifida</i>)	P	Dry sites in grasslands and open coniferous forests, roadsides and railways	Not identified as important for forage
Prairie sunflower (<i>Helianthus petiolaris</i>)	A	Waste areas	Not identified as important for forage
Golden aster (<i>Heterotheca villosa</i>)	P	Roadsides, most abundant in sandy and rocky or calcareous soils; resistant to drought and intense light and heat	Not identified as important for forage
Blackfoot daisy (<i>Melampodium leucanthum</i>)	P	Rocky soil	Not identified as important for forage
New Mexico butterweed (<i>Pakera neomexicana</i>) [syn. <i>Senecio neomexicanus</i>]	P	Dry mountainous slopes, often among oak or pine woodlands	Not identified as important for forage
Threadleaf groundsel (<i>Senecio flaccidus</i>) [syn. <i>Senecio longilobus</i>]	P	Rangeland, roadsides, waste areas; occurs on a variety of soils, from rocky or sandy to adobe clay, but prefers sandy or gravelly loams; drought-resist.	Not identified as important for forage
Bitterweed (<i>Tetranuris acaulis</i>) [syn. <i>Hymenoxys acaulis</i>]	P	Open rocky or limestone sites; dry slopes in foothills, montane and alpine zones	Not identified as important for forage
BORAGINACEAE			
Wayside gromwell (<i>Lithospermum multiflorum</i>)	P	Tends to grow in rocky or gravelly soil on banks and hillsides.	Not identified as important for forage
Stickseed (<i>Lappula occidentalis</i>)	A,B	Dry to moderately moist sites, along roadsides or overgrazed ranges	High in palatability, and fair forage for sheep and goats, otherwise poor for livestock
BRASSICACEAE			
Tansy mustard (<i>Descurainia Sophia</i>)	A,B	Grows in a variety of soils, abundant in open fields, along roadsides and ditches	Fair to poor forage for livestock, fair for sheep and goats
Western wallflower (<i>Erysimum capitatum</i>)	B,P	Found in coniferous forests at higher altitudes, rarely below 7,000 feet	Not identified as important for forage
Western peppergrass (<i>Lepidium montanum</i>)	B,P	Dry open slopes and disturbed ground	Not identified as important for forage

**Table D-1. Pinyon-Juniper Woodland Species in the Kirtland Air Force Base Region
(continued)**

Name	Duration, Life Cycle*	Characteristics/Soils	Wildlife/Livestock Use
CACTACEAE			
Claret's cup cactus (<i>Echinocereus triglochidiatus</i>)	P	Gravelly soils in grasslands, shrublands, grows against rock outcrop	Edible fruit for wildlife
Englemann cactus (<i>Opuntia engelmanni</i>)	P	Well drained soil. Found on dry rocky flats and slopes	Good forage for cattle and sheep
Fendler's hedgehog cactus (<i>Echinocereus fendleri</i>)	P	Grasslands and hills	Fruits are edible
Green pitaya (<i>Echinocereus viridiflorus</i>)	P	Dry rocky areas, and sandy plains	Not identified as important for forage
Spiny star (<i>Escobaria vivipara</i> (Nutt.) <i>Buxbaum</i> var. <i>vivipara</i> [<i>Coryphantha vivipara</i> (Nutt.) Britt & Rose])	P	Occurs in various soils	Not identified as important for forage
Tree cholla (<i>Opuntia imbricata</i>)	P	Sandy or gravelly soils	Not identified as important for forage
New Mexican prickly pear (<i>Opuntia phaeacantha</i>)	P	Dry, rocky areas	Not identified as important for forage
CAPRIFOLIACEAE			
Snowberry (<i>Symphoricarpos rotundifolius</i>)	P	Rocky slopes	Sheep, cattle, and goats browse its foliage; fruits eaten by many species of birds
CHENOPODIACEAE			
Winterfat (<i>Krascheninnikovia lanata</i>) [syn. <i>Eurotia lanata</i>]	P	Most abundant in dry subalkaline or chalky soils	Exceptionally nutritious food for deer, pronghorn, elk, and rabbits, especially in winter
CUPRESSACEAE			
One-seed juniper (<i>Juniperus monosperma</i>)	P	Adapted to a broad range of soil types	Fruits are eaten by deer, quail, fox, chipmunks, squirrels, songbirds, and coyotes
Rocky Mountain juniper (<i>Juniperus scopulorum</i>)	P	Often on undeveloped, erodible soils; most abundant on calcareous and somewhat alkaline soils	Important browse plant for pronghorn, mule deer, and bighorn sheep; birds and other animals eat the fruits
FABACEAE			
Missouri locoweed (<i>Astragalus missouriensis</i>)	P	Plains, prairies, and open dry slopes	Harmful to livestock

**Table D-1. Pinyon-Juniper Woodland Species in the Kirtland Air Force Base Region
(continued)**

Name	Duration, Life Cycle*	Characteristics/Soils	Wildlife/Livestock Use
FAGACEAE			
Gambel oak (<i>Quercus gambelii</i>)	P	Prefers sandy or gravelly loams and attains its best development in rich loam soils; a good soil builder	Fair for deer and porcupines, acorns eaten by wildlife such as deer and turkeys; provides shelter
Gray oak (<i>Quercus grisea</i>)	P	Dry, rocky slopes of foothills and mountains. Also found in canyons with other oaks, pinyons, and junipers	Acorn eaten by wildlife
Shrub live oak (<i>Quercus turbinella</i>)	P	Occurs on sandy, gravelly, or rocky soils	Deer consume the foliage on a considerable scale; porcupines also eat the leaves; acorns are relished by deer, wild turkey, and possibly other wild game, as well as by many small mammals
Wavy leaf oak (<i>Quercus x pauciloba</i>)	P	Dry gravelly slopes	Acorns eaten by wildlife
FUMARIACEAE			
Golden smoke (<i>Corydalis aurea</i>)	B	Sandy or gravelly soils along roadways, stream banks, and open fields	Not identified as important for forage
GERANIACEAE			
Purple geranium (<i>Geranium caespitosum</i>)	P	Dry grasslands, forest, and meadows	Not identified as important for forage
GROSSULARIACEAE			
Trumpet gooseberry (<i>Ribes leptanthum</i>)	P	Sandy, loamy, and clay soils, well-drained, streamsides	Fruit forage for wildlife
LEGUMINOSAE			
New Mexican locust (<i>Robinia neomexicana</i>)	P	Valley bottoms, canyon sides, streambanks, dry ridges, and rocky slopes	Occasionally grazed by deer, quail and squirrels eat the seeds
Wright's lotus (<i>Lotus wrightii</i>)	P	Dry parks, open ridges, and open stands of timber; occurs in sandy gravelly, or clayey soils	Deer graze on it readily
LAMIACEAE			
Dragonhead (<i>Dracocephalum parviflorum</i>)	A,B,P	Open, moist sites, also in gravelly soils. Found along streams and moist-wooded hillsides	Not identified as important for forage
False pennyroyal (<i>Hedeoma drummondii</i>)	A,B,P	Dry hills and plains	Not identified as important for forage
LILIACEAE			
Bear grass (<i>Nolina microcarpa</i>)	P	Gravelly or sandy soils	Not identified as important for forage

**Table D-1. Pinyon-Juniper Woodland Species in the Kirtland Air Force Base Region
(continued)**

Name	Duration, Life Cycle*	Characteristics/Soils	Wildlife/Livestock Use
MALVACEAE			
Fendler's globemallow (<i>Sphaeralcea fendleri</i>)	P	Open slopes and ponderosa pine forest	Not identified as important for forage
NYCTAGINACEAE			
Wild four-o'clock (<i>Mirabilia nyctaginea</i>) [syn. <i>Oxybaphus nyctagineus</i>]	P	Open dry ground, sometimes in gravelly areas	Not identified as important for forage
OLEACEAE			
Rough menodora (<i>Menodora scabra</i>)	P	Dry, rocky slopes, grassy slopes, and brushy deserts	Edible to animals but not an important browse plant
ONAGRACEAE			
Velvet gaura (<i>Gaura mollis</i>)	P	Roadsides; sandy soils; noxious weed in some states	Not identified as important for forage
Prairie evening primrose (<i>Oenothera albicaulis</i>)	A	Sandy soil; disturbed ground	Not identified as important for forage
OROBANCHACEAE			
Squawroot (<i>Conopholis americana</i>)	P	Moderately moist soils, open weedy parks, stands of aspen, and in moist meadows	Fair to highly palatable for livestock and wildlife. Good quality forage.
PINACEAE			
Pinyon pine (<i>Pinus edulis</i>)	P	Most abundant on dry and rocky soils	Seeds are important food for several songbirds, quail, squirrels, chipmunks, black bears, mule deer, and goats
POACEAE			
Side-oats grama (<i>Bouteloua curtipendula</i>)	P	Most abundant in fine-textured soils; seldom grows in coarse-textured soils; better adapted to calcareous and moderately alkaline soils than to neutral or acid soils; grows on well-drained soils	Good forage for all classes of wildlife throughout the summer and fall; remains moderately palatable into winter; excellent forage grass; important butterfly larval host plant
Blue grama (<i>Bouteloua gracilis</i>)	P	In all soil textures, but most abundant in sandy or gravelly soils; not found in wet, poorly drained soils; drought resistant	Good for all classes of wildlife; quality is highest when it is green, but it retains much of its value when dry and furnishes fall and winter grazing
Hairy grama (<i>Bouteloua hirsuta</i>)	P	Most abundant on dry, loose sands and neutral to slightly calcareous soils	Fair for wildlife forage; palatability is highest late in the growing season; furnishes winter forage when not covered by snow

**Table D-1. Pinyon-Juniper Woodland Species in the Kirtland Air Force Base Region
(continued)**

Name	Duration, Life Cycle*	Characteristics/Soils	Wildlife/Livestock Use
POACEAE (continued)			
Squirreltail (<i>Elymus elymoides</i>)	P	Grows on dry, gravelly soils or in saline situations, but also occurs in deep or alkaline soils	Not identified as important for forage
Foxtail barley (<i>Hordeum jubatum</i>)	P	Roadsides and waste areas; grows in moist saline and dry soils	Used for grazing while young, but becomes troublesome and unpalatable after the heads form; dry heads cause sores and infections in the mouths of all grazing animals; mature awns cause serious injury to animals' eyes, throat, nose, and ears
Indian ricegrass (<i>Achnatherum hymenoides</i>)	P	Characteristically grows on dry sandy soils, but will occur on well-drained silty and limey soils; seldom on gravelly or rocky soil; moderate tolerance for alkaline conditions; drought tolerant	Grazed by many types of livestock
Kentucky bluegrass (<i>Poa praetnsis</i>)	P	Grows on a wide range of sites, but best suited to well-drained or clay loams with high organic matter content	Used as a forage for a wide variety of animals including cattle, sheep, elk, deer, and horses; excellent livestock forage
POLYGALACEAE			
White milkwort (<i>Polygala alba</i>)	P	Dry rocky slopes	Distasteful to grazing animals
POLYGONACEAE			
Antelope sage (<i>Eriogonum jamesii</i>)	A,P	Prefers rocky, sandy, and well-drained soils	Not identified as important for forage
POLEMONIACEAE			
Desert gilia (<i>Gilia sinuate</i>)	P	Rocky and gravelly soils	Not identified as important for forage
Santa Fe phlox (<i>Phlox nana</i>)	P	Harsh dry sites, bare, rocky ground. Found on plains, hills, and mountain slopes, often in grassy areas	Not identified as important for forage
ROSACEAE			
Wild rose (<i>Rosa woodsii</i>)	P	Dry to moist areas, common in alluvial soils. Good soil stabilizer. Can be found in thickets, and along streambeds	Good wildlife forage. Livestock and big game find Wood's rose leaves palatable from spring through fall browsed by livestock and big game from spring through fall. Moderate use by mule deer and elk beavers also browse the leaves

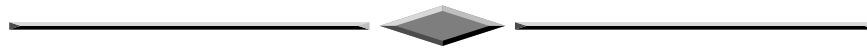
**Table D-1. Pinyon-Juniper Woodland Species in the Kirtland Air Force Base Region
(continued)**

Name	Duration, Life Cycle*	Characteristics/Soils	Wildlife/Livestock Use
ROSACEAE (continued))			
Alderleaf mountain mahogany (<i>Cercocarpus montanus</i>)	P	Occurs in the coarse, sometimes poor, shallow soil on dry slopes and ridges or in the slightly moister, deeper soils of depressions and canyon bottoms	Wild animals browse the twigs and leaves, to which elk and deer show a preference; one of the most valuable winter feeds for deer
Apache plume (<i>Fallugia paradoxa</i>)	P	A valuable aid in erosion control	Important browse for big game; deer and possibly other game animals will browse this plant; becomes more valuable winter forage when other browse becomes scarce; chief value is on winter ranges
RUTACEAE			
Hop tree (<i>Ptelea trifoliata</i>)	P	Common in pine belts and canyons	Avoided by livestock due to its strong order
SAXIFRAGACEAE			
Alumroot (<i>Heuchera parvifolia.</i>)	P	Steep, rocky hillsides	Grows where it is inaccessible to livestock and seldom used as forage
SCROPHULARIACEAE			
Southwestern paintbrush (<i>Castilleja integra</i>)	P	Most common among oaks and pines	Good source of forage for livestock
Scarlet penstemon (<i>Penstemon barbatus</i>)	P	Dry, rocky to limestone soils. Canyon bottoms and rocky slopes in piñon-juniper woodland and lower montane coniferous forest	Attracts hummingbirds and butterflies
Mullein (<i>Verbascum thapsis</i>)	B	Disturbed roadsides, fence lines, waste places, railway embankments, sunny, dry localities	Not identified as important for forage
Juniper lousewort (<i>Pedicularis centranthera</i>)	P	Common in pine forests	Not identified as important for forage
SOLANACEAE			
Pale wolfberry (<i>Physalis pallidum</i>) [syn. <i>Lycium pallidum</i>]	A,P	Common on washes and dry slopes, in desert or semi-desert areas	Winter forage for livestock, edible berries
Silverleaf nightshade (<i>Solanum elaeagnifolium</i>)	P	Old lots, along roads, rangeland, and waste areas; grows in dry soil	Berries and foliage are poisonous to livestock
VERBENACEAE			
Wright's verbena (<i>Glandularia wrightii</i>) [syn. <i>Verbena wrightii</i>]	A	Sandy soils, roadsides	Not identified as important for forage
New Mexico vervain (<i>Verbena macdougalii</i>)	A	Most common in pine forest	Not identified as important for forage

**Table D-1. Pinyon-Juniper Woodland Species in the Kirtland Air Force Base Region
(continued)**

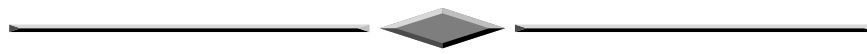
Name	Duration, Life Cycle*	Characteristics/Soils	Wildlife/Livestock Use
VISCACEAE			
Juniper mistletoe (<i>Phoradendron juniperinum</i>)	P	Parasitic on several species of juniper, rarely on pinyon pine	Not identified as important for forage
VITACEAE			
Canyon grape (<i>Vitis arizonica</i>)	P	Moist, well-drained and moderately fertile loam soils. Found along streams, and canyons	Fruit, and leave forage

*A-Annual, B-Biennial, P-Perennial [] Former name



APPENDIX E

PONDEROSA PINE WOODLAND COMMUNITY



**APPENDIX E
PONDEROSA PINE WOODLAND COMMUNITY**

Table E-1. Ponderosa Pine Woodland Vegetation Species in the Kirtland Air Force Base Region

Name	Duration, Life Cycle *	Characteristics/Soils	Wildlife/Livestock Use
AGAVACEAE			
Banana yucca (<i>Yucca baccata</i>)	P	Rocky soil	Large fleshy fruits are edible
ASTERACEAE			
Easter daisy (<i>Townsendia exscapa</i>)	P	Dry sandy soils, found in rock crevices, and open areas	Not identified as important for forage
Golden aster (<i>Heterotheca villosa</i>)	P	Roadsides; most abundant in sandy and rocky or calcareous soils; resistant to drought and intense light and heat	Not identified as important for forage
New Mexico butterweed (<i>Packera neomexicana</i>) [syn. <i>Senecio neomexicanus</i>]	P	Dry mountainous slopes, often among oak or pine woodlands	Not identified as important for forage
BERBERIDACEAE			
Creeping barberry (<i>Mahonia repens</i>)	P	Wooded and well drained slopes, open pine forest.	Berries are eaten by a variety of wildlife
BORAGINACEAE			
Narrow-leaved gromwell (<i>Lithospermum incisum</i>)	P	Warm dry open sites, often on rocky ground and waste areas	Not identified as important for forage
BRASSICACEAE			
Pink windmills (<i>Schoenocrambe linearifolis</i>) [syn. <i>Sisymbrium linearifolium</i>]	A,P	Common in pine forests	Not identified as important for forage
CAPRIFOLIACEAE			
Snowberry (<i>Symphoricarpos rotundifolius</i>)	P	Rocky slopes	Sheep, cattle, and goats browse its foliage; fruits eaten by many species of birds
CUPRESSACEAE			
Rocky Mountain juniper (<i>Juniperus scopulorum</i>)	P	Often on undeveloped, erodible soils; most abundant on calcareous and somewhat alkaline soils	Important browse plant for pronghorn, mule deer, and bighorn sheep; birds and other animals eat the fruits

Table E-1. Ponderosa Pine Woodland Vegetation Species in the Kirtland Air Force Base Region (continued)

Name	Duration, Life Cycle *	Characteristics/Soils	Wildlife/Livestock Use
FABACEAE			
Missouri locoweed <i>(Astragalus missouriensis)</i>	P	Plains, prairies and dry open slopes	Harmful to livestock
Wright's deer vetch <i>(Lotus wrightii)</i>	P	Occur in sandy, gravelly, or clay soils	Deer and probably other herbivorous wildlife graze it readily
New Mexican locust <i>(Robinia neomexicana)</i>	P	Valley bottoms, canyon-sides and bottoms, streambanks, dry ridge tops, rocky slopes, open ponderosa pine stands, and openings in aspen and spruce-fir forests	Quail and squirrels eat the seeds; occasionally heavily grazed by deer, but usually lightly grazed
FAGACEAE			
Gambel oak <i>(Quercus gambelii)</i>	P	Prefers sandy or gravelly loams, and attains its best development in rich loam soils; a good soil builder	Fair for deer and porcupines, acorns eaten by wildlife such as deer and wild turkeys; provides shelter
HYDRANGEACEAE			
Cliff fendlerbush <i>(Fendlera rupicola)</i>	P	Dry rocky and gravelly slopes	Browsed by mule deer, bighorn sheep, domestic goats, and cattle when other plants are scarce
Mock-orange <i>(Philadelphus microphyllus)</i>	P	Dry cliffs, or rock canyons in mountainous areas	Browsed by bighorn sheep
MALVACEAE			
Fendler's globemallow <i>(Sphaeralcea fendleri)</i>	P	Open slopes and ponderosa pine forests	Not identified as important for forage
PINACEAE			
Pinyon pine <i>(Pinus edulis)</i>	P	Most abundant on dry and rocky soils	Seeds are important food for several songbirds, quail, squirrels, chipmunks, black bears, mule deer, and goats
Ponderosa pine <i>(Pinus ponderosa)</i>	P	Grows in moist or dry soils and in a wide range of soil types	Seeds are eaten by several bird species and small mammals; pines are browsed by mule deer, white-tailed deer, and mountain sheep

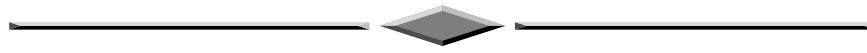
Table E-1. Ponderosa Pine Woodland Vegetation Species in the Kirtland Air Force Base Region (continued)

Name	Duration, Life Cycle *	Characteristics/Soils	Wildlife/Livestock Use
POACEAE			
Indian ricegrass (<i>Achnatherum hymenoides</i>)	P	Characteristically grows on dry sandy soils, but will occur on well-drained silty and limey soils; seldom on gravelly or rocky soil; moderate tolerance for alkaline conditions; drought tolerant	Grazed by many types of livestock
Red three-awn (<i>Aristida purpurea</i> var. <i>longiseta</i>)	P	In soils of all textures, especially dry sandy soils; aggressive invader of denuded areas and recently disturbed soils	Poor forage value for wildlife, grazed only in early growth stages before awn development; worthless in winter, although green in spring and highly abundant; invades the eyes and nostrils of range animals
Side-oats grama (<i>Bouteloua curtipendula</i>)	P	Most abundant in fine-textured soils; seldom grows in coarse-textured soils; better adapted to calcareous and moderately alkaline soils than to neutral or acid soils; grows on well-drained soils	Good for all classes of wildlife throughout the summer and fall; remains moderately palatable into winter; excellent forage grass; important butterfly larval host plant
Kentucky bluegrass (<i>Poa pratensis</i>)	P	Grows on a wide range of sites, but best suited to well-drained or clay loams with high organic matter content	Used as a forage for a wide variety of animals including cattle, sheep, elk, deer, and horses; excellent livestock forage
POLYGALACEAE			
White milkwort (<i>Polygala alba</i>)	P	Dry rocky slopes	Distasteful to grazing animals
POLEMONIACEAE			
Sante Fe phlox (<i>Phlox nana</i>)	P	Harsh, dry sites, Found in grass and bare rock ground	Not identified as important for forage
PRIMULACEAE			
Rock jasmine (<i>Androsace septentrionalis</i> var. <i>subulifera</i>)	A,P	Found in springs in coniferous forests	Not identified as important for forage
ROSACEAE			
Alderleaf mountain mahogany (<i>Cercocarpus montanus</i>)	P	Occurs in the coarse, sometimes poor, shallow soil on dry slopes and ridges or in the slightly moister, deeper soils of depressions and canyon bottoms	Wild animals browse the twigs and leaves, to which elk and deer show a preference; one of the most valuable winter feeds for deer

Table E-1. Ponderosa Pine Woodland Vegetation Species in the Kirtland Air Force Base Region (continued)

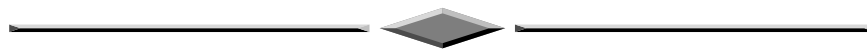
Name	Duration, Life Cycle *	Characteristics/Soils	Wildlife/Livestock Use
RUTACEAE			
Hop tree (<i>Ptelea trifoliata</i>)	P	Common in pine belts; mostly in canyons	Avoided by livestock due to its strong odor
SCROPHULARIACEAE			
Southwestern penstemon (<i>Penstemon barbatus</i>)	P	Mountains, well drained soils. Dry rocky slopes in open forest	Not identified as important for forage
Southwestern paintbrush (<i>Castilleja integra</i>)	P	Most common among oaks and pines	Good source of forage for livestock
Juniper lousewort (<i>Pedicularis centranthera</i>)	P	Common in pine forests	Not identified as important for forage
Southwestern penstemon (<i>Penstemon barbatus</i>)	P	Well-drained soils; coniferous or oak forests	Good source of forage for browsing animals
Wandbloom penstemon (<i>Penstemon virgatus</i>)	P	Pine or woodlands and mountain meadows	Good source of forage for browsing animals
VERBENACEAE			
New Mexico vervain (<i>Verbena macdougalii</i>)	P	Most common in pine forests	Not identified as important for forage
VISCACEAE			
Juniper mistletoe (<i>Phoradendron juniperinum</i>)	P	Parasitic on several species of juniper, rarely on pinyon pine	Not identified as important for forage

* A-Annual, B-Biennial, P-Perennial, [] Former names



APPENDIX F

RIPARIAN/WETLAND/ARROYO COMMUNITY

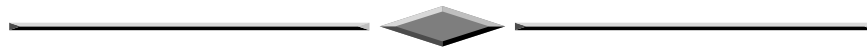


**APPENDIX F
RIPARIAN/WETLAND/ARROYO COMMUNITY**

Table F-1. Riparian/Wetland/Arroyo Community Species in the Kirtland Air Force Base Region

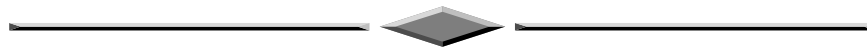
Name	Duration, Life Cycle *	Characteristics/Soils	Wildlife/Livestock Use
JUNCACEAE			
Torrey's rush (<i>Juncus torreyi</i>)	P	Coarse, textured soils and wet sandy soils. Grows along marches, wet prairies, roadside ditches, and also streams, small wet depressions, swales, moist meadows, and banks of lakes	Good forage for deer
Wire rush (<i>Juncus balticus</i>)	P	Sand, clay, coarse soils, mostly acidic	Fair to poor forage for all grazing animals
ANACARDIACEAE			
Smooth sumac (<i>Rhus glabra</i>)	P	Moist soil along streams or on rocky canyon walls	Provides cover for small mammals
CYPERACEAE			
Three-square bulrush (<i>Schoenoplectus americanus</i>)	P	Moist and wet soils	Not identified as important for forage
POACEAE			
Rabbitfoot grass (<i>Polypogon monspeliensis</i>)	P	Wet ground along roadsides, waterways, marshy or saline waste areas.	Not identified as important for forage
SALICAEAE			
Fremont cottonwood (<i>Populus fremontii</i>)	P	Along streams in deserts, woodlands, and grasslands	Bark feed upon by beavers and horses; beavers use branches to construct dams
Bluestem willow (<i>Salix irrorata</i>)	P	Along streams	Not identified as important for forage
Arroyo willow (<i>Salix lasiolepis</i>)	P	Wet soils along streams, arroyos, and gullies; found in valleys, foothills, and mountains	Not identified as important for forage
SAURURACEAE			
Yerba mansa (<i>Anemopsis californica</i>)	P	Open, damp, sandy, or alkaline areas; found in river valleys and wetlands	Not identified as important for forage
TAMARICACEAE			
Salt cedar (<i>Tamarisk chinensis</i>)	P	Along drainages, tolerant of saline soil conditions	Dense stands provide cover for doves and other wildlife
TYPHACEAE			
Cattail (<i>Typha latifolia</i>)	P	Marshes and other wet areas	Provides cover for nesting waterfowl

* A-Annual, B-Biennial, P-Perennial, [] Former names



APPENDIX G

**NATIVE SEED DISTRIBUTORS AND WHOLESALE NURSERIES
AS OF JULY 2004**



APPENDIX G
NATIVE SEED DISTRIBUTORS AND WHOLESALE NURSERIES
AS OF JULY 2004

1) Curtis and Curtis Inc.
4500 N. Prince
Star Route Box 8A
Clovis, NM 88101
Phone (505) 762-4759
Fax (505) 763-4213
<http://www.curtisseed.com>

2) Energy, Minerals, and Natural
Resources Dept.
New Mexico Forestry Division
(New Mexico Conservation Seedling
Program)
P.O. Box 1948
Santa Fe, NM 87504
(505) 476-3353 or 476-3333
<http://www.emnrd.state.nm.us/FORESTRY/tree/web/home/main.cfm>

3) Trees That Please
3084 Highway 47
Los Lunas, NM 87031
505- 866-5027

6) Rio Grande Cacti
2188 NM Hwy 1
Socorro, NM 87801
<http://www.riogrande-cacti.com/>

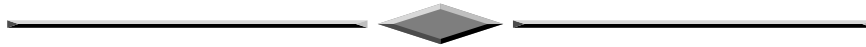
7) Santa Ana Garden Center
Native Plants
Wholesale
2 Dove Rd.
Bernalillo, NM 87124
(505) 867-
<http://www.santaana.org/garden.htm>

8) High Country Gardens (Catalog
information for Santa Fe Greenhouses)
2902 Rufina Street
Santa Fe, NM 87505-2929
(800) 925-9387
<http://www.highcountrygardens.com>

4) Santa Fe Greenhouses, Inc.
2904 Rutina St.
Santa Fe, NM 87505
(505) 473-2700
<http://santafegreenhouses.com>

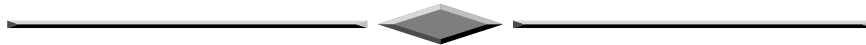
5) Plants of the Southwest
6680 4th Street, NW
Albuquerque, NM
(505) 344-8830 or
1-800-788-7333 (SEED), FAX (505)-
438-8800
<http://www.plantsofthesouthwest.com>

9) Mesa Garden Plant & Seed List
PO Box 72
Belen, NM 87002
(505) 864-3131
(505) 864-3124 (fax)
<http://www.mesagarden.com>



APPENDIX H

SEEDING PARAMETERS



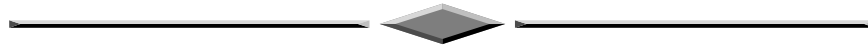
APPENDIX H SEEDING PARAMETERS

Table H-1. Seeding Parameters

Common Name	Scientific Name	Seeds/lb	Seeding Rates	Notes
Blue grama	<i>Bouteloua gracilis</i>	711,000	1-3lb PLS/acre	Firm seedbed by drilling or broadcasting no more than ¼ to ½ inches deep.
Indian ricegrass	<i>Achnatherum hymenoides</i>	235,000	3-6lb PLS/acre	Seed at no more than 2-3 inches deep.
Side-oats grama	<i>Bouteloua curtipendula</i>	191,000	2 ½ -5lb PLS/acre	Drilling in firm, weed-free seedbeds, protect from grazing from date of seeding through the second growing season.
Rubber rabbitbrush	<i>Ericameria nauseosa</i> <i>var. nauseosa</i>	693,000	1lb PLS/acre	Drill 0.1 inches or broadcast 0.2 lbs PLS per acre.
Scarlet globemallow	<i>Sphaeralcea coccinea</i>	500,000	1 lb PLS/acre	Drill 0.2 or broadcast 0.4 pounds PLS per acre with grass mixture
Galleta	<i>Pleuraphis jamesii</i>	160,000	2-6lb PLS/acre	Seed at no more than 1 inch deep.
Four-wing saltbush	<i>Atriplex canescens</i>	55,000	2-6lb PLS/acre	Drilling is the most successful, seed should be covered no deeper than ½-1 inch.
Apache plume	<i>Fallugia paradoxa</i>	540,000	1lb PLS/acre	Seed at no more than ¼ inch deep in drainages. Drill 0.1 inches or broadcast 0.2 lbs PLS per acre.
Kochia	<i>Kochia americana</i>	500,000	2lb PLS/acre	Drill seed no more than ¼ inched deep. Broadcast seeding also works well.
Pinyon Pine	<i>Pinus edulis</i>	NA	50 seedlings/acre	Dig a hole to place the seedling into the ground. Be sure to compact the soil around the seedling to avoid roots being exposed to air.
Ponderosa Pine	<i>Pinus ponderosa</i>	NA	50 saplings/acre	Dig a hole to place the sapling into the ground. Be sure to compact the soil around the sapling to avoid roots being exposed to air.
Gambel oak	<i>Quercus gambelii</i>	325	20-100 acorns/acre	Acorns should be planted “ deep by hand. Seeds should be planted in groups of 5 -15 acorns distributed throughout the site.
Southwestern penstemon	<i>Penstemon barbatus</i>	207,000	1.5-5lb PLS/acre	Drilled or broadcast at a depth of ¼ inch or less into a firm seedbed. Ideal seeding depth is 1/8 inch

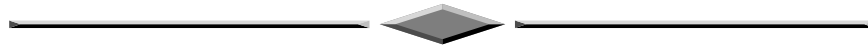
Source: NRCS

Notes: NA = Not Applicable
PLS (pure live seed)



APPENDIX I

DEVELOPING A REVEGETATION CONTINGENCY PLAN



APPENDIX I DEVELOPING A REVEGETATION CONTINGENCY PLAN

In addition to monitoring and maintenance, a contingency plan is needed in case revegetation efforts do not succeed. The following recommendations should be considered in a contingency plan or as part of the monitoring and maintenance process.

Five or more years may be needed to properly assess a revegetation project. After five years, a contingency plan may be necessary if revegetation is unsuccessful. Revegetation success should be based on achieving minimum threshold of species diversity, cover, and productivity. Prior to revegetation actions, success criteria should be established to determine if revegetation is succeeding. If revegetation is failing, the following actions could be implemented:

- Planting seedlings instead of seeds;
- If a particular plant is not growing well, consider alternative plants. Native plants should be used for success in revegetation;
- Reseeding or replanting;
- Developing regular schedules for monitoring and maintenance;
- Fertilizing;
- Using supplemental watering;
- Using barriers, fencing to protect from browsing, grazing, and access to site while vegetation is being established; and
- Presence of noxious weeds or weed encroachment after vegetation has been established may require some control methods such as applying herbicides.