RESTORATION OF
CIENEGA CREEK BOTTOMLANDS

ASSISTANCE AGREEMENT
AAA030023

Pima County, Arizona
Board of Supervisors

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Abstract

The goal of this project was to assist natural restoration of mesquite bosque and sacaton plant communities within the Cienega Creek Natural Preserve through the removal of stressors and impediments. This is in keeping with the biological goal of the Sonoran Desert Conservation Plan:

> *to ensure the long-term survival of the full spectrum of plants and animals that are indigenous to Pima County through maintaining or improving the ecosystem structures and functions necessary for their survival.*

This project was a joint BLM-County venture, and included the Empirita Ranch permittee (land steward). The project resulted in changes in habitat for wildlife, and the first steps toward natural restoration. Fencing and cooperative management reduced herbivory along approximately 880 acres of the Cienega Creek bottomlands, which allowed grasslands to rest and litter to accumulate during a time of extraordinary drought. This project included a commitment to specific actions to restore the hydrology of tributaries, and to relocate stock water to manage livestock more effectively and reduce riparian impacts.

The project is intended to increase vegetation cover and structure, which will improve the connectivity of riparian plant communities along Cienega Creek. Mesquite woodland and sacaton plant communities are relatively scarce in Pima County, and are among those identified as having disproportionate historic losses in the region. In addition, increased vegetation in the channel should result in dissipating the energy of floodwaters and capturing sediment and nutrients, which will benefit endangered species habitat downstream.

Water resource monitoring has been ongoing over the last twelve years. Rainfall over the duration of the project was below average, indicating continued drought conditions. Most of the rainfall during the last two years occurred within a few short-duration events, resulting in significant runoff and erosion. Lower annual precipitation was reflected in the groundwater levels measured from wells in the area, which have been generally trending downward over the last four to five years.

Range and watershed conditions were monitored annually from 2004 through 2006. The farm fields and adjacent floodplain were generally in poor condition during the term of the project, but showed trends of improvement over time. The creek channel was determined to be in fair to good condition, based on monitoring by District staff at two cross-sections near the Empirita Ranch headquarters in October 2005. Riparian vegetation was predominantly small in size and consisted mostly of velvet mesquite and rabbitbrush, along with a number of native and non-native grasses.

Despite prevailing drought conditions over the last twelve years, there has been natural establishment of native plant species (mainly mesquite) in a farm field that was excluded from livestock grazing on the Cienega Creek Natural Preserve downstream of the project site, and an increase in vegetative cover in other excluded areas. Natural recruitment of perennial species has been slow, however, suggesting we consider activities such a seeding, localized water harvesting and berm construction to assist in the recovery of the watershed.

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1.0 Background

The District's restoration project is consistent with the purposes for which the Cienega Creek Natural Preserve was established. On December 5, 1986, the Chief Engineer of the Flood Control District, C. H. Huckleberry, wrote the Board of Directors that he would use the Cienega Creek acquisitions to "make long-term preservation commitments to the U. S. Army Corps of Engineers, United State Fish and Wildlife Service, and Arizona Game and Fish Department to offset the issue of adverse cumulative impact to riparian habitat." Other reasons for establishing the Preserve were to provide for natural flood storage upstream of the urbanized area, and to preserve a source of groundwater to the Tucson Basin.

In 1994, the District developed a management plan for the Preserve in conjunction with Arizona Game and Fish Department and Pima County Parks and Recreation Department. The management plan identified areas previously disturbed as sites either for future recreational facilities or to be restored to native vegetation. The management plan envisioned pilot programs to re-establish native plant cover and to improve habitat on previously disturbed areas of the Preserve will be implemented when grants or other funding sources for such programs become available.

In December 2001, the Pima County Board of Supervisors adopted a revised Comprehensive Land Use Plan. The Plan designated the bottomlands along Cienega Creek, as well as along several tributaries, as important riparian areas within the Sonoran Desert Conservation Plan (**Figure 1**). The plan identifies these areas as '*extremely important elements in this Conservation Lands System and every effort should be made to protect, restore and enhance the structure and functions of these areas, including hydrological, geomorphic and biological functions.*'

Areas adjacent to the creeks are designated biological core management areas, where *land uses and management...will focus on conservation, restoration and enhancement of natural communities, with provision for other land uses that are consistent with improvement of conditions for vulnerable species, soils and native vegetation.*

Pima County is working with U. S. Fish and Wildlife Service, Bureau of Land Management and many others agencies and individuals on the Sonoran Desert Conservation Plan. The biological goal of the Sonoran Desert Conservation Plan is

> *to ensure the long-term survival of the full spectrum of plants and animals that are indigenous to Pima County through maintaining or improving the ecosystem structures and functions necessary for their survival.*

This goal is the basis of an existing cooperative agreement with BLM.

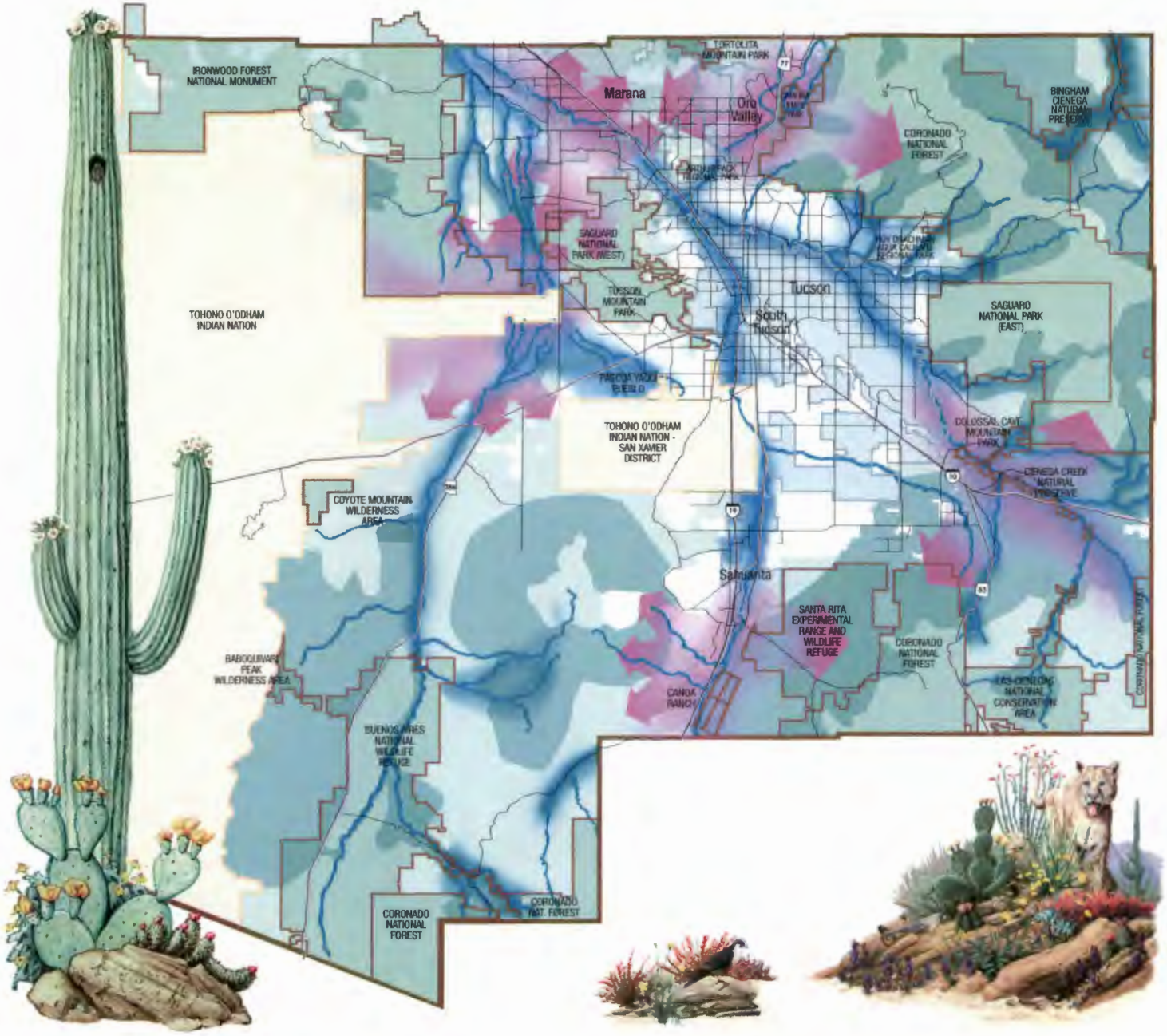
In addition, Pima County wishes to see the adjoining state and private lands remain in conservation through ranching and other uses. To that end, Pima County submitted a grant application to U. S. Fish and Wildlife Service for acquisition of over 1200 acres of private land within the Sonoita Valley Acquisition Planning District. By preventing subdivision of the land for home sites, this acquisition would allow for continued ranching to occur in the area. Pima County Flood Control District intends to contribute to ranching by providing its buildings and other facilities for use as a ranch headquarters.

FIGURE 1

SONORAN DESERT CONSERVATION PLAN

BIOLOGICAL CORRIDORS AND CRITICAL HABITAT

The work on the biological corridors and critical habitat element of the Sonoran Desert Conservation Plan revealed that biology is the basis for all other elements. The strong interconnections of all five elements is critical in forming a viable land management plan that ensures continuing biodiversity for Pima County.



LEGEND

- Important Riparian Areas
- Biological Core Areas
- Multiple Use Areas
- Wildlife Corridors

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www.pima.gov/sdcp

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1.1 Location and Ownership

The project site is located approximately 35 miles southeast of Tucson, within Pima County Flood Control District's Cienega Creek Natural Preserve (**Figure 2**). The area proposed for restoration lies within Section 17, Township 17 South, Range 18 East. The land (tax codes 306-18-006E and -006F) is owned by the District in fee simple. It was purchased from Empirita Ranch Partnership, Inc. in 1991. The 360-acre parcel is sometimes referred to as the Headquarters tract of the Empirita Ranch portion of the Cienega Creek Natural Preserve. BLM owns the land to the east. State Trust lands adjoin the Headquarters Tract on the other sides.

1.2 Purpose and Authority

The purpose of this report is to summarize the activities performed to restore the bottomlands at the Headquarters Tract at Empirita Ranch. The Pima County Flood Control District wishes to restore natural hydrologic processes and native plant communities to the bottomlands within the Cienega Creek Natural Preserve. The Preserve is an area owned and managed by the District, with assistance from Pima County Natural Resources, Parks and Recreation Department. .

State statutes authorize flood control districts to enhance wildlife and recreation values where appropriate by preserving riparian vegetation in "greenbelts" along watercourses and floodplains and to enter into agreements with other governmental entities to carry out the purposes of the District.

1.3 Site Description and Recent Land Use History

The vegetation of the Cienega Creek bottomlands was mapped by the University of Arizona Office of Arid Lands Studies in the early 1970s, shortly after the land was cleared. At that time, the area had both mesquite woodland and mesquite-sacaton savannah (Lacey et al., 1975).

The area around the Headquarters was cleared for pasture (**Figure 2**), probably in the early 1970s. The mesquite trees were sold for lumber, the stumps removed and the slash burned in windrows in and around the field. The land was graded or plowed, seeded in alfalfa and bermuda grass and then irrigated.

The land was acquired for the Cienega Creek Natural Preserve by Pima County Flood Control District in 1991. Livestock were removed from the land north of the freeway. Grazing continued south of the freeway within the Preserve. Meanwhile, Empirita Ranch was sold from the Ohrel family to Empirita Ranch Limited Partnership. The Limited Partnership leased its land to Parson Company for ranching purposes.

The Preserve lands south of the freeway were made available to Parson Company through a caretaker agreement, beginning in 1991. The most recent agreement covered the period from January 3, 1993 to January 2, 1998 and was extended 5 years, expiring January 2, 2003. The agreement permitted the caretaker to use the Preserve land and buildings, subject to certain limitations set forth in the agreement.

The limitations specified that the caretaker would not include the Preserve acreage in the surrounding grazing allotment acres, and would use the Property for cattle transfer purposes only and not for grazing. However, because the property boundary was not fenced, and State law requires non-grazers to bear the responsibility for fencing out livestock, the Cienega Creek

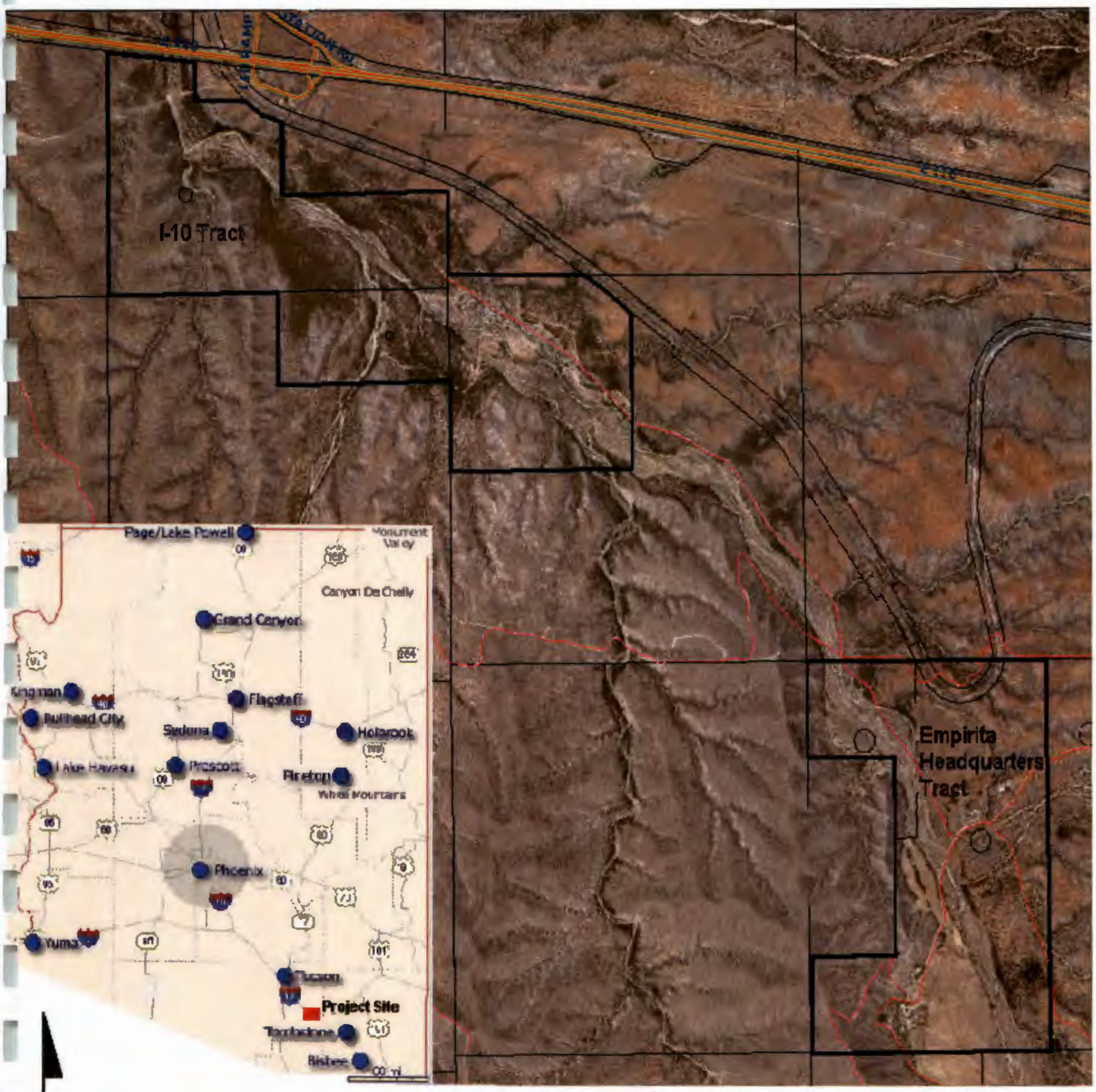

Figure 2. Project Site Map

scale 1 : 23,470

bottomlands at Empirita Ranch have in fact been grazed since their acquisition. A field study by Don Ward in 2002 found deteriorating range conditions (**Appendix A**).

Parsons Company today also leases adjacent state, and BLM land for grazing purposes. No base property is maintained, nor is there base property requirement for use of the adjoining state or federal lands. Parsons grazes a total of 80 head of cattle on the combined District/BLM/State/Partnership land. The grazed portions of the Cienega Creek Natural Preserve are not included in the calculation of the grazing capacity.

The District entered into a new agreement with Parson Company during this project. During this period we fenced the southerly 330-acre property, and began restoration activities on the land.

1.4 Restoration Goal

The goal of the project was 1) to assist natural restoration of bottomland plant communities through the removal of stressors and impediments, and 2) to improve the cover and structural diversity of plant communities along the bottomlands. This is in keeping with the biological goal of the Sonoran Desert Conservation Plan.

1.5 Significance of the Project

The Cienega Creek bottomlands are part of an important movement corridor for terrestrial wildlife moving between the Tucson and San Pedro Basins, as well as between the Rincon and Whetstone Mountains (**Figure 1**). Interstate Highway 10 impedes terrestrial wildlife movement between the Rincon and the Empire or Santa Rita Mountains except at infrequent drainage crossings, the largest of which are located at Cienega Creek and its tributary Davidson Canyon. For these reasons, restoring habitat within this corridor will help preserve the diversity of animal life in the region.

Although the streams are ephemeral, the bottomland soils retain moisture for longer periods of time, and cool shade and elevated humidity is offered along the bottoms. These considerations are particularly important given the long-term prognosis for drought conditions in southern Arizona. Improved habitat will contribute to the resilience of native plants and animals to climatic variability.

The project has particular significance for neotropical migratory birds which would use mesquite woodlands. Based on occurrence in adjacent habitats, these would include such species as Bell's vireo, Western and Scarlet Tanagers, and Vermilion Flycatcher. Improved soil stability should assist in the stability of the perennial reach downstream, which includes populations of Huachuca water-umbel and Gila topminnow.

The project also offers significant opportunities to involve community organizations, families, individuals and classes in improving the condition of the land. It complements an ongoing effort to stabilize the historic buildings on the property.

2.0 Physical Factors Affecting Feasibility

Physical factors such as rainfall, soil characteristics, existing vegetation and the availability of water to the site affect how and whether it is possible to restore the plant communities to the site.

2.1 Rainfall

Rainfall is highly variable. In the Preserve, the majority of rainfall occurs during the summer months (July, August and September) and winter months (December to January). During "El Niño" years, tropical storms may provide heavy rains during the months of September and October. Average rainfall is reported to be 14 inches within the Preserve (Sellers and Hill, 1974). Rainfall measured at Pima County precipitation gages in and near the Preserve has varied from 18 inches in 1990 to a low of 4 inches in 1989. More detailed monitoring information is provided in Section 3.2 of this report.

Pima County Flood Control District maintains precipitation and stream flow sensors on Cienega Creek upstream and downstream of the study area. The sensors provide real-time data to the District for flood warning purposes. The nearest sensors are located at the I-10 bridge, approximately 2 miles northwest of the site. The devices were installed in 1988 and 1989. In addition, the land stewards record rainfall and streamflow at the Empirita Ranch Headquarters.

The District's previous observations within the Preserve indicate that the re-establishment of native plants is facilitated by exceptionally wet periods, such as the El Nino event of late 1983-early 1984, which we believe was responsible for the last major recruitment event for mesquite in an abandoned farm field north of the Interstate.

Droughts, such as the one we are in, reduce the potential for natural recruitment, and reduce the rate of growth for vegetation, which is not groundwater dependent. Despite drought conditions which have prevailed during the period 1995 to present, the District has seen the natural establishment of at least one native plant species (mesquite) in an abandoned farm field that was excluded from livestock grazing on the Cienega Creek Natural Preserve downstream of the project site, and the increase of vegetation cover in other excluded areas.

2.2 Surface Water

The principal stream in the area is Cienega Creek. Most of the land is subject to inundation from Cienega Creek or the tributaries, which debouch onto the valley floor. Important tributaries include Anderson and Wakefield Canyons, which originate in the Whetstone Mountains to the east. Detailed stream flow monitoring for this project is provided in Section 3.2 of this report.

Historically, Cienega Creek was a cienega and sacaton bottomland. Arroyo-cutting along Cienega Creek began in the 1880's resulting in a channel incised into the former floodplain. Today, flow in Cienega Creek within the Empirita Ranch is ephemeral, but perennial flow occurs both upstream and downstream along Cienega Creek. Anderson Wash, Wakefield Canyon and other tributaries are considered to be ephemeral in the project area. The tributary flow paths have been modified by channelization and berms within the Headquarters parcel, associated with the construction of houses, pastures and roadways.

2.3 Hydrogeology

The youngest deposits are in unconsolidated fluvial sediment deposited along Cienega Creek, its terrace, and along its major tributaries. This unit is reported to be 80 to 100 feet thick along the axis of the valley, on the basis of drill logs for wells located on the terraces, except at the southern part of the property, where the alluvial deposits are only 30 feet thick.

The older basin-fill deposits are weakly consolidated, poorly sorted gravels deposited by Quaternary and possible Tertiary fans. These are exposed in the higher terraces and ridges. Bedrock is not generally exposed along the Cienega Creek bottomlands in the Headquarters Tract. Bedrock, in the form of the Pantano Formation siltstone, is also found near the southern boundary of the Headquarters tract at a depth of about 30 feet.

Groundwater is found primarily in basin-fill and recent alluvial deposits. Together these form an unconfined aquifer. The recent alluvium receives recharge from the streambed infiltration during stormflow events. The depth to water varies from 35 to 60 feet below the land surface, based on driller's logs for most wells located on the terrace. An exception is the proximity of groundwater, which at times has been at the surface, in a well in the southern part of the Headquarters Tract. This condition has been interpreted to indicate confined aquifer conditions.

Groundwater levels are monitored at several locations in the Cienega Creek Natural Preserve, including the Empirita #2 well. Due to the depth to water, most of the plants are thought to be dependent on surface water, with the possible exception of some mesquite.

2.4 Soils

The channel of Cienega Creek consists of very deep, excessively drained sands, gravels and cobbles, with little soil horizon development. Soils of the Cienega Creek bottomlands outside the channel on the east side are sandy loams to silt loams. They are classified as Comoro soils, which are deep soils and well-drained. Permeability on the Comoro soils is moderate. Riverroad soils, which occur in the pasture on the west side of Cienega Creek, have a clay loam texture, which reduces permeability. Erosion potential is high, and flooding is rare. The land surface is level and gently sloping (0-2%).

The soils in the adjacent Pleistocene terraces and hillslopes of basin fill contain much cobble and gravelly material. They are classified as the Powerline-Kimrose and the Nolam-Tombstone complex. The Kimrose soils have an indurated calcic horizon and the Nolam soils have a reddish clay-rich horizon in the subsurface.

Soil was characterized using test pits in the farm fields. Four trenches were excavated with a backhoe. Three of the pits encountered floodplain alluvium, which had a loamy texture, while one encountered gravelly loam alluvial fan deposits. All soils were relatively poorly developed, lacking a B horizon, which indicated that they were fairly young (Entisols). Because of the soils are relatively fine-grained and well drained, they are well-suited to restoration efforts.

2.5 Wildlife

Preserving large blocks of suitable land and important wildlife corridors is necessary to maintain the present diversity of plant and animal life in the area. The BLM's acquisition of the Empire-Cienega Ranch to the south was a good start in this respect. BLM has, since then, substantially improved habitat conditions in that area.

Traditionally, scrub-grassland in southern Arizona has been subject to extensive development, while mountainous land has been isolated in separate Coronado National Forest units, the so-called "sky islands." But many wildlife species, principally large mammals and birds, depend at some point in the year upon the availability of lower elevation plant communities lying outside National Forest boundaries.

The project acted to preserve and enhance wildlife movement corridors linking a number of mountain ranges (Whetstone Range, and Empire Mountains) to the Cienega Creek corridor and adjacent grasslands. The restoration effort is focused on the bottomlands, which are critically important to wildlife during times of drought. The restoration effort will facilitate the ability of wildlife to withstand drought. Studies near Saguaro National Monument have shown that xeroriparian corridors are particularly important refuge for game species such as mule deer and javelina, particularly during the hottest times.

Increased stability of the stream banks and other soil resources in the bottomlands will contribute to the improved conditions for the perennial stream segments of Cienega Creek, which lie downstream of the project area. The perennial stream hosts populations of several endangered species, such as the Huachuca water-umbel and the Gila topminnow, as well as other native aquatic fauna.

Potentially suitable habitat for up to 26 priority vulnerable species occurs in the Headquarters tract, including riparian species such as Abert's towhee, Bell's vireo, Western yellow bat, Western red bat, Mexican long-tongued bat, Merriam's mouse, Mexican garter snake, California leaf-nosed bat, and Lowland leopard frog. Grassland species including Western burrowing owl, Desert box turtle, Rufous-winged sparrow, Swainson's hawk, and Needle-spined pineapple cactus also occur or have potentially suitable habitat.

Potentially suitable habitat is present for listed and candidate species such as Lesser long-nosed bat, Cactus ferruginous pygmy-owl, Huachuca water-umbel, Southwest willow flycatcher, Chiricahua leopard frog, and Yellow-billed cuckoo, however these species are not known to use the site for reproduction.

The Headquarters tract is considered a priority conservation area for Bell's vireo and Abert's towhee. Improved habitat conditions are likely to benefit these species. In addition, they may benefit from reductions in nest parasitism by cowbirds.

2.6 Vegetation

Riparian vegetation mapping conducted by Office of Arid Land Studies (Lacey et al., 1975) shows that mesquite dominated the bottomlands outside the channel in the 1970's. Mapping was based on 1972 1:125,000 color infrared photography, as well as ground surveys and low-level aerial overflights presumably conducted during 1973 or 1974. Communities mapped in the bottomlands included mixed scrub (seepwillow, burrobrush and tamarisk) at less than 25% cover along the channel, and velvet mesquite and mesquite-sacaton associations on the floodplain and terraces. The percent cover of these two associated varied, but included some areas with cover greater than 75% in sections 1 and 2 of Township 17 South, Range 17 East. The farm fields were not mapped as riparian.

Vegetation mapping in 1993 for the Cienega Creek Management Plan was conducted using field investigations and 1990 aerial photography at a scale of 1:4800 (**Figure 3**). Communities

mapped along the bottomlands included burroweed-mesquite association, mixed grass-mixed scrub association, velvet mesquite association, low-density velvet mesquite association, velvet mesquite-mixed deciduous tree association, and sparsely vegetated channel bottom (McGann & Associates Inc., 1994). The farm fields were mapped as pasture grazing/agricultural fields.

Perennial native grasses such as sideoats gramma, various *Aristida* species, black gramma grass, bush muhly, sand dropseed, cane bluestem, and rothrock gramma grass are present on the uplands which surround the field. Upland shrubs include paperflower, *Ephedra* spp., *Calliandra* spp., *Agave* spp., desert broom, *Larrea* sp., *Opuntia engelmannii*, *Mammillaria* spp., *Acacia constricta*, *Juniperus* (redberry), and *Atriplex canescens*.

In 2003 the dominant plants within the field are grasses such as Bermuda and Lehman's lovegrass (**Figure 4**). Percent cover is estimated at 9% grass and 11% litter. The field also has a scattering of 1- to 6 foot-high mesquite. Along the terraces, several specimens of sacaton are found.

A survey of non-native species was recently completed for the Cienega Creek Natural Preserve (Pima Association of Governments, 2003). Non-native species which occur in the Headquarters Tract include; giant reed, filaree, Lehmann's lovegrass, bermuda, Johnson grass, tamarisk, tumbleweed, stinkgrass, and a mustard. One large clump of giant reed *(Arundo donax)* was removed to prevent the spread of seeds of this invasive species to downstream perennial portions of Cienega Creek.

Adjacent, contemporaneous clearings provide locations where natural re-vegetation processes can be compared. Re-establishment of vegetation has proceeded more slowly in the farm fields compared to an adjacent area to the south that was cleared, but not farmed. Intensive herbivory, soil compaction, exotic grasses, and generally inadequate soil moisture seem to be retarding the rate of recovery. The fields are used for pasturing horses, and watering livestock, as well as for grazing cows, so uses are more intensive than on adjacent lands. The large size of the fields (which reduces the efficiency of seed dispersal and increases evapotranspiration losses) compared to other clearings is probably another factor.

We believe that the former fields have the potential for increased species diversity, increased cover, and increased structural diversity. The natural plant community would contain a higher proportion of herbaceous cover, and an overstory of mesquite. Mesquite growth should increase over time on the farm fields, as they have been grazed by livestock from the adjacent mesquite areas, although recruitment events may be constrained by exceptional rainfall or runoff events. Small mesquite are already in the fields but were heavily grazed. Terraces have mesquite thickets and remnant sacaton plants that show heavy past grazing (**Figures 5a and 5b**). There is potential for increase in sacaton and mid-sized native bunchgrasses such as cane beardgrass, sideoats grama and spike dropseed, as well as many other herbs.

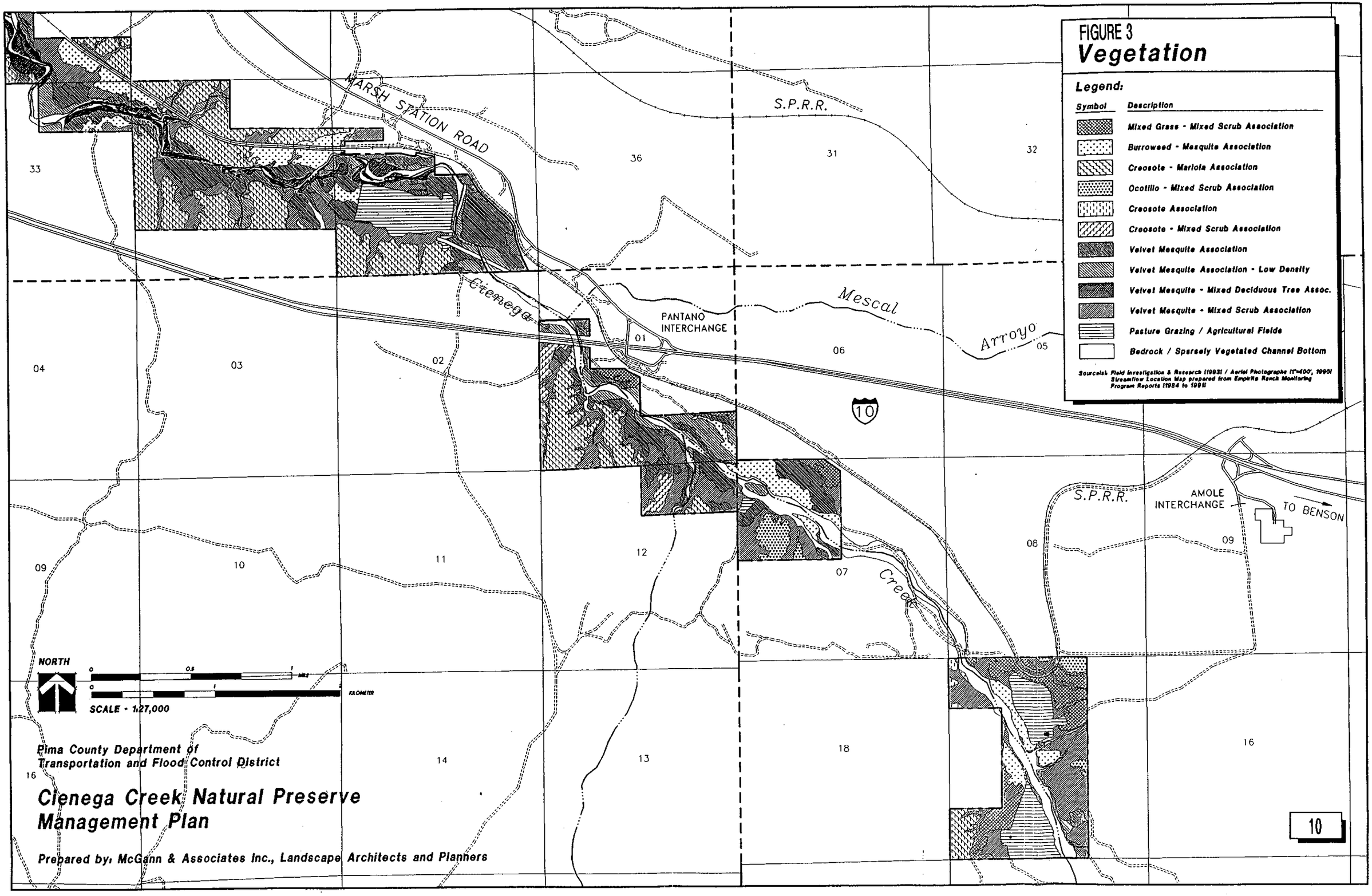
FIGURE 3
Vegetation
Legend:
Symbol
Description
Mixed Grass - Mixed Scrub Association
Burroweed - Mesquite Association
Creosote - Mariola Association
Ocotillo - Mixed Scrub Association
Creosote Association
Creosote - Mixed Scrub Association
Velvet Mesquite Association
Velvet Mesquite Association - Low Density
Velvet Mesquite - Mixed Deciduous Tree Assoc.
Velvet Mesquite - Mixed Scrub Association
Pasture Grazing / Agricultural Fields
Bedrock / Sparsely Vegetated Channel Bottom
Sources: Field Investigation & Research (1992) / Aerial Photographs (1"=400', 1990)
Streamflow Location Map prepared from Empirita Ranch Monitoring Program Reports (1984 to 1991)
MARSH STATION ROAD
S.P.R.R.
Cienega
Mescal
Arroyo
Creek
PANTANO INTERCHANGE
AMOLE INTERCHANGE
TO BENSON
10
33
36
31
32
04
03
02
01
06
05
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11
12
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14
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16
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NORTH
SCALE - 1:27,000
Pima County Department of
Transportation and Flood Control District
Cienega Creek Natural Preserve
Management Plan
Prepared by: McGann & Associates Inc., Landscape Architects and Planners
10

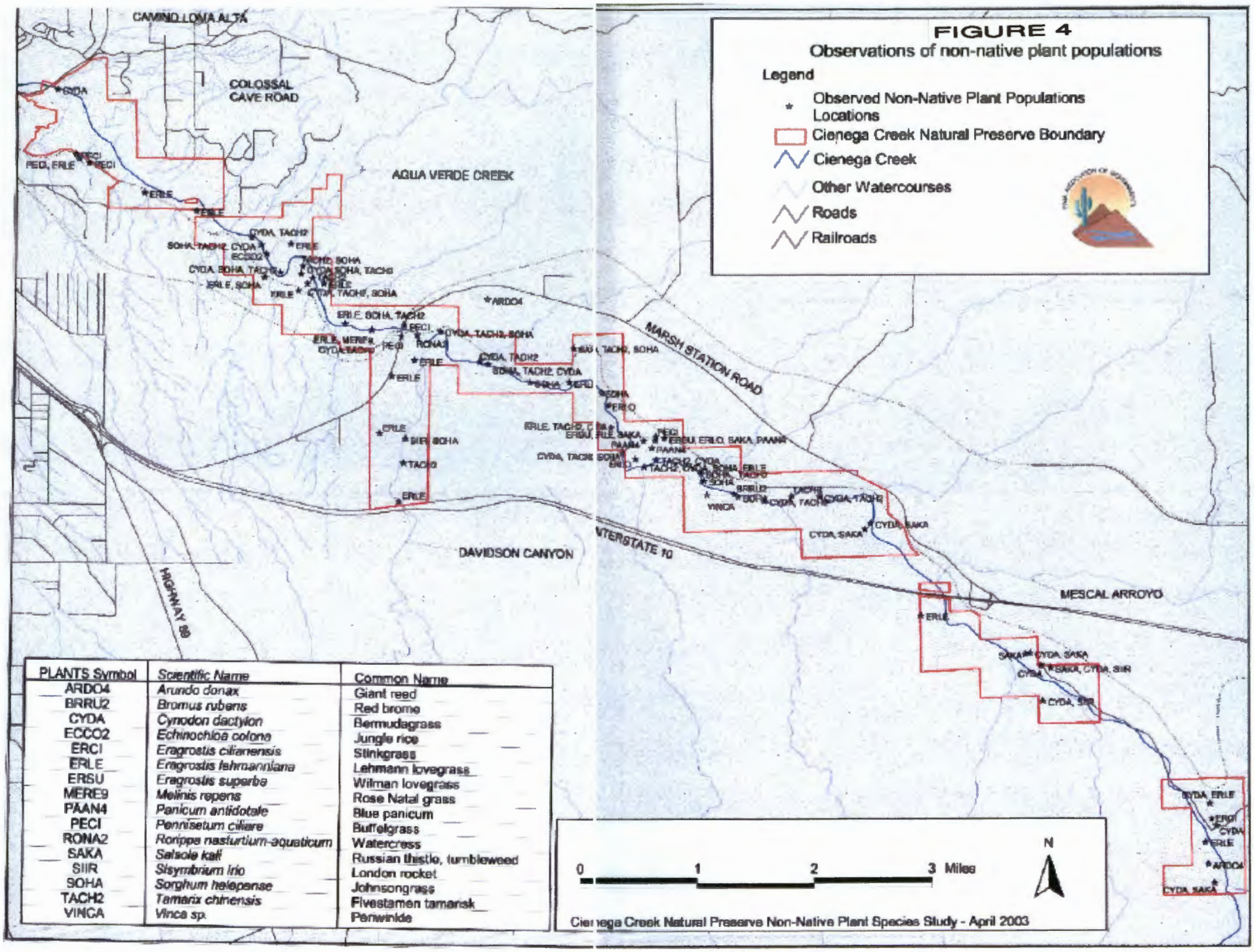


FIGURE 4

Observations of non-native plant populations

Legend

- Observed Non-Native Plant Populations Locations
- Cienega Creek Natural Preserve Boundary
- Cienega Creek
- Other Watercourses
- Roads
- Railroads

PLANTS Symbol	Scientific Name	Common Name
ARDO4	*Arundo donax*	Giant reed
BRRU2	*Bromus rubens*	Red brome
CYDA	*Cynodon dactylon*	Bermudagrass
ECCO2	*Echinochloa colona*	Jungle rice
ERCI	*Eragrostis cilianensis*	Stinkgrass
ERLE	*Eragrostis lehmanniana*	Lehmann lovegrass
ERSU	*Eragrostis superba*	Wilman lovegrass
MERE9	*Melinis repens*	Rose Natal grass
PAAN4	*Panicum antidotale*	Blue panicum
PECI	*Pennisetum ciliare*	Buffelgrass
RONA2	*Rorippa nasturtium-aquaticum*	Watercress
SAKA	*Salsola kali*	Russian thistle, tumbleweed
SIIR	*Sisymbrium irio*	London rocket
SOHA	*Sorghum halepense*	Johnsongrass
TACH2	*Tamarix chinensis*	Fivestamen tamarisk
VINCA	*Vinca sp.*	Periwinkle

Cienega Creek Natural Preserve Non-Native Plant Species Study - April 2003

Figure 5a. Mesquite recruitment and remnant sacaton plants on floodplain terrace, November 2002

Figure 5b. Mesquite thicket with no understory due to livestock grazing, November 2002

3.0 Overview of Project Activities

The District characterized baseline vegetation in areas to be fenced, and more particularly, the farm fields. Approximately 3.5 miles of new fencing was erected. A large clump of an invasive plant species located near the ranch headquarters was removed. Locations and strategies for restoring the flow paths of the tributaries and providing upland waters were identified. Erosion problems along access roads were evaluated. Livestock water was relocated. Vegetation, water and soil resources were monitored in order to evaluate the impact of the project.

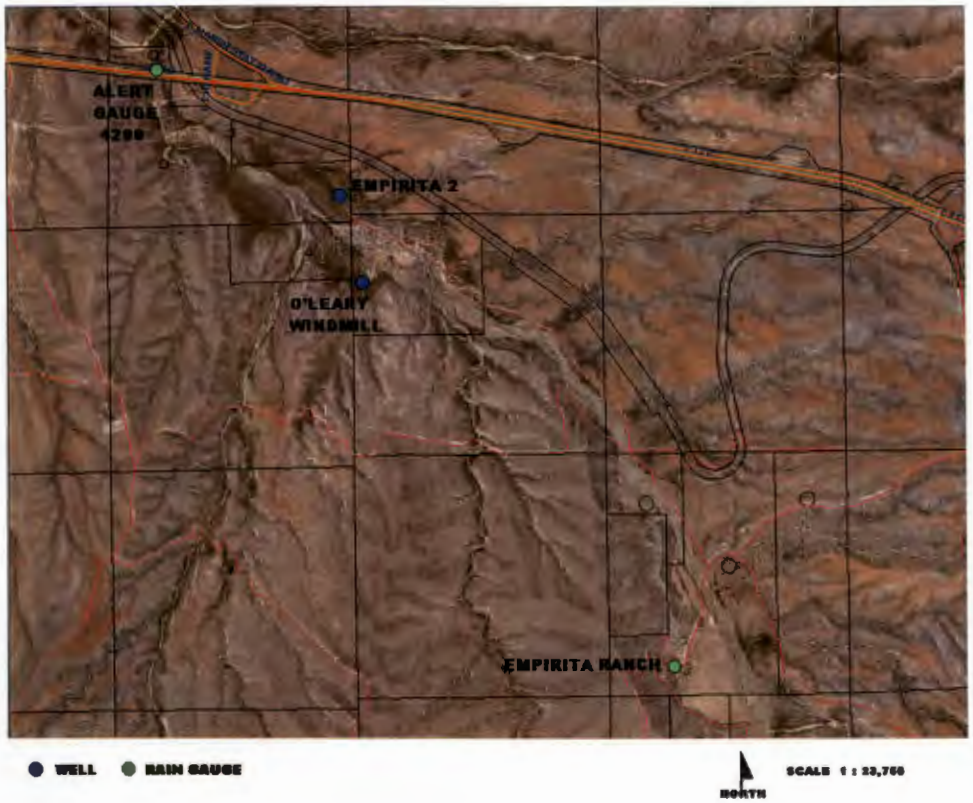
3.1 Site Tours with Interested Parties

During the term of this project, Pima County conducted site tours for BLM, the Nature Conservancy and the Sonoran Institute, primarily to discuss channel and watershed monitoring methodologies, and to explore the potential for joint monitoring efforts.

3.2 Water Resource Monitoring

Water resource monitoring has been an ongoing activity in the Cienega Creek Natural Preserve for over a decade. Continuous rainfall and stream flow data are provided by the District's ALERT gauge, #4280, located along Cienega Creek at the I-10 Bridge crossing. Rainfall data are also provided on a monthly basis by the on-site caretaker located at the ranch headquarters. Pima Association of Governments performs quarterly water level sampling of two wells, Empirita 2 and O'Leary Windmill, which are centrally located on the I-10 Tract. **Figure 6** displays the locations of all the water resource monitoring sites in the project area.

Figure 6. Water resource monitor sites



Precipitation

Monthly precipitation from ALERT Gauge #4280 over the last four years is depicted in **Figure 7**. Monthly precipitation at the Empirita Ranch Headquarters over the last three years is depicted in **Figure 8**. In general, drought conditions prevailed over the term of the grant (January 2004 through October 2007), with a notable lack of rain from November 2005 through February 2006. This was followed by exceptionally heavy rains in July 2006, which was ideal for hillslope erosion.

Figure 7. Monthly Rainfall for Cienega Creek at I-10 Bridge, January 2002 - December 2006

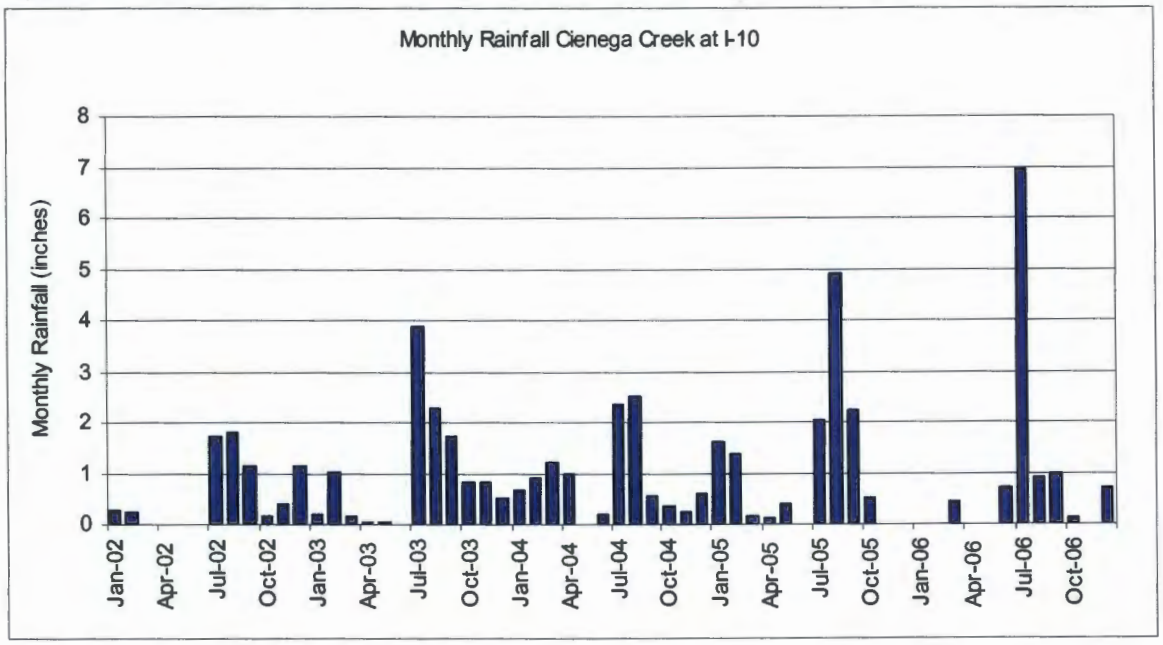
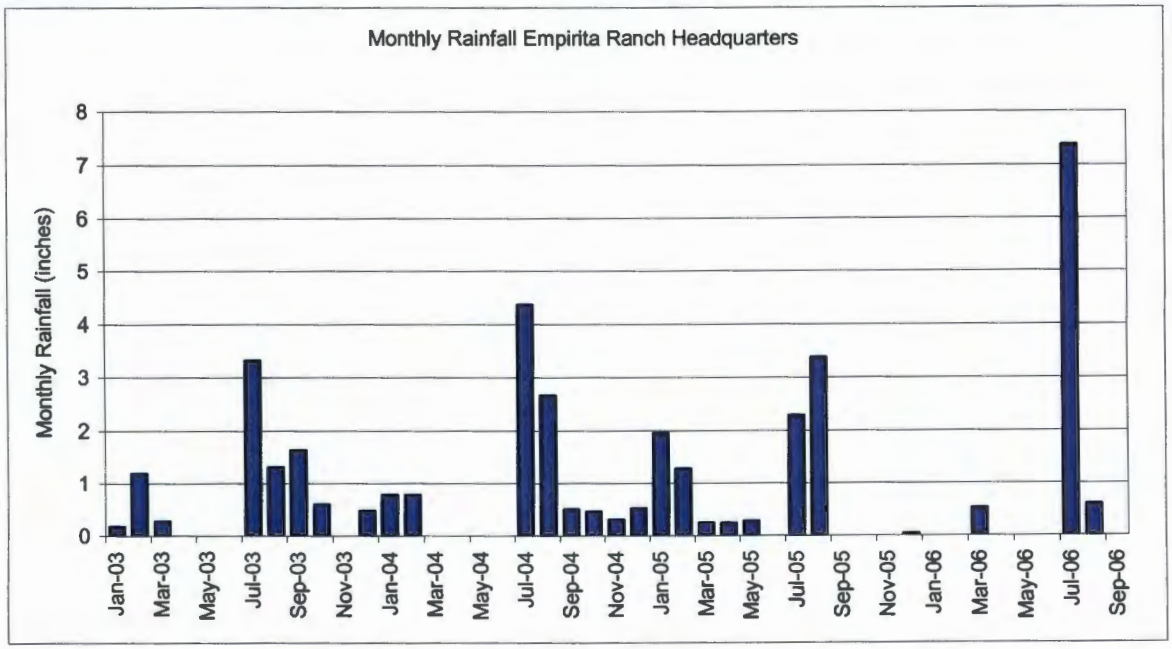
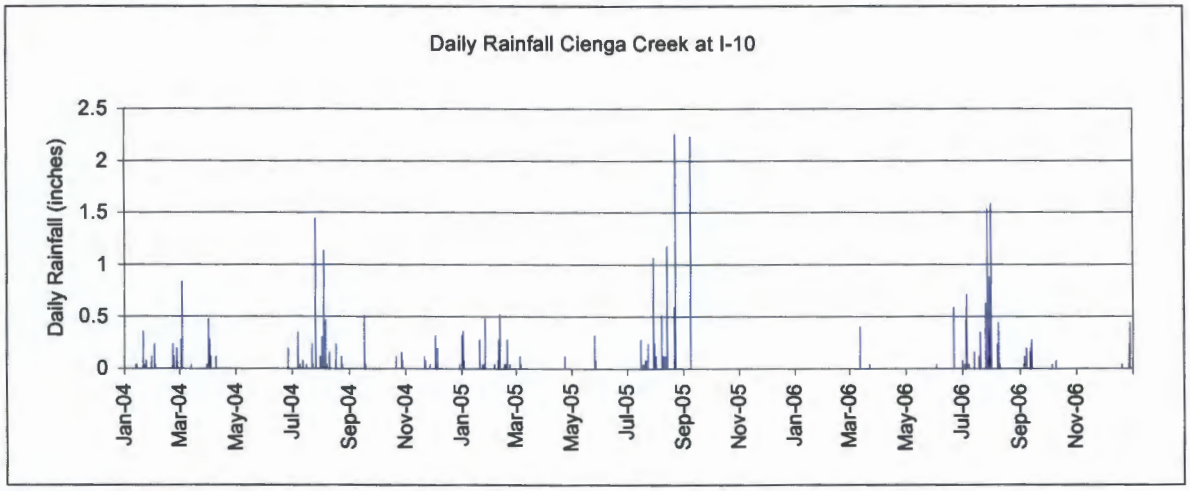


Figure 8. Monthly Rainfall at Empirita Ranch Headquarters, January 2003 - September 2006



During this project rainfall was slightly below the 14 inch/year average. Yearly rainfall was 10.63 inches in Calendar Year 2004, 13.36 inches in Calendar Year 2005, and 10.81 inches in Calendar Year 2006. However, a significant portion of rainfall over the last two years occurred in just a few, large runoff-producing events (**Figure 9**). Calendar 2005 experienced two events in excess of 2.24 inches of rainfall in 24 hours, which is the 5-year event according to NOAA Atlas 14. Calendar Year 2006 had over 5 inches of rainfall over a seven-day period in July, which is slightly greater than the 25-year event according to the NOAA Atlas 14 (Bonnin et. al., 2006).

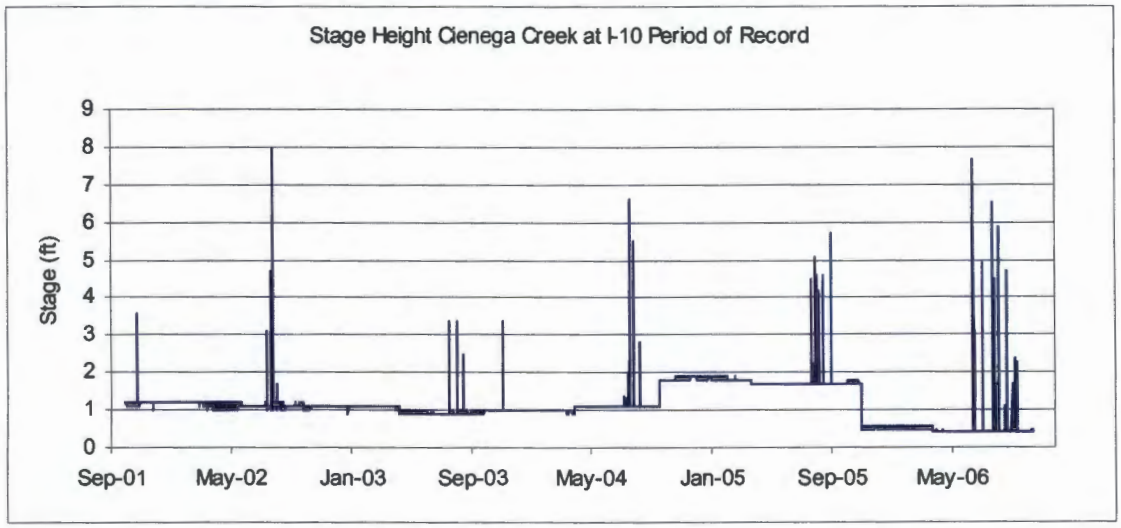
Figure 9. Daily Rainfall for Cienega Creek at I-10 Bridge, January 2004 – December 2006



Streamflow

Figure 10 displays stage heights for ALERT Gauge #4280 from September 2001 through December 2006. In general, surface flows at this gauge occur annually during the monsoon season (July-September) due to stormwater runoff. Flows recorded during the grant term were very sparse, except during the Summer of 2006.

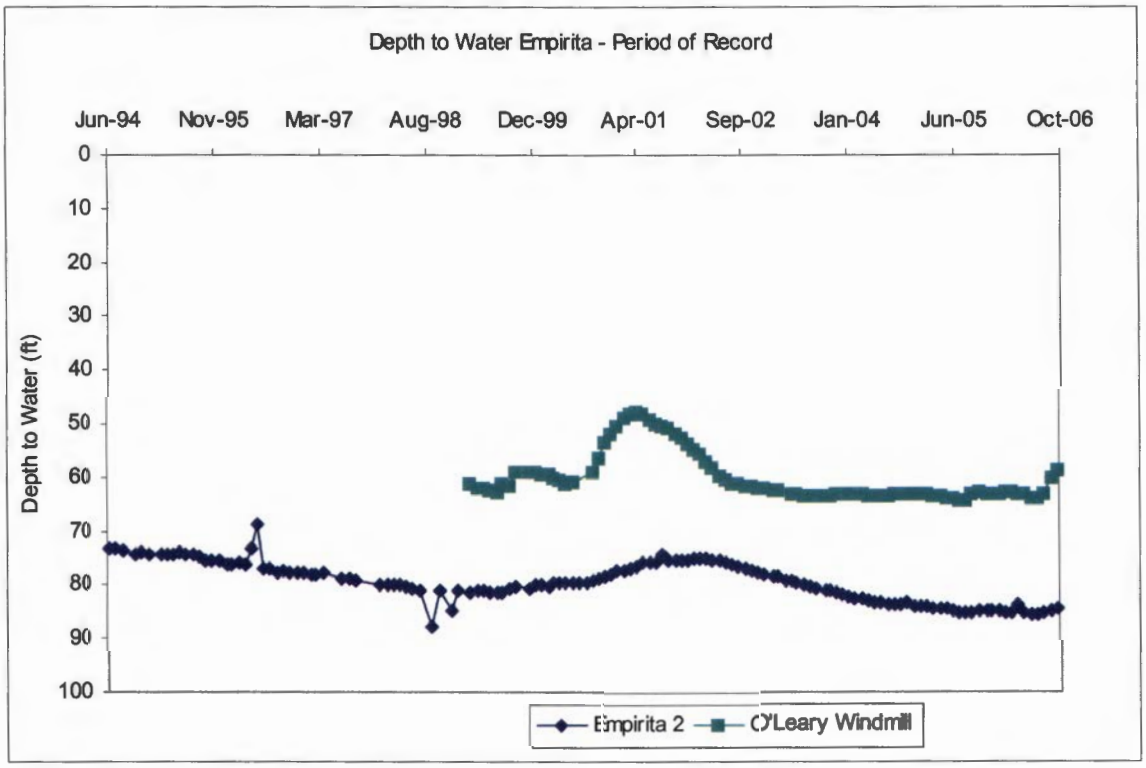
Figure 10. Stage heights recorded for Cienega Creek at I-10 bridge crossing, September 2001 - September 2006



Water Levels

Water levels have been recorded monthly near Empirita Ranch since July 1994 (**Figure 11**). In general, depth to water increased slightly during the period of this grant. However, water levels did rise a little in response to monsoonal storm runoff in 2006.

Figure 11. Water levels for Empirita wells, January 1994 – October 2006



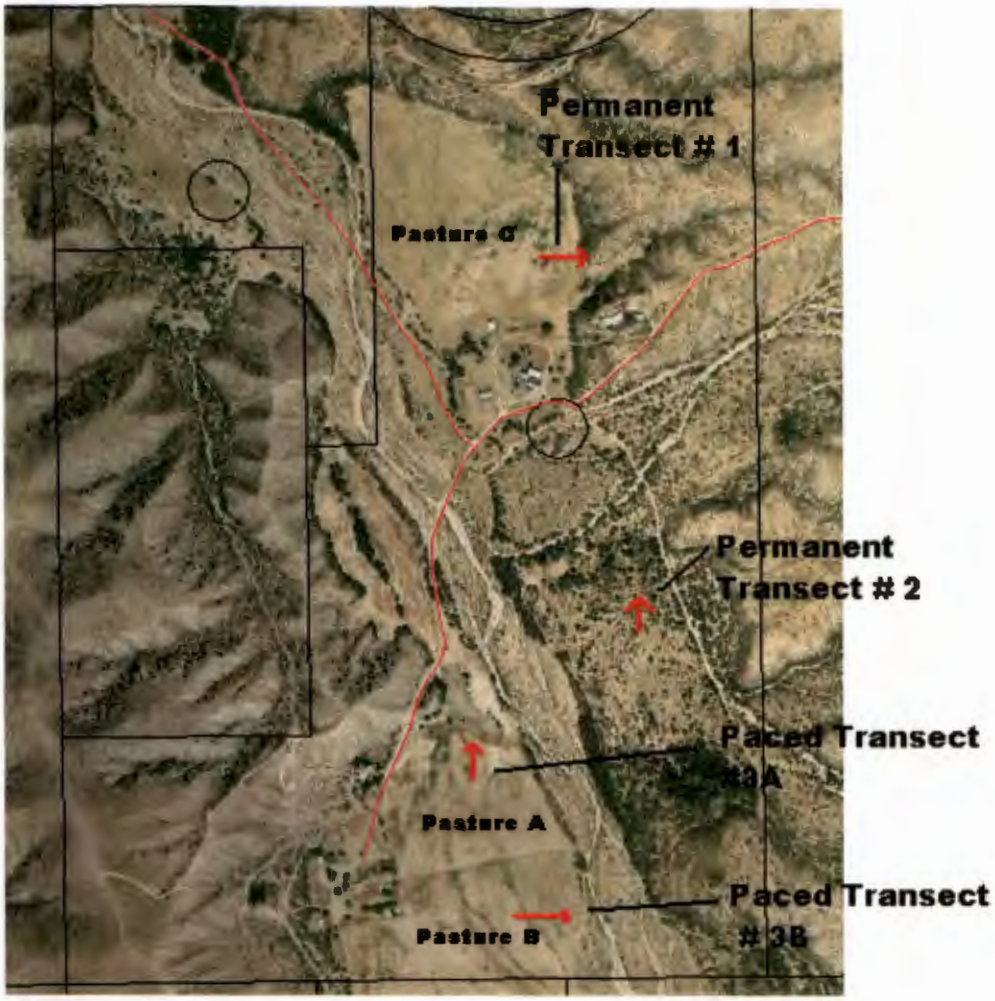
3.3 Boundary Survey

Pima County Survey identified and field marked the corners of the District's properties at the Empirita Headquarters and the I-10 Tracts. District staff used a hand held Global Position System (GPS) unit to identify and flag the property boundaries between the corners for fence construction.

3.4 Vegetation and Watershed Condition Baseline Surveys

An initial characterization of range condition was done in 2003 (**Appendix B**) along four transects located on the Cienega Creek floodplain near the Empirita Ranch headquarters. Three transects were located on the three historic pastures (Pastures A, B and C) and one was on the floodplain of Wakefield Canyon near the confluence with Anderson Canyon and Cienega Creek (**Figure 12**). District personnel used a method employed by the U. S. Forest Service that quantitatively measures soil cover and plant species diversity and qualitatively determines soil stability and erosion potential. Results of the baseline survey indicated that the range lands are in poor to fair condition, with a trend towards stable.

Figure 12. Range condition monitoring transects



3.5 Vegetation and Watershed Condition Monitoring

Watershed and riparian areas were monitored as part of the project. Watershed condition was monitored in August during the 2005 and 2006 Calendar Years. The riparian areas were monitored in October 2005 and compared with data gathered at cross-sections in 2002 by the Arizona Department of Environmental Quality (ADEQ).

For range conditions, District personnel used the same method as described in Section 3.4. Results indicated that the range lands at the project site are generally in poor condition, but are showing a trend of improvement over the last year. The annual reports, including photographs, are located in **Appendix C**

Conditions of the Cienega Creek channel and riparian vegetation were monitored along two transects shown in **Figure 13**. The monitoring methods used were based predominantly on the methods developed by Rosgen, but were refined by ADEQ to reflect conditions in Southern Arizona. Data collected at each transect included channel cross-section survey, bankfull identification, particle size classification, longitudinal profile, embededness and deposition, and an estimate of channel roughness. Using the data, District staff was able to classify the stream

reaches and perform a stream stability assessment (**Appendix D**). Vegetation data was also gathered along each cross-section to determine overall composition and health of the riparian community (**Appendix D**).

Cienega Creek is classified as a C channel along the project reach using the Rosgen Classification System (Rosgen, 1996), which indicates that the channel is slightly entrenched with a large width-to-depth ratio and a moderate sinuosity (channel meandering). This type of channel is typical in the lower valleys of Southeastern Arizona. The mean bed material is cobble at Cross-section 14 and gravel at Cross-section 16, making the overall channel classifications C3 and C4 respectively. The stream stability scores indicated that the channel is in fair condition at Cross-section 14 and in good condition at Cross-section 16.

The dominant grasses along the creek near Empirita Ranch (XS-14) were feather fingergrass (*Chloris virgata*) and threeawn (*Aristida sp.*). Bermuda grass (*Cynodon dactylon*), a non-native invader species, was the most common grass found at XS-16. Velvet mesquite (*Prosopis velutina*) and rabbitbrush (*Chrysothamnus nauseosus var. latisquameus*) were the dominant woody species at both locations. Most of the woody vegetation was small, with over 90 percent of the species observed being sprouts (height < 4.5 feet) and saplings (height > 4.5 feet and diameter of breast height up to 4.9 inches).

Figure 13. Location of Cross-section Monitoring Points

Scale 1:20,000

3.6 Soil Characterization

Soils within the northern pasture at Empirita Ranch (Pasture C) were characterized by Statistical Research, Inc. for the purpose of assessing opportunities for the District to restore natural vegetation in the abandoned agricultural field (**Appendix E**). The contractor identified soil horizons, recorded morphological properties (e.g., color, texture, size and density of rock fragments, density of roots, etc.), and took photographs within four backhoe trenches located by District staff in the field. Results indicated that the soils in this field consist of weakly developed and highly stratified sandy loam and silt loam textures. These types of soils are favorable for plant growth because of their ability to conserve moisture in the rooting zone (Homburg and Sterner, 2004).[1]

3.7 Archeological Mitigation

A cultural resources survey was conducted by Archeological Research Services, Inc. for the proposed fence line segments on the Empirita Ranch properties (**Appendix F**). One previously recorded prehistoric site was identified by field personnel on the southeast corner of the Empirita Headquarters Tract. The District had originally planned to have a new fence line run through this site along the property boundary, but modified the plan to connect up to the existing fence line in the area to completely avoid the site. There were no new archeological sites or cultural resources identified along the other fence line segments planned by the District (Curtis, 2004).

In conjunction with soils characterization activities described in Section 3.6, Statistical Research, Inc. documented an earthen berm located along the southeast corner of Pasture C at Empirita Ranch (**Appendix E**). The berm averages 45 feet in width, is 250 feet in length, and extends between two ridges to form an earthen dam across an ephemeral drainage. It is believed that the earthen berm was built sometime in the 1970s and was used to protect the field from damaging floods and to provide water for livestock (Homburg and Sterner, 2004).

In cooperation with the Arizona Game and Fish Department (AGFD) and Pima County Natural Resources, Parks and Recreation (PCNRPR), the District opened access onto the Empirita Headquarters Tract to the public in September 2005. This was designed to be a temporary program to provide hunters and other recreationists a means to access State lands in the Whetstone Mountains. A permit was required through PCNRPR and a registry was installed at the main entrance gate for the public to sign in and out. Apart from one incident where a hunter drove through the main ranch complex to go south, there have been no observed problems stemming from this program in regards to the protection of cultural resources.

3.8 Special Status Species Survey

Clearances were needed from the U. S. Fish and Wildlife Service for the disturbance of federally threatened and endangered species (T&E species) that could occur along the fence line proposed for construction on the Empirita Ranch properties. The County's Environmental Compliance Officer, Becky Pearson, provided USFWS with the District's fencing plan for this area and other portions of the County for review and determination of T&E species concerns. The only species of concern at Empirita Ranch was the cactus ferruginous pygmy-owl. Considerations for fence construction in the area included the use of wildlife friendly materials

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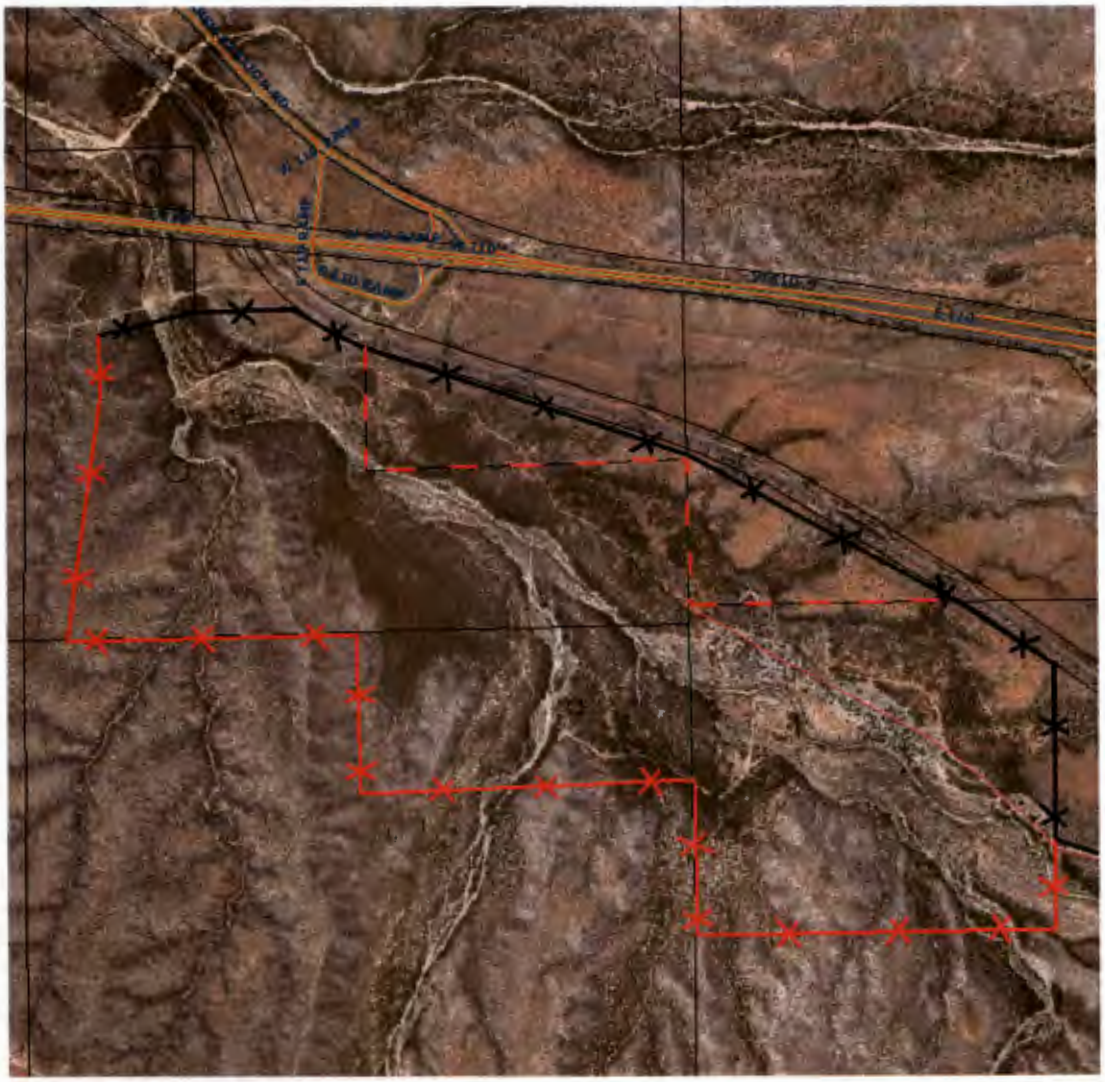
[1] A buried A horizon was noted by Homburg and Sterner in two of the trenches. This slightly darker horizon may represent a cienega deposit that was seasonally wet next to Cienega Creek (Homburg and Sterner, 2004).

(3-4 strands of barb wire sandwiched between smooth top and bottom strands), avoidance of permanent trail or road building, work performed outside of breeding season, and pruning vegetation instead of removal.

3.9 Fencing

Approximately 2.5 miles of fencing was installed at the I-10 Tract, which covered the southern half of the property boundary (**Figure 14**). An old fence line was kept in place along the northern half of the property boundary, which also encloses approximately 61 acres of vacant State Trust land. A gate was installed at the southeastern corner of the property where a dirt road crosses the fence line.

Figure 14. New and old fence lines on the I-10 Tract



Empirita Ranch, I-10 Tract Property

Old Fence Line

Newly Constructed Fence Line

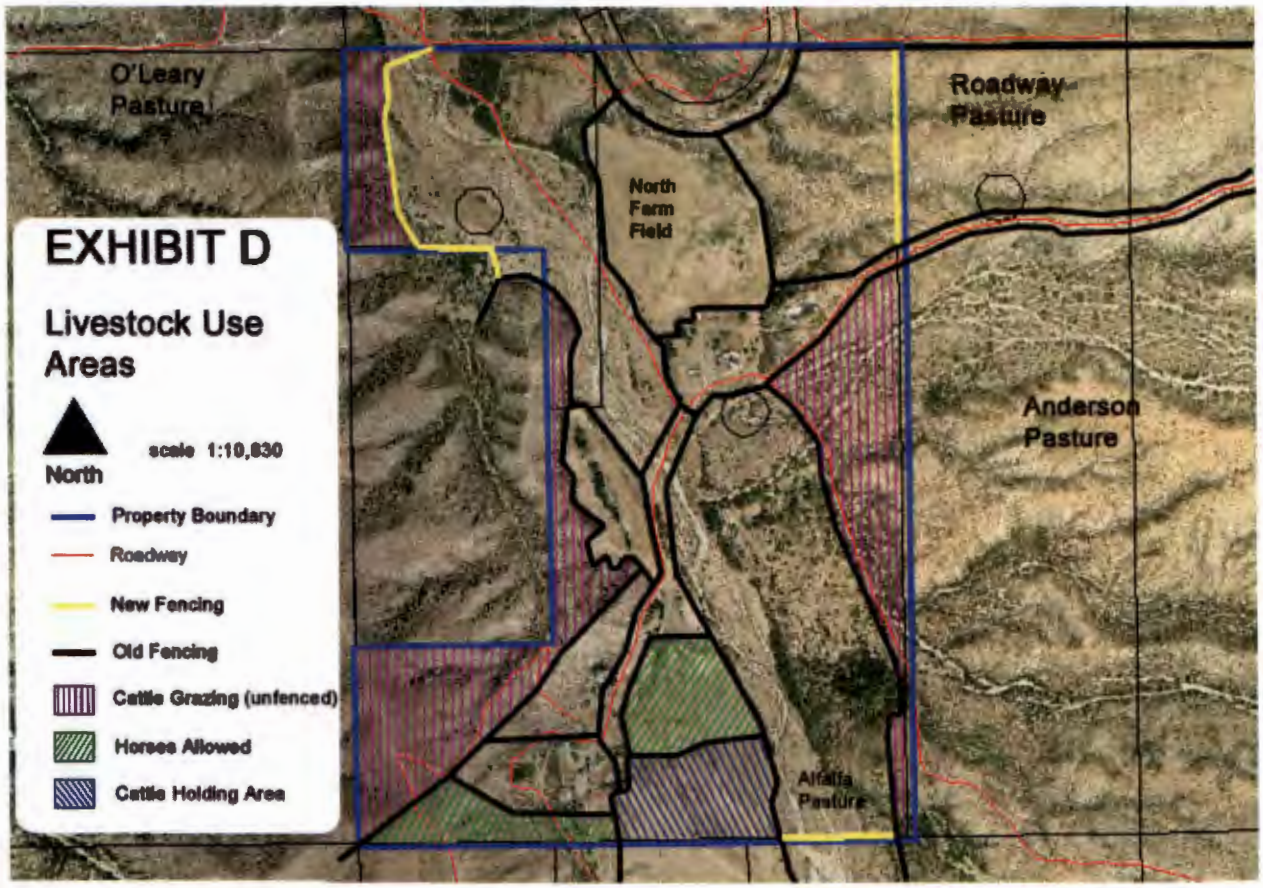
Property boundary not fenced

North

Scale 1:12,500

Approximately one mile of new fencing was erected at the Empirita Ranch Headquarters property as shown in **Figure 15**. All of the old pasture fence lines were kept intact to keep cattle and horses within the designated grazing areas and to maintain movement corridors from one pasture to the other. Fencing along the western portion of the property (both old and new) runs along the bottom of a steep ridge, which cattle do not enter. A portion of the property along the eastern boundary can still be grazed by cattle from the neighboring BLM leased land; a new fence line in this area would have been too costly to erect and to maintain just for the purposes of removing the small acreage from grazing. A gate was installed at the northwest corner of the property where a dirt road crosses the fence line. Another gate was installed at the eastern boundary just north of the main entrance road to allow the rancher to move cattle from the Roadway Pasture to the other pastures surrounding Empirita Ranch.

Figure 15. New and old fence lines on the Empirita Ranch Headquarters



3.10 Noxious/invasive Plant Control

A large clump of giant reed (*Arundo donax*) was located just north of Pasture A near the Empirita Ranch headquarters (**Figure 16**). This plant was removed and hauled away by Pima County Operations in August 2005. The plant has since resprouted in some areas, as shown in **Figure 17**, which the District will cut and treat with herbicide.

Figure 16. Location of Arundo donax near Empirita Headquarters

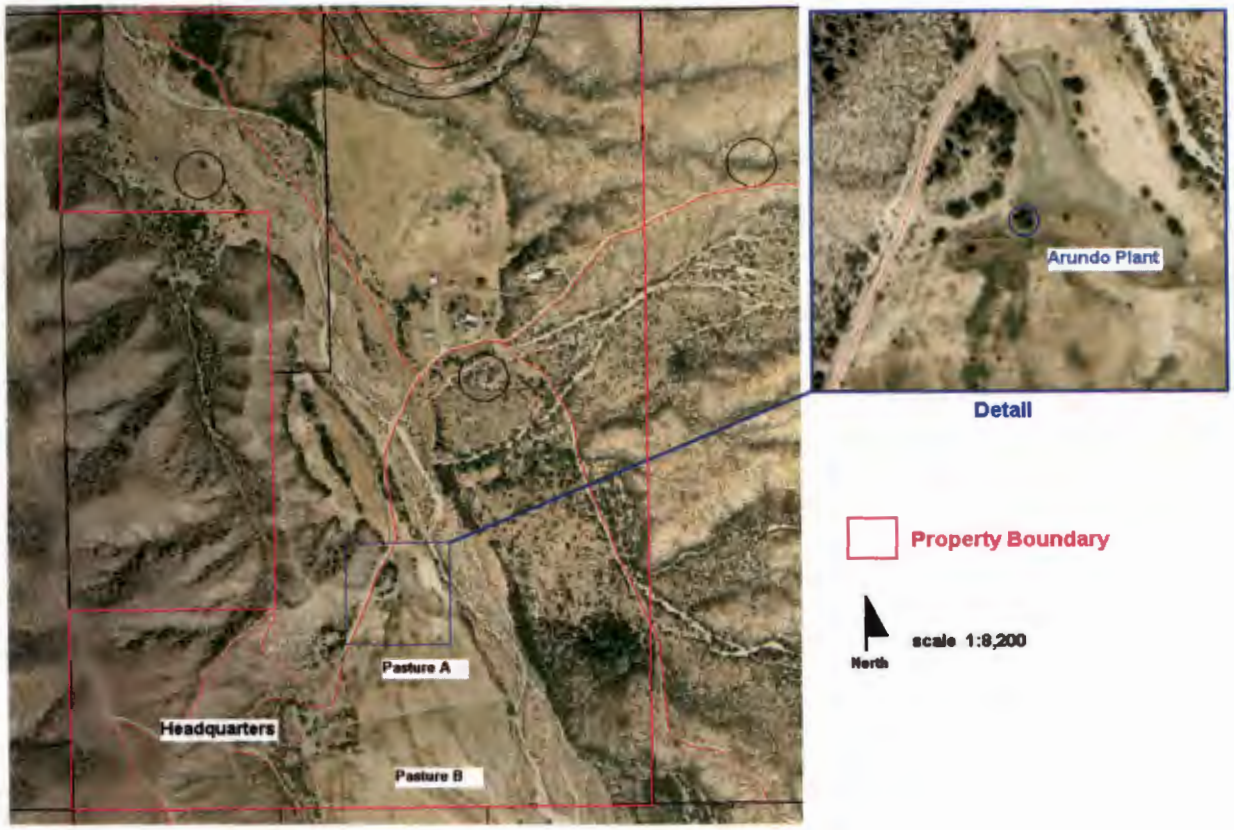


Figure 17. Arundo sprouts observed near Empirita Ranch headquarters

3.11 Roadway Evaluation

An evaluation was conducted to assess the effects of the existing roadway network on resource management in the project area (**Appendix G**). Aerial photographs were reviewed to identify roads on the properties and field studies were conducted to determine problem areas. In all, four roads were identified as administrative roads, meaning that they serve some useful purpose to the District, the caretaker or the public with regards to resource management, operation of the ranch, or recreation. District staff noted some drainage and erosion problems observed along portions of the administrative roads and identified a number of wildcat roads created by off-road vehicles and by the Pima County Natural Resources, Parks and Recreation crews during fence construction. Recommendations to help solve these problems were provided at the end of the report.

3.12 Livestock Water Development

A new water development was needed to help relieve stress from livestock along the bottomlands of Cienega Creek near Empirita Ranch headquarters. The best location for the new water source was determined to be at the O'Leary Windmill (see Figure 6), due to the existence of a well on site that taps into a relatively shallow groundwater table (approximately 65 feet below ground surface). The windmill no longer functioned, however the well was still in good condition.

The well was equipped with a solar pump, which was determined to be more efficient and cost effective than restoring the windmill. Water pumped from the well is piped into a 5,000 gallon storage tank (**Figure 18**), which has a flapper water level switch to shut the pump off when the tank is full. The tank is connected to a pipe that feeds into a livestock drinker, located approximately 250 feet west of the well site (**Figure 19**). The drinker is also equipped with a flapper water level switch to close the pipe when the drinker is full.

Figure 18. 5,000 gallon storage tank for livestock water

Figure 19. Livestock drinker, located west of O'Leary Windmill

In addition to its use for livestock, the drinker may also be used by native wildlife looking for water. District staff is looking into the installation of features on the tank that would keep wildlife from drowning.

4.0 References

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APPENDIX A

Empirita Ranch/Cienega Creek Visit (11/19/02)

David Scalero, Don Ward

Background information on the Empirita Ranch:
The Empirita Ranch includes 24,988 total acres of which 23,908 acres are grazed. The breakdown is 440 acres of Bureau of Land Management (BLM) lands and 23,468 acres of Arizona State Land Department (ASLD) lands. In addition, there are 1080 other acres of BLM lands, 880 acres of Pima County lands, and 320 acres of private lands not owned by the ranch. These lands are not physically fenced to exclude the Empirita Ranch cattle (See attached Empirita Ranch Map # 1). Arizona State Livestock Laws require that livestock be fenced out by the property owner not wanting livestock on their property, ARS 3- 1427.

There is a Livestock Grazing Management Plan developed in 1994. Parties to the grazing plan were the BLM, Natural Resources Conservation Service (NRCS), ASLD, and the Parsons Company. Pima County was not included, but requested a copy of the plan and any monitoring data from the NRCS because the Pima County properties are not fenced separately. NRCS would not provide the request because of non- government Privacy Act issues. ASLD is not restricted by the Act and provided a copy of the documents and data they have.

The grazing plan prescribed how livestock would be grazed to sustain resources, established vegetation monitoring sites, and listed needed range improvements. The grazing strategy was a deferred rotation grazing system with the allowable vegetation utilization of 40-60% use level on annual growth of selected key perennial grasses.

1994 Ecological Site Inventory data collected by the BLM and NRCS were used as background data in developing the plan, but the plan does not include a biological planning process. The various government agencies involved in administering the grazing plan have not collected adequate vegetation data needed for biological planning. Also, watershed health guidelines were not included in the plan. Evaluating watershed condition and function requires ground cover data, which is lacking. Note: Dr. Holechek, New Mexico State University, suggested that the 40-60% use levels are likely to reduce plant vigor and density, resulting in reductions in watershed condition.

The Pima County lands are under a Caretaker Agreement with the Parson Company. The agreement covered the period from January 3, 1993 to January 2, 1998 and was extended 5 years, expiring January 2, 2003. The agreement permitted the Caretaker to graze cattle and horses on the Property, subject to certain limitations set forth in the Caretaker Agreement. The limitations specified that the Caretaker would not include the Pima County Property acreage in the surrounding grazing allotment acres, and would use the Property for cattle transfer purposes only and not for grazing. This limitation is not feasible until the Property is fenced.

Field Visit, 11/19/02

The purpose for the visit was to inspect the Pima County owned portion of the Empirita Ranch operations to make recommendations for re-issuing the Caretaker Agreement with Parsons Co., Inc. that expired January 2, 2003.

Items looked at were structural improvements (fences, buildings, wells) and livestock grazing use.

A map was prepared that outlined the Pima County owned properties within the Empirita Ranch operation. The map also shows soils based on vegetation that helps in locating where reference points are when in the field (See attached Map # 2).

The area first visited was along Cienega Creek, south of I-10. A vegetation transect (attached) was run that shows the vegetative potential of the bench area adjacent to Cienega Creek. Photo 1 shows the general view of the transect area. The major grass species was Alkali sacaton with a sparse over-story of mesquite. The transect indicated a bare ground index of 32%, basal plant hits of 30% and litter ground cover of 38%. This would indicate a stable watershed condition. Plant composition was 95% Alkali sacaton, 1% bush muhly, 1% vine mesquite and 2% mesquite over-story. There was very little cattle use for the first ¼ to ½ mile. Light use and abundant forage is explained because there is no water in the area to draw cattle. Cattle use picked up further south and east as indicated in photos 2, 3, and 4. Photo 6 shows a fence line contrast where the right side of the fence shows heavy grazing use in the 60% range, while the left side of the fence had not been grazed. The area is within a few hundred feet of Cienega Creek and is Pima County property.

Further south and closer to the Ranch headquarters, grazing use picked up significantly. Photo 7 shows extreme use in a mesquite thicket and photo 8 shows heavy cattle trailing from the farm field and Barn and corral area. The photo area is a middle terrace between the farm field and Cienega Creek. Photo 9 shows the farm field next to the barn and corral. Photo 10 is Cienega Creek between the two sets of ranch buildings. The major plant species in the photo is burro bush and it has been heavily browsed. Hoof action was 100% of the soil surface.

Photo 11 was taken south of the Empire Ranch Road, just east of the first set of ranch buildings after entering the Ranch from the east. It shows sparse vegetation, but the area had not been grazed. The main plant species were Rothrock grama, Black grama, and fairy duster.

Photo 12 and 13 are general views of Cienega Creek about ½ mile south of I-10. Both areas had cattle use.

Field inspection verified that the property boundaries do not match fences. This prevents the control of grazing on the Pima County property.

Most of the fences and facilities were found to be in poor condition and not being maintained. Also, the fence across Cienega Creek adjacent to the south side of I-10 was washed out since at least the last stream flow.

Lack of permanent water is also affecting cattle distribution and may be a major cause of the heavy grazing use near the ranch headquarters where water is located. The heavy livestock use, soil impacts, and lack of ground cover are affecting the watershed condition in and adjacent to Cienega Creek. Observed watershed condition from the Ranch Headquarters north to I-10 in and adjacent to Cienega Creek is less than satisfactory and is contributing sediment to the system.

Recommendations:

The ideal situation would be to exclude cattle use from the Pima County property and especially from Cienega Creek, but since the Pima County property is not fenced and Parsons will continue to graze the area under their BLM and ASLD allotments, the next idea is to continue the Caretaker Agreement and prepare a grazing management plan for the next 5 year Caretaker Agreement period outlining required management along with monitoring. Recommended management is attached. It includes the summary for the current management system and a proposed management outline for the Pima County owned property. It also includes a map, Map # 3, showing existing and proposed fences for fencing the Pima County Property within the Ranch. The proposed fencing, if constructed, would control or eliminate livestock from the property.

Empirita Ranch Map 1

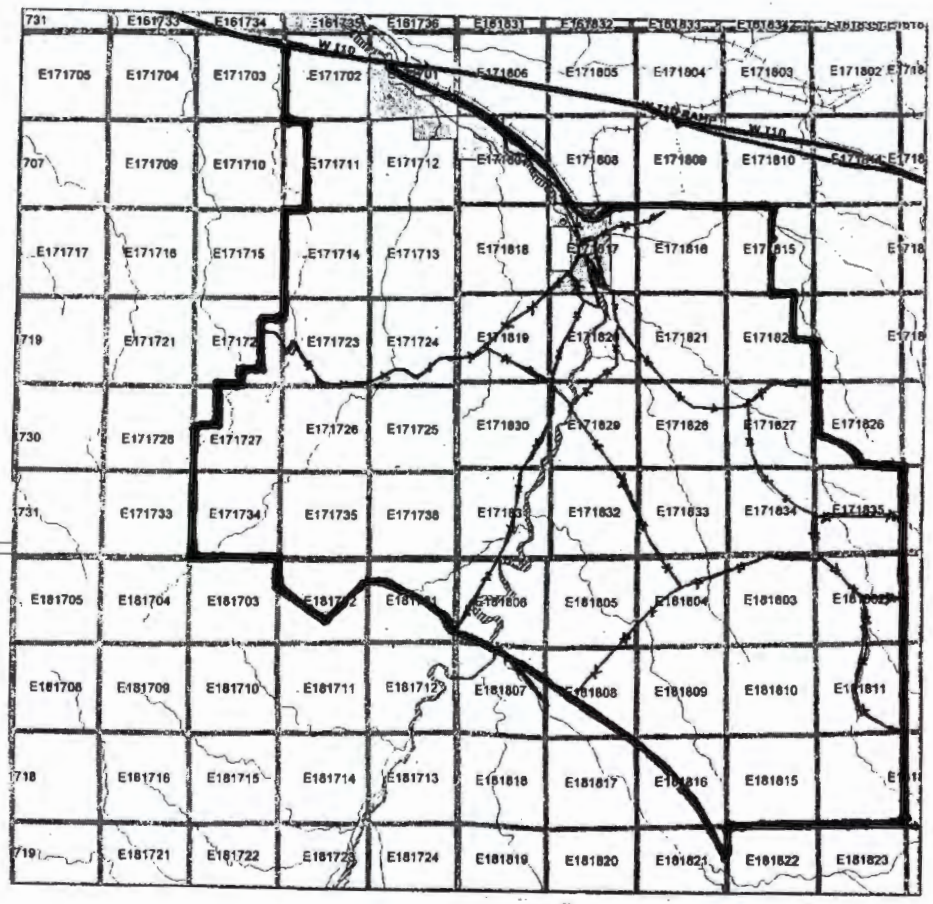
Legend January 2003

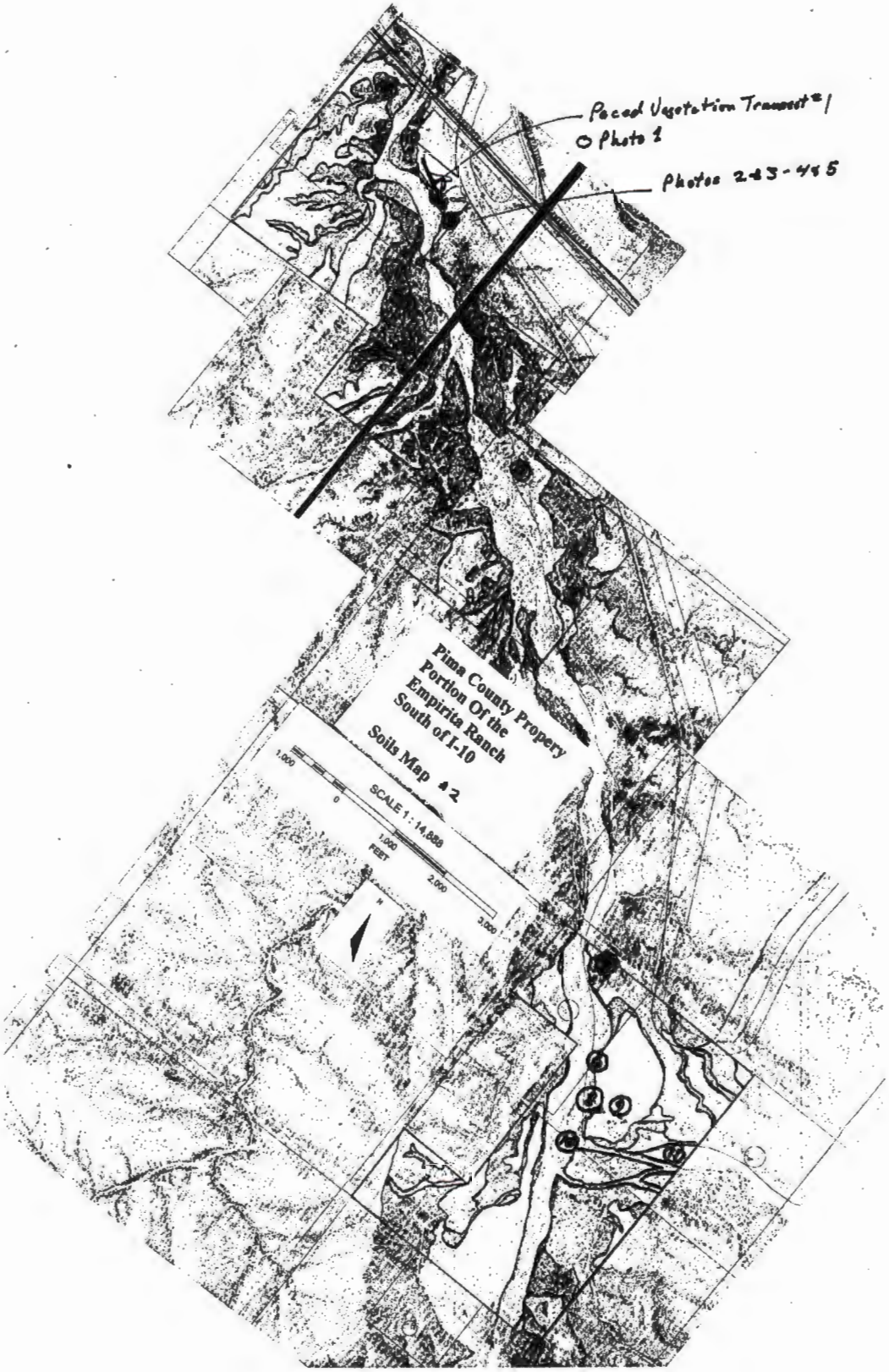
- Ranch Boundary
- Interior Pasture Fences
- Pima County Owned parcels

SCALE 1 : 98,266

1 0 1 2

MILES




Paced Vegetation Transect #1
Photo 1
Photos 2&3-4&5
Pima County Propery
Portion Of the
Empirita Ranch
South of I-10
Soils Map #2
SCALE 1: 14,888
1,000
0
1,000
FEET
2,000
3,000
N

Current status of the Empirita Ranch

Current Management Grazing Agreement # 117321-093, Expires January 2003

3-4 pasture rotation of the cowherd.

Pastures used are O'Leary, Wildcat, Smitty and Narrows.

Jo Ann pasture is not used because there is no water.

Crystal and Homestead pastures are used by the J-6 Ranch

Anderson Bull pasture is used for replacements part of the year.

The pasture north of I-10 is not used because there is no water.

Various traps are used for roundups.

Proposal for future management of the Pima County portion of the Ranch.

For proper planning and management, a range resource analysis is needed. This requires:

1. Map of pastures and acreage calculations and carrying capacity (AUM's).
2. Map of the ranch range improvements (fences, wells, corrals etc.
   - Inventory of condition and the age of the improvements.
3. Distribution of grazing use map, showing where grazing use is occurring and the level of use in each area.
4. Map showing existing vegetation with ecological status and trend analysis.
5. Map of soil condition showing trend.
6. Wildlife conflicts and TE&S coordination. This should include biological assessments and evaluations for TE&S species and also species of concern to look at grazing effects.
7. Other uses conflicts
8. Cultural and historic features coordination

Based on the above analysis, develop a short term Grazing Management Plan for the Pima County owned portion. This should tier to the overall ranch plan and should include:

1. A grazing system that will meet ecological goals (desired landscape description) while allowing for grazing use until property boundary fences are constructed;
   - Reviews the terms of the Caretaker Agreement, regulations and policies.
   - Include the grazing schedule of the Empirita Allotment.

- Indicate needed boundary fences and a schedule for development and maintenance.
- Require a maintenance schedule for existing structural range improvements, and a determination if they are needed or should be removed.
- Include a stated salting policy, where salt and supplemental feed will be placed.
- Require an Annual Operating Plan that reviews the grazing management plan and makes recommendations where needed.
- Schedules range improvement work and maintenance needs.
- States the Pima County Riparian Policy
- States Pima County policies and regulations as a part of the plan. This includes stating the penalties for non-compliance.

2. Monitoring requirements.
    - Monitoring plan compliance
    - Frequent forage use documentation during grazing in each pasture.
    - Monitoring general watershed condition and function.

3. Adaptive Management.
    - Assessing problems, evaluating and adjusting the grazing management plan.

Railroads

Streets

Streets - Major - With Names

Washes

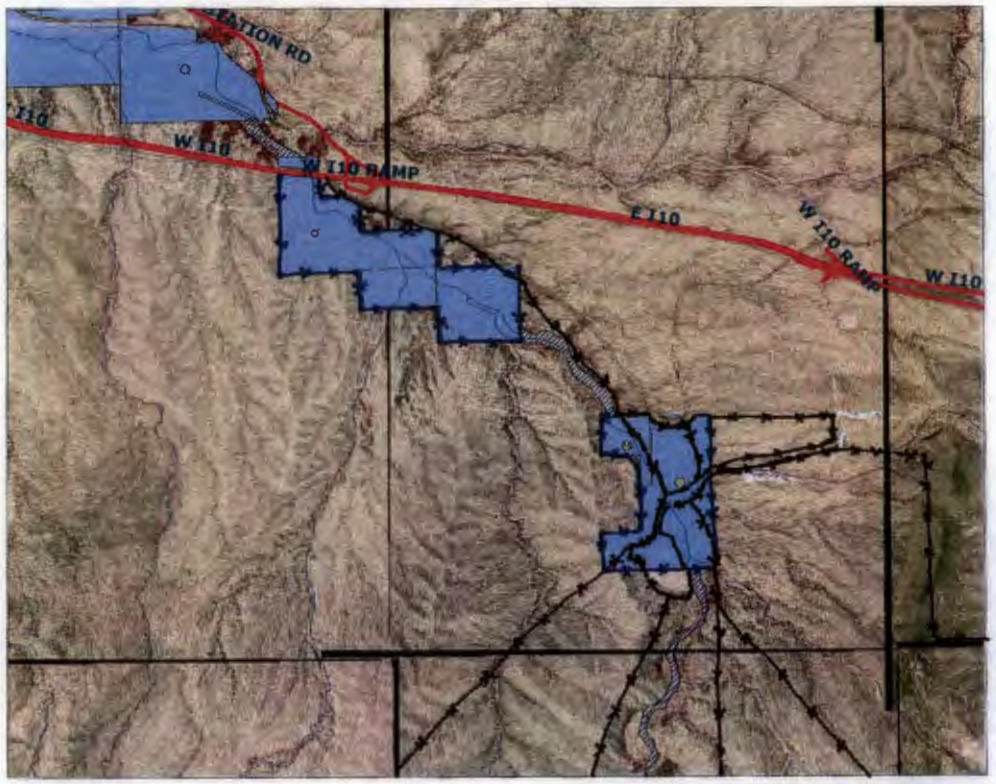
Parcels

Parcels - Pima County Owned

Pima County Owned Parcels

Washes - Major

Major Washes - Polygons



Empirita Ranch
Legend January 2003

3

Existing Pasture Fences
Proposed Fences

SCALE 1 : 55,157

1 0 1 2 3
MILES

N

LOOP MEASUREMENTS

Paced Transect ¼ mile Long

~~Climatic Div.~~ Range Allotment Empirita Ranch

Line Transect No. 1 Date Nov 19, 2002 By Don Ward

Location

LOOP MEASUREMENTS

1	2	3	4	5	6	7	8	9	10
B	L	B	B	Spai	L	Spai	Spai	Spai	Spai
11	12	13	14	15	16	17	18	19	20
L	B	B	B	B	L	Spai	L	Spai	Mupol
21	22	23	24	25	26	27	28	29	30
L	Spai	Paob	Spai	B	Spai	B	Spai	L	L
31	32	33	34	35	36	37	38	39	40
B	B	Spai	Spai	L	L	B	L	B	B
41	42	43	44	45	46	47	48	49	50
L	Spai	L	L	B	B	B	L	B	Spai
51	52	53	54	55	56	57	58	59	60
L	L	Spai	Spai	L	L	B	Spai	B	L
	Prjuv			Prjuv					
61	62	63	64	65	66	67	68	69	70
Spai	L	L	B	B	L	L	L	Spai	B
71	72	73	74	75	76	77	78	79	80
B	B	Spai	B	B	L	B	L	L	Spai
81	82	83	84	85	86	87	88	89	90
Spai	L	Spai	L	L	L	L	L	Spai	B
91	92	93	94	95	96	97	98	99	100
L	B	L	B	Spai	L	L	B	B	L

DOT TALLY & COMPOSITION

SPECIES	HITS	DOTS	TOTAL
Spai			95
Mupol			1
Paob			2
Prjuv			2
TOTAL	30	70	100

SUMMARY OF HITS – Symbol

Hits, All Plants		30
Rock	R	0
Litter	L	38
Bare Soil	B	32
Total		100

Hits, All Forage Plants (Decreasers & Increasers) 28

Erosion Hazard Index (Bare Soil) 32

No. DECREASERS = 2

No. INCREASERS = 26

No. INVADERS = 2

No. COOL SEASON = 0

Vigor Measurements

Plant	Species: Spai Leaf Height	Species: Leaf Height
1	14	
2	12	
3	12	
4	12.5	
5	10	
6	13	
7	12	
8	12	
9	11.5	
10	13	
Ave	12.2	

Picture 1.

Picture 2.

Picture 3.

Picture 4.

Picture 5.

Picture 6.

Picture 7.

Picture 8.

Picture 9

Picture 10.

Picture 11.

Picture 12.

Picture 13.

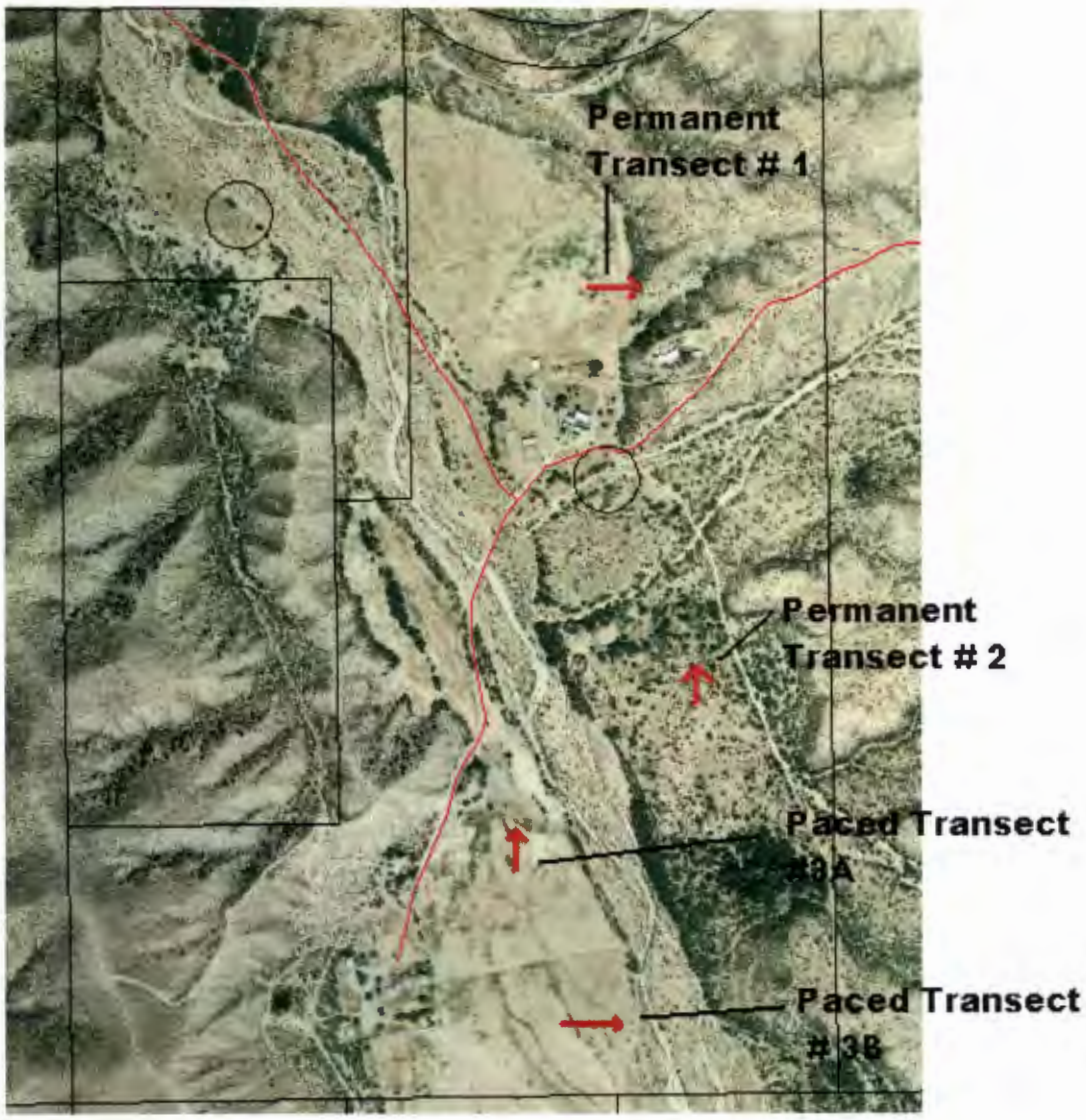
APPENDIX B

Empirita Ranch Watershed Condition Transects **Survey Date August 3, 2004**

The watershed/soil evaluation monitoring method used is a modified method of a long time standard method used by the Forest Service for evaluating rangeland and watershed ecological trend and condition. For the purpose of monitoring the Empirita Ranch, the transects rate the percentage of exposed soil to erosion and soil disturbance factors. These result in soil stability rating scores with a numerical rating and apparent condition. Trend was assumed to be stable for this baseline assessment. Photographs and changes in transect and plot data will be used to re-evaluate trend when the next monitoring survey is performed. The method is attached as a guide for conducting the evaluation.

Summary of the transects

Transect #	Score	Condition Class	Current Trend
1	31	Poor	→ Stable
2	28	Poor	→ Stable
3A	50	Fair	→ Stable
3B	47	Fair	→ Stable



Transect locations

Permanent Transect # 1 Lat. 31 degrees, 57' 31.81" Lon. 110 degrees 31' 38.84"
Transect direction is 90 degrees east with out magnetic declination

Permanent Transect # 2 Lat. 31 degrees 57' 11.12" Lon. 110 degrees 31' 33.65"
Direction is 360 degrees north with out magnetic declination

Paced Transect # 3A Lat. 31 degrees 57' 3.31" Lon. 110 degrees 31' 44.02"
Direction is 360 degrees north with out magnetic declination

Paced Transect # 3B Lat. 31 degrees 56' 56.73" Lon. 110 degrees 31' 42.18"
Direction is 90 degrees east with out magnetic declination

Summary of the transects

Permanent Transect # 1. The ecological site is an old irrigated agricultural field that was planted to Bermuda grass pasture. Soil is a sandy loam. It was abandoned in the 1960's and has been used as a holding pasture for roundups since. The Bermuda grass has generally died out but there are patches in low spots around the field. Bermuda is being replaced by annuals and scattered mesquite trees. The dominant perennial grass is still Bermuda grass. It makes up 90+ percent of the perennial grasses. Lehmann lovegrass is also present. Mesquite canopy made up 19% of the overstory on the transect line but is not representative of the field in general. The soil stability rating was 31 indicating a mid poor condition classification with a stable trend.

Photo of Transect # 1, general view

The transect runs 90 degrees east. Two angle iron pins mark the transect line. They are set 99.5 feet apart with the zero pin on the west end.

Transect 1, 3 foot X 3 foot plot taken at the 3.5 foot tape location

Permanent Transect # 2 The ecological site is a desert scrub grassland. It is located in the Wakefield wash drainage fan and is a "valley plain". Soils are sandy and have a low water holding capacity. Vegetation potential for perennial grasses is limited to the water holding capacity. Catclaw and mesquite are common. The area has historically been used as a holding pasture during roundups.

Transect 2, general view

The transect runs 360 degrees north. Two angle iron pins mark the transect and are set 99.5 feet apart. The zero pin is the south pin.

Transect 2. 3 foot X 3 foot close up

The location is at the 3.5 foot mark on the tape.

Transect 3A. General view north 360 degrees

Transect 3A. General view south 180 degrees

Transect 3B. General view, east 90 degrees

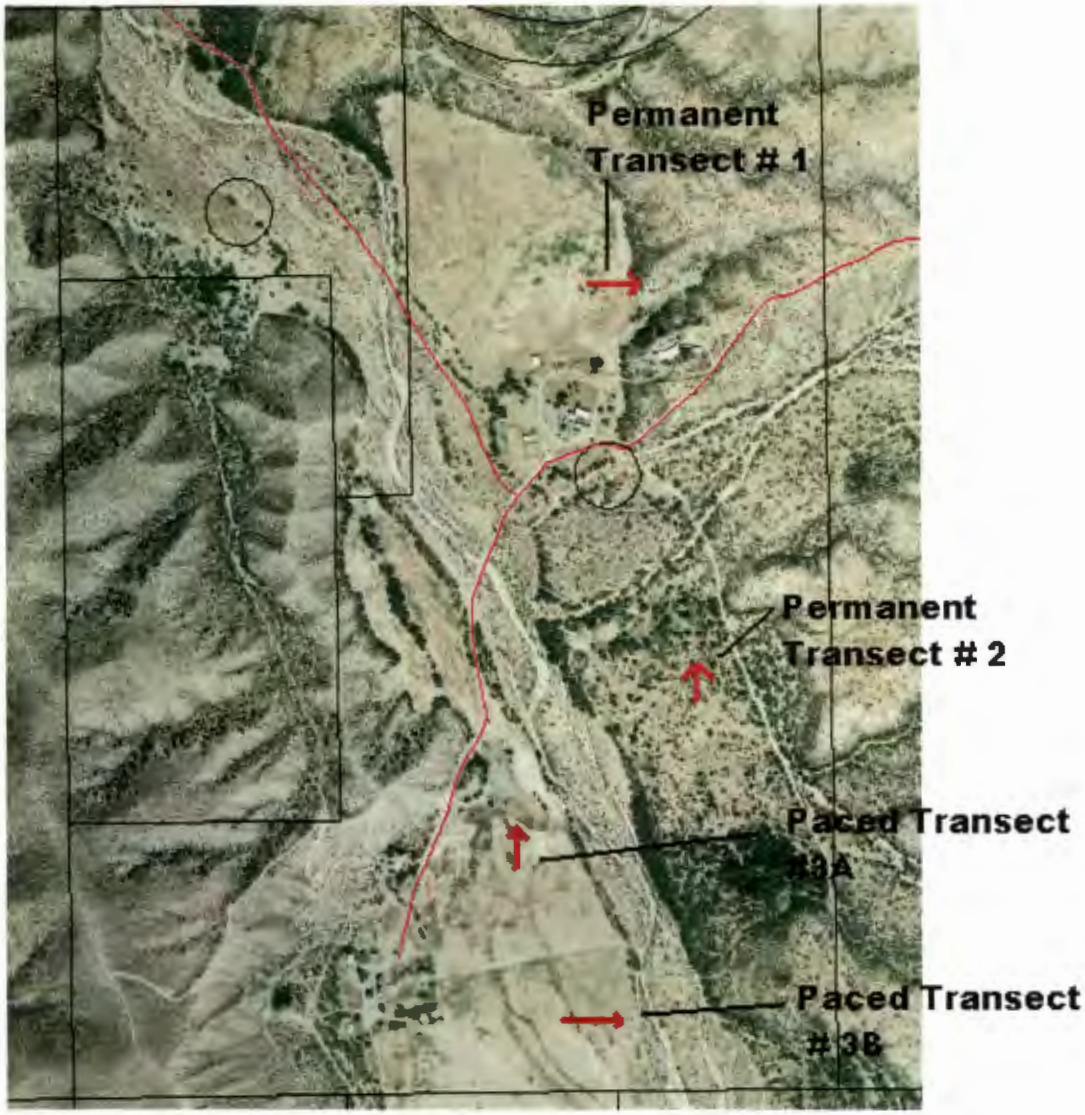
APPENDIX C

RANGE CONDITION REPORT
AUGUST 2005

Date: August 4 2005
To: Julia Fonseca, David Scalero
CC: Frank Postillion, Neva Connoly
From: Evan Canfield
Subject: Summary of 2005 Empirita Monitoring Exercise

Background:

This is a follow-up to the first round of monitoring performed on August 3, 2004. We used a method that Don Ward had used while at the Forest Service to assess range condition on four transects. While I was new to this method, David, Neva and Frank had done it last year. The cover counts were fairly straightforward, and we tended to agree on the qualitative range condition scoring. However, I was unclear about the purpose of the dot counts. We were comfortable with most aspects of the technique, though we were unsure about the identity of some of the species, and the protocol for selecting plants further from the transect.



Transect locations

Permanent Transect # 1 Lat. 31 degrees, 57' 31.81" Lon. 110 degrees 31' 38.84"
Transect direction is 90 degrees east with out magnetic declination

Permanent Transect # 2 Lat. 31 degrees 57' 11.12" Lon. 110 degrees 31' 33.65"
Direction is 360 degrees north with out magnetic declination

Paced Transect # 3A Lat. 31 degrees 57' 3.31" Lon. 110 degrees 31' 44.02"
Direction is 360 degrees north with out magnetic declination

Paced Transect # 3B Lat. 31 degrees 56' 56.73" Lon. 110 degrees 31' 42.18"
Direction is 90 degrees east with out magnetic declination

Permanent Transect # 1

The ecological site is an old irrigated agricultural field that was planted to Bermuda grass pasture. Soil is a sandy loam. It was abandoned in the 1960's and has been used as a holding pasture for roundups since. The Bermuda grass has generally died out but there are patches in low spots around the field. Bermuda is being replaced by annuals and scattered mesquite trees.

In 2004, the dominant perennial grass was Bermuda grass, and Lehmann lovegrass was also present. This year, we did not note the present of Lehmann's lovegrass. Mesquite canopy increased from 19% of the overstory on the transect line to 27% but is not representative of the field in general. The soil stability rating improved to 41 this year from 31 last year, which moved the condition class from 'Poor' to 'Fair'. Perhaps most indicative was the increase in litter from 38% last year to 57% this year. The impact of the lack of monsoon rainfall this year is clearly noted in the comparison photos from last year, and is especially apparent in the 3'x 3' plot photos, which show green Bermuda last year and brown Bermuda this year. Still, the photos and the data show an increasing litter cover, and improving range condition.

The transect runs 90 degrees east. Two angle iron pins mark the transect line. They are set 99.5 feet apart with the zero pin on the west end.

Photo of Transect # 1, general view, 2004

Photo of Transect # 1, general view, 2005

Transect 1, 3 foot X 3 foot plot taken at the 3.5 foot tape location, 2004

Transect 1, 3 foot X 3 foot plot taken at the 3.5 foot tape location, 2005

Permanent Transect # 2

The ecological site is a desert scrub grassland. It is located in the Wakefield wash drainage fan and is a "valley plain". Soils are sandy and have a low water holding capacity. Vegetation potential for perennial grasses is limited to the water holding capacity. Catclaw and mesquite are common. The area has historically been used as a holding pasture during roundups.

Despite the drought and the die back of some of the grasses, conditions are very similar to last year. Last year, the Soil Stability score was 23, this year the score was 24. Both scores represent 'Poor' condition. Some species noted last year are not present (e.g. Bush Muhly), and canopy cover has increased from 11% to 18%. In both years, the condition was 'Stable.'

The transect runs 360 degrees north. Two angle iron pins mark the transect and are set 99.5 feet apart. The zero pin is the south pin.

Transect 2, general view, 2004

Transect 2, general view, 2005

Transect 2. 3 foot X 3 foot close up, 2004

Transect 2. 3 foot X 3 foot close up, 2005

The location is at the 3.5 foot mark on the tape.

Paced Transects 3A and 3B

In 2004, two of the fields near the headquarters were scored using a less rigorous technique where litter, bare, rock and hit were scored a each pace along a transect. This method did not allow the surveyors to return to the exact same location on the transect, but it did allow the fields to be scored.

These fields had been irrigated using center pivots, and had been largely Bermuda. Currently, they are not irrigated, and they are used as holding pens for horses, though there was one cow in the field when I went.

Paced Transect 3A

The monitoring report from 2004 indicated that this field had some Bermuda, and the photo indicates an abundance of Russian Thistle as well. There were 4 hits on live Bermuda, and litter covered 46% of the surface. The soil stability score was 50 resulting in a 'Fair' rating. In 2005, there were no hits on live plants, litter covered 25% of the surface and the soil stability score was 21 resulting in a low 'Poor' rating. The decreasing soil stability score indicates a downward trend. No 'dot' counts were taken in 2004. The constituent species this year would have been similar to those in transect 3B.

Paced Transect 3B

The monitoring report from 2004 indicated that this field had some Bermuda, and the photo indicates an abundance of Russian Thistle as well. This field is similar to 3A, though there is a rocky area in what appears to be an abandoned channel area that sits a little lower than the rest of the field, but above the current channel. In 2004, there were 28 hits on live Bermuda. Litter covered 14% of the surface, and rock covered 6%. The soil stability score was 47 resulting in a 'Fair' rating. In 2005, there were 5 hits on live plants, litter covered 16% of the surface and the soil stability score was 23 resulting in a 'Poor' rating. The decreasing soil stability score indicates a downward trend. The dot counts indicated an abundance of Bermuda and Mesquite with some Burrow Bush, and Cholla. The constituent species appear to be little changed from last year.

Transect 3A. General view north 360 degrees, 2004

Transect 3A. General view north 360 degrees, 2005

Transect 3B. General view, east 90 degrees, 2004

Transect 3B. General view, east 90 degrees, 2005

Empirita Ranch Watershed Condition Transects, Survey Date: August 2, 2005

The watershed/soil evaluation monitoring method used is a modified method of a long time standard method used by the Forest Service for evaluating rangeland and watershed ecological trend and condition. For the purpose of monitoring the Empirita Ranch, the transects rate the percentage of exposed soil to erosion and soil disturbance factors. These result in soil stability rating scores with a numerical rating and apparent condition. Trends were assumed to be stable for the baseline assessment in 2004. Photographs and changes in transect and plot data were used to re-evaluate trend when the 2005 monitoring survey was performed. Overall, one transect showed improving conditions, two showed degrading conditions, and one showed a slight downward trend but was characterized as 'stable' because the change was small and could be attributed to uncertainties in the method.

Summary of the transects

Transect #	Score 2004	Condition 2004	Score 2005	Condition 2005	Current Trend
1	31	Poor	41	Fair	Upward
2	28	Poor	24	Poor	Stable
3A	50	Fair	21	Poor	Downward
3B	47	Fair	23	Poor	Downward

RANGE CONDITION REPORT
AUGUST 2006

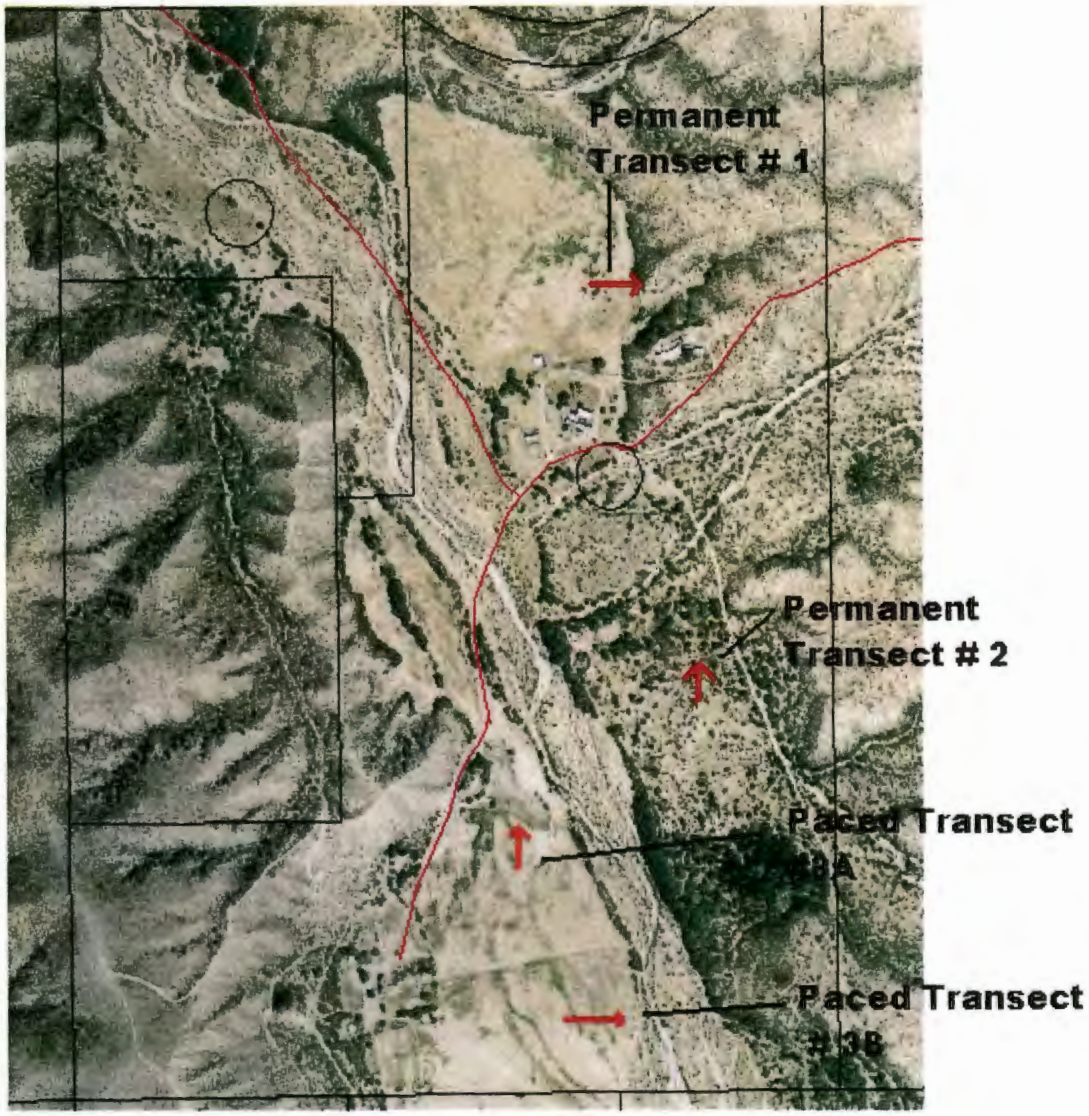
Field Report
Vegetation and Watershed Monitoring at Empirita Ranch
August 7, 2006

Introduction

This is the third round of monitoring using a method Don Ward had used while working for the U. S. Forest Service to assess range conditions on four transects at Empirita Ranch (Figure 1). Monitoring of the two permanent transects (Tansects 1 & 2) was performed by David Scalero, Frank Postillion, Julia Fonseca and Neva Connolly. Julia and Neva monitored Paced Transect 3A, while David and Frank monitored Paced Transect 3B. All of the team members had previously used this method in prior years.

The qualitative range conditions scoring (Current erosion) is still new to the team members, but all were in agreement to the final scores determined. Assumptions written down during the qualitative scoring should be useful for future monitoring sessions. It is very beneficial to have team members who can identify plant species (Julia was especially helpful this round) for the purposes of determining plant composition and diversity. The protocol for selecting plants for the "Dot" totals (away from the transect line) is still a little confusing, but all team members were in agreement with the results during this session. All field forms are provided in Appendix A of this report.

Figure 1. Transect Locations



Permanent Transect # 1 Lat. 31 degrees, 57' 31.81" Lon. 110 degrees 31' 38.84"
Transect direction is 90 degrees east with out magnetic declination

Permanent Transect # 2 Lat. 31 degrees 57' 11.12" Lon. 110 degrees 31' 33.65"
Direction is 360 degrees north with out magnetic declination

Paced Transect # 3A Lat. 31 degrees 57' 3.31" Lon. 110 degrees 31' 44.02"
Direction is 360 degrees north with out magnetic declination

Paced Transect # 3B Lat. 31 degrees 56' 56.73" Lon. 110 degrees 31' 42.18"
Direction is 90 degrees east with out magnetic declination

Permanent Transect # 1

This transect is located in Pasture C and runs 90 degrees east. Two angle iron pins mark the transect line. They are 99.5 feet apart with the zero pin on the west end.

The ecological site is an old irrigated agricultural field that was planted to Bermuda grass pasture. The soil is a sandy loam. The field was abandoned in the 1960's and has since been used as a holding pasture for cattle. Most of the Bermuda grass has died out, but there are a few patches in low spots around the field. The Bermuda is generally being replaced by annuals and scattered mesquite trees.

A list of the plant species found in the general area is provided in Table 1. The dominant perennial grass along this transect continues to be Bermuda. There was another species of perennial grass at the site, identified as Johnson grass, but it was not common. Mesquite canopy increased from 27% of the overstory along the transect line to 35%. This percentage of overstory is not indicative of the whole field in general, as the majority of the mesquites occur within a small area along the eastern portion of the field. The soil stability rating dropped to 37 this year from 41 last year, which moved the condition class from 'Fair' to 'Poor'. It was still higher than the 2004 rating of 31. The reduction of litter from 57% to 21% is the major reason for the drop in the rating over the last year. Comparison of stake heights from 2005 to 2006 shows a fairly stable soil in the area (0.02 inch decrease to 0.09 inch increase from west to the east).

Table 1. Plants found in the general area of Transect # 1

Bermuda grass	*Cynodon dactylon*
Velvet mesquite	*Prosopis velutina*
Silverleaf nightshade	*Solanum elaeaginifolia*
Desert broom	*Baccharis sarothroides*
Russian thistle (tumbleweed)	*Salsola tragus*
Amaranth	*Amaranthus sp.*
Spiderling	*Boerhavia sp.*
Horse purslane	*Trianthema portulacastrum*
Johnson grass	*Sorghum halepense*

Transect # 1. General view east 90 degrees, 2005

Transect # 1. General view east 90 degrees, 2006 DSC 3758

Transect # 1. 3' X 3' plot taken at the 3.5' tape location, 2005

Transect # 1. 3' X 3' plot taken at the 3.5' tape location, 2006 DSC 3759

Permanent Transect # 2

This transect is located northeast of Pasture A and runs 360 degrees north. Two angle iron pins mark the transect and are set 99.5 feet apart. The zero pin is the south pin.

The ecological site is a desert scrub grassland. It is located in the Wakefield Canyon drainage fan and is a "valley plain". The soils are sandy and have a low water holding capcity, which limits the potential for perennial grasses at the site. Catclaw and mesquite a very common. The area has historically been used as a pasture for cattle.

A list of the plant species found in the general area is provided in Table 2. Burrowweed and catclaw acacia are the dominant species, however plant diversity is much greater at this site compared to Tansect # 1. More rainfall over this summer has increased the production of annual vegetation, thus producing a higher litter count this year (22%) compared to last year (19%). The picture comparison of the transect is more indicative of the increased litter in the area than the actual count made along the transect. The soil stability score of 38 still indicates a 'Poor' condition class, but it is much higher than the two previous years, which were 23 and 24 respectively. Canopy cover was close to the same as last year, 17% in 2006 compared to 18% in 2005. Comparison of stake heights from the ground indicate an increase in soil ranging from 0.19 inches (south) to 0.25 inches (north). Based on the higher soil stability score this year, the overall condition at this site appear to be improving.

Table 2. Plants found in the general area of Transect # 2

Burroweed	*Isocoma tenuisecta*
Catclaw acacia	*Acacia greggii*
Wolfberry	*Lycium sp.*
Velvet mesquite	*Prosopis velutina*
Whitethorn acacia	*Acacia constricta*
Barrel cactus	*Ferocactus wislizeni*
Hedgehog cactus	*Echinocereus sp.*
Prickly pear cactus	*Opuntia engelmannii*
Summer poppy	*Kallstroemia grandiflora*
Devil's claw	*Proboscidea altheaefolia*
Honeymat	*Tidestromia lanuginosa ssp. eliassonii*
Amaranth	*Amaranthus sp.*
Thurber's desert honeysuckle	*Anisacanthus thurberi*
Morning glory	*Ipomoea sp.*
Yucca	*Yucca sp.*
Desert hackberry	*Celtis pallida*
Mexican oregano	*Lippia graveolens*
Sacaton	*Sporobolus wrightii*
Bush muhly	*Muhlenbergia porteri*

Transect # 2. General view north 360 degrees, 2005

Transect # 2. General view north 360 degrees, 2006 DSC 3763

Transect # 2. 3' X 3' plot taken at the 3.5' tape location, 2005

Transect # 2. 3' X 3' plot taken at the 3.5' tape location, 2006 DSC 3762

Paced Transects 3A and 3B

The two fields near the Empirita Ranch headquarters, Pastures A & B, are scored using a less rigorous technique where ltter, bare soil, rock and plant 'hits' are tallied at each pace along the transect. There are no stakes at each end of the field, so the location and direction are determined using a Global Positioning System (GPS) unit. This method only provides a general comparison of the field conditions from year to year.

The ecological site for both transects is Bermuda grass pasture. The fields had been irrigated using center pivots during the past, but are currently not irrigated. The both fields, which are separated by a barbed-wire fence, are used as holding pens for horses and temporarily cattle.

There is an abondoned, rocky channel located at the eastern end of this transect, which sits a little lower than the rest of the field. In order to properly score the field, the monitoring crew made a 90 degree turn to the south to score the last 30 paces of the transect (see last photograph), which was similar to what was done in 2004.

Paced Transect 3A

The monitoring report from 2005 indicated that the dominant species in the general area were Bermuda grass and Russian thistle. However, there were no plant hits recorded and the litter cover was very low, 25% of the paces. This resulted in a soil stability score of 21 and a low 'Poor' rating. A small mesquite provided the 3% canopy cover recorded over the paced transect. No dot counts were recored in 2005.

In 2006, there were two plant hits (Bermuda grass) and litter covered 49% of the paced transect. The increase in litter was due to the greater extent of annuals present in 2006, which is highly noticeable in the photograph comparison below. The total soil stability score was 38, which is still a 'Poor' rating, but is much higher than the previous year, indicating an upward trend. Dot counts indicate that the plant composition is primarily Bermuda grass, small mesquite trees and desert broom.

Paced Transect 3B

In 2005, the number of hits on live plants (5) and litter cover (16) was quite low. This resulted in a low soil stability score of 23 and an overall 'Poor' rating. In 2006, there were 21 hits on live plants (Bermuda grass) and litter covered 32% of the surface. As a result, the erosion hazard index was 11 points higher in 2006. Coupled with the visual observation of current erosion in the area, the soil stability score in 2006 was 53, resulting in a 'Fair' rating. The significant increase in the soil stability score indicates an upward trend. Dot counts indicate a continuing abundance of Bermuda grass and small mesquite trees at this site. The other constituent species appear to be the same as last year, except for the presence of wolfberry (*Lycium sp.*) along the southeastern end of the transect.

Transect 3A. General view north 360 degrees, 2005

Transect 3A. General view north 360 degrees, 2006 DSC 3764

Transect 3B. General view, east 90 degrees, 2005

Transect 3B. General view, east 90 degrees, 2006 DSC 3766

Transect 3B. General view, south 360 degrees, 2006 DSC 3768

Summary

Table 3 displays a summary of the soil stability scores, range conditions and current trends for the four monitoring transects at Empirita Ranch. Overall, three of the transects showed improving conditions over the last year and one showed a slight downward trend, but was characterized as 'stable' because the change was small and could be attributed to uncertainties in the method. The greatest uncertainies occur in the visual determination of the Soil Disturbance Factor (Current erosion). For 2006, the monitoring crew listed the characteristics they observed in the 'Comments' section to help justify the rating and, hopefully, assist future monitoring crews with scoring.

Photographs are also very useful in showing changing conditions at the site. The biggest differences between 2006 and 2005 is the lack of vegetative debris along Transect 1 and the significantly greater amounts of annual vegetation along Transects 2, 3A and 3B.

Table 3. Summary of the transects

Transect #	Score 2004	Condition 2004	Score 2005	Condition 2005	Score 2006	Condition 2006	Current Trend
1	31	Poor	41	Fair	37	Poor	Stable
2	28	Poor	24	Poor	38	Poor	Upward
3A	50	Fair	21	Poor	38	Poor	Upward
3B	47	Fair	23	Poor	53	Fair	Upward

APPENDIX A

APPENDIX D

STREAM CLASSIFICATION & STABILITY ASSESSMENT
CROSS-SECTION 14 (XS-14)

CROSS-SECTION DATA AT CONTROL POINT #14

CP 14 3727.612 from Lin Lawson ADEQ

LL Stationing	Station (our initial survey)	BS	HI	FS	Elev	Comment	Bankfull
1	373	2.73	3730.342		3727.612	CP14	
40	334		3730.342	7.13	3723.212	Fill	
46	328		3730.342	10.89	3719.452	Fill on terrace?	
53	321		3730.342	11.67	3718.672	overbank	
56	318		3730.342	11.5	3718.842	overbank	
59	315		3730.342	12.21	3718.132	Bankfull W side	bankfull
61	313		3730.342	12.48	3717.862	channel	
64	310		3730.342	13.25	3717.092	channel	
66	308		3730.342	13.72	3716.622	channel	
73	301		3730.342	14.28	3716.062	channel Thalweg	
81	293		3730.342	14.2	3716.142	channel	
82	292		3730.342	12.81	3717.532	Top of Bank E side	bankfull
91	283		3730.342	11.42	3718.922	overbank	
103	271		3730.342	11.02	3719.322	overbank	
107	267		3730.342	11.4	3718.942	overbank	
140	234		3730.342	12.14	3718.202	overbank	
163	211		3730.342	11.78	3718.562	overbank	
169	205		3730.342	11.56	3718.782	overbank	
218	156		3730.342	11.29	3719.052	overbank	
241	133		3730.342	10.94	3719.402	overbank	
247	127		3730.342	12.16	3718.182	overbank channel	
250	124		3730.342	13.02	3717.322	overbank channel	
260	114		3730.342	12.56	3717.782	overbank channel	
267	107		3730.342	11.17	3719.172	overbank	
298	76		3730.342	11.73	3718.612	overbank	
309	65		3730.342	11.45	3718.892	overbank	
344	30		3730.342	12.39	3717.952	overbank	
354	20		3730.342	12.2	3718.142	overbank	
369	5		3730.342	5.06	3725.282	Terrace	
374	0		3730.342	4.94	3725.402	Top of Rebar	

XS-14 Empirita 10-17-05

	3718.132		Width x depth	
2	0.27	0.27	0.54	
3	1.04	1.965	3.12	
2	1.51	2.55	3.02	
7	2.07	12.53	14.49	3720.202
8	1.99	16.24	15.92	
1	0.6	1.295	0.6	
Area		34.85	37.69	
Width		23		
Depth		1.638696		
W/D		14.03555		
Width at 2x		323		
Entrenchment		14.04348		

Stream Type

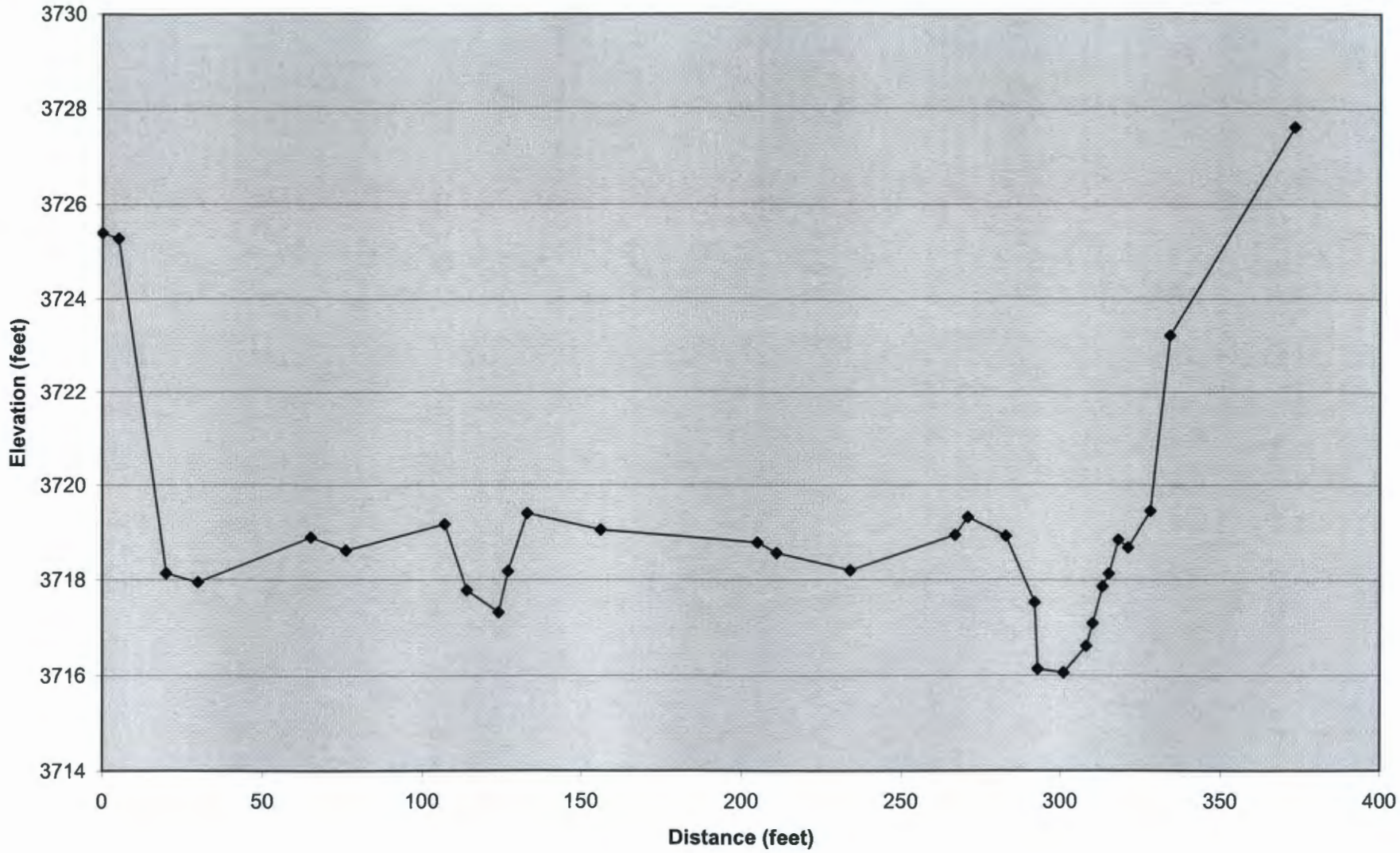
Level I

Entrenchment	14	> 2.2	
W/D Ratio	14	>12	
Sinuosity	say 1.4	> 1.4	
Slope	0.0094	<0.02	
			C

Level II

Bed Material	Cobble	C3	
Slope Class	0.008	<0.02	
			C3c

CROSS-SECTION AT CONTROL POINT #14

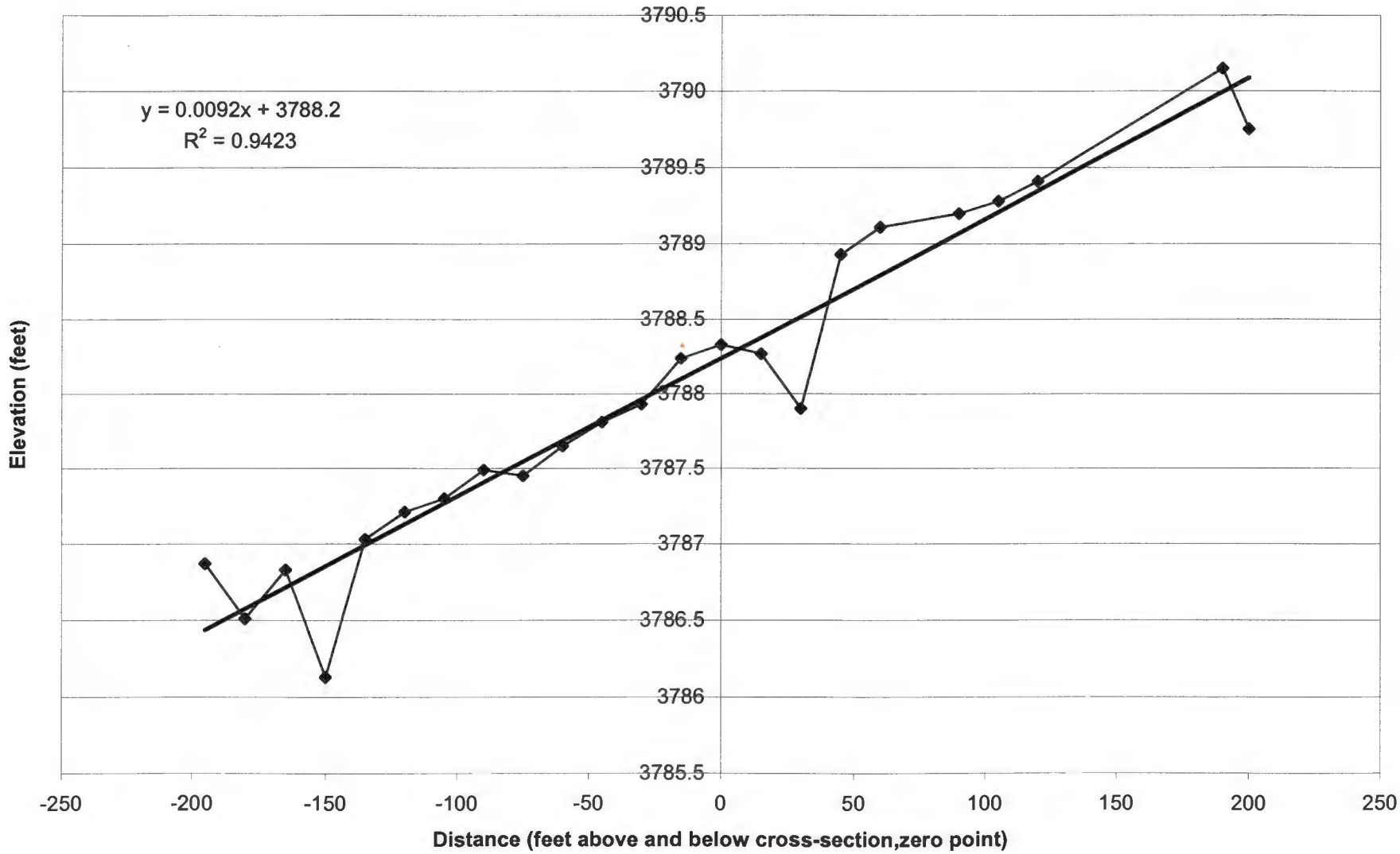


LONGITUDINAL PROFILE AT CONTROL POINT #14

CP 14 3800 Estimate

Station	BS	HI	FS	Elev	Comment
373	2.73	3802.73		3800	CP14
200		3802.73	12.98	3789.75	
190		3802.73	12.58	3790.15	
120		3802.73	13.32	3789.41	
105		3802.73	13.45	3789.28	
90		3802.73	13.53	3789.2	
60		3802.73	13.62	3789.11	
45		3802.73	13.8	3788.93	
30		3802.73	14.83	3787.9	
15		3802.73	14.46	3788.27	
0		3802.73	14.4	3788.33	Cross XS 14 plot at about point 301
-15		3802.73	14.49	3788.24	
-30		3802.73	14.8	3787.93	
-45		3802.73	14.92	3787.81	
-60		3802.73	15.08	3787.65	
-75		3802.73	15.28	3787.45	
-90		3802.73	15.24	3787.49	
-105		3802.73	15.43	3787.3	
-120		3802.73	15.52	3787.21	
-135		3802.73	15.7	3787.03	
-150		3802.73	16.6	3786.13	
-165		3802.73	15.9	3786.83	
-180		3802.73	16.22	3786.51	
-195		3802.73	15.86	3786.87	

LONGITUDINAL PROFILE AT CONTROL POINT #14



CHANNEL ROUGHNESS AT CONTROL POINT #14

Left Overbank	Left Overbank		
Stations	0 107		
	Soil	Firm Fine Sand/silt	0.03
	Degree of Irregularity	minor	0.005
	Variation of Flood Plain X-section		
	Effect of Obstructions	Negligible	0.002
	Amount of Vegetation	Medium	0.025
			0.062
Overbank Channel			
Stations	107 133		
	Soil	Gravel	0.035
	Degree of Irregularity	Minor	0.005
	Variation of Channel X-section	Gradual	0
	Effect of Obstructions	Negligible	0
	Amount of Vegetation	Medium	0.01
			0.05
Left Overbank			
Stations	133 292		
	Soil	Firm Fine Sand/silt	0.03
	Degree of Irregularity	Minor	0.005
	Variation of Flood Plain X-section		
	Effect of Obstructions	Negligible	0.004
	Amount of Vegetation	Medium	0.025
			0.064
Main Channel			
Stations	292 315		
	Soil	Cobble	0.04
	Degree of Irregularity	Minor	0.002
	Variation of Channel X-section	Gradual	0
	Effect of Obstructions	Negligible	0
	Amount of Vegetation	Small	0.002
	Meander	Minor	0
			0.044
Left Overbank			
Stations	315 328		
	Soil	Firm Fine Sand/silt	0.03
	Degree of Irregularity	Minor	0.005
	Variation of Flood Plain X-section		
	Effect of Obstructions	Negligible	0.005
	Amount of Vegetation	Large	0.05
			0.09

PFANKUCH-ROSGEN STREAM STABILITY SCORES
XS-14 Empirita
10-17-05

Upper Banks			
	Landform Slope	Good	4
	Mass Wasting	Fair	9
	Debris Jam	Excellent	2
	Vegetative Bank Protection	Excellent	3
sub-total			18
Lower Banks			
	Channel Capacity	Fair	6
	Surface Protection	Good	4
	Obstructions to Flow	Good	4
	Cutting (LB)	Fair	6
	Cutting (RB)	Poor	8
sub-total			28
Channel Bottom			
	Bottom Deposits	Fair	18
	Bar Development	Poor	16
	Embededness	Excellent	2
sub-total			36
Total			82
AZDEQ Adjustment			19
Grand Total			101

Overall "Fair" for C3 stream type

RIPARIAN VEGETATION ALONG CROSS-SECTION AT CONTROL POINT #14

Station	Grass or Forb	Woody Plant	Size of Woody Plant
0	FFG	M	Pole
4	FFG	CC	Sappling
8	B	CC	Mature
12	TA	M	Mature
16	FFG	RB	Sappling
20	FFG	M	Sprout
24	FFG	M	Sprout
28	FFG	M	Sprout
32	FFG	RB	Sprout
36	FFG	RB	Sappling
40	FFG	RB	Sprout
44	FFG	RB	Sprout
48	B	RB	Sprout
52	LL	M	Sprout
56	TA	M	Sprout
60	FFG	RB	Sappling
64	B	M	Sprout
68	TA	RB	Sappling
72	TA	M	Sprout
76	TA	M	Sprout
80	ST	RB	Sprout
84	TA	RB	Sprout
88	TA	RB	Sappling
92	LL	M	Sappling
96	TA	RB	Sprout
100	B	M	Sappling
104	B	RB	Sappling
108	B	RB	Sappling
112	B	RB	Sappling
116	CHANNEL	RB	Sappling
120	CHANNEL	RB	Sappling
124	FFG	RB	Sappling
128	LL	LL SUMAC	Sprout
132	TA	M	Sappling
136	FFG	M	Sprout

Grass summary	Number
Alkali Sacaton (SAC)	2
Bare	2
Bermuda (B)	16
Channel	7
Feather Fingergrass (FFG)	30
Lehmann Lovegrass (LL)	8
Six Weeks	6
Stinkgrass (ST)	3
Threeawn (TA)	20
Total	94

Woody Species summary	Number	Mature	Pole	Sappling	Sprout
Cat Claw Acacia (CC)	9	4	1	2	2
Rabbitbrush (RB)	51	0	1	28	22
Graythorn (GT)	1	0	0	0	1
Little Leaf Sumac (LL Sumac)	2	0	0	0	2
Velvet Mesquite (M)	30	1	1	8	20
White Thorn Acacia (WT)	1	0	0	1	0
Total	94	5	3	39	47

Size Categories

Mature	Diameter at Breast Height (DBH) > 9 inches
Pole	Diameter at Breast Height (DBH) 5 to 8.9 inches
Sappling	Height > 4.5 feet and DBH to 4.9 inches
Sprout	Height < 4.5 feet

RIPARIAN VEGETATION ALONG CROSS-SECTION AT CONTROL POINT #14

Station	Grass or Forb	Woody Plant	Size of Woody Plant
140	FFG	RB	Sappling
144	FFG	M	Sappling
148	TA	WT	Sappling
152	TA	RB	Sappling
156	LL	RB	Sappling
160	TA	M	Sprout
164	TA	M	Sprout
168	TA	RB	Sprout
172	FFG	RB	Sappling
176	FFG	LL SUMAC	Sprout
180	ST	M	Sprout
184	FFG	M	Sappling
188	TA	RB	Pole
192	LL	M	Sprout
196	FFG	M	Sappling
200	TA	RB	Sprout
204	TA	RB	Sprout
208	FFG	RB	Sprout
212	LL	M	Sprout
216	TA	M	Sprout
220	SAC	RB	Sappling
224	SAC	RB	Sappling
228	LL	RB	Sprout
232	FFG	CC	Pole
236	FFG	RB	Sprout
240	FFG	CC	Sappling
244	FFG	RB	Sprout
248	LL	RB	Sappling
252	FFG	RB	Sprout
256	TA	RB	Sappling
260	FFG	RB	Sappling
264	TA	CC	Sprout
268	FFG	RB	Sappling
272	B	RB	Sappling
276	B	RB	Sappling
280	B	RB	Sappling

RIPARIAN VEGETATION ALONG CROSS-SECTION AT CONTROL POINT #14

Station	Grass or Forb	Woody Plant	Size of Woody Plant
284	B	RB	Sappling
288	B	RB	Sappling
292	B	RB	Sprout
296	CHANNEL	RB	Sprout
300	CHANNEL	RB	Sprout
304	CHANNEL	RB	Sprout
308	CHANNEL	RB	Sprout
312	CHANNEL	RB	Sprout
316	B	RB	Sappling
320	FFG	CC	Mature
324	FFG	RB	Sappling
328	B	CC	Mature
332	B	M	Sappling
336	ST	CC	Mature
340	SIX WEEKS	GT	Sprout
344	SIX WEEKS	CC	Sprout
348	SIX WEEKS	RB	Sprout
352	SIX WEEKS	M	Sappling
356	SIX WEEKS	M	Sprout
360	SIX WEEKS	M	Sprout
364	FFG	M	Sprout
368	BARE	M	Sprout
372	BARE	M	Sprout

Looking north from XS-14 at channel mid-section, December 13, 2002 (Lin Lawson)

Looking north from XS-14 at channel mid-section, October 17, 2005

Looking south from XS-14 at channel mid-section, December 13, 2002 (Lin Lawson)

Looking south from XS-14 at channel mid-section, October 17, 2005

STREAM CLASSIFICATION & STABILITY ASSESSMENT
CROSS-SECTION 16 (XS-16)

CROSS-SECTION DATA AT CONTROL POINT #16

CP 16 3750 Estimate

Station	BS	HI	FS	Elev	
ADOT BM	1.66	3751.66		3750	CP 16
0		3751.66	9.05	3742.61	E Bank Rebar
0		3751.66	9.59	3742.07	E Bank ground
18		3751.66	12.85	3738.81	
41		3751.66	13.4	3738.26	
70		3751.66	13.42	3738.24	
111		3751.66	13.28	3738.38	
150		3751.66	13.62	3738.04	
159		3751.66	12.17	3739.49	
165		3751.66	13.19	3738.47	
171		3751.66	12.85	3738.81	
177		3751.66	14	3737.66	
179		3751.66	14.52	3737.14	bankfull
181		3751.66	15.86	3735.8	
185		3751.66	15.74	3735.92	
189		3751.66	16.08	3735.58	
196		3751.66	15.93	3735.73	
198		3751.66	15.46	3736.2	
200.5		3751.66	14.14	3737.52	bankfull
206		3751.66	13.04	3738.62	
218		3751.66	12.4	3739.26	
220		3751.66	13.32	3738.34	
228		3751.66	11.97	3739.69	
235		3751.66	12.23	3739.43	
240		3751.66	12.57	3739.09	
250		3751.66	12.05	3739.61	
260		3751.66	12.65	3739.01	
269		3751.66	12.4	3739.26	
281		3751.66	12.21	3739.45	
293		3751.66	12.09	3739.57	
298		3751.66	11.76	3739.9	
298		3751.66	11.02	3740.64	
306		3751.66	12	3739.66	
312		3751.66	11.72	3739.94	
315		3751.66	12.05	3739.61	
325		3751.66	11.45	3740.21	
334		3751.66	12.74	3738.92	
355		3751.66	11.12	3740.54	
362		3751.66	11.98	3739.68	
369		3751.66	11.86	3739.8	
376		3751.66	11.32	3740.34	
380		3751.66	11.76	3739.9	
385		3751.66	11.44	3740.22	
400		3751.66	10.97	3740.69	
400		3751.66	10.48	3741.18	

	3737.33		Width x depth	
2	1.53	1.53	3.06	
4	1.41	5.88	5.64	
4	1.75	6.32	7	3739.08
7	1.6	11.725	11.2	
2	1.13	2.73	2.26	
2.5	-0.19	1.175	-0.475	

Area		29.36	28.685
Width		21.5	
Depth		1.334186	
W/D		16.11469	
Width at 2x		110	
Entrenchment		5.116279	

Stream Type

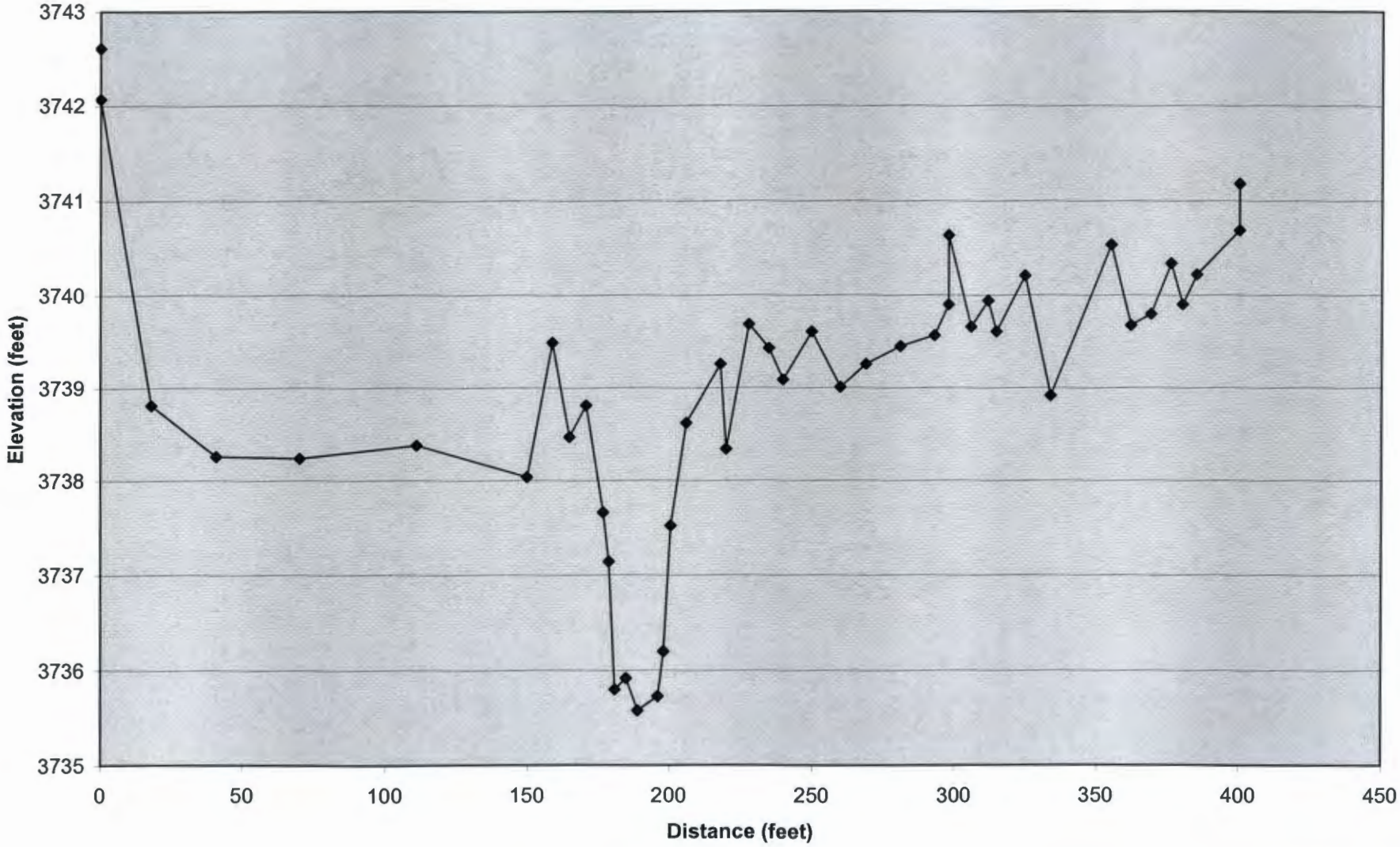
Level I

Entrenchment	5.1	> 2.2	
W/D Ratio	16	>12	
Sinuosity	1.4 (mapgı	> 1.4	
Slope	0.008	<0.02	
			C

Level II

Bed Material	Gravel	C4	
Slope Class	0.008	<0.01	
			C4c

CROSS-SECTION AT CONTROL POINT #16

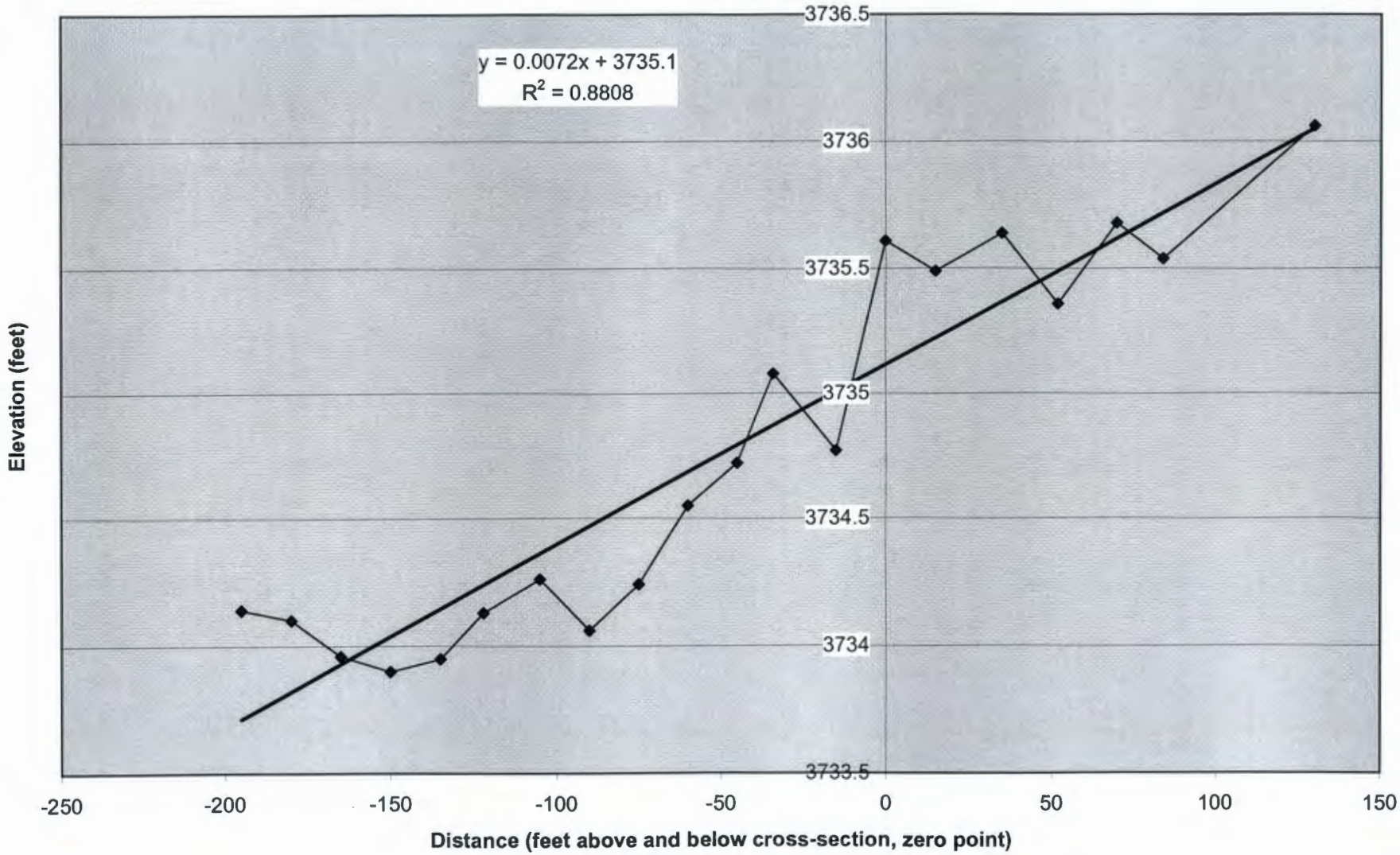


LONGITUDINAL PROFILE AT CONTROL POINT #16

CP 16 3750 Estimate

	BS	HI	FS	Elev	Comment
Station					
ADOT BM	1.66	3751.66		3750	CP 16
130		3751.66	15.6	3736.06	
84		3751.66	16.12	3735.54	
70		3751.66	15.98	3735.68	
52		3751.66	16.3	3735.36	
35		3751.66	16.02	3735.64	
15		3751.66	16.17	3735.49	
0		3751.66	16.05	3735.61	
-15		3751.66	16.89	3734.77	
-34		3751.66	16.58	3735.08	
-45		3751.66	16.94	3734.72	
-60		3751.66	17.11	3734.55	
-75		3751.66	17.42	3734.24	
-90		3751.66	17.6	3734.06	
-105		3751.66	17.4	3734.26	
-122		3751.66	17.53	3734.13	
-135		3751.66	17.71	3733.95	
-150		3751.66	17.76	3733.9	
-165		3751.66	17.7	3733.96	
-180		3751.66	17.56	3734.1	
-195		3751.66	17.52	3734.14	

LONGITUDINAL PROFILE AT CONTROL POINT #16



CHANNEL ROUGHNESS AT CONTROL POINT #16

Left Overbank	Left Overbank		
Stations	0 177		
	Soil	Firm Fine Sand/silt	0.03
	Degree of Irregularity	minor	0.005
	Variation of Flood Plain X-section		
	Effect of Obstructions	Negligible	0.002
	Amount of Vegetation	Medium	0.025
			0.062
Overbank Channel			
Stations	177 200.5		
	Soil	Gravel	0.03
	Degree of Irregularity	Minor	0.005
	Variation of Channel X-section	Gradual	0.005
	Effect of Obstructions	Negligible	0
	Amount of Vegetation	Medium	0.002
			0.042
Right Overbank			
Stations	200.5 400		
	Soil	Firm Fine Sand/silt	0.03
	Degree of Irregularity	moderate	0.01
	Variation of Flood Plain X-section		
	Effect of Obstructions	Negligible	0.004
	Amount of Vegetation	Large	0.03
			0.074

PFANKUCH-ROSGEN STREAM STABILITY SCORES
XS-16 Empirita
10/20/2005

Upper Banks			
	Landform Slope	Excellent	2
	Mass Wasting	Good	6
	Debris Jam	Excellent	2
	Vegetative Bank Protection	Excellent	3
sub-total			13
Lower Banks			
	Channel Capacity	Good	4
	Surface Protection	Ex-Good	3
	Obstructions to Flow	Good	4
	Cutting (LB)	Good	3
	Cutting (RB)	Fair	6
sub-total			20
Channel Bottom			
	Bottom Deposits	Good	12
	Bar Development	Fair-Poor	14
	Embededness	Fair	6
sub-total			32
Total			65
AZDEQ Adjustment			15
Grand Total			80

Overall "Good" for C4 stream type

RIPARIAN VEGETATION ALONG CROSS-SECTION AT CONTROL POINT #16

Station	Grass or Forb	Woody Plant	Size of Woody Plant
0	B	M	SPROUT
4	B	M	SPROUT
8	B	M	SPROUT
12	B	M	SPROUT
16	B	M	SPROUT
20	B	M	SPROUT
24	B	M	SPROUT
28	B	M	POLE
32	B	M	SPROUT
36	ST	M	SPROUT
40	B	M	MATURE
44	SIX WEEKS	M	POLE
48	SIX WEEKS	M	SAPPLING
52	SIX WEEKS	M	SAPPLING
56	ST	M	SPROUT
60	SIX WEEKS	M	SPROUT
64	ST	M	SPROUT
68	B	RB	MATURE
72	SIX WEEKS	M	SAPPLING
76	B	M	SAPPLING
80	ST	M	POLE
84	B	M	SPROUT
88	B	RB	SPROUT
92	B	M	SAPPLING
96	B	RB	SPROUT
100	LL	M	SAPPLING
104	B	RB	SPROUT
108	ST	M	POLE
112	ST	M	SPROUT
116	FFG	M	SAPPLING
120	SIX WEEKS	M	SPROUT
124	FFG	M	SPROUT
128	B	M	SPROUT
132	FFG	M	SAPPLING

Grass summary	Number
Plains Lovegrass (PB)	1
Lehmann's Lovegrass (LL)	2
Alkali Sacaton (SAC)	2
Channel	3
Plains Bristlegrass (PB)	3
Threeawn (TA)	3
Feather Fingergrass (FFG)	8
Six Week (SIX WEEKS)	8
Stinkgrass (ST)	8
Bermuda (B)	63

Woody Species summary	Number	Mature	Pole	Sappling	Sprout
Cat Claw Acacia (CC)	1	0	0	0	1
Rabbitbrush (RB)	46	1	1	20	24
Hackberry (HB)	1	0	0	1	0
Mesquite (M)	51	2	5	18	26
Seep Willow (SW)	1	0	0	1	0
Undetermined Willow (W)	1	0	1	0	0
total	101	3	7	40	51

Size Categories

Mature	Diameter at Breast Height (DBH) > 9 inches
Pole	Diameter at Breast Height (DBH) 5 to 8.9 inches
Sappling	Height > 4.5 feet and DBH to 4.9 inches
Sprout	Height < 4.5 feet

RIPARIAN VEGETATION ALONG CROSS-SECTION AT CONTROL POINT #16

Station	Grass or Forb	Woody Plant	Size of Woody Plant
136	FFG	M	SPROUT
140	ST	M	SPROUT
144	B	RB	SAPPLING
148	B	RB	POLE
152	B	RB	SPROUT
156	PB	SW	SAPPLING
160	B	RB	SAPPLING
164	PB	RB	SAPPLING
168	B	RB	SAPPLING
172	B	RB	SAPPLING
176	B	RB	SAPPLING
180	B	RB	SPROUT
184	Channel	RB	SPROUT
188	Channel	RB	SPROUT
192	Channel	RB	SPROUT
196	LL	RB	SAPPLING
200	SIX WEEKS	M	MATURE
204	B	M	SPROUT
208	SIX WEEKS	W	POLE
212	B	M	POLE
216	B	RB	SPROUT
220	B	RB	SAPPLING
224	B	RB	SAPPLING
228	SAC	RB	SAPPLING
232	B	RB	SPROUT
236	B	RB	SAPPLING
240	B	RB	SPROUT
244	B	RB	SPROUT
248	FFG	RB	SAPPLING
252	B	M	SAPPLING
256	FFG	M	SAPPLING
260	B	M	SAPPLING
264	B	RB	SPROUT
268	B	RB	SPROUT
272	PL	M	SAPPLING
276	B	M	SPROUT

Photo taken

RIPARIAN VEGETATION ALONG CROSS-SECTION AT CONTROL POINT #16

Station	Grass or Forb	Woody Plant	Size of Woody Plant
280	ST	M	SAPPLING
284	FFG	RB	SPROUT
288	B	RB	SPROUT
292	TA	M	SPROUT
296	TA	M	SPROUT
300	B	RB	SPROUT
304	TA	M	SPROUT
308	PB	M	SPROUT
312	B	RB	SPROUT
316	B	RB	SAPPLING
320	B	M	SAPPLING
324	B	M	SAPPLING
328	B	RB	SAPPLING
332	B	M	SPROUT
336	B	M	SAPPLING
340	B	RB	SAPPLING
344	B	RB	SAPPLING
348	B	RB	SAPPLING
352	B	RB	SPROUT
356	B	M	SAPPLING
360	FFG	RB	SPROUT
364	B	RB	SPROUT
368	B	RB	SPROUT
372	B	M	SAPPLING
376	B	RB	SPROUT
380	B	CC	SPROUT
384	B	RB	SAPPLING
388	B	RB	SPROUT
392	B	RB	SAPPLING
396	B	RB	SAPPLING
400	SAC	HB	SAPPLING

Photo taken

Looking west along XS-16, October 30, 2002 (Lin Lawson)

Looking west along XS-16, October 20, 2005

Looking north from XS-16 at channel mid-section, October 30, 2002 (Lin Lawson)

Looking north from XS-16 at channel mid-section, October 20, 2005

Looking south from XS-16 at channel mid-section, October 30, 2002 (Lin Lawson)

Looking south from XS-16 at channel mid-section, October 20, 2005

APPENDIX E

Soil Testing and Study of an Earthen Berm at the Empirita Ranch (AZ EE:2:499 [ASM]), Pima County, Arizona

Jeffrey A. Homburg and Matthew A. Sterner

Prepared for the
Pima County Administrator's Office
Archaeology and Historic Preservation
201 North Stone Avenue, 7th Floor
Tucson, AZ 85701-1207

Pima County Contract No. 25-04-S-13426-0604
Work Order No. 4OCCCI

Technical Report 04-43
Statistical Research, Inc.
Tucson, Arizona

October 4, 2004

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MANAGEMENT SUMMARY

AGENCY: Pima County Administrator's Office, Archaeology and Historic Preservation

PROJECT TITLE: Soil Testing at the Empirita Ranch (40PFCDADM8)

PROJECT NUMBERS: Contract No.: 25-04-S-13426-0604, Work Order No. 4OCCCI, Requisition No. 73072

PROJECT DESCRIPTION: Statistical Research, Inc. (SRI) conducted field soil tests to document the profiles of four backhoe trenches excavated in the northern agricultural field associated with the Siemund/Ohrel complex (AZ EE:2:499 [ASM]) of the Empirita Ranch. A historical-period earthen berm on the southeast side of the field was mapped, photographed, and related to the history of the Upper Complex of the Empirita Ranch.

PROJECT LOCATION: The project area is located in the eastern part of Pima County, Arizona, about 2 km south of Interstate-10. It is located at the end of Empirita Road, about 1.5 km south and then 1.5 km east-southeast from the Empirita Road exit from I-10. The northern field of the Empirita Ranch is east of Cienega Creek, northwest of Anderson Canyon, south of a sharp bend in the Southern Pacific Railroad, and west of high Pleistocene fan terraces that overlook the field. The project area is in the NE ½ of Section 17, Township 17 South, Range 18 East, Gila and Salt River Base Line and Meridian; The Narrows USGS 7.5-minute Quadrangle.

CULTURAL RESOURCES PERMIT NUMBER: Documentation of the historical-period earthen berm was conducted under SRI's Arizona Antiquities Act Blanket Permit No. 2004-0001Bl, which authorizes noncollection archaeological or paleontological survey on lands of the state of Arizona under rules implemented pursuant to the Arizona Antiquities Act, A.R.S. § 41-841, et seq. (see Arizona Board of Regents, Chapter VIII B, rules 8-201 through 8-207 by A.R.S. § 15-1631). Permit authorized by Dr. Hartman H. Lomawaima, interim director of the Arizona State Museum.

FIELD PERSONNEL: Jeffrey A. Homburg and Matthew Sterner

DATE OF FIELDWORK: July 20, 2004

SPONSOR: Pima County Cultural Resources Office

RECOMMENDATIONS: Soils in the Northern Field of the Empirita Ranch are dominated by deep, weakly developed soils that are highly stratified, mainly of sandy loam and silt loam textures. These stratified soils are favorable for plant growth because of they help to reduce deep infiltration and to conserve moisture in the rooting zone. These soils provide good opportunities for restoring natural vegetation in this field next to Cienega Creek.

The earthen berm may have functioned both to protect the irrigated field downslope from damaging floods and to provide water to livestock. The age and span of use of the berm is uncertain based on this field evaluation alone, but it was apparently constructed by the Ohrels, who abandoned the ranch in the 1970s. The Empirita Ranch has been nominated for listing in the National Register of Historic Places, but the nomination form contains no reference to this berm.

We recommend that if any future plans by Pima County will entail damaging this berm, additional archival work should be completed prior to any such undertaking. This work should include interviews of former ranchers knowledgeable of the berm as a way to better document its age and span of use, as well as to obtain additional details on how it functioned.

Introduction

Statistical Research, Inc. (SRI), documented a series of test trenches at the Empirita Ranch for the purpose of soil characterization. This work was completed by SRI under contract to the Pima County Administrator's Office. Pima County requested that this soil testing project be undertaken to obtain information needed by the Pima County Flood Control Department (PCFCD) for management purposes. In particular, PCFCD sought information pertinent to assessing opportunities for restoring natural vegetation in an abandoned agricultural field that is now sparsely covered by weedy vegetation.

This soil testing project was conducted within the boundary of the historical-period Empirita Ranch, a property owned and managed by Pima County about 30 miles (48 km) southeast of Tucson. The project area is in the eastern part of Pima County, Arizona, about 2 km south of Interstate-10 (Figure 1). It is located at the end of Empirita Road, about 3 km southeast of the I-10 Empirita Road exit. The Northern Field of the Empirita Ranch is sandwiched between Cienega Creek to the west, Anderson Canyon to the southeast, a sharp bend in the Southern Pacific Railroad to the north, and high Pleistocene fan terraces to the east. The project area is in the NE ½ of Section 17, Township 17 South, Range 18 East, Gila and Salt River Base Line and Meridian; The Narrows USGS 7.5-minute Quadrangle.

Soil pedons (i.e., the smallest unit of soil large enough for characterizing the nature and arrangement of soil horizons) were documented in the profiles of four backhoe trenches placed in the Northern Field associated with the Siemund/Ohrel Complex (AZ EE:2:499 [ASM]) of the Empirita Ranch (Figure 2).

The Siemund/Ohrel Complex consists of residential buildings and agricultural structures located south and southeast of the Northern Field. The Northern Field encompasses an irrigated agricultural field that was abandoned in the 1970s. This irrigated field was watered by a center-pivot system fed by a well on the west side of the Northern Field that is depicted on the USGS quadrangle map. Three backhoe trenches were placed in this abandoned field and a fourth trench was placed on a historical-period earthen berm next to the field. In addition to soil testing, the berm on the southeast side of the field was mapped, photographed, and related to the history of the Upper Complex of the Empirita Ranch. Trench 3 was placed to test the soil material used to build this berm (see location in Figure 2, Figure 3).

Methods

Four backhoe trenches were excavated in parts of the Northern Field where Pima County requested soil descriptions be made (see Figure 2). Each trench was about 10 feet long, 2 feet wide, and 5 feet deep, and it was stepped for easy access (Figure 4). A step was also made on the opposite side of the profile that was described to provide better sunlight for photography. Digital photographs were taken to document all trench settings, profiles, and examples of field tasks. Pedon descriptions were made in each of the four trenches, which entailed identifying soil horizons and recording morphological properties such as depth, Munsell color, texture, structure, consistence, type of boundary, size and density of rock fragments, size and density of roots, pores, pH, effervescence (based on treatment with dilute hydrochloric acid to test

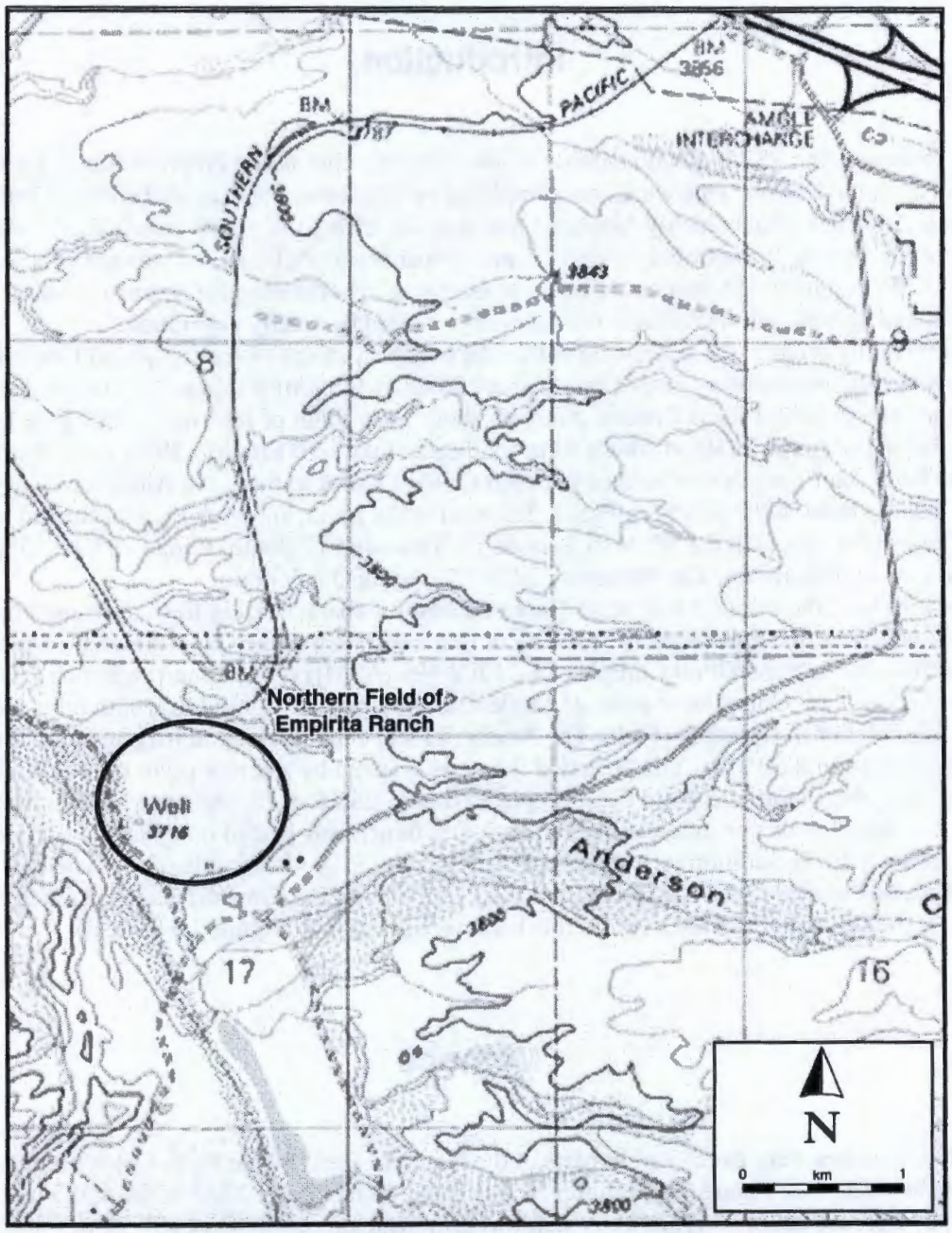

Figure 1. Map of the project area (note: Interstate-10 is in the northeast corner; adapted from 1981 The Narrows USGS 7.5-minute Quadrangle).

Test pit location

Coordinates
1 - N31°57'40.0", W110°31'50.4"
2 - N31°57'35.2", W110°31'45.8"
3 - N31°57'30.1", W110°31'36.3"
4 - N31°57'30.8", W110°31'46.5"

N

0 meters 100
0 feet 250

Scale ~ 1:3500

Figure 2. Aerial photograph showing the trench locations (aerial obtained from David Scalero, senior hydrologist, Pima County Flood Control District, Water Resources Division).

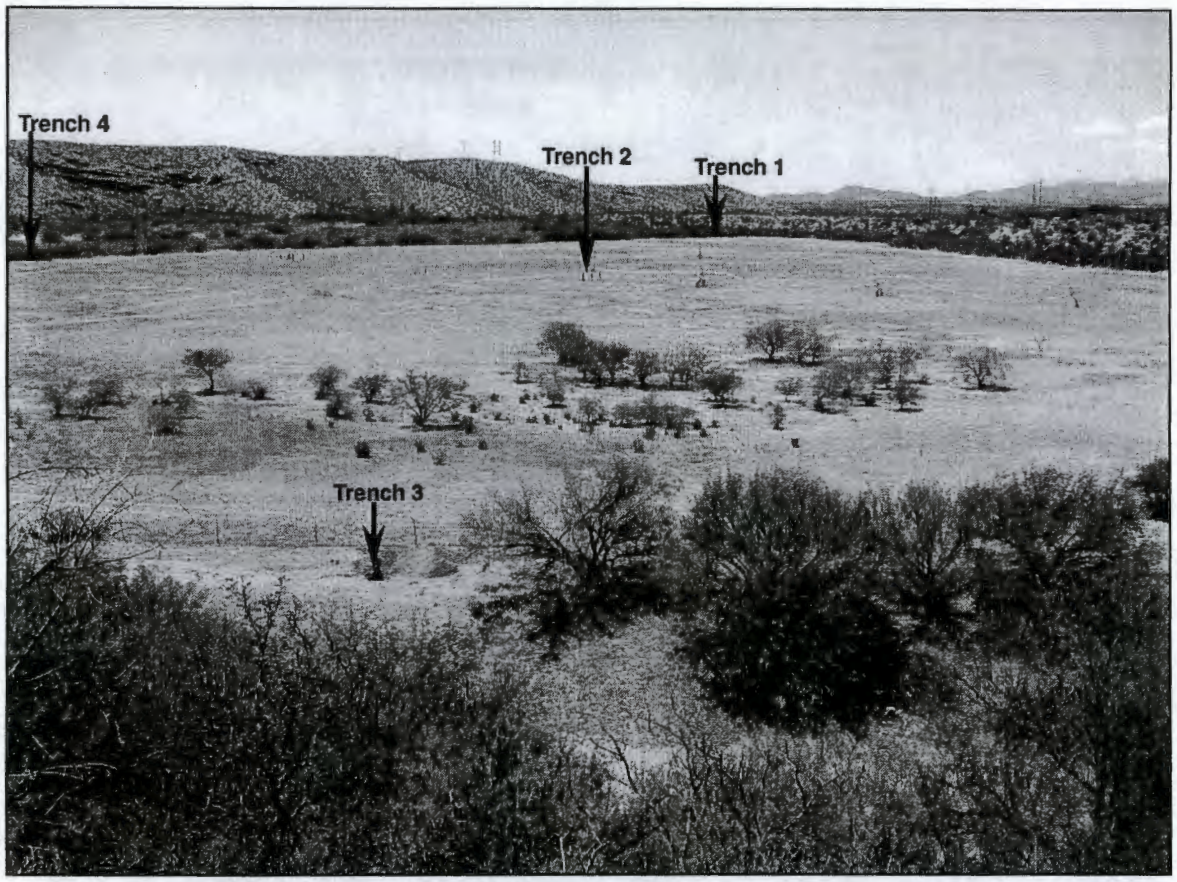

Figure 3. Overview of the soil testing area in the Northern Field of the Empirita Ranch from the south, showing the trench locations.

for calcium carbonate), and other noteworthy observations. Descriptions were made using standard nomenclature and format recommended for soil surveys in the United States (Soil Survey Staff 1993). Pedons were classified according to the USDA Soil Taxonomy (Soil Survey Staff 1999). The published soil survey of the eastern part of Pima County (Cochran and Richardson 2003) was consulted prior to conducting the fieldwork to find out what kind of soil map units have been identified previously in the project area. The The historical-period earthen berm was documented by making field observations of its morphology, making interpretations of its function, taking photographs, and by preparing a sketch map.

Results

Soil Testing

The detailed pedon descriptions for Trenches 1–4 are presented in Appendix A. Appendix B presents the pedon descriptions for soil map units in and near the Northern Field, including along Cienega Creek and its floodplain, and higher fan terraces to the east on the Empirita Ranch. The pedon descriptions in Appendix B are presented alphabetically, based on soil map units identified in the "Soil Survey of Pima County, Arizona, Eastern Part" (Cochran and Richardson 2003:Sheet 64) (Figure 5). These descriptions are

Figure 4. Backhoe excavating Trench 3 on earthen berm.

for soil series and their respective inclusions: (1) Unit 5-Arizo-Riverwash complex, 0 to 3 percent slopes (Glendale and Anthony series) in the drainageways and lowest floodplain positions along Cienega Creek and its ephemeral tributaries; (2) Unit 19-Comoro sandy loam, 0 to 2 percent slopes (Riveroad and Keysto series) on higher parts of the Cienega Creek floodplain; and (3) Unit 51-Nolam-Tombstone complex, 8 to 30 percent slopes (White House, Caralampi, Kimrose, Comoro, Riveroad, and Keysto series) on the rolling to hilly, Pleistocene fan terraces that overlook the Cienega Creek floodplain from the east.

The Northern Field of the Empirita Ranch falls almost entirely within Unit 19, the Comoro sandy loam. A small part of the field, including the berm and Trench 3, extends to Unit 51, where the Nolam-Tombstone complex was mapped at the edge of the high Pleistocene alluvial fan. The Comoro soil series is commonly used today for livestock grazing and as irrigated crop land for cultivating cotton, small grains, sorghum, and alfalfa. Because of its fertility, prehistoric agricultural settlements were also commonly established on or near the Comoro sandy loam in the Tucson Basin (Ciolek-Torrello and Homburg 1990: 16–17; Homburg and Ciolek-Torrello 1998). The Comoro sandy loam is classified as coarse-loamy, mixed, superactive, calcareous, thermic Ustic Torrifluvents. This soil consists of very deep, well to somewhat excessively well drained soils formed in stratified alluvium derived mainly from granite and rhyolite sources. Mean annual precipitation is 12 to 16 inches and the frost-free period ranges from 160 to 240 days. Typical native vegetation includes catclaw, mesquite, yucca, burroweed, threeawn, grama grasses, Arizona cottontop, bush muhly, and annual grasses. The Nolam-Tombstone complex contrasts sharply with the Comoro soil series. This complex is dominated by gravelly to very gravelly soils and much stronger soil development, with argillic (high in illuvial clay), calcic (>15 percent calcium carbonate), and petrocalcic (>50 percent calcium carbonate and hard like rock; commonly called caliche) horizons.

Figure 6 shows the senior author documenting a soil profile in the field, with the various field equipment used for making the description. Trenches 1, 2, and 4 were all placed on the Cienega Creek flood plain, in or around the abandoned center-pivot irrigation system that is still visible in Figure 2, and

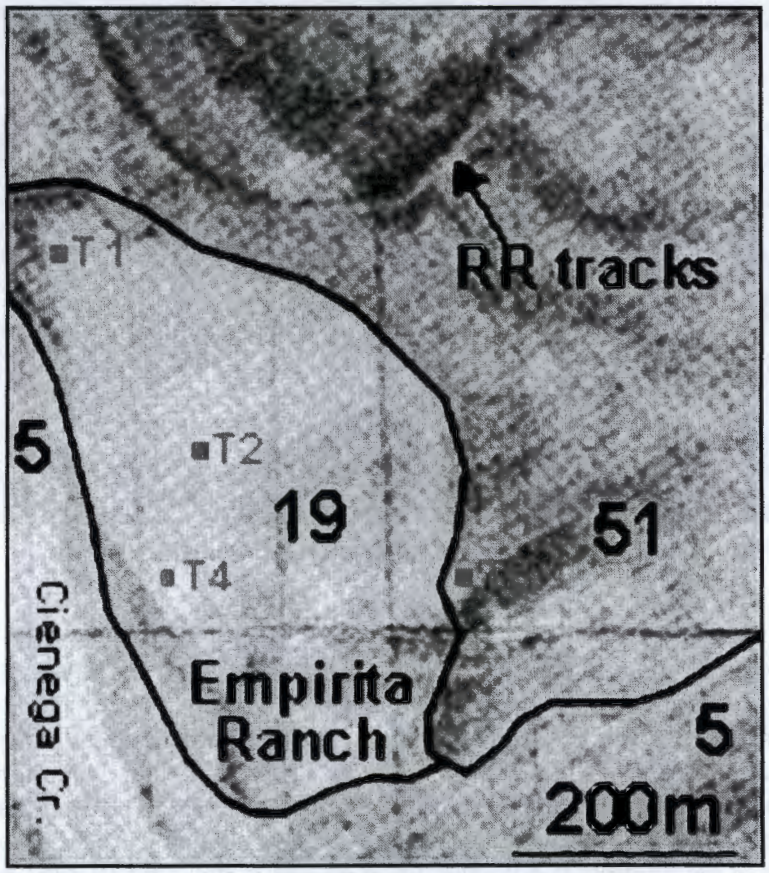

Figure 5. Soil map units in and near the Northern Field of the Empirita Ranch (adapted from Cochran and Richardson 2003:Sheet 64). Key: Unit 5-Arizo-Riverwash complex, 0–3 percent slopes; Unit 19-Comoro sandy loam, 0–2 percent slopes; Unit 51-Nolam-Tombstone complex, 8–30 percent slopes.

Figure 6. Jeffrey Homburg documenting the soil profile of Trench 1 near the northwest corner of the Northern Field.

Trench 3 was placed at the eastern edge of the Northern Field where the alluvial fan fed by an ephemeral drainage grades to the flood plain. Figures 7–12 show these trenches and their soil profiles.

Trenches 1, 2, and 4 are all characterized by weak soil development (that is, A–C profiles lacking B horizons), highly stratified alluvium, and few color differences between horizons. The weak development is because of the young age of the sediment, which, in all likelihood, represents no more than a few centuries of alluvial deposition. Soil structure is generally weak in the A horizon (granular or subangular blocky) and massive in the C horizons. Primary sedimentary structure is still preserved (that is, not significantly disturbed by bioturbation) in many of the C subhorizons, as indicated by the finely stratified laminations. A buried A horizon was noted in Trenches 1 and 2, and this slightly darker horizon may represent a *cienega* deposit that was seasonally wet next to Cienega Creek). Textures in Trenches 1, 2, and 4 consist mainly of sandy loams and silty loams, with occasional strata of loamy sand and gravelly loam sand that mark relict bar and channel deposits. The stratified soils on the floodplain are favorable for crop and plant growth because the varied textures help to slow deep infiltration, thereby conserving moisture in the rooting zone. The sandy loam surface textures, which dominate the Northern Field, have a mulching effect to reduce evaporation from the surface. In addition, sandy loams and silt loams are productive for plant growth because they typically have a high levels of plant-available water (defined by the difference in the amount of water held at the permanent wilting point and at field capacity). Rooting depth is at least 60 inches in each of these trenches. Most roots are fine (1–2 mm) to very fine (< 1 mm) in size, mainly associated with weedy growth in the field, and concentrated in the upper 2 feet or so of the soil. Mesquite roots ranging up to very coarse (>10 mm) in size were only noted in Trench 1, which was placed approximately 10 m east of the mesquite bosque along Cienega Creek.

Trench 3, the one placed on the historical-period berm, contains soil material that is dramatically different from the soils noted on the floodplain. The fill deposits on the summit of the berm and on the lower

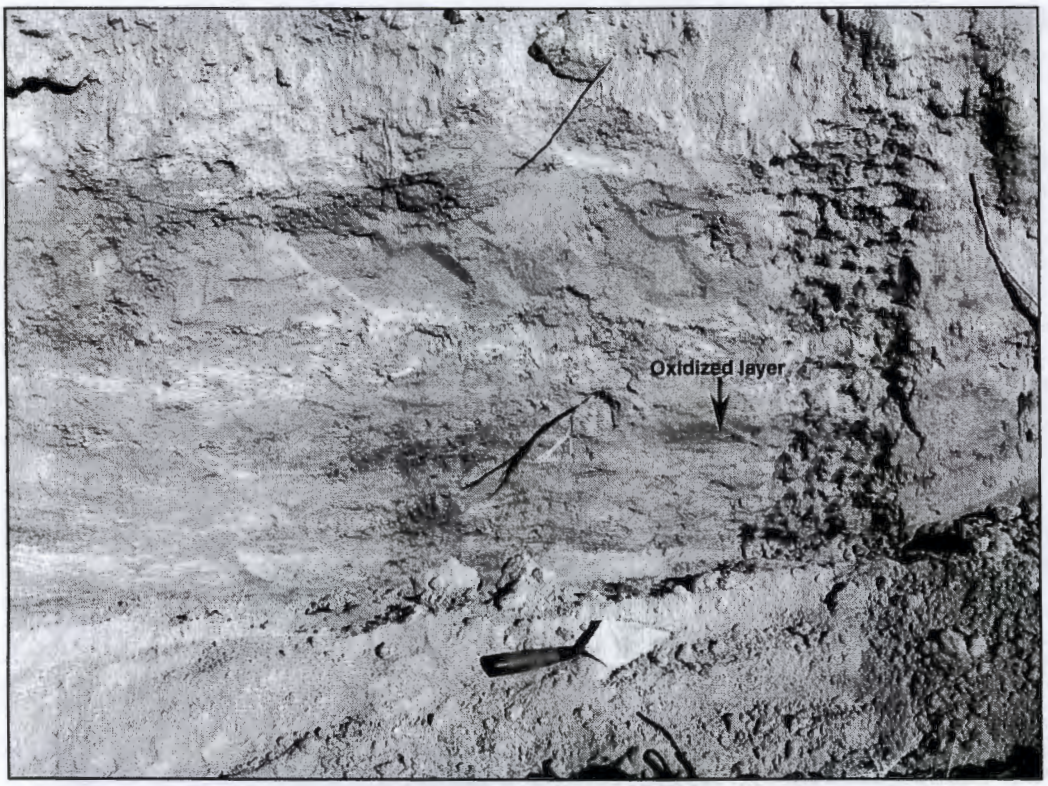

Figure 7. West profile of Trench 1.

Figure 8. Trench 2 in the west-central part of the Northern Field.

Figure 9. West profile of Trench 2.

Figure 10. Trench 3 on the earthen berm near the southeast corner of the Northern Field.

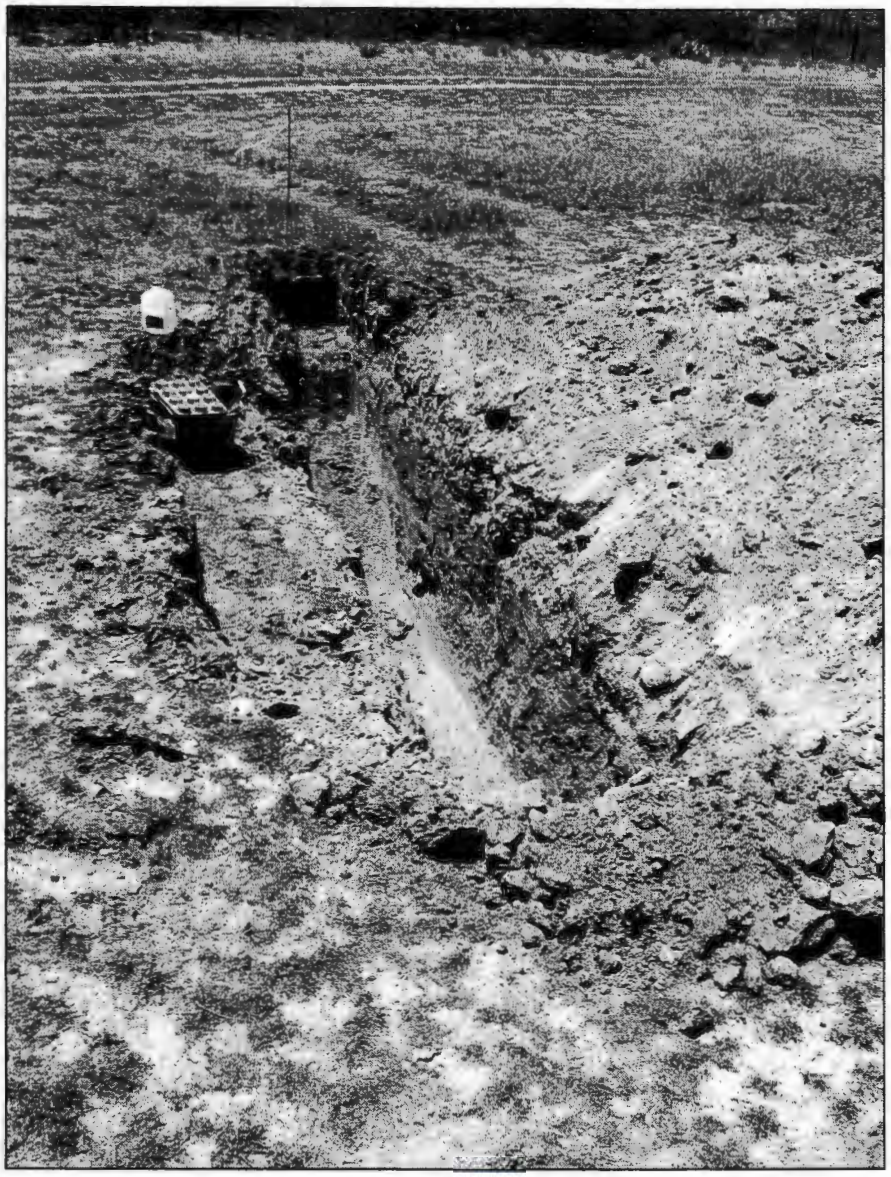

Figure 11. Trench 4 in the southwest part of the Northern Field.

Figure 12. North profile of Trench 4.

berm are described in detail in Appendix A. Trench 3 was placed entirely in gravelly fill material that was used to build the berm. This gravelly fill is clearly derived from the alluvial fan, judging from the shape of the gravel (angular, subangular, and subrounded), which indicates short distance transport). Two layers were found, both of which consisted of gravelly, sandy loam. About 4 feet of compacted gravelly, sandy loam fill overlies more than 1 feet (the latter is probably about 2.5 feet thick, based on the estimated overall berm thickness of about 6.5 feet) of looser fill. Both layers are gravelly, but the upper fill had coarser gravel than below. Fine and very fine roots were noted in both layers of fill on the summit of the berm, but only in the upper 34 inches on the lower berm.

Earthen Berm

The earthen berm is located next to the southeastern corner of the Northern Field. It was constructed as a water control feature to mitigate potential damaging flood waters draining from the wash into the eastern portion of the Northern Field. The berm averages 45 feet in width and it is approximately 250 feet long, extending across an ephemeral drainage between two cobbly ridges on the Pleistocene alluvial fan terrace (see Figure 2). These ridges form a natural catchment that drains westward into the Northern Field (Figure 13). The ends of the berm terminate at the footslope of the two ridges to form an earthen dam (Figure 14). The top of the berm is flat to very gently sloping, varying from 10 to 15 feet wide, and it stands approximately 6 feet above the natural ground surface to the west (Figure 15). The ground surface to the east of the berm is slightly lower, ranging from 6 to 9 feet, and is probably where a borrow pit was excavated to build the berm with gravelly fan alluvium. The sides of the berm have slope gradients of approximately 20 percent. The berm is sparsely vegetated with bermuda grass, four immature mesquite trees, scattered tumbleweeds, and other miscellaneous weeds.

Figure 13. Photograph of earthen berm.

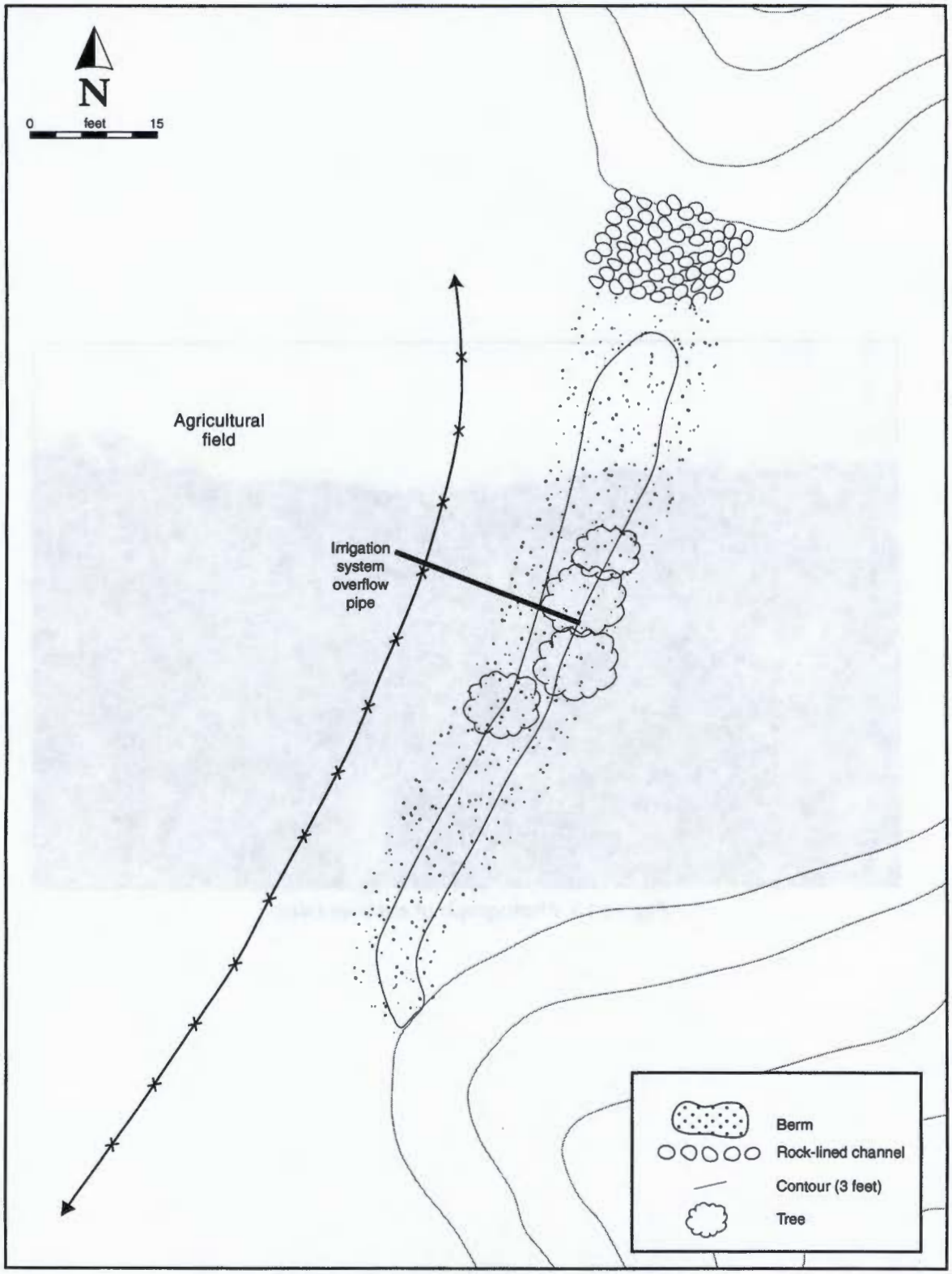

Figure 14. Plan map of the earthen berm.

Figure 15. Overview of earthen berm terminating in northern ridge. Note overflow pipe in background (view to north).

At the northern end of the berm, a unique component was incorporated into the feature construction. Cobbles on both the berm and the adjacent ridge form a through channel (Figure 16) that may have functioned as a spillway for transmitting high water across the berm westward to the floodplain and the Northern Field. The cobbles may also have served to armor the surface and prevent gullying. The channel extends only half the height of the berm. Approximately 80 feet south of the northern end is a 6-inch diameter metal pipe that appears to be associated with the agricultural irrigation system. The pipe emerges from the Northern Field just west of the barbed wire fence (see Figure 14), extends across the berm just under the surface and extends only slightly beyond the top of the berm. The end of the pipe is outfitted with a hand-made, lever-type closure valve (Figure 17). An 8-foot section of sheet metal gutter at one time had been affixed to the pipe to broadcast the water flow beyond the berm, but this mechanism has been displaced and a small erosional channel has formed below the pipe outlet. The function of the pipe is unclear, but it may have served as an irrigation system overflow mechanism or delivered water to cattle grazing on the east side of the feature.

The absence of associated temporally diagnostic artifacts provides little information for determining when the berm was constructed. Feature function and proximity to the Upper Complex, however, strongly suggest a date of construction that is contemporaneous with agricultural use of the Northern Field by the Ohrels, which continued into the 1970s. Curiously, a description of the berm feature was omitted in a recently prepared National Register of Historic Places nomination as contributing to the eligibility of the property (Parkhurst and Ayres 2003).

In addition to this berm, a second, much smaller earthen berm was found within about 100 m to the east, further upstream on the same drainageway. This berm, which has been breached by a small channel that cut completely through it, may have functioned to slow runoff and help protect the larger berm described above.

Figure 16. Cobbly channel at north end of berm (view to west).

Figure 17. Outlet pipe with hand-made closure handle on upper berm.

Summary and Recommendations

Soils in the Northern Field of the Empirita Ranch are dominated by deep, weakly developed soils that are highly stratified, mainly of sandy loam and silt loam textures. These stratified soils are favorable for plant growth because they help to reduce deep infiltration and to conserve plant-available moisture in the rooting zone. These soils provide good opportunities for restoring natural vegetation in this field next to Cienega Creek.

The earthen berm may have functioned both to protect the irrigated field downslope from damaging floods and to provide water for livestock. The age and span of use of the berm is uncertain based on this field evaluation alone, but it was apparently constructed by the Ohrels, who abandoned the ranch in the 1970s. The Empirita Ranch has been nominated for listing in the National Register of Historic Places, but the nomination form contains no reference to this berm. We recommend that if any future plans by Pima County will entail damaging this berm, additional archival work should be completed prior to any such undertaking. This work should include interviews of former ranchers knowledgeable of the berm to better document its age and span of use, as well as to obtain additional details on how it functioned.

APPENDIXES

Soil Pedon for Trenches 1–4 in the Northern Field of the Empirita Ranch

Soil profiles were described for four trenches at the Empirita Ranch on July 20, 2004. The pedon descriptions for the trenches are presented below. Trenches 1, 2, and 4 were placed on the alluvial floodplain of Cienega Creek, and Trench 3 was placed on the historical-period earthen berm that was built across an ephemeral drainageway just east of the floodplain (Trench 3).

Trench 1, Northwest Corner of Northern Field

Classification: Fine-silty, mixed, superactive, calcareous, thermic Ustic Torrifluvents
Geomorphic setting: Floodplain of Cienega Creek, elevation 1,133 m (~3,716 feet), 1–2 percent slope
Parent Material: Stratified stream alluvium from metamorphic, sedimentary and basic and acid igneous rock.
Trench Orientation: 20–200°
UTM Coordinates: Zone 12, NAD 83, N 3536221.3, E 544350.0 (south end of trench)
Latitude and Longitude: N31° 57' 40.0", W110° 31' 50.4"

Ap—0 to 8 inches; brown to grayish brown (10YR 5/2.5) silt loam, brown (10YR 4.5/3) moist; weak fine and medium subangular blocky structure; moderately hard, firm, slightly sticky, slightly plastic; common very fine and fine roots; few fine irregular pores; 0 percent gravel; strongly effervescent; moderately alkaline (pH 7.9); clear smooth boundary.

A—8 to 13 inches; brown (10YR 5/3) silt loam, brown to dark brown (10YR 4/3) moist; massive; hard, very firm, slightly sticky, slightly plastic; common very fine and fine roots; few very fine tubular pores; 0 percent gravel; strongly effervescent; moderately alkaline (pH 7.9); abrupt smooth boundary.

C1—13 to 24 inches; brown (10YR 5/3) fine sandy loam, brown (10YR 4.5/3) moist; massive; slightly hard, friable, nonsticky, slightly plastic; common very fine and fine and few medium to very coarse roots; few very fine tubular pores; 0 percent gravel; strongly effervescent; moderately alkaline (pH 7.9); abrupt smooth boundary. Note: This is the main horizon with coarse to very course lateral mesquite roots, approximately 10 m from the bosque to the west.

C2—24 to 30 inches; brown (10YR 5/3) silt loam, brown (10YR 4/3) moist; massive; hard, very firm, slightly sticky, slightly plastic; common fine and very fine roots; few fine tubular pores; 0 percent gravel; finely stratified with thin (1–2 mm or less in thickness), pale brown (10YR 6/3) silt loam laminae; strongly effervescent; moderately alkaline (pH 8.0); clear smooth boundary.

C3—30 to 33 inches; brown to pale brown (10YR 5.5/3) silt loam, brown (10YR 4.5/3) moist; massive; moderately hard, firm, slightly sticky, slightly plastic; few fine and very fine roots; many fine inter-

stitial pores; 0 percent gravel; strongly effervescent; moderately alkaline (pH 8.0); abrupt smooth boundary.

C4—33 to 34 inches; brown (10YR 5/3) silt loam, brown to dark brown (10YR 4/3) moist; massive; moderately hard, firm, slightly sticky, slightly plastic; few very fine and fine roots; many fine interstitial pores; 0 percent gravel; finely stratified with thin (1–2 mm or less in thickness), pale brown (10YR 6/3) silt loam laminae; strongly effervescent; moderately alkaline (pH 8.0); abrupt smooth boundary.

C5—34 to 37 inches; yellowish brown (10YR 5/4) silt loam, dark yellowish brown (10YR 4/4) moist; massive; moderately hard, firm, slightly sticky, slightly plastic; few fine and very fine roots; many very fine interstitial pores; 0 percent gravel; strongly effervescent; moderately alkaline (pH 7.9); clear smooth boundary. (Note: A burned-out mesquite stump and tap root, now in-filled with some charcoal, was noted originating within the C5 horizon. The soil was visibly oxidized for several meters away from this old stump).

Ab1—37 to 43 inches; brown (10YR 5/3) silt loam, brown to dark brown (10YR 4/3) moist; massive; hard, very firm, slightly sticky, slightly plastic; few very fine and medium fine roots; many very fine interstitial pores; 0 percent gravel; finely stratified with thin (1–2 mm or less in thickness), pale brown (10YR 6/3) silt loam laminae; strongly effervescent; moderately alkaline (pH 8.1); clear smooth boundary.

Ab2—43 to 60+ inches; brown (10YR 4.5/2) silt loam, very dark grayish brown (10YR 3.5/2) moist; massive; hard, very firm, slightly sticky, slightly plastic; few fine and very fine roots; many very fine interstitial pores; 0 percent gravel; finely stratified with thin (1–2 mm or less in thickness), pale brown (10YR 6/3) and brown (7.5YR 5/4) silt loam laminae; strongly effervescent; moderately alkaline (pH 8.0).

Trench 2, West-Central Part of Northern Field

Classification: Coarse-loamy, mixed, superactive, calcareous, thermic Typic Torrifluvents
Geomorphic setting: Floodplain of Cienega Creek, elevation 1,133 m (~3,717 feet), 1–2 percent slope
Parent Material: Stratified stream alluvium from metamorphic, sedimentary and basic and acid igneous rock.
Trench Orientation: 10–190°
UTM Coordinates: Zone 12, NAD 83, N 3536074.0, E 544471.4 (south end of trench)
Latitude and Longitude: N31° 57' 35.2", W110° 31' 45.8"

Ap—0 to 15 inches; brown (10YR 5/3) very fine sandy loam, brown (10YR 4/3) moist; weak fine and medium subangular blocky structure; moderately hard, firm, nonsticky, nonplastic; common very fine and fine and few medium roots; few fine irregular pores; 0 percent gravel; strongly effervescent; slightly alkaline (pH 7.8); clear smooth boundary.

C1—15 to 25 inches; brown (10YR 5/3) loamy sand, brown to dark brown (10YR 4/3) moist; massive; slightly hard, friable, nonsticky, nonplastic; common very fine and few fine roots; few very fine tubular pores; 0 percent gravel; strongly effervescent; slightly alkaline (pH 7.8); abrupt smooth boundary.

C2—25 to 31 inches; brown to grayish brown (10YR 5/2.5) silt loam, dark brown to dark grayish brown (10YR 4/2.5) moist; massive; slightly hard, friable, slightly sticky, slightly plastic; common very fine

and few fine roots; few very fine tubular pores; 0 percent gravel; finely stratified with thin (1–2 mm or less in thickness), pale brown (10YR 6/3) silt loam laminae; strongly effervescent; moderately alkaline (pH 7.9); abrupt smooth boundary.

C3—31 to 35 inches; brown (10YR 5/3) loamy sand, brown to dark brown (10YR 4/3) moist; massive; soft, very friable, nonsticky, nonplastic; few fine and very fine roots; many fine interstitial pores; 0 percent gravel; strongly effervescent; moderately alkaline (pH 8.0); clear smooth boundary.

Ab1—35 to 40 inches; brown (10YR 5/3) silt loam, brown to dark brown (10YR 4/3) moist; massive; moderately hard, firm, slightly sticky, slightly plastic; few fine and very fine roots; many very fine interstitial pores; 0 percent gravel; finely stratified with thin (1–2 mm or less in thickness), pale brown (10YR 6/3) and brown (7.5YR 5/4) silt loam laminae; strongly effervescent; moderately alkaline (pH 8.0); abrupt smooth boundary.

Ab2—40 to 60+ inches; grayish brown to dark grayish brown (10YR 4.5/2) silt loam, dark grayish brown to very dark grayish brown (10YR 4/3) moist; massive; hard to very hard, very firm to extremely firm, moderately sticky, moderately plastic; few very fine and fine roots; many very fine interstitial pores; 0 percent gravel; finely stratified with thin (1–2 mm or less in thickness), pale brown (10YR 6/3) and brown (7.5YR 5/4) silt loam laminae; strongly effervescent; moderately alkaline (pH 8.0); abrupt smooth boundary.

Trench 3, On Berm in Southeast Corner of Northern Field

Classification: Not applicable because this trench was placed in redeposited fill, not a natural soil
Geomorphic setting: Footslope of alluvial fan next to the floodplain of Cienega Creek, elevation 1,137 m (~3,730 feet), 1-2 percent slope on top of the berm and 21 percent slope on the western side of the berm.
Parent Material: Redeposited gravelly fan alluvium from mixed sources (granite, rhyolite, andesite, dacite, and related tuff, and agglomerates).
Trench Orientation: 100-280°
UTM Coordinates: Zone 12, NAD 83, N 3535918.1, E 544721.4 (east end of trench)
Latitude and Longitude: N31° 57' 30.1", W110° 31' 36.3"

Summit of Berm:
Upper fill—0 to 49 inches; brown (7.5YR 5/4) gravelly sandy loam, brown to dark brown (7.5YR 4/4) moist; massive; hard to very hard, very firm to extremely firm, nonsticky, nonplastic; common very fine and fine roots; common fine and medium irregular pores; ~20 percent fine, medium, and coarse, angular, subangular, and subrounded gravel; strongly effervescent; moderately alkaline (pH 8.0); clear smooth boundary.

Lower fill—49 to 60+ inches. Brown (7.5YR 5/4) gravelly sandy loam, brown to dark brown (7.5YR 4/4) moist; massive; slightly hard, friable, nonsticky, nonplastic; few very fine roots; common fine and medium irregular pores; ~20 percent fine and medium, angular, subangular, and subrounded gravel; strongly effervescent; moderately alkaline (pH 8.0).

Lower Berm:
Upper fill—0 to 34 inches. Brown to dark brown (7.5YR 4/2) gravelly sandy loam, dark brown (7.5YR 3/2) moist; massive; very hard, extremely firm, nonsticky, nonplastic; many very fine and common fine roots; common fine and medium irregular pores; ~20 percent fine, medium, and coarse, angular,

subangular, and subrounded gravel; strongly effervescent; moderately alkaline (pH 8.0); clear smooth boundary.

Lower fill—34 to 51+ inches. Brown (7.5YR 5/4) gravelly sandy loam, brown to dark brown (10YR 4/4) moist; massive; slightly hard, friable, nonsticky, nonplastic; no roots; common fine and medium irregular pores; ~20 percent fine, and medium, angular, subangular, and subrounded gravel; strongly effervescent; moderately alkaline (pH 8.0).

Trench 4, Southwest Part of Northern Field

Classification: Coarse-loamy, mixed, superactive, calcareous, thermic Typic Torrifluvents
Geomorphic setting: Floodplain of Cienega Creek, elevation 1,133 m (~3,716 feet), 1–2 percent slope
Trench Orientation: 75–255°
UTM Coordinates: Zone 12, NAD 83, N 3535938.5, E 544453.6 (west end of trench)
Latitude and Longitude: N31° 57' 30.8", W110° 31' 46.5"

Ap—0 to 11 inches; pale brown (10YR 6/3) very fine sandy loam, brown (10YR 5/3) moist; moderate fine and medium subangular blocky to clod structure; hard, very firm, nonsticky, nonplastic; many very fine and common fine roots that are commonly flattened between clods; many fine and medium irregular pores; ~5 percent fine and medium, subangular and subrounded gravel; strongly effervescent; moderately alkaline (pH 8.1); clear smooth boundary.

A—11 to 15 inches; pale brown (10YR 6/3), brown (10YR 5/3) moist; weak fine granular structure; hard, very firm, nonsticky, nonplastic; many very fine and common fine roots; common fine irregular pores; 5 percent fine and medium, subangular and subrounded gravel; strongly effervescent; moderately alkaline (pH 8.1); abrupt smooth boundary.

2C1—15 to 22 inches; brown to dark brown (7.5YR 4/2) very gravelly loamy sand, dark brown (7.5YR 3/2) moist; massive; soft, very friable, nonsticky, slightly plastic; common very fine and fine roots; fine and medium interstitial pores; ~40 percent fine, medium, and coarse, subangular and subrounded gravel; strongly effervescent; moderately alkaline (pH 8.0); abrupt smooth boundary.

3C2—22 to 41 inches; brown (10YR 5/3) silt loam, brown (10YR 4/3) moist; massive; slightly hard, friable, slightly sticky, slightly plastic; common very fine and few fine roots; fine interstitial pores; ~3 percent fine and medium, subangular and subrounded gravel; strongly effervescent; moderately alkaline (pH 8.0); clear smooth boundary.

3C3—41 to 60+ inches; brown to pale brown (10YR 5.5/3) silt loam, brown (10YR 4.5/3) moist; massive; moderately hard, firm, slightly sticky, slightly plastic; few fine and very fine roots; many fine interstitial pores; 0 percent gravel; strongly effervescent; moderately alkaline (pH 8.0); abrupt smooth boundary.

C4—33 to 34 inches; brown (10YR 5/3) silt loam, brown to dark brown (10YR 4/3) moist; massive; moderately hard, firm, slightly sticky, slightly plastic; few very fine and fine roots; many fine interstitial pores; <1 percent fine subangular and subrounded gravel; strongly effervescent; moderately alkaline (pH 8.1).

Soil Pedon Descriptions for Map Units in and near the Northern Field of the Empirita Ranch

The following soil descriptions are presented alphabetically, based on soil map units identified in the "Soil Survey of Pima County, Arizona, Eastern Part" (Cochran and Richardson 2003: Sheet 64). The official pedon descriptions for the soil series in these map units were obtained from the website of the Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture. Official Soil Series Descriptions [Online WWW]. Available URL: "http://soils.usda.gov/soils/technical/classification/osd/index.html" [Accessed July 19, 2004].

ANTHONY SERIES

Location: ANTHONY, AZ+NM TX
Established Series
Revised by YHH/RCH/PDC/WWJ, 11/2001

The Anthony series consists of very deep, well drained soils formed in stratified alluvium. Anthony soils are on alluvial fans and floodplains and have slopes of 0 to 15 percent. The mean annual precipitation is about 8 inches and the mean annual air temperature is about 65°F.

Taxonomic Class: Coarse-loamy, mixed, superactive, calcareous, thermic Typic Torrifluvents

Typical Pedon: Anthony sandy loam, rangeland. (Colors are for dry soil unless otherwise noted.)
A—0 to 2 inches; brown (10YR 5/3) sandy loam, brown (10YR 4/3) moist; weak medium platy structure; soft, very friable, nonsticky and nonplastic; few very fine roots; few fine irregular pores; slightly effervescent; moderately alkaline (pH 8.0); abrupt smooth boundary. (1 to 8 inches thick)

C1—2 to 30 inches; pale brown (10YR 6/3) fine sandy loam, brown (10YR 4/3) moist; massive; slightly hard, very friable, nonsticky and slightly plastic; few fine and medium and common very fine roots; few very fine tubular pores; strongly effervescent; moderately alkaline (pH 8.0); gradual wavy boundary. (20 to 30 inches thick)

C2—30 to 46 inches; brown (10YR 5/3) sandy loam, brown (10YR 4/3) moist; massive; slightly hard, friable, nonsticky and slightly plastic; few very fine roots; few very fine tubular pores; few fine gravel; strongly effervescent; moderately alkaline (pH 8.0); clear wavy boundary. (12 to 22 inches thick)

C3—46 to 60 inches; brown (10YR 5/3) very gravelly sandy loam, brown (10YR 4/3) moist; massive; slightly hard, friable, nonsticky and slightly plastic; few very fine roots; few very fine tubular pores; 50 percent gravel; strongly effervescent; moderately alkaline (pH 8.0).

Type Location: Graham County, Arizona; 9 miles east of Safford; 900 feet north and 1,600 feet west of the southeast corner of section 2, T.7 S., R.27 E.

Range in Characteristics:

Soil moisture: intermittently moist in the soil moisture control section during July–August and December-January. Driest during May and June. Typic aridic soil moisture regime.

Soil temperature: 59 to 72°F

Rock fragments: 5 to 35 percent gravel in the control section

Organic matter: Less than 1 percent that decreases irregularly with depth

Reaction: Neutral to strongly alkaline

Stratification: Usually thin strata of finer or coarser material

A horizon—Hue: 10YR, 7.5YR
Value: 5, 6, or 7 dry, 3 through 6 moist
Chroma: 2, 3, or 4, dry or moist
Calcium carbonate: None to strongly effervescent

C horizon—Hue: 10YR, 7.5YR
Value: 4 through 7 dry, 3 through 6 moist
Chroma: 2 through 6, dry or moist
Texture: Sandy loam, coarse sandy loam, fine sandy loam, containing more than 15 percent medium, coarse and very coarse sand
Calcium carbonate: Slightly or strongly effervescent as disseminated or accumulations as filaments

Competing Series: These are the Excelsior, Gila, Grabe, Junction, Rucker, and Tobler series. Potential competitors that do not yet have CEA class assigned are the Ireteba, Popson, and Victorville series. Excelsior, Popson and Victorville soils receive most of their precipitation in the winter and are dry in the soil moisture control section from April to December. Gila and Grabe soils are loam, silt loam or very fine sandy loam with less than 15 percent medium or coarser sand in the control section. Junction and Tobler soils have hue redder than 7.5YR, and Junction soils contain gypsum. Ireteba soils contain horizons of distinct calcium carbonate accumulations. Rucker soils contain more than 1 percent organic matter in the surface.

Geographic Setting: Anthony soils are on alluvial fans and floodplains. Elevations range from 1,400 to 4,800 feet. Slopes range from 0 to 15 percent. These soils formed in stratified alluvium from mixed sources. The mean annual precipitation is 4 to 12 inches, occurring as summer thunderstorms and gentle winter rain. The mean annual air temperature is 57 to 70°F. Frost-free period is 180 to 275 days.

Geographically Associated Soils: These are the Arizo, Brazito, Glendale and Hantz soils. Arizo soils are sandy-skeletal. Brazito soils are sandy. Glendale soils are fine-silty. Guest soils are fine textured.

Drainage and Permeability: Well drained. Permeability is moderately rapid. Runoff is negligible on slopes less than 3 percent, very low on 3 to 5 percent slopes, low on 5 to 10 percent slopes, and medium on 10 to 15 percent slopes.

Use and Vegetation: These soils are used for livestock grazing, wildlife habitat and irrigated cropland. Vegetation is creosote bush, bur sage, cacti, palo verde, bush muhly, spike dropseed, Pima pappusgrass, fourwing saltbush and annual forbs and grasses. Irrigated crops are cotton and alfalfa.

Distribution and Extent: Southern Arizona, southern New Mexico, southern Nevada and west Texas. The Anthony series is extensive. This soil occurs in LRR-D, MLRAs 40, 41 and 42.

MLRA Office Responsible: Phoenix, Arizona

Series Established: Mesilla Valley, New Mexico; 1912

Remarks: Diagnostic horizons and features recognized in this pedon are:
Ochric epipedon—The zone from 0 to 2 inches (A horizon)
Entisol feature—The absence of diagnostic subsurface horizons
Fluvial feature—Irregular decrease in organic carbon in the zone from 2 to 60 inches (C1, C2, C3 horizons)

Classified according to Soil Taxonomy Second Edition, 1999.

ARIZO SERIES

Location: ARIZO, NV+AZ CA NM
Established Series
Revised by LNL/RPZ/ET, 01/2000

The Arizo series consists of very deep, excessively drained soils that formed in mixed alluvium. Arizo soils are on recent alluvial fans, inset fans, fan apron, fan skirts, stream terraces, floodplains of intermittent streams and channels. Slopes are 0 to 15 percent. The mean annual precipitation is about 7 inches and the mean annual temperature is about 62° F.

Taxonomic Class: Sandy-skeletal, mixed, thermic Typic Torriorthents

Typical Pedon: Arizo very gravelly fine sand, desert wildlife habitat. (Colors are for dry soil unless otherwise noted.)

A—0 to 8 inches; light brownish gray (10YR 6/2) very gravelly fine sand, dark grayish brown (10YR 4/2) moist; weak coarse platy structure; slightly hard, very friable, nonsticky and nonplastic; few fine and medium roots; few fine vesicular and many very fine and fine interstitial pores; 35 percent pebbles; strongly effervescent; moderately alkaline (pH 8.2); abrupt wavy boundary (0 to 10 inches thick).

C1—8 to 36 inches; light brownish gray (10YR 6/2) extremely gravelly sand, dark grayish brown (10YR 4/2) moist; single grained; loose, nonsticky and nonplastic; few fine and medium roots; many very fine and fine interstitial pores; 60 percent pebbles, 10 percent cobbles; few very thin coats of lime on undersides of pebbles; strongly effervescent; moderately alkaline (pH 8.2); gradual wavy boundary. (12 to 36 inches thick)

C2—36 to 62 inches; light brownish gray (10YR 6/2) extremely gravelly sand, dark grayish brown (10YR 4/2) moist; single grained; loose, nonsticky and nonplastic; few very fine and fine roots; many very fine and fine, and few medium interstitial pores; 60 percent pebbles, 20 percent cobbles, 3 percent stones; strongly effervescent; moderately alkaline (pH 8.2).

Type Location: Clark County, Nevada; about 1,000 feet east and 600 feet south of center of section 20, R. 13 S., R. 17 E.

Range in Characteristics:

Soil moisture: Usually dry, moist for short periods throughout the moisture control section during December through March. Moist above and periodically in upper part of moisture control section for 10 to 20 days cumulative, during July through October.

Soil temperature: 59 to 71°F

Reaction: Neutral to strongly alkaline.

Other features: Effervescent in some or all parts, with thin lime coatings on undersides of rock fragments in some pedons.

Control section: Rock fragments: 35 to 85 percent, mainly pebbles.

A horizon—Hue: 10YR or 7.5YR
Value: 5 through 8 dry, 3 through 6 moist
Chroma: 2 through 6

C horizon—10YR or 7.5YR
Value: 5 through 8 dry, 3 through 6 moist
Chroma: 2 through 6
Texture of fine earth: Averages coarse sand through loamy sand
Structure: Single grained or massive

Competing Series: These are the Jean (NV) and Kokan (NM) series. Jean soils have a shallow Bw horizon and have textures in the upper control section of loamy sand or loamy fine sand with less than 15 percent rock fragments. Kokan soils are moist for short periods in some part mainly in July, August, and early September and are dry the rest of the year.

Geographic Setting: Arizo soils are on recent alluvial fans, inset fans, fan aprons, fan skirts, stream terraces, floodplains of intermittent streams and channels. These soils formed in alluvium from mixed rock sources. Slopes are 0 to 15 percent. Elevations are 750 to 4,500 feet. The climate is arid or semiarid with mild winters and hot dry summers. The mean annual precipitation is 2 to 10 inches and may range to 13 inches in Arizona where temperatures are 67 to 70°F; mean annual temperature is 57 to 70°F, and the frost-free season is 200 to 340 days.

Geographically Associated Soils: These are the Bard, Bitter Spring, Gila, Nickel, Tonopah, and Vinton soils. Bard soils have a petrocalcic horizon. Bitter Spring soils have a gravelly sandy loam B2t horizon. Gila soils have a loamy control section. Nickel and Tonopah soils have a calcic horizon. Vinton soils have a loamy fine sand or loamy sand control section.

Drainage and Permeability: Excessively drained; negligible to medium runoff; rapid to very rapid permeability. Arizo soils with sandy loam and loam surface textures have moderate or moderately rapid over very rapid permeability.

Use and Vegetation: Source of sand and gravel, rangeland, and wildlife habitat. The present vegetation is mainly creosote bush and white bur sage.

Distribution and Extent: Southern Nevada, Southern California, Arizona, and New Mexico. These soils are extensive. The central concept for the series is in MLRA 30. Use in MLRA 40, 41, 42 should be reevaluated.

MLRA Office Responsible: Davis, California

Series Established: Clark County (Virgin River Area), Nevada. 1971.

Remarks: Diagnostic horizons and features recognized in this pedon are:
Particle-size control section—The zone from 10 to 40 inches.

BERNARDINO SERIES

Location: BERNARDINO, AZ
Established Series
Revised by MLR/DLR/PDC/WWJ, 06/2000

The Bernardino series consists of very deep, well drained soils that formed in fan alluvium from igneous and sedimentary rock. Bernardino soils are on fan terraces and have slopes of 0 to 30 percent. The mean annual precipitation is about 14 inches and the mean annual air temperature is about 62°F.

Taxonomic Class: Fine, mixed, superactive, thermic Ustic Calciargids

Typical Pedon: Bernardino gravelly clay loam, rangeland. (Colors are for dry soil unless otherwise noted.)

A—0 to 2 inches; dark brown (7.5YR 3/2) gravelly clay loam, dark brown (7.5YR 3/2) moist; weak medium platy structure parting to moderate fine granular; slightly hard, friable, moderately sticky and moderately plastic; common very fine and fine roots; many very fine irregular pores; 35 percent gravel; slightly alkaline (pH 7.5); abrupt smooth boundary. (1 to 3 inches thick)

Bt1—2 to 9 inches; dark reddish brown (5YR 3/3) gravelly clay loam, dark reddish brown (5YR 3/4) moist; moderate fine subangular blocky structure; hard, friable, moderately sticky and moderately plastic; common very fine and fine roots; few very fine tubular and irregular pores; common faint patchy clay films on faces of peds and lining pores; 20 percent gravel; slightly alkaline (pH 7.5); clear wavy boundary. (5 to 8 inches thick)

Bt2—9 to 15 inches; dark reddish brown (5YR 3/4) gravelly clay, dark reddish brown (5YR 3/4) moist; moderate fine and medium subangular and angular blocky structure; hard, friable, moderately sticky and moderately plastic; few very fine and medium roots; few very fine tubular and common very fine irregular pores; common faint clay films on faces of peds and lining pores; 15 percent gravel; strongly effervescent in spots; moderately alkaline (pH 8.0); clear wavy boundary. (4 to 9 inches thick)

2Bk1—15 to 48 inches; pinkish gray (5YR 7/2) gravelly sandy loam, reddish brown (5YR 5/3) moist; massive; very hard, friable, nonsticky and slightly plastic; few very fine and fine roots; many very fine and fine irregular pores; 30 percent gravel; common fine irregular calcium carbonate masses; violently effervescent; moderately alkaline (pH 8.0); gradual smooth boundary. (30 to 40 inches thick)

2Bk2—48 to 60 inches; pinkish gray (5YR 7/2) very gravelly sandy loam, reddish brown (5YR 5/3) moist; massive; very hard, friable, nonsticky and slightly plastic; many very fine and fine irregular pores; 40 percent gravel; few fine irregular calcium carbonate masses; strongly effervescent; moderately alkaline (pH 8.0).

Type Location: Santa Cruz County, Arizona; about 2 miles southeast of Sonoita; 500 feet west and 650 feet north of the southeast corner of Section 29, T. 20 S., R. 17 E.

Range in Characteristics:

Soil Moisture: Intermittently moist in some part of the soil moisture control section during July–September and December–February. Driest during May and June. Ustic aridic soil moisture regime.

Soil Temperature: 60 to 70°F

Depth to calcic horizon: 5 to 20 inches. Calcium carbonate equivalent averages 15 to 40 percent and decreases with increasing depth

Rock Fragments: Averages less than 35 percent in the control section; can range to 80 percent in any one horizon

Organic matter: Averages 1 percent or more in the surface

Reaction: Neutral or slightly alkaline in the upper part and slightly or moderately alkaline in the lower part

A horizon—Hue: 5YR, 7.5YR, 10YR
Value: 3 through 6 dry, 2 through 5 moist
Chroma: 2, 3 or 4, dry or moist

Bt horizon—Hue: 2.5YR, 5YR, 7.5YR
Value: 3, 4 or 5 dry, 2, 3 or 4 moist
Chroma: 2 through 6, dry or moist
Texture: Clay loam, clay

Bk or C horizon—Hue: 2.5YR through 10YR
Value: 5 through 8 dry, 4 through 7 moist
Chroma: 2 through 6, dry or moist
Texture: Sandy loam, sandy clay loam, clay loam, loam, loamy sand

Competing Series: These are the Forrest and Stellar series. A potential competitor that does not yet have CEA class assigned is the Penthouse series. All these soils have a calcic horizon at depths of 20 to 40 inches.

Geographic Setting: Bernardino soils are on fan terraces and have slopes of 0 to 30 percent. These soils formed in fan alluvium from mixed sources. Elevation ranges from 3,500 to 5,500 feet. The mean annual precipitation ranges from 12 to 16 inches. The mean annual air temperature is 58 to 68°F. The frost-free period is 160 to 250 days.

Geographically Associated Soils: These are the Bonita, McAllister, Stronghold, Tombstone and the competing Forrest and White House soils. Bonita soils are fine textured. McAllister soils are fine-loamy. Stronghold and Tombstone soils do not have argillic horizons.

Drainage and Permeability: Well drained; slow or medium runoff; slow permeability.

Use and Vegetation: Bernardino soils are used for livestock grazing and wildlife habitat. The present vegetation is sideoats grama, slender grama, purple grama, plains lovegrass, cane beardgrass, curly mesquite, tobosa, bear grass, and mesquite.

Distribution and Extent: Southern Arizona. This series is of moderate extent. MLRA is 41.

MLRA Office Responsible: Phoenix, Arizona

Series Established: Santa Cruz County (Santa Cruz County Area), Arizona; 1971.

Remarks: Diagnostic horizons and features recognized in this pedon are:
Ochric epipedon—The zone from 0 to 2 inches (A horizon)
Argillic horizon—The zone from 2 to 15 inches (Bt1, Bt2 horizons)
Calcic horizon—The zone from 15 to 60 inches (2Bk1, 2Bk2 horizons).
Classified according to Soil Taxonomy Second Edition, 1999

CARALAMPI SERIES

Location: CARALAMPI, AZ+NM
Established Series
Revised by MLR/CCC/PDC/CEM/WWJ, 06/2000

The Caralampi series consists of very deep, well drained soils formed in fan and slope alluvium from granitic and volcanic rock. Caralampi soils are on fan terraces and hills. Slopes range from 1 to 50 percent. The mean annual precipitation is about 14 inches and the mean annual air temperature is about 62°F

Taxonomic Class: Loamy-skeletal, mixed, superactive, thermic Ustic Haplargids

Typical Pedon: Caralampi very gravelly sandy loam, rangeland. (Colors are for dry soil unless otherwise noted.)

A—0 to 2 inches; dark brown (7.5YR 4/4) very gravelly sandy loam, dark reddish brown (5YR 3/4) moist; weak fine granular structure; slightly hard, friable, nonsticky and nonplastic; common very fine and fine roots; common irregular pores; 40 percent gravel; slightly acid (pH 6.2); abrupt smooth boundary. (1 to 5 inches thick)

BAt—2 to 5 inches; dark brown (7.5YR 4/2) very gravelly sandy clay loam, dark brown (7.5YR 3/2) moist; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and moderately plastic; common very fine and fine roots; many irregular pores; few faint clay films in tubular pores; 55 percent gravel; slightly acid (pH 6.5); clear wavy boundary.

Bt1—5 to 9 inches; dark reddish brown (5YR 3/4) very gravelly sandy clay loam, dark reddish brown (5YR 3/4) moist; weak fine and medium subangular blocky structure; slightly hard, friable, moderately sticky and moderately plastic; many very fine and fine roots; common irregular and fine tubular pores; few faint clay films on faces of peds; 50 percent gravel; slightly acid (pH 6.1); abrupt wavy boundary.

Bt2—9 to 13 inches; yellowish red (5YR 4/6) very gravelly sandy clay loam, dark red (2.5YR 3/6) moist; moderate medium subangular blocky structure; hard, friable, moderately sticky and moderately plastic; many very fine and fine roots; common irregular and fine tubular pores; common faint clay films on faces of peds and in pores; 50 percent gravel; slightly acid (pH 6.1); clear wavy boundary.

Bt3—13 to 23 inches; yellowish red (5YR 4/6) and reddish yellow (5YR 6/6) gravelly sandy clay loam, yellowish red (5YR 4/6) moist; weak fine and medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; common fine roots; few very fine tubular pores; common faint clay films on faces of peds; 40 percent gravel; slightly acid (pH 6.5); clear wavy boundary. (Combined thickness of the Bt horizons is 12 to 29 inches)

BCt1—23 to 31 inches; reddish brown (5YR 5/4) very gravelly sandy loam, reddish brown (5YR 4/4) moist; common fine faint pink (5YR 7/3) and light reddish brown (5YR 6/3) features, light reddish brown (5YR 6/4) moist; massive; hard, friable, slightly sticky and slightly plastic; few very fine and fine roots; few very fine tubular pores; few faint clay films in pores; 50 percent gravel; slightly acid (pH 6.5); clear wavy boundary.

BCt2—31 to 42 inches; light reddish brown (5YR 6/4) very gravelly sandy loam, reddish brown (5YR 4/4) moist; massive; hard, friable, nonsticky and slightly plastic; few very fine roots; few faint clay films in pores; 50 percent gravel; slightly acid (pH 6.5); clear wavy boundary. (Combined thickness of the BC horizons is 6 to 21 inches)

C—42 to 60 inches; light brown (7.5YR 6/4) gravelly sandy loam, dark brown (7.5YR 4/4) moist; massive; hard, friable, nonsticky and nonplastic; 30 percent gravel; slightly acid (pH 6.5).

Type Location: Santa Cruz County, Arizona; 2.5 miles north-northwest of Nogales, Arizona; about 2,800 feet north and 1,600 feet west of the southeast corner of section 36, T. 23 S., R. 13 E.

Range in Characteristics:

Soil moisture: Intermittently moist in some part of the soil moisture control section during July–September and December–March. Driest during May and June. Ustic aridic soil moisture regime.

Soil temperature: 59 to 69°F

Rock fragments: 35 to 80 percent

Calcium carbonate: Noneffervescent in the upper part, may have slight to strong effervescence below 40 inches

Organic matter content: Greater than 1 percent in the upper 10 inches

A horizon—Hue: 10YR, 7.5YR, 5YR
Value: 3 through 5 dry, 3 or 4 moist
Chroma: 2, 3, or 4, dry or moist
Reaction: Neutral to moderately acid

Bt horizons—Hue: 5YR, 2.5YR
Value: 3 through 5, dry or moist
Chroma: 3, 4, or 6, dry or moist
Texture: Sandy clay loam, clay loam, sandy loam (more than 18 percent clay)
Reaction: slightly acid to slightly alkaline

BC, Bk and C horizons—Hue: 7.5YR, 5YR
Value: 3 through 7, dry or moist
Chroma: 2, 3, 4, or 6, dry or moist
Texture: Sandy loam, coarse sandy loam, sandy clay loam
Reaction: Slightly acid to moderately alkaline

Competing Series: These are the Holliday, Hoppswell, Hyrhy, and Monza series. Potential competitors still classified as Ustollic are the Coxwell and Maloy series. Coxwell, Hyrhy, and Monza soils have bedrock at moderate depths. Holliday soils contain less than 18 percent clay. Hoppswell soils are moist in the soil moisture control section less than 20 days cumulative from July to September. Maloy soils contain dominantly cobble size rock fragments in the control section.

Geographic Setting: Caralampi soils are on strongly sloping to steep fan terraces and hills. Slopes range from 1 to 50 percent. Elevations range from 2,800 to 5,200 feet. These soils formed in fan and slope alluvium derived from granite, rhyolite, andesite, dacite, and related tuff, and agglomerates. Mean annual air temperature ranges from 57 to 68°F and the mean annual precipitation ranges from 12 to 16 inches. The frost-free period is 180 to 260 days.

Geographically Associated Soils: These are the Riveroad, Comoro, and White House soils. Riveroad and Comoro soils do not have argillic horizons. White House soils are clayey.

Drainage and Permeability: Well drained; medium to rapid runoff; moderately slow permeability.

Use and Vegetation: These soils are used for livestock grazing, wildlife habitat and urban development. Vegetation is curly mesquite, sprucetop grama, hairy grama, sideoats grama, threeawn, cane beardgrass,

wolftail, and plains lovegrass. Brush species are mesquite, catclaw, mimosa, calliandra, range ratany, and a few oak and cacti.

Distribution and Extent: Southern Arizona. Caralampi soils are moderately extensive.

MLRA Office Responsible: Phoenix, Arizona

Series Established: Santa Cruz County Area, Arizona; 1971.

Remarks: Diagnostic horizons and features recognized in this pedon are:
Ochric epipedon—The zone from 0 to 2 inches (A horizon)
Argillic horizon—The zone from 2 to 42 inches (BAt, Bt1, Bt2, Bt3, BCt1, BCt2)
Classified according to Soil Taxonomy Second Edition, 1999

COMORO SERIES
Location: COMORO, AZ+NM
Established Series
Revised by CWG/JEJ/PDC/CEM/WWJ, 11/2001

The Comoro series consists of very deep, well or somewhat excessively well drained soils formed in stratified alluvium. Comoro soils are on alluvial fans and flood plains and have slopes of 0 to 8 percent. The mean annual precipitation is about 14 inches and the mean annual air temperature is about 65°F

Taxonomic Class: Coarse-loamy, mixed, superactive, calcareous, thermic Ustic Torrifluvents

Typical Pedon: Comoro sandy loam, irrigated cropland. (Colors are for dry soil unless otherwise noted.)

Ap—0 to 8 inches; brown (7.5YR 5/2) sandy loam, dark brown (7.5YR 3/2) moist; weak fine and medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; many very fine and fine roots; many fine irregular pores; slightly alkaline (pH 7.5); clear smooth boundary. (5 to 8 inches thick)

C1—8 to 19 inches; brown (7.5YR 5/3) sandy loam, dark brown (7.5YR 3/3) moist; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; many very fine and fine roots; many very fine and fine tubular pores; moderately alkaline (pH 8.0); clear wavy boundary. (5 to 12 inches thick)

C2—19 to 46 inches; light brown (7.5YR 6/3) fine sandy loam, brown (7.5YR 4/3) moist; massive; slightly hard, very friable, nonsticky and nonplastic; common very fine and fine roots; many fine and very fine tubular pores; slightly effervescent; moderately alkaline (pH 8.2); clear wavy boundary. (20 to 40 inches thick)

C3—46 to 60 inches; light brown (7.5YR 6/3) sandy loam, brown (7.5YR 4/3) moist; massive; slightly hard, very friable, nonsticky and nonplastic; common very fine and fine roots; many very fine and fine tubular pores; slightly effervescent; moderately alkaline (pH 8.0).

Type Location: Cochise County, Arizona; about 2 miles north of Elfrida; 2,500 feet east and 2,000 feet south of the northwest corner of section 9, T.20 S., R.26 E.

Range in Characteristics:
Soil Moisture: Intermittently moist in some part of the soil moisture control section during July–September and December–February. Driest during May and June. The epipedon is moist in some part less

than 90 days (cumulative) when the soil temperature is above 41°F in 7 out of 10 years. Ustic aridic soil moisture regime.

Soil Temperature: 59 to 72°F

Stratification: Usually thin strata of finer or coarser material.

Rock Fragments: Averages less than 35 percent in the control section.

Organic matter: more than 1 percent in the surface that decreases irregularly with depth. Commonly dark colored to a depth of 36 inches or more.

Reaction: Neutral to moderately alkaline; can range to slightly acid in the upper part.

A horizon—Hue: 10YR, 7.5YR
Value: 3, 4 or 5 dry, 2 or 3 moist
Chroma: 1, 2 or 3, dry or moist
Calcium carbonate: none to strongly effervescent

C horizon—Hue: 10YR, 7.5YR
Value: 3 through 6 dry, 2, 3 or 4 moist
Chroma: 1 through 4, dry or moist
Texture: Sandy loam, coarse sandy loam, fine sandy loam, loamy sand (less than 18 percent clay)
Calcium carbonate: Slightly to violently effervescent as disseminated or as filaments. Some areas on alluvial fans, in swales, and along narrow drainageways do not effervesce.

Competing Series: This is the Ubik series. A potential competitor that does not yet have CEA class assigned is the San Jose series. San Jose soils have soil temperatures of about 58 to 62°F, hue redder than 7.5YR from the influence of red sandstone and shale, and occur on the Great Plains as part of MLRA 70. Ubik soils are loam, very fine sandy loam and silt loam in the control section.

Geographic Setting: Comoro soils are on alluvial fans and flood plains. Elevations range from 2,200 to 5,200 feet. Slopes range from 0 to 8 percent. These soils formed in stratified alluvium from predominantly granite and rhyolite sources. The mean annual precipitation is 12 to 16 inches occurring as summer thunderstorms and winter rain. The mean annual air temperature is 57 to 70°F. Frost-free period is 160 to 240 days.

Geographically Associated Soils: These are the Bodecker, Elgin, McAllister, and Stronghold series and the competing Ubik series. Bodecker soils have sandy-skeletal control sections. Elgin, McAllister, and Stronghold soils are on fan terraces.

Drainage and Permeability: Well or somewhat excessively well drained; medium runoff; moderately rapid permeability.

Use and Vegetation: Used for livestock grazing and irrigated cropland. Vegetation is catclaw, mesquite, yucca, burroweed, threeawn, grama grasses, Arizona cottontop, bush muhly and annual grasses. Irrigated crops are cotton, small grains, sorghum and alfalfa.

Distribution and Extent: Southern Arizona. Comoro soils are extensive. This soil occurs in LRR-D, MLRAs 40, 41, 42.

MLRA Office Responsible: Phoenix, Arizona

Series Established: Santa Cruz County, Arizona; 1930.

Remarks: Formerly part of the Rucker series that included both typic aridic and ustic aridic soil moisture

regimes. The type location for Comoro was moved in 1981 to a typic aridic area in Graham County, Arizona. The Comoro concept has a long history of use and familiarity to ranching, research, and soil survey. It is extensively referenced in many documents, publications, and thesis. This historical use has prompted us to structure the series as close to the original concept as possible and necessitates moving the type location to a ustic aridic (12–16 inch pz) soil moisture regime with a change in classification. Rucker soils have a limited extent and will reflect a typic aridic (<12 inch pz) moisture regime.

Diagnostic horizons and features recognized in this pedon are:
Ochric epipedon—The zone from 0 to 8 inches (Ap horizon)
Entisol feature—The absence of diagnostic subsurface horizons
Classified according to Soil Taxonomy Second Edition, 1999.

GLENDALE SERIES

Location: GLENDALE, AZ+NM NV TX
Established Series
Revised by JEJ/DLR/PDC/CEM/WWJ, 11/2001

The Glendale series consists of very deep, well drained soils formed in stratified alluvium. Glendale soils are on alluvial fans, flood plains, and stream terraces and have slopes of 0 to 5 percent. The mean annual precipitation is about 8 inches and the mean annual air temperature is about 65°F.

Taxonomic Class: Fine-silty, mixed, superactive, calcareous, thermic Typic Torrifluvents

Typical Pedon: Glendale loam, rangeland. (Colors are for dry soil unless otherwise noted.)

A—0 to 8 inches; light brownish gray (10YR 6/2) loam, brown (10YR 4/3) moist; weak medium platy structure parting to massive; slightly hard, friable, slightly sticky, and slightly plastic; common very fine roots; few very fine and fine irregular pores; strongly effervescent; moderately alkaline (pH 8.0); abrupt smooth boundary. (6 to 12 inches thick)

Ck1—8 to 18 inches; grayish brown (10YR 5/2) clay loam, dark grayish brown (10YR 4/2) moist; weak fine and coarse subangular blocky structure; very hard, friable, slightly sticky and moderately plastic; few very fine and fine roots; few very fine and fine tubular, and few fine irregular pores; common very fine and fine irregular accumulations of calcium carbonate; strongly effervescent; moderately alkaline (pH 8.0); clear smooth boundary. (10 to 30 inches thick)

Ck2—18 to 60 inches; grayish brown (10YR 5/2) stratified silty clay loam, brown (10YR 4/3) moist; massive; very hard, friable, moderately sticky, and moderately plastic; few very fine and fine roots; few very fine tubular pores; common very fine and fine irregular accumulations of calcium carbonate; strongly effervescent; moderately alkaline (pH 8.0).

Type Location: Graham County, Arizona; about 5 miles south of Safford; 400 feet east and 2,640 feet south of the northwest corner of Section 5, T. 8 S., R. 26 E.

Range in Characteristics:

Soil Moisture: Intermittently moist in some part of the soil moisture control section during July–September and December–February. Driest during May and June. Typic aridic soil moisture regime.

Rock Fragments: Usually nongravelly but may range to 35 percent in any one horizon

Organic Matter: Less than 1 percent that decreases irregularly with depth

Stratification: Usually less than 1 inch thick strata of finer or coarser material

A horizon—Hue: 7.5YR, 10YR
Value: 5, 6 or 7 dry, 3, 4 or 5 moist
Chroma: 2, 3 or 4, dry or moist

C horizon—Hue: 7.5YR, 10YR
Value: 4 through 7 dry, 3 through 6 moist
Chroma: 2, 3 or 4, dry or moist
Texture: Loam, silt loam, clay loam, silty clay loam
Reaction: Neutral to strongly alkaline
Calcium carbonate: Slightly to violently effervescent as disseminated or fine irregular accumulations
Buried horizons: A buried argillic horizon is present at depths greater than 40 inches in some pedons.

Competing Series: This is the Pima series. A potential competitor that does not yet have CEA class assigned is the Rift series. Pima soils have more than 1 percent organic matter to depths of 20 inches or more. Rift soils are moist in the soil moisture control section for less than 20 days cumulative during July–September and occur in MLRA 30 of the Mohave Desert.

Geographic Setting: Glendale soils are on alluvial fans and flood plains at elevations of 1,500 to 5,100 feet. These soils formed in stratified alluvium from mixed sources. Slopes range from 0 to 5 percent. The mean annual precipitation is 4 to 12 inches. The mean annual air temperature is 57 to 70°F. The frost-free period is 180 to 280 days.

Geographically Associated Soils: These are the Anthony, Brazito, Gila, Grabe, Hantz, and the competing Pima soils. Anthony, Gila, and Grabe soils are coarse-loamy. Arizo soils are sandy-skeletal. Brazito soils are sandy. Hantz soils are fine.

Drainage and Permeability: Well drained; medium runoff; moderately slow permeability.

Use and Vegetation: Glendale soils are used for livestock grazing and irrigated cropland. The present vegetation is creosote bush, mesquite, palo verde, ironwood, salt cedar, cacti, annual forbs, and grasses.

Distribution and Extent: Arizona, Nevada, California and New Mexico. This series is extensive. This soil occurs in LRR-D, MLRAs 40, 41, and 42.

MLRA Office Responsible: Phoenix, Arizona

Series Established: Maricopa County (Queen Creek SCD), Arizona; 1946.

Remarks: Diagnostic horizons and features recognized in this pedon are:
Ochric epipedon—The zone from 0 to 8 inches (A horizon)
Entisol feature—The absence of diagnostic subsurface horizons
Fluvial feature—Irregular decrease in organic carbon in the zone from 8 to 60 inches (Ck1, Ck2 horizons)
Classified according to Soil Taxonomy Second Edition, 1999.

KEYSTO SERIES

Location: KEYSTO, AZ
Established Series
Revised by DJB/WAS/PDC/CEM/WWJ, 11/2001

The Keysto series consists of very deep, well drained soils formed in mixed fan alluvium and stream alluvium. Keysto soils are on alluvial fans and stream terraces with slopes of 0 to 8 percent. The mean annual precipitation is about 14 inches. The mean annual air temperature is about 65°F.

Taxonomic Class: Loamy-skeletal, mixed, superactive, nonacid, thermic Ustic Torrifluvents

Typical Pedon: Keys to very gravelly sandy loam, rangeland. (Colors are for dry soil unless otherwise noted.)

C1—0 to 3 inches; dark brown (7.5YR 3/2) very gravelly sandy loam, dark brown (7.5YR 3/2) moist; weak thin platy structure; soft, very friable, nonsticky and nonplastic; common very fine, fine and medium roots; common fine irregular pores; 5 percent cobble and 45 percent gravel; noneffervescent; neutral (pH 6.6); abrupt smooth boundary. (2 to 5 inches thick)

C2—3 to 24 inches; dark brown (10YR 3/3) extremely cobbly sandy loam, very dark brown (10YR 2/2) moist; massive; soft, very friable, nonsticky and nonplastic; common very fine, fine, medium and coarse roots; common fine irregular pores; 55 percent cobble and 24 percent gravel; noneffervescent; neutral (pH 6.8); clear wavy boundary. (20 to 30 inches thick)

Ck—24 to 60 inches; brown (10YR 4/3) extremely cobbly loamy sand, dark brown (10YR 3/3) moist; massive; soft, very friable, nonsticky and nonplastic; common very fine, fine, and few medium roots; common fine irregular pores; many distinct continuous calcium carbonate coatings on rock fragments; 55 percent cobble and 30 percent gravel; noneffervescent in the fine earth; slightly alkaline (pH 7.4).

Type Location: Pima County, Arizona; latitude of 31 degrees 47 minutes 33 seconds North and a longitude of 111 degrees 39 minutes 30 seconds West. Chiuli Shaik topoquad, Sycamore Canyon road.

Range in Characteristics:

Soil moisture: Intermittently moist in some part of the soil moisture control section during July–September and December–February. Driest during May and June. The epipedon is moist in some part less than 90 days (cumulative) when the soil temperature is above 41°F in 7 out of 10 years. Ustic Aridic soil moisture regime.

Soil temperature: 61 to 69°F
Rock fragments: 35 to 75 percent gravel, cobble, and stones
Reaction: slightly acid to slightly alkaline
Organic matter: 1 to 3 percent, decreasing irregularly with depth
Depth to calcium carbonate: greater than 20 inches

C horizons—Hue: 10YR, 7.5YR
Value: 3 through 5 dry, 2 through 4 moist
Chroma: 2 through 4, dry or moist
Texture: sandy loam, loamy sand, fine sandy loam, coarse sand
Calcium carbonate: occurs as coatings on rock fragments

Competing Series: There are no competitors.

Geographic Setting: The Keysto soils are on alluvial fans and stream terraces. Slope ranges from 0 to 8 percent. They formed in mixed fan and stream alluvium. Elevation ranges from 3,000 to 5,200 feet. The mean annual precipitation is 12 to 16 inches. The mean annual air temperature ranges from 59 to 67°F. The frost-free period is about 180 to 250 days.

Geographically Associated Soil: These are the Cellar, Lampshire, Romero, Chiricahua, and Oracle soils. These soils have bedrock within 60 inches.

Drainage and Permeability: Well drained; medium runoff; moderately rapid permeability.

Use and Vegetation: Keysto soils are used for livestock grazing and wildlife habitat. Vegetation includes mesquite, paloverde, catclaw acacia, burroweed, cacti, sideoats grama, Arizona cottontop, spike dropseed, annual grasses and forbs.

Distribution and Extent: Southern Arizona. This series is of moderate extent. This soil occurs in LRR-D, MLRAs 40 and 41. Subject to flooding.

MLRA Office Responsible: Phoenix, Arizona

Series Established: Pima County, Arizona; soil survey of Tohono O'odham Nation, Arizona; parts of Maricopa, Pima and Pinal counties, Arizona, 1993.

Remarks: Diagnostic horizons and features recognized in this pedon are:
Entisol feature—The absence of diagnostic subsurface horizons
Fluvial feature—Irregular decrease in organic carbon in the zone from 3 to 60 inches (C2, Ck horizons)
Classified according to Soil Taxonomy Second Edition, 1999.

KIMROSE SERIES

Location: KIMROSE, AZ
Established Series
Revised by DJB/CEM/PDC/WWJ, 09/2002

The Kimrose series consists of very shallow or shallow to hardpan, well drained soils formed in mixed alluvium dominantly from gneiss, schist and granite. Kimrose soils are on fan piedmonts and fan terraces with slopes of 1 to 20 percent. The mean annual precipitation is about 13 inches. The mean annual air temperature is about 65°F.

Taxonomic Class: Loamy-skeletal, mixed, superactive, thermic, shallow Ustic Petrocalcids

Typical Pedon: Kimrose very gravelly sandy loam, rangeland. (Colors are for dry soil unless otherwise noted.)

A—0 to 2 inches; strong brown (7.5YR 5/6) very gravelly sandy loam, dark brown (10YR 3/3) moist; weak thin platy structure; soft, very friable, nonsticky and nonplastic; common very fine and fine roots; common very fine and fine interstitial and tubular pores; 35 percent gravel; strongly effervescent, 8 percent calcium carbonate equivalent; slightly alkaline (pH 7.6); abrupt smooth boundary. (1 to 7 inches thick)

Bk1—2 to 12 inches; strong brown (7.5YR 5/6) very gravelly sandy clay loam, brown (10YR 4/3) moist; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; common very

fine, fine and coarse roots; common very fine and fine interstitial and tubular pores; 40 percent gravel with few distinct continuous carbonate coatings; few medium irregular soft masses and common threads of calcium carbonate; violently effervescent, 15 percent calcium carbonate equivalent; slightly alkaline (pH 7.8); abrupt wavy boundary. (0 to 18 inches thick)

Bk2—12 to 20 inches; white (7.5YR 8/1) strongly cemented extremely gravelly sandy loam, white (7.5YR 8/1) moist; massive; hard, firm, nonsticky and nonplastic; few very fine and fine roots; 60 percent gravel and 10 percent cobble with few distinct continuous carbonate coatings; violently effervescent, 36 percent calcium carbonate equivalent; moderately alkaline (pH 8.4); abrupt wavy boundary. (0 to 20 inches thick)

Bkm—20 to 60 inches; white (7.5YR 8/1) indurated petrocalcic with a thin laminar cap; extremely hard; few very fine roots in fractures.

Type Location: Pima County, Arizona; west of the Baboquivari Mountains and south of Hiavanan Nakya on the Tohono O'odham Indian Nation; 31 degrees 56 minutes 20 seconds north latitude and 111 degrees 41 minutes 35 seconds west longitude.

Range in Characteristics:

Soil Moisture: Intermittently moist in some part of the soil moisture control section during July–September and December–February. Driest during May and June. Ustic aridic soil moisture regime.

Soil Temperature: 65 to 69°F
Rock Fragments: 35 to 60 percent gravel; some pedons contain cobble
Reaction: Neutral to moderately alkaline
Depth to petrocalcic horizon: 7 to 20 inches
Calcium carbonate equivalent: Greater than 15 percent
Clay content: Averages 18 to 35 percent in the particle size control section

A horizon—Hue: 7.5YR, 10YR
Value: 3 through 5 dry, 2 through 4 moist
Chroma: 1 through 6 dry, 2 through 4 moist

B horizon (not present in all pedons)—Hue: 7.5YR, 10YR
Value: 3 through 8, dry or moist
Chroma: N/ through 6, dry or moist
Texture: sandy loam, sandy clay loam, loam

Bkm horizon—Cementation: strongly cemented to indurated

Competing Series: These are the Missile, Monterosa, and Pedregosa series. The Missile soils have mean annual soil temperature of 61 to 65°F and contain less than 15 percent calcium carbonate in the particle size control section. Monterosa soils are dry in the soil moisture control section for longer periods because of a lower rainfall component and have moderately fine textured soil material below the hardpan at moderate depths. Pedregosa soils have 5 to 18 percent clay in the particle-size control section.

Geographic Setting: The Kimrose soils are on fan piedmonts and fan terraces. Slopes range from 1 to 20 percent. They form in alluvium from gneiss, schist and granite. Elevation ranges from 2,800 to 4,900 feet. The mean annual precipitation is 12 to 16 inches. The mean annual air temperature ranges from 59 to 67°F. The frost-free period is about 190 to 250 days.

Geographically Associated Soils: These are the Nolam, Whitehouse, Hathaway, Caralampi, and Selevin soils. These soils are very deep and lack a petrocalcic horizon.

Drainage and Permeability: Well drained; slow to medium runoff; moderate permeability.

Use and Vegetation: Kimrose soils are used for livestock grazing and wildlife habitat. Vegetation includes bush muhly, black grama, slender janusia, fluffgrass, spidergrass, creosote bush, littleleaf paloverde and ocotillo.

Distribution and Extent: Southern Arizona. This series is of moderate extent.

MLRA Office Responsible: Phoenix, Arizona

Series Established: Pima County, Arizona; Soil survey of Tohono O'odham Indian Reservation, AZ, Parts of Maricopa, Pima and Pinal Counties; 1993.

Remarks: Diagnostic horizons and features recognized in this pedon are:
Ochric epipedon—The zone from 0 to 2 inches (A horizon)
Calcic horizon—The zone from 2 to 20 inches (Bk1, Bk2 horizons)
Petrocalcic horizon—The zone from 20 to 60 inches (Bkm horizon)
Classified according to Soil Taxonomy Second Edition, 1999

NOLAM SERIES

Location: NOLAM, NM+AZ
Established Series
Revised by HEB/CEM/PDC/WWJ, 06/2000

The Nolam series consists of very deep, well drained, moderately slow permeable soils that formed in alluvial sediments derived from rhyolite and andesite on terraces and piedmonts. Slopes range from 2 to 15 percent. Mean annual precipitation is about 12 inches. Mean annual air temperature is about 66°F.

Taxonomic Class: Loamy-skeletal, mixed, superactive, thermic Ustic Calciargids

Typical Pedon: Nolam very gravelly sandy loam, rangeland. (Colors are for dry soil unless otherwise noted.)

A—0 to 2 inches; light brown (7.5YR 6/4) very gravelly fine sandy loam, brown (7.5YR 5/4) moist; weak fine granular structure; soft, very friable, nonsticky and nonplastic; few medium roots; slightly alkaline; abrupt smooth boundary. (1 to 4 inches thick)

Bt—2 to 10 inches; red (2.5YR 4/6) very gravelly sandy clay loam, dark red (2.5YR 3/6) moist; some volumes of 5YR hue; weak medium and coarse subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common fine roots; common prominent clay films coating and bridging sand grains and gravel; slightly alkaline; clear wavy boundary. (4 to 20 inches thick)

Btk—10 to 17 inches; dominantly reddish brown (5YR 5/4) very gravelly sandy clay loam, reddish brown (5YR 4/4) moist; some parts have 7.5YR hue, particularly in the lower part; massive; soft, friable, slightly sticky and slightly plastic; common fine roots; few distinct clay films coating and bridging sand grains and gravel; strongly effervescent; moderately alkaline; abrupt wavy boundary. (2 to 16 inches thick)

Bk1—17 to 24 inches; dominantly pink (7.5YR 8/4) very gravelly sandy loam, pink (7.5YR 7/4) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; few fine roots; strongly effervescent; most gravel are separated by calcium carbonate; moderately alkaline; clear wavy boundary. (6 to 12 inches thick)

Bk2—24 to 40 inches; mixed pink (7.5YR 8/4) and light brown (7.5YR 6/4) very gravelly sandy loam, light brown (7.5YR 6/4) and brown (7.5YR 5/4) moist; massive; slightly hard, very friable, slightly sticky and slightly plastic; few fine roots; strongly effervescent; calcium carbonate thickly coats gravel in light colored parts, thinly coats them in darker parts, light and dark parts occur in nearly vertical tongues and in irregular volumes, 1 to several inches across; moderately alkaline; clear wavy boundary. (10 to 20 inches thick)

Bk3—40 to 52 inches; alternating tongues and lenses of very pale brown (10YR 7/4) and yellowish brown (7.5YR 5/4) very gravelly loamy sand, yellowish brown (10YR 5/4) and dark yellowish brown (7.5YR 4/4) moist; massive; soft, very friable, nonsticky and nonplastic; few fine roots; strongly effervescent; light colored parts commonly held together by weak carbonate cementation, darker parts have only thin carbonate coatings; moderately alkaline; clear wavy boundary. (8 to 20 inches thick)

Bk4—52 to 71 inches; dominantly brown (7.5YR 5/4) very gravelly sand, dark brown (7.5YR 4/4) moist; few tongues and lenses of pink (7.5YR 8/4), light brown (7.5YR 6/4) moist; massive; soft, very friable, nonsticky and nonplastic; few fine roots; strongly effervescent; material weakly held together by calcium carbonate; moderately alkaline; clear wavy boundary. (10 to 30 inches thick)

C—71 to 79 inches; brown (7.5YR 5/4) gravelly sand, dark brown (7.5YR 4/4) moist; massive and single grained; soft, loose, nonsticky and nonplastic; slightly effervescent; some gravel have very thin discontinuous calcium carbonate coatings; moderately alkaline.

Type Location: Doña Ana County, New Mexico; 200 feet west of Soledad Canyon road, south bank of arroyo; in the NE ¼ of section 21, T.23 S., R.3 E.; 106 degrees 38 minutes 18 seconds west longitude and 32 degrees 17 minutes 45 seconds north latitude.

Range in Characteristics:

Soil Moisture: Intermittently moist in some part of the soil moisture control section during July–September and December–April. Driest during May and June. Ustic aridic soil moisture regime.

Soil temperature: 59 to 69°F

Rock fragments: more than 35 percent

Depth to calcic horizon: 20 to 40 inches

A horizon—Hue: 5YR, 7.5YR
Value: 3 through 6 dry, 3 through 5 moist
Chroma: 2 through 6, dry or moist
Texture: fine sandy loam, sandy loam

Bt and Btk horizons—Hue: 2.5YR, 5YR
Value: 3 through 6 dry, 3 through 5 moist
Chroma: 3 through 6, dry or moist
Texture: sandy loam, loam, sandy clay loam, clay loam (averages 18 to 35 percent clay)

Bk and C horizons—Hue: 2.5YR through 10YR
Value: 4 through 8 dry, 3 through 8 moist
Chroma: 2 through 6, dry or moist
Texture: fine sandy loam, coarse sandy loam, sandy clay loam, sandy loam, loamy sand, sand

Competing Series: This is the Beewon and Throne(T) series. A potential competitor not yet reclassified is the Alsco series. Alsco soils typically have hue of 7.5YR or yellower in the argillic. Beewon soils have 35 to 50 percent clay. Throne soils are moderately deep.

Geographic Setting: The Nolam soils are on fan piedmonts and fan terraces. Slopes range from 1 to 15 percent. Elevation ranges from 3,500 to 6,000 feet. The mean annual precipitation ranges from about 10 to 16 inches. The mean annual air temperature ranges from 57 to 67°F. The frost-free period is about 180 to 240 days.

Geographically Associated Soils: These are the Boracho, Casito, Delnorte, Monterosa, Pinaleno, Terino and Vado soils. Casito and Terino soils are shallow and have petrocalcic horizons. Pinaleno soils lack calcic horizons within 40 inches of the surface. Boracho, Delnorte and Monterosa soils have a petrocalcic horizon and lack an argillic horizon. Vado soils lack argillic and calcic horizons.

Drainage and Permeability: Well drained; medium runoff; moderate or moderately slow permeability.

Use and Vegetation: This soil is used primarily for livestock grazing. Native vegetation includes snakeweed, range ratany, fluffgrass, prickly pear, yucca and creosote bush. In some areas there are scattered clumps of black grama and bush muhly.

Distribution and Extent: Southern New Mexico and Arizona. The series is of moderate extent. MLRA is 41 and 42.

MLRA Office Responsible: Phoenix, Arizona

Series Established: Doña Ana County, New Mexico; 1972.

Remarks: Diagnostic horizons and features recognized in this pedon are:
Ochric epipedon—The zone from 0 to 2 inches (A horizon)
Argillic horizon—The zone from 2 to 17 inches (Bt, Btk horizons)
Calcic horizon—The zone from 24 to 52 inches (Bk2, Bk3 horizons)
Classified according to Soil Taxonomy Second Edition, 1999

RIVEROAD SERIES

Location: RIVEROAD, AZ
Established Series
Revised by CCC/PDC/CEM/WWJ, 11/2001

The Riveroad series consists of very deep, well drained soils formed in stream alluvium from mixed sources. Riveroad soils are on flood plains and alluvial fans and have slopes of 0 to 5 percent. The mean annual precipitation is about 14 inches and the mean annual air temperature is about 65°F.

Taxonomic Class: Fine-silty, mixed, superactive, calcareous, thermic Ustic Torrifluvents

Typical Pedon: Riveroad clay loam, rangeland. (Colors are for dry soil unless otherwise noted.)

A—0 to 4 inches; brown (10YR 5/3) stratified clay loam, dark brown (10YR 3/3) moist; weak thick platy structure; slightly hard, friable, moderately sticky and moderately plastic; common very fine roots; common very fine irregular pores; common thin sand coatings on faces of peds; thick (4 cm) pale brown (10YR 6/3) finely stratified silt loam and very fine sandy loam layer on the surface, brown (10YR 4/3) moist; slightly alkaline (pH 7.4); abrupt smooth boundary. (2 to 13 inches thick)

C1—4 to 21 inches; brown (10YR 4/3) clay loam, very dark brown (10YR 2/2) moist; moderate medium subangular blocky structure; hard, friable, moderately sticky and moderately plastic; common very fine roots; many very fine irregular pores; few thin very fine sand coatings on faces of peds; slightly effervescent, few fine filaments of calcium carbonate in pores; slightly alkaline (pH 7.4); clear wavy boundary. (12 to 20 inches thick)

C2—21 to 33 inches; dark grayish brown (10YR 4/2) clay loam, very dark brown (10YR 2/2) moist; weak medium subangular blocky structure; hard, friable, moderately sticky and moderately plastic; common very fine roots; common very fine tubular pores; slightly alkaline (pH 7.4); clear wavy boundary. (6 to 15 inches thick)

C3—33 to 60 inches; brown (7.5YR 4/4) clay loam, dark yellowish brown (10YR 3/4) moist; moderate medium subangular blocky structure; very hard, friable, moderately sticky and moderately plastic; few very fine roots; common fine tubular pores; slightly effervescent, few fine filaments of calcium carbonate in pores; common faint organic stains on faces of peds and lining pores; slightly alkaline (pH 7.4).

Type Location: Pima County, Arizona; 1,660 feet south and 200 feet east of the northwest corner of section 26, T. 18 S., R. 9 E.

Range in Characteristics:

Soil moisture: Intermittently moist in some part of the soil moisture control section during December–March and July–September. Driest during May and June. The epipedon is moist in some part less than 90 days (cumulative) when the soil temperature is above 41°F in 7 out of 10 years. Ustic aridic soil moisture regime.

Soil temperature: 62 to 72°F

Rock fragments: 0 to 15 percent gravel

Texture: Averages less than 15 percent fine sand or coarser. Averages 5–40 percent very fine sand and 18 to 35 percent clay in the control section

Organic matter: 1–5 percent decreasing irregularly with depth

Reaction: Neutral to moderately alkaline

Stratification: commonly stratified with finer or coarser material throughout

Gypsum content: 0 to 4 percent

A and C horizons—Hue: 10YR, 7.5YR
Value: 3 through 6 dry, 2 through 5 moist
Chroma: 1 through 4, dry or moist
Texture: Loam, silt loam, silty clay loam, clay loam, silty clay

Competing Series: These are the Crowflats and Nillo series. Crowflats soils are dominantly silt loam and very fine sandy loam in the control section and have mean annual precipitation of 8 to 10 inches. Nillo soils are formed in tuff parent material from the Duff and Pruett Formations.

Geographic Setting: Riveroad soils are on flood plains and alluvial fans with slopes of 0–5 percent. They

formed in stratified stream alluvium from metamorphic, sedimentary and basic and acid igneous rock. Elevation ranges from 2,200 to 4,600 feet. Mean annual precipitation is 12–16 inches occurring as summer thunderstorms and winter rain. Mean annual air temperature is 60–70°F. The frost-free period is about 180 to 280 days.

Geographically Associated Soils: These are the Bodecker, Comoro, Guest, Hayhook, Sonoita, and Ubik soils. Bodecker soils are sandy-skeletal. Hayhook, Comoro, Sonoita, and Ubik soils are coarse-loamy. Guest soils are fine.

Drainage and Permeability: Well drained; slow runoff; moderate to moderately slow permeability. This soil is subject to flooding.

Use and Vegetation: Used for livestock grazing, irrigated cropland and urban development. Vegetation is mesquite, sacaton, vine mesquite, grama grasses, cane beardgrass, and catclaw. Irrigated crops include cotton, sorghum, wheat, alfalfa, sugar beets, lettuce and small grains.

Distribution and Extent: Southern Arizona. The Riveroad soils are moderately extensive. This soil occurs in LRR-D, MLRAs 40 and 41.

MLRA Office Responsible: Phoenix, Arizona

Series Established: Pima County, Arizona; Soil survey of Pima County, Arizona, Eastern Part; 1985.

Remarks: Diagnostic horizons and features recognized in this pedon are:
Ochric epipedon—The zone from 0 to 4 inches (A horizon)
Entisol feature—The absence of diagnostic subsurface horizons
Fluvial feature—Irregular decrease in organic carbon in the zone from 4 to 60 inches (C1, C2, C3, C4 horizons)
Classified according to Soil Taxonomy Second Edition, 1999.

TOMBSTONE SERIES

Location: TOMBSTONE, AZ
Established Series
Revised by CLG/PDC/CEM/WWJ, 09/2002

The Tombstone series consists of very deep, somewhat excessively drained soils that formed in fan alluvium. Tombstone soils are on fan and stream terraces and have slopes of 1 to 50 percent. The mean annual precipitation is about 14 inches and the mean annual air temperature is about 63°F.

Taxonomic Class: Loamy-skeletal, mixed, superactive, thermic Ustic Haplocalcids

Typical Pedon: Tombstone very gravelly fine sandy loam, rangeland. (Colors are for dry soil unless otherwise noted.) Surface rocks: 50 to 65 percent of the surface is covered with gravel and cobbles

A—0 to 1 inch; grayish brown (10YR 5/2) very gravelly fine sandy loam, dark grayish brown (10YR 4/2) moist; weak thin platy structure; soft, very friable, nonsticky and nonplastic; few fine roots; few fine tubular pores; 52 percent gravel; strongly effervescent, 13 percent calcium carbonate equivalent; moderately alkaline (pH 8.2); abrupt smooth boundary.

Bk1—1 to 5 inches; dark grayish brown (10YR 4/2) gravelly fine sandy loam, very dark grayish brown

(10YR 3/2) moist; massive; soft, very friable, nonsticky and nonplastic; common very fine and fine roots; common fine tubular pores; many distinct calcium carbonate coatings on rock fragments; 21 percent gravel; violently effervescent, 17 percent calcium carbonate equivalent; moderately alkaline (pH 8.2); abrupt smooth boundary.

Bk2—5 to 13 inches; pinkish white (7.5YR 8/2) gravelly sandy loam, pinkish gray (7.5YR 6/2) moist; massive; soft, very friable, nonsticky and nonplastic; common very fine and fine roots; common very fine and fine tubular pores; many distinct calcium carbonate coatings on rock fragments; 21 percent gravel; violently effervescent, 22 percent calcium carbonate equivalent; moderately alkaline (pH 8.2); clear smooth boundary.

Bk3—13 to 27 inches; pinkish gray (7.5YR 7/2) very gravelly sandy loam, pinkish gray (7.5YR 6/2) moist; massive; soft, very friable, nonsticky and nonplastic; common very fine and fine roots; few very fine and fine tubular pores; many distinct calcium carbonate coatings on rock fragments; 47 percent gravel; violently effervescent, 19 percent calcium carbonate equivalent; moderately alkaline (pH 8.2); gradual smooth boundary.

Bk4—27 to 60 inches; pinkish gray (7.5YR 6/2) very gravelly loamy sand, brown (7.5YR 4/2) moist; massive; soft, very friable, nonsticky and nonplastic; few fine roots; common very fine and fine irregular and tubular pores; few prominent calcium carbonate coatings on rock fragments; 38 percent gravel; strongly effervescent, 6 percent calcium carbonate equivalent; moderately alkaline (pH 8.0).

Type Location: Cochise County, Arizona; located at a latitude of 32 degrees, 44 minutes, 13 seconds North and a longitude of 109 degrees, 59 minutes, 50 seconds West; about 1,310 feet west and 2,275 feet north of the southeast corner of section 33, Township 19 S., Range 23 E.

Range in Characteristics:

Soil Moisture: Intermittently moist in some part of the soil moisture control section during July–September and December–February. Driest during May and June. Ustic aridic soil moisture regime. The epipedon is moist in some part less than 90 days (cumulative) when the soil temperature is above 41°F in 7 out of 10 years.

Rock Fragments: Averages 35 to 70 percent in the particle-size control section, but ranges from 15 to 90 percent in any one horizon

Soil Temperature: 59 to 70°F

Depth to calcic horizon: 1–20 inches. Weakly cemented in some pedons

Calcium carbonate equivalent: Averages 20–35 percent, but ranges from 5 to 40 percent in any one horizon

A horizon—Hue: 7.5YR, 10YR
Value: 4 through 7 dry, 2 through 5 moist
Chroma: 2 through 4, dry or moist

Bk horizon—Hue: 7.5YR, 10YR
Value: 3 through 8, dry or moist
Chroma: 2, 3 or 4 dry, 1 through 4 moist
Texture: Sandy loam, loam, coarse sandy loam, fine sandy loam (5–18 percent clay); can range to include loamy sand and loamy coarse sand below 30 inches.

Competing Series: These are the Chilicotal, Gallen, Polar, and Powerline series. Chilicotal soils have 15–27 percent clay in the control section. Gallen soils have gypsum accumulations. Polar soils have mean

annual precipitation of 16–24 inches. In addition, Gallen soils are in the Pecos-Canadian Plains and Valleys (MLRA 70); Polar soils are in the Central Rolling Red Plains (MLRA 78); both soils are more moist in May and June. Powerline soils have bedrock at depths of 20–40 inches.

Geographic Setting: Tombstone soils are in the Sonoran and Chihuahuan deserts on fan terraces and stream terraces and have slopes of 1 to 50 percent. These soils formed in fan alluvium from mixed sources. Elevations range from 3,000 to 5,300 feet. The mean annual precipitation is 12 to 16 inches. The mean annual air temperature is 57 to 68°F. The frost-free period is 160 to 250 days.

Geographically Associated Soils: These are the Elgin, Pedregosa and Stronghold soils. Elgin soils have argillic horizons. Pedregosa soils are very shallow and shallow to a petrocalcic horizon. Stronghold soils are coarse-loamy.

Drainage and Permeability: Somewhat excessively drained; slow runoff; moderately rapid permeability.

Use and Vegetation: Tombstone soils are used for livestock grazing and wildlife habitat. Some areas are used for watershed research. The present vegetation is threeawn, black grama, sideoats grama, tarbush, whitethorn, and creosote bush.

Distribution and Extent: Central Arizona portion of the Upper Sonoran desert and Southeastern Arizona portion of the Chihuahuan desert. This series is not extensive. MLRA is 38 and 41.

MLRA Office Responsible: Phoenix, Arizona

Series Established: Pima County, Arizona; Soil survey of Pima County, Arizona, Eastern Part; 1985.

Remarks: Diagnostic horizons and features recognized in this pedon are:
Ochric epipedon—The zone from 0 to 1 inch (A horizon)
Calcic horizon—The zone from 1 to 60 inches (Bk1, Bk2, Bk3, Bk4 horizons)
Classified according to Soil Taxonomy Second Edition, 1999
The type location was moved to the Douglas-Tombstone Area in April 2000.

WHITE HOUSE SERIES

Location: WHITE HOUSE, AZ+NM
Established Series
Revised by MLR/JEJ/PDC/CEM/WWJ, 06/2000

The White House series consists of very deep, well drained soils that formed in fan alluvium from mixed sources. White House soils are on fan terraces and have slopes of 0 to 35 percent. The mean annual precipitation is about 14 inches and the mean annual air temperature is about 62°F

Taxonomic Class: Fine, mixed, superactive, thermic Ustic Haplargids

Typical Pedon: White House gravelly loam, rangeland. (Colors are for dry soil unless otherwise noted.)
A—0 to 3 inches; brown (7.5YR 5/4) gravelly loam, dark brown (7.5YR 3/2) moist; weak thin platy structure parting to moderate fine granular; slightly hard, friable, nonsticky and slightly plastic; many very fine and fine roots; common fine irregular pores; 15 percent gravel; moderately acid (pH 5.6); clear smooth boundary. (2 to 8 inches thick)

Bt1—3 to 9 inches; reddish brown (5YR 5/4) clay loam, dark reddish brown (5YR 3/4) moist; weak

medium subangular blocky structure; hard, friable, moderately sticky and moderately plastic; common fine and very fine roots; few fine and very fine tubular pores; few faint clay films on faces of peds; 2 percent fine gravel; slightly acid (pH 6.2) clear smooth boundary. (5 to 9 inches thick)

Bt2—9 to 22 inches; reddish brown (5YR 4/4) clay, dark reddish brown (5YR 3/4) moist; moderate medium and coarse prismatic structure; hard, firm, moderately sticky and moderately plastic; common fine and very fine roots; few very fine irregular and tubular pores; many distinct clay films on faces of peds; 2 percent fine gravel; neutral (pH 7.0); clear wavy boundary. (9 to 26 inches thick)

Btk1—22 to 26 inches; dark red (2.5YR 3/6) clay, dark red (2.5YR 3/6) moist; moderate medium and coarse subangular and angular blocky structure; hard, firm, moderately sticky and moderately plastic; common fine roots; few fine tubular pores; many distinct clay films on faces of peds; common pressure faces; common medium slickensides; 2 percent gravel; 9 percent calcium carbonate equivalent; strongly effervescent; moderately alkaline (pH 8.0); clear wavy boundary. (3 to 10 inches thick)

Btk2—26 to 39 inches; mixed red (2.5YR 4/6) and pink (5YR 7/4) clay loam, dark red (2.5YR 3/6) and light reddish brown (5YR 6/4) moist; weak medium subangular blocky structure; hard, friable, sticky and plastic; few fine roots; few very fine and fine tubular pores; common faint clay films on faces of peds; 5 percent gravel; common medium irregular calcium carbonate masses; 10 percent calcium carbonate equivalent; strongly effervescent; moderately alkaline (pH 8.0); gradual wavy boundary. (6 to 15 inches thick)

Bk1—39 to 49 inches; mixed yellowish red (5YR 5/6) and pink (5YR 7/4) sandy clay loam, yellowish red (5YR 4/6) and light reddish brown (5YR 6/3) moist; massive; hard, friable, slightly sticky and moderately plastic; few very fine tubular and irregular pores; 10 percent medium and coarse gravel; few fine and medium calcium carbonate masses; 2 percent calcium carbonate equivalent; slightly effervescent; moderately alkaline (pH 8.0); gradual wavy boundary. (8 to 12 inches thick)

Bk2—49 to 60 inches; mixed yellowish red (5YR 5/8) and pink (5YR 7/3) very gravelly sandy clay loam, yellowish red (5YR 4/6) and light reddish brown (5YR 6/3) moist; massive; hard, friable, moderately sticky and moderately plastic; few very fine irregular pores; 35 percent medium and coarse gravel; few fine calcium carbonate masses; 2 percent calcium carbonate equivalent; slightly effervescent; moderately alkaline (pH 8.0).

Type Location: Santa Cruz County, Arizona; 1.3 miles east southeast of Highway 83 and .1 mile south of the El Paso Natural Gas pipeline in the San Ignacio Del Babocomari Grant, 3 miles south and 4.5 miles east of Sonoita in Section 11, T. 21 S., R. 17 E.

Range in Characteristics:

Soil Moisture: Intermittently moist in some part of the soil moisture control section during July–September and December–February. Driest during May and June. Ustic aridic soil moisture regime.

Soil Temperature: 59 to 70°F

Rock Fragments: Averages less than 35 percent in the control section

Organic matter: Averages 1 percent or more in the surface

Reaction: moderately acid through moderately alkaline

A horizon—Hue: 2.5YR, 5YR, 7.5YR
Value: 3 through 6, dry or moist
Chroma: 2 through 6, dry or moist

Bt horizon—Hue: 2.5YR, 5YR, 7.5YR
Value: 3 through 6, dry or moist
Chroma: 2 through 8, dry or moist
Texture: Clay loam, clay, sandy clay loam (averages more than 35 percent clay)

B, Bk or C horizon—Hue: 2.5YR through 10YR
Value: 3 through 8 dry, 3 through 7 moist
Chroma: 2 through 8, dry or moist
Texture: Sandy clay loam, clay loam, clay
Some pedons contain thin layers of coarse sandy loam, loamy sand, or loamy coarse sand at depths greater than 25 inches.

Competing Series: There are no competitors.

Geographic Setting: White House soils are on fan terraces and have slopes of 0 to 35 percent. These soils formed in fan alluvium from mixed sources. Elevations range from 3,000 to 5,400 feet. The mean annual precipitation is 12 to 16 inches. The mean annual air temperature is 57 to 67°F. The frost-free period is 160 to 250 days.

Geographically Associated Soils: These are the Forrest and Bernardino soils. In addition is the Caralampi soil. Caralampi soils are loamy-skeletal. Forrest and Bernardino soils have calcic horizons.

Drainage and Permeability: Well drained; slow or medium runoff; slow or very slow permeability.

Use and Vegetation: White House soils are used for livestock grazing and wildlife habitat. A few areas are used for homesites and other urban uses. Present vegetation is grama grasses, plains lovegrass, wolftail, curly mesquite, tobosa, and mesquite.

Distribution and Extent: Southern Arizona. This series is extensive. MLRA is 38 and 41.

MLRA Office Responsible: Phoenix, Arizona

Series Established: Pima County (Tucson Area) Arizona; 1931.

Remarks: Diagnostic horizons and features recognized in this pedon are:
Ochric epipedon—The zone from 0 to 3 inches (A horizon)
Argillic horizon—The zone from 3 to 39 inches (Bt1, Bt2, Btk1, Btk2 horizons)
Classified according to Soil Taxonomy Second Edition, 1999

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APPENDIX F

CULTURAL RESOURCES SURVEY OF FOUR PROPOSED FENCE LINE SEGMENTS AT EMPIRITA RANCH, EASTERN PIMA COUNTY, ARIZONA

(Pima County Contract Nos: 07-04-A-133579-1203 & 07-04-A-133580-1203; Work Order Nos. 4OLMGT and 40CCCI)

by

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January 28, 2004
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Archaeological Research Services, Inc. Project Report No. 2003:080

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ABSTRACT

AGENCY: Pima County (Administrators Office-Cultural Resources Office).

PROJECT TITLE: Cultural Resources Survey of Four Proposed Fence Line Segment at Empirita Ranch, Eastern Pima County, Arizona.

PROJECT DESCRIPTION: Pima County Flood Control proposes to fence county owned property in eastern Pima County with four new fence segments in two separate areas of Empirita Ranch (fences to be erected by Pima County Natural Resources, Parks, and Recreation). The first fence alignment area (Empirita-North/Fence Line #1) is located to south of Interstate Highway 10 at the northwest corner of Empirita Ranch and is 14,830 feet long.

The second fence alignment area (Ranch Headquarters) is near the center of Empirita Ranch about two miles southeast of the first fence alignment area (Fence Line #1), and includes three shorter fence line alignments. One fence alignment is at the northwest corner of the ranch headquarters area (Fence Line #2)and is 4380 feet long,. Another fence alignment is at the southeast corner of the ranch headquarters area (Fence Line #3) and is 800 feet long, The third fence line in this area is at the northeast corner of the ranch headquarters area (Fence Line #4) and is 1,300 feet long,

This survey was requested by Pima County as required by Pima County Board of Supervisors Resolution 1983-104. The reason for the survey was to determine if there were important cultural resources present in the project area that might be eligible for listing on the National Register of Historic Places (NRHP) and subject to negative impacts by the proposed fence line construction.

LOCATION: The fence lines are situated in portions of the west ½ of Section 1, and north ½ of Section 12, T17S, R17E; west ½ of Section 7, T17S, R18E; North ½ , and SE 1/4 of Section 17, T17S, R18E (USGS The Narrows, AZ, 7.5', 1981).

NUMBER OF SURVEYED ACRES: The four fence line segments were all surveyed as 50 foot wide corridors. Empirita North (Fence Line 1) totals 17.02 acres/ 6.88 hectares, and Ranch Headquarters (Fence Lines 2-4) total 7.42 acres/ 3 hectares. The 24.44 acres/ 9.88 hectares that comprise the total project area were surveyed in an intensive, systematic fashion.

NUMBER OF SITES: One, AZ EE:2:253 (ASM)

LIST OF REGISTER ELIGIBLE PROPERTIES: AZ EE:2:253 (ASM)

LIST OF INELIGIBLE SITES: None.

COMMENTS: As a result of the field survey, one previously recorded prehistoric site (AZ EE:2:253 [ASM]) was identified close to Fence Line #3, but no new archaeological sites or other cultural resources were identified in the remaining study area. Previous archaeological research at AZ EE:2:253 (ASM), suggest the site is a habitation dating to the Hohokam Sedentary Period (ca. A.D. 900-1100). Pima County initially had Fence Line #3 extending north through this prehistoric site, but has modified the original plan by not constructing the northern extension, and therefore, achieving complete avoidance of the site. Based on the lack of important prehistoric or historic resources within the project area no negative impacts to important cultural resources will occur in the remaining parts of the project area as a result of the fence line construction. However, it is recommended, in the event that any previously unreported, subsurface cultural features or deposits are encountered during future ground-disturbing activities within the project area, that these activities be discontinued in the immediate area of the remains, and a qualified archaeologist consulted to evaluate their nature and significance.

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INTRODUCTION

On December 18, 2003, and January 8, 2004 Archaeological Research Services, Inc. (ARS) conducted cultural resources surveys of four proposed fence line alignments for Pima County Flood Control District on county owned lands at Empirita Ranch in eastern Pima County, Arizona (**Figures 1a & 1b**). Pima County Flood Control proposes to fence county owned property in eastern Pima County with four new fence segments in two separate areas of Empirita Ranch (fences to be erected by Pima County Natural Resources, Parks, and Recreation).

The first fence alignment area (Empirita-North/Fence Line #1) is located to south of Interstate Highway 10 at the northwest corner of Empirita Ranch (**Figure 1a**). This single segment of fence line is 14,830 feet long. The fence line was surveyed as a 50 foot wide corridor and this survey area totals 17.02 acres/ 6.88 hectares. This fence line is situated in portions of the west ½ of Section 1, and north ½ of Section 12, T17S, R17E; west ½ of Section 7, T17S, R18E (USGS The Narrows, AZ, 7.5', 1981).

The second fence alignment area (Ranch Headquarters) is near the center of Empirita Ranch about two miles southeast of the first fence alignment area (Fence Line #1), and includes three shorter fence line alignments all surveyed as a 50 foot wide corridors (**Figure 1b**). One fence alignment is located at the northwest corner of the ranch headquarters area (Fence Line #2), is 4380 feet long, and totals 5.02 acres/ 2.03 hectares surveyed. Another fence alignment is at the southeast corner of the ranch headquarters area (Fence Line #3), is 800 feet long, and totals .91 acres/ .37 hectares surveyed. The third fence line in this area is at the northeast corner of the ranch headquarters area (Fence Line #4), is 1,300 feet long, and totals 1.49 acres/ .60 hectares surveyed. These three fence lines (total = 7.42 acres/ 3 hectares) are situated in portions of the north ½ and SE 1/4 of Section 17, T17S, R18E (USGS The Narrows, AZ, 7.5', 1981).

This archaeological survey was requested by Pima County for the proposed project as required by Pima County Board of Supervisors Resolution 1983-104. The reason for the survey was to determine if there were important cultural resources present in the project area that might be eligible, or potentially eligible for listing on the National Register of Historic Places (NRHP), and that would be subject to negative impacts by the proposed fence line construction projects. ARS has compiled a definition of what constitutes cultural resource based on existing laws and professional standards. In this definition, cultural resources may include prehistoric and historic archaeological sites or objects, historically or architecturally significant structures or buildings, cultural landscapes, and traditional cultural properties.

This project was conducted by ARS for Pima County. ARS is a company on the Pima County Qualified Consultant List for cultural resources services. As such, this survey was conducted at the request of Pima County in a two separate letters of December 4, 2003 (Contract Nos: 07-04-A-133579-1203 & 07-04-A-133580-1203; Work Order Nos: 4OLMGT & 40CCCI). Authorization to proceed with the cultural resources survey was sent to ARS by Roger Anyon, Cultural Resources Coordinator for the Pima County Administrators Office, Cultural Resources Office on December 4, 2003. Pima County provided ARS with scaled aerial photographs of the proposed fence lines (scale: 1 inch = 40 feet). ARS was asked by Pima County Archaeology and Historic Preservation to coordinate access for the surveys with Donald Ward of Pima County Flood Control District. Mr. Ward coordinated with Pima County Natural Resources, Parks, and Recreation Department to insure the proposed fence line alignments were flagged or staked prior to the archaeological surveys. Background research for this project was conducted by Shearon Vaughn of ARS. Fieldwork was conducted by Ross S. Curtis. The Projects Manager was Suzanne Krohn, and Dr. Lyle M. Stone served as the Principal Investigator.

Because the project area consists of Pima County land, the survey was conducted under the conditions and authority of an Arizona State Museum, Arizona Antiquities Act permit (Blanket

Figure 1a. Location of Project Area.

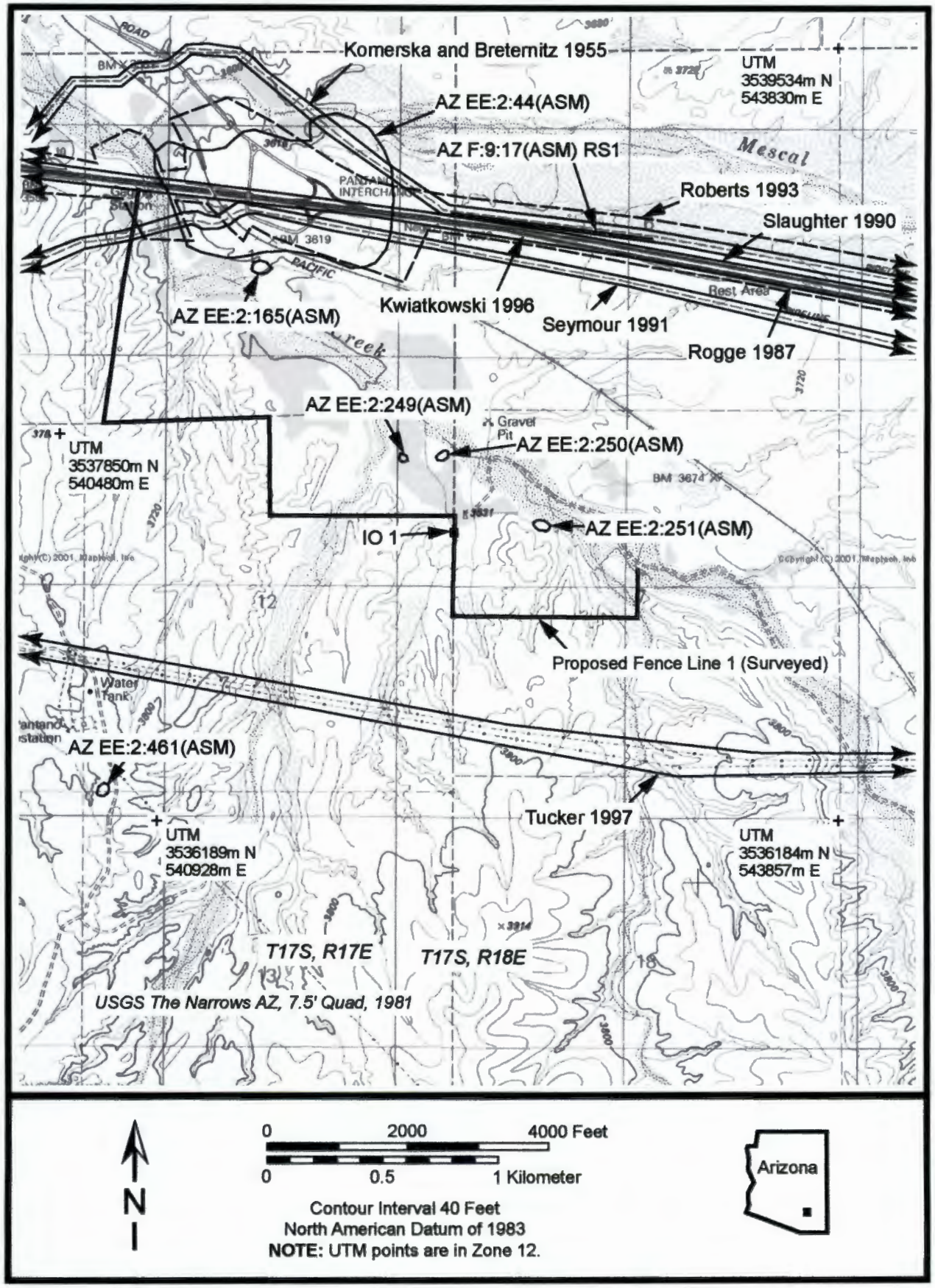
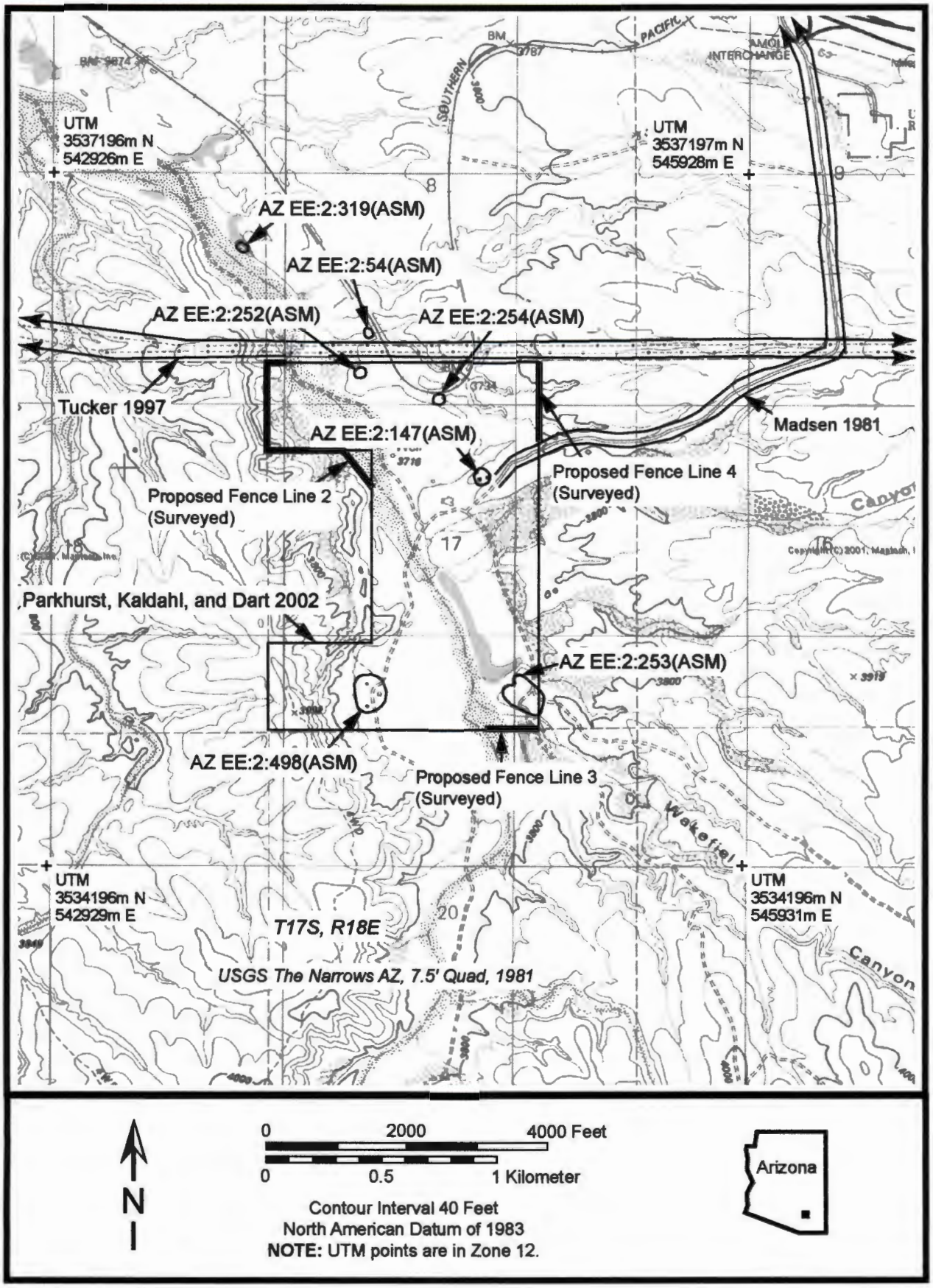


Figure 1b. Location of Project Area.



Permit No. 2003-027BL) for non-collection, no-disturbance surveys. ARS sent a notification of intent to conduct this survey under the blanket permit to ASM on December 10, 2003. The survey was conducted to the standards specified in the conditions of the Arizona Antiquities Act permit, with the report compiled in accordance with the Arizona State Historic Preservation Office Standards for Reporting Cultural Resources Surveys (2001).

PROJECT SETTING

Physical Setting

The study area is located at Empirita Ranch to the south/southeast of Interstate Highway 10 in eastern Pima County. This area is situated within Arizona's Basin and Range Physiographic Province, characterized by high, rugged mountains and broad alluvial valleys (Wilson 1962). The surveyed fence lines are situated in a broad valley between the Rincon Mountains to the north, and the Whetstone Mountains to the south. This area contains intact desert with gravel covered ridges separated by small-to-moderate sized drainages. Local soils found in the project area are alluvial and colluvial silt, sand, and gravels. The elevation is approximately 3600-3720 feet above mean sea level. The surveyed parcels are crossed by several small unnamed washes and drainages. The major drainage in the near vicinity is Cienega Creek which flows through much of the center of the present project areas. Area vegetation is characteristic of the Sonoran Desert Scrub Biome (Turner and Brown 1994:181). Plants observed included palo verde, mesquite, acacia, prickly pear cactus, saguaro cactus (dispersed), barrel cactus, cholla cactus, other cacti, and assorted grasses.

Cultural Setting

Prehistory

The prehistory of the area east of Tucson may be described within the general context of prehistoric development in the southern desert region of Arizona. The first recognized prehistoric group to occupy southern Arizona were limited numbers of Paleo-Indian (ca. 8,000-10,000 B.C.) big game hunters who were highly mobile and hunted big game species such as mammoth (Cordell 1984). Following the Paleo-Indian Period the next recognizable prehistoric group in southern Arizona were mobile Archaic peoples (ca. 8000 B.C.- A. D. 150) who practiced a seasonal hunting and gathering lifestyle exploiting wild plant and animal resources (Huckell 1984). The Cienega Creek drainage and it's tributaries in southern Arizona is known to have been occupied by at least the Late-Archaic (1500 B.C. to A.D.150) by local groups attributed to the San Pedro stage of the Cochise culture (Huckell 1995).

The introduction of domesticated plant species to the subsistence strategy of the late prehistoric peoples of southern Arizona resulted in the development of a more sedentary agricultural life way by at least ca. A.D. 150. Recent discoveries of domesticated plants as early as 1200 B.C. in the Tucson area indicate that the adoption of domesticated crops by some groups occurred much earlier in certain parts of southern Arizona than previously thought (Mabry 1999). The change in subsistence strategy included the cultivation of corn and squash, and the appearance of ceramics. The primary prehistoric group recognized in association with this sedentary agricultural lifestyle in southern Arizona are the Hohokam peoples who occupied an area from south of Tucson and north into the Phoenix Basin (Whittlesey 1998). The Hohokam are known to have practiced irrigation agriculture and exploited wild resources in the southern Arizona desert region from approximately A.D. 150-1450. The present project area falls at the eastern edge of the Hohokam culture area, and not far from the San Simon Branch of the Mogollon culture which is found to the east.

History

There appears to be a continuity between the prehistoric and historic or protohistoric Native American groups found in the area east of Tucson. It is generally accepted that the prehistoric Hohokam were the ancestors of Piman groups (e.g. the Akimel O'odham, a.k.a. Piman Indians, and the Tohono O'odham, formerly Papago Indians) that lived in Southern Arizona at the time of European contact (Seymour 1993). When the Spanish arrived in southern Arizona in the mid-A.D. 1500s, the Piman groups of the area lived in small extended family units and practiced a subsistence lifestyle based on hunting and gathering with some agriculture. Because of the similarity in material culture, settlement, and subsistence practices between the prehistoric Hohokam groups and the Piman peoples, the latter are thought to be the direct ancestors of the prehistoric peoples of the area.

The Spanish began exploration and settlement of Arizona as early as the 1530s, and they traveled through southern Arizona by 1540 when Hernando de Alarcon entered the area on a military expedition (Sheridan 1995). Tucson was established as a Spanish presidio in 1776. The Spanish Period in Arizona lasted until 1821 when Mexico achieved its independence from Spain and the Mexican Period began. The City of Tucson developed around the presidio and was a small community through the Mexican Period. The Mexican Period lasted in Arizona until 1848 with the end of the Mexican American War. After the war, U.S. military groups under the direction of commanders such as Lieutenant Amiel Weeks Whipple began exploration of Arizona and the southwest. The discovery of mineral wealth in Arizona during this period fostered an interest in Arizona becoming part of the United States, and in 1863 the Territory of Arizona was formally established. Tucson and the surrounding areas continued to grow and saw an influx of settlers following establishment of the territory. The U.S. Army established Camp Lowell in the center of Tucson in 1866, and this camp was later moved to the northeastern part of Tucson (Sonnichsen 1982:79). Tucson and the surrounding areas continued to grow and saw an influx of population following the coming of the Southern Pacific Railroad in 1880. After the coming of the railroad rural areas continued to be developed with homesteads and ranches established in many of the surrounding areas. Tucson and its surrounding areas remained relatively small through the early 20th Century and saw gradual population growth as the dry climate drew health seekers and tourists to the area. Historical research conducted by Old Pueblo Archaeology Center in the area indicates the Emprirta Ranch Headquarters was established by at least 1912 as the area is referred to as "Josefa Villa" on the 1912 GLO map for T17S, R18E (Parkhurst, Kaldahl, and Dart 2002). After World War II Tucson saw dramatic growth as the post-war economic boom in the United States reached southern Arizona, but rural areas surrounding the city continued to be sparsely populated. Eastern Pima County has remained a rural area to this day with scattered residences and, ranches.

STUDY PROCEDURES

Prior to the initiation of fieldwork, archaeological and historical records on file at ARS, the Arizona State Museum, and the Arizona State Historic Preservation Office were checked to determine whether previously identified cultural resources were present within or immediately adjacent to the project area.

The entire project area (fence line alignments) was subjected to a Class III (intensive field inventory) cultural resources survey. An archaeologist walked an east-west or north-south oriented transect following a staked or flagged alignment through the center of the 50 foot wide survey corridor. This strategy resulted in an interval of approximately15 meters in order to observe surface evidence of cultural resources. Ground surface visibility in the parcels was good at 70-80 %. Cultural resources of historic or prehistoric age found within the study area were recorded, following guidelines established by the Arizona State Museum (Fish 1995). According to these guidelines, cultural resources are defined as "sites," which represent concentrated physical remains of past activities or events, or as "isolated occurrences" which, due to their low frequency (e.g., a single artifact) and/or sparse distribution (e.g., 10–15 artifacts scattered across an area several hundred feet in diameter), are not considered eligible for site designation.

STUDY RESULTS

Archival Studies

As a result of the above-cited site file review, it was determined that two recent archaeological surveys (Desert Archaeology 1996.; Parkhurst, Kaldahl, and Dart 2002) had overlapped part of the Ranch Headquarters fence line area. Desert Archaeology conducted a judgmental reconnaissance survey as part of a research project (Cienega Valley Survey-exact areas surveyed are not known) along Cienega Creek in 1996 and recorded a number of prehistoric sites including AZ EE:2:253 (ASM) which is found close to the present project area. No formal report has been produced for this project (AZ SITE information on the recorded sites is available from the data base).

A recent study was also completed in 2002 by Old Pueblo Archaeology Center (OPAC) for Pima County that resulted in the survey of the entire 366 acre Empirita Ranch Headquarters parcel. This included survey of the areas that comprise the fence line alignments that are the focus of the present study, and an evaluation of the historic ranch buildings (Parkhurst et al. 2002). This previous survey again recorded site AZ EE:2:253 (ASM), and this site falls close to Fence Line # 3 of the present study (the site is discussed in detail below under "Field Investigations").

No previous studies overlapped portions of the Empirita North fence line area, and no archaeological sites had been previously recorded within this part of the present project area. There have been several archaeological surveys conducted within one mile of the two areas of Empirita Ranch that comprise the present study area, and these are listed in below Table 1. Also of note is the presence of the historic Southern Pacific Railroad route which is found adjacent to the present project area and has been assigned the designation AZ Z:2:40 (ASM) for its entire route in Arizona by Arizona State Museum.

Table 1. Prior Archaeological Surveys Conducted Within One Mile of the Project Areas

ASM Proj. #	Description	Size (Acres)	Sites Found	Reference	Institution
1955-3	Southern Pacific Pipeline		None	Komerska and Breternitz 1955	ASM
1981-73	Mtn. Bell Siemond Ranch	15	None	Madsen 1981	ASM
1987-222	Buried Fiber Optics Cable	862	None	Rogge 1987	D&M
1990-70	Optic Line		None	Slaughter 1990	SWCA
1991-233	Mountain View Survey		None	Seymour 1991	SWCA
1993-262	Marsh Station E A	175	None	Roberts 1993	SWCA
	Interstate 10 Survey	404	AZ EE:2:44(ASM)	Kwiatkowski 1996	ARS
	Cienega Valley Survey		AZ EE:2:249-254 (ASM)	DA 1996	DA
1997-469	Butterfield to Pantano Survey	474	None	Tucker 1997	SWCA
2002-269	Empirita Ranch Survey	366	AZ EE:2:253 (ASM)	Parkhurst, et al. 2002	OPAC

ARS = Archaeological Research Services, Inc. ASM = Arizona State Museum DA = Desert Archaeology, Inc. D&M = Dames and Moore OPAC = Old Pueblo Archaeological Center SWCA = SWCA, Inc. Environmental Consultants

Field Investigations

As a result of the field survey one previously recorded prehistoric site (AZ EE:2:253 [ASM]) was identified near Fence Line #3, and an isolated occurrence (IO 1) consisting of a small concentration of historic artifacts was found along Fence Line #1. IO 1 consists of 1, hole-in-cap food can; 10 fragments of a hand finished amber quart beer bottle, 10 fragments of a sun-colored amethyst patent medicine bottle; and 5 fragments of an aqua quart beer bottle. No features were found, and this isolated occurrence may represent a temporary camp from ca. 1900. The isolated occurrence is not considered an important cultural resource and not further work is recommended. No new archaeological sites or other cultural resources were identified in the remaining study area. The previously recorded site is further described below.

Previously Recorded Site AZ EE:2:253 (ASM)

Location. This prehistoric site is found at the southeast corner of the Empirita Ranch Headquarters property on a bluff overlooking Cienega Creek to the west (**Figure 1b**). The site is located within a portion of the SE 1/4, SW 1/4, SE 1/4 of Section 17, T17S, R18E (USGS The Narrows, AZ, 7.5', 1981) at an elevation of 3760 feet above mean sea level. The UTM coordinates for the site are Zone 12, 3534890 meters North, and 545000 meters East.

Description. This site consists of and extensive scatter of ceramic, flaked stone and ground stone artifacts (**Figure 2**) covering an area 250 meters long (east-west) by 150 meters wide (north-south). No surface features were noted but the large size and high density of materials suggest a high probability that buried features such as pit houses are present.

Previous recordings of this site noted in excess of 2000 flaked stone, ceramic, and ground stone artifacts. Ceramic artifacts identified at this site included primarily 1000+, brown, plainware sherds; and few decorated examples including Rincon Red-on-brown (Tucson Basin Sedentary Period style, dating A.D. 950-1000); and Sacaton Red-on-buff (Phoenix Basin Hohokam Sedentary Period style, dating A.D. 950-1100). Flaked stone artifacts found at the site included in excess of 1000 pieces of fine grained basalt and chert debitage, representing all phases of the reduction sequence. Ground stone artifacts were represented by at least two, two-handed manos, and one metate of granite were also noted.

Discussion. This site has been previously recorded on two separate occasions, in previous archaeological studies of the area. The first recording occurred in 1996 when the site was documented by Desert Archaeology as part of the Cienega Valley Project (Desert Archaeology 1996). This was a research project conducted by Desert Archaeology, and although site forms were completed during the study, a final report has not been produced for the study. The site was thought to represent a habitation based on the quantity and variety of artifacts present. This site was attributed to the Hohokam Early Rincon Phase based on painted ceramics identified on the surface.

This site was again visited and re-recorded during a recent archaeological survey of the Empirita Ranch Headquarters by Old Pueblo Archaeology Center (Parkhurst et al. 2002). During this recording, OPAC noted there were not as many decorated ceramics as noted during the first 1996 recording, but believed the site boundaries and condition of the site had not changed. Recommendations were made in this recent survey for protection of the site through fencing, and avoidance of any future impacts to the site in ranch development activities.

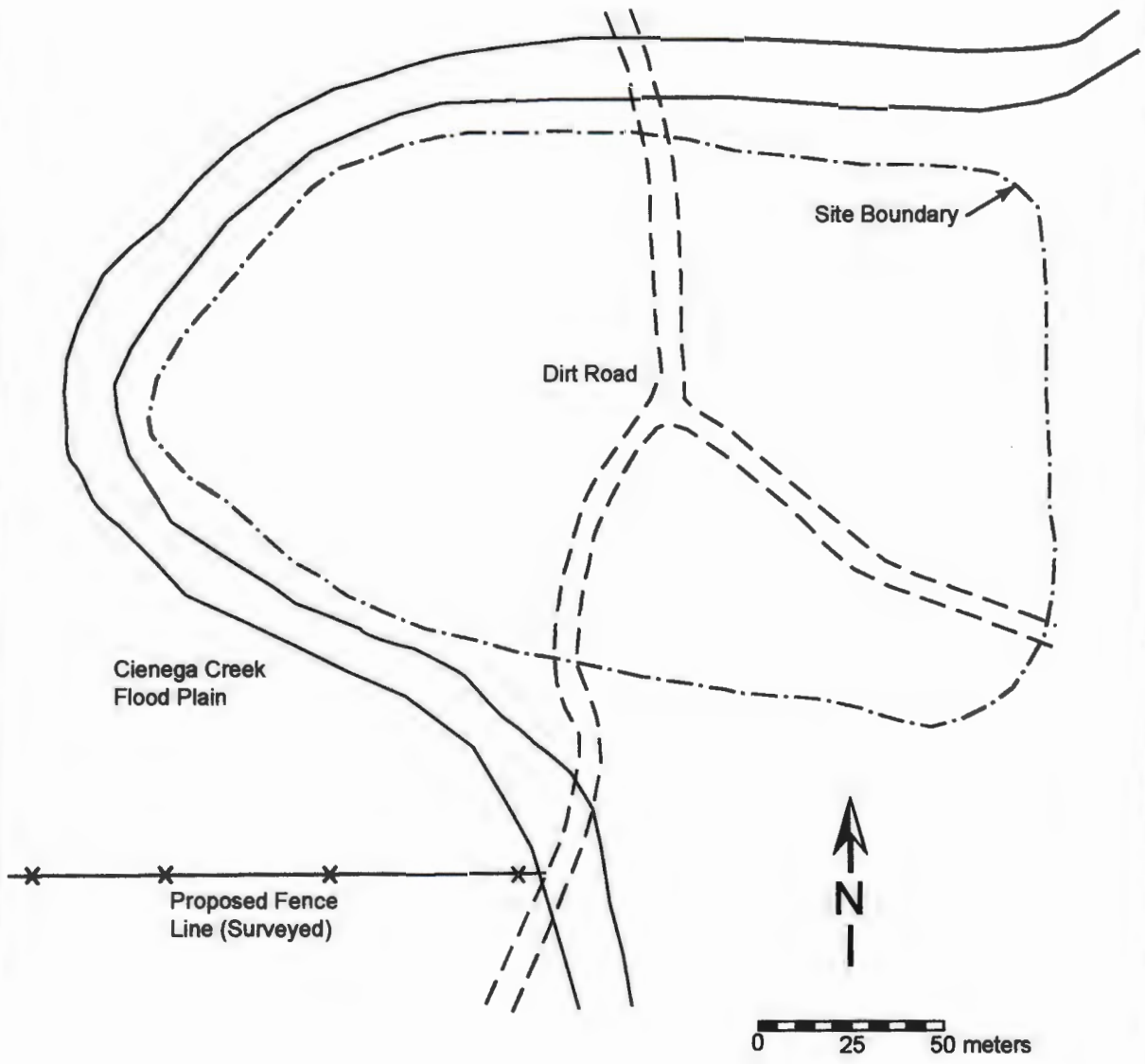
Previous archaeological research at this site, suggests it is a habitation dating to the Hohokam Sedentary Period (ca. A.D. 900-1100). The Cienega Valley Project documented the research potential of settlements between the Tucson Basin and San Pedro River Valley, and the contribution of the area to an understanding of the prehistory of the region. This site may contain buried structures and other important materials that could inform on the nature and timing of

Figure 2

Site Plan

Empirita Ranch Project 2003:080

AZ EE:2:253 (ASM)



prehistoric development in this part of southern Arizona. ARS also believes this site could provide important data that could contribute to an understanding of the prehistory of the area under the context: *Prehistoric Hohokam Settlement and Land Use in the Cienega Valley.*

Recommendations. The site is in very good condition and contains a high degree of integrity in terms of location, setting, feeling, and association. Because of its high degree of integrity and potential to provide information important to an understanding of the prehistory under the above noted context, this site is recommended as eligible for inclusion in the National Register of Historic Places under Criteria D (information potential).

As initially proposed, a northern extension of Fence Line # 3 would go through the center of the site. Roger Anyon, Pima County Cultural Resources Coordinator, consulted with Don Ward of Pima County Flood Control District and determined that Pima County did not need to build the northern extension of the fence line (the section that would go through the site), and the fence line alignment was modified to eliminate this section. This strategy will result in complete avoidance of the site (by at least 60 meters) with no negative impacts.

SUMMARY AND CONCLUSIONS

On December 18, 2003, and January 8, 2004 Archaeological Research Services, Inc. (ARS) conducted cultural resources surveys of four proposed fence line alignments for Pima County Flood Control District on county owned lands at Empirita Ranch in eastern Pima County, Arizona. Pima County Flood Control proposes to fence county owned property in eastern Pima County with four new fence segments in two separate areas of Empirita Ranch (fences to be erected by Pima County Natural Resources, Parks, and Recreation).

The first fence alignment area (Empirita-North/Fence Line #1) is located to south of Interstate Highway 10 at the northwest corner of Empirita Ranch. This single segment of fence line is 14,830 feet long. The fence line was surveyed as a 50 foot wide corridor and this survey area totals 17.02 acres/ 6.88 hectares. This fence line is situated in portions of the west ½ of Section 1, and north ½ of Section 12, T17S, R17E; west ½ of Section 7, T17S, R18E (USGS The Narrows, AZ, 7.5', 1981).

The second fence alignment area (Ranch Headquarters) is near the center of Empirita Ranch about two miles southeast of the first fence alignment area (Fence Line #1), and includes three shorter fence line alignments all surveyed as a 50 foot wide corridors. One fence alignment is at the northwest corner of the ranch headquarters area (Fence Line #2), is 4380 feet long, and totals 5.02 acres/ 2.03 hectares surveyed. Another fence alignment is at the southeast corner of the ranch headquarters area (Fence Line #3), is 800 feet long, and totals .91 acres/ .37 hectares surveyed. The third fence line in this area is at the northeast corner of the ranch headquarters area (Fence Line #4), is 1,300 feet long, and totals 1.49 acres/ .60 hectares surveyed. These three fence lines (total = 7.42 acres/ 3 hectares) are situated in portions of the north ½ , and SE 1/4 of Section 17, T17S, R18E (USGS The Narrows, AZ, 7.5', 1981).

This archaeological survey was requested by Pima County for the proposed project as required by Pima County Board of Supervisors Resolution 1983-104. The reason for the survey was to determine if there were important cultural resources present in the project area that might be eligible, or potentially eligible for listing on the National Register of Historic Places (NRHP), and that would be subject to negative impacts by the proposed fence line construction projects.

This project was conducted by ARS for Pima County. ARS is a company on the Pima County Qualified Consultant List for cultural resources services. As such, this survey was conducted at the request of Pima County in a two separate letters of December 4, 2003 (Contract Nos: 07-04-A-133579-1203 & 07-04-A-133580-1203; Work Order Nos: 4OLMGT & 40CCCI). Authorization to proceed with the cultural resources survey was sent to ARS by Roger Anyon,

Cultural Resources Coordinator for the Pima County Administrators Office, Cultural Resources Office on December 4, 2003

As a result of the field survey, one previously recorded prehistoric site (AZ EE:2:253 [ASM]) was identified near Fence Line #3, and one isolated occurrence consisting of historic artifacts was found on Fence Line #1). No new archaeological sites or other cultural resources were identified in the remaining study area. The site consists of and extensive scatter of ceramic, flaked stone and ground stone artifacts covering an area 250 meters long (east-west) by 150 meters wide (north-south). No surface features were noted but the large size and high density of materials suggest a high probability that buried features such as pit houses are present.

Previous archaeological research at this site, suggest the site is a habitation dating to the Hohokam Sedentary Period (ca. A.D. 900-1100). The Cienega Valley Project documented the research potential of settlements between the Tucson Basin and San Pedro River Valley, to an understanding of the prehistory of the region. This site may contain buried structures and other important materials that could inform on the nature and timing of prehistoric development in this part of southern Arizona. ARS also believes this site could provide important data that could contribute to an understanding of the prehistory of the area under the context: *Prehistoric Hohokam Settlement and Land Use in the Cienega Valley.*

The site is in very good condition and contains a high degree of integrity in terms of location, setting, feeling, and association. Because of its high degree of integrity and potential to provide information important to an understanding of the prehistory under the above noted context, this the site is recommended as eligible for inclusion in the National Register of Historic Places under Criteria D (information potential).

As initially proposed a northern extension of Fence Line # 3 would extend through the center of the site. Roger Anyon, Pima County Cultural Resources Coordinator, consulted with Don Ward of Pima County Flood Control District and determined that Pima County did not need to build the northern extension of the fence line (the section that would go through the site), and the fence line alignment was modified to eliminate this section. This strategy will result in complete avoidance of the site (by at least 60 meters) with no negative impacts.

Based on the lack of important prehistoric or historic resources within the project area no negative impacts to important cultural resources will occur in the project area as a result of the proposed undertaking (fence line construction). Therefore, it is recommended, in the event that any previously unreported, subsurface cultural features or deposits are encountered during future ground-disturbing activities within the project area, that these activities be discontinued in the immediate area of the remains, and a qualified archaeologist consulted to evaluate their nature and significance.

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APPENDIX G

RESTORATION OF CIENEGA CREEK BOTTOMLANDS ROADWAY EVALUATION

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Draft of November 23, 2005

Introduction

High road density is a significant threat to wildlife and natural systems in the world today. Like urbanized development, the biggest impacts of roads are the loss, fragmentation, and degradation of native habitats (Kline, 2002). Although their direct impacts (e.g., road kills) are less noticeable than paved roads, dirt roads can have quite a profound effect on the native environment by providing access to humans and their subsequent activities (e.g., wood-cutting). As with paved roads, dirt roads also provide a corridor for non-native species invasions because they cause disturbance, change microhabitats, and create edge effects that stress the native plants and animals while providing suitable habitat for the non-native species adapted to such activities (Kline, 2002).

This study was undertaken as part of the Restoration of Cienega Creek Bottomlands Project through funding provided by the Pima County Regional Flood Control District and a Federal Assistance Agreement from the Bureau of Land Management. The goal of the overall project is 1) to assist natural restoration of the bottomland plant communities through the removal of stressors and impediments, and 2) to improve the cover and structural diversity of plant communities along the bottomlands (PCFCD, 2003). Evaluation of roads and their effects on native habitats is an important task related to the first goal of the overall project.

Study Area

The study area for this project includes all of the District lands within the Cienega Creek Natural Preserve south of Interstate 10 and portions of the surrounding State Trust and Federal (Bureau of Land Management) lands. Since the District lands are not contiguous, they are identified as two separate properties. The northernmost property is referred to as the "I-10 Tract", due to its proximity to Interstate 10, and the southern property is the "Headquarters Tract" because it contains the Empirita Ranch buildings.

Purpose

The purpose of this study was to identify all known roadways within the study area and to evaluate their contribution or detriment to resource management. For instance, a road could contribute to resource management by creating a fire break and providing access to firefighters, but may be detrimental by focusing water flows into certain areas and causing severe channel erosion. Roads

on adjacent State and Federal lands were also evaluated in this study to determine if they might affect the Preserve.

Methods

Roads were initially identified using aerial photography, September 2002 orthophotographs, obtained from Pima County's MapGuide website. A couple of field trips were made to the site to determine the current condition and purpose of the roads, to see if any new roads have been created since September 2002, and to identify any problem areas that have been created by road development that are not visible on the aerial photographs. Locations of gates were included in the evaluation to show places where access could be limited to authorized users only, if necessary. In addition, off-road vehicle tracks were noted in areas off the main roads to identify those areas where new "wildcat" roads may form.

A series of four maps are provided to indicate the road network that occurs within the study area (see below). The main roads are marked in red. For the most part, these roads are well defined and serve administrative purposes for the Preserve and Empirita Ranch operations. Roads marked in blue serve purposes other than those for the Preserve (i.e., service of utility lines; old ranch roads, "wildcat" roads). Gates are highlighted with green circles. Problem areas, or potential problem areas, are circled in purple on the maps.

Road Identification

<u>Map 1</u>

A utility road, used by El Paso Gas, runs east to west through the northern portion of the property. A series of wildcat roads have formed along this utility road (A and B). One of these roads runs through Cienega Creek itself, where there is a gate located at the District's fence line approximately 100 feet from the main utility road (B).

An administrative road (Cienega Administrative Road) stems off of the utility road and runs parallel to Cienega Creek. Roughly, the first 1500 feet of this road, as you travel southeastward, is used by another utility company for an underground fiber optics line. A number of off-road vehicle tracks have produced a noticeable wildcat road going into Cienega Creek, approximately 3500 feet from the northern boundary of the District's property (H).

A portion of the dirt road that runs to O'Leary Windmill is located on this map. A series of off-road vehicle tracks stem off of this road as it crosses an unnamed wash (F). These tracks end shortly downstream of the crossing, but continue for quite a distance upstream. There is a gate along the District's fence line as it crosses the wash, approximately 1000 feet upstream of the roadway crossing (G). The off-road vehicle tracks continue southward for quite a distance past the gate (most likely to the power line road, which is located along the bottom of the map.

Map 2

The Cienega Administrative Road continues to run parallel to Cienega Creek. A gate has recently been installed by Pima County Natural Resources, Parks and Recreation (PCNRPR) personnel at the boundary between District and State properties (J). A portion of the Cienega Administrative Road was washed out approximately 1000 feet southeast of the gate, on State land (K). A new alignment was developed by vehicle traffic to circumvent the washed out portion.

There is an abandoned roadway near the northwest corner of the map, which is primarily defined by an old path of cleared trees. There are no visible tracks in the area, and it appears that scrubby vegetation is starting to mask the roadway.

The O'Leary Windmill Road is also identified in the northwest corner of the map. PCNRPR fence crews created an additional set of tracks near the beginning of this roadway, where the old alignment was rutted due to storm flows. This road continues beyond the windmill, crosses an unnamed wash (see Map 1), and ends in a thicket of vegetation as it nears what is believed to be a historic encampment (E).

There is evidence of ORV tracks on District land just before the gate (I) and on State land just after the washed out portion of the Cienega Administrative Road (L). The former tracks are faint and do not seem to go far beyond the administrative road. The latter tracks form a discernable road that has been blocked by the construction of a berm to keep vehicles from entering Cienega Creek.

Map 3

The Cienega Administrative Road continues to run parallel to Cienega Creek, crossing the creek twice near the North Field of Empirita Ranch. The road ends near the center of the Headquarters Property, linking up to the main entrance road to Empirita Ranch. There is a gate between the two roads that is locked for security purposes (O).

A power line utility road crosses the Cienega Administrative Road near the northwest corner of the District's property. This road briefly crosses into the District's property near the railroad easement, but is located primarily on State land. The utility road is fairly rough as you go up the hill on the west bank of the creek.

A fairly well-defined road extends off of the Cienega Administrative Road, heading west across Cienega Creek. This appears to be an old road that was used by the previous rancher to gain access to the gate on the eastern edge of the property. Dense vegetation blocks any traffic from going further than the new fence line located on District property. Numerous tracks were evident along the terrace in this area (N), however, it appears that these were created during construction of the fence line. The tracks do not enter into the creek at any time and there is no discernable path to suggest usage other than what was created by the PCNRPR fence crew.

There is another short road that extends off of the administrative road, runs through an unlocked gate, and heads into the North Field. This was most likely used by previous ranchers to gain access to the wells and irrigation system on the field.

The main entrance road for Empirita Ranch (Public Entry Road) runs through the central portion of this map. This road is accessed from Interstate 10 via the Empirta Road turn-off (Exit 283). The road is gated and locked approximately 4500 feet from the eastern boundary of the District's property, on Federal land managed by the Bureau of Land Management.

There are a number of short loop roads stemming off of the main road that are used to gain access to the historic structures, referred to as the Upper Complex of Empirita Ranch. The main road crosses Cienega Creek near the central portion of the property.

There is a well defined road near the bottom of the hill at the Upper Complex that is used by the rancher to gain access to cattle pastures east of the ranch headquarters. This road has also been designated as a temporary access road for public recreationists going onto State Trust lands near the Whetstone Mountains (Temporary Public Access Road). A gate is located at the northern end of this road as it stems off of the Public Entry Road (Q).

Map 4

The Public Entry Road continues through the District's property past the ranch headquarters, and heads south towards Empire Ranch. An unlocked gate is located near the southern property boundary (S). There is also a gate located at the south end of the corrals on the District's property, which was used by previous owners to gain vehicle access to the southern field (R). There are faint tracks along the pasture that have been created by the current ranch manager and District staff. A gate is located at the southeastern end of the field as it links back to the administrative road (T).

The Temporary Public Access Road also continues south and east through this map. The road exits the District's property near the southeastern corner. Flows from Anderson Canyon run down the road for approximately 500 feet before spilling into Cienega Creek.

Review of aerial photographs has identified an old ranch road along the western end of the Headquarters Property. This road starts near the main ranch house and runs up along the ridge. Although the road was not traversed during any field visit, it is assumed to be accessible only by four-wheel drive, if at all. There were no tracks leading off of the Public Entry Road to this road.

Road Evaluation

There are a total of four roads that are used for administrative purposes in the study area. The first is the Public Entry Road, which is the most direct route into the ranch and is also the easiest to traverse. The second is the Cienega Administrative Road, which runs parallel to Cienega Creek from the northern boundary of the District property (see Map 1) to its intersection with the Public Entry Road

(see Map 3). This road provides an alternative access to the ranch and is used by the ranch manager for inspecting fence lines and by District staff for monitoring watershed conditions along Cienega Creek. Third is the Temporary Public Access Road, which starts from the Public Entry Road and heads southward to the Whetstone Mountains (see Map 3). This road is used by the rancher for monitoring fence lines and by District staff for monitoring rangeland conditions. In cooperation with the Arizona Game and Fish Department, Pima County will allow this road to be temporarily open to hunters and recreationists wishing to access State lands near the Whetstone Mountains. The last administrative road is the O'Leary Windmill Road (see Maps 1 and 2). This road is used by District staff, their representatives, and the current land steward (ranch manager) for access to the windmill. It can also be used for monitoring recently constructed fence lines on District property.

All of the other roads identified in this study are either wildcat roads or old ranch roads that no longer serve a viable purpose for the current ranching operation nor for Preserve management. Apart from those identified on pasture lands or near structures, the roads are not well developed and are passable only by four-wheel drive and all terrain vehicles. An evaluation of the road conditions and their impacts on natural resource management are provided below.

Public Entry Road

This road is mostly in good condition. There is a drainage crossing located on State land that has experienced events of erosional down-cutting, almost to the point that the road is impassable. This section was recently repaired by Pima County, but additional work will be needed to help prevent future erosion. This may ultimately require the installation of a culvert. A second trouble spot is located along the hill just west of the Upper Complex ranch buildings (P). Heavy rainfall and increased public traffic could significantly damage the road along this hill and make it almost impassable. This portion of the road should be re-graded and filled with material to help stem erosion; a suggestion was made to obtain aggregate left over from Arizona Department of Transportation crews for highway repairs. Drainage bars could also be developed across the road to keep water from eroding the hill slope and forming gullies. The Arizona Game and Fish Department has offered to help grade the road annually (in early Fall) to insure safe public access.

Cienega Administrative Road

This road is well traveled, but there are a few areas where four-wheel drive may be needed to safely traverse the roadway, especially where the road drops from a hill into the creek bottom. Approximately 2000 feet along the northernmost portion of this road is deeply rutted due to water erosion. Further investigation found that the road is channeling water through this area and focusing flows into the creek at a point approximately 300 feet south of the gate (marked C on the map). A large head cut has formed in the area and is displayed in Figures 1-4 at the end of the report.

Head cut erosion is also occurring at Location K, on Map 2, where the old road alignment was washed away by flows down a tributary watercourse (Figure 5). Downcutting is not as severe in this area, as in Location D, and an alternative route has already been created to enter into Cienega Creek

and reconnect with the road about 500 feet upstream. Further investigation will be needed to determine if any action should be taken to prevent future erosion in this area.

The road runs along a high terrace as it enters the Headquarters Tract (Map 3). This terrace is slowly being eroded by runoff in Cienega Creek, which could eventually destroy the entire roadway in this area. However, it does not appear that the road itself is contributing to any erosion problems in this area. There are currently no plans to realign the road away from the edge of the terrace at this time.

The fence line will need to be completed and a new gate installed at the point where the road enters the Headquarters Tract from the north (M). The northern boundary of this property was recently fenced by the District to keep cattle from entering Cienega Creek and adjacent sensitive areas. The gate would help restrict non-authorized vehicles from entering the Preserve via adjacent State lands.

Temporary Public Access Road

This road is well defined, but has not had much traffic in recent years. Washes flowing across and/or down the roadway could provide difficulties for vehicle traffic over time. This was evident on a recent field trip by District staff to monitor rangeland conditions in the area, where the road was observed to be washed away along a major tributary about 900 feet from the entrance gate. There is no evidence, however, that flows down the roadway are causing any erosion problems along the creek itself.

Increased vehicle traffic and access needs could significantly change the character of this road. Portions of the road would need to be repaired after significant flow events or there could be the possibility of vehicles creating new paths to circumvent the washed out areas and creating more habitat destruction. The intersection of this road with the Public Entry Road will need to be modified to allow safe access by the public. Any other modifications will need to consider the potential for increased erosion or habitat destruction (i.e., spread of non-native grass and associated fire conditions).

As this road starts to head east, it crosses a documented archeological site (U). This site, identified at AZ EE:2:253 (ASM), consists mostly of prehistoric sherd and lithic scatter. It is suggested that the existing road be aligned to bypass this site and that the site be fenced and signed to prohibit removal of the artifacts (Parkhurst et. al., 2002).

O'Leary Windmill Road

This road is visible, but does not appear to have much vehicle traffic use. Since it does traverse Cienega Creek, four-wheel drive is recommended. There are tracks leading down the eastern hill slope that were created to circumvent a rutted area, but it did not appear that the rutted area was significant enough to warrant the creation of an alternative path.

The road continues westward past the O'Leary Windmill, crossing a large tributary wash, and ending approximately 800 feet in a densely vegetated area. Vehicle tracks were noted where the road crosses a tributary wash (D). These tracks appear to be coming down the wash from a point where the electric utility line road crosses the tributary (outside of the map area). A gate was installed by the PCNRPR fence crew, and repaired by the Empirita Ranch caretaker, at a location approximately 800 feet upstream of the road crossing.

There is an undocumented archeological site located within the mesquite woodland just west of where the road becomes impassable. This site appears to be a historic encampment, with artifact scatters and structure remnants strewn throughout the area. Although there is little evidence of vehicle traffic, disguising the road near the tributary wash crossing would help insure the protection of this site.

Wildcat Roads

As mentioned previously, most of the wildcat roads are not well developed and passable only by four-wheel drive vehicles or ATV's. They appear to be primarily developed by recreationists, although some of them may have been created by illegal drug traffic or people smuggling activities. In almost all cases, these roads (or tracks) run into Cienega Creek, which could lead to further destruction of the riparian ecosystem. Tracks within the creek and its major tributaries were noted upstream of Location B, at Location H, and both upstream and downstream of Locations F and G during field investigations. The tracks at Location I did not enter into the creek and the wildcat road created at Location L was blocked by a steep berm constructed by the District's land steward.

It is recommended that all of the wildcat roads be concealed with vegetation to eliminate further usage and destruction of the native flora. Driven rails and/or boulders could be used to block some of the roads leading directly into the creek itself. Although these activities may not deter certain criminal usage, it is believed that recreational usage will diminish. Gates and posted signs should also help deter recreation off-road vehicle use.

There were several tracks all over the floodplain terrace located in the northwest corner of the Headquarters Tract (N). It would appear that these tracks were created by PCNRPR staff during construction of the new fence line in the area. The tracks were not evident during previous site visits by District staff. Based on this observation, it would seem that the site would recover on its own and that no concealment activities would be required, however the situation should be monitored to make sure these do not become recreational roads.

Old Ranch Roads

Most of these roads are either driveways to abandoned structures or maintenance roads for wells and irrigation systems in the pastures. Some of the roads may still be used by the ranch manager for monitoring fence lines or opening gates to transfer cattle from one pasture to another. None of these roads appeared to be used by anyone but the ranch manager and District staff.

For the most part, these roads serve some purpose for current operations of the ranch or for management of the Preserve. The driveways to the structures will need to be repaired and maintained if and when the property is opened to the public. All other roads can be left intact, but do not require any maintenance.

Non-native Species Invasions

The most notable plant species found along the roadways in the study area is Lehmann lovegrass (*eragrostis lehmanniana*). Lehmann lovegrass is a fine-textured, warm season perennial bunchgrass that has been well known to out-compete and replace native grasses. It is the dominant grass species found along the Preserve (PAG, 2003). Other non-native species observed along the roadways in the area are Russian thistle (*salsola kali*), bermudagrass (*cynodon dactylon*), and London rocket (*sisymbrium irio*). Due to their extensive distribution within the Preserve and the difficulty of eradication efforts, management of these species has been given low priority (PAG, 2003).

Conclusion

There are four major roads located on the Cienega Creek Natural Preserve, south of Interstate 10, that are being used for administrative purposes. These purposes include, but are not limited to, the monitoring and maintenance of fence lines used to keep cattle out the bottomlands, monitoring of water levels and rangeland conditions, maintenance of historic structures, public recreation access and daily cattle grazing operations. The roads are, for the most part, well defined and passable by two-wheel drive vehicles. There are some eroded areas along the Public Entry Road that will need repairs to allow safe access onto the Preserve by District staff, their representatives, and the general public. The other three roads are in decent condition, but are susceptible to storm water erosion and may need minor repairs after such activity. Most of the minor repair work can be performed by the land steward. Due to their need for public access onto State lands south of the Preserve, the Arizona Game and Fish Department should be responsible for maintaining the Temporary Public Access Road.

The most notable resource problem stemming from the roadway network within the study area occurs along the Cienega Administrative Road near the northern boundary of the I-10 Tract (Map 1). The road collects water runoff coming from the adjacent hill slope and focuses it at a point labeled "D" on the map, thus creating a significant head cut along the eastern bank of Cienega Creek in this area. Based on past experience of similar problems in the downstream area, the most practical solution to this problem would be to grade the road to a higher elevation and construct water bars at particular intervals to divert flows from the hill slope towards the creek.

Wildcat roads also appear to be a significant problem in the study area. The majority of these roads occur within the I-10 Tract, which is covered in Maps 1 and 2. Access points along the administrative roads could be blocked to discontinue use by off-road recreationists. Posted signs along the fence lines and gates could also help reduce recreation off-road vehicle use. However,

these actions may not reduce the overall off-road vehicle use in the area, since there are a number of people using the Cienega Creek corridor for illegal drug and people smuggling activities.

Protection of the historic ranch buildings and prehistoric archeological sites is a concern because of the recent decision to open the Public Entry and Temporary Public Access Roads to the public for access onto State lands along the Whetstone Mountains. Efforts are being made by the District, Arizona Game and Fish Department, PCNRPR, the Bureau of Land Management and others to help insure protection of these resources once this action takes place. As for the historic site located at point E on Map 1, it appears that the natural vegetative regrowth in the area has effectively hidden the site from Preserve visitors.

Old ranch roads still exist on the property and are being used, to some degree, by the land steward for repairing fencing and transferring cattle from one pasture to another. These roads do not appear to be used by anyone but the land steward and, occasionally, District staff. Due to limited use, these roads should be left alone and allow nature to recover on its own. There are some roads leading to the driveways of historic structures on the property, which can be left alone until such time that the structures are repaired and open to the public or to additional land stewards for the Preserve.

Recommendations

The most significant resource damage is located along the Cienega Administrative Road near the northern boundary of the I-10 Tract parcel (Map 1, Location D). Regrading the road to a higher elevation and installing drainage bars periodically could allow smaller flows to pass over the road and head directly into the creek, rather than collect in the roadway and focus all their power on further eroding the gully at Location C. Pima County Operations has performed this type of work for the District in areas north of I-10, and they may be the most suitable for this effort.

Wildcat roads and abandoned ranch roads (Locations A, B, D, F, H, I, K, L and N) should be concealed with vegetation to eliminate further usage and allow reestablishment of native flora. The District can schedule this type of work for summer youth crews. Driven rails and half buried boulders can be used in areas where simple concealment is not working to prevent off-road vehicle use. Gates and posted signs may help to deter recreational users, but is unlikely to stop those performing illegal activities such as drug trafficking. The most effective deterrent will be regular patrols by law enforcement officers. Most of these activities would fall under the responsibility of the District and its representatives, with a cooperative effort from the Federal government (Border Patrol) to reduce illegal activities.

Both the Public Entry Road and the Temporary Public Access Road should be maintained for safe access by District staff, their representatives, and the general public, to protect valuable cultural resources on District and State lands, and to help reduce the likelihood of new alignments or roadways being developed to circumvent problem areas. In cooperation with the Arizona Game and Fish Department, maintenance activities should include:

1. Regrading the steep slope of the Public Entry Road east of the intersection with the Temporary Public Access Road and filling in with aggregate material to provide more friction for vehicles during periods of wet weather.
2. Building drainage bars along relatively steep inclines to prevent gully formation.
3. Monitoring and repairing, if necessary, stream crossings to insure safe passage of vehicles and to prevent the diversion of flows along the roads themselves.
4. Proper fencing and sign posting in highly visible areas containing sensitive resources (i.e., historic resources) to build public awareness and help prevent vandalism.
5. Building by-passes or maintaining quick access routes (i.e., installing cattle guards instead of gates) in sensitive areas that are less visible to the public, but could become more visible if traffic were slowed by obstacles.

It is recommended that all parties involved in the maintenance of roadways in this area (project managers, equipment operators, etc.) be more familiar with environmentally friendly road drainage techniques and strategies. Courses are available periodically and some District and Natural Resources Department staff have training already.

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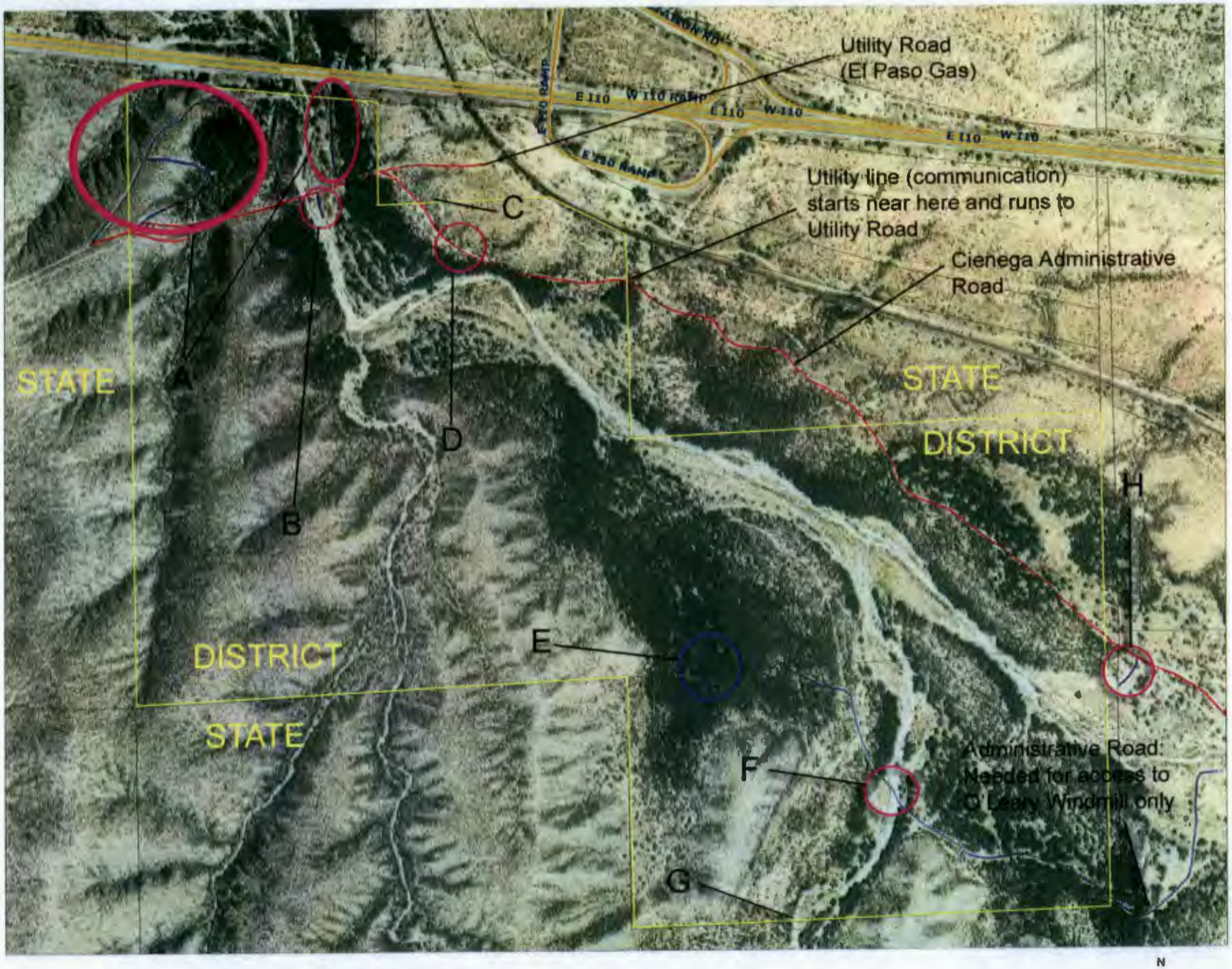

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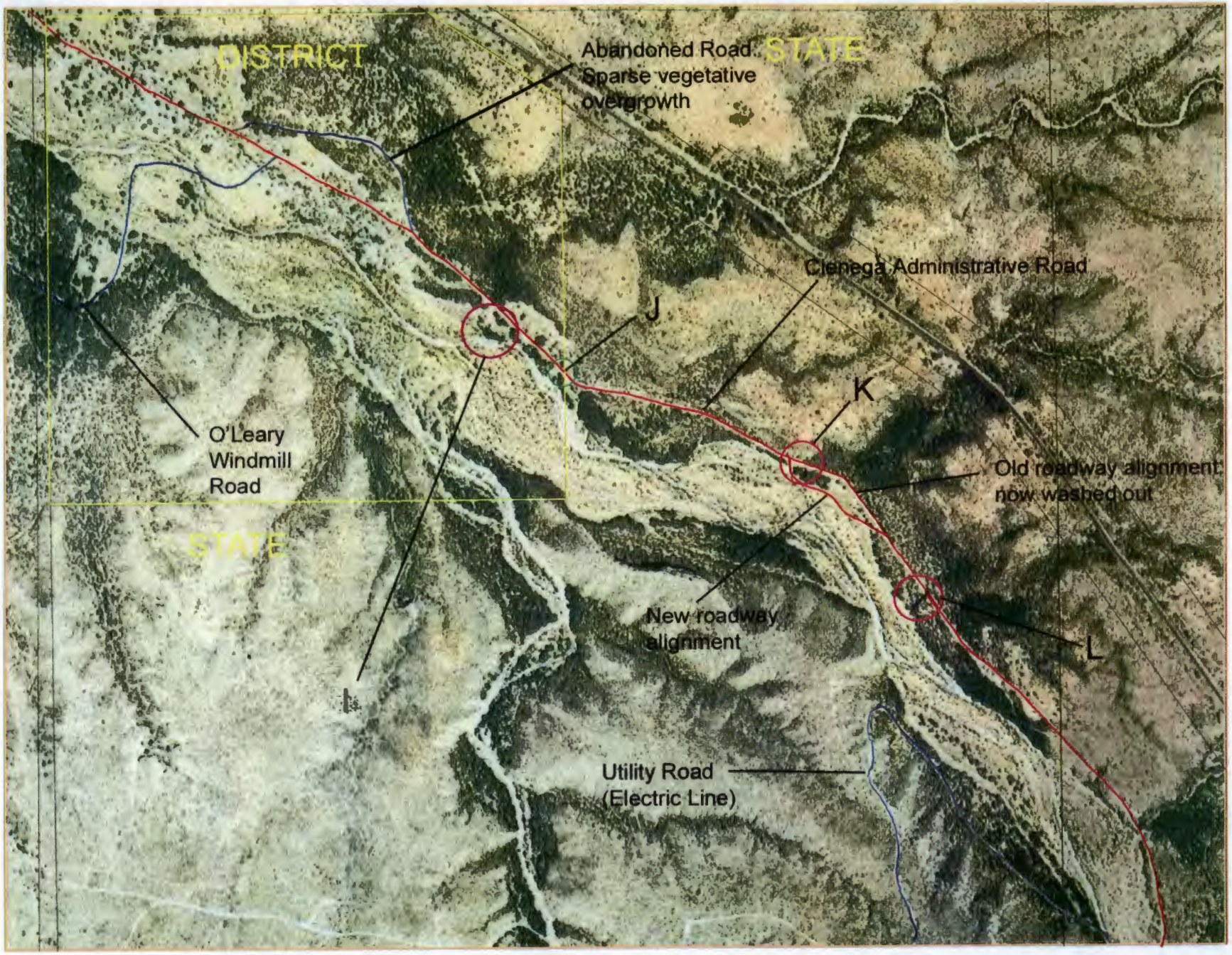
Map 1

N



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Map 2

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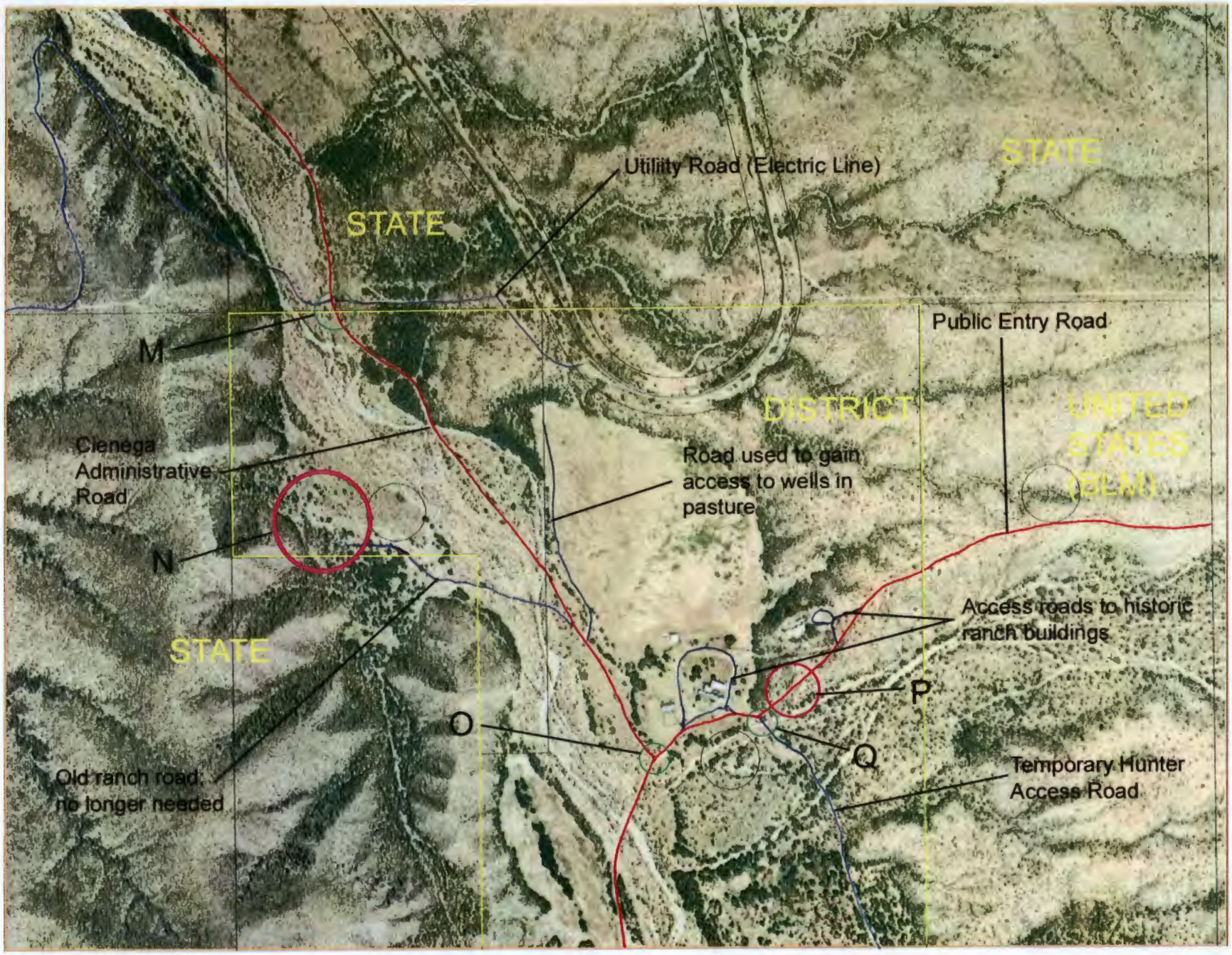

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Map 3

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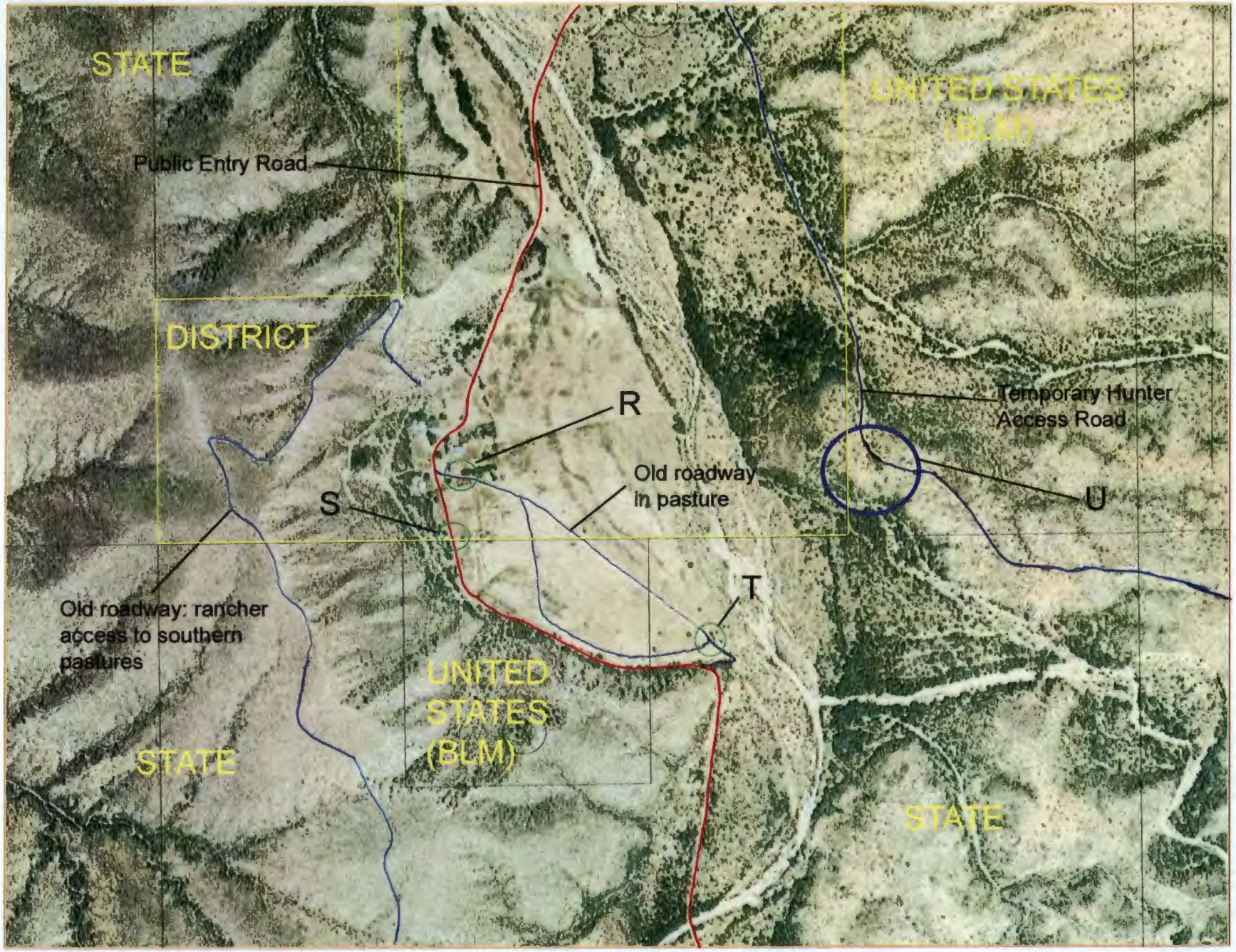

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Map 4

N

Figure 1. Water is diverted along the rut located on the right (East) side of the Cienega Administrative Road; viewing Northwest.

Figure 2. Water erosion through vegetation just west of the road at Location D.

Figure 3. Headcut of gully created by focused water flows down the Cienega Administrative Road at Location D.

Figure 4. Gully erosion as seen from the top of the bank at Location D.

Figure 5. Erosion along abandoned alignment of the Cienega Administrative Road at location K.