DRAFT

MEMORANDUM

Date: August 7, 2000

To: The Honorable Chair and Members
Pima County Board of Supervisors

From: C.H. Huckelberry
County Administrator

Re: **Importance of Conserving Resources in the Altar Valley**

Overview

Prior studies: The Sonoran Desert Conservation Plan is being developed in the context of a vast land base and with a great deal of data. This scale creates a risk that some of the basic insights provided by the information-driven side of the effort will be lost or diluted. Two weeks ago I issued a report on the *Importance of Conserving Resources in the Cienega Creek Watershed* in order to provide a brief summary of some of the resource issues that make the Cienega Creek watershed vital to the overall success of the Sonoran Desert Conservation Plan. The Cienega-Rincon area, like the Altar Valley, has high natural and cultural resource value, and thus high conservation potential as a watershed planning unit. The attached report, *Importance of Conserving Resources in the Altar Valley,* is a companion to the Cienega Creek document and provides a focus on Altar Valley. A few points from prior studies include that:

- Altar Valley is rich in natural and cultural resources: it has the highest number of priority vulnerable species of any watershed; the highest number of priority streams; and high conservation potential for cultural resources.

- Altar Valley covers 713,807 acres. This makes it the largest watershed planning unit in Eastern Pima County, comprising almost 30 percent of the total 2.4 million acres. Altar Valley is more than twice the size of the Cienega-Rincon watershed planning unit (which has 318,535 acres), and it is almost five times larger than the maximum area that might be protected under the Las Cienegas National Conservation Area within Pima County. Viewed another way, the entire regional multi-species conservation planning area for San Diego would fit into Altar Valley, and the watershed still exceeds the size of the San Diego multi-jurisdictional regional effort by over 130,000 acres.

- Altar Valley is remarkably unfragmented. Approximately 30 ranches make up the majority of the land base, and the ranchers participating in the conservation plan process would like to continue to maintain the unfragmented nature of the land base. Almost 90 percent of the Altar Valley is currently public and vacant land.

- Altar Valley does not have zoning in place that has generated large investment backed expectations in commercial or residential enterprise. These expectations exist in many other areas of Eastern Pima County to varying degrees. On the order of 94 percent of vacant land in Altar Valley is zoned Rural Homestead (RH). The full cash value of land in Altar Valley is also significantly lower than many other areas of Eastern Pima County, which could lead to less expensive conservation programs, or, it could lead to large scale land purchases by developers speculating on its future use.

Attached reports: To date the Sonoran Desert Conservation Plan technical process has generated over 100 reports and 1000 data layers. We are fortunate to be able to have the opportunity to improve this store of knowledge by considering the attached detailed investigations into the historic conditions of the watershed, current rangeland conditions of biotic communities, and the environmental impact of a potential floodplain project, as part of three studies that have been conducted and forwarded to Pima County by the Altar Valley Conservation Alliance: (1) Dr. Nathan Sayre has investigated and documented the historic conditions of the Valley; (2) Dr. Walter Meyer has surveyed and evaluated the rangeland conditions of the valley; and (3) Westland Resources has prepared an Environmental Assessment, which was submitted to the Arizona Water Protection Fund Commission.

This memorandum provides a brief summary of some of the resource issues that make the Altar Valley critical to the overall success of the Sonoran Desert Conservation Plan, and it includes descriptions of the reports from the Altar Valley Conservation Alliance.

Regional Significance of the Altar Valley to Multiple Species and Multiple Resources

A few data sets are presented here, excerpted from the more than 100 studies that have been undertaken to develop the information base for all elements of the Preliminary Sonoran Desert Conservation Plan. The Altar Valley, like the Cienega-Rincon area, has high natural and cultural resource value, and thus high conservation potential as a watershed planning unit.

- Summary of Priority Vulnerable Species by Subarea: The chart below combines the total number of priority vulnerable species from the categories mammals, birds, reptiles, amphibians, fish, invertebrates, and plants, and ranks the areas from most to least number of species within the area that need protection due to their imperiled status. Just as the Altar Valley and Cienega-Rincon areas have the highest percent of priority streams (described below), these two watershed planning units have the greatest number of priority vulnerable species. (Source: *Priority Vulnerable Species*, 6-8-00)

WATERSHED SUBAREA	NUMBER OF PRIORITY VULNERABLE SPECIES
Altar Valley	**31**
Cienega-Rincon	29
Upper Santa Cruz	23
Middle Santa Cruz	22
Tortolita Fan	17
Western Pima County	17
Avra Valley	16
Middle San Pedro	16

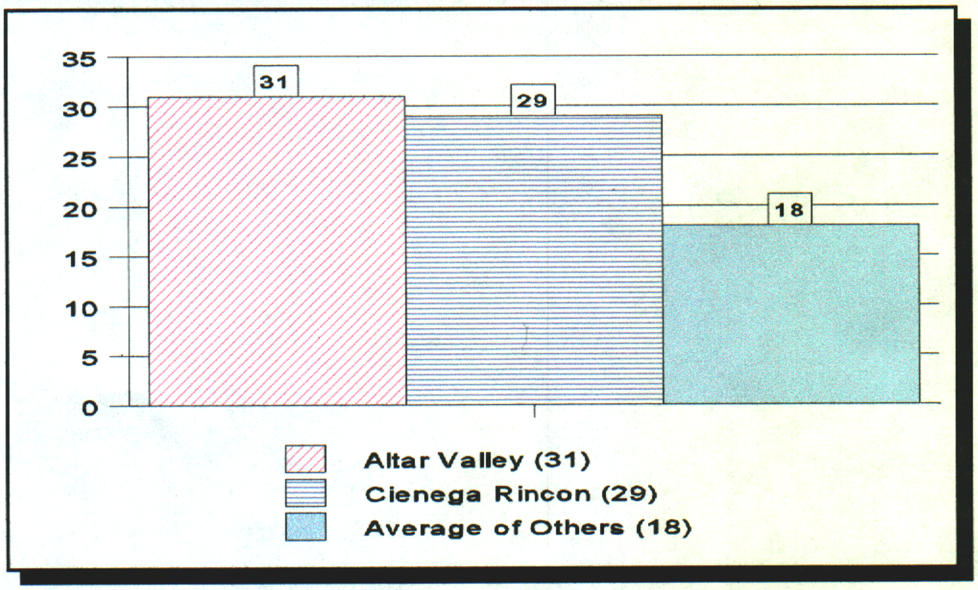
- <u>Summary of Priority Vulnerable Species by Taxonomic Group</u>

The chart below shows the number of priority vulnerable species from each taxonomic group, with the Cienega-Rincon and Altar Valley subareas compared to the average of the other six watershed planning units.

SUBAREA	MAMMAL	BIRDS	FISH	AMPHIB	REPTILES	INVERT	PLANTS	TOTAL
ALTAR VALLEY WATERSHED	7	7	2	2	4	7	2	**31**
CIENEGA-RINCON WATERSHED	7	7	3	2	2	5	3	**29**
AVERAGE OF OTHER SIX WATERSHEDS	6	6	0.8	0.7	2.2	1.2	1.5	**18**

- Source: *Priority Vulnerable Species*, June 8, 2000

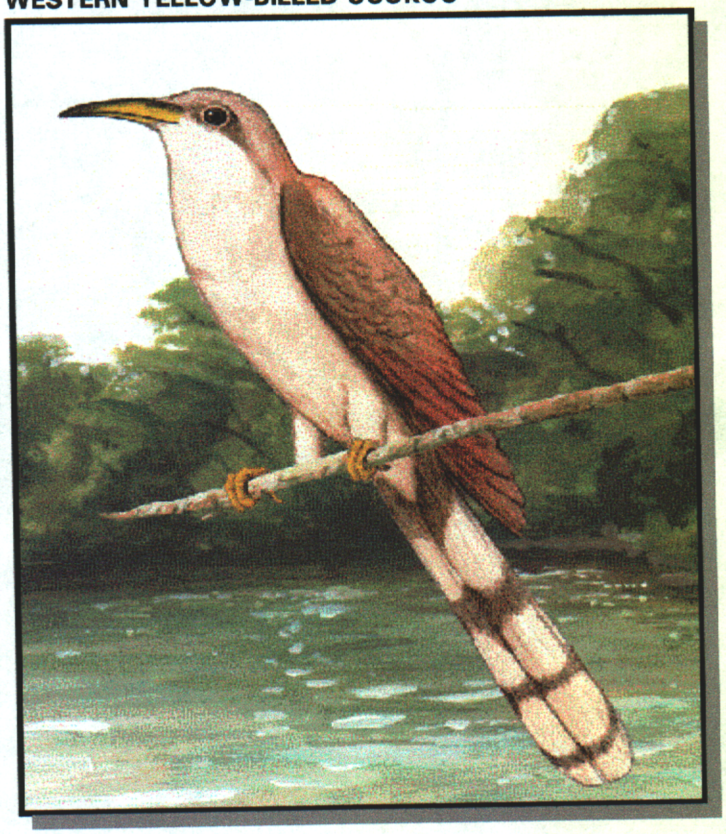
NUMBER OF PRIORITY VULNERABLE SPECIES BY WATERSHED



- Priority Vulnerable Mammal Species -- Nine mammals are considered to be priority vulnerable species. Seven are known or thought to be potentially present in the Altar Valley watershed planning unit.

- Priority Vulnerable Bird Species -- Eight birds are considered to be priority vulnerable species. Seven are known to be present in the Altar Valley watershed planning unit. Significantly, both the cactus ferruginous pygmy-owl, which is listed as endangered, and the Western Yellow-billed Cuckoo, which is being studied by the Service and could be listed in the future, are found in the Altar Valley.

WESTERN YELLOW-BILLED CUCKOO

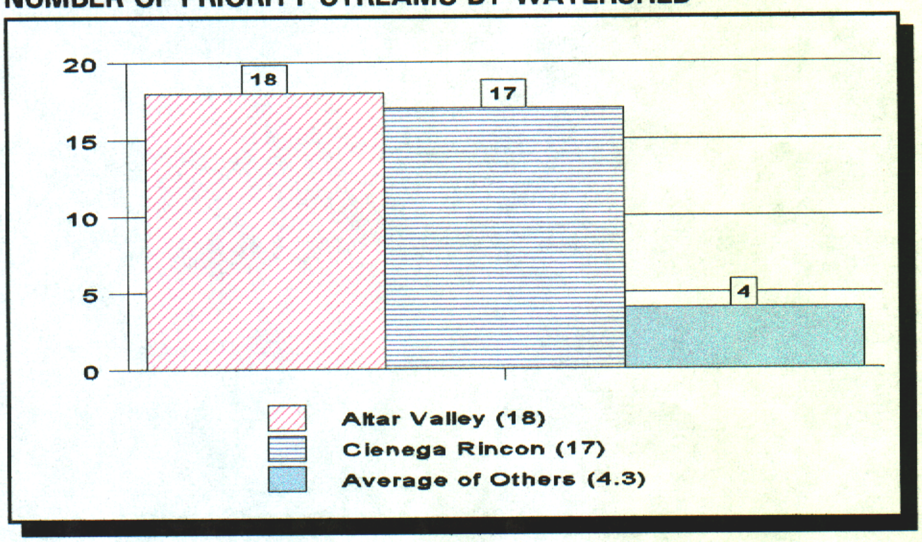


- Priority Vulnerable Amphibian Species -- Two amphibian species are considered to be priority vulnerable species. The Chiricahua leopard frog, which has been proposed for listing, is present. The Lowland leopard frog has been historically present in the Altar Valley watershed planning unit.

- Prioritization of Streams for Conservation in Pima County -- Streams that ranked in the top 20 by the following parameters are recommended for priority consideration: perennial stream length and intermittent stream length; area of hydro-mesoriparian vegetation and of xeroriparian Class A vegetation; area of shallow groundwater; and presence of native fish. Over 50 percent of the priority streams within the County are found within the Altar Valley and the Cienega Rincon area.

SDCP Planning Unit	Number of Priority Streams	Percentage of Total
1. Middle San Pedro	8	12
2. Cienega Rincon	17	26
3. Upper Santa Cruz	3	4
4. Middle Santa Cruz	9.5	15
5. Tortolita Fan	5.5	8
6A. Altar Valley	**18**	**28**
6B. Avra Valley	2	3
7. Tohono Nation	1	2
8. Western Pima Co.	1	2
Total	65	100

NUMBER OF PRIORITY STREAMS BY WATERSHED



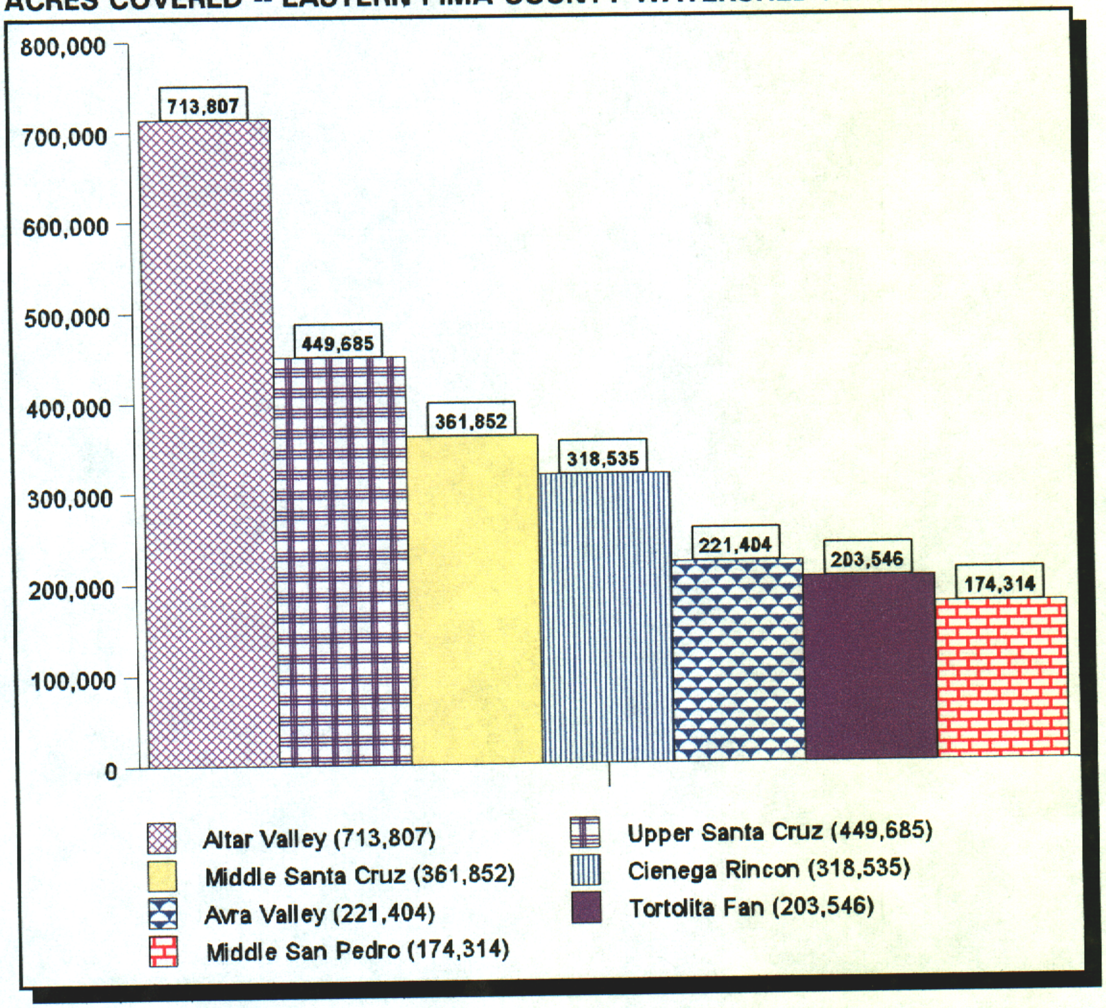
- Potentially covered species in need of riparian areas -- Potentially covered species are those for which an incidental take permit might be sought under the Endangered Species Act. The potentially covered species thought to need riparian areas are summarized by subarea in the table below.

Common Name	Included in Altar Valley Subarea?
Mexican Long-tongued Bat	yes
Merriam's Mouse (Mesquite Mouse)	yes
Western Yellow Bat	yes
Allen's Big-eared Bat	
Western Red Bat	yes
Arizona Shrew	
Southwestern Willow Flycatcher	
Western Yellow-billed Cuckoo	yes
Cactus Ferruginous Pygmy-Owl	yes
Abert's Towhee	yes
Bell's Vireo	yes
Chiricahua Leopard Frog	yes
Lowland Leopard Frog	yes
Mexican Garter Snake	yes
Red-backed Whiptail Lizard	
Giant Spotted Whiptail	yes
Sonora Sucker	
Gila Chub	
Desert Pupfish	yes (captive)
Longfin Dace	
Gila Topminnow	yes (captive)
Desert Sucker	
Huachuca Water Umbel	

- Extent of land base -- Altar Valley is distinguished from other watershed planning units by its vast expanse. Covering over 713,000 acres, it is over 130,000 acres more than the land base covered by the entire San Diego regional multi-species conservation plan. Almost 90 percent of this land base is vacant or in public ownership.

  The chart below shows the relative size of the Eastern Pima County watershed planning units.

ACRES COVERED -- EASTERN PIMA COUNTY WATERSHED PLANNING UNITS



Summary

- Altar Valley comprises almost 30 percent of the 2.4 million acre landscape.

- Cultural Resources Element -- An analysis of the conservation potential of each watershed for cultural resources was conducted measuring four variables: sensitivity, integrity, legal protection and development threat. Among the Eastern Pima County watershed planning units, the Altar Valley area rated third of seven subareas (with the same ratings as the Avra Valley area).

RANK BY SUBAREA	FUTURE THREAT	SENSITIVITY	LEGAL PROTECTION	INTEGRITY OF RESOURCE BASE	CONSERVATION POTENTIAL
SAN PEDRO	LOW	MED	HIGH	HIGH	1st of 7 subareas
CIENEGA RINCON	MED	HIGH	MED	MED	2nd of 7 subareas
ALTAR VALLEY	MED	MED	MED	MED	3rd of 7 subareas
AVRA VALLEY	MED	MED	MED	MED	3rd of 7 subareas
UPPER SANTA CRUZ	MED	MED	LOW	MED	5th of 7 subareas
TORTOLITA	HIGH	HIGH	LOW	LOW	6th of 7 subareas
MIDDLE SANTA CRUZ	HIGH	MED	MED	LOW	7th of 7 subareas

- Ranch Conservation Element -- In order to characterize ranching as a land use, data were gathered both regionally and by subarea to objectively describe, map, and quantify this land use in terms of its extent, productive capacity, threats, and conservation potential. An analysis was conducted to evaluate ranch lands and ranching as a land use throughout Pima County. What results is the following preliminary assessment and comparative rankings of the different subareas.

Highest Extent of Ranch Lands

1. **Altar Valley**
2. Empire-Cienega Valley
3. Upper Santa Cruz Valley
4. San Pedro Valley
5. Avra Valley
6. Tortolita Fan
7. Western Pima County
8. Middle Santa Cruz Valley

Highest Productivity / Capacity

1. Empire-Cienega Valley
2. **Altar Valley**
3. Upper Santa Cruz Valley
4. San Pedro Valley
5. Middle Santa Cruz Valley
6. Tortolita Fan
7. Avra Valley
8. Western Pima County

<u>Highest Threats to Ranchlands</u>

1. Middle Santa Cruz Valley
2. Tortolita Fan
3. Upper Santa Cruz Valley
4. Avra Valley
5. Empire-Cienega Valley
6. **Altar Valley**
7. Western Pima County
8. San Pedro Valley

<u>Highest Conservation Potential</u>

1. **Altar Valley**
2. Empire-Cienega
3. Upper Santa Cruz Valley
3. San Pedro Valley
4. Western Pima County
5. Avra Valley
6. Tortolita Fan
7. Middle Santa Cruz

<u>Historic Conditions in the Altar Valley Watershed</u>

The first attachment in the series of reports forwarded by the Altar Valley Conservation Alliance is an investigation of historic conditions by Dr. Nathan Sayre. Unique in both approach and in the level of expertise and knowledge that Dr. Sayre is able to bring to the task, the investigation presents these topics in the more than fifty pages it covers:

- Conditions in Altar Valley Prior to Euro-American Settlement
- Euro-American Settlement Before 1880
- Settlement in Altar Valley, 1880 to 1905
- The End of Uncontrolled Grazing, 1905-1934
- Management Practices and Stocking Rates, 1910-1955
- Management Practices and Stocking Rates, 1955-1990
- Ranch Histories (14 ranches are discussed)

Based on this review of the Valley, Dr. Sayre makes five major findings (pages 3-4), which state in part that:

1. "Stocking rates were three to five times higher during the period 1886-1920 than they are today."

2. "Heavy stocking during droughts caused severe and lasting changes to the hydrology and vegetation of the watershed. The Altar Wash formed in the decades after 1905 due to a combination of factors. Its formation removed some of the valley's most productive soil and lowered the alluvial water table. Sacaton was largely replaced by Johnson grass and, as the water table dropped further, by mesquite trees. In the uplands, perennial grasses gave way to annuals, and shrubs and woody species increased relative to grasses. These vegetative changes were especially long-lasting in the lower, drier, northern portion of the watershed."

3. "Measures to counteract the negative changes and improve the range have been ongoing for as long as livestock have grazed the watershed. The installation of water

sources first made large-scale livestock production feasible in the 1880s. Stocktanks were built both to provide water and to control erosion beginning no later than the first decade of the twentieth century. Throughout the middle of the century, spreader dams were maintained on drainages to slow floodwaters and distribute them across floodplain fields. From the '50s through the '70s, bulldozers were used to remove mesquite trees and restore roughly 85,000 acres to grass. More recently, fire has been employed as a tool to set back shrubs and woody species."

4. "Conservative stocking rates and rotational management have demonstrably improved the condition and diversity of vegetation in the watershed during the past thirty years. First implemented in the 1970s, rest rotation and deferred rotation grazing practices have increased the cover, composition and vigor of forage species. Transect data from ranches throughout the watershed, compiled by ranchers in cooperation with the Natural Resource Conservation Service, document these improvements in quantitative detail."

5. "The Altar Wash arroyo and shrub invasion remain significant problems affecting the watershed as a whole. Work on the Buenos Aires Ranch during the 1940s and 1950s demonstrates that arroyos can be healed by mechanical intervention."

<u>Survey and Assessment of Rangeland Resources</u>

Dr. Walter Meyer surveyed and evaluated the rangeland conditions of the valley. His findings are presented in a detailed and interesting document that translates the terms of Brown and Lowe biotic classification methods to the Natural Resource Conservation Service classification method, which delineates biotic communities into categories known as "Major Land Resource Areas." Dr. Meyer provides a cross-walk between classification systems, and goes on to describe the methods he employed in his assessment, and the results across the three Major Land Resource Areas in Altar Valley. In summary form, Dr. Meyer concludes:

- "The ecological sites in the Mexican Oak-Pine Woodland and Oak Savannah Major Land Resource Area contained vegetative communities similar to the potential plant community. The trends on these sites were up. The sites were healthy, the soils and sites were stable, and the watersheds were functioning. Areas that had experienced wildfires contained fewer trees and shrubs and better vegetative cover than areas that had not burned. Prescribed burns or controlled wildfires would benefit this resource area." (p. 5)

- "The ecological sites in the Southern Arizona Semidesert Grassland and the Upper Sonoran Desert Shrub Major Land Resource Areas had varied plant communities some of which differed from the potential plant communities for those sites. Collectively, the sites were healthy. Trends were stable to slightly up. Overall the soils and sites rated low stable, the biotic integrities rated low intact, and the watershed conditions rated functioning. Erosion and the density of mesquites were major concerns. As mesquite canopy increased, soil stability decreased and erosion accelerated. ... " (p. 5)

<u>**Environmental Assessment, Altar Valley Wash Grade Control Structure**</u>

The third document forwarded by the Altar Valley Conservation Alliance is an Environmental Assessment of a proposed project intended to stop the erosion of a significant portion of the Altar Wash drainage -- erosion which has created a gully that is in places up to 20 feet deep and over 1,400 feet wide -- by trapping sediment behind a grade control structure while allowing water to flow through. This study suggests the proactive approach the Altar Valley residents are prepared to consider in light of their historic conditions and current environmental circumstances.

<u>**Conclusion**</u>

Studies conducted as part of the broad, region-wide assessment of multiple resources in Pima County emphasize the value of the resource base in Altar Valley. The Altar Valley landowners themselves have offered a remarkable set of documents for consideration as part of the Sonoran Desert Conservation Plan analysis. Combined, the documents by Pima County and the Altar Valley Conservation Alliance indicate that in general there is not a conflict between the landowner's goals and the goal of protecting natural and cultural resources in the largest unfragmented and perhaps the richest natural resource base of the watershed planning units.

As is true in the Cienega-Rincon area, protecting the Altar Valley watershed would be a major positive step for advancing conservation in Southern Arizona. It would benefit not only the watershed planning unit, but the entire region. By making a long term commitment to conserve natural resources in defined parts of the region, we will also create certainty for other land uses.

Dr. Sayre points out that because early land laws rewarded those who improved parcels through agricultural practices and the construction of agricultural related infrastructure, private land ownership follows the lines of water availability. This is true across Pima County and Arizona -- the riparian areas are largely held by private landowners.

What this means, at a minimum, is that the success of the Endangered Species Act will depend greatly on the benefits it can confer to landowners with riparian resources. A major challenge for the Sonoran Desert Conservation Plan will be to set new standards for balancing riparian protection and ranch conservation, and crafting measures that align the incentives of the landowners with the goals of resource conservation.

ALTAR VALLEY WATERSHED

RESOURCE ASSESSMENT

TASK THREE:

INVESTIGATE AND DOCUMENT HISTORIC CONDITIONS

28 April 2000

SUBMITTED TO:

ALTAR VALLEY CONSERVATION ALLIANCE

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TASK 3. INVESTIGATE AND DOCUMENT HISTORIC CONDITIONS

3.0 Overview

3.0.1 Purpose

The purpose of this task is to document the historic conditions of the Altar Valley Watershed. This is necessary for two reasons.

First, the watershed has changed dramatically in the past 120 years, due to the direct and indirect effects of human land uses. Effects prior to U.S. settlement are poorly documented, but they appear slight compared to what has occurred since. Broadly speaking, the Altar Valley's vegetation and hydrology were severely impacted between 1880 and the 1930s by the combined effects of drought, uncontrolled grazing, firewood and timber cutting, cultivation and flooding. Since that time, better management practices have resulted in stable and improving conditions in vegetation, soils and water cycle functioning.

Second, an understanding of this history is necessary in order to define and implement effective projects for the conservation and enhancement of the watershed. History reveals both the natural potential of the watershed and the successes and failures of previous efforts to restore that potential. Conservation goals must be based on a realistic assessment of what can and cannot be expected given the watershed's natural endowment. Moreover, the methods that have proven successful--for grassland restoration, soil and water conservation, and wildlife habitat--lay the foundation for further improvements in the area's capacity to provide economic, cultural and ecological values to local and regional communities.

3.0.2 Methodology

The methodology used for this task has three primary components: historical research, interviews, and review of recent reports and monitoring data.

3.0.2.1 Historical research

Materials studied for historical research include old photographs, family histories, ranch files, correspondence, newspaper articles, library and museum archives, monitoring data, and soil surveys and resource assessments from federal agencies. In addition to ranches in the watershed, research was conducted in the Arizona Historical Society archives, the University of Arizona Library Special Collections Department, the University of New Mexico's Southwest Research Center, and in the files of the Bureau of Land Management (where General Land Office files are housed), the Arizona State Land Department, the U.S. Forest Service Supervisor's Office in Tucson, and the Buenos Aires National Wildlife Refuge. A wide variety of memoirs, essays, biographical sketches and other published materials were also reviewed. A bibliography of these materials is provided as Appendix 3.1.

Collectively, these data constitute an important baseline for evaluating watershed resource conditions and potential conservation actions. They reveal: 1) the conditions of the watershed prior to Euro-American settlement; 2) changes in conditions since settlement; and 3) the role of management decisions in changing resource conditions.

It is important to stress that historical data for the Altar Valley watershed are fragmentary and various. No photographs exist from before 1893, for example, and no systematic monitoring data were collected (aside from weather data) before the 1970s. It is often difficult to know when or where an old photograph was taken, or to what extent the area pictured was representative of conditions in the watershed as a whole. Similarly, standards of evaluation in Soil Conservation Service reports from the 1930s were different from standards employed more recently, making direct comparison difficult. Fortunately, these limitations diminish as we approach the present, since more comprehensive and quantifiable data have been collected in recent decades.

3.0.2.2 Interviews

Interviews were conducted with past and present landowners and managers from the Altar Valley. A standard set of questions was used in interviewing present landowners and managers, and is presented as Appendix 3.2. These questions were designed to elicit information on ranch management practices, ranch improvements, and ranchers' perceptions of past and present conditions in the watershed. Notes from these interviews were prepared and submitted to the interviewees for review prior to inclusion in this report. A list of past landowners and managers interviewed is included as Appendix 3.3. Where possible, data on ranch improvements were checked against information from resource management agencies.

3.0.2.3 Review of recent reports and monitoring data

In order to connect historical data to present watershed conditions, a review of recent reports and monitoring data was conducted in collaboration with contractor Walt Meyer and Dan Robinett of the Natural Resource Conservation Service. This review was deemed important because significant changes in ranch management have been implemented across much of the watershed in recent decades.

3.0.3 Summary of Major Findings

Major findings of the historical research conducted for this component include the following:

1. Stocking rates were three to five times higher during the period 1886-1920 than they are today. While precise figures are difficult to find, and the lack of fences meant that cattle were not limited to defined areas of range, there were at least 20 and perhaps as many as 35 head per section on most of the watershed during this early period. Today the average stocking rate for the watershed is 7.5 head per section including the Buenos Aires National Wildlife Refuge and just under 10 head per section excluding the refuge.

2. Heavy stocking during droughts caused severe and lasting changes to the hydrology and vegetation of the watershed. The Altar Wash formed in the decades after 1905 due to a combination of factors. Its formation removed some of the valley's most productive soil and lowered the alluvial water table. Sacaton was largely replaced by Johnson grass and, as the water table dropped further, by mesquite trees. In the uplands, perennial grasses gave way to annuals, and shrubs and woody species increased relative to grasses. These vegetative changes were especially long-lasting in the lower, drier, northern portion of the watershed.

3. Measures to counteract the negative changes and improve the range have been ongoing for as long as livestock have grazed the watershed. The installation of water sources first made large-scale livestock production feasible in the 1880s. Stocktanks were built both to provide water and to control erosion beginning no later than the first decade of the twentieth century. Throughout the middle of the century, spreader dams were maintained on drainages to slow floodwaters and distribute them across floodplain fields. From the '50s through the '70s, bulldozers were used to remove mesquite trees and restore roughly 85,000 acres to grass. More recently, fire has been employed as a tool to set back shrubs and woody species.

4. Conservative stocking rates and rotational management have demonstrably improved the condition and diversity of vegetation in the watershed during the past thirty years. First implemented in the 1970s, rest rotation and deferred rotation grazing practices have increased the cover, composition and vigor of forage species. Transect data from ranches throughout the watershed, compiled by ranchers in cooperation with the Natural Resource Conservation Service, document these improvements in quantitative detail.

5. The Altar Wash arroyo and shrub invasion remain significant problems affecting the watershed as a whole. Work on the Buenos Aires Ranch during the 1940s and '50s demonstrates that arroyos can be healed by mechanical intervention. Chaining, grubbing and reseeding on the Buenos Aires, Santa Margarita, Joe King, Elkhorn and Anvil ranches demonstrates that grasses can be restored to areas invaded by mesquite, but only if implemented in combination with fire.

3.1 Conditions Prior to Euro-American Settlement

Compared to other valleys in the region, the Altar Valley has received little attention from ecological historians, archaeologists and other scientists (Sayre 1999). This reflects the relatively sparse historic human occupation of the valley, which can be traced to the lack of reliable water sources prior to the advent of deep wells in the 1880s. Without water, intensive human settlement was impossible. Attempts at settlement in the Spanish and Mexican periods were further inhibited by the threat of attack by Apache Indians. Until more comprehensive archaeological study of prehistoric sites is done, assessment of resource conditions prior to Euro-American settlement must rely on a handful of written descriptions and inference from other, comparable areas in the region.

3.1.1 Geology and Hydrology

The geology of the Altar Valley watershed fundamentally determines its hydrology. Located at the head of a relatively small watershed, the valley receives no run-off from other areas. Average precipitation varies from twelve to twenty-four inches per year, depending on elevation. Rainfall runs quickly off of the steep mountains that define the watershed and across a narrow pediment of shallow bedrock. It then sinks quickly underground into deep, unconsolidated alluvial soils (Andrews 1937). As a result of this geology, the main portion of the watershed has never supported a perennial stream. Live water is found only in or near the mountains on the margins of the valley. Wells in the central valley must be extremely deep--150 to 600 feet below the surface--to reach water.

Prior to the entrenchment of the Altar Wash (see below), the broad bottomlands of the valley formed a nearly flat plain, up to a mile and a half wide, which was subject to sheet flooding during major rain events. This densely vegetated alluvial plain retained significant quantities of subsurface moisture, which sometimes collected in small basins known as *charcos* (Bryan 1920, 1922, 1925). The vegetation of the watershed strongly reflected the pattern of water flows across the landscape.

3.1.2 Vegetation

The earliest known description of vegetation in the Altar Valley watershed was written by Juan Bautista de Anza on his first expedition to California in 1774. Anza's party camped for one night at Arivaca, where the cienega and creek offered water. The area, he wrote, had abundant grasses that could support more than 5,000 cattle. The boundary survey of William Emory, published in 1857, echoed Anza's description of Arivaca. Neither Anza nor Emory described the main Altar Valley, however.

Two accounts from the 1860s provide the earliest first-hand descriptions of the vegetation of the Altar Valley. Raphael Pumpelly, an engineer from Harvard, traveled west from the Cerro Colorado mountains in 1861, crossing the middle of the watershed. He described the valley as "a wide expanse of grassy steppe, and forests of mesquit and cacti" (Pumpelly 1870: 37). Three years later, popular writer J. Ross Browne traveled from Arivaca to Sasabe via Arivaca Creek, San Luis wash, and Sasabe Flats. He wrote:

> No water is found in this tract of country, but it is well wooded with mesquit, and the grass is excellent. The road continues through this valley till it strikes the rise of an extensive mesa to the right, over which it continues for twelve miles. A vast plain covered with small stones and pebbles and a scanty growth of grass and cactus, is all the traveller can depend upon for enjoyment during the greater part of this day's journey... Descending from the mesa, as we approached the mountain range on the right, we entered a beautiful little valley, in which the grass was wonderfully luxuriant; but as usual there was no sign of water. (Browne 1871: 273-4)

General Land Office surveyors' notes from the middle and late 1880s describe the vegetation of the Altar Valley in more detail. While grazing of cattle and sheep had begun by this time, it had not yet had a strong impact on vegetation, so these accounts may be taken as describing the valley's pre-settlement conditions. U.S. Deputy Surveyor George Roskruge, surveying the area around the Buenos Aires Ranch in 1885, observed "fine grass for miles N[orth] and S[outh]...but no trees and no brush" (GLO records, Book 1494). A year later he described the same area as "gently rolling grassy hills" (Book 937). Near what would later become the Las Delicias Ranch, Roskruge noted "level mesa land covered with fine grasses. Mesquite and Sycamore abound in the arroyos" (Book 1485). In the center of the valley, in the vicinity of the Pozo Nuevo Ranch, he wrote: "The bottomland is covered with sacaton and the mesa or uplands with white and black gramma grasses [sic]. The timber in the Township consists of [a] scattering growth of mesquite" (Book 897). Judging from common names for grasses used in the period, white grama referred to what is now called blue grama (*Bouteloua gracilis,* at Roskruge's time *B. oligostachya*), while black grama meant *B. eriopoda* (black grama), *Muhlenbergia porteri* (bush muhly), and/or *Hilaria mutica* (tobosa grass). Further north, at the site of what is now the Anvil Ranch, Roskruge observed "a luxuriant growth of Grama grasses" and a scattering of mesquite and palo verde trees (Book 1485). By "scattered," Roskruge appears to have meant roughly one or two mesquite trees per acre, each from four to twelve inches in diameter (Sayre 1999). Mesquite densities appear to have increased from south to north, with very few in the higher end of the valley (around the Buenos Aires) and "an abundance of mesquite timber suitable for fuel" from Robles Junction (Three Points) north to what is now Marana (Book 1453).

From these early accounts, one can draw the following conclusions regarding vegetation in the watershed prior to Euro-American settlement:

1. The flat, loamy bottomlands were dominated by sacaton grass.
2. The margins of the bottomlands and the drainages through the uplands supported mesquite trees of significant size, with densities inversely correlated with elevation.
3. The "mesa" or uplands were dominated by perennial bunch grasses. These grasses presumably extended up into the foothills and canyons of the mountains.
4. The higher mountains contained significant stands of trees, including white and black oak, pine, black walnut, ash, hackberry and sycamore.
5. Cacti, palo verde and other desert shrub vegetation increased as one moved north (that is, as elevation decreased).

3.1.3 Prehistoric Human Use

No comprehensive survey of archaeological sites in the Altar Valley has been conducted. Experts at the Arizona State Museum are aware of numerous sites, in particular three platform-mounds near the eastern base of the Coyote Mountains. These mounds probably date to the Classic or late Hohokam period, 500 to 850 years ago. Petroglyphs can be found in several mountain locations in the watershed. Along with manos and metates found throughout the valley, these sites testify to prehistoric human use of the area and limited settlement. It is reasonable to assume that Hohokam and/or Pima Indians practiced some flood-water farming, relying on seasonal sheet flooding in the bottomlands to raise their crops (Bryan 1929). Any irrigated agriculture or year-around settlement would have been limited to the mountain canyons, however, due to the absence of water in the central valley.

3.1.4 Historic Native American Use

Very little is known about Native American uses of the Altar Valley during the historic period. Jesuit missionary Eusebio Francisco Kino established a mission just south of the watershed at Pozo Verde and a *visita* in Arivaca, but he never described the Altar Valley in his writings (Urban 1982). Certainly, Piman Indians utilized water sources in the area, but the extent and nature of these uses is unknown.

We know from Pumpelly's account that by 1860 the Altar Valley had become a sort of no-man's land in the ongoing skirmishes of both Pimans and Euro-Americans with bands of Apaches. The valley was little used by Apaches due to the lack of water, and it therefore served as a buffer for the Papagos to the west.

3.1.5 Fire

The consensus among ecologists is that fire must have played an important role in maintaining the dominance of grasses over shrubs and trees in areas like the Altar Valley. Based on a review of historic documents, Bahre (1985) concluded that fires were "fairly frequent" in southern Arizona's desert grasslands prior to 1882. There is debate, however, over how such fires were started. Lightning strikes during the monsoon season are common and undoubtedly started some fires. Dobyns (1981) points out, however, that Apaches routinely utilized fire as a hunting tool. Additionally, he cites evidence that up to the end of the nineteenth century, O'odhams burned the neighboring Baboquivari Valley every year in order "to keep down the mesquite and improve the feed for game." As Stephen Pyne (1982) argues, little point is served by attempting to classify fire as "natural" or "unnatural." Regardless of how they started, fires were critical in maintaining grasslands in the Altar Valley.

3.2 Euro-American Settlement Before 1880

Kino's visita in Arivaca was abandoned following the Pima uprising of 1751. Euro-American settlement in the Altar Valley watershed after that time is poorly documented, but it clearly was limited to areas where natural water sources were available, especially the Arivaca basin. Because water remained unavailable in the main valley, settlement there was not possible.

3.2.1 Mining

Silver and gold mines were operated in the vicinity of Arivaca by the Spanish in the eighteenth century. The mine at Cerro Colorado (later visited by Pumpelly) was among the richest of these. The mines were abandoned following the Pima uprising, then reopened and expanded between 1790 and 1830. Samuel Heintzelman and Charles Poston obtained the mines following the Gadsden Purchase of 1854, but Apache violence again interrupted operations (Mattison 1946).

Mining operations entailed the cutting of trees for timbers and fuel, but the extent of cutting is unknown. Dobyns (1981: 151-2) characterizes fuelwood cutting in the area as "significant" by 1856, when Heintzelman and Poston were attempting to bring steam-powered reduction works to the mines (Mattison 1946: 308 n.103). The 1857 annual report of their mining company describes the Arivaca area as having "much beautiful meadow land, fine pasture on the low surrounding hills for thousands of cattle; good oak grows in the gulches, mezquite on the hills, and on the lower ends of the streams, it is thickly lined, for five or six miles, with groves of cottonwood, ash, walnut, and other useful woods..." (Sonora Exploring and Mining Company 1857: 6). Timber cutting in the Arivaca basin may have contributed to earlier formation of arroyos on Arivaca Creek than in the main Altar Valley.

3.2.2 Ranching

The Arivaca mining operations required livestock to supply meat for workers. A Don Antonio de Rivera raised livestock on his ranch near Arivaca in the 1740s. Very likely, some animals persisted in feral condition after Spanish and Mexican settlers retreated from the area in 1751. In 1833, Tomas and Ignacio Ortiz petitioned the *alcalde* at Tubac for possession of the Arivaca Grant, two *sitios* of land which, they claimed, had been granted to their father by the Spanish government in 1812. Mexican authorities confirmed the grant, but U.S. courts later refused to recognize it (Mattison 1946). J. Ross Browne (1871: 271) wrote that the Arivaca Ranch "comprises within its boundaries 17,000 acres of agricultural lands, 25 silver mines formerly worked by Mexicans and numerous gold, copper and lead mines, as yet undeveloped. It contains a large amount of rich meadow land bordering on a never-failing stream; it is well wooded with oak, walnut, ash, cottonwood and mesquit... The reduction works of the Heintzelman mine were situated on the ranch for the convenience of wood, water and pasturage."

The earliest known Euro-American settlements in the Altar Valley proper were small homesteads or *ranchos* located at the foot of the Baboquivari mountains. When these settlements were established is not clear. Don Antonio Aros founded his ranch in the late 1870s or early 1880s, according to his grandson (Aros n.d.). In 1886, Roskruge noted that William Sturges, John Wasson, Rollin Brown, Jesus Contreras, Estevan Redondo, Francisco Leon and "a Mexican" (probably Aros) had homes, corrals, and shallow wells located at the mouths of canyons on the east side of the Baboquivaris. The wells were dug into the sandy washes in the pediment zone where water could be found approximately thirty feet below the surface. The water was limited in quantity, and judging from Roskruge's notes, none of these homesteads possessed large numbers of livestock before 1886.

3.2.3 Agriculture

It is safe to assume that crops such as corn, beans and squash were planted in the Arivaca area in the 1700s, and perhaps earlier. There is speculation that Native Americans might have constructed irrigation canals near the creek and cienega, but these may date to a later period.

3.3 Settlement in the Altar Valley, 1880-1905

The cattle boom of 1873-1893 led to a rapid and dramatic increase in cattle numbers throughout the western United States. In Arizona, all grazing lands convenient to water were fully stocked with cattle from the Santa Cruz River east by 1880 (Gordon et al. 1883: 95). To the west of the Santa Cruz, however, limited water sources inhibited the spread of grazing. The Arivaca area, due to its natural waters, supported a considerable number of sheep and cattle. Pedro Aguirre lived in Arivaca and reportedly had 400 cattle and more than 10,000 sheep in 1880. It is likely that these animals grazed out into the main Altar Valley when conditions were favorable. But the absence of natural water sources there limited livestock production and settlement.

3.3.1 Water development

Aguirre was the first person to succeed in developing artificial water sources in the main valley. In 1883, he constructed a large reservoir, now known as Aguirre Lake, to capture run-off at his Buenos Aires Ranch. A drought in 1885 dried up the lake, and in the spring of 1886 Aguirre dug the valley's first deep well, striking water at 515 feet below surface. Others followed his lead. By 1886 a well, 180 feet deep, had been dug at the Warren Ranch (now the Anvil), and a man named Russell had dug a well more than 200 feet deep at the Palo Alto Ranch. The deep wells provided abundant water, and they allowed large herds to be grazed in the central valley, year-round, for the first time. But they were few in number, and cattle did not likely travel more than two or three miles away for feed. In consequence, a large area of the watershed remained little grazed.

The deep wells were powered by steam, which was produced by burning wood fuel (Griffiths 1904: 35). Given the depth, tremendous quantities of fuel were required to raise the water to the surface (one cord per ten hours of operation, by one estimate, for a shallow well (Bahre 1991: 163)). Mesquite trees were not numerous to begin with, and it appears that virtually all of them were cut down in the late 1880s and 1890s. Up to the advent of gas-powered engines in the early 1900s, it became necessary to haul wood long distances to power the pumps. Traffic from the Buenos Aires to the Baboquivari Mountains--a distance of some eight miles--was so steady that a "wood road" appears on Roskruge's 1886 survey map. Fuelwood cutting, especially in the mountains, probably increased run-off rates in the watershed.

3.3.2 Farming

According to newspaper and descendents' accounts, Pedro Aguirre planted corn, beans, barley and squash on the margins of Aguirre Lake, timing his planting so that the seeds would germinate as waters receded from the broad plain above his dam. Further north, near what came to be known as Pozo Nuevo, three men--named Hemme, Labaree and Taylor--likewise attempted to farm in the loamy bottomlands in the center of the valley. Roskruge observed in 1886 that good rains that year had produced a crop of corn on Taylor's field, but he predicted that regular production would not be possible without irrigation.

A more common practice was the cutting of forage grasses as hay. In the bottomlands, Sacaton and later Johnson grass were valuable hay species; in the uplands, native grama grasses could be cut in favorable years. Some of the hay may have been transported to feed confined livestock elsewhere, but most was stacked for use by local animals.

3.3.3 Land Ownership Patterns

Under federal laws of the period, land could be claimed only in small parcels (640 acres or less) and only by "improving" it through the construction of agricultural infrastructure or the planting and/or harvesting of crops. Such activities could only be undertaken in areas where water was available, either naturally or by digging wells. The distribution of private land in the Altar Valley today reflects these constraints. Private parcels are found primarily in two areas: at the margins of the surrounding mountain ranges (where early settlers dug shallow wells) and along the axial drainage in the middle of the valley. In the bottomlands, floodwater irrigation or the cutting of natural hay could satisfy the terms of the Desert Land Act even where crops were unreliable (as with Taylor's field mentioned above). Early ranchers like Pedro Aguirre were able to consolidate many small claims into sizeable private holdings running up the center of the valley.

3.3.4 The droughts of the 1890s

In 1891-93, a severe drought beset southern Arizona. Tens of thousands of cattle died on the range after denuding the landscape of vegetation. Hundreds died in the Arivaca area; some became bogged down in the muddy cienega seeking water. The concentrated herds there may have contributed to arroyo formation, which occurred on Arivaca Creek earlier than in the Altar Valley. It appears that the relative lack of water in the main valley limited the effects of overgrazing during this drought. The only photographs from this period, taken in 1892-94 as part of the International Boundary Survey, show denuded land 0.2 miles from Sasabe (where there was a well) and grazed but surviving grass 2.5 miles east of Sasabe (Photos 3.1-3.4).

The drought of the early 1890s appears to have prompted ranchers to develop more water sources, enabling grazing across more of the valley. Precise dates are unavailable for the construction of water tanks, but there were more than 200 on the Buenos Aires Ranch alone by 1915. By 1917, there were seven deep wells in the central valley and 22 wells overall. Kirk Bryan, who surveyed the valley in 1917 for the U.S. Geological Survey, wrote: "In the Altar Valley...stock-watering places are so numerous that the traveler will have no difficulty in obtaining water" (Bryan 1925: 256).

Degraded ranges elsewhere in the region may have led to an increase in cattle numbers in the Altar Valley in the 1890s, as waters were developed. During a second drought, from 1898-1904, the valley experienced severe overgrazing, captured in photographs by researcher David Griffiths (Photos 3.5-3.7). In the Three Points area, horses and cattle perished on devegetated ranges. A photo taken at the Rancho de la Osa shows scrubby mesquites and a large snakeweed population. Griffiths observed that snakeweed and burroweed were "very abundant" in portions of the Altar Valley in 1904 (Griffiths 1904: 59).

3.3.5 Formation of the Altar Wash

The drought ended with very heavy rains from December 1904 to March 1905. These rains appear to have initiated the formation of the Altar Wash, an event made possible by several factors acting together:

1) Uncontolled grazing during the drought had removed the vegetation across much of the watershed.

2) Cutting of fuelwood had increased run-off rates from the adjacent mountains.

3) Areas of the flat, loamy bottomlands had been cleared for agriculture, especially around the area now known as Pozo Nuevo.

4) The main road through the valley ran north-south through the loamy bottomlands.

5) Aguirre Lake concentrated a large body of water in one place near the head of the watershed.

At the end of January 1905, Pedro Aguirre told the editor of a Tucson newspaper that Aguirre Lake was "full to overflowing" (*Daily Star* 29 January 1905). We know from the writings of Kirk Bryan that the dam had no spillway at the time. During February and March, another eight inches fell at Tucson--most likely more than that fell in the Altar Valley. It seems likely that these rains washed out the dam at Aguirre Lake, sending a pulse of water downstream (Sayre 1999). The current found the roadbed and the cleared farm fields in its path and excavated a narrow trench (Cooke and Reeves 1976). In 1908, livestock inspector Willard Wright testified that the wash could be seen near the Palo Alto and Pozo Nuevo ranches; by 1919, it reached the Anvil Ranch; and by 1937, it extended beyond the Robles Ranch near Three Points (Photo 3.8).

3.4 The End of Uncontrolled Grazing, 1905-1934

Observers agreed that the severe overgrazing of the cattle boom period resulted from open range policies, which made public rangelands a common resource. Individuals could only perfect title to small parcels of land, usually located around water sources; the public domain could not legally be fenced. While neighbors typically recognized informal "range rights," by which the owner of a water source could graze his animals half-way to the next water source, these rights were unenforceable under the law. Every rancher thus had an incentive to use as much forage as possible or risk losing it to another. The aggregate effect was a classic "tragedy of the commons."

Between 1905 and 1934, the open range was replaced by a complex system of leases which permitted individual ranchers exclusive access to the forage on defined areas of public lands called allotments. Combined with fencing, leases made management of the range possible for the first time. Lease systems were implemented in three stages, corresponding to three types of public lands: forests, administered by the U.S.D.A. Forest Service; state trust lands, administered by the Arizona State Land Department; and remaining public lands, administered by the General Land Office's Grazing Service (now the Bureau of Land Management).

3.4.1 Forest Service Lands

National forests were established beginning in the 1890s, with the primary objective of protecting watersheds against erosion and flooding. The first Forest Reserves in southern Arizona were established between 1902 and 1907. On the southeast edge of the Altar Valley, the Tumacacori, Atascosa and San Luis ranges became the Garces National Forest. The Baboquivari Mountains became a reserve in 1906, and were merged with the Garces in 1908. In 1910, the Baboquivaris were removed from the forest and made part of the Papago Indian Reservation. The following year, the Garces was combined with other reserves into the Coronado National Forest (Allen 1989). Grazing allotments were organized on the forest lands beginning in 1907.

3.4.2 State Trust Lands

Under the terms of the Enabling Act, the State of Arizona was granted four sections of land per township upon statehood in 1912. Many of these sections had already been claimed (by homesteaders, miners, or by the federal government for Indian Reservations, forests or irrigation projects), so the state was authorized to claim *in lieu* sections to make up for them. The Altar Valley, along with other prime grasslands to the east and north, was quickly selected by the State Land Department because of its high value for grazing. By 1917, almost the entire valley was fenced and leased for grazing (Bryan 1925). The State Land Department remains the largest landowner in the watershed to this day.

3.4.3 BLM Lands

Lands not claimed by private citizens, the National Forests, or the State Land Department remained open range until the Taylor Grazing Act of 1934. In the Altar Valley, the significance of the Taylor Act was that it enabled final resolution of the boundary with the Papago Reservation to the west. The Civilian Conservation Corps fenced the boundary--along the top of the Baboquivari and Coyote Mountains--in the 1930s. Today, the BLM owns roughly 25 sections of land scattered around the margins of the Altar Valley. These parcels are leased for grazing and managed as parts of larger units; in most cases they are not fenced off from adjacent private, state and federal lands.

3.5 Management Practices and Stocking Rates, 1910-1955

Management practices established in conjunction with leases prevailed in the Altar Valley through most of the century. The central idea of management was to limit stocking rates to the land's carrying capacity, defined as "the amount of stock that these lands will carry profitably year after year" (Griffiths 1904: 32). Boundary fences were necessary to control the number of stock in an allotment, and every allotment had to have at least one water source. With these improvements in place, the carrying capacity of an allotment could be calculated and included in the lease agreement.

The State Land Department did not set carrying capacities until the mid 1950s, however. Prior to that time stocking decisions were largely at the discretion of individual lessees. The rates set in the 1950s were based in part on what ranchers had determined to be the land's capacity over the years. It was not until the early 1980s that the State Land Department began active enforcement of stocking rates on its lands (Dan Robinett, personal communication). In the Altar Valley watershed, no rancher exceeds recommended stocking rates today, and most stock at lower rates. In the past, however, it appears that overstocking did occur, on some ranches at some times.

3.5.1 World War I

After 1904, the number of cattle in the Altar Valley steadily increased again, boosted by high cattle prices during World War I. Less productive lands were drawn into production for the war effort. Bryan (1925: 154) wrote of the area west of the Santa Cruz river that "The high prices for cattle prevailing from 1915 to 1919 and the use of better cattle ranges for dry farming accelerated the movement of stock raisers into the poorer forage areas." The Forest Service aided the increase by adjusting its calculations of carrying capacity upward for the region as a whole (Wooton 1916). Cattle numbers peaked in about 1920, both regionally and in the Altar Valley. "In 1920, livestock numbers were high and the animals were restricted by the new fencing. The summer was extremely dry and there was no market for livestock. Range areas formerly not used heavily were so for the first time. This year probably saw the start of the large scale change of the valley's flora from grasslands to shrublands" (Robinett n.d.: 3). As had happened in the previous droughts, many cattle died on the range after stripping the land of all available forage.

3.5.2 Making improvements

Long-time residents report that World War I had another effect, as well. Prices for cattle were good, and war-time rationing discouraged spending. Funds saved during the war went into improvements on the range: fences, stocktanks and wells. These improvements increased the carrying capacity of the range. By developing more than one water source in their allotments, ranchers could distribute livestock more evenly and thereby access more forage. This was recognized very early on and was encouraged by public agencies. Ideally, water sources would be distributed every two miles, so that no forage was more than one mile from water. Multiple water sources had the additional benefit of providing a margin of insurance against drought conditions. In the 1920s and '30s, the construction of dams (both in the mountain canyons and out in the valley) was further encouraged in the name of erosion control. Agricultural extension agencies and the

Soil Conservation Service also advocated contour plowing and dike construction in the Altar Valley (Photos 3.9, 3.10). These installations intercepted floodwaters and spread them out across the range, increasing forage production. Researchers also experimented with reseeding techniques, although few were found to be consistently successful. One exception was Johnson grass, which established well in the bottomlands where Sacaton has flourished previously. By cutting and stacking Johnson grass, ranchers could conserve its forage value through dry seasons, increasing the carrying capacity of their lands (Photo 3.11).

Until the 1970s, management focused on these and other means of increasing the amount of forage produced and its accessibility to livestock. Some cross-fences were built to facilitate the breeding and management of stock, but pastures were almost always grazed year-around by a more or less stable number of animals.

3.5.3 Watershed-wide Conditions

It is difficult to assess conditions in the watershed as a whole over time due to the lack of comprehensive surveys or reports. At best, the Altar Valley received peripheral attention in studies of either the Indian Reservation to the west or the better-watered valleys to the east.

From the studies that do exist, a number of general points can be drawn.

1. The watershed has generally been divided into two vegetative zones: desert shrub in the lower, northern part of the watershed and desert grassland in the higher, southern part (Brown and Lowe; Duncklee 1967). Bryan estimated the dividing line at 3,000 feet elevation; he recognized rainfall as the decisive factor, however. The Soil Conservation Service recognizes three separations based on soil temperature and moisture regimes: one below 3200 feet elevation, one above 3450 feet elevation, and a transition zone in between (Robinett n.d.). Based on field work done in 1917, Bryan (1925: 375) observed that the lower zone was dominated by creosote bush, palo verde, catclaw and mesquite, while the higher zone was dominated by "grasses, mostly of annual types, which spring up rapidly after rains... Occasionally on the plains and usually at the borders of the mountains are clumps and areas of perennial grasses... It seems evident that the increased rainfall due to higher altitude is the main cause of the growth of the grass, and that the burning of the dry grass has eliminated most of the woody plants." The annuals observed by Bryan were opportunistically taking the place of perennials, which had been impacted by drought and overgrazing in the preceding decades.

2. The desert grassland zone appears to have demonstrated a greater resilience to the impacts of grazing than the desert shrub zone. A Soil Conservation Service map

completed in 1938 depicts range conditions in the southern portion of the Altar Valley as good ("none to slight deterioration") while the northern portion was poor ("severe deterioration"). Soil erosion conditions were judged as severe in the north and moderate to severe in the south (SCS 1938). A 1936 report noted:

> The density of the vegetation varies from a .1 in minimum in the lower portion of the area to a maximum of .65 in the upper portion. Apparently the density over the entire area is lower than it has been in the past, due to the effects of overgrazing and the accompanying bad effects of sheet and gully erosion.
>
> It is quite evident that the entire area has been badly overgrazed in the past, but not particularly so at present, except in certain areas. Recovery can be established by protection and erosion control. The amount of recovery up to the present varies greatly. Generally there is very little recovery in the northern portion...
>
> Most of the southern portion which has a higher rainfall with quicker recovery from drouth conditions, etc., now supports a moderate cover of perennial grasses. Erosion cannot be said to be severe in any of this region. It is much more in the more poorly covered areas to the north, and has reached the state of severe gullying in portions, due in a large measure to the loss of vegetative cover for soil protection. (SCS 1936: 6, 9).

Stocking rates at this time varied from 30-35 head per section in the south to as little as 5-10 head per section in the north.

3.6 Management Practices and Stocking Rates, 1955-1990

Dendrochronologists have determined that the drought of the mid-1950s was the most severe in the region in some 350 years. It did not result in cattle dying on the range as had happened in the 1890s and 1920s, however, for several reasons. First, fences and waters gave ranchers improved control over stocking rates and the distribution of cattle. Second, truck and highway transport made it easier to bring feed in from elsewhere or to sell and remove cattle. Federal emergency programs were made available to help ranchers buy hay. Altogether, it was no longer necessary to rely exclusively on range forage during the drought. Third, many ranchers had invested heavily in genetic improvement of their herds. Allowing their animals to die on the range was a greater economic sacrifice than it had been in the past.

While detailed historical figures are not available for every ranch, it appears that stocking rates generally declined following the 1950s drought, stabilizing in the 1970s and

'80s at present levels. The higher, southern end of the watershed continues to support greater stock densities, as much as sixteen head per section on Forest Service lands in the San Luis Mountains. Stocking rates in the lower, drier, northern end of the watershed are about six head per section. Taking the watershed as a whole, the stocking rate at present is 7.5 head per section; excluding the Buenos Aires National Wildlife Refuge (which is entirely ungrazed), the average is ten head per section.

3.6.1 Mesquite Control Efforts

The 1950s drought probably contributed to an increase in the rate of spread of mesquite trees on Altar Valley rangelands. It certainly drew attention to the problem of mesquites displacing grasses on semiarid rangelands, and major new research programs were launched to find ways to restore grasslands. On major ranches in the valley, bulldozers that had been used to build stocktanks and erosion control structures in the earlier period were now deployed to chain or grub mesquite trees. Chaining involved pulling a sea-anchor chain between two bulldozers. This did not kill the trees, which resprouted from the undisturbed root crown. Grubbing solved this problem by using a steel probe to dig underground and break the tree below the root crown. These methods were demonstrated to ranchers as early as 1948. They were employed in the Altar Valley first on the Santa Margarita Ranch, then on a large scale on the Buenos Aires, and also on the Anvil and Joe King ranches. Altogether, some 85,000 acres of mesquites were chained and/or grubbed in the valley between 1950 and 1980.

Mesquite clearing has left a mixed legacy in the watershed. On the one hand, it did succeed in setting mesquites back and promoting grasses, as illustrated by the dramatic transformation of the Buenos Aires Ranch. These improvements benefitted range production and retarded surface erosion. But clearing has rarely proved permanent: In most cases, mesquites have reasserted themselves from root crowns or through new recruitment. In the absence of fire, new shoots and seedlings have usually returned to dominance within twenty years. There are also financial and regulatory obstacles to clearing. Increasing fuel costs in the 1970s rendered large-scale mesquite clearing uneconomical, at least from the perspective of cattle production. Around the same time, regulatory requirements for archaeological preservation and endangered species raised costs further. Clearing continues to be practiced today, but on much smaller scales and usually on private lands.

3.6.2 Seeding

Chaining and grubbing were almost always followed by seeding of grasses. Lehmann lovegrass (*Eragrostis lehmanniana*), a native of South Africa, was utilized by highway departments in Arizona for erosion control as early as the 1930s (Anable et al. 1992). It established easily without expensive inputs, and competed successfully with native vegetation. Lehmann probably entered the Altar Valley in this way. By the 1950s, the Soil Conservation Service was advocating its use for range restoration.

Several large ranches in the watershed have seeded significant acreages to native and/or non-native grasses in the past fifty years. Some 60,000 acres of the Buenos Aires Ranch were seeded in the 1970s and early 1980s, using a mixture of native and non-native species. Blue panicgrass, Lehmann lovegrass and green sprangletop were seeded on all areas cleared of mesquite. Plains and Boer lovegrass were seeded to upland areas; bottomlands received large amounts of Johnson grass seed (Sayre 1999). (Johnson grass entered the valley no later than World War I. It is not known if it was intentionally seeded or entered adventitiously. It grew abundantly on bottomland soils, competing with giant sacaton. As the Altar Wash deepened, it was often succeeded by mesquites, which were better adapted to the lowering alluvial water table.) Details of seeding on other ranches are found below.

Monitoring conducted by the Natural Resource Conservation Service suggests that Lehmann lovegrass continues to dominate in areas where it was seeded, and that in some cases it is spreading into areas of bare ground. Its persistence is attributable to several traits: it greens up earlier and stays green longer than native perennial grasses; it withstands drought and fire well; livestock prefer it only when natives are not green, meaning that it receives lighter grazing pressure through much of the growing season (Cable 1965, 1971).

Seeding of native perennial grasses has proved less reliable as a means of range revegetation, despite extensive research on the issue. Most ranchers interviewed would prefer to see native perennials to Lehmann, but they feel that Lehmann is preferable to bare ground or shrubs.

3.6.3 Fire

Prior to U.S. settlement, fires played an important role in maintaining grasslands, as noted above. The combination of fire suppression, uncontrolled grazing during droughts (described above) and mesquite invasion resulted in a dramatic decrease in the incidence of fires during most of the twentieth century. The return of mesquites following chaining and grubbing efforts drew renewed attention to the need for fires.

In the late 1970s, prescribed fire was used as a management tool on a pasture of the Buenos Aires Ranch. The results, monitored by the NRCS, showed an 85 percent decrease in snakeweed and burroweed production and a 58 percent increase in grass production one year later (Photos 3.14, 3.15). Since conversion of the Buenos Aires to a National Wildlife Refuge in 1985, prescribed fires have been used extensively to keep mesquites in check.

In the 1980s, a fire program was initiated on the Anvil Ranch at the north end of the watershed. Several large pastures were burnt before the program was halted, around 1991, due to the listing of the Pima pineapple cactus as an endangered species. The fire program on the Buenos Aires has been permitted to continue only after extensive field reconnaissance and black-line burning around specimens.

3.6.4 Rest Rotation Grazing Management

In cooperation with the NRCS (formerly Soil Conservation Service), most of the major ranches in the watershed have instituted some form of rest rotation grazing management since 1970. In most cases, cattle are kept in the higher, mountain pastures during the winter and rotated through numerous lowland pastures during the summer growing season. Monitoring data from NRCS demonstrate that rest rotation has benefitted production, cover and composition of range vegetation.

3.7 Ranch Histories

3.7.1 La Osa Cattle Company

The La Osa Cattle Company grew from the holdings of Col. W.S. Sturges, who homesteaded the Las Moras Ranch in the 1880s. He obtained the Rancho de la Osa in 1885, as well as the Secundino, Pozo Nuevo and Palo Alto ranches, before selling the entire company to William Coberly in the early 1900s. Coberly bought the Buenos Aires in 1909, giving him control of most of the valley from the Palo Alto south to the Mexican border. In about 1913, the company passed into the ownership of Jack Kinney, apparently by default. Kinney broke it up after 1926, selling the Buenos Aires to the Gills, the Palo Alto to the Mannings, and the Las Delicias to Fred Ronstadt. The Rancho de la Osa base property became a dude ranch at or before this time. Today it comprises about a section of deeded and state lease land.

A photograph taken by David Griffiths at La Osa headquarters in 1903 shows vegetation dominated by snakeweed and scrubby mesquites, presumably a result of overgrazing during the droughts of the preceding decade. The range rebounded somewhat over the following decade, judging from another photograph, taken on the Buenos Aires in 1914. Fragmentary evidence suggests that Coberly and Kinney ran 5,000-9,000 cattle on the entire ranch, for a stocking rate of 18-32 head per section. It was during the La Osa period that boundary fences were built and the state grazing leases established over much of the valley. Kirk Bryan, who surveyed the valley in 1917, observed that fence construction entailed realigning the road in places, and that arroyo crossings required maintenance due to the active erosion occurring on the valley at the time (Bryan 1925: 376). Bryan (1925: 377) estimated that the La Osa controlled 17,220 acres of deeded land and 94,000 acres of leased land, but the latter figure appears much too low. Photos taken in the late 1920s show large stacks of Johnson grass hay cut from the bottomlands of the La Osa (at Palo Alto), as well as horses, mules and pigs foraging in uncut fields of Johnson grass. Kinney improved the ranches' earthen tanks, and registered them with the state for the first time (in 1919). He claimed water rights on more than 200 tanks, and he backdated them to 1883 (suggesting that most had been built before his ownership).

3.7.2 Anvil and 98

Manuel King came to the Altar Valley in 1885 and went to work for Hubbard Larabee at the Palo Alto Ranch. During a drought, Larabee laid off his cowboys and paid them in cattle. King took his animals up into Brown Canyon, where he filed a homestead claim. Drought forced him to abandon the claim and move north, where he took up the Redondo homestead in 1895. Over time, King was able to acquire adjacent properties: homesteads in Mendoza, Contreras, Alambre and Solano canyons, all along the east face of the Baboquivari-Coyote range; and, down in the middle of the valley, the Rouse Ranch (now the 98) in 1903 and the Anvil Ranch (previously the Warren Ranch owned by Albert Steinfeld) in 1908. The ranch has remained in King family ownership ever since.

The Kings have made significant investments in water improvements throughout their ownership. In Manuel King's day, before the entrenchment of the Altar Wash, floodwaters would spread out across the ranch's flat bottomland areas and support thick stands of Johnson grass, which were sometimes harvested as hay. As the Altar dropped through the '20s, '30s and '40s, the Kings built spreader dams to raise floodwaters up onto these pastures. The Altar became to deep and wide for this practice around World War II, and dikes were constructed in 1964 to protect their bottomland fields from further erosion. Spreader dams continued in use on tributary washes until the floods of 1983 washed them out. Today, the Kings irrigate 100 acres of pasture near their headquarters.

From 1930 to 1980, the Kings constructed 49 earthen tanks and developed five wells. In the 1980s and '90s, they installed nine waterlines to provide more reliable water.

Until the 1970s, the ranch carried approximately 650 cattle in four pastures which were grazed year-around. Rest rotation was implemented in the 1970s, with seven cross-fences built since that time to divide the ranch into nineteen large pastures (more than 900 acres each) and sixteen traps and holding pastures. At the same time--and due in part to drought conditions--the herd was reduced to its present size of around 550 head. Under the rotation, the mountain pastures are grazed in the dormant season only, and the cattle are rotated through the lower pastures during the summer, with different pastures rested each year. A recent resurvey of 35 transects established in 1975 shows significant increases in native perennial grass cover.

In the late 1960s and 1970s, the Kings chained approximately sixteen sections of the ranch, mostly in broad strips. These lands show higher forage production today due to the treatment. Prescribed fires on 20-25 sections in the late 1980s and early '90s also helped to control shrubs and encourage grasses.

3.7.3 Buenos Aires

The Buenos Aires Ranch was founded by Don Pedro Aguirre, Jr., in approximately 1883. At that time it comprised roughly eighty to one hundred sections in the southeast part of the Altar Valley watershed. Aguirre developed farm fields around his reservoir, Aguirre Lake, and cut natural grasses for hay. Estimates from the time suggest that Aguirre had as many as 5,000 cattle and 10,000 sheep, though these numbers may have varied considerably from year to year. In addition to the reservoir and a deep well, Aguirre probably developed numerous earthen stocktanks in tributary drainages from the San Luis mountains. Aguirre died in 1907 and his estate sold the ranch to William Coberly in 1909. Coberly ran the Buenos Aires as a part of his La Osa Cattle Company (see above). Under Jack Kinney's ownership, the Aguirre Lake dam was improved and a spillway added (Bryan 1925: 150).

When Fred Gill and Sons bought the Buenos Aires from Kinney in 1926, there were approximately 2,000 cattle on a range of about 110 sections. Over the next 33 years, the Gills expanded the ranch to about 155 sections and the herd to as many as 6,800 head. The Gills invested heavily in fencing and water improvements, with some costs shared by Soil Conservation Service after 1941. According to Pete Phelps, the Gills removed cattle from 1926 to 1928 and spent the time building fences. They built some 250 miles of fence; by 1946 there were ten pastures, and by 1959 there were sixteen. They re-engineered Aguirre Lake, adding headworks on Bailey wash (from the west) and a system of pumps and ditches to better control and retain water. A fourteen-mile, gravity-fed waterline was installed from Arivaca Creek north to Secundino, providing water at two-mile intervals.

Earthen tanks were rebuilt with sandtraps and, in some cases, headworks for diverting floodwaters without risk of blowouts. Bulldozers were used to build spreader dams across the incised channels of major washes. On Arivaca wash, these structures successfully healed the arroyo, reducing it from about eight feet in depth to about two feet today. Other spreader dams (on Compartidero and Puertocito washes) blew out in major flood events.

The Gills converted from a stocker operation to cow-calf production in 1948. According to former manager Clayton Vincent, they branded 3,000 calves a year from 1948 to 1955. They ran their cattle as four herds. It appears that seasonal or best-pasture rotation was practiced beginning in the '40s. The drought of the 1950s caused the Gills to reduce their herd to about 2,000 head. They sold the ranch to Clifford Dobson in 1959.

The Gills' investments in fencing and waters enabled them to stock the Buenos Aires with large numbers of cattle in the '30s and '40s, but the overall trend of range conditions under their ownership appears to have been downward. The extent of bulldozer work suggests that run-off rates were very high, corresponding with thin vegetation in the uplands. A visiting reporter wrote in 1946 that the soil "sheds water like concrete--every rain produces a series of flash floods along the arroyos and dry stream beds" (Thruelsen 1946). A wildlife survey conducted by the Arizona Game and Fish Department in 1948 concluded that the Buenos Aires was poor habitat for deer, javelina, song birds and upland game birds--a condition that persisted into the 1970s (Knipe n.d.). Vincent recalls that Roy Gill said there were very few mesquites in 1926, when he bought the ranch--he complained that there was no shade for the cattle. By the time the Gills sold, mesquites were widely established across the ranch. A rancher who considered purchasing the Buenos Aires in the early 1950s recalls it as having been dominated by scrubby mesquite (John Donaldson, personal communication).

Clifford Dobson ran about 3,200 cattle on the Buenos Aires. In 1962 he added the Pozo Nuevo area to it, increasing the ranch to approximately 185 sections. He sold the ranch in 1966 to John Norton. The herd had diminished to 1,600 head by 1972, when Norton sold the Buenos Aires to the Victorio Company, owned by Peter Wray and Wayne Pruett.

Pruett and Wray implemented a massive program of range improvements during their eleven years of ownership. They repaired the tanks and waterlines from the Gills' era and resumed the practice of building spreader dams across major washes. They built more than 100 more miles of fence, dividing the range into about 70 pastures. The pastures enabled them to control the breeding of registered Hereford and Brangus cattle and to practice rotational grazing. Using bulldozers, they chained or grubbed some 60,000 acres of mesquite trees and pushed up small dams across incipient arroyos. (Aerial spraying of

2,4,5-T was attempted on 4,000 acres of mesquites, but without much success.) After treatment, these areas were seeded with grasses: Johnson grass in the loamy bottomlands (Photo 3.13), Plains and Boer lovegrass in the uplands, and blue panicgrass, Lehmann lovegrass and green sprangletop throughout. The pastures were rested for at least one and usually two growing seasons to allow the grasses to establish. The result was a radical transformation of approximately half of the ranch from mesquite shrub back to grassland, albeit one dominated in many areas by the non-native Lehmann lovegrass. One result of this program was a diminution of run-off (due to increased grass cover) which rendered some stocktanks inoperable. According to Pruett, run-off from the ranch as a whole virtually ceased during the 1970s, due to the combined effects of the spreader dams and the revegetation work. Prescribed fire was also used, on a much smaller scale in 1979 and 1980, to remove snakeweed and burroweed.

Even with all of these improvements, Pruett and Wray did not attempt to stock the Buenos Aires as heavily as previous owners had done. They ran no more than 2,700 head on the ranch, and they incorporated wildlife habitat needs into their revegetation work. Concurrently, researchers with the U.S. Fish and Wildlife Service and the Arizona Game and Fish Department launched experiments to reintroduce the masked bobwhite quail, using pastures that were being rested after treatment. Limited successes with the experiments in the late 1970s led directly to the formation of the Buenos Aires National Wildlife Refuge in 1985. The influence of Pruett and Wray's revegetation and erosion control work on the released masked bobwhites was never carefully examined, however. It is possible that the spreader dams, mesquite removal and seeding all benefitted the quail (Sayre 1999). Under the brief ownership of Pablo Brenner (1983-85), these programs were discontinued. The spreader dams blew out in the flooding of 1983, and heavy grazing impacted quail habitat during this period, according to an internal Fish and Wildlife Service memo. These may explain the difficulties encountered by further masked bobwhite releases since 1985.

Livestock have been excluded from the Buenos Aires since creation of the refuge. Many fences have been removed, and much of the water infrastructure has been allowed to deteriorate. Prescribed fire has been used on a large scale (up to 20,000 acres per year) to set back mesquites and encourage grasses. Approximately two-thirds of the stocktanks no longer fill, presumably due to increased grass cover in the uplands. There is very little solid data on the effects of refuge management; what there is suggests that Lehmann lovegrass remains dominant across much of the land treated by Pruett and Wray; Johnson grass continues to dominate in the bottomlands; areas not treated remain in a mesquite shrub condition.

Under the 1988 Arizona-Idaho Public Lands Act, the State Trust Lands previously leased to the Buenos Aires (approximately 90,000 acres) were transferred to Fish and Wildlife ownership in exchange for the Santa Rita Experimental Range south of Tucson. The Fish and Wildlife Service has also bought additional properties for addition to the refuge, mostly along Arivaca Creek and in Brown Canyon. The present size of the Buenos Aires is around 118,000 acres.

3.7.4 Chilton Ranch and Cattle Company, Arivaca Division

The Chilton-Arivaca Ranch comprises some 2,000 acres of deeded land, the Montana and Jarillas allotments of the Coronado National Forest, and about 13 sections of State Trust Land. All but the Montana allotment was part of the Arivaca Ranch from the late 1800s until 1950.

The history of the Forest Service allotments is complex. The Montana allotment was formed by the combination of two allotments in 1935, with a grazing preference for 731 cattle held by Phil Clarke. Clarke's sons sold the allotment and its base property to Manerd and Alice Gayler in 1965; in 1973, the Gaylers sold to Dale Smith. Smith sold to Kay and John Sturdevant in 1985. The Sturdevants cross-fenced the allotment and implemented a rest rotation grazing system in 1988-89, before selling the permit to the Chiltons in 1991 (without the Clarke homestead base property, which was sold to the Fish and Wildlife Service). At some time after 1965 and before 1988, the grazing preference was reduced to 531 head.

The Chiltons have installed one waterline, two new tanks, and made repairs or improvements to six other water sources in the Montana allotment. They run 500 head as a unit, rotating through five pastures and a trap; the northern pastures are grazed only in the dormant season while the two southern pastures alternate in the summer, each one resting every other growing season. Another 31 head are allocated to the allotment but run as part of a herd of 119 that rotates through five pastures on both Forest and State land. Transect data indicate that net primary productivity of the Montana allotment has more than doubled since the rotational system was implemented, while bare ground has decreased. Paired photographs taken in the 1950s and 1990 show a dramatic long-term increase in grass cover.

The Jarillas allotment has undergone a series of divisions and recombinations over the years. It was created in 1955, when the Osborne brothers, Homer and Earl, divided their holdings in what had previously been known as the Fresnal and Tres Bellotas allotments. With minor adjustments, Earl took the Tres Bellotas, renamed the Cross S; Homer took the Fresnal, renamed the Jarillas. In 1956, the Jarillas carried a preference for

616 head of cattle. It was sold to Cecil Honnas in 1961, and in 1962 it was divided in two: One portion, with a preference for 325 head, was sold to Lawrence Jones and renamed the Fresnal allotment; the other, carrying 291 head, retained the Jarillas name. The Honnas family sold the Jarillas permit to the Parsons in 1982, who sold it to the Chiltons in 1987. Finally, in about 1990, the adjacent Canoa allotment was divided in two, and the northern portion was added to the Jarillas allotment (the southern portion became part of the Cross S (Fresnal) allotment). Presently, the Chiltons run 270 head on the Jarillas, rotating the herd through nine pastures. They have added two waterlines to improve the reliability and distribution of water on the allotment.

A fourth herd, numbering 70 head, rotates among three pastures of State Trust Lands just north of the Jarillas allotment. The fences that define the pastures were built in 1988-89 under the Sturdevants. Three of the six earthen tanks were constructed under Honnas tenure in the late '60s and '70s.

3.7.5 Chilton Ranch and Cattle Company, Diamond Bell Division

The Chilton family bought the Diamond Bell Ranch in 1979. Previous owners include Ron Jolly, Bob Walker, and Claire Wolfswinkel. Portions of it have been owned previously by Muller and by the King family. It now comprises 200 acres of deed land, 27,000 acres of state land, 700 acres of BLM land, and 3500 acres of adverse grazing land. The northernmost 4,000 acres of state land were added to the ranch in about 1990; previously they were leased by the Robles Ranch.

The large amount of adverse grazing is the result of efforts in the late 1960s and early 1970s to develop the ranch into a high-density subdivision. The development failed to generate returns sufficient to pay for infrastructure costs, so the majority of lots never received water, sewer and electricity service. Roads were bladed and street signs erected but little else was accomplished. The roads are a major source of erosion and sediment today.

John Duncklee has published a memoir of his experiences as sublessee of the Diamond Bell (then the O Bar J Ranch) in the 1950s under the title *Good Years for the Buzzards*. "The O Bar J rangeland was abused--too many cattle for too many years," Duncklee writes. "The north pasture's seven sections of deeded land had one of the densest stands of cholla I have ever seen... The grass was mainly six weeks grama... Two noxious plants grew prolifically: burroweed and snakeweed... [In] the south pasture...the composition of grasses...was more varied and of better quality for forage, but it had seen better days. The Pacheco pasture...contained the best forage on the entire ranch... [including] perennial grasses and *guajilla*... There was one other section next to the ranch headquarters called the Horse Pasture. It too had seen hard use over the years." (1994: 9-10).

It does not appear that conditions improved during Duncklee's tenure. Extreme drought conditions compelled him to singe the spines off of cholla cacti for his cattle to eat. There were only two drilled wells and one hand-dug well on the ranch at the time, and only one of the four earthen tanks was reliable (Duncklee 1994: 14). The ranch had three pastures and a holding trap; cattle were moved to wherever feed and water were available.

The distribution of water has improved since Duncklee's time, in part due to wells bought by the City of Tucson in the area in the 1970s. There are eleven tanks now and nine wells. Four waterlines distribute the water more evenly across the range.

Duncklee does not say how many cattle he stocked on the O Bar J. In the '60s and '70s, other owners ran as many as 1500 head, mostly stockers. When the Chiltons bought the ranch in 1979 there was a lot of bare ground. The Diamond Bell pasture was "hammered." The Chiltons brought the stocking rate down below its state-rated capacity of 329 head and implemented deferred rotation management. In 1984-85, they cross-fenced the southwest pasture into three pastures and a holding trap. Vegetation transects installed to monitor the results of these measures show increased grass cover, with short-term decreases during the droughts of the late '80s and mid '90s.

3.7.6 Elkhorn

The Elkhorn ranch was originally homesteaded by Sabino Otero in the 1870s. In 1920, it was purchased by the Ronstadts along with the Las Delicias Ranch to the south and east. The Las Delicias lacked any water developments, and the Ronstadts relied on the natural water sources on Otero's homestead. Tom Peters acquired the Las Delicias and the Otero homestead in the late '20s or early '30s, reportedly through payment of back taxes. Peters' brother, Brian, homesteaded the present-day Elkhorn headquarters land (just west of the Otero homestead) and subsequently bought out Tom. Brian Peters started a ranch school for boys, which operated until about 1943. Peters sold the Las Delicias to Dave Hibbs in the mid 1930s. In late 1945, he sold the remaining property to Ernest Miller, who had a dude ranch in Montana. Miller made the Elkhorn into a dude ranch as well, returning to Montana for summer seasons. It remains in the Miller family, as a dude ranch, to this day. It comprises 3,000 acres of deeded land, just under 7,000 acres of state trust land, and 870 acres of BLM land.

The Millers report that the ranch was "totally denuded" of vegetation when they bought it in 1945. Mesquite trees were only five or six feet high, and even the palo verde trees had been browsed by livestock. There were two dams in the canyon, and a well; the rest of the water sources were natural. Water developments installed by the Millers include North Tank (1946, cleaned 1986), Middle Tank (1950s), South Tank (1950s, cleaned 1987), West Matador Tank (early 1960s), and two wells (1977 and 1990-91).

The Millers raise their own horses for use on the dude ranch. Until 1961, the main herd was on the ranch in Montana, and only 20-30 head grazed on the Elkhorn. In that year the Arizona Millers left Montana (another branch of the family took over the Montana operation) and moved the breeding herd to Arizona, bringing it eventually to 120 head. From 1946 to 1980, they also ran cattle: as many as 200 cows and 200 steers in the 1960s. In some years, they leased land elsewhere in the area to augment their own lands. The combined horse and cattle herd was more than the range could support, however, and drought in the late 1970s prompted the Millers to get out of cattle production altogether.

Beginning in 1983, the Millers implemented more active rotational grazing, ending a century of continuous year-long or seasonal rotational grazing. They cross-fenced the Matador Pasture in 1985 and the Desert Pasture in 1986. Once the rains start in the summer, the herd is rotated once a week through eight lower pastures. The geldings used by dudes are rotated through the smaller pastures near the headquarters through the winter dude season. The native perennial grasses in the mountains (e.g. Plains lovegrass) have responded well to the new system.

Approximately one section of the Matador Pasture was chained in the 1960s, but the mesquites recolonized the area in subsequent decades. From 1984 to 1990, the Millers grubbed mesquites from a total of about 1,000 acres of their deeded land in the middle of the ranch, at an average cost of $35 per acre. These areas were seeded with Lehmann, Boer, Cochise and Wilman lovegrasses. Net primary productivity of the cleared areas is now around 1,500 pounds per acre; before treatement it was almost nothing, due to the dense cover of mesquites. Vegetation transects installed in 1983 to monitor the results of the new management have documented the improvements in range productivity and condition.

Despite these improvements, brush continues to invade many areas of the Elkhorn. The Millers identify three factors that explain this: historic overgrazing, fire suppression, and the relative increase in winter rains in recent decades. A large wildfire in 1994 set back the woody species, for example, but heavy winter rains in 1995 enabled the mimosa to reassert itself more quickly than expected. The Millers would like to use prescribed fire to help control the brush, especially in the lower pastures.

3.7.7 Honnas Land and Cattle Company

Cecil Honnas bought the Honnas Ranch from Homer Osborne in November 1960. At that time it included seven sections of state lease land and the Jarillas allotment of the Coronado National Forest, which are now part of the Chilton-Arivaca Ranch (see above). Don Honnas sold the leases in 1982. The ranch today comprises 815 acres of deeded land, originally homesteaded by Joseph Ball, Francisco Moreno, William Earle and Miguel Egurrola.

From 1962 to 1982, the Honnases ran no more than 425 head of cattle on their deeded, Forest and state lands combined. They also kept 15-18 horses in a pasture at headquarters. They added nine wells and six tanks, most of them on the state and forest lands. They also developed one spring on the state land. Additionally, they built fourteen miles of fence on the Jarillas allotment in the early 1960s, dividing two pastures into five pastures plus a holding trap. Their deeded land has five wells (three of which are capped) and one small tank; the boundaries were fenced after sale of the leases in 1982. Since 1982, the Honnas Ranch has carried a herd of 35-40 cows, managed under a five pasture rest rotation system.

The outstanding feature of the Honnas Ranch is the riparian area along Arivaca Creek. In 1965, Honnas cross-fenced a pasture to enable him to exclude cattle from the creek, and since that time the area has rested during most of the growing season every year. Especially after a major flood in the mid-1960s--which blew out the Arivaca Lake dam upstream and scoured the channel of the creek--this management change has resulted in tremendous regeneration of cottonwood, willow, walnut and hackberry trees along the creek. In the dry early summer, the creek runs only at night, when these trees are not transpiring the water. Don Honnas has noticed a decrease in flows in the creek, associated with upstream water use (both by wells and by retention in Arivaca Lake) and increased vegetation and thus transpiration.

3.7.8 Joe King Ranch

Joe King bought the Aros Ranch in 1961 and the Los Encinos Ranch in 1971, consolidating both to form the Joe King Ranch. They had previously been owned by Arthur Loew, the Ronstadts (as part of the Santa Margarita Ranch, see below), Harold Bell Wright and Dan Olney. The Los Encinos was originally homesteaded by Kirt Hart, and the Aros by Antonio Aros. The Joe King Ranch today comprises six sections of deeded land and 16,000 acres of state lease land.

A dam in Los Encinos canyon was constructed under Ronstadt ownership in the late 1920s or early '30s. Many other water improvements also date to before Joe King's tenure (see Santa Margarita Ranch, below). Joe King built six or seven of the twenty-three earthen tanks on the ranch and he expanded the others. One new well has been drilled under King ownership; three wells are older. Large areas of the lower pastures were chained in the '60s, concurrent with chaining on the Santa Margarita Ranch to the north. About 200 acres of one pasture were cleared of mesquites in 1997-98 and seeded with yellow bluestem.

The Kings have practiced rest rotation grazing since 1981; previously the ranch had been grazed year-around. At that time they reduced the cattle herd from around 400 to a little over 300 head. They have cross-fenced Legunita pasture (in 1990), McGrail pasture (1993, and Encinos/Aros pastures (1991-92), resulting in a total of thirteen pastures. Cattle graze the mountain pasture in the winter and rotate through the lower pastures in the summer. Four vegetation transects installed in 1982 and two more installed in 1998 suggest: 1) that grass cover has increased under the rotation, and 2) that Lehmann lovegrass has increased at the expense of natives in the lower pastures, moving in from the east, where it was seeded on a large scale on the Buenos Aires Ranch in the 1970s.

3.7.9 Marley Cattle Company

Kemper Marley purchased the Marley Ranch from the Manning family in 1954; up to that time it had been part of the Mannings' huge Canoa outfit. The ranch comprises about 39 sections of deeded land, 80 sections of state lease land, and a small amount of BLM land. Approximately 99 sections of the ranch are in the Altar Valley watershed, while the balance is in the Santa Cruz watershed to the east.

Marley made significant investments in water improvements in the late '50s and early '60s, just after purchasing the ranch. On the Altar Valley side of the ranch, there are seven earthen tanks and six wells equipped with waterlines to distribute water to troughs. Three spreader dams on two washes help to retain water. Until just recently, grazing was continuous year-around. Cross-fencing completed in the past two years have divided the ranch into 26 pastures, compared to eight before, and a rotation is in process of implementation. Seven pastures are in the Altar Valley watershed. The Marley Company runs about 1200 mother cows; stocking in the past has reached as high as 1500 head. Don Caswell, who has lived on the ranch for 46 years and managed it for 30, reports that sideoats grama grass has replaced three-awns at the base of the Cerro Colorado mountains, and that mesquites are thicker in some areas than they once were. He also has observed Lehmann lovegrass moving onto the ranch from the Buenos Aires to the southwest. He recalls that there was a lot of bare ground when his father arrived in 1956--towards the end of the century's worst drought--and that Kemper Marley sold a lot of cattle to destock the ranch at that time. "The country's ten times better now than it was then," he says.

3.7.10 Noon Ranch

The Noon Ranch comprises 450 acres of deeded land adjacent to the Buenos Aires National Wildlife Refuge at Arivaca Cienega. It has been in the Noon family since early in the twentieth century. In 1956, it was split between heirs, and Forest Service permits went with the other portion of the ranch. Mary Noon and her husband, Rob Kasulaitis, run forty head of cattle under an eleven-pasture rest rotation system. Snakeweed has been pulled by hand from much of the ranch, and Green sprangletop has been seeded. Four vegetation transects installed and monitored in collaboration with the NRCS indicate an upward trend across the entire ranch over the past three years.

3.7.11 Palo Alto Ranch

The early history of the Palo Alto Ranch is somewhat unclear. Surveyor's notes from 1885-86 describe it as belonging to a man named Russell, who drilled a deep well. In the 1890s, it apparently belonged to Hubbard Larabee and A. Hemme. The name dates to 1907, and derives from a very tall mesquite tree in front of the house (Barnes 1960). It seems likely that Larabee and Hemme used another name, Poso Bueno, in reference to two productive wells there (Granger 1983: 495). The ranch later became part of the La Osa Ranch (see above), and was sold to Howell Manning in the early 1930s. Manning managed it as part of his much larger Canoa Ranch. In 1951 the Palo Alto was purchased, along with the Pozo Nuevo to the south, by Manerd Gayler and Roland Curry, who subsequently split it up: Gayler took the Pozo Nuevo and Curry took the Palo Alto. Curry left the ranch to his grand-daughter, Fran Snure, when he died in 1961. The ranch today comprises 1,378 acres of deeded land and 31,366 acres of state lease land.

More than any other ranch in the watershed, the Palo Alto has been impacted by the growth of the Altar Wash. The abutments of the old highway bridge, built in the late '20s at the south end of the ranch, are likely responsible for channeling floodwaters just downstream, cutting the arroyo to over 1000 feet in width. The Altar has removed some of the most productive land on the Palo Alto, along with an extensive corral system, barn and scales lost in the 1983 floods. These floodplain bottomlands once supported large areas of Johnson grass, which were cut for hay in the 1920s (Photo 3.11).

Water improvements on the Palo Alto include the old house well, an irrigation well drilled in 1959 or '60, two wells drilled in the 1970s, and Soldier Well, drilled for a military hospital during World War II. Eight earthen tanks were built before 1951, of which two are washed out; one more was built in 1970. Waterlines deliver water from three wells into adjacent pastures.

Spreader dams were used extensively in the past to raise floodwaters up out of the Altar and other tributary washes. The last of these washed out in the 1983 floods. Replacing the spreader dams would benefit both the grasses on the old floodplain and erosion control in the watershed as a whole.

The Snures run 300 cows and 30 bulls on the Palo Alto today. They have destocked the ranch three times due to drought since 1981. The cattle graze the east side of the ranch in the winter and rotate to the west during the summer. This rotation has been in place since 1981, and has benefitted the vegetation. The range produces good browse in all years, and a strong flush of annuals when the rains are good (Photo 3.16).

Stocking rates prior to 1981 were higher, and may have been much higher during the La Osa and Manning periods. The ranch has never been chained, grubbed or seeded. It has four pastures, dating to the early '60s, when the highway was fenced, splitting the ranch in two.

3.7.12 Rancho Seco/Santa Lucia Ranch, dba Hooker Associates or Carrow Company

The Rowley family bought the Rancho Seco from the Rubels in 1951; it had previously belonged to the Boices (see Arivaca Land and Cattle Company, above) and had been homesteaded by Montano and Peck. In the early 1960s the Rowleys added the adjacent Santa Lucia Ranch, previously owned by the Elys and the Angulos. Three other small parcels have been obtained since then. The combined ranch today comprises about 10,000 acres of deeded land, 26,000 acres of state lease land, and 3,000 acres of BLM land. Roughly half of the ranch lies in the Altar Valley watershed, while the rest is in the Santa Cruz watershed to the east.

The Rowleys have made significant investments in water improvements during their tenure. They have redrilled twelve old hand-dug wells and drilled ten new wells; eleven other wells pre-date their ownership, most of which have been improved by installation of submersible pumps. Fourteen old earthen tanks have been maintained or expanded, and nine others have been built under Rowley ownership. They have also built many fences, dividing the range into thirteen pastures and three traps. These improvements enable them to operate a rest rotation grazing system, with each pasture resting one growing season out of three. For a brief period in the 1960s, they ran 1100 cattle. This was too many, and they soon reduced the herd to 700 or so. At present they run about 885 animal units.

Approximately six sections in the Guijas Valley were chained in 1962. Smaller areas on the east half of the ranch were grubbed at about the same time. Three or four sections of Tapioca pasture were seeded to Lehmann lovegrass in the 1960s.

3.7.13 Santa Margarita

The Santa Margarita Ranch was homesteaded by a man named Verduzzo, who sold it to Jose "Pepe" Ronstadt in 1903. Ronstadt ran the ranch in partnership with Henry Dalton. They added the Las Moras and the Thomas Canyon area in the early 1900s. In 1920, Fred Ronstadt acquired the Las Delicias Ranch from the La Osa Company; the lands were consolidated by the Ronstadts to form the Baboquivari Cattle Company. In 1929, they bought the Los Encinos and Aros (Buena Vista) ranches from the Cross Anchor Cattle Company, owned by Walter Bailey and Harold Bell Wright (AHS files). The Ronstadts' holdings thus became one of the largest ranches in the watershed at that time, with approximately 100 sections of range. A newspaper article (*Daily Star* 6 March 1929) reports that Bailey and Wright had "only a thousand head" grazing on their 25,000 acres at the time of sale (or 25 head per section). The Ronstadts ran purebred Hereford cattle and sold registered Hereford bulls.

According to Karl Ronstadt, the Santa Margarita boundary fences were built in the late 1910s. Because the fence posts were wooden, grass fires were suppressed as much as possible after this time. During the drought of 1920-21, hundreds of cattle died on the Santa Margarita range. The drought prompted the Ronstadts to invest in water improvements, including some fourteen earthen tanks in the lower country and eleven concrete and masonry dams in the canyons of the Baboquivaris. After 1933, a pipeline was built from Shaffer Canyon down across the uplands; similar waterlines were built from Las Moras and Thomas canyons. After 1937, the Ronstadts used tractors to construct spreader dams across Legunita, Cuadro, Pozo Hondo, Las Moras, Placeritos and Shaffer washes. Karl says that Carlos Ronstadt, who oversaw the work, anticipated that the spreader dams would help mesquites to spread. The spreader dams enabled Mexican families living on the ranch to farm the floodplains in Cuadro wash, raising corn, squash and melons. A homesteader named Salcido farmed in similar fashion on the Bailey wash. By the 1940s, mesquites had begun to invade the grasslands, and in 1945-48, the Ronstadts cleared one section of floodplain land (T20S, R8E, section 34) and seeded it to Johnson grass. Karl Ronstadt recalls eleven pastures on the Santa Margarita (including the Las Delicias) and five on the Aros. He reports that the ranch carried up to 1,000 cows, but averaged around 800. Steers were bought in Mexico and stocked on the ranch, with numbers varying according to forage conditions.

Karl Ronstadt reports that pronghorns were eliminated from the valley by the 1930s. White tail deer were numerous in the Baboquivaris in the 1930s, but mule deer were absent. From 1933 to shortly after World War II, the Santa Margarita was recognized as a game refuge by the Game and Fish Department. Ronstadt also recalls a big fire in 1932 or 1933, and a large flood in 1949 or 1950. The arroyo now found in T20S, R8E, sections 17 and 18 was originally a wagon road, which washed out in flooding and came to be known as Arroyo de la Carretela.

The Ronstadts sold the core of the Santa Margarita to the Nelson family in about 1950. At that time it comprised sixty sections of range and had 1,000 cattle on it. They held onto the Aros and Los Encinos until 1957, when they sold them to Arthur Loew, who sold them to Joe King three years later. The Las Delicias passed out of their hands, reportedly by tax default, in the 1930s.

The Nelsons lived in Kansas City and hired Pete Phelps to manage the ranch beginning in September 1956. Between 1965 and 1972, Phelps cleared mesquite from approximately 20,000 acres of the range, at a cost of $150,000. A 1968 photo shows the results of the clearing (Photo 3.12). He tried chemical spraying (2,4,5-T mixed with diesel fuel) on 2200 acres, achieving a 60-65 percent kill. Throughout Phelps' time, the ranch had eight pastures. He developed six new wells and cleaned out all but one of the fourteen earthen tanks built by the Ronstadts. As on the Buenos Aires later, Phelps found that clearing all the mesquite above a tank and reestablishing grass would cause the tank to cease filling. Limited experiments with buffel grass were unsuccessful. Phelps never seeded Lehmann lovegrass on the ranch, but it invaded from the highway, where it was seeded by the Highway Department as an erosion control measure. Phelps stocked the ranch at fourteen head per section, an increase of two head per section over the State Land Department's recommended rate; he felt that the revegetation work justified the increase. With one exception (Heifer pasture), Phelps ran all the ranch's pastures year-around.

The Nelsons sold the ranch to its present owners in 1984. It is managed by Headquarters West under contract. The Santa Margarita Ranch, Incorporated, entered into a cooperator's agreement with the Soil Conservation Service (now NRCS) and commenced a program of improvements and rest rotation grazing management. The old waterlines were replaced in Las Moras canyon (1984), Shaffer canyon (1985) and Thomas canyon (1987). Cross-fences were constructed to divide three large pastures into eight smaller ones. Stocking was reduced to twelve head per section. The rotation calls for winter grazing in the mountain pastures and alternate year grazing in the lower pastures. Key area transects installed in 1985 showed a positive response to the rotational system after five years. The system was neglected for a couple of years in the early 1990s, however, and stocking rates increased slightly. During the drought of the early '90s, downward trends were observed in cover and composition on two transects in the lower country, including increases in Lehmann lovegrass. The stocking rate has been reduced again, to 500-600 head, and the rotation is in the process of being re-implemented.

3.7.14 Tortuga

The Tortuga Ranch was bought by the Pascua Yaqui Tribe in 1998. It is presently leased back to its previous owners, John and Mac Donaldson, who bought it in 1952 from John Kai. Kai bought it from Bob Lock. The Tortuga comprises about nine sections of deeded land, 11.5 sections of BLM land, and twenty sections of state lease land. The majority of the ranch is two large pastures, Yodi and Tortuga, which lie almost wholly in the Roskruge Mountains; five smaller pastures divide up the east end of the ranch, which lies in the floodplain of the Altar Wash. The fences date to before 1952.

The sediment removed from the Altar Wash further upstream settles out on the floodplain of the Tortuga and the Garcia Strip immediately to the north. Thousands of acres of land have received one to two and a half feet of sediment as a result of the entrenchment of the Altar (Robinett n.d).

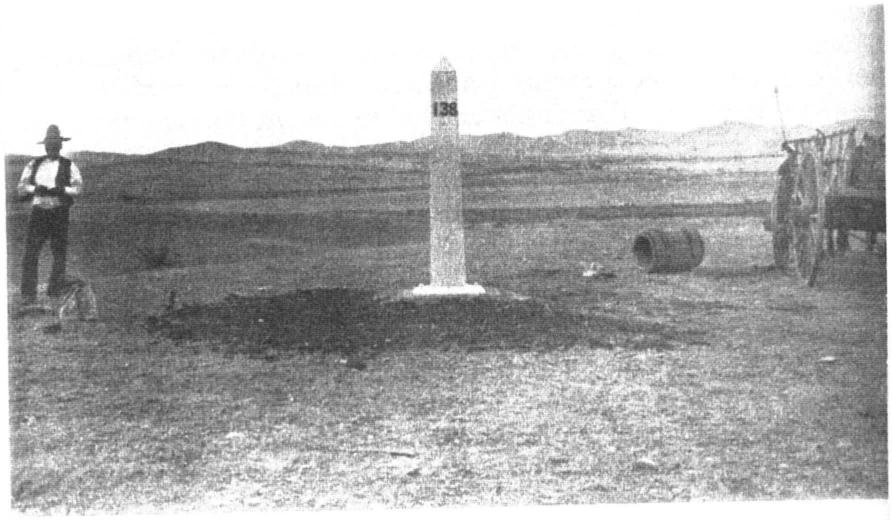
Bob Lock built spreader dams on many gullies on the ranch. There are seven earthen tanks; one large dam on Altar built by Donaldson in 1953; four GFD wildlife water catchments; seven wells, including one off property owned by city; and one pipeline. Thirty-eight range condition trend transects and six key area transects have been installed and monitored in collaboration with NRCS.

John Donaldson reports that there was no Bermuda grass on the ranch in 1952. Today it dominates the Altar floodplain, having come downstream with floodwaters. It established first near the dam. Donaldson cleared large areas of mesquite trees in the floodplain and seeded Johnson grass (which was already present in smaller quantities). Today, Johnson grass dominates alongside the Bermuda. Donaldson further reports that tumbleweed entered the area only after the planting of cotton on irrigated fields in the 1950s. Finally, Donaldson seeded some blue panic grass on sandy benches.

Under Donaldson management, cattle grazed the Roskruge hills in the winter, after shipping. In March, the herd was moved down onto the floodplain flats. Jojoba, guajilla, catclaw, and mesquite browse are the primary feed in the hills; there is a lot of curly mesquite on north-facing slopes. Rothrock grama grew on the flats coming down from the hills, but dry conditions in '60s and '70s killed out a lot of it. In years of good rain, the range produces healthy stands of tobosa, indian wheat, and mediterranean grass. Donaldson stocked the ranch with about 300 cows, plus 400-600 steers in the summer.

After acquiring the Empire Ranch lease in 1975, Donaldson ran the Tortuga as an adjunct range. For the past ten years or so, that has meant grazing the Tortuga only during the dormant season.

PHOTOGRAPHS



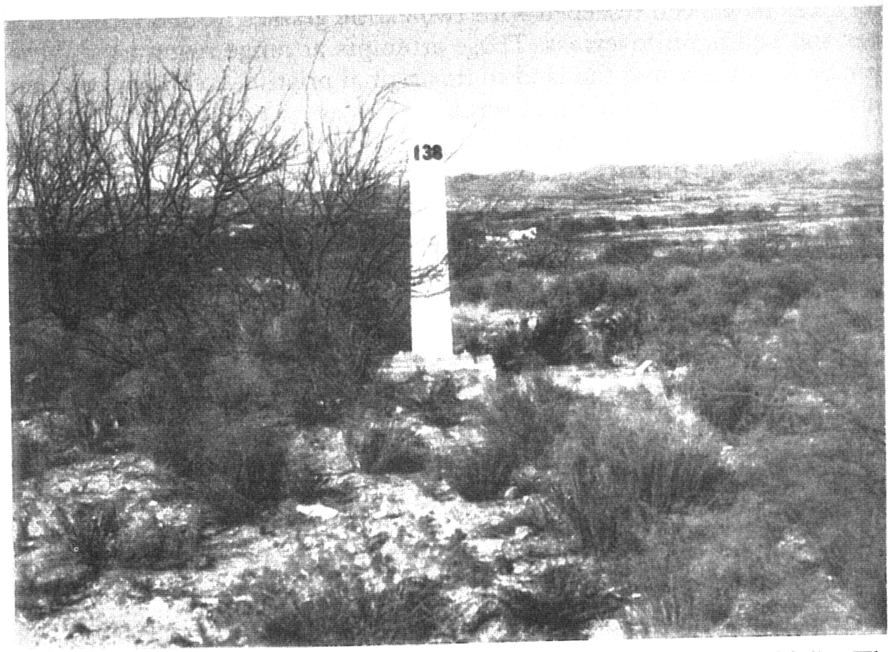


Photo 3.1 (top). Boundary monument 138 in 1893. Source: Humphrey (1987: 294). The monument is 2.5 miles east of the town of Sasabe, which was the nearest water source at the time. Note the absence of mesquite trees or shrubs. The grasses appear heavily grazed but still constitute a cover of vegetation. Humphrey notes that the area "was still essentially open, rolling prairie grassland" in 1930, when he visited as a graduate student (1987: 293).

Photo 3.2 (bottom). Boundary monument 138 in 1983. Source: Humphrey (1987: 294). In his annotations of these photos, Humphrey writes: "A large-scale, extensive mesquite eradication program has been carried out recently north of the boundary here on what is now known as the Buenos Aires Ranch. Were it not for this program, the area showing to the right of Monument 138 and to the left of No. 139 [see photo 3.4] would have appeared in the repeat photos as a mesquite woodland, as it still is across the line in Mexico. The range, both north and south of the boundary throughout this area, has been heavily grazed for many years, and grazing pressure is still extreme on the Mexican side. In Arizona, not only has much of the mesquite been removed, but grazing pressure has been reduced..." (1987: 293).

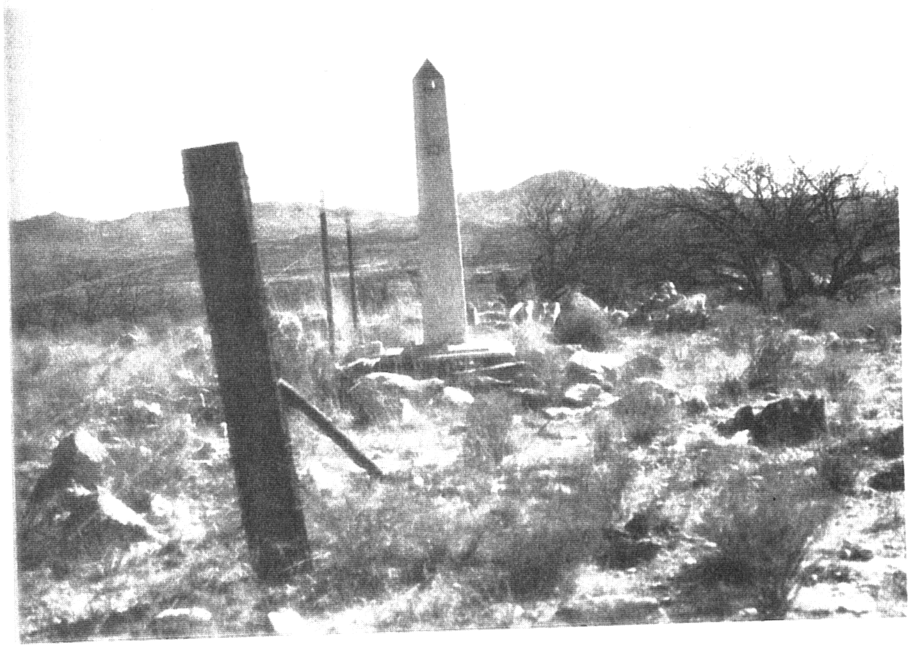


Photo 3.3 (top). Boundary monument 139 in 1893. Source: Humphrey (1987: 295). The lack of grass cover compared to Monument 138 was probably related to this area's greater proximity to water at Sasabe, 0.2 miles to the west.

Photo 3.4 (bottom). Boundary monument 139 in 1983. Source: Humphrey (1987: 295). The photo is taken looking to the east, so that the Buenos Aires Ranch, where mesquites had been cleared, appears on the left.

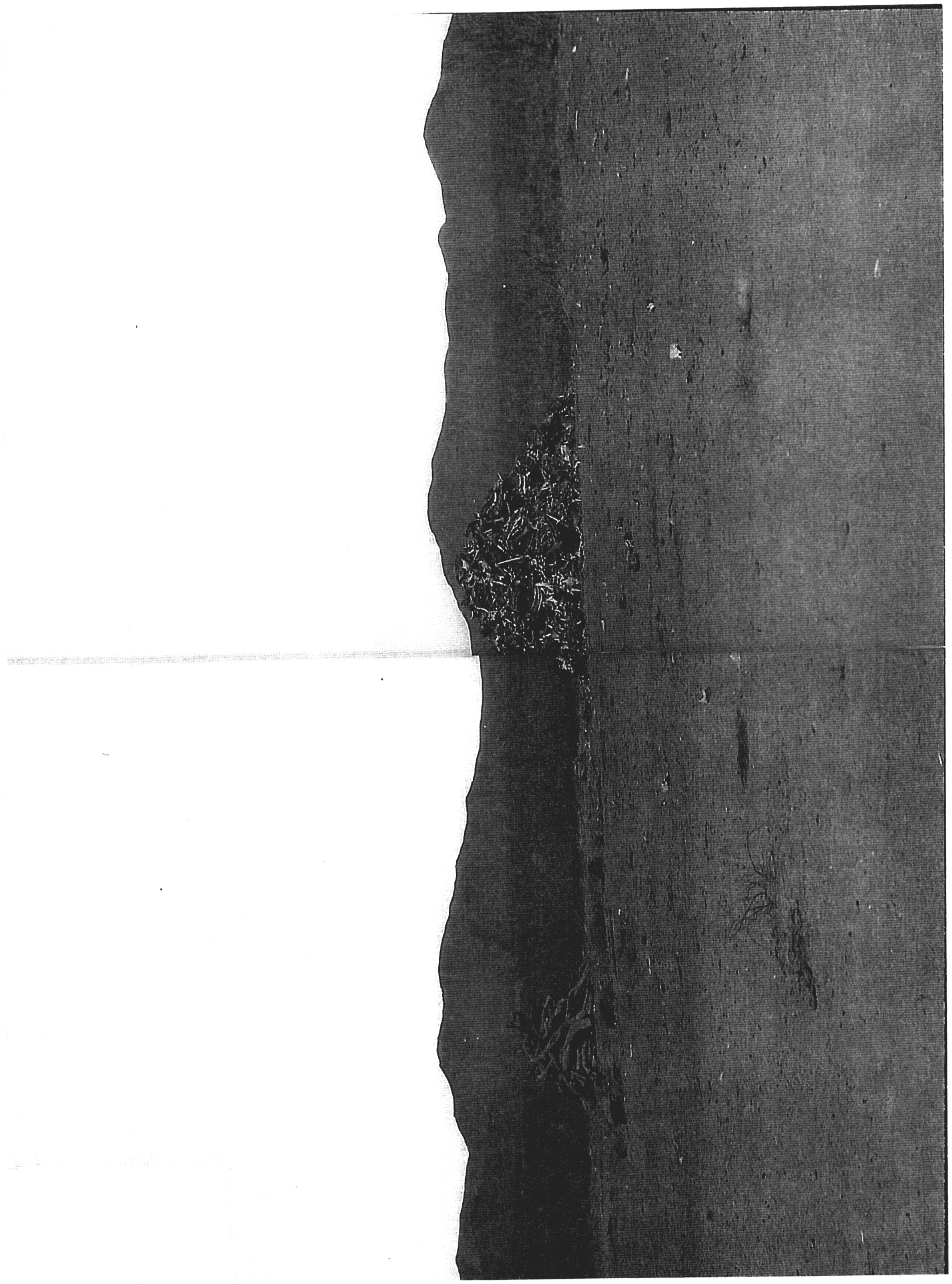


Photo 3.5. Cattle and horse bones stacked on the Robles Ranch, 1903. Source: Bahre and Shelton 1996 (reprinted from National Archives, original by David Griffiths). Uncontrolled grazing during a prolonged drought from 1898 to 1904 denuded the range and led to die-offs. The bones were collected and hauled away for fertilizer.

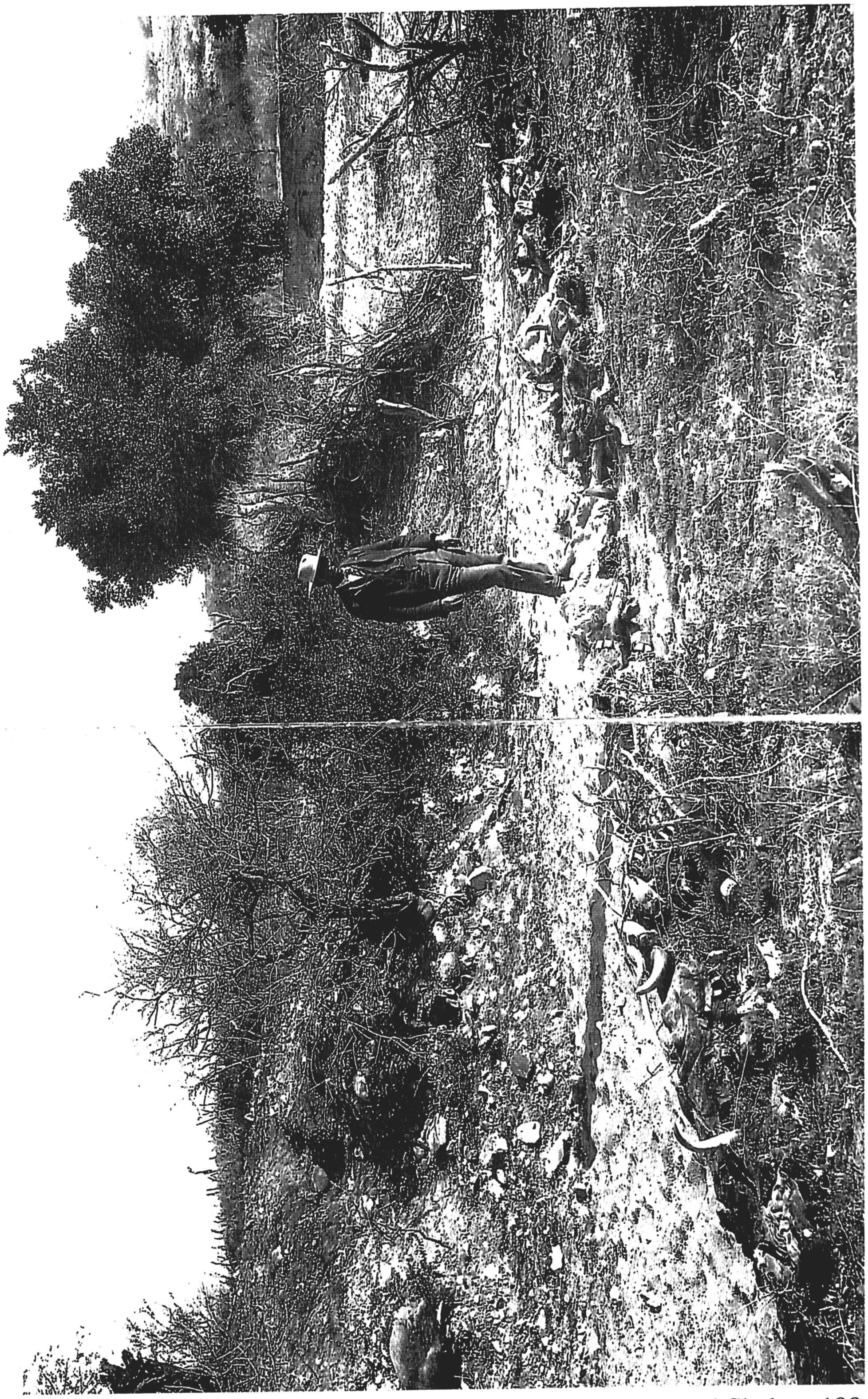


Photo 3.6. Cattle bones along Arivaca wash, 1903. Source: Bahre and Shelton 1996 (reprinted from National Archives, original by David Griffiths). Note the fresh-cut arroyo in the center right of the photo. As far as we know, this arroyo formed prior to the entrenchment of the main Altar Wash.

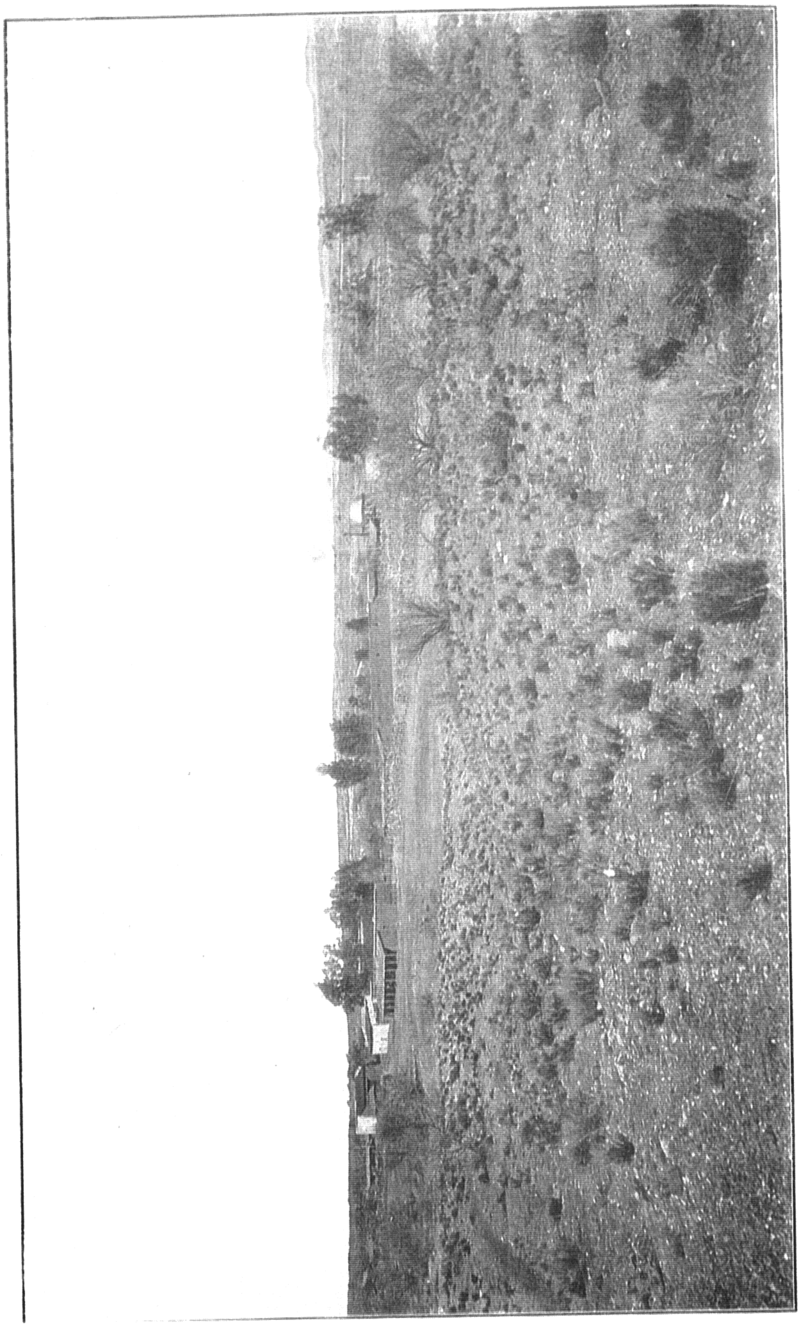
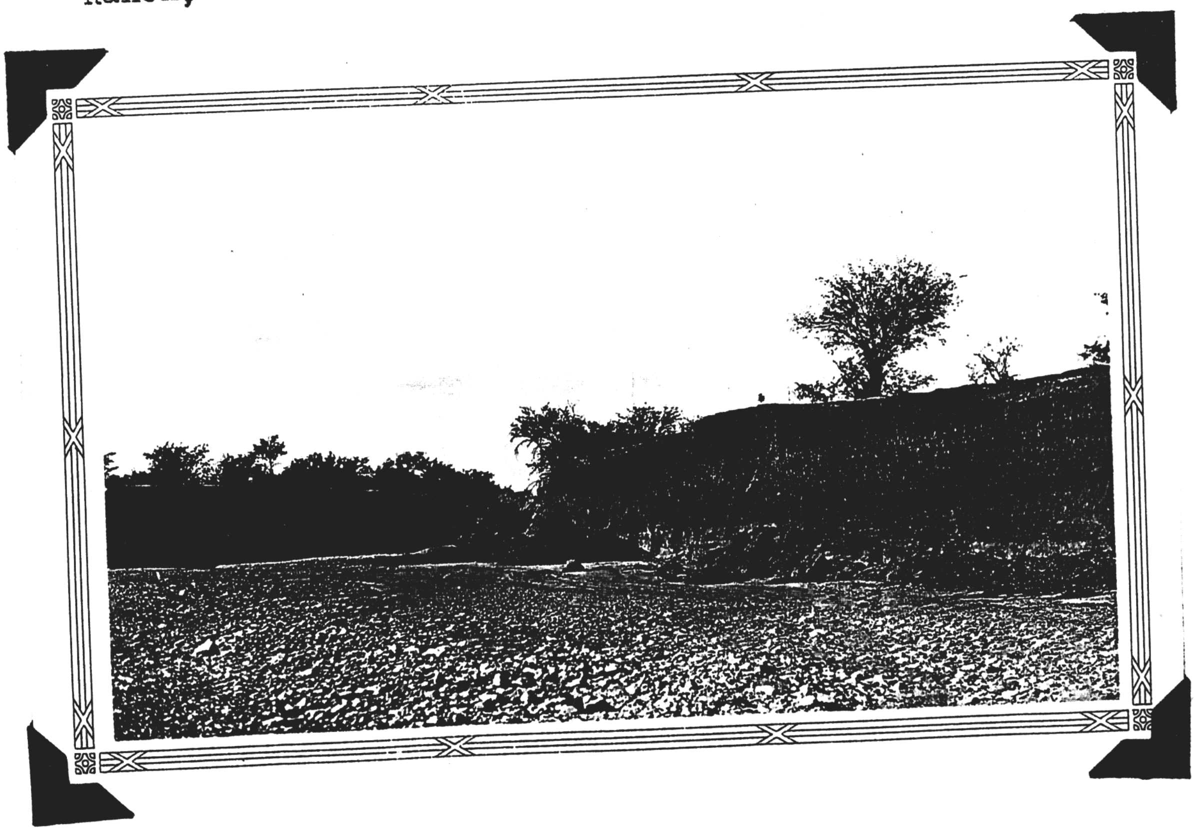


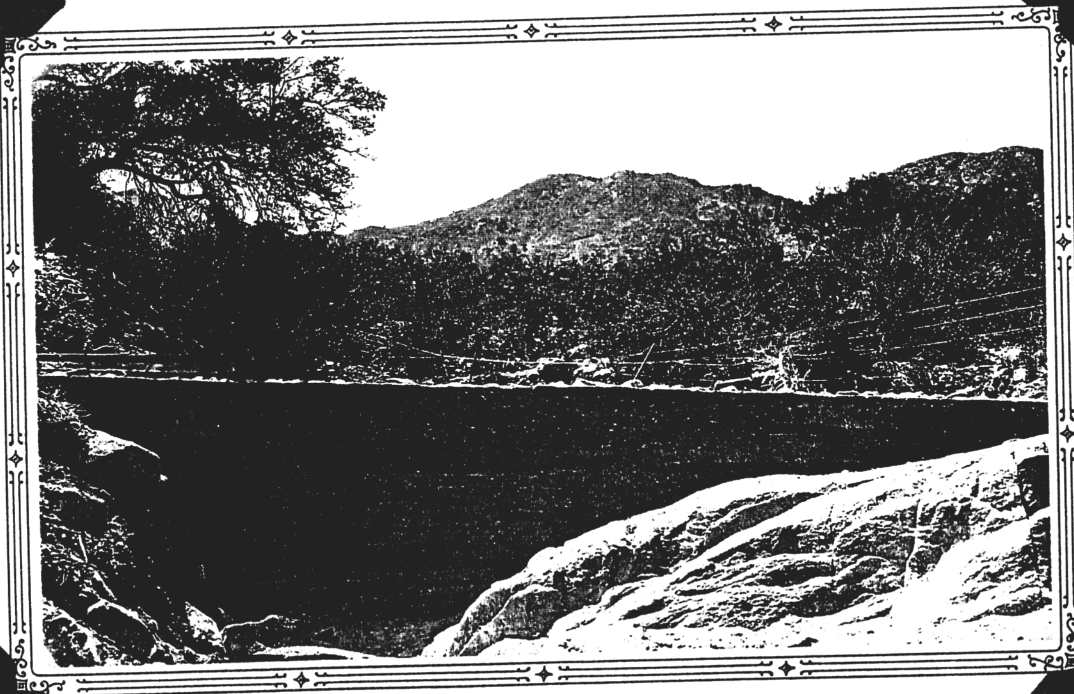
Photo 3.7. La Osa Ranch, 1903. Source: Griffiths 1904. Note the dominance of burroweed and shrubby mesquite, and the almost complete absence of grasses.

Damage done to flood water ditch, A. J. Stephens Ranch, Altar Valley. 10-14-29



Erosion Robles Wash, La Osa Land and Livestock Co. at Palo Alto. 10-31-29

Dam site in canyon on Stump Homestead, Tortollito Mts.
Dam and Reservoir surveyed 7-22-31.



Dam in canyon on Chili-tepin Canyon Ranch, Fred Ronstadt owner. Southwest of Tucson in Baboquivari Mountains. Can be built onto. 1931.

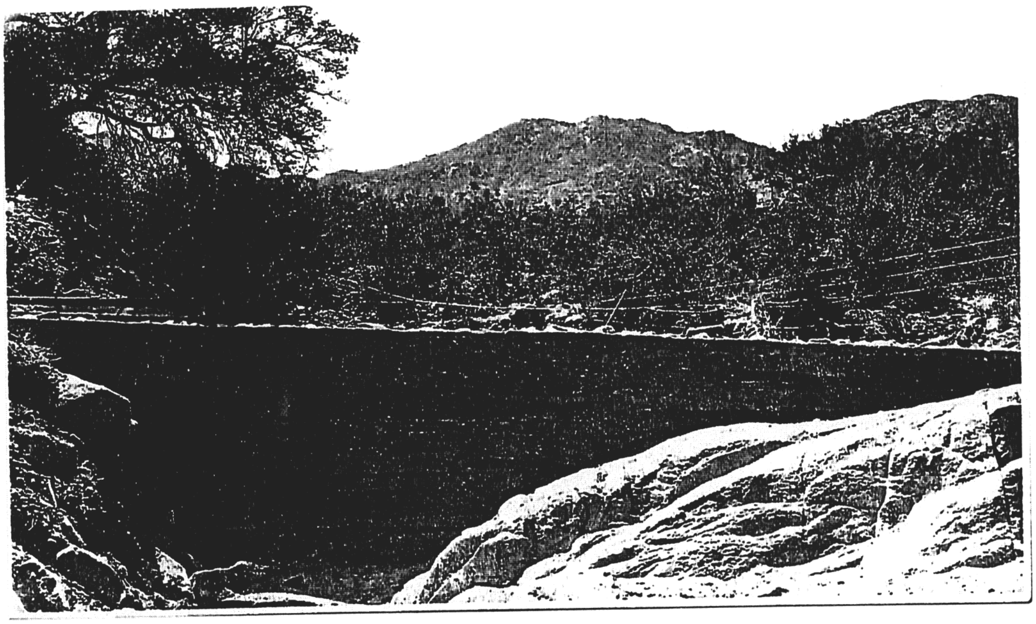


Photo 3.8 (top). The arroyo on the Altar Wash at the Palo Alto Ranch, 31 October 1929. Source: Reports of C.B. Brown, Pima County Agricultural Extension Officer, housed at Arizona Historical Society, Tucson. It appears that this arroyo began formation early in 1905 and grew rapidly during the subsequent fifty years. Note mesquite trees on the former floodplain bench.

Photo 3.9 (bottom). Dam in Chiltepin Canyon, 1931. Source: Reports of C.B. Brown, Pima County Agricultural Extension Officer, housed at Arizona Historical Society, Tucson. Dams such as this one were built both as erosion control measures and to provide stockwater, usually transported by pipeline to points down in the valley.

Range Contour construction in Altar Valley,
15 miles west of Tucson, on Ajo Road.

Range Contour demonstration, Ajo Road. Filling
up arroyos with large fresno and caterpillar tractor.
January 1931.

W. G. McGinnis, University Range Specialist, seeding Australian salt bush seed in test enclosure about 1/2 mile east of Palo Alto, La Osa Land and Cattle Co. 5-28-29. Shad scale seed, a native shrub, was also seeded on the same date.

A well put up stack of Johnson Grass hay on La Osa Land and Cattle Co., Palo Alto. 10-31-29

Photo 3.10 (top). Range contour construction near Ajo Highway, at north end of Altar Valley watershed, 1931. Source: Reports of C.B. Brown, Pima County Agricultural Extension Officer, housed at Arizona Historical Society, Tucson. Using small contour ridges like this one, Brown demonstrated the potential of erosion control to retain water and increase vegetation.

Photo 3.11 (bottom). Johnson grass stacked on the Palo Alto Ranch, 1929. Source: Reports of C.B. Brown, Pima County Agricultural Extension Officer, housed at Arizona Historical Society, Tucson.

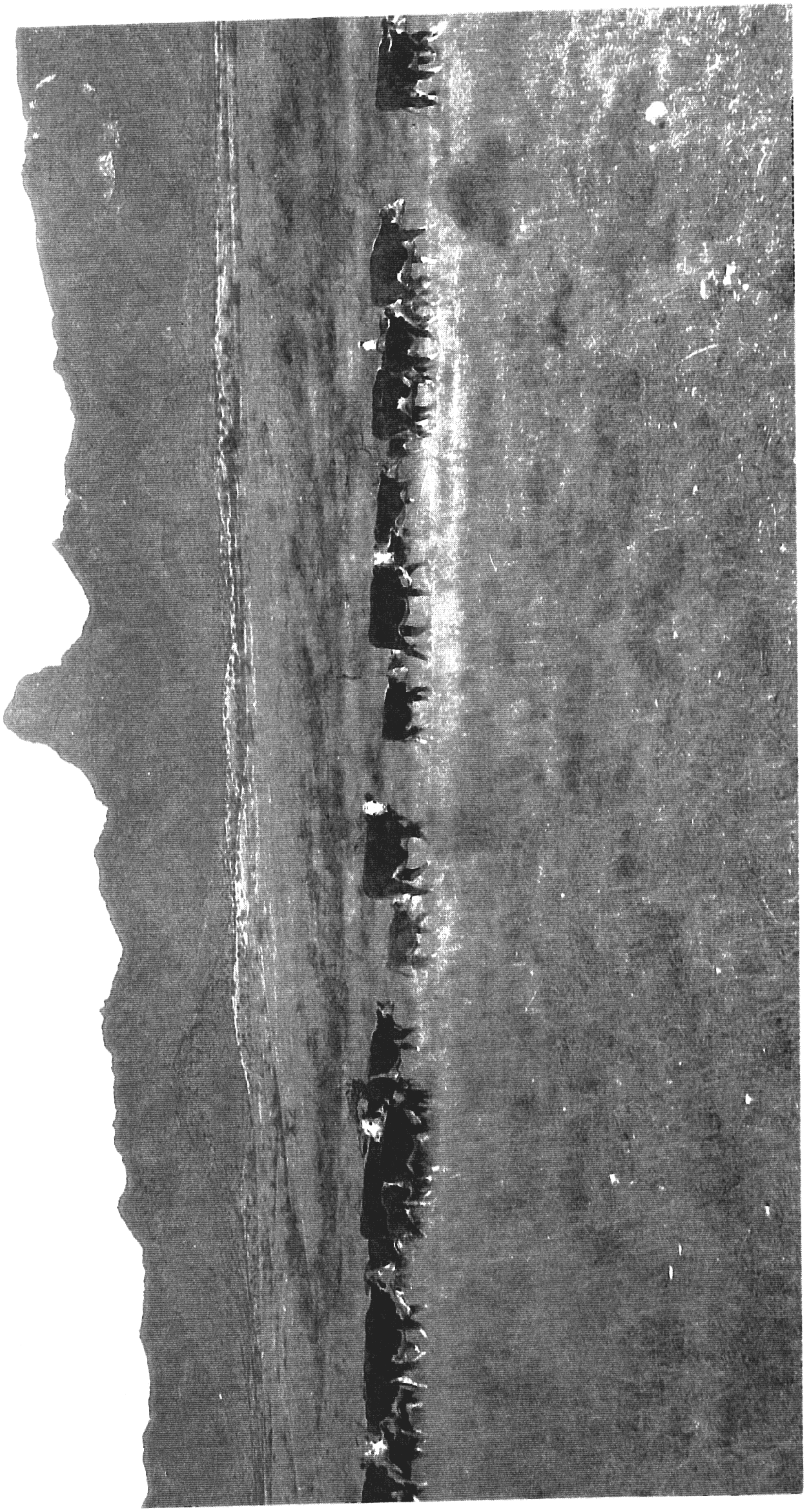


Photo 3.12. Rangeland cleared of mesquite, Santa Margarita Ranch, 1968. Courtesy of Pete Phelps. Mesquites in the bottoms were not cleared. Rows of mesquites pushed up by chaining can be seen on the far hill, center right.

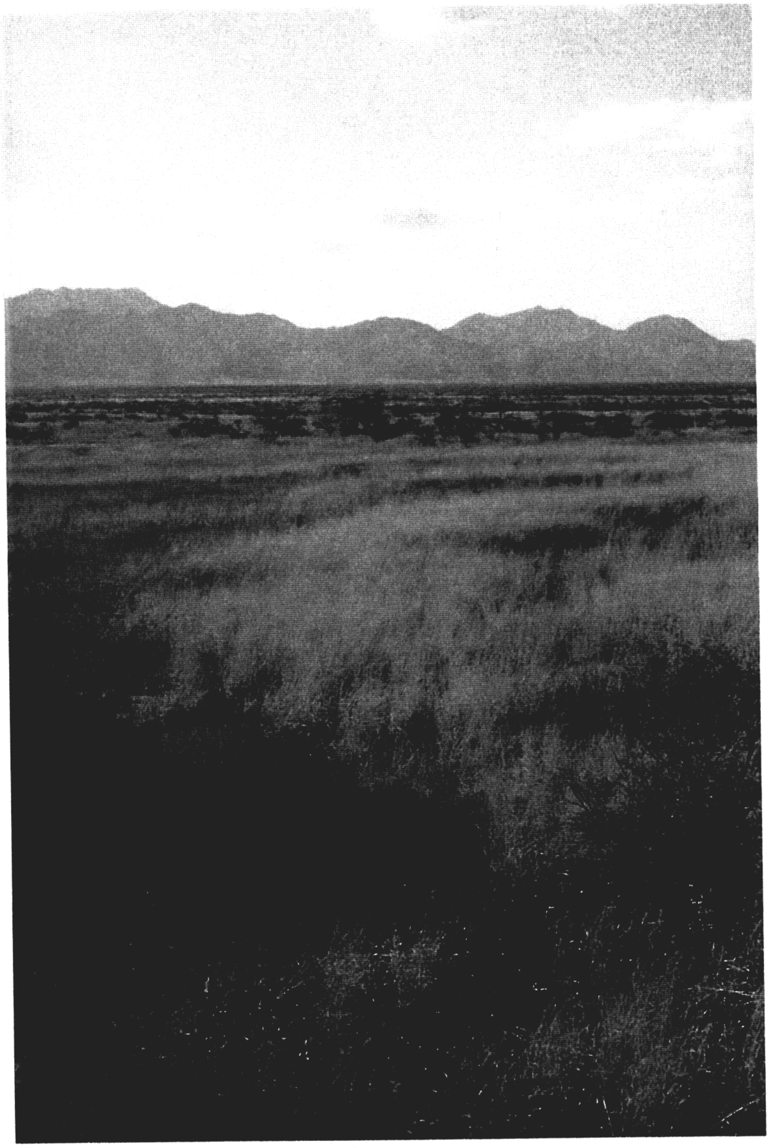
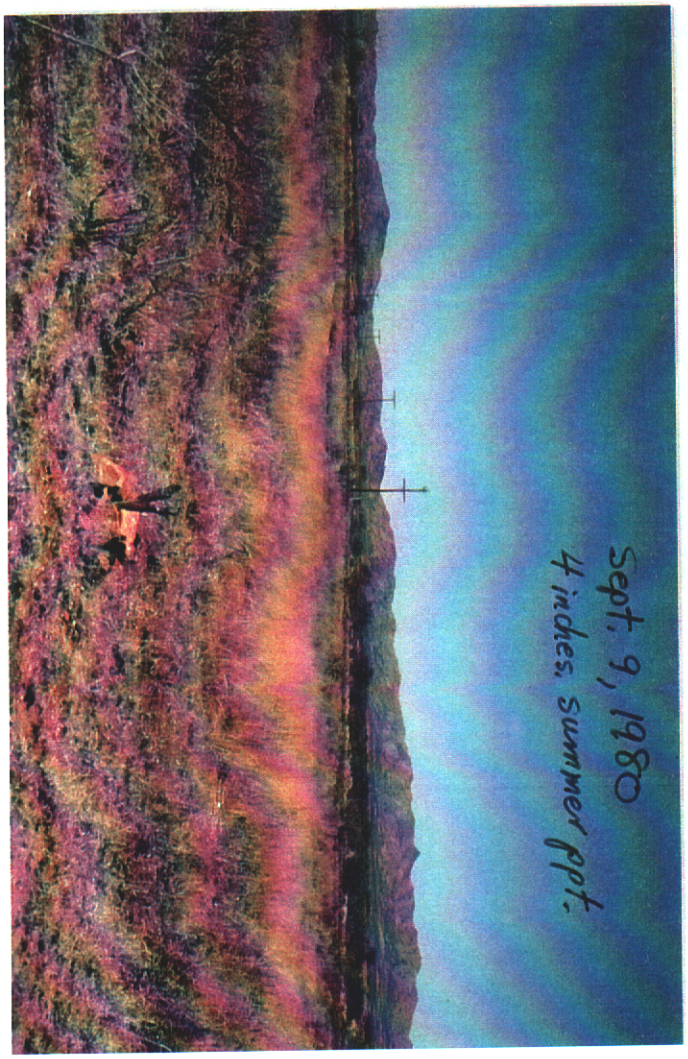


Photo 3.13. Bottomland pasture on the Buenos Aires National Wildlife Refuge, 1998. Courtesy of Nathan Sayre. This area was dominated by large mesquites (a few of which were left standing to provide shade and wildlife habitat). Under the management of Wayne Pruett and Peter Wray, the mesquites were removed by bulldozers and Johnson grass was seeded. Today, the Johnson grass dominates large areas of bottomland such as this one, often reaching heights of six to eight feet in the late summer.

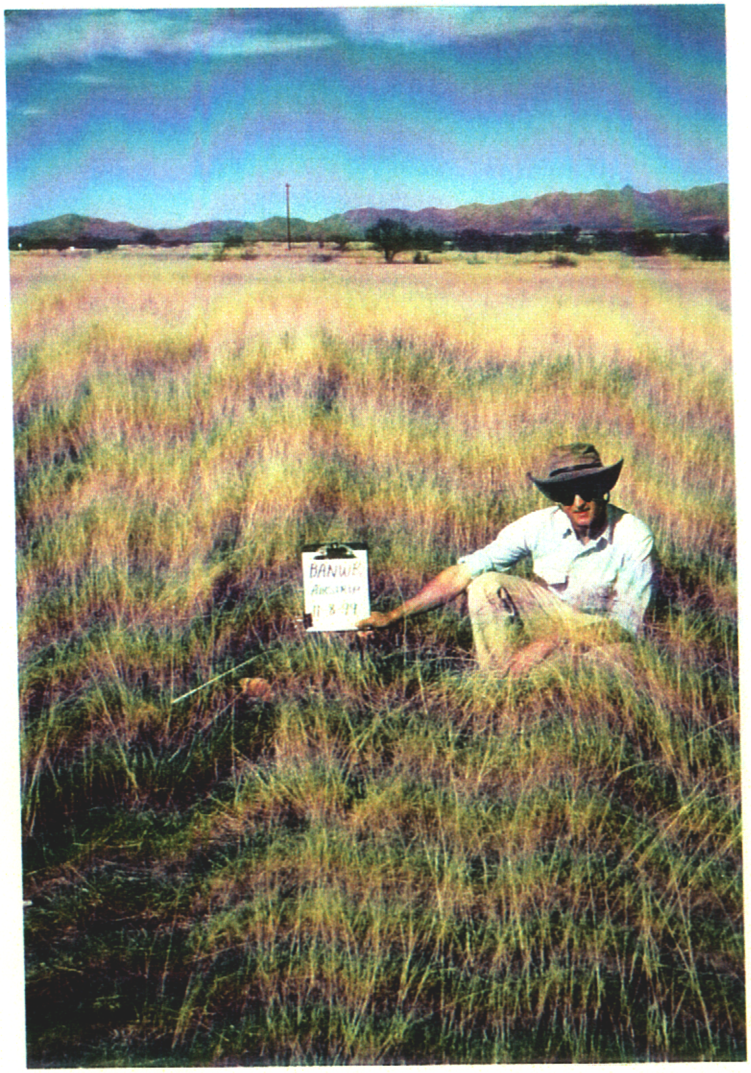
BA NWR

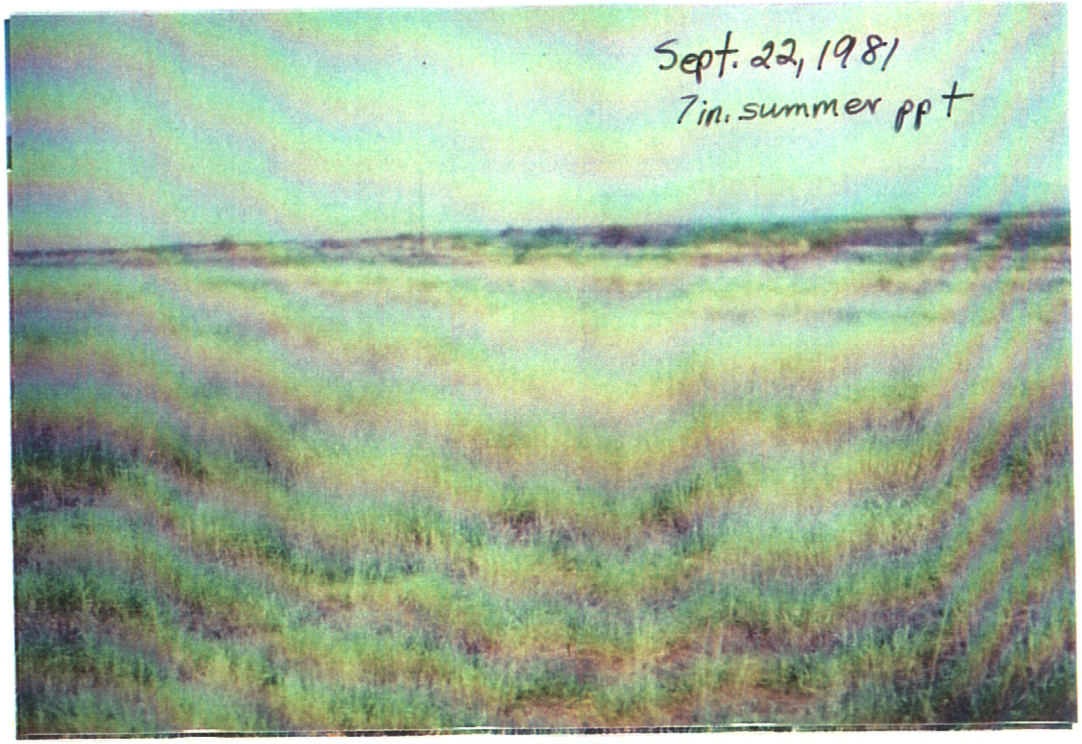
Airstrip Pas Transect



BANWR

Airstrip Pasture transect





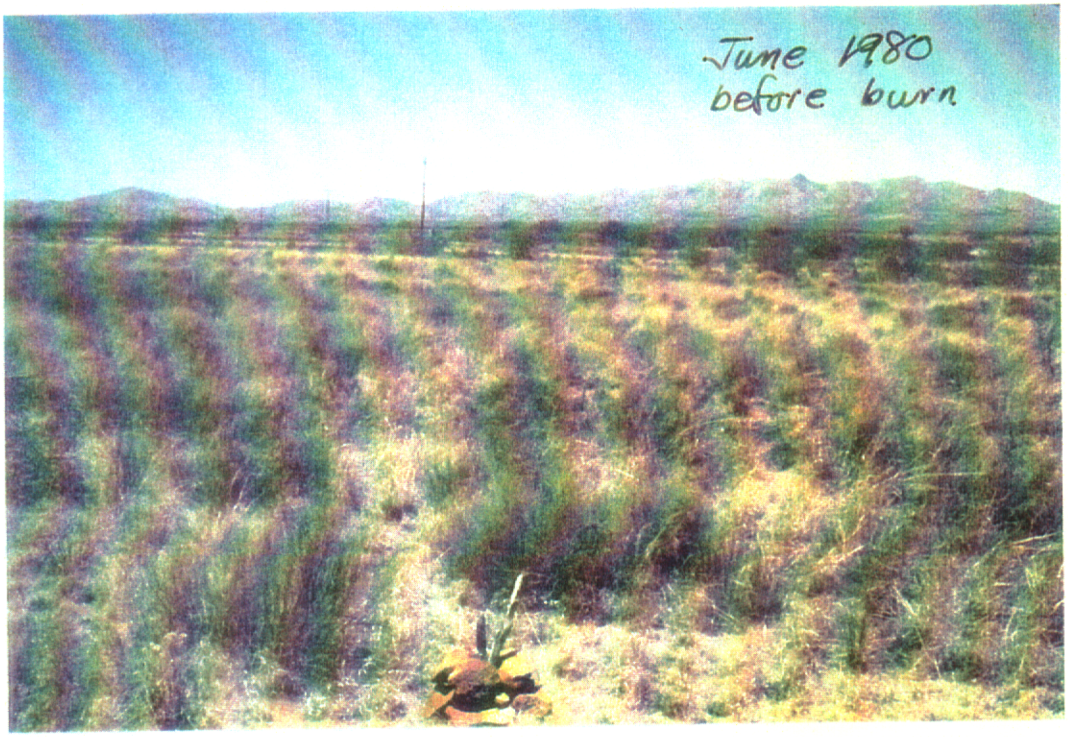


Photo 3.14 (top). Pasture of Buenos Aires Ranch before prescribed burning, June 1980. Courtesy of Dan Robinett, Natural Resource Conservation Service.

Photo 3.15 (bottom). Same pasture after burning, September 1981. Courtesy of Dan Robinett, Natural Resource Conservation Service.

Photo 3.16. Annual grasses and forbs on the Palo Alto Ranch, summer 1998. Courtesy of Francine Snure.

APPENDIX 3.1. REFERENCES

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APPENDIX 3.2 INTERVIEW QUESTIONS

Ranch name:
Date:
Name(s) of interviewee(s):
Relation to ranch: owner manager
other:

How long have you owned/managed the ranch?

Who else has owned the ranch in the past?

How large is the ranch now? Deeded acres:
State land:
BLM:
Forest Service:
other:

Has the ranch changed in size over the years? How and when?

In your opinion, what are the best features of the ranch?

If you could improve three things on the ranch, what would they be?

What kind of operation do you run now (cow-calf, stocker)?

What other kinds of operation have you run in the past, or have been run by previous owners/managers?

Have sheep, horses or other livestock ever grazed on the ranch? If so, when and in what kinds of numbers?

Do you irrigate part of the ranch? No Pasture Hay Other crops (list)

Has any part of the ranch been irrigated in the past? If so, when and for what?

How many head do you run now?

How many have you or others run in the past?

What kind of management do you practice now? rest-rotation year-round others...

How many pastures does your ranch have?

How many has it had in the past? Dates of fence construction.

Has the ranch ever been:
chained? if so, when and how much?
sprayed? if so, when and with what?
seeded? if so, when and with what species?
burned? if so, when and how much?

Have spreader dams, check dams, dikes or other major water-control structures ever been constructed on the ranch?

When were the wells and stock-tanks on the ranch constructed?

What changes have you observed in the vegetation of the ranch over time?

Have other changes occurred? (e.g. rainfall, run-off, wildlife, etc.)

What kinds of monitoring do you practice?

How long have you or previous owners been monitoring conditions?

Have you got photographs, memoirs, stories or other records that might help document the conditions of the ranch over the years?

APPENDIX 3.3 PERSONS INTERVIEWED

Don Caswell, manager, Marley Land and Cattle Company
Jim and Sue Chilton, Chilton Ranch-Arivaca Division
Tom and Ken Chilton, Chilton Ranch-Diamond Bell Division
John and Mac Donaldson, former owners-managers, Tortuga Ranch
Don Honnas, Honnas Cattle Company
Mary Noon Kasulaitis, owner-manager, Noon Ranch
John and Pat King, Anvil Ranch
Celia King, owner, Joe King Ranch
Walter Lane, manager, Santa Margarita Ranch
Rees Madsen, Fire Management Officer, Buenos Aires National Wildlife Refuge
Bob and Charlie Miller, owners-managers, Elkhorn Ranch
Jim and Kitti Oliver, owners-managers, Joe King Ranch
Jim Patton, former manager, Buenos Aires Ranch
Pete Phelps, former manager, Santa Margarita Ranch
Wayne Pruett, former owner-manager, Buenos Aires Ranch
Dan Robinett, Range Conservation Agent, Natural Resource Conservation Service
Karl Ronstadt, former owner-manager, Santa Margarita Ranch
Jon and Peggy Rowley, owners-managers, Santa Lucia Ranch/Rancho Seco
Francine Snure, owner, Palo Alto Ranch
Chapo Valenzuela, former manager, Santa Lucia Ranch/Rancho Seco
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Altar Valley Watershed Resource Assessment
Grant No. 97-041 WPF

ALTAR WASH GRADE CONTROL STRUCTURE ENVIRONMENTAL ASSESSMENT

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Submitted to:

ARIZONA WATER PROTECTION FUND COMMISSION

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1. PROJECT PURPOSE AND NEED

1.1. INTRODUCTION

The Altar Wash watershed is located in Altar Valley in Pima County. This watershed is situated in southern Arizona approximately 20 miles west of Tucson. The Altar Valley is a broad, north trending basin bounded on the east and west by rugged mountains (Figure 1).

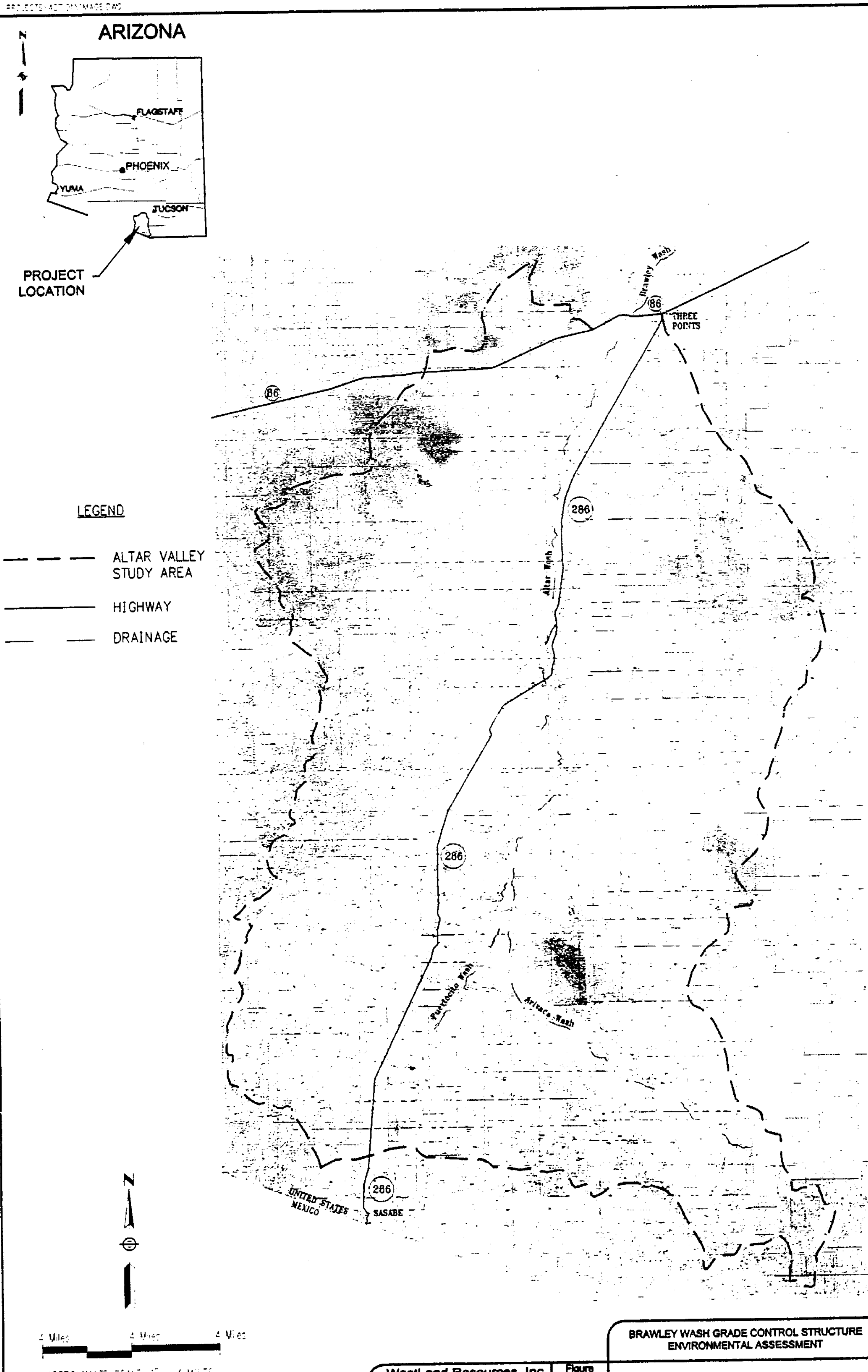
Erosion in the floodplain of Altar Wash began in the early 1900s, following a period of drought, overgrazing, and fuel wood cutting in the surrounding mountains. By 1930, erosion in the valley had progressed to the point that a gully (Altar Wash) had traversed half of the valley. Erosion in the Altar Wash has created a gully that is 20 feet deep and over 1,400 feet wide in places. The proposed action considered for this Environmental Assessment (EA) is a grade-control structure that would re-grade the floodplain of Altar Wash in order to abate and repair the effects of soil erosion.

1.2. HISTORICAL SETTING AND PROJECT BACKGROUND

The early settlers of the Altar Valley came in the 1860s and 1870s from Mexico and California. Families of Spanish descent came first, followed shortly thereafter by the Anglos. These people established ranches in the valley and flanking mountains where water could be obtained from shallow wells or springs (Robinett, 1981; Wilbur-Cruce, 1989). Basically, ranches existed by owning and controlling water places. According to the customs of the times, the owner of a water place controlled the range halfway to the next water.

When George Roskruge first surveyed the valley in 1886, he found no evidence of gullies in the valley floor (Cooke and Reeves, 1976). The axial floodplain varied from one-quarter to one-half mile in width, was almost flat, and was thickly vegetated with giant sacaton (*Sporobolus wrightii*). There was no "live" or running water in the valley; and therefore, water was sometimes collected in small man-made depressions called charcos. However, due to the nature of the alluvium, water would soon sink underground. Efforts to dig wells in the sand were mostly unsuccessful because water was 180 to 500 feet down in the valley. In terms of vegetation, native perennial grasses with high forage value dominated the upland, and mesquites were limited to drainage areas. Many of these mesquites were cut down for fuel between 1885 and 1900 to power steam pumps, which raised the water from the deep wells in the center of the valley.

In 1891 to 1893 southern Arizona experienced a severe drought. This drought did not directly impact the main valley of the Altar Valley in the sense that its relative lack of water discouraged its use by cattle and limited the effects of overgrazing. However, this drought event prompted the development of water sources across more of the valley, allowing grazing to occur in areas that were previously ungrazed. Cattle numbers increased in the Altar Valley as waters were developed. A second period of drought occurred from 1898 to 1904. With grasses denuded, the watershed was left with little protective cover.



WestLand Resources Inc.
Engineering and Environmental Consultants

Figure 1

BRAWLEY WASH GRADE CONTROL STRUCTURE ENVIRONMENTAL ASSESSMENT

VICINITY MAP

The drought ended with very heavy rains from December 1904 to March 1905. These rains appear to have initiated the formation of the Altar Wash. The path of the arroyo appears to have been set by man-made disturbances: the main wagon road up the valley; several large farm fields which had been cleared in the loamy bottomland soils; and numerous charcos, which were probably dug to capture water. Together, these formed a nearly continuous line of disturbed soil for approximately twenty miles up the center of the valley. Circumstantial evidence suggests that Aguirre Lake, a man-made reservoir near the head of the watershed, burst its dam during the heavy rains of February and March 1905, providing the pulse of water necessary to carve the arroyo from these disturbed lands (Sayre, 1999). By 1930, erosion had progressed to the point that the gully, or Altar Wash, had traversed half of the valley (Cooke and Reeve, 1976).

Improvements to the range have been ongoing as long as livestock have grazed the valley. Measures to counteract the negative changes in the watershed are manifold. Stocktanks were built to provide water and control erosion no later than the first decade of the twentieth century. Throughout the middle of the century, spreader dams were maintained on drainages to slow floodwaters and distribute them across floodplain fields. From the 1950's to the 1970's mesquite trees were removed to restore roughly 85,000 acres to grass. Stocking rates today are three to five times lower than they were in the period from 1886 to 1920 (Sayre, 1999).

Increases in the cover, composition, and vigor of forage species continues to this day due to the implementation of rest rotation and deferred rotation grazing practices, which began in the 1970's. These practices have restored much of the upland areas to healthy range and benefited the watershed as a whole (personal communication, Daniel Robinett, 2000). Restoration of the Altar Wash floodplain would only enhance the ongoing efforts to improve range conditions. In its current condition, the Altar Wash arroyo allows water that would otherwise spread out across the wide floodplain, and sink into the aquifer, to run off and leave the valley. This in turn causes the entire historic floodplain to dry out and, over time, has greatly diminished the forage productivity of some of the valley's most fertile land (Sayre, 1999).

Mitigating the effects of soil erosion through the use of grade control structures is a widely used restoration method, and has been successfully used on the former Buenos Aires Ranch (now the Buenos Aires Wildlife Refuge), (Sayre, 1999), and within the watershed of the San Simon Valley (Bureau of Land Management [BLM], 1997).

1.3. San Simon Watershed Restoration Efforts

The San Simon Valley is located in southeastern Arizona. The San Simon was recognized as one of the most degraded watersheds in the United States in the 1940's (Peterson, Dejulio, and Rupkey, 1960; Ryan, 1963). Causes for degradation in the watershed include: construction of a ditch to drain excess waters away from fields in the San Simon valley above the confluence with the Gila River; the development of a freight wagon trail up the valley to the towns of San Simon and Bowie; and the introduction of 50,000 to

100,000 head of cattle into the watershed, coupled with very severe droughts during 1903 through 1905 and 1914 through 1915. The heavy rains at the end of each drought period caused head cutting and the formation of gullies that moved up the valley with each major flood.

Watershed restoration work in the San Simon Valley began in the 1930's with projects by the Civilian Conservation Corps, and continued into the 1940's and 1950's with the construction of retention dams on the main stem of the river and its major tributaries, first by the Natural Resources Conservation Service (NRCS) and then by the BLM. The construction of grade control structures continued until 19 structures were completed (BLM, 1997).

By 1992, the San Simon structures had regraded a length of 10 miles of the floodplain and trapped approximately 19 million tons of sediment (Soil Conservation Service [SCS], 1992). The concept of retaining sediment and controlling erosion with grade control structures also applies to the Altar Wash.

1.4. PURPOSE AND NEED FOR DOCUMENT

Since 1975 approximately 75 percent of the ranches in the Altar Valley have adopted grazing management practices such as deferred and rotational grazing systems, put in pipelines for additional water sources to facilitate the movement of livestock, used prescribed burns to control the invasion of woody species into the native grasslands, and built small-scale sediment retention structures in the uplands. These practices have improved the vigor and percent cover of forage species.

The watershed as a whole has benefited from improvements in the uplands, however the wash requires management in the form of a grade control structure to enhance and expedite the restoration process. In its current condition, erosion in Altar Wash has created a gully that is up to 20 feet deep and over 1,400 feet wide in places. The NRCS estimates that the valley loses an average of seven acres of land and 100 acre-feet of sediment to erosion annually. Stream-bank erosion contributes to the continued loss of xeroriparian and range habitat; impacts to downstream water quality, farmland, and county and state road crossings; and reductions to groundwater recharge due to accelerated, and concentrated flows within the incised wash (SCS, 1992).

Many methods of erosion control have been used in the uplands of the watershed. These methods alone are not enough to slow the water and regrade the downcutting within the Altar Wash.

The purpose of the proposed action is to arrest a significant portion of gully erosion in the Altar Wash drainage by trapping sediment behind a grade-control structure while allowing water to flow through the structure. Sediment would accumulate behind the structure and fill the incision, raising the grade of the wash bottom and tributaries within the area of effect.

1.5. Scoping Process and Efforts

Interest in improving Altar Wash began with the leadership of the Pima Natural Resources Conservation District (NRCD). In 1987, the agency began coordinating studies, public meetings, and reviews. In September 1989, a scoping meeting was held to determine significant issues, planning objectives, and local participation. In April 1990, the Pima NRCD sponsored a project-area tour that was attended by 60 people and covered by the local news media.

Those supporting the study efforts and providing technical assistance or information include:

Arizona Department of Environmental Quality
Arizona Department of Water Resources
Arizona Game & Fish Department
Arizona State Land Department
Arizona-Sonora Field School
City of Tucson
Cooperative Extension Service
Pima Association of Governments
Pima County Flood Control District
Pima County Parks & Recreation Department
Private Landowners
Sierra Club
Southern Arizona Water Resources Association
Tohono O'odham Indian Nation
Town of Marana
U.S. Bureau of Land Management
U.S. Bureau of Reclamation
U.S. Fish & Wildlife Service
U.S. Forest Service
University of Arizona

Comments were received from the following agencies and organizations:

Arizona Department of Environmental Quality
Arizona State Parks
Pima Association of Governments
Pima County Flood Control District
The Nature Conservancy, Arizona Chapter
Tohono O'odham Nation
Tucson Water, City of Tucson
U.S. Bureau of Land Management

1.6. Future Coordination Required for Implementation of Proposed Action

The steps necessary to implement the proposed action are summarized below:

1. Identify the entity or agency that will assume responsibility for long-term maintenance and operation of the facility;

2. Coordination with the entity that will assume ownership and operation to secure funding or sources of funding for facility design;

3. Obtain a commitment for construction funds;

4. Determine the lead federal agency for National Environmental Policy Act compliance, based on the matrix of land ownership, funding, and operation and maintenance responsibilities; and

5. Determine the baseline needs for permitting objectives as directed by the final site design.

1.7. Document Organization

A brief summary of the content of each chapter is provided below.

- Chapter 1 – *Project Purpose and Need* summarizes the project's history, provides a summary of San Simon project which is similar to the proposed action, identifies the project's purpose and need, identifies the agencies that were contacted during public and agency scoping efforts, and describes the future analyses and coordination necessary to implement the proposed action.

- Chapter 2 – *Alternatives Considered* describes the process used to formulate alternatives, describes the alternatives considered, examines the criteria used to eliminate alternatives from further consideration, describes the preferred alternative, and provides an impact summary.

- Chapter 3 – *The Affected Environment* describes current conditions of the environmental setting.

- Chapter 4 – *Environmental Consequences* analyzes the direct, indirect, and cumulative impacts of the proposed action and its alternatives on the existing environment. This chapter provides the analyses for the summary table of impacts provided in Chapter 2.

- Chapter 5 – *Other Planned and Developed Activities* summarizes the direct, indirect, and cumulative impacts of the project.

- Chapter 6 – *List of Preparers* identifies those persons primarily responsible for contributing to the preparation of this EA and lists their qualifications.

2. ALTERNATIVES CONSIDERED

2.1. NO ACTION

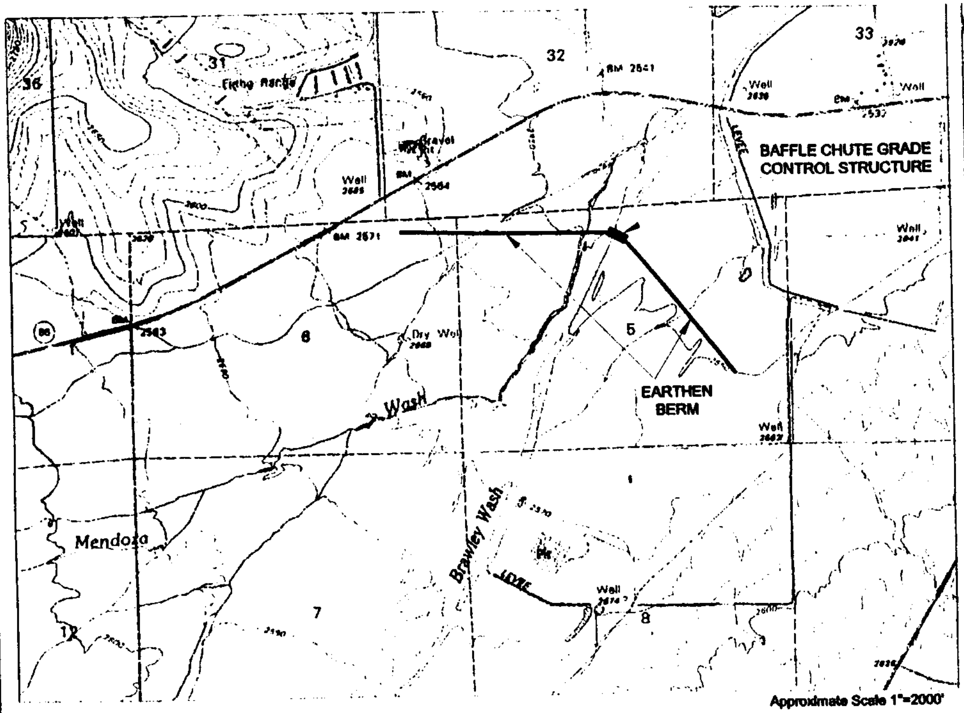
Under this alternative, no baffle-chute structure would be constructed and Altar Wash would continue to experience seven acres of land loss and 100 acre-feet of sediment loss per year. Range and wildlife habitat would continue to be degraded due to sheet, rill, and gully erosion. Sedimentation effects on downstream water quality, farmland, and county and state road crossings would continue. Flash-flood events will continue to damage roads, farmland, and local communities (SCS, 1992).

2.2. PROPOSED ACTION – ALTAR WASH SEDIMENT RETENTION STRUCTURE

The proposed action is to construct a baffle-chute structure on Altar Wash to decrease erosion in the natural channel and prevent the advance of head cutting in the tributaries. The structure will trap and store sediment upstream of the structure, while allowing water to pass through the structure. This will be accomplished by using a combination of practices that include earth embankments, and structural and rock-faced earthen spillways with the installation of weir tubes. Figure 2 shows the proposed structure location. This downstream (northern) location allows for the spreading of water over the greatest amount of area, maximizes flow duration, and allows the maximum amount of floodplain area to fill with sediment and be restored.

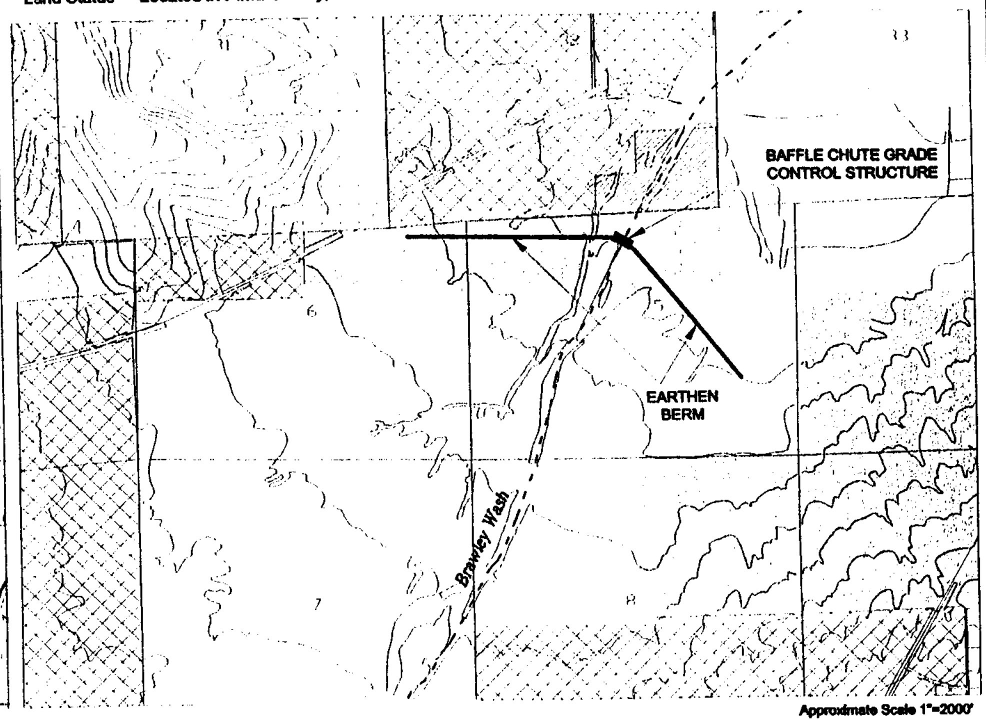
If the sediment retention structure is constructed, it is estimated by the Pima NRDC that 75 acres of incised land will be restored, flow velocities will be reduced by as much as 15 feet per second, the potential for natural groundwater recharge will be improved, and peak discharges will be reduced by as much as 6,000 cubic feet per second. The average loss of seven acres of land per year and 100 acre-feet of sediment per year will be reduced. The recurring damage to fences, structures, and state and county roadways will be decreased. Wildlife habitat will be improved and the production of game species will be increased due to the restoration of grasslands in the floodplain. Forage production will also be increased eight to ten times that of an average upland range site (SCS, 1992).

Three Points USGS Quadrangle



Approximate Scale 1"=2000'

Land Status - Located in Pima County, T.16S.,R.10E. Sections 5 &6



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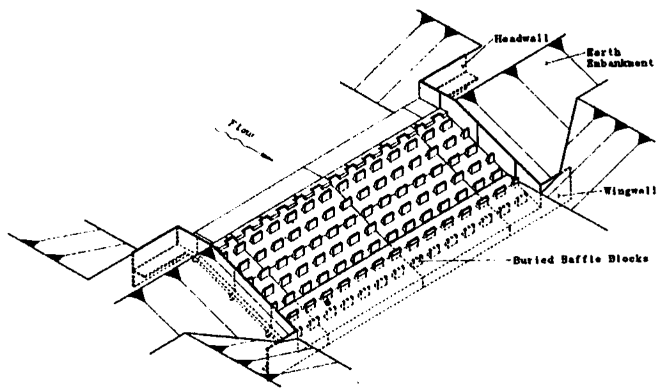
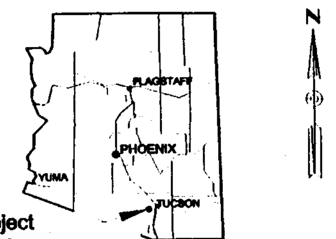


BAFFLE CHUTE GRADE CONTROL STRUCTURE

LEGEND
Land Status

- PRIVATE
- BUREAU OF LAND MANAGEMENT
- STATE
- CITY OF TUCSON
- PIMA COUNTY
- ARIZONA GAME AND FISH DEPARTMENT

STATE CONTEXT MAP



Project Location

		BRAWLEY WASH GRADE CONTROL STRUCTURE ENVIRONMENTAL ASSESSMENT
WestLand Resources Inc. Engineering and Environmental Consultants	Figure 2	BRAWLEY WASH PROPOSED GRADE CONROL STRUCTURE

2.3. Impacts Summary

Table 1 summarizes each alternative's direct, indirect, and cumulative impacts for the issues raised during scoping and critical elements for which consideration is required by the BLM.

Table 1. Indirect, direct, and cumulative impacts to specific resources.

Resource/Issue	No Action	Proposed Action
Land Use	The primary land use in the area will continue to be ranching.	The primary land use in the area will continue to be ranching.
Physical Resources	Continued erosion rate of seven acres of land and 100 acre-feet of sediment per year (SCS, 1992).	The grade-control structure will slow erosion in the wash and its tributaries, and improve the state of the valley's physical resources.
Biological Resources	If the erosion is allowed to expand, it will impact upland areas and continue to diminish rangeland and wildlife resources, as well as habitat for Pima pineapple cactus.	The valley's biological resources are expected to benefit from the restoration of grasslands and xeroriparian habitat.
Cultural Resources	Cultural resources are exposed, rearranged, and washed downstream with each rain event.	Stabilization of the wash will improve the state of cultural resources in the valley. Only those cultural resources directly in the path of construction of the grade-control structure are expected to be impacted. A formal archaeological survey will be completed once the specific site for the structure is identified.
Socioeconomic Resources	Without restoration of the wash, rangeland will continue to degrade, making ranching less economically viable.	The structure is expected to reduce the costs associated with maintenance of local and state roadways, which averages $45,000 annually. No impacts to socioeconomic resources are anticipated as a result of the proposed action.
Indian Trust Resources	Indian trust land is located downstream of the Altar Wash project area. In its current condition, sediment generated from the Altar Wash deposits on Indian lands causing increased maintenance costs.	Indian trust land is located downstream of the Altar Wash project area. Any improvements in erosion control upstream are anticipated to benefit lands downstream.

3. THE AFFECTED ENVIRONMENT

3.1. LAND USE

The Altar Wash study area covers 506,880 acres. Land ownership is summarized in Table 2 below.

Table 2. Land ownership summary.

Land Ownership	Acres	Percent
State of Arizona	268,646	53
Private, City of Tucson, and others	86,170	17
U.S. Fish & Wildlife Service	81,101	16
U.S. Bureau of Land Management and U.S. Forest Service	45,619	9
Tohono O'odham	25,344	5

A small portion of the structure would be constructed on City of Tucson land and the remaining portion would be built on BLM land. The City of Tucson owns much of the land south of the project and their future land use is in question. Tucson Water, the municipal water utility, constructed a pilot surface-recharge facility next to Altar Wash to assess the area's recharge potential. The construction of a full-scale recharge project was based on the economic delivery of Central Arizona Project (CAP) water to the site. Construction of a pipeline for delivery of CAP water to this area was once considered, but eliminated from consideration prior to preparation of the alternatives analysis for the Environmental Impact Statement for the CAP – Tucson Aqueduct System Reliability Investigation. Therefore, a permanent recharge facility will not be constructed at this site.

Grazing is the predominant land use in the watershed. The grazed area supports about 5,100 mother cows producing about 3,800 calves and yearlings each year. This produces a gross value of nearly $2 million in new wealth each year from the renewable forage resources of the watershed (SCS, 1992).

Other significant uses of the watershed's renewable resources are hunting and fuel-wood harvest. Hunting is a major recreation use of the wildlife resources of the watershed. Deer, javelina, Gambel and scaled quail, mourning and white-wing dove, cottontail, Allen's and blacktail jackrabbits, mountain lion, and coyote are numerous in this valley, and are legally pursued by licensed hunters in their respective seasons. Due to the predominance of state land and heavy stands of upland mesquite in the Altar Valley, the Arizona State Land Department administers a fuel-wood sales program. The state is currently selling an average of 100 cords of mesquite wood per year.

Altar Wash crosses Highway 86 to the north and Highway 286 to the south. The present state of erosion from the wash and its tributaries creates sedimentation problems on Highway 286. State and local highway authorities estimate annual sediment cleanup costs to area roads at approximately $45,000. This includes the time spent by crews to repair damage due to advancing gullies (SCS, 1992).

3.2. PHYSICAL RESOURCES

3.2.1. Climate

The climate of the area is semi-arid, characterized by low precipitation, low humidity, and high summer temperatures. In Altar Valley, rainfall varies from approximately 12 inches in the central valley to 20 inches on some of the higher slopes. There are typically two rainy seasons: summer rainfall, which occurs usually in local torrential convection showers, often concentrated over mountain masses, and winter rainfall which is usually slow, steady, and of several days duration. Precipitation in the winter sometimes occurs as snow in the mountains.

The desert temperatures of the valley have extreme daily and monthly ranges. Daily variations of 30 to 50 degrees Farenheit or more result from the low degree of cloudiness and the arid characteristics of the desert climate. Maximums of 100 to 110 degrees Farenheit are common in the summer while minimum winter temperatures generally do not fall below 20 to 25 degrees Farenheit (SCS, 1992).

3.2.2. Soils

The type of soil that is associated with the location of this project is the Anthony-Sonoita Association. It is described as deep, moderately coarse-textured, and nearly level to gently sloping soils on alluvial fans.

General soil information for the Altar Wash study area is classified in five categories (SCS, 1992).

3.2.2.1. Warm, Arid Soils on Floodplains and Stream Terraces

The soils in this group are formed in mixed, stratified alluvium, and are very deep and well drained to excessively drained. Elevation ranges between 2,000 to 4,600 feet. The average annual precipitation is 10 to 16 inches. Slopes range from zero to three percent with vertical scarps near the channels. This group makes up about eight percent of the watershed and is used mainly for rangeland.

3.2.2.2. Warm, Arid Soils on Fan Terraces, Hills, and Valley Floors

The soils in this group are formed in mixed alluvium, and are very shallow to deep and well drained. Elevation ranges between 2,200 to 3,600 feet. The average annual precipitation is 10 to 13 inches. Slopes range from 0 to 35 percent. This group makes up about 24 percent of the watershed and is used mainly for rangeland.

3.2.2.3. Warm, Semi-Arid Soils on Fan Terraces and Hills

The soils in this group are formed in mixed alluvium and colluvium, and are very shallow to very deep and well drained. Elevation ranges between 3,100 to 5,200 feet. The average annual precipitation is 12 to 16 inches. Slopes range from 1 to 50 percent. This group makes up about 32 percent of the watershed and is used for rangeland.

3.2.2.4. *Warm, Arid and Semi-Arid Soils on Pediments, Hills, and Mountains*

The soils in this group are formed in mixed alluvium and colluvium, and are very shallow to shallow and well drained. Elevation ranges between 2,200 to 5,500 feet. The average annual precipitation is 10 to 16 inches. Slopes range from 1 to 65 percent. This group makes up about 31 percent of the watershed, and is used mainly for rangeland and some recreation.

3.2.2.5. *Cool and Cold, Subhumid Soils on Hills and Mountains*

The soils in this group are formed in gravelly, flagstone-covered, loamy alluvium derived dominantly from gneiss, granite, and schist, and are shallow to moderately deep and somewhat excessively drained to well drained. Elevation ranges between 5,400 to 7,740 feet. The average annual precipitation is 16 to 20 inches. Slopes range from 10 to 65 percent. This group makes up about five percent of the watershed, and is used mainly for recreation and some rangeland.

3.2.3. Geology

Altar Wash flows from its origin near the United States-Mexican border in a northerly direction through the Altar and Avra valleys to the Santa Cruz River near the Town of Marana. The valleys occupy a deep structural trough.

The watershed boundaries are formed by a series of partially detached mountain ranges. The Coyote, Baboquivari, Pozo Verde, Quinlan, Roskruge, Waterman, and Silverbell mountains border the west side of the valley. These mountains form a continuous chain typified by steep slopes. Baboquivari Peak rises to an elevation of 7,740 feet. The Tucson, Sierrita, Cerro Colorado, Guijas, San Luis, Oro Blanco, and Tumacacori mountains border the eastern side of the valley.

Granite of Pre-Cambrian age is the predominant rock type in the Serrita, Coyote, Quinlan, San Luis, Oro Blanco, and Pozo Verde mountains. Granite also comprises the central portion of the Silverbell Mountains. Limestone of Paleozoic age is exposed in small areas of the Waterman Mountains, the southern part of the Silver Bell Mountains, and in the Tucson Mountains. Sandstone and shale of Cretaceous age is found on the flank of the Baboquivari Mountains, the slopes between the Guijas and San Luis mountains, and on the west side of the Sierrita and Tucson mountains. Intrusive granite and porphyry of Cretaceous age is also found in the Sierrita and Tucson mountains. The Cerro Colorado, Baboquivari, Roskruge, Waterman, and Silverbell mountains are predominately lava of Tertiary age.

The lower mountain slopes, transition into a pediment surface of moderate slope. This surface is covered by a thin mantle of gravel and rock debris. Bedrock is present at shallow depths on this surface.

The lower slopes of the pediment surface grade into the lowland area of the valley floor. The valley floor is underlain by several thousand feet of alluvium ranging in age from Tertiary to Recent. The alluvial valley fill deposits underlying the valley floor are important sources of groundwater. The Recent alluvium consists mainly of sand and gravel, with some silt and clay. The Fort Lowell Formation of Quaternary age underlies the Recent alluvium. It consists of a sequence of unconsolidated to weakly lithified, interbedded, clayey silt, sandy silt, sand, and gravel (Davidson, 1973). The Tinaja beds are generally divided into three zones: lower, middle, and upper. The upper Tinaja beds consist of a sequence of heterogeneous deposits of unconsolidated to weakly lithified, interbedded, clayey silts, sandy silts, sands, and gravels (Davidson, 1973). The middle Tinaja beds are mainly moderately lithified, gypsiferous, anhydritic, clayey silt, and mudstone. The lower Tinaja beds consist of clayey silt, mudstone, gravel, and moderately lithified conglomerate (SCS, 1992).

3.2.4. Erosion

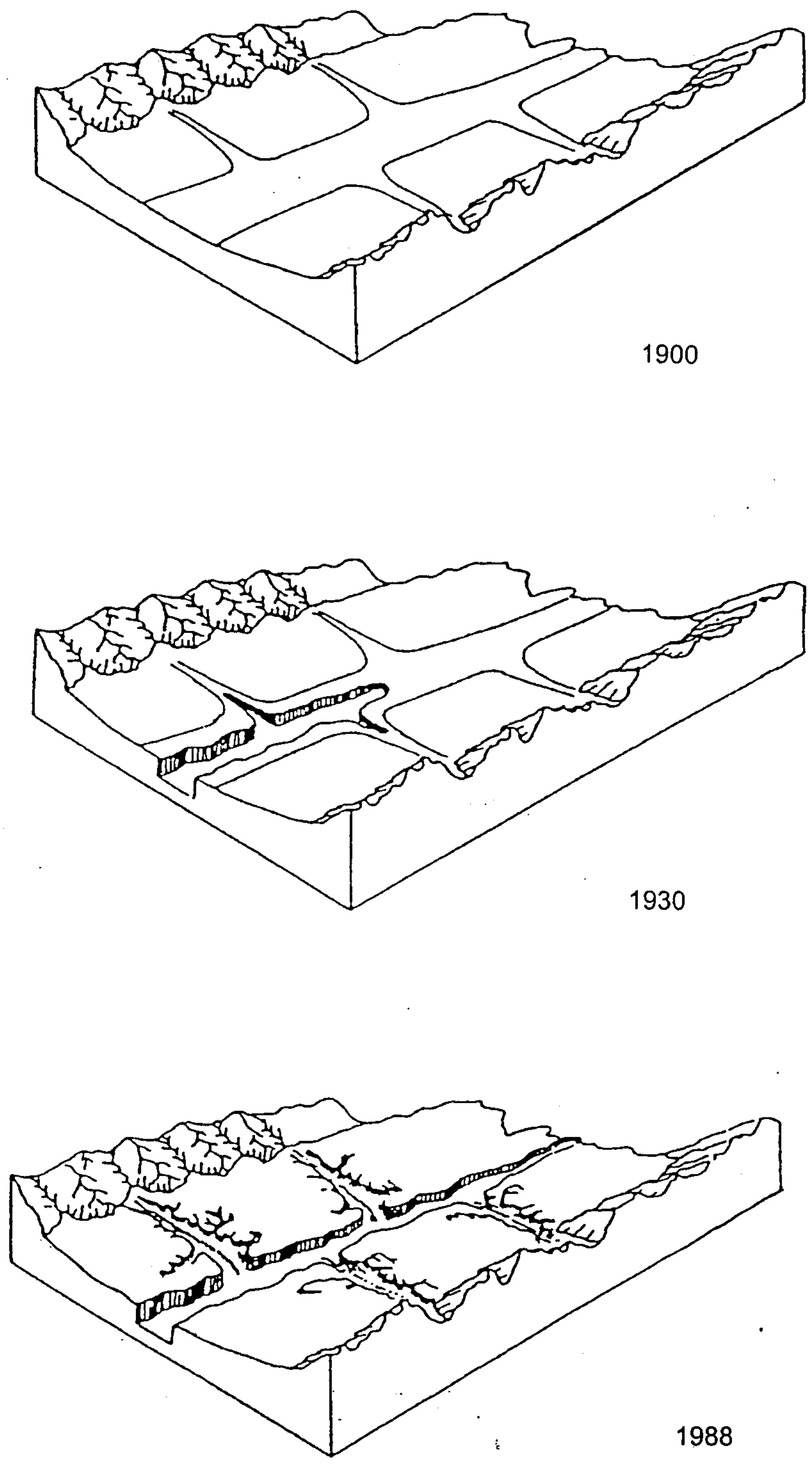
The term erosion is defined as the detachment of soil and rock particles by water, wind, ice, or gravity. Erosion is occurring throughout the drainage area of Altar Wash. The degree of erosion varies greatly from place to place in the basin, ranging from slight to severe. The erosion rates are greatly influenced by man's activities and the climatic factors. Figure 3 is a depiction of the extent and trend of erosion in the valley from 1900 to 1988.

The major types of erosion recognized in the watershed are sheet and rill and stream channel and gully. Sheet and rill erosion accounts for a majority of the total erosion in the watershed. However, stream channel and gully erosion is much more severe in localized areas. The effects of stream channel and gully erosion are highly visible. Stream channel erosion is most pronounced in the channel reach between Highways 86 and 286 (SCS, 1992).

The history of channel erosion is well chronicled by aerial photos made in 1936 and 1987. Erosion before that period is less precisely known. However, historical reports provide insight into the development of channel and gully erosion. At present, the drainage system consists of a wide, well-entrenched channel that continues to widen at a rapid rate. Many deep tributary gullies have further incised the valley floors and slopes (SCS, 1992).

The rate of land loss due to stream bank erosion during the time interval from 1936 and 1987 was evaluated from aerial photographs for the channel reach between Highways 86 and 286. During that interval, significant channel widening occurred due to bank erosion. The channel length also increased significantly due to channel meander. The average channel width in this reach increased from about 217 feet in 1936 to about 410 feet in 1987. In 1936, the channel length in this reach was about 18.2 miles. In 1987, the channel length was about 19.5 miles (SCS, 1992).

During the time interval from 1936 to 1987, about 341 acres of land were lost to channel erosion between Highways 86 and 286, producing about 5,100 acre-feet of sediment. It is currently estimated that the average annual rate of land loss for this reach is about seven acres, which generates about 100 acre-feet of sediment per year (SCS, 1992).



BRAWLEY WASH GRADE CONTROL STRUCTURE
ENVIRONMENTAL ASSESSMENT

Source: Soil Conservation Service 1992	WestLand Resources Inc. Engineering and Environmental Consultants 2343 E. Broadway Blvd. Suite 202 Tucson, Az 85719 (520) 206-9585	Figure 3	Erosion Trend From 1900 to 1988

WESTLAND\PROJECTS\245\HISTORIC-RANGE.DWG 5/11/99

Under present conditions, it is estimated that sheet, rill, and gully erosion is occurring at an average annual rate of about one acre-foot per square mile per year for the watershed as a whole. This equates to about 2.8 tons per acre per year. About 800 acre-feet of sediment are generated per year by sheet, rill, and gully erosion from the watershed. It is estimated that about 432 acre-feet of this sediment reaches Altar Wash annually (SCS, 1992).

3.2.5. Sediment

Sediment is the product of erosion, and is defined as solid material that has been detached and is being transported or has been deposited.

Approximately 900 acre-feet of sediment are generated by all types of erosion in the watershed on an average annual basis. Under current conditions, about 532 acre-feet of this sediment are transported past Highway 86 annually. Much of this sediment is deposited on rangeland and farmland when Altar Wash overflows its channel. Some is deposited in the channel. The remainder of the sediment is transported to the Santa Cruz River, which in turn conveys most of the sediment onto irrigated croplands and rangeland. Only a small portion of the sediment is transported to the Gila River, the outlet for the Santa Cruz River (SCS, 1992).

3.2.6. Flooding

Before 1900, rancher John King's grandfather said he could walk a horse ahead of any flood in the valley. As mentioned in the Introduction, the valley floodplain at that time was covered with grass and there was no evidence of gullies (Sayre, 1999).

Altar Wash has since been subject to erosion and gullying to the extent that it has become an efficient channel that concentrates runoff and transports floodwaters at a much higher flow rate. As a result, Altar Wash sends floodwaters downstream to Avra Valley and the Town of Marana.

Avra Valley consists of small braided channels bordered by narrow banks of dense vegetation that cause the flood waters to spread over a wide area at shallow depths. The Garcia strip, within the Schuk Toak District of the Tohono O'odham Nation, is located in Avra Valley and extends through the Altar Wash drainage. Under the Southern Arizona Water Rights Settlement Act, this area is being developed as agricultural land with irrigation improvements and some flood protection.

The Town of Marana is located in the area where Altar Wash outlets into the Santa Cruz River. Urbanization in the Town of Marana and vicinity is increasing, and developments on the floodplain areas encroach on the main watercourses.

3.2.7. Ground Water

Floods no longer spread over the wide Altar Valley floodplain, but instead are concentrated within the incised wash and are quickly transported downstream. This flood action allows little stream flow recharge to the groundwater aquifer in Altar Valley.

A reconnaissance study made after the floods of September 26 through 28, 1962 by the Ground Water Branch, U.S. Geological Survey (USGS), to determine the possibilities of recharge of the groundwater reservoir supports this statement. Analysis of the available data from these studies indicates that some groundwater was added to the groundwater reservoir in the area from Stanfield to Maricopa, but no recharge of only a slight amount had taken place in the area to the southwest through Avra Valley to Three Points (USGS, 1963).

The Altar Wash Pilot recharge study conducted by Tucson Water identified the area as a prime site for recharge. The infiltration rates of the pilot project were among the highest in the valley (from 4 to over 10 acre-feet per acre per day). Another indication of a prime recharge site is the speed at which recharged water reaches the regional groundwater. Water moving down through the vadose zone at poor recharge sites encounter confining layers that trap or delay the downward movement of water. None of these were encountered at the Altar site. Therefore, the results of Tucson Water's study indicate that water recharging behind the grade-control structure will replenish the regional aquifer (SCS, 1992).

An opportunity exists to regain some of the area's dwindling groundwater with stream-flow recharge. These groundwater supplies are a major source of public drinking water for the Tucson metropolitan area, Marana, and Three Points.

3.3. Biological Resources

3.3.1. Habitat

The year 1920 probably saw the start of the large-scale change of the valley's flora from grasslands to shrublands (Bryan, 1925). Burroweed (*Isocoma tenuisecta*) and snakeweed (*Gutierrezia sarothrae*) were indigenous to at least the northern quarter of the valley before settlement. It was not until the early 1940s that they had moved as far south as the Elkhorn-Las Delicias Ranch area. The spread and thickening of these two species is very simply due to the continuous past grazing whereby forage species were slowly removed and these toxic species were able to occupy the vacant space left (Robinett, 1981).

Bank erosion, and the associated lowering of the water table and base floodplain has also removed xeroriparian vegetation and limited further xeroriparian habitat establishment and growth.

Throughout the 1930s and 1940s, shrubby species continued to spread and thicken. By the early 1960s, rangeland carrying capacities had diminished to about the state-rated capacity. Photographs of the international boundary monuments taken in 1893 and again in 1983 show the result of this vegetative change (Humphrey, 1987).

Numerous species of game and non-game animals are found in Altar Valley, as well as federally listed plant and animals species. Common valley animals include javalina, mourning dove, white-wing dove, mule deer, Gambel quail, scaled quail, and cottontail rabbits. Other grassland species that could occur in the valley include pronghorn; spotted ground squirrel; Hispid pocket mouse; Ord's, banner-tailed, and Merriam kangaroo rats; white-footed mouse; cotton rats; southern grasshopper mouse; southern plains and white-throated wood rats; badger; coyote; Cassin's and black-throated sparrows; burrowing owl; verdin; Swainson's hawk; cactus wren; house finch; lark sparrow; whit-necked raven; horned lark; prairie falcon; American kestrel; roadrunner; barn swallow; Scott's oriole; loggerhead shrike; mockingbird; brown-headed cowbird; ash-throated flycatcher; poor-will; ladder-backed woodpecker; black-tailed gnatcatcher; Say's phoebe; western and eastern meadowlark; curve-billed thrasher; and western kingbird (Brown, 1994).

The Altar Wash area probably provides critical nesting and forage during dry times of the year. The aforementioned species will take full advantage of any increase in xeroriparian plants or water resulting from structures along the wash.

3.3.2. Endangered Species

A U.S. Fish & Wildlife Service (USFWS) list of endangered, threatened, proposed, candidate, and conservation agreement species for Pima County, Arizona was evaluated to determine the potential for their occurrence within the project area (Appendix A). There are 25 special-status species for Pima County, six mammals, six birds, four fishes, one reptile, one amphibian, six plants, and one invertebrate. The potential for occurrence of 22 of these species was none to unlikely, due to the very rare occurrence of species or an absence of appropriate habitat. Only three species (Pima pineapple cactus, cactus ferruginous pygmy-owl, and Lesser long-nosed bat) are anticipated to occur within the study area. Table 3 provides a summary to support these findings.

Table 3. A summary of the 25 federally listed species for Pima County, their status, and their potential for occurrence in the project area.

Species	Status	Potential for Occurrence in Project Area	Basis for Determination
Huachuca water umbel	Endangered	None	Lack of habitat (cienegas, perennial low-gradient streams, wetlands).
Kearney's blue star	Endangered	None	Range is extremely limited (west-facing drainages in Baboquivari Mountains).
Nichol's Turk's head cactus	Endangered	None	Lack of appropriate habitat (found on unshaded microsites in Sonoran desertscrub).

Table 3. A summary of the 25 federally listed species for Pima County, their status, and their potential for occurrence in the project area.

Species	Status	Potential for Occurrence in Project Area	Basis for Determination
Pima pineapple cactus	Endangered	Occurs in valley, but not in floodplain, where project will occur.	Reconnaissance surveys by the NRCD and USFWS (Appendix B).
Jaguar	Endangered	Unlikely	Species is very rare in Arizona and is typically found in more mountainous areas.
Jaguarundi	Endangered	Extremely unlikely	Habitat is mainly found in mountainous areas.
Lesser long-nosed bat	Endangered	Could potentially forage in the area, but no known roost sites in vicinity.	Cave of Bells is the nearest known nest site.
Mexican gray wolf	Endangered	Extremely unlikely	No confirmed reports of the species other than those released from captivity.
Ocelot	Endangered	Extremely unlikely	Extremely rare in Arizona. Also lack of appropriate habitat (universal component of appropriate habitat is dense cover).
Sonoran pronghorn	Endangered	Unlikely	Lack of appropriate habitat (broad, intermountain alluvial valleys with creosote-bursage and palo verde-mixed cacti associations).
Desert pupfish	Endangered	None	Lack of appropriate habitat (shallow springs, small streams, and marshes).
Gila topminnow	Endangered	None	Lack of appropriate habitat (small streams, springs, and cienegas).
Cactus ferruginous pygmy-owl	Endangered	Occurs in valley	Recent confirmation of species in valley.
Masked bobwhite	Endangered	Extremely unlikely	Formerly occurred in the Altar and Santa Cruz valleys, as well as Sonora, Mexico. It is currently only known from a reintroduced population on the Buenos Aires Wildlife Refuge.
Southwestern willow flycatcher	Endangered	None	Lack of habitat (distribution within its range is restricted to riparian corridors).
Spikedace	Threatened	None	Lack of habitat (moderate to large perennial streams).
Bald eagle	Threatened	None	Lack of habitat (large trees or cliffs near water with

Table 3. A summary of the 25 federally listed species for Pima County, their status, and their potential for occurrence in the project area.

Species	Status	Potential for Occurrence in Project Area	Basis for Determination
			abundant prey).
Mexican spotted owl	Threatened	None	Nests in canyons and dense forests with multi-layered foliage structure.
Mountain plover	Proposed	Unlikely	Prefers aquatic areas, open arid plains, short-grass prairies, and scattered cacti.
Acuna cactus	Candidate	None	Lack of appropriate habitat (well-drained knolls and gravel ridges in Sonoran desert scrub).
Gila chub	Candidate	None	Lack of appropriate habitat (pools, springs, cienegas, and streams).
Sonoyta mud turtle	Candidate	None	Lack of appropriate habitat (ponds and streams).
Chiricahua leopard frog	Candidate	Unlikely	Requires permanent or nearly permanent water sources.
Gooddings onion	Conservation agreement	None	Lack of appropriate habitat (north-facing slopes and moist forested drainage bottoms).
San Xavier talussnail	Conservation agreement	None	Lack of appropriate habitat (deep, limestone rock-slides with outcrops of limestone and decomposed granite).

After site selection is made, species-specific ground searches will be conducted along with consultations with the USFWS as outlined in Section 7 of the Endangered Species Act of 1973. Consultation with the USFWS will be necessary due to the federal nexus created by the Army Corp of Engineers' involvement in permitting the project.

3.4. CULTURAL RESOURCES

Much of our understanding of the prehistoric use of the valley is derived from archaeological research conducted in the adjacent Tucson Basin. The occupation of Avra Valley dates back at least 11,000 years, and can be divided into five different periods. These periods include the Paleoindian (10,000 to 7500 B.C.), Archaic (7500 B.C. to A.D. 300), Ceramic (A.D. 300 to 1450), Protohistoric (A.D. 1450 to 1700), and Historic (A.D. 1700 to 1942). The basic differences are reflected in different subsistence practices in each of the periods. During the Paleoindian period, the large, now extinct, mammals were hunted (e.g., mammoths), projectile points were labor intensive to make, and these groups roamed over a wide range of territory. The Archaic period is dominated by a people who were mobile hunters and gatherers, with a greater use of plant material and a reduction in mobility as compared to the Paleo Indian period. During the Ceramic period, the Hohokam, dominated both the Tucson and Avra valleys. During this period, there is a trend toward full-time sedentism and agriculture. The Protohistoric period is not well known in the study area. Generally, the groups of the Protohistoric period decrease their agrarian pursuits (in comparison to the preceding period) and change their social organization and material culture. The Historic period is dominated by the arrival of Europeans and their material culture to the region.

Small fragments of pottery, stone flakes, and ground stone pieces appear to be scattered along the whole length of Altar Wash (Appendix C). After the specific site is chosen for construction, a formal archaeological and historical survey will be completed, as will consultations per Section 106 of the National Historic Preservation Act of 1966.

Upon discovery of unknown buried resources during construction, the construction will be halted until appropriate consultations and mitigation plans are carried out.

3.5. SOCIOECONOMIC CONDITIONS

Grazing is the predominant land use in the watershed. The grazed area supports about 5,100 mother cows, producing about 3,800 calves and yearlings each year. This produces a gross value of nearly $2 million in new wealth each year from the renewable forage resources of the watershed.

Sheet, rill, and gully erosion reduce productivity of the soil, and increase land management costs. Also, stream bank erosion results in land loss, land depreciation, damage to wildlife habitat, and damage to improvements and facilities.

To date, the land lost to channel erosion has been primarily rangeland with relatively low commercial value. Damages may increase in the future, however, as higher-valued land closer to ranch building is threatened. Cattle fences are washed away several times a year, and ranchers must spend both time and money to replace them. In several cases, cattle could be lost if stream banks near enclosed cattle pastures suddenly gave way. Other damages that have occurred due to bank erosion include the destruction of upland levees, water tanks, and water wells.

Headcuts have advanced up the sides of the foothills into the surrounding rangeland. These increasingly large incised tributaries are damaging state and local roads, and threatening associated structures. In addition, damages have occurred to these roads as a result of the deposition of sediment and debris, and the deterioration from being submerged in flows.

State work crews have built and annually repair diversions and straightened channels to keep annual flows from causing major damage. However, bank erosion of the main channel is threatening Highway 286, Palo Alto Ranch, and Route 86 at the bridge crossing (SCS, 1992).

During a storm event in the valley, the improvements near Highway 86 were completely washed away and the old channel became re-established. This channel has begun to take a course that will outflank the bridge abutment. The structure is in no immediate danger, but remedial measures will be required in the future (SCS, 1992).

Sediment derived from accelerated erosion in Altar Wash contributes to many offsite damages. State and local highway authorities estimate annual sediment cleanup costs to area roads at approximately $45,000. This includes the time crews must repair damage due to advancing gullies (SCS, 1992).

It may take highway crews up to eight hours to clear sediment from blocked roadways. However, no medical emergencies have been exacerbated by the time needed to remove sediment or for the flows in the washes to recede. Accidents have occurred in the past due to sediment and flooding, but they are not well documented (SCS, 1992).

4. ENVIRONMENTAL CONSEQUENCES

4.1. LAND USE

4.1.1. No Action

Land use in the Altar Valley watershed is 76 percent rangeland, 17 percent wildlife refuge, and 7 percent other (SCS, 1992). Altar Valley is one of the most significant traditional ranching areas in eastern Pima County. In eastern Pima County, land ownership is 28 percent federal, 9 percent Indian, 33 percent state, and 31 percent private. State trust lands are held in trust for specific public institutional beneficiaries and the State Land Department has a mandate to maximize revenue for beneficiaries. Given that 64 percent of the land in eastern Pima County is either developable private or State Trust land, projects that improve rangeland are needed to ensure that the land maintains its productivity and ranching continues to be an economically viability operation. Improvement projects encourage landowners to maintain current land uses. If no action is taken, the land will continue to deteriorate due to channel erosion and this valuable rangeland will remain in jeopardy.

4.1.2. Proposed Action

With construction of the proposed structure, sediment moved by storm events will be retained in Altar Wash and the incision will eventually be filled. Raising the level of the wash bottom will allow water to spread over more land, increasing the acreage of forage, which in turn will help maintain the economic viability of ranching in the area and foster land ownership stability in the valley.

4.2. PHYSICAL RESOURCES

4.2.1. No Action

The NRCS estimates that the valley loses an average of seven acres of land and 100 acre-feet of sediment to erosion annually. Stream bank erosion contributes to the continued loss of xeroriparian and range habitat; impacts to downstream water quality, farmland, and county and state road crossings; and reductions to groundwater recharge due to accelerated and concentrated flows within the incised wash. The no action alternative will allow continued degradation of rangelands in the valley.

4.2.2. Proposed Action

An average project site with a grade-control structure will restore approximately 75 acres of incised land within the channel (37 percent of original grade or 7,000 feet to 8,000 feet in length) and create approximately 550 acres of sediment deposition. The timeframe required to restore this area will depend on the type of structure installed, and the number and intensity of storms. Anticipated benefits of restoring the incised wash to its original floodplain elevation include spreading out flows beyond the incised channel thus increasing flow duration, increasing the potential for groundwater recharge, and reducing peak discharge. Figure 4 depicts the restoration process following construction of the grade control structure.

The largest flow on record in Altar Wash near Three Points, Arizona occurred on October 1, 1983. It was recorded at 19,100 cubic feet per second, which is approximately a 20-year return period (U.S. Department of Interior and Geological Survey, 1988). The 100-year peak discharge for Altar Wash above its confluence with Los Robles Wash is 35,000 cubic feet per second (Federal Emergency Management Agency, 1982; Franzoy Corey Engineers & Architects, 1985). The grade-control structure would attenuate flows allowing infiltration to occur, reducing the 100-year peak discharges as much as 6,000 cubic feet per second, and change the existing flow characteristics from a high velocity (20 feet per second) channel condition to a low velocity (2.5 to 5.5 feet per second) floodplain condition (SCS, 1992).

In addition, the structure will reduce or eliminate bank erosion and reduce sediment yield from the watershed. This will result in decreased land loss due to channel erosion, a decrease in re-occurring damage to fences and structures along Altar Wash, and a decreased potential for damage to state and county highways.

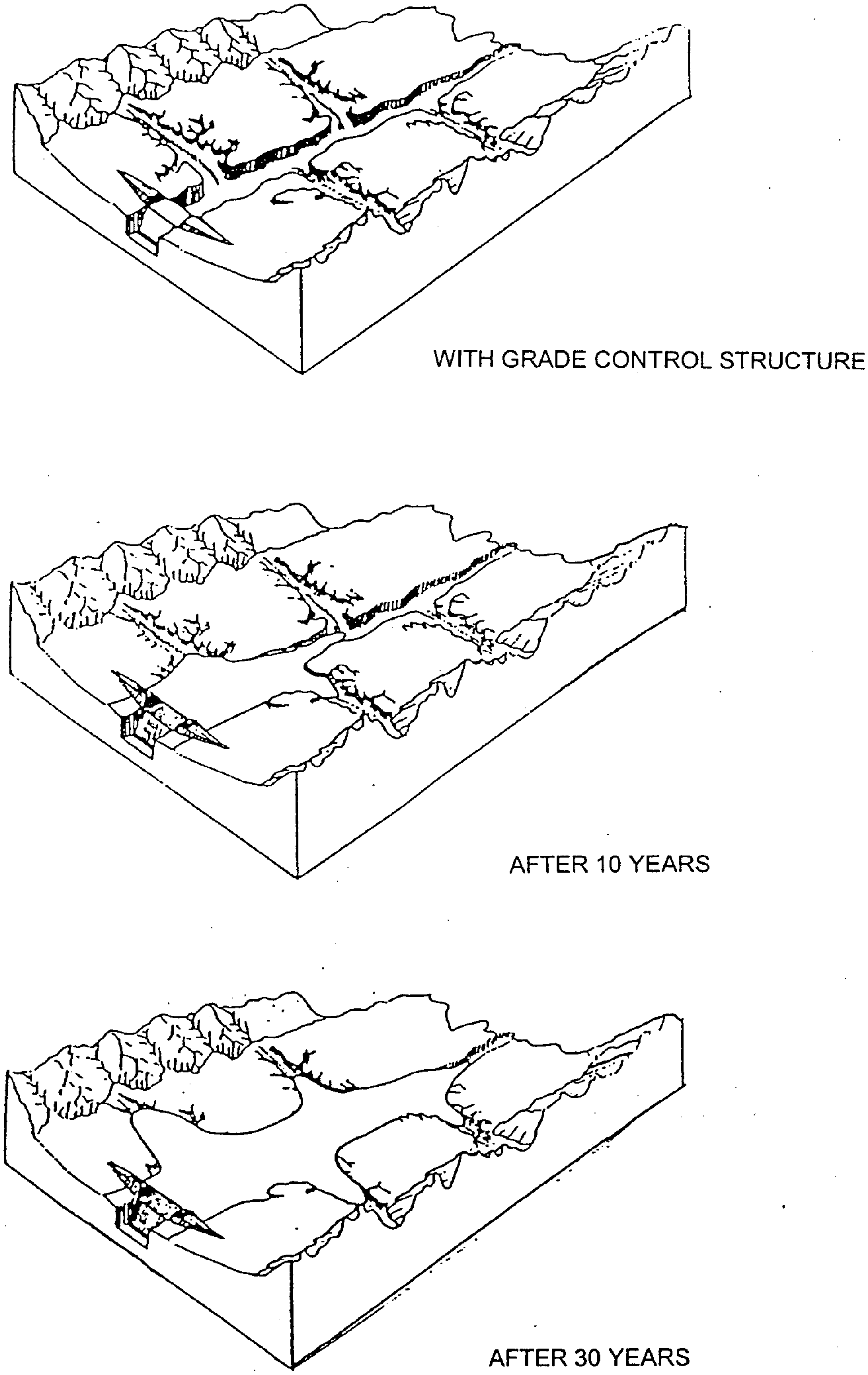
Implementation of the proposed grade-control structure will restore equilibrium to the physical resources in the area. Ultimately, the structure will slow the rate and amount of erosion, by causing rainwater to be spread out and slow down. This will encourage groundwater recharge to occur.

4.3. Biological Resources

4.3.1. No Action

Unless remedial measures are undertaken to reduce bank erosion, the channel banks of Altar Wash will continue to erode and fail due to slumping. The channel will continue to widen, thereby causing additional land loss. At present, the average annual rate of land lost to stream bank erosion is estimated to be about seven acres per year.

As the channel banks recede, many miles of dikes will be destroyed. This will allow runoff from adjacent lands to flow in an uncontrolled manner over the channel banks. As a result, much of the valuable floodplain land will experience serious damage due to gullying. Vegetation will be deprived of the runoff water. Plant vigor will suffer, thereby depriving wildlife and livestock of valuable forage. Xeroriparian vegetation on the channel banks will be lost as banks continue to fail.



			BRAWLEY WASH GRADE CONTROL STRUCTURE ENVIRONMENTAL ASSESSMENT
Source: Soil Conservation Service 1992	WestLand Resources Inc. Engineering and Environmental Consultants 2343 E. Broadway Blvd. Suite 202 Tucson, Az 85719 (520) 206-9585	Figure 4	Restoration Process Following Construction of Grade Control Structure

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Biological resources in the project area will be adversely affected under the no action alternative. Without improvement to Altar Wash, valuable range and wildlife habitat will continue to be lost.

4.3.2. Proposed Action

The project is located outside of critical habitat for the endangered cactus ferruginous pygmy-owl (Figure 5). Historical habitat for the owl is riparian habitat in central and southern Arizona. Stabilizing the banks of the wash and slowing flood flows will help restore xeroriparian vegetation. This project will facilitate the recovery of the species by allowing the return of historical plant communities and ensuring that present plant communities continue to thrive.

The project is within the published range for Pima pineapple cactus (PPC; *Coryphantha scheeri* var. *robustispina*). Personnel with the NRCS under the direction of personnel with the USFWS conducted a survey for the PPC on December 4 and 5, 1996 on the strip of BLM land where the proposed structure is to be located. No PPC were found. They were found on upland sites adjacent to the floodplain area of Altar Wash, but none were found in the floodplain. Based on previous experience, personnel with the USFWS determined that the floodplain would be an unlikely habitat for the PPC (Appendix B).

Biological impacts associated with the project are expected to be positive due to the stabilization and replenishment of natural resources in and along the floodplain. Species-specific surveys, if necessary, and consultation with the USFWS, as outlined in Section 7 of the Endangered Species Act of 1973, will be carried out prior to construction of the grade-control structure.

4.4. Cultural Resources

4.4.1. No Action

The current rate of erosion is allowing cultural sites to be exposed and altered with each rain event. The no action alternative allows for the continued loss of cultural resources adjacent to Altar Wash and its tributaries.

4.4.2. Proposed Action

Construction of the grade-control structure will protect the valley's cultural resources by retaining sediment to repair current gully erosion and prevent the spread of gully erosion along Altar Wash and its tributaries.

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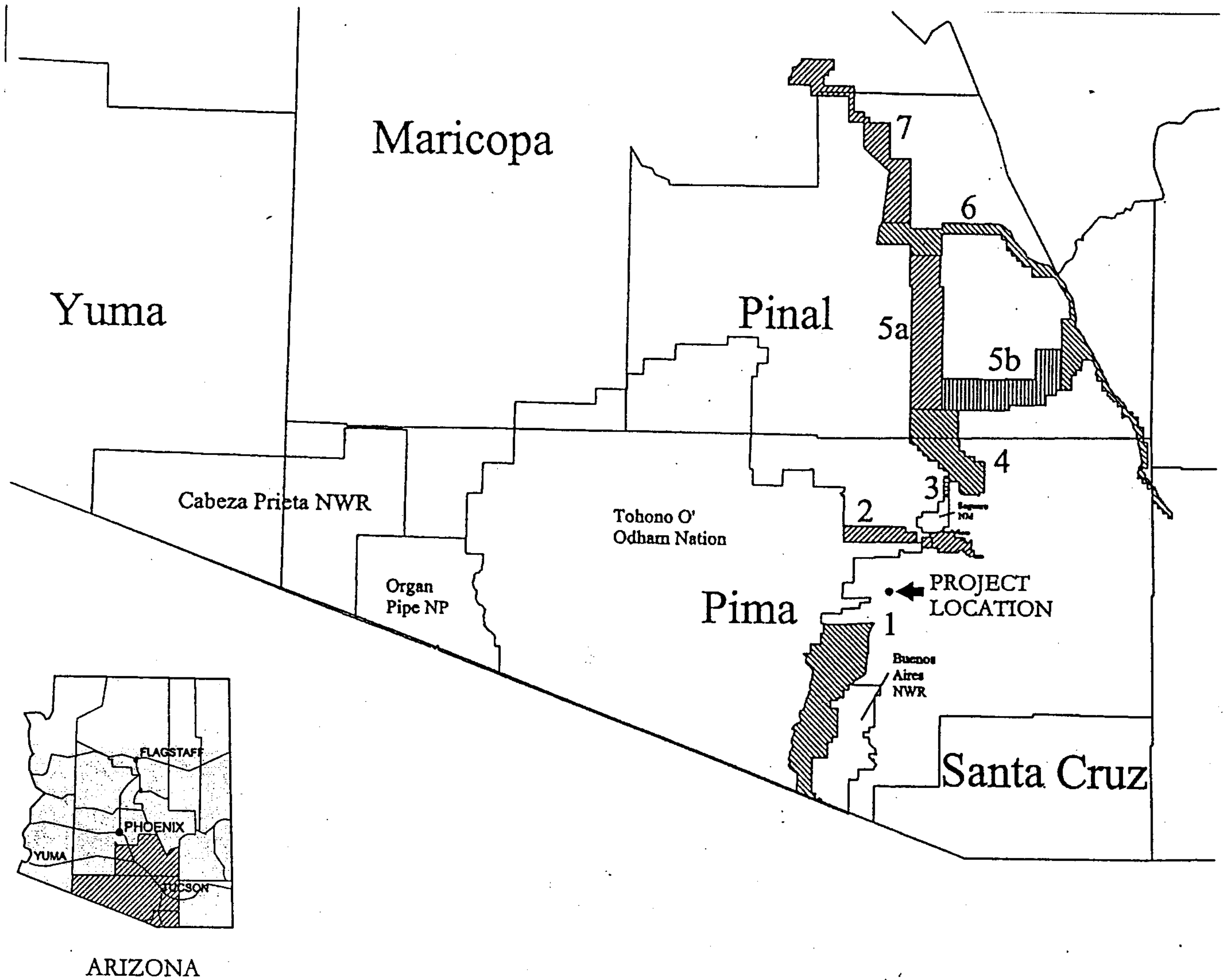

Source: Federal Register/Vol.63, No. 250, December 30, 1998/ Proposed Rules

WestLand Resources Inc.
Engineering and Environmental Consultants
2343 E. Broadway Blvd. Suite 202
Tucson, AZ 85719 (520) 206-9585

Figure 5

BRAWLEY WASH GRADE CONTROL STRUCTURE
ENVIRONMENTAL ASSESSMENT

Cactus Ferruginous Pygmy-Owl Critical Habitat Unit Map

4.5. SOCIOECONOMIC

4.5.1. No Action

Ranchers using the NRCS's Conservation Operations Program have made significant improvement to the land in the last 23 years, considering that in 1975 not one ranch unit in this area utilized any grazing rotation scheme. Approximately 75 percent of the ranches in the Altar Valley have adopted grazing management practices since 1975, such as deferred and rotational grazing systems, put in pipelines for additional water sources to facilitate the movement of livestock, used prescribed burns to control the invasion of woody species into the native grasslands, and built small-scale sediment retention structures in the uplands. These practices have improved the vigor and percent cover of upland vegetation (personal communication, Daniel Robinett, 2000).

Grazing is the predominant land use in the watershed. The grazed area supports about 5,100 mother cows producing about 3,800 calves and yearlings each year. This produces a gross value of nearly $2 million in new wealth each year from the renewable forage resources of the watershed.

Improvements such as farm buildings, wells, fences, and highways will be in jeopardy if the channel continues to widen and meanders enlarge.

The amount of sediment transported downstream will increase if the dikes along the channel bank are lost and additional gully development is initiated. Productivity of the gullied land will be lost. Additional sediment will cause aggradation of the channel downstream from Highway 86, causing more frequent overflow of the channel. This will cause more sediment deposition on range and farmlands.

Bank erosion of the main channel is threatening Highway 286, the Palo Alto Ranch, and Route 86 at the bridge crossing. Sediment derived from accelerated erosion in Altar Wash contributes to many offsite damages. State and local highway authorities estimate annual sediment cleanup costs to area roads at approximately $45,000.

4.5. PROPOSED ACTION

The Altar Wash grade-control structure is expected to increase productivity of the land by stabilizing bank erosion and slowing the flow of water in the channel, allowing it to percolate into the soil. The structure will also benefit state and local highways by reducing the hazards associated with flow events and reducing maintenance costs. Decreasing flow impacts with also benefit Indian farms downgradient.

4.6. INDIAN TRUST RESOURCES

4.6.1. No Action

Indian Trust land is located downstream of the Altar Wash project area. In its current condition, sediments generated from Altar Wash deposit on Indian lands, causing increased maintenance costs.

4.6.2. Proposed Action

Indian trust land is located downstream of the Altar Wash project area. Any improvements in erosion control upstream are anticipated to benefit lands downstream.

5. OTHER PLANNED AND DEVELOPED ACTIVITIES

5.1. DIRECT

The project is designed to reduce flow velocities in the channel, allowing water to percolate into the stream basin and retain sediment in Altar Wash so the grade of the wash bottom is eventually raised to that of the top of the bank. Other direct impacts of the project are those related to soil disturbances associated with construction of the grade-control structure. A site-specific archaeological survey will be necessary once the specific location of the grade-control structure has been determined.

5.2. INDIRECT

Regrading the floodplain will allow floodplain waters to spread out beyond the incised channel and irrigate the adjacent grassland. This will slow erosion in these areas and increase the productivity of forage for wildlife and cattle. In addition, slowing the flood flows of Altar Wash will decrease the damage flood flows cause downstream and will help protect areas such as the Town of Marana, which has been heavily impacted by flood waters in the past. The Schuk Toak District Farm is downgradient of the grade-control structure and is currently under construction. The grade-control structure would help reduce the potential for stormwater impacts to this farm.

5.3. CUMULATIVE

If the grade-control structure performs as anticipated, it would help maintain and improve the vigor of the grasslands in Altar Valley. Also, locating the structure in the northernmost part of the study area will improve the maximum amount of the floodplain at the least expense, lessening the need for additional structures upstream.