Sierra Land Grant Community Coalition

Fire Plan

Carnuel Creek pond

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INTRODUCTION

The Sierra Land Grant Community Coalition is comprised of traditional communities in the East Mountain Range of the Sandia and North Manzano Mountains in the Cibola National Forest. Specifically, the coalition is composed of the Chilili Land Grant, the Cañon de Carnue Land Grant, the Concilio de San Pedro, and the Acequia Madre de Carnuel, all of which are adjacent to the Cibola National Forest. These communities have always maintained a connection to the local ecology, predating the establishment of the National Forest, and have utilized the mountain for hunting, grazing, fuel, and the gathering of medicine plants.

Since the 1950's, when much of their traditional land base became part of the national trust lands, the land grant communities' relationship to the land has been significantly altered. Many of the traditional uses have been restricted, and urban sprawl has encroached into the East Mountain area, detracting from the overall land base. Over the same period of time, an increase in small diameter fuels in the watershed has drastically reduced the water quantity and quality in the San Antonio and Carnuel Acequias while posing a fire threat. While some of the strategies outlined will benefit all of the coalition communities given overlapping interests and proximity, the focus of this fire management plan is on the Chilili Land Grant and the Acequia Madre de Carnuel Grant.

PURPOSE OF THE PLAN

This plan will develop the following strategies:

1. Establish a community cooperative amongst the Sierra member communities engaged in exploiting the economic potential of small diameter timber from the Cibola National Forest adjacent to the San Pedro, Carnuel, and Chilili Land Grants.

2. Improve water yields and watershed health of the Acequia of Carnuel through proper ecosystem management. Auxiliary to this is the identification of opportunities to improve or expand existing water diversion ponds for wildfire fighting efforts.

3. Reduce wildfire risk on land grant properties in Carnuel and Chilili adjacent to United States Forest Service (USFS) and private lands via improved ecosystem management. Geographic Information System (GIS) databases will be developed to assist in this effort.

4. Re-institute the use of USFS lands to sustain local livestock herds by establishing a sheep or goat husbandry cooperative. The use of an associated, sustainable grazing plan can improve the biological diversity and ecological health of the implicated

forests. Currently, there are many individuals who raise sheep and goats but have difficulty finding sufficient grazing land. The development of this goal will also serve to identify the potential and limitations of animal husbandry in the area.

5. Identify areas of improvement to achieve a level of adequate fire protection in Carnuel and Chilili via infrastructural development.

6. Revitalize or identify current, traditional cultural activities, such as the collection of botanical resources for medicinal purposes, that could further improve forest health and biological diversity.

BACKGROUND

Both members of the Sierra Land Grant Community Coalition, the Chilili Grant and the Carnuel Grant lands differ in size, tree species composition and use.

Chilili Grant

The Chilili Land Grant is bounded by the USFS Mountainair Ranger District to the south and west, the Isleta Indian Reservation to the Northwest, and by private land to the north and east. Approximately 10,000 acres of the Chilili Grant is forested with ponderosa pine. The remaining 30,000+ acres of the grant is dominated by a piñon-juniper association with scattered ponderosa pine present along the canyons. There are approximately 300 heirs who live throughout the land grant, mostly among the piñon-juniper stands. They use the land grant primarily as a source of fuelwood and cattle pasture. The majority of the fuelwood is harvested from ponderosa pine stands.

The grant is accessible from Highway 337, which crosses through the grant from north to south. The grant community maintains several miles of high clearance road for access, patrol routes and fire suppression activities. Traffic within the land grant is controlled by entrance gates and land grant officials who patrol the ground.

Land History and Status

Logging activities in the 1930's removed the majority of the overstory from the ponderosa pine stands. Presently this area is characterized by dense, pole-sized stands of 800-1000+ trees per acre of secondary growth. Within the stand, downed slash, consisting of broken treetops, slash pipes and lopped slash from timber sales or woodcutters, averages between 15 to 20 tons per acre. Slash poles can also be found along the recently constructed gas line that runs from west to east through the pine stands. Machine piles have been left from timber sale near the road and in clearings; some of these piles are near live trees. Downed treetops and 15 to 20 foot tall snags resulting from an ice storm suffered by a ponderosa pine stand a little over a year ago also contribute to the fuel load.

Photograph 1 - Downed slash in logged area in Chilili Grant

Photograph 2 - Slash piles pushed against remaining stand in Chilili Grant

Fuel Rating and Water Sources

All of the ponderosa pine stands are rated high fire hazard, while the piñon-juniper associations are a low to moderate risk. Many of the homes within the piñon-juniper forests are close to the stands. Water reservoirs are scattered throughout the grant. The reservoirs gather mostly surface water for cattle and wildlife, but all of the reservoirs are presently empty due to the current drought. The grant is also home to many springs, but like the reservoirs, some are a mere trickle while others have dried up completely. The present drought and fierce botanical water competition resulting from high tree densities are the main, contributing factors.

Carnuel Grant

Photograph 3 - Town of Carnuel

The Carnuel Grant consists of approximately 900 acres between Cedar Crest and the Sandia foothills along the Tijeras drainage basin and Interstate 40. Piñon-juniper is the primary forest type here, while the Tijeras canyon riparian zone supports a mixture predominantly composed of willow, cottonwood, and elm (see map, Appendix VI).

Land History and Status

For a good account of the Carnuel Grant's rich history, see the Heritage Resource Report No. 2002-03-008 March 15, 2005 (Appendices I and II). Evidence of a fish hatchery, an associated fishing reservoir, and a cement plant are the primary legacies. The hatchery

Photograph 4 - Proposed campground area, site of former fish hatchery

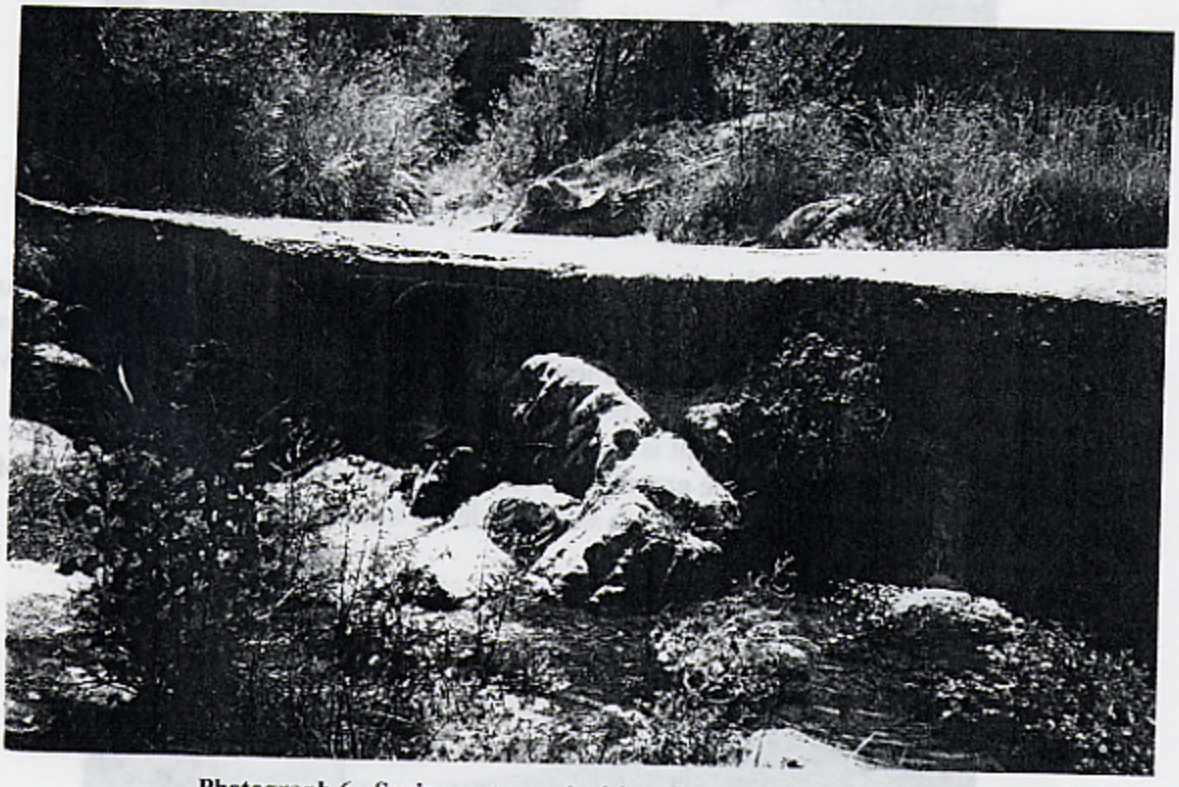
facility is not currently serviceable, but it does hold the potential to be revitalized for future use. The cement plant, which has been in operation for several years and promises to remain so for years to come, is located at the southeast end of the land grant. Rapid water quality tests conducted nearby the plant reflect that pollution from the plant is minimal. Another industrial consideration for the grant is that it has also permitted a gravel screening plant to operate within its boundaries. The gravel plant is located along the creek in the section of the grant east of the defunct fishery. There is some evidence of pollution from its activities.

Photograph 5 - Gravel pit drainage area

Fuel Rating

The grant's piñon-juniper forests rate as a low to moderate fire hazard. Moderate ratings apply to areas where the stand is particularly dense, and where it is susceptible to strong, prevailing winds. Because of the ignition threat associated with children walking to and from school, stands immediately adjacent to schools within the grant require special attention. Dead material currently littering the riparian zones should also be addressed.

Water Resources



Photograph 6 - Spring water replenishes Carnuel Creek, July 2002

The Sandia Mountain watershed feeds a creek, which drains into Carnuel and is the source for two to three springs. Several earthen dams and their associated reservoirs may also be found in the grant. Typically, the creek evinces a consistent and strong flow throughout the year, and the springs are prolific enough to fill some of the reservoirs. This year, however, the drought has forced the creek to flow underground in some places, has emptied all of the reservoirs, and has substantially reduced the flow of many of the springs. Headwater yields at Sandia Crest could be improved by thinning the stands along the drainage path (Appendix III). Such a project, however, would require the permission and cooperation of the USFS and would be labor intensive. A more detailed study is necessary before any work should be planned.

Grant heirs primarily use water within the grant for lawn and garden irrigation, and for other similar activities. The grant is in the process of redoing some of the acequias, the means by which local communities irrigated their land and which evidence indicates were destroyed during highway construction, to better utilize available water. There also exists the potential to improve irrigation and fire suppression water efficiency by developing or ameliorating existing water facilities. For instance, a two-tank reservoir system, which would not be possible in Chilili, could be established within the Carnuel Grant because of the grant's generally consistent water supply.

Finally, the community reportedly bases its sewage system on septic tank use. While preliminary research found no evidence of seepage, a more comprehensive study should be conducted to assess the health and water quality of local wells.

Other Management Goals

Grant members have also expressed an interest in improving lands both within their grant and currently administered by the USFS. Project suggestions target meadow restoration to provide forage for goat and sheep and fuelwood management. These projects could be realized with the cooperation of the USFS, especially if National Forest Restoration Program funds are acquired.

FUEL MANAGEMENT PRESCRIPTIONS

Work priorities for the Chilili Grant and the Carnuel Grant are discussed separately. The Chilili Grant is sub-divided to address specific, heterogeneous needs within the grant and for future management (Appendix IV).

Chilili Grant

One necessary operation for the grant as a whole is to dispose of the machinery piles along the pipeline and on and adjacent to past logging sites. These piles can be burned or shredded on site.

Unit 101

The highest priority for Chilili is to construct a fuelbreak along the USFS boundary to the west and south and continuing north toward Highway 337 along the Isleta Pueblo and private lands (see attached map, Appendix V). The break will help contain fires on either side of the grant boundary, inhibiting them from becoming catastrophic in nature. This project will also serve as a safeguard until the ponderosa pine stands are thinned and their fuel loads reduced.

The total land area to be treated is 156 acres: 100 acres along the USFS boundary; 25 acres that border the Isleta Pueblo Indian Reservation; and 31 acres that abut private land. The fuelbreak will encircle the ponderosa pine stands and should be no less than 300 feet wide. The grant's proposed contribution to the fuelbreak width is 100 feet with some variation to

account for specific landscape contouring and features. This assumes that the Isleta Pueblo Reservation and private landowners agree to establishing a 200 foot-wide fuelbreak on the edges of their properties. If they do not, the Chilili Grant will have to absorb the additional work and acreage. The USFS and the Mountainair Ranger District plan to construct their side of the fuelbreak as soon as funding is acquired, which could be as early as this fall.

The fuelbreak will be open; the crowns of the remaining trees will not touch with the possible exception of a few, small tree groups that might be left for site-specific, ecological purposes. The grant will also construct a ten-foot wide road where possible along the fuel break for fire access. Trees to be excluded from this treatment are the dominant ponderosa pines in the ≤11-inch dbh (diameter at breast height) class. Timber created by the project will be sold for vigas, poles, firewood, posts or chips. If a market for wood chips cannot be found, excess wood will simply be chipped on site.

Units 1-19

These units have not been logged since the 1930's and are over-dense with large second-growth stands and thick pole-sized stands. The understories of these units need to be thinned down to basal areas of 60-70. The thinning operations will financially benefit the community, but this treatment should not reduce the canopy cover of the stands to less than 80%. The harvest could be done by the grant if they are able to purchase their own equipment through supplemental or state funding, or alternatively by a private contractor.

If the grant executes the operation, they could establish a rotation cycle that will allow these stands to supply an annual yield in perpetuity. The Chilili Grant and its neighboring communities' economies would benefit from the sustained yield. One possible rotation begins at the western end of the fuelbreak and follows it to the east with each successive cut. If, however, the grant opts to use a private contractor, larger sub-units should be harvested to minimize the frequency of logging events. The grant should individually mark the trees to be thinned and closely administer the sale to ensure that no other trees besides those that were selected are felled.

Within the piñon stands, the grant, with the assistance of the state forestry office or other organizations, should focus on establishing adequate defensible space around their residences. A second project to restore grasslands in specific areas within the grant is also recommended. Improved grass production in selected sub-units would not only reduce the overall fire risk on grant lands, but it would also increase forage for grant livestock and wildlife.

Unit 20-23

The forests in these units have been logged more heavily than they should have been within the last couple of years. For this reason, fire treatment requirements are limited to thinning small pockets of pole-sized stands. The slash should be disposed through prescribed burning or chipping.

Carnuel Grant

The following prescription recommendations apply to the Carnuel Grant as a whole.

1. Grant management efforts should emphasize the efficient use and expansion of its water resources. One possible strategy is to thin the areas surrounding the headwaters of the grant to free up water currently used by trees. The specifics of such a project, however, need to be determined by an intensive, long-term study that would involve USFS cooperation.

2. The piñon stands surrounding the schools should be thinned. Although initial observations found that fine fuels are lacking, additional precautions are recommended given the ignition risk associated with school-aged children walking to and from school. The removal of a few of the larger trees and the subsequent opening of the stand would most likely restore grass as the dominant ground cover, thus reducing fire risk. It is also suggested that grant and/or school personnel create environmental trails to address ignition threat issues. The trails would educate students about the environment, instilling a greater awareness of potential degradation and environmental hazards. Educational trails could incorporate historical information at various observation stops, instructing students about the grant's history as well.

3. Dead slash, cottonwood regeneration and Russian elm trees should all be cleaned from the Tijeras riparian zone. Management goals for the riparian zone should focus on promoting native species. Russian elm is an exotic and needs to be thinned or removed to open the creek to more sunlight. Elms can be replaced with transplanted cottonwoods from within the same area.

4. The defunct fish hatchery pond should be removed while the existing, neighboring pond is enlarged. This larger pond could then serve as a reservoir for fire fighting and fishing. The water, however, may have to be filtered to sustain a fresh water fish population.

5. The area westward of and immediately surrounding the hatchery pond could be developed for recreational vehicle parking. Educational trails should be built to educate patrons of the campground, and a fee could be levied that would finance maintenance and generate income for the grant economy.

6. Other water holes can be built along the main drainage route of the grant to supply water for irrigation and fire suppression. The storage facilities would be stocked during years of heavy run off and tapped during drought years.

7. Grassland restoration within forest lands adjacent to the grant will need to be a cooperative effort between the grant and the USFS. This will allow for the coordination of project goals and aid in the identification of funding sources. The goal

is to augment grass production to decrease the risk of catastrophic fire while increasing available forage for grant livestock and wildlife.

RECOMMENDATIONS

Based on current conditions of the grants, the Forest Trust makes the following, prioritized recommendations:

Chilili Grant

1. Dispose of all mechanical brush piles prior to any additional, slash-creating activity.

2. Coordinate with the current USFS and Mountainair Ranger District fuelbreak efforts and acquire funding to realize the 100-foot wide fuelbreak within the grant. Also, continue negotiations with the Isleta Pueblo Indian Reservation and private landowners to agree upon respective responsibilities for fuelbreak width.

3. Obtain funding for logging, thinning and processing equipment to establish a timber enterprise beneficial to the local economy. If this is unfeasible, then small, carefully administered sales should be considered. Revenues from the sales would finance future thinning and slash removal operations, thus reducing the existing, overall fire hazard.

4. Devise a fire plan for defensible space for all grant residences. If the drought continues, this plan should be implemented by the summer of 2003.

5. Maintain springs and water tanks for livestock and use against fires.

6. Continue road maintenance and strategically timed closures for use in fire prevention and wildfire suppression.

7. Perpetuate the area's volunteer fire department and explore means to upgrade the equipment used to fight structure and forest fires.

Carnuel Grant

1. Thin the piñon stands around grant schools and work with them to construct environmentally and historically education trails.

2. Clean the riparian zones by removing dead material and thinning some of the pole-sized cottonwoods. These can then be transplanted into vacancies left by cleared Russian elms. Russian elm trees are invasive in nature and should be removed in favor of native species.

3. Construct a new acequia to replace the one buried by the highway. It will be used primarily for irrigation.

4. Coordinate with the USFS and the Sandia Ranger Station to monitor spring water yields for the Sandia headwaters. Concurrently, formulate thinning strategies for Hondo, Cañoncito and other implicated canyons to increase the water yields of grant springs.

5. Remove the fish hatchery tank and enlarge the nearby reservoir to double its present size. The resultant water cache can be used for fire suppression and recreational fishing.

6. Level the areas south and west of the former fish hatchery to develop an RV campground. Also, construct a recreational loop trail along the drainage basin with scenic viewing stops. The campground and trail will provide economic benefits to the grant community.

7. Remove the gravel pit operation and construct a second water reservoir in its stead, which could be incorporated into the campground trail.

8. Test the community drinking water to ensure that there is no septic tank seepage compromising public health.

9. Begin coordinating with the USFS and the Sandia Ranger Station to delineate areas targeted for grassland restoration. The project will increase forage for livestock and wildlife, provide firewood for the community, and reduce the risk of wildfire.

10. Establish a storage and distribution area, assuming the Chilili Grant decides to process its own wood products. One suggested location is a site near the school. As this area is a section of the grant closest to Albuquerque and other smaller cities and communities, it would be strategic for distribution.

11. Introduce utilization of goats for future restoration projects.

12. Coordinate water projects planned within the wilderness area with the Forest Service and the general public. Train work crews in this area according to established policies for wilderness areas.

Appendix I

Such sites are not commonly found in montane areas, but rather occur in gentler terrain, often near playas or lakebeds. Paleoindian remains have been found south of the project area, near Abo Pass (Tainter and Levine 1987), in the Manzano Mountains (Garber 1982), and near Las Huertas Creek, approximately 11 miles to the north of Tijeras (Tainter and Levine 1978).

Archaic Period. 6000 B.C. – 400 A.D.

With the extinction of Pleistocene megafauna and a general shift in climatic conditions toward a decrease in effective rainfall (Stuart and Gauthier 1981), adaptive changes took place in cultural patterns of resource and environmental exploitation between 6000-5000 B.C. This period, referred to as the Archaic, is defined by a wide variety of projectile points that are on the whole smaller and more crudely fashioned than their Paleoindian predecessors (Thacker 2001: 5-6). These points were generally manufactured for use with the *atl atl*, or spearthrower, which replaced the earlier thrusting spear in many areas. There are many types of Archaic projectile points, including stemmed, side-notched, and corner notched varieties. These types vary through time and are good diagnostics for site dating.

The occurrence of groundstone implements also increased during the Archaic period (Tainter and Levine 1987), as subsistence strategies shifted from the hunting of huge, now-extinct, Pleistocene species such as the wooly mammoth, to predation upon smaller modern species and the procurement and processing of plant resources. The most common Archaic site type is the lithic scatter, with or without associated hearths and/or groundstone artifacts.

It is postulated that the upland regions east of the Rio Grande Valley experienced an increase in population during the Late Archaic due to population pressure, subsistence stress, and changes in settlement patterns in the valley. This expansion likely occurred through Tijeras Canyon, to the north of the project area, and through Abo Pass, to the south, resulting in population increases throughout the foothills of the eastern slopes of the Manzanita and Manzano mountains and into the Estancia Basin (Thacker 2001: 5-6; Tainter and Levine 1987).

Due to the paucity of other cultural remains, the Archaic Period is most frequently recognized in the archeological record by projectile point and associated lithic tool types. The Oshara Tradition of lithic technology is believed by some to be ancestral to the Anasazi/Puebloan cultures (Irwin-Williams 1973:11). Most Prehistoric and historic Native sites in the project area have been identified as Anasazi/Puebloan; therefore, many of the Archaic lithics identified therein may be expected to bear Oshara stylistic traits. However, due to the mobility of Archaic hunter-gatherers and inter-group trading, projectile points ascribable to the more-southerly Cochise Tradition (Sayles and Antevs 1941) may make an occasional appearance here, as well (Cliff Nicoll personal communication, February, 2002).

Irwin-Williams used projectile point morphological changes through time to create a chronology for the Oshara Tradition that is still in use today (Irwin-Williams 1973. See

this monograph for illustrations of point types, site locations, climatic and subsistence changes etc.). For additional discussion and debate of the Archaic Period and its tool types, see Binford 1994, 1980,1979; Huckell 1993, Vierra, 1994.

Except where noted, the following descriptions of the Oshara phase sequence are from Irwin-Williams (1973:4-15).

Jay Phase. 5500 – 4800 B.C. Jay points are about six to eight cm. long and slightly shouldered. They may occur with lanceolate bifacial knives and "very well-made" side scrapers. Reduction technology includes hard and soft hammer percussion.

Bajada Phase. 4800 B.C. – 3200 B.C. Early Bajada points are similar in form to Jay points, but with basal thinning and a basal indentation. Late Bajada points become increasingly shorter through time, with increasingly well-defined shoulders. Bifacial knives are rare; well-made side scrapers persist in abundance.

San Jose Phase. 3000 -- 1800 B.C. San Jose points become increasingly more serrated through time, with a corresponding decrease in length. Their stems also become increasingly expanded. They are accompanied by side scrapers fashioned on thin flakes; knives and side scrapers have virtually disappeared. Workmanship on both points and other tools is poor; hard hammer technique is used almost exclusively. Shallow basin metates and one hand manos appear.

The San Jose Phase is associated with increased moisture and an increase in the number and size of sites, particularly in the upland canyon areas (Thacker 2001:6).

Armijo Phase. 1800 -- 800 B.C. Armijo points resemble late San Jose serrated points with short, widely expanded stems. Early Armijo point bases are concave at first, but become straighter through time. Later Armijo points "show increased internal variety, and a number of variations on a shallow corner notch or narrow stemmed node" begin to appear.

It is during this phase that domesticated corn (maize) makes its appearance. However, there is no evidence of sedentism as yet.

En Medio Phase. 800 B.C. -- 400 A.D. According to Irwin-Williams, this phase "included the earliest recognizable Anasazi-Pueblo materials, generally termed Basketmaker II." En Medio points "are variations of stemmed corner notched forms which trend through time toward the use of increasingly long barbs. Bifacial knives and drills occur in small numbers near the beginning of the period, and increase in importance through time." There is a marked increase in groundstone tools. Deep basin metates and one hand manos occur throughout the phase, while slab and trough metates appear toward its end, accompanied by "long flat handstones" (two hand manos?).

Trujillo Phase. 400 -- 600 A.D. This is a variant of the Early Basketmaker III phase (see below). Though very similar to the En Medio, this phase is marked by the appearance of

the bow and arrow and of ceramics. Early Trujillo arrowheads resemble miniature En Medio points. Ceramics are of the plain gray type called Lino Grey.

Archaic remains have been discovered in the project area. For example, the mid-section of a Bajada style projectile point was recorded as IO #204 in the Heatherland Hills Fuels Reduction Project survey (Thacker 2001-03-044:6), and an Armijo type projectile point was recorded on site AR-03-03-05-198/LA77096 in 1990. To date, all Archaic finds on the project area have been limited to isolates or Archaic point types associated with lithic scatters. Most lithic scatters recorded in the project area lack diagnostic artifacts, and their temporal and cultural affiliations remain unknown. On the Mountainair Ranger District, the occasional presence of Archaic points in undeniably Anasazi contexts suggest that these artifacts were occasionally collected and curated in later times (author's personal experience).

Anasazi/Puebloan Period. 400 A.D. -- Present
This is the period during which the ancestors of the modern Pueblo Indians become identifiable in the archeological record of the Southwest. The period is broken into phases, the original version of which is called the *Pecos Classification*. This chronology forms the baseline upon which later, regional phase sequences have been developed. Anasazi/Puebloan cultural resources in the Sandia Range District are described by the *Rio Grande* phase sequence. Table 1 compares this sequence with the overarching Pecos Classification.

Except where noted, the following descriptions of the Rio Grande phases are after McGraw, 1997:10-11 and Rowland 1982:7-9.

Developmental Phase. 600 – 1200 A.D. The Developmental Phase is thought to have evolved directly from the Archaic/Oshara Tradition. It is marked by the first appearance of ceramics in northern New Mexico, the use of small oval shaped pithouses and surface structures, large semi-subterranean structures, increased reliance on cultivated crops, and distinctive lithic assemblages. The lithic assemblages are varied and often possess groundstone artifacts. Two hand manos and full-grooved axes appear late in the phase, after 900 A.D.

Sites tend to be located on the top of high mesas, ridges and hills with steeply sloped sides. Many of these sites occur some distance from the nearest water source.

Pithouses dating to the Developmental Phase tend to have the following characteristics: floors may be plastered or made of hard packed clay; ventilator shafts may be oriented toward the east; two, four, or no roof support posts may be present; storage cysts may be located inside the structures or in their vicinity. Pithouses occurring later in the phase, i.e., after A.D. 900, tend to possess four roof supports, ladder holes, ash pits and *sipapus*.

TABLE 1. COMPARISON OF PECOS CLASSICIFICATION AND RIO GRANDE PHASE SEQUENCES

DATE A.D.	PECOS	RIO GRANDE
1900	Pueblo V	
1800		
1700		
1600		Historic
1500	Pueblo IV	
1400		Classic
1300		
1200	Pueblo III	Coalition
1100		
1000	Pueblo II	
900		
800	Pueblo I	
700		
600	Basketmaker III	Developmental
500		
400	Basketmaker II	
300		Pre-Ceramic

After Cordell (1979) and McGraw (1997)

Associated ceramics include Lino Grey, Kana'a Gray, graywares with fugitive red paint, and Mogollon tradewares, e.g., Alma Plain and Alma Neckbanded. Red Mesa Black-on-White occurs after 900 A.D.

Several sites dating to the Developmental Phase, including the Big Boulder site (LA 14258) have been recorded in Tijeras Canyon (Cordell 1980). The two pithouses found at that site were not visible from the surface, but were only discovered "by extensive testing and stripping" (Rowland1982:8). The survey conducted in conjunction with the UNM field school at Tijeras Pueblo (see below) recorded 22 Late Developmental Phase sites, all located "either on or adjacent to alluvial land" below 6400 feet in elevation. Other sites in Tijeras Canyon dating to, or possessing components dating to, the Developmental Phase include LA 586, LA 10793, and LA 12843.

Coalition Phase 1200 – 1325 A.D. The Coalition Phase is marked by a substantial increase in site density. The phase is also marked by a change from mineral pigment to carbon pigment in paints used on local ceramics. Pithouses persist, but small roomblocks -- sometimes including rectangular kivas – appear late in the phase. Other features typical of the Coalition Phase include small masonry "field houses," associated agricultural features, and reservoirs.

Habitation sites increase during the Coalition Phase and tend to occur "adjacent to major drainages and [on] arable land at relatively low elevations" in Tijeras Canyon. The last 50 years of this phase witnessed the creation of "numerous small communities" there. Moreover, "[r]esearchers believe that this period may mark the first year-round use of the area" (Rowland 1982:8).

There are many ceramic types associated with this phase, including a locally produced variety of Santa Fe Black-on-White, Wiyo Black-on-White, local Kwahe'e Black-on-White, Chupadero Black-on-White, Socorro Black-on-White, Galisteo Black-on-White, and Saint John's Polychrome.

Sites dating from Coalition Phase in the Tijeras Canyon area include LA 580, LA 581 (Tijeras Pueblo), LA 583, LA 856, LA 846, LA 1279, LA 6906, LA 6907, LA 10794 (Coconito), LA 11612, LA 11613, LA 12845, LA 13812, and LA 14857 (Dinosaur Rock).

Classic Phase. 1325 – 1600 A.D. During the Classic Phase, the population peaked in the region surrounding the project area. Sites consist of small "field houses," villages situated on ridges or mesas, and large mesa-top villages with several hundred rooms, multiple plazas, and great kivas. Several of these sites have associated soil and water control features. Population moved into higher elevation areas away from permanent drainages, and evidence suggests that several of the field houses in the Padre Springs project may have been occupied during this phase. During this phase, population in the region was concentrated at San Antonio, Tijeras, (Cordell 1980), and Pa'ako pueblos.

The appearance of glaze decorated, red slipped ceramics mark the beginning of the Classic Phase.

Classic Phase sites in Tijeras Canyon include LA 581 (Tijeras Pueblo), LA 24 (San Antonio Pueblo), LA 1516 (a small roomblock), LA 15166 (an isolated "room") (Rowland 1982:8).

Historic Phase. 1600 A.D. -- Present. The Historic phase is marked by the appearance of the Spanish in New Mexico, in the mid-1500's. Following their arrival, the Native populations began to decline, and native peoples were forced into large communities in river valleys where they could be more easily controlled. The manufacture of glaze painted ceramics also began to decline. This may have been the result of less available time to produce the wares, or restricted access to resources, e.g., lead deposits, necessary to manufacture the glazes (McGraw 1997:11).

The prehistory of the project area from the early Basketmaker Phase, after A.D. 400, to the beginning of the Rio Grande Classic Phase, ca. A.D. 1325, is not well known. Beginning in the 1300's, there was a distinct trend toward population aggregation, evidenced by the establishment of large habitation sites, such as Tijeras Pueblo, in the northwestern corner of the project area, and San Antonio and Pa-ako pueblos, farther north. Toward the south, the pueblos of Chilili, Tajique, and Quarai were built in the foothills of the Manzano Mountains.

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Historic Period. 1600 – 1952.
1600 – 1863 A.D. The first type of use of the lands in the project area during the Historic Period was probably by nomadic Native bands that used Tijeras Canyon as a conduit through which they traveled to attack Puebloan and Spanish settlemlents in the Rio Grande Valley. Apachean (Navajo and Apache) populations appear in the archeological record of the Southwest by the early 16th Century just prior to the Spanish Entrada (Rowland 1982:10).

Depredations by nomadic tribes were a major problem throughout the Spanish Colonial period in the area (1696 – 1821) the Mexican period (1821 – 1846) and the early Territorial period (1846 – mid-1860's). Quintana and Kayser identify the bands that most frequently traversed Tijeras Canyon until the mid-18th Century as being Faraon Apaches. The Faraons were then displaced by Comanche raiding parties (Quintana and Kayser 1980:45). Other Apachean raiders reappeared after the Comanches were pacified in New Mexico by General De Anza in 1776. Ute raiders also traversed the canyon to harass the settlements in the river valley beyond (Quintana and Kayser 1980:43).

Due to the danger of nomadic attack, the project area was probably not used for sedentary Hispanic occupation until after the Navajos and Apaches were forced onto the Bosque Redondo reservation, in 1863 (Cordell, 1979: 112). However, the San Miguel de Laredo de Carnué Land Grant (aka the Cañon de Carnué Land Grant) -- which originally

included the project area (Quintana and Kayser 1980: 49) -- was created in 1763 for the purpose of obstructing the nomads' access to the river valley. That same year its first settlement, San Miguel de Laredo, was established at the western mouth of Tijeras Canyon, somewhere beneath the present-day village of Carnuel. The exact number of original settlers is not known: "Although nineteen names appear in the grant of the petition, ... more than that number settled in Carnué as revealed in later documents" (Garcia-Luna 1999:158). Included in this group were at least five *genízaros*, i.e., Hispanisized Indians, and four *coyotes*, i.e., people of half Spanish and half Indian blood (Garcia-Luna 1999:157). The village was known as a genízaro settlement (Moisés Gonzales personal communication, February, 2002).

San Miguel de Laredo was intended to form one of the geographically marginal buffer communities with which the colonial administration sought to stem the flow of Native war bands into established New Mexican communities. Many of these buffer communities included genízaro settlers in their ranks. Today, the most well known of these genízaro villages is Abiquiu, in northern New Mexico.

Although San Miguel de Laredo successfully established friendly trading relations with the Carlana Apaches, the settlement soon failed, overwhelmed by attacks from other nomadic groups. It was abandoned in late 1770, after an especially lethal raid by Gila Apaches. The survivors fled to seek succor with relatives in Albuquerque. After they refused to return to the grant, the Alcalde Mayor of Albuqeurque ordered them to demolish the structures they had built at the site. A petition to resettle the village, submitted in 1774 by 39 displaced families from the Rio Puerco area, was denied on the grounds that the petitioners lacked sufficient arms and resources to defend the settlement (Quintana and Kayser, 1980: 45-46).

From 1770 to 1817, the slopes and canyon bottoms of the Sandias' and Manzanitas' eastern flanks were apparently uninhabited. Their only use during these years appears to be for the passage of Native raiding parties, for occasional firewood cutting by Puebloans, and for livestock grazing, woodcutting and mineral prospecting by Spanish colonists (Quintana and Kayser 1979:45).

In 1817, the tenacious Spanish colonists tried again. Eight families received permission to re-inhabit San Miguel de Laredo. The following year, they were among the 47 Albuqueque families that submitted two grant petitions for the land. These were approved, and the second Cañon de Carnué Land Grant was born. In February of 1819, 24 more families swelled the population at San Miguel de Laredo, and 22 families broke ground at the new settlement of San Antonio de Padua (San Antonio)(Quintana and Kayser 1980: 46). Several individuals among this new wave of settlers were *mestizo* (Spanish and Indian mixed blood) descendants of the original grantees, including sons of the genízaros Gregorio Gutiérrez and Juan Cristóval Jaramillo (Moisés Gonzales and Macario Griego personal communication, February, 2002).

Although the original documents for the 1763 grant have been lost, the boundaries for the new grant –as well as those described in the failed petition of 1774 – are believed to be

the same as for the first grant. Quintana and Kayser report them thusly: The north boundary was marked by the headwaters of Bear Canyon, north and west of the village of Cañoncito; another north boundary marker was "the gypsum cliff which faces Cañoncito from east of present-day State Highway 14." The south boundary followed Coyote Creek, "which runs into Tijeras Arroyo from the southeast after crossing much of the present-day Sandia Military Reservation." The west boundary lay "near the [western] entrance to Tijeras Canyon, at a line marked by a tiny rock outcrop called El Huérfano (The Orphan), and the east boundary was the divide east of present-day Sedillo." In the 1890's, the grant's heirs estimated its total acreage to be over 36,000 hectares, or some 90,000 acres (Quintana and Kayser 1980:46).

Settlement of Carnué grant lands appears to have been confined to the eastern slopes of the Sandia Mountains, along the western boundary, until the 1860's. The continued presence of Apache raiders, notably the Mescalero at this time, discouraged permanent settlement of the project area, in the eastern part of the grant. San Miguel de Laredo, San Antonio, Cañoncito, Ranchitos, and Tijeras struggled to survive amid Indian attacks, drought, rugged terrain, and short growing seasons. Due to the scarcity of water at San Miguel de Laredo, population growth at the other, more northern, settlements, soon outstripped it (Quintana and Kayser 1980:48-49). The land that lay between and beyond the villages was utilized for a variety of seasonal subsistence activities, e.g., herding, dry-land farming, and woodcutting (Moisés Gonzales personal communication, February, 2002).

1863 – 1920 A.D. It was not until after the U.S. government quelled the Navajos and Mescaleros in 1863, that permanent settlements began to spring up in and around the project area:

> Following the removal of the Apache threat in 1865[sic], new villages were founded throughout the Canon de Carnue Grant. These villages include: Primera Agua, Gutierrez Canyon, Bartolo Baca, Tablazon, Zamora, Yrisarri, Cedro, Well Country Camp/Hobbies, and Carlito Springs. (Bernalillo County 1992:30)

Passage of the Homesteading Act of 1862 and similar laws permitting the privatization of public lands enabled land grant heirs to extend their holdings, and to later recoup some of their losses resulting from the decisions by the U.S Court of Land Claims inn1901, which reduced their holdings to some 2,000 acres (U.S. Surveyor General's Office March 30, 1901:Cañon de Carnué Grant patent.). The homesteading laws also enabled Anglo settlers to obtain a foothold, mostly on the eastern margin of in the project area.

The village of Cedro apparently first saw settlement in the late 1860's as the Griego family, Carnué grant heirs, settled the area (Wilson 1994:37). Many homestead patents in the Cedro area, dating from 1882 through 1890, were issued to Hispanics surnamed Griego (U.S. General Land Office, n.d.: Homestead Entry (HE) Patents numbers 279, 281, 310, 911, 974). Testimony before the U.S. Office of the Surveyor General in 1882 identifies Cedro as one of the Carnué land grant villages (U.S. Office of the Surveyor General 1882). It is still inhabited today.

Primera Agua was settled in the late 1870's (Quintana and Kayser, 1980:49.) It has since become part of the village Tijeras, as that community expanded throughout the 20th Century.

Ojo del Sabino (Sabino) was another community within the original grant boundaries. It, too, is mentioned as being one of the Carnué land grant towns in testimony before the Office of the Surveyor General (U.S. Office of the Surveyor General 1882). Aside from one entry in 1881 (U.S. General Land Office n.d.: H.E. Patent No. 280), land patents found for this area date from 1913 to 1922 (U.S. General Land Office n.d.: H.E. Patent numbers 367091, 574018, 715937, 848124). The surnames of the homesteaders, i.e., Gonzales and García -- are common among Carnué heirs (Moisés Gonzales and Macario Griego personal communication, February, 2002). This village was abandoned during the WWII era (1993d).

The village lay along the road through Sabino Canyon that is now known as Forest Road 242, near the center of T10N R6E Sec. 6. Only a few house foundations now remain, and there are traces of bean fields nearby (John Hayden personal communication, February, 2002). A typed report on the history of the area states that Sabino "use [sic] to be a fairly good size town" and that some residents worked at the nearby Riedmont Fox Farm when it was in operation. The author goes on to say:

> The village people had a hand dug well which the water came from a springfeed and they fed there[sic] animals as well as their selves[sic] from this well. There use[sic] to be a path where they would walk with the water to the village.
> (N. Sharp 1991)

The Riedmont Fox Farm, located in the extreme northwest corner of T10N R6E Sec. 6, now lies abandoned on Forest Service land. It raised silver foxes for the fur industry. It appears to have been constructed sometime after the village of Sabino (John Hayden personal communication, February, 2002). It was in operation in 1936, when it was cited in a WPA report as "one of the successful fur farming industries in New Mexico" (D.D. Sharp 1936:6).

Juan Tomás is said to have been named for an Anglo homesteader, John Thomas, who settled in the area in the 1870's (Wilson 1994:39). One source states that its period of occupation lasted from 1870 through the early 1960's (Thacker 2001:17). There are indications, however, that use of the area began earlier, as residents from Carnuel (San Miguel de Laredo) and other older land grant villages established agriculture fields on or near the townsite (Herrera n.d.:1; Wilson 1994:39). Four homestead patents found for this area were dated 1886 (H.E. Patent No. 230), 1890 (H.E. Patent No. 275), 1909 (H.E. Patent 69670), and 1914 (H.E. Patent 433772; all patents in U.S. General Land Office n.d.).

The 1886 patent produced the only Anglo name to appear on homestead land patents researched for the project area: Henry Carpenter. He may have been a Frenchman whose

name, Kopenter(?) became anglicized through time. This individual may be the father of Mrs. Esther Carpenter Runner, who in 1992 told an interviewer that her father had cut timber in the Oak Flat area in the 1920's and 1930's (McGraw 1997:5). The village of Juan Tomás is reported to once have been "a thriving logging community" (Thacker 2001:7). The townsite is occupied today, but this may represent a recent repopulation of the area.

The area known as Tablazón follows the dispersed Midwestern settlement pattern and may date from 1890's to the early years of the 20th Century. It consisted of three or four homesteads in the vicinity of T20N R6E Sec.20. Tablazón's inhabitants apparently also farmed pinto beans during the "bean boom" era (John Hayden personal communication, February, 2002). It is now abandoned and lies on Forest Service land.

The village of Bartolo Baca is the site of what may be the last penitente *morada* to be built on the Carnué grant (Anonymous, "Historical Sites," in Wilson, n.d.: Folder 5). The morada is apparently still standing but is no longer in use. Traces of the *via cruces* (stations of the cross) route from the old morada in San Antonio to this community may still be seen (John Hayden personal communication, February, 2002).

The period of time between 1860 and 1880 marked the settlement of Zamora, Sedillo, and Tecolote (Gutiérrez), near the eastern end of the Cañon de Carnué grant (Quintana and Kayser 1980:49). Like Cedro and Ojo del Sabino, Sedillo is also mentioned as being a Carnué grant town (Surveyor General 1882). All of these communities lay along the east-west passage through Tijeras Canyon, a route that eventually became the renowned Route 66 and, finally, today's Interstate 40. The Anglo homestead community of Barton sprang up around the turn of the century, just south of present-day I-40 at the intersection of NM 217, just northeast of the project area.

1920 – 1950 A.D. (The "Bean Boom")

This was the era of dry farmed pinto bean production in the Estancia Valley -- a vast closed watershed lying a few miles to the east of the project area. Although the project area is marginal to prime bean-growing land, "many Hispanos homesteaded additional lands east of their villages, and also began to raise beans by dry land methods" (Wilson 1994:15). There are traces of bean fields throughout the project area especially in its eastern area (John Hayden personal communication, February, 2002;). However, commercial bean farming probably only supplemented the traditional subsistence strategies of the Hispanic population of the area. A 1937 Soil Conservation Services report stated that, at that time there was "practically no marketable surplus of beans in the villages of Carunel, La Tijera [Tijeras], San Antonio, and San Antonito" (Soil Conservation Services 1937:18).

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Settlement and Land Use Patterns

The relative age and predominant ethnicity of settlements in and around the project area may sometimes be deduced by aggregation or dispersal of habitation sites. San Miguel de

Laredo and other pre-1860's land grant villages were compact, plaza-centered, and fortified against Indian attack. The able-bodied male inhabitants used these as base camps, from which they ranged during the warm months to perform a number of subsistence tasks, e.g., herding, farming *al temporal* (dry-farming) in small dispersed fields, cutting firewood, gathering medicinal plants, quarrying *cal* (limestone), and hunting game. They also carried out retaliatory raids against nomadic bands and traveled to east to the Plains to hunt buffalo (Moisés Gonzales and Macario Griego personal communication, February, 2002).

With the exception of the introduction of domesticated herding animals and orchards, much of the lifeway of the grant settlers during these early years resembled that of the Anasazi/ Peubloans whom they replaced. There was extensive use of stone tools, e.g., the bow and arrow, stone-tipped lances, manos and metates. In addition to the acequia-irrigated fields near the villages, dispersed and isolated garden plots were cultivated throughout the grant lands. In the spring, men would journey from their homes, herding their flocks of sheep and goats throughout the extent of the grant. Traditionally, members from the same families would travel together (Moisés Gonzales and Macario Griego personal communication, February, 2002).

The herders would pause along the way to sow crops in small dry-farmed *milpas* (cornfields) and *huertas* (fields that bore crops other than corn). They would then continue on their way with their herds and leave the crops to fend for themselves during the growing season. In the fall, they would return for the harvest. For shelter, they constructed small "field houses" for shelter and *corrales* for their animals. This seasonally nomadic lifestyle served to utilize portions of the grant too dangerous for permanent settlement and to evade detection by hostile Native bands. Even after that threat was removed, the grant heirs continue this dispersed use pattern throughout the grant lands to this day, to the extent to which their diminished land base permits (Moisés Gonzales and Macario Griego personal communication, February, 2002).

With the cessation of the threat of Indian attack in the 1860's, new construction in the established villages gradually encroached on the plazas and spread along streambeds and roads. This type of linear settlement has been termed the *cordillera* pattern (Wilson 1994:19).

Hispanic homesteaders tended to cluster habitation and other structures at the convergence of adjacent homestead allotments; the villages of Cedro, and possibly Ojo del Sabino and Juan Tomás, were created in this manner. Moreover, the physical isolation of the Hispanic villages throughout the Tijeras Canyon was mitigated by "their common heritage of the land grant and by the dense network of kinship that prevailed among most families" (Quintana and Kayser 1980:50).

Anglo homesteaders tended to build in the middle of their lands, using their fields and pastures as a buffer zone between themselves and their neighbors. This pattern that been called the *Midwestern* style.

Most, if not all, of the settlements located in the project area are believed to be Hispanic or Hispanic dominated (Wilson 1994:*passim*; Soil Conservation Services 1937:3):

> Of the 240 families in the villages [located in the vicinity of today's Sandia Ranger District] other than Cedar Crest and Sandia Park, 217 are of Spanish-American extraction and are Spanish-speaking. There are only 23 so-called 'Anglo' groups. (Soil Conservation Service 1937:17)

Tijeras appears to be the only village located in the project area prior to the elimination of Indian threat in the early 1860's. The other known settlement came into being after this time. Most are laid out in plaza-less cluster or cordillera patterns. Tablazón seems to be the only known settlement in the area that follows the Midwestern pattern. This dispersed pattern, coupled with its proximity to the Anglo homesteaded settlement of Barton (located just south of I-40 at the junction of NM 217), may indicate a relatively late date for its beginnings and/or the presence of Anglo inhabitants.

A 1936 WPA report on Tijeras Village provides a glimpse of the subsistence activities that probably characterized many of the small Hispanic communities in the study area from time of settlement to the beginning of WWII: "Most of the villagers make their living hauling wood to Albuquerque and rounding out with small 'milpas' of corn, beans, chili, and some have herds of goats" (D.D. Sharp 1936:4-5). Orchards of "apples, peaches, and wild plums" were also grown for home consumption (Soil Conservation Service 1937:18).

The Hispanic villagers also practiced various "cottage industries," such as the tanning of hides and the making of cheese. Village technology was primitive by Anglo-American standards well into the 20th Century. Bread was baked in outdoor *hornos*; women hand-plastered their homes, using "a very white baked gypsum which is taken from nearby hills." In addition, "[b]eans and wheat are still threshed by driving ponies around and around upon the threshing floor, except where large acreages are planted. Campfires are still numerous up and down the canyon where the 'leñeros' or wood-haulers have halted to feed their ponies and heat their coffee and beans" (D.D. Sharp 1936:5).

Many village inhabitants, particularly the able-bodied males, have traditionally augmented their subsistence activities with wage work or barter. In Colonial times, men sometimes ventured onto the Plains to hunt buffalo and trade with the Indian tribes in that region. They joined the ranks of teamsters on the Santa Fe Trail during the Mexican and early Territorial periods (1821 to mid- to late 1800's), and hauled freight from the railhead in Raton in the 1870's (Quintana and Kayser, 1980:47-49). They first prospected, then worked in the ore mines during the mining boom of the 1860's – early 20th Century, along the present-day Turquoise Trail, to the north of Tijeras Canyon (Quintana and Kayser, 1980:47-48). They also cut timber and built sawmills to supply lumber for those mines and for the railroad when it came through the region in 1905 – 1930. (Cordell 1979:129).

The mining and railroad construction booms died in 1919. With their demise, most local employment opportunities virtually disappeared, and out-of-area jobs followed suit soon after, in the Depression years (Soil Conservation Service 1937:22-23). The health and recreation boom that began just before 1920 brought growth and culture change to what is now the I-40 corridor and the Anglo-dominated communities of Cedar Crest and Sandia Park. It had little positive effect on the economies of the traditional Hispanic towns. "The resort camps, dance halls, and highway filling stations and stores are functionally no part of the communities in the canyon" (Soil Conservation Service 1937:21). This situation holds true, to a certain extent, today.

The creation of the national forest had a gradual but considerable adverse effect on the ability of the inhabitants of the project area to pursue their traditional land use activities:

> Large portions of both the Manzano and Sandia Mountains went into the Manzano Forest Reserve in 1906, which was renamed the Cibola National Forest in 1931, and were finally designated wilderness areas under the Wilderness Preservation Act of 1964. Residents of the land grants and other Hispanic villages at first continued as they had for generations to graze their livestock, cut firewood, and cut timbers in the forests. But gradual imposition of regulations, permits, fees and outright prohibitions substantially curtailed access to these resources by World War II. (Wilson 1994:15)

The curtailment of firewood cutting also effectively halted the commercial production of lime in the area, as traditional sources of wood for the firing of the lime kilns became unavailable (Soil Conservation Service 1937:22).

Area Access

The traditional means of traversing the region has been and continues to be through Tijeras Canyon. The routes that navigate it have been known progressively through time as Tijeras Road, Route 66, and, now I-40. The principal north-south access route cut a somewhat wider swath, in the area of Cedro, Otero, and Juan Toro canyons. John Hayden reports that portions of this route can be traced via rock art sites and later, multiple wagon roads (John Hayden personal communication, February, 2002; also see Benedict 1996). A recent Forest Service heritage resource survey discovered traces of one of these roads in the western portion of the project area:

> A natural surfaced road that traverses the central portion of the [Oak Flat Fuelwod Survey] project was historically the main highway from Tijeras to the communities of Cedro, Juan Tomas, and Escabosa. Primary utilization of the road began following WWII, and the road was permanently closed by the Forest Service in 1975. State Highway #14 replaced the road during the 1950's. (McGraw 1997:5).

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Historic Land Uses and Site Types

It is important to realize that the Spanish/Hispanic inhabitants of New Mexico -- due to their isolation from sources of manufactured items -- produced lithic and ceramic artifacts. Lithics included gunflints, as well as projectile points, utilized flakes, and other stone tools usually associated with "Indian" manufacture. This technology is thought to have persisted until Anglo trade via the Santa Fe Trail made metal tools commonplace (Moore 1992). Hispanic ceramic production is believed to have begun in the late 18th Century and to have persisted nearly until the 20th Century. In contrast to indigenous techniques, some Hispanic pottery was mass produced by the use of molds (Carrillo 1997).

- **Early ephemeral use.** Traces of early Apachean, Comanche, and Ute raiding parties are difficult to observe in the archeological record, though projectile points whose styles are attributable to these nomadic cultures sometimes occur as isolated finds through the Sandia and Mountainair Ranger Districts (personal observation by the author). Pre-1860's, Hispanic use of the area includes widely dispersed herding and agricultural practices, retaliatory strikes against nomadic raiders, hunting, small scale limestone quarrying, and mineral prospecting. Look for "field house" type structures used by seasonal herders; *corrales* made of dry-laid rock, horizontal pole-and-rock construction, or vertical posts connected by brush, poles, wire, etc.; check dams, rock alignments, and other water control features; *Hispanic* lithic arrowheads and lance points Moore 1992) and *Hispanic* potsherds (Carrillo 1997).

(The following descriptions rely on information provided by John Hayden personal communication, February, 2002.)

- **Traditional Hispanic settlements, with associated *milpas*, or garden and orchard plots**. Other Hispanic hamlets and farmsteads may exist in addition to the settlements discussed above. Such a settlement is located in Cedro Canyon, in Twp 9 N R5E Sec. 2 SE ¼. This site contains remnants of garden plots and a forge with associated cinder and ash deposits. Also look for adobe, jacal (*casas de lata*), and horizontal log (*fuerte*) construction technologies; "hewn logs with double-boxed notching" (Wilson 1994:21); dry-laid rock corrals; "feral" domesticated plants (e.g., apple and other fruit trees), and ditches and other features associated with acequia irrigation technology (Warren 1980). Settlements begun after the mid-1860's will probably follow plaza-less clustered, cordillera, or – less frequently -- dispersed ("Midwestern") settlement patterns. Again, Hispanic-produced lithics (Moore 1992) and potsherds may occur.
- **Anglo homesteads.** Research in the GLO records archived in the Santa Fe BLM office suggests that Anglo homesteaders did not begin to settle in the project area until the 1870's. Some, perhaps the "John Thomas" -- after whom Juan Tomás is purportedly named – may have acculturated to the existing Hispanic lifestyle. It may difficult to determine the ethnicity of post-1880's homesteads. As seen in the case of Tablazón, above, a Midwestern settlement pattern alone does not guarantee Anglo occupation. Cultural elements diagnostic of Anglo presence *may* include: "unhewn logs with double saddle notching" (Wilson 1994:21),

commercially milled lumber, windmill-based irrigation, relatively more and more costly manufactured household items, tools, and farm equipment (including mail order goods); absence of dry laid stone corrals; absence of jacal construction; windmills; earlier replacement of draft animals with autos and other motorized equipment; and other indications of greater affluence and participation in a monetized, commercial, and supra-regional economy, relative to the Hispanic population. This discrepancy may become progressively marked through time, e.g., presence of draft animals and absence of an automobile in a late 1930's site would strengthen the argument for Hispanic affinity.

- **Commercial pinto bean farming.** As noted above, sites representing this activity may be expected to increase towards the eastern boundary of the project area. Conditions in the project area -- in terms of elevation, climate, and ruggedness of terrain -- made this type of agricultural endeavor risky, and the area remained an outlier to the heart of the bean farming industry, a few miles to the east in the Estancia Valley. The bean-farming boom probably began the 1920's and ended with the catastrophic drought in the late 1940's – early 1950's (Donald Hall personal communication, February, 2002). Fields were mostly dry-farmed, i.e., not irrigated by either acequia or windmill technologies. Check dams and diversion dams may be visible as cobble alignments associated with and across drainages (author's observations in the Mountainair Ranger District). Look for vegetation changes, cleared areas in tree cover, old barbed wire fencing, boundary rock cairns and alignments, old two-track roads.
- **Firewood gathering.** This may be the most common ephemeral use of the area since Puebloan times. Sites may be expected to occur throughout the area. **Single-episode dumping of historic trash** is often associated with this activity: People would take their trash with them when they went to cut wood and leave it on site. Look for axe and crosscut saw scars on trees and stumps. Use diagnostic historic artifacts in associated trash scatters to date the sites.
- **Timber harvesting and processing.** Distinct from wood gathering, this activity involved the commercial harvesting of ponderosa pine and processing it into lumber. This activity may have begun as early as the 1860's; it continued through ca. 1930. A resident of the Oak Flat vicinity, Mrs. Esther Carpenter Runner, told Forest Service personnel in 1992 that her father once operated a sawmill in that area (John Hayden personal communication, February, 2002). Look for crosscut saw (and possibly early steam powered chainsaw) scars on stumps. **Portable sawmill sites** will be associated with this activity and may include rock piles for temporary foundations, sheets of galvanized metal (used in smokestacks and other structures), concrete foundations for "donkey" engines and boilers. Sometimes the ruins of semi-permanent houses may be found, as well. These domiciles were usually occupied for five to ten years and similar to, but sometimes more affluent than, homestead houses. Look for house mounds, window glass, porcelain and other historic potsherds, wood stove parts, miscellaneous refuse, feral landscaping plants, e.g., domesticated iris. To date, use makers' marks on ceramics and bottles, and other diagnostic artifacts.

- **Commercial quarrying and burning of limestone.** Much of the bedrock in the project area is limestone. This was commercially quarried and burned to obtain lime, probably beginning in the late 19th Century. The industry came to an end shortly after 1906, when the creation of the (future) Cibola National Forest curtailed the harvesting of firewood for the kilns (soil Conservation Service 1937:22). Limestone kilns are semi-subterranean and beehive in shape. They are known to occur throughout the Sandia District. Most, if not all, are said to have belonged to Charlie Campo, "an early trader and well known character in the village [of Tijeras], though he has been dead now about fifteen years," i.e., ca. 1921 (D.D. Sharp 1936:2). One such kiln, located on private land in T10N R6E Sec. 22 is accompanied by an above-ground kiln that may be a charcoal kiln. A Mr. Tolouse, a lawyer who lives in Albuquerque, may own the land on which it is situated.
- **Prospecting and mining for precious ores**, including gold and copper. This activity apparently began in Puebloan times (e.g., turquoise mine in Cerrillos, malachite mine near Tijeras Pueblo) and may continue to the present day. A mineral entry land patent dated 1958 refers to several claims in "the Cedro mining district" (U.S. General Land Office: Mineral Entry Patent No.1184898). A copper mine once existed on a ridge east of the present heliport; remnants of its headframe may still exist. For historic claims, look for validation trenches, wooden claim markers with attached cans or (later) glass jars. These containers once held claim documents for all to inspect. Used associated historic trash to date. For mining activities, look for headframes and associated structures, remnants of placer technologies, associated miners' camps. Examples of the latter are said to occur just south of the project area.
- **Beacons for aircraft.** Dating from the beginning of the aviation era, i.e., late 1930's to early 1940's, a system a of beacons was set out as navigational. The project area lies across one such flight route, and a beacon site has been recorded nearby (Wilkes 1990). Another beacon was constructed on Cedro Peak in 1935 by the CCC (Phillips 1996:1). Look for concrete pilons that form a polygon on the ground, remains of the beacon tower base, associated structures.
- **Multi-episode trash dumps**. In addition to the ephemeral trash dumps and scatters often associated with woodcutting, The project area is dotted with concentrations of historic trash that represent repeated depositions at family or community dumpsites. These are frequently located in and around side canyons leading off of old roads, e.g., along Forest Road 462, especially near NM 337. Look for obviously stratified deposits, partially buried deposits, diagnostic artifacts from more than one significant time period, e.g., more than one decade. (Moisés Gonzales and Macario Griego personal communication, February, 2002).
- **Bootlegging**. Several sources mention this activity as a source of cash income (and entertainment?) during the Prohibition era (Rowland 1982:11) "The excellent spring water of San Antonio gave the product a high reputation" (Quintana and Kayser 1980:5). Look for moonshine stills!

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References

Anonymous
1991? Historical Sites. In Wilson n.d., Folder 5: *Bernalillo County Historical Background.*

Anonymous
1975 New Mexico Dig Uncovers 700-Year-Old Ruins. *Albuquerque Journal*, Sunday, July 22, 1975:F8. In vertical files, "Tijeras Canyon" folder, Center for Southwest Research, Zimmerman Library, University of New Mexico, Albuquerque.

Benedict, Cynthia Buttery
2001 Heatherland Hills Fuels Reduction Project. Heritage Resources Report No. 2001-03-044B. On file at the Cibola National Forest Supervisor's Office, Albuquerque, NM.

1996 Trails, Fuels, Habitat, Recreation, and Roads Project in the Manzanita Mountains–Phase 4. Heritage Resources Report No. 1996-03-037. On file at the Cibola National Forest Supervisor's Office, Albuquerque.

Bernalillo County Planning Dept.
1992 East Mountain Area Plan. On file at the City-County Building, Albuquerque, NM.

Binford, L.R.
1994 System Integration of "Fragmentary Oddments": The Challenge of Settlement Pattern Approaches." *Archaic Hunter-Gatherer Archaeology in the American Southwest*, Bradley J. Vierra, ed. Contributions in Anthropology 13(1):527-565. Eastern New Mexico University, Portales.

1980 Willow Smoke and Dogs' Tails: Hunter-Gatherer Settlement Systems and Archaeological Site Formation. *American Antiquity* 45:4-20.

1979 Organization and Formation Processes: Looking at Curated Technologies. *Journal of Anthropological Research* 35:255-273.

Buddecke, Martha
1968 Sandia Ranger Home Site Excavation Yields Artifacts. *Albuquerque Journal*, Sunday, June 30, 1968: C-10. In vertical files, "Tijeras Canyon" folder, Center for Southwest Research, Zimmerman Library, University of New Mexico, Albuquerque.

Carrillo, Charles M.
1997 Hispanic New Mexican Pottery: Evidence of Craft Specialization, 1790 – 1890. LPD Press, Albuquerque, New Mexico.

Cordell, Linda S.
1979 *A Cultural Resources Overview of the Middle Rio Grande Valley, New Mexico*. USDA National Forest Service and USDI Bureau of Land Management, US Government Printing Office, Washington, DC.

Cordell, Linda S., editor.
1980 *Tijeras Canyon: Analyses of the Past*. University of New Mexico Press, Albuquerque.

Cordell, Linda S., Blevins, Byron, and Joiner, Carol
1977 The 1975 Excavation of Tijeras Pueblo, Cibola National Forest, NM. The Archaeological Survey of Tijeras Canyon. The 1976 Excavation of Tijeras Pueblo, Cibola National Forest, NM. USDA Forest Service, Southwest Region, Albuquerque.

Fredine, Jeffrey L. and Wick, Robert
1998 Archaeological survey of 2,070 Acres for the Armijo and David Canyon Prescribed Burns, Cibola National Forest, Bernalillo County, New Mexico. Lone Mountain Archaeological Services, Inc., Albuquerque, NM. Report No. 269. NMCRIS #60888. Heritage Resources Report No. 1998-03-062. On file at the Cibola National Forest Supervisor's Office, Albuquerque.

Garber, Emily H.
1982 Prehistoric Technology and Subsistence Organization in the Sedillo, New Mexico, Vicinity. Heritage Resources Report No. 1982-03-010. On file at the Cibola National Forest Supervisor's Office, Albuquerque.

1980 Cultural Resources Clearance Investigation of the Proposed Land Exchange Area South of Sedillo, NM, Cibola National Forest. Heritage Resources Report No. 1980-03-016. On file at the Cibola National Forest Supervisor's Office, Albuquerque.

Garcia-Luna, Jacqueline
1999 The San Miguel de Laredo – Carnué Land Grant of 1763. *New Mexico Genealogist* 34(4):151-171.

Gentry, Rita
2000 Forest Road 462 Maintenance. Heritage Resources Report No. 00-03-031. On file at the Cibola National Forest Supervisor's Office, Albuquerque.

Haecker, Charles M.
1988 Eleven Miles of ROW on I-40, Tijeras Canyon. New Mexico State Highway and Transportation Department Project No. IR-040-3(80)168, NMSHTD Report No. 87-95. Heritage Resources Report No. 88-03-020. On file at the Cibola National Forest Supervisor's Office, Albuquerque.

Stuart, David E., and Rory P. Gauthier
1981 *Prehistoric New Mexico: Background for Survey*. New Mexico Historic Preservation Division, Santa Fe.

Sundt, William M. and Bice, Richard A.
1989 Preliminary Report: Tijeras Canyon Sites AS-10. Albuquerque Archaeological Society, NM. Heritage Resources Report No. 1989-03-041. On file at the Cibola National Forest Supervisor's Office, Albuquerque, NM.

Tainter, Joseph A.
1982 Cultural Resources Clearance for the Sedillo Section of the Proposed Elena Gallegos Land Exchange. Heritage Resources Report No. 1982-03-032. On file at the Cibola National Forest Supervisor's Office, Albuquerque, NM.

Tainter, Joseph A., and Levine, Frances
1987 *Cultural Resources Overview: Central New Mexico*. USDA Forest Service, SE Region, Albuquerque, NM; USDI Bureau of Land Management, New Mexico State Office, Santa Fe.

Thacker, John
2001 Heatherland Hills Fuels Reduction Project. NMCRIS Activity #76153. Heritage Resources Report No. 2001-03-044. On file at the Cibola National Forest Supervisor's Office, Albuquerque, NM.

U.S. General Land Office
n.d. Land patent and lease plats for T9N R5E , T9N R6E, T10N R5E, and T10N R6E. On file at the USDI Bureau of Land Management, New Mexico State Office, Santa Fe.

U.S. Office of the Surveyor General

1901 Cañon de Carnué Grant patent, March 30, 1901. SANM1 Rel 27, SG 150 Frames 1000 to 1002. New Mexico State Records Center and Archives, Santa Fe.

1882 File No. 96 3. Juan Ignacio Tafoya Cañon de Carnué Grant. Depositions of Salvador Garcia, Pablo Crespin, Abad Nieto, Francis Martinez. Taken July 18, 1882. SANM 1, Reel 27, SG 150 Frames 755 to 765. New Mexico State Records Center and Archives, Santa Fe.

Vierra, Bradley J., ed.
1994 *Archaic Hunter-Gatherer Archaeology in the American Southwest*. Contributions in Anthropology 13(1). Eastern New Mexico University, Portales.

Warren, Nancy Hunter
1980. The Irrigation Ditch. *El Palacio* (86)1: 20-28.

Wilkes, Joan
1993a Tablazon, Forest Road #462: a Cultural Resources Survey. Heritage Resources Report 1993-03-048. On file at the Cibola National Forest Supervisor's Office, Albuquerque, NM.

1993b Tablazon Well and Drinker: A Cultural Resources Survey. Heritage Resources Report No. 1993-03-051. On file at the Cibola National Forest Supervisor's Office, Albuquerque, NM.

1993c Forest Roads 242/252: A Cultural Resources Survey. Heritage Resources Report 1993-03-103. On file at the Cibola National Forest Supervisor's Office, Albuquerque, NM.

1993d NM 337, Cutbank Scaling: A Cultural Resources Survey. Heritage Resources Report No. 1993-03-089. On file at the Cibola National Forest Supervisor's Office, Albuquerque, NM.

1990 Oak Flat Material Pit: A Cultural Resources Survey. Heritage Resources Report No. 1990-03-089. On file at the Cibola National Forest Supervisor's Office, Albuquerque, NM.

1988 A Cultural Resources Survey, Cedro Campground, Group Reservation Area. Heritage Resources Report No. 1988-03-142. On file at the Cibola National Forest Supervisor's Office, Albuquerque, NM.

Wilson, Chris
1994 *Historic Resources Reconnaissance Survey of the Manzano and Sandia Mountain Villages*. New Mexico Historic Preservation Division, Santa Fe.

n.d. Research notes and photographs for *Historic Resources Reconnaissance Survey of the Manzano and Sandia Mountain Villages.* On file at the NMHPD, Santa Fe.

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Appendix II

CAÑON DE CARNUÉ: SETTLEMENT OF A GRANT

ROBERT ARCHIBALD

The Villa de Albuquerque, founded early in 1706, was settled at a time unpropitious for success.[1] Powerful Comanches continued to push various Apache groups from their adopted homes on the southern plains into the arid and often hostile Southwest.[2] As early as 1706 Governor Francisco Cuervo y Valdez found it prudent to assign a squad of soldiers for protection of the tenuous new town in view of constant raids undertaken by Apaches.[3] The Apache menace became a fact of life for farmers and ranchers of the area who tenaciously struggled for survival along the Río Grande. These pioneers found existence precarious and, with Pueblo allies, fought a continuous battle against incursions from all directions, particularly Apache raiding parties which conducted frequent and often violent attacks from the direction of the Sandia Mountains.[4]

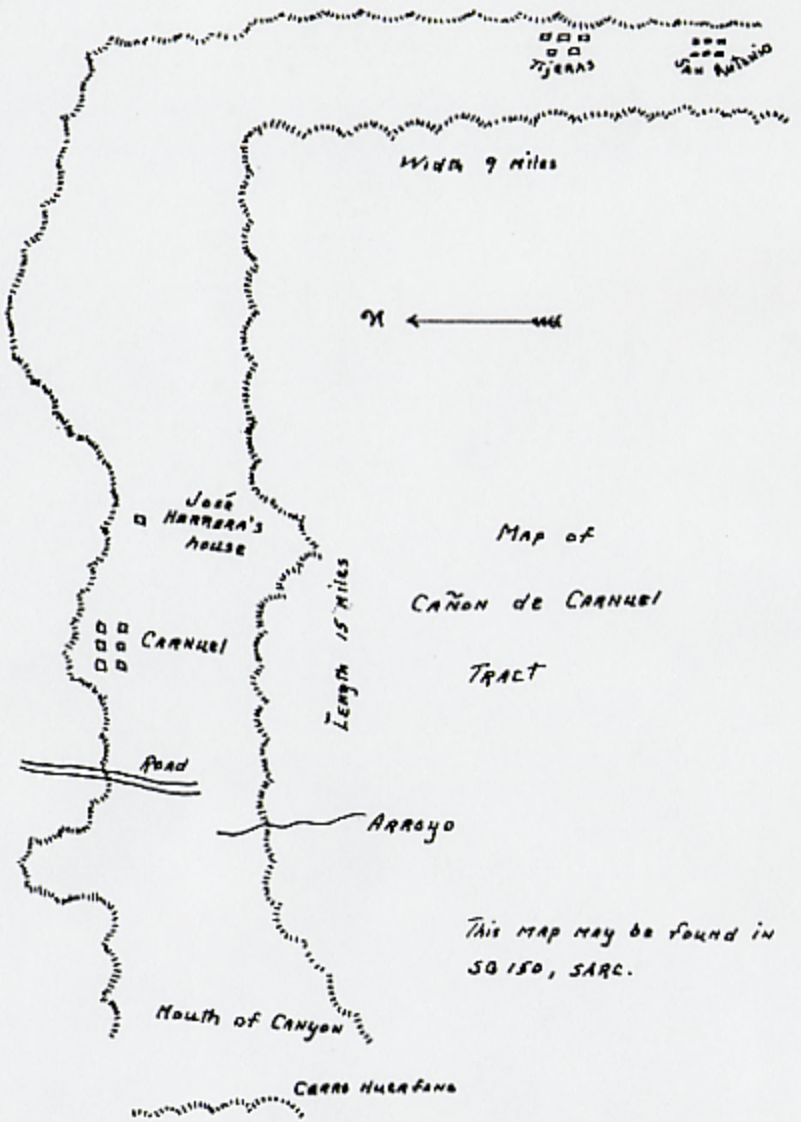
Apaches variously identified as Faraones, Gileños and Natages raided for livestock and captives to be dearly ransomed at a later date.[5] These warriors were alternately at war or peace with the Spaniards and Pueblo Indians, depending upon advantages to be gained for themselves. Despite laws to the contrary, settlements in the Albuquerque jurisdiction, stretching from Alameda south, were poorly designed for defense. Instead of compact plazas adjacent to farm and stock land, foolhardy but brave settlers preferred to live each on his own piece of land.

In the 1780s Fray Juan Agustín de Morfi observed the disorder and chaos caused by the dispersed pattern of settlement. Not one town was well organized for defense. Albuquerque was the worst

offender with its inhabitants scattered for a dozen leagues along the Río Grande lifeline. If citizens could be compelled to form compact villages a large town would develop, common defense would be possible and sufficient acreage of land for agriculture and grazing would be available for all.[6]

Much of the menace to Albuquerque and its environs centered on the Sandia Mountains, located just to the east, and in the ancient pass through the mountains, Tijeras or Cañon de Carnué. As early as 1704 General Diego de Vargas had campaigned against the Faraon Apaches in this area. Vargas marched south on March 30, 1704 from Bernalillo to a wooded area between the Río Grande and Sandia Mountains with his force complemented by a troop of thirty Pueblo auxiliaries. Vargas ordered his auxiliaries under Captain Joseph Naranjo to reconnoiter from the "watering place of Carnué" where Apaches were keeping sheep stolen from Spanish citizens. The troops reported that the entire Apache camp was fortified in a defensive position but that upon being spotted the group had abandoned their position and had left stolen stock in their wake. This document and others suggest that the canyon was frequented by raiding Apaches who found between its narrow walls a safe haven and a secure base of operations. Small fields with plentiful vegetation along the Tijeras Arroyo provided feed for stock and water for man and beast.[7] In 1754 Governor Vélez Cachupín noted the threat posed to the Río Abajo villages and specifically Albuquerque by raiding Apaches:

> The capital city of Santa Fe, with its forces, has the responsibility of repelling incursions by Carlana and Natage Apaches and also by the Comanches, that of Santa Cruz [de la Cañada] with its adjacent districts and towns, from attacks by Utes and other allies; and that of Albuquerque against the Faraones and Gileños. Thus each town with its outlying districts has this annoying and difficult situation, its residents living in constant anxiety, they and all their rural property subject to becoming victims of the cruelty and fierceness of those barbarians.[8]



The Indian threat to Albuquerque, and the availability of fertile land and water determined that petitions for grants of land in Tijeras Canyon, known then as Cañon de Carnué, would receive favorable consideration. Settlement in the canyon could prosper because of geographical advantages and would additionally constitute a frontier buffer against raiding Apaches for larger Río Grande Valley settlements.

In 1762 nineteen prospective settlers petitioned Governor Tomás Vélez Cachupín for a grant of land in the Cañon de Carnué. Governor Cachupín replied in February of the following year, confirming the grant.[9] A search of the provincial archives proved that indeed there were no adverse claims to the requested parcel and further that the land was unoccupied and uncultivated. All men named in the grant except Joseph Antonio Baca were married and with families. Baca was ordered to "marry for the increase and concord of the settlement" before he would be confirmed in his grant. The concession as specified by Governor Cachupín was for agricultural lands only, although a house lot fifty varas square was allowed per family to assure sufficient space in corrals for large and small stock "so that the enemy may not steal them." The town and its buildings were to be constructed in the usual adobe style and precautions were to be made for security in view of incursions which hostile Indians frequently made.[10]

Antonio Baca, Alcalde Mayor of the Albuquerque jurisdiction in which the new settlement was to be located, was ordered to place the recipients in possession and to mark off lands most appropriate for the village and its houses. Grazing lands were to be held in common and the town rather than individuals was to be given title to them.[11]

On February 12, 1763, Antonio Baca led the prospective settlers up the gentle slope from Albuquerque into the Cañon de Carnué where, in accordance with the governor's order, he put them in possession of land. In grand feudal style the alcalde related:

> I took them by the hand, and one by one, I walked them over their lands where they shouted, pulled up grass, threw stones, and acquired royal and personal possession, shouting—Long live our King, Don Carlos III . . .[12]

Ceremonies completed, the alcalde began the critical process of assigning lands to each settler. The settlement was laid out in a perfect square and lands for house lots were allotted on the basis of "thirty square Castillian varas to those who could do least and those who could do more were left to their own decision." In this fashion each family was allowed a garden plot and agricultural lands for wheat and corn. It now remained for the alcalde to designate the permanent boundaries of the grant itself. As was standard, the grant was to encompass four leagues, one league in each cardinal direction from the center of the plaza. In 1763, without modern measuring devices, the league was an indefinite and personal measure at best. It is apparent that Baca did not literally walk the boundaries but rather gave landmarks in each direction towards which the boundaries extended.[13] Hence on the east the league extended toward an old ruined Pueblo near the center of the mountain; on the north toward Cañada de Oso; on the west toward the plain; and on the south in the direction of the Agua del Coyote.

The settlers were enjoined to set up permanent landmarks at the boundaries. All land not assigned individually, including pasturage, was to be held and used in common and shared with later settlers. A total of twenty-five settlers were authorized by Governor Cachupín but only nineteen were put in possession, leaving room for some increase.

On February 20, Governor Cachupín gave his approval to the act of possession supervised by the alcalde mayor. He further approved the permanent boundaries which had already been delineated and added that this was a reduction of those originally sought by the grantees. The size of the grant was restricted because of possible future settlements in the area. The governor did allow that if the settlement of San Miguel de Carnué increased

in size more agricultural lands extending west out onto the plain along Tijeras Arroyo might be added since there was no other irrigable land and the cañada out toward the plain was narrow. The governor scolded the alcalde for having restricted the size of the house lots and for having exceeded his authority by so doing. In accordance with legal provisions he decreed house lots were to be fifty varas square.[14]

Life in the fledgling community was difficult indeed. Under constant threat from marauding Apaches, the settlement lacked even a local church and was dependent upon San Felipe de Neri de Albuquerque. Several entries in books kept by the Albuquerque church testify to this dependent relationship.[15] Records of a later settlement on the same site provide a clue to farming activities at San Miguel. Major crops certainly included chiles, onions, maize, wheat, beans, tobacco and pumpkins. Small gardens provided other produce consumed domestically.[16]

In early 1771 the discouraged settlers of San Miguel de Carnué abandoned the grant because of their inability to defend themselves adequately and sought refuge in Albuquerque. On April 8 they returned, albeit reluctantly, to San Miguel under orders from Governor Pedro Fermín de Mendinueta. The settlement dwindled to thirteen men capable of bearing arms of which four had no weapons. "What force is this," they asked Mendinueta, "to oppose the great boldness which the barbarous enemy now exhibits?" Answering their own question, the frightened thirteen once again abandoned the village and returned to Albuquerque on April 10th. They related to the governor that they had no food and no way of resisting the enemy which held the area in its possession. "The causes are sufficient," they claimed, "that your Lordship may be pleased to relieve us from so perilous a situation . . . ."[17]

Governor Mendinueta denied the request. He had been informed by the Alcalde Mayor of the Albuquerque jurisdiction, Francisco Trebol Navarro that a number of genízaros who were scattered in the Río Puerco region might be willing to join the original grantees at San Miguel de Carnué. Mendinueta fervently

hoped that the settlement might succeed and thus provide a defensive bastion for Albuquerque and its environs from Indian attack. With the genízaros as an additional source of manpower, success might be possible. Thus Trebol Navarro was ordered to assemble the genízaros together with the original settlers and make clear to them the governor's desire for a cooperative resettlement.[18]

Mendinueta accused the settlers of exaggerating the danger because of a lack of courage. If the unhappy grantees did not immediately proceed with a resettlement their grant would be revoked. The recalcitrant settlers were ordered to complete building the town, indicating that the eight-year-old village had never been finished and suggesting a reluctance on the part of the settlers to commit themselves to permanent existence in such a perilous situation. Fortification, cultivation of fields and buildings had never been completed. If the villagers did not return they were to be sent where they had lived before and work for others if they had no land. They were "not to wander about as vagrants" suggesting that some of the settlers had been unreliable vagabonds from the beginning.[19]

The alcalde mayor ordered all the settlers of Carnué to appear before him in the Albuquerque plaza on April 24th. The alcalde of the Río Puerco region was ordered to notify genízaros without fixed homes in his area to appear at Albuquerque on the same day.[20] The meeting took place as scheduled. Trebol Navarro promised the genízaros perfect equality with original grantees if they would join in resettling the San Miguel grant. The wary and frightened people replied "that in no way could they consent to go up to the resettlement, nor was it in their interest. . ." Trebol Navarro pleaded and attempted to minimize the risks involved but neither genízaros nor grantees agreed to a return, despite loss of the grant. They had, they maintained, inadequate force of arms and feared greatly that they would lose their lives at the hands of the Apaches. They pointed out that they had initially abandoned the site because in October of 1770 a number of their companions had been killed in just such an Apache raid. They were perfectly willing to re-

linquish the grant to avoid going back. The frustrated alcalde ended the meeting by reminding the settlers to gather before him on an appointed day for the purpose of going to Carnué to destroy signs of habitation. Furthermore, they were to return guns and ammunition supplied by the governor.[21]

On May 27th Alcalde Mayor Francisco Trebol Navarro proceeded with the settlers to demolish San Miguel de Carnué. Upon arriving in the doomed village each was ordered to demolish his residence and the buildings "were left in ruins on the ground."[22] The epitaph for this unfortunate initial settlement of San Miguel de Carnué was written by the famous clerical visitor, Fray Francisco Atanasio Domínguez, in 1776. Carnué, he observed, "was a settlement of ranchos like those everywhere, with very good farmlands irrigated from a stream of their own in that place. It was abandoned in the year 1772 because of the continual Apache raids."[23]

The 1763 settlement of San Miguel de Carnué unfortunately preceded the great Spanish frontier offensive against the Apaches which covered the twenty-five year period after 1772. The Reglamento of 1772 set the stage by sanctioning vigorous warfare against the Apache. This new policy became effective in 1786 when Viceroy Bernardo de Gálvez began to encourage a uniform policy for the northern frontier including peace treaties with various Apache bands and inducements for them to become dependent upon rations, inferior firearms and liquor provided by the government. The policy was implemented on the frontier by high caliber officials including Jacobo Ugarte y Loyola and Juan Bautista de Anza. Governor Anza of New Mexico effectively used Comanche and Pueblo allies to curb Apache resistance with vigorous campaigns. Unfailing support from Ugarte as Commandant General of the Provincias Internas gave Anza's efforts official backing and substantial success.[24]

In the second decade of the nineteenth century settlers once more began to move into the Cañon de Carnué or Tijeras Canyon area. Indian danger had abated and the narrow thread of fertile land tracing the arroyo at the bottom of the canyon was attractive.

In 1817 José Laureano López and a number of companions were permitted by Governor Pedro María de Allande to cultivate land on or near the old Carnué grant. This, however, did not constitute a new grant of the tract since Governor Allande stated unequivocally that the "land was in the nature of a loan which they might be dispossessed of at any time they may be ordered."[25]

A petition for a regranting of the Carnué tract was made by Juan Durán of Albuquerque on November 1, 1818, on behalf of himself and a number of companions.[26] The petition was referred by Governor Facundo Melgares to the Alcalde Mayor, Pedro Bautista Pino, who in turn asked the Alcalde of Albuquerque, Josef Mariano de la Peña for an opinion. Peña replied positively and recommended approval of the grant which he clearly identified with the 1763 tract. Success was possible, he observed, since the Gilas (Apaches) who had previously forced abandonment were at peace.[27]

In January of 1819 a second petition for land in the canyon was made by Juan Ignacio Tafoya on behalf of twenty-six residents of Albuquerque.[28] Alcalde Josef Mariano de la Peña notified the governor that there were three groups of petitioners for the lands but that many of the individuals already possessed land as a consequence either of grants or inheritances. Governor Melgares ordered the alcalde to prepare a list of those petitioners who had no land. Peña responded with a list of thirty-five persons, including Laureano López who had been given provisional lands in 1817.[29] Investigations concluded, the governor ordered Peña to put the grantees in possession of the lands and to set the period within which they were to provide themselves with arms and horses for defense. The two new settlements were to be governed by two lieutenant alcaldes "to govern in peace and be responsible for that which belongs to the King." This last provision included oversight and management of one-third of all produce of the community which the grantees had promised to give the government for two years.[30]

On account of the number of petitioners it was determined to locate two towns, San Miguel and San Antonio, on the Carnué

grant. The original petition had requested boundaries extending from the mouth of the canyon on the west to the pueblo ruins at San Antonito. The request was denied "because the woods, waters and pastures of watering places are common to the frontier from Bernalillo to Belen." The grant as made was described as follows:

> The grant being from the entrance of the Cañon de San Miguel de Carnué to the Tijera, the width of the Cañon west to east and from here south to north as far as the cross set up to the north of San Antonio . . .[31]

Within the grant some areas were left open for future settlement by petitioners with no lands of their own.

On February 24 and 25, 1819, the first settlement at San Miguel de Carnué was laid out and its residents put in possession of their lands. A cross marking the plaza was erected and a fifty vara square was measured. In several instances grantees were allotted lands on both sides of the stream, particularly where the canyon was narrow. Agricultural lands were thus located on both the north and south sides of the arroyo. Lands were measured in terms of numbers of cordels (fifty varas) along the stream and width depended solely upon the dimensions of the canyon at any given point. As a final reminder, settlers were enjoined to give one-third of their crops for the first two years for the king's account and it was expected that the town would be completed, planting done, and arms available for defense by May.[32]

On February 26, 1819, the second village, San Antonio de Padua, was laid out and lands assigned to anxious settlers. Allocations followed the contours of the canyon, and frontage along the arroyo depended on available width. The following day a fifty vara square plaza was measured off and residents were admonished in the same fashion as those at San Miguel.[33]

The Alcalde, Josef Mariano de la Peña, ordered the alcalde of the new settlements from San Miguel to San Antonio to repeat monthly a set of ordinances promulgated for the better government of the area. Theft of personal property would result in immediate loss of rights in the grant as well as all improvements made. The alcalde was given sole right to put new settlers in possession of land. Anyone harboring criminals was subject to exile and punishment. Persons failing to cultivate their land through indolence were to be removed. A corresponding reward was given for hard work since lands vacated through death were to be reassigned to the most industrious. No grantee was permitted to sell or alienate land on account of debt for a period of ten years.[34]

A few days later Peña turned his pen to the perennial problem of regulating the precious supply of water at San Miguel and San Antonio. All settlers were reminded of their equal rights to water and of their obligation to see that farmers at the west end of the canyon had sufficient water. No person was to construct a dam and each should "irrigate in his turn day or night, in order that all may irrigate equally, without preference." All surplus water left in lateral ditches had to be returned to the acequia madre or arroyo.

Also held in common was the responsibility for construction and upkeep of the plazas, which fell to community members in proportion to the size of landholdings. The penalty for refusal to comply was exile from the settlement.[35]

Attracted by the possibility of fertile land a new group of eight led by Antonio Chaves petitioned Mariano de la Peña, the alcalde, for lands in the Cañon de Carnué. The prospective settlers, Chaves testified, were without lands of their own and all agreed to meet the terms agreed upon by the original grantees, that is, they would give a third of their crops for the first two years to the king. After appropriate investigations, Governor Melgares assented to the petition and ordered Peña to assign agricultural land.[36]

On March 26, 1819, Peña proceeded from Albuquerque to San Miguel with the seven petitioners and a number of others who made verbal requests to be included in the grant. These grantees were allotted lands along the canyon in the usual fashion and, as had been promised, the most industrious of the earlier settlers were given additional land.[37]

Although dwellings were concentrated in the vicinity of San Miguel and San Antonio, agricultural lands encompassed much of the irrigable land from west of San Miguel east along the canyon

to San Antonio. In November of 1819 there were fifty-seven farmers living in the canyon, each with a parcel of farmland running 150 to 450 feet along the bed of the arroyo.[38] A rough estimate suggests that over three miles along the canyon was being used for irrigated agriculture. Practically, farmers must have gradually built houses near their fields to facilitate daily chores of cultivation and irrigation. This was possible as threat of Indian attack had subsided since the ill fated 1763 settlement.

At the end of 1819, the settlers were called to relinquish a third of their produce as had been stipulated in the grant. Fifty-seven people were ordered to contribute in kind for the benefit of the government.

MAJOR CROPS IN 1819[39]

	For The King	*Home Use*	*Total*
Corn (sacks)	96.25	192.5	288.75
Wheat (almudes)*	130.00	260.0	390.00
Beans (almudes)	11.00	22.0	33.00
Chile (strings)	4.00	8.0	12.00
Tobacco (bundles)	33.00	66.0	99.00
Onions	336.00	672.0	1008.00
Pumpkins	205.00	410.0	615.00

*An almud was a variable dry measure with an approximate value in New Spain of 6.88 dry quarts. See Manuel Carrera Stampa, "The Evolution of Weights and Measures in New Spain," *The Hispanic American Historical Review* 30 (October 1950).

The size of the crop and the variety produced are remarkable considering the brief period in which these hardly colonists had to construct plazas, homes, ditches and tend crops including their cultivation and harvest. The alcalde was ordered by Governor Melgares to shell the corn and give notice when all was ready to be transported to Santa Fe where it would be disposed of for the benefit of the government.

By the end of 1819 the Cañon de Carnué grant sustained two permanent settlements at San Miguel and San Antonio. Despite apparent success the villages were forced to rely upon San Felipe de Neri de Albuquerque for spiritual necessities. A chaotic political and religious situation in an independent Mexico diverted attention

from the needs of the northern frontier. Thus, although chapels were licensed for San Miguel and San Antonio in 1823 and the licenses later renewed, no structures were built until the 1830s.[40]

The settlements at San Miguel and San Antonio have been continuous since 1819. The two initial villages were complemented by a continuing settlement process which has resulted in an almost unbroken thread of human habitation through the canyon.

In July of 1882 heirs of the grantees submitted documents and depositions to the surveyor general's office but confirmation waited until approval by the Court of Private Land Claims in 1894.[41] Testimony in the case reveals a chronologically continuous settlement. Witnesses were intimately acquainted with the grant through personal knowledge of many of the settlers of 1819. Typical testimony was provided in 1885 by Andrés Nuañez, an 85-year-old man who lived just north of Albuquerque. In reference to the Carnué grant Nuañez stated

> I have known it since it has been inhabited there. It is east of here four or five leagues. The boundaries are on the east—the Town of Sedillo—which lies east of San Antonio. On the west the entrance of the canyon where there are some ruins, and on the south by the mountains and on the north by the mountains.[42]

All witnesses identified San Miguel and San Antonio with the two original settlements.[43] Since the depositions of 1882 the place names have remained as Carnuel toward the western outlet of the canyon and San Antonio toward the east in the vicinity of Cedar Crest, New Mexico.

Continuous habitation at San Miguel and San Antonio from 1819 to the present, corroborated by witnesses testifying before the surveyor general, and persistence of place names at Carnuel and San Antonio, leave little doubt concerning the location of these settlements. The grant made in 1819 was identified at the time as being identical with the concession of 1763. The obvious conclusion on this basis and on the description of the 1763 grant made by the alcalde is that the earlier allotment was in the vicinity of the present village of Carnuel.

NOTES

1. Richard Greenleaf, "The Founding of Albuquerque, 1706: An Historical–Legal Problem," *New Mexico Historical Review* (NMHR), 39: (January 1964): 1-15. See also C. W. Hackett, ed., *Historical Documents Relating to New Mexico, Nueva Vizcaya and Approaches Thereto, to 1773*, 3 vols. (Washington, 1923-1937), 3:378.

2. Rupert N. Richardson, *The Comanche Barrier to South Plains Settlement* (Glendale, 1934), p. 53.

3. Fray Juan Alvarez to the Viceroy, Duque de Alburquerque, April 16, 1706, *Archivo General de la Nación* (AGN), Provincias Internas, 36. Alvarez was custodian of the Province of New Mexico.

4. See for example, Testimonio de las juntas de guerra que se formaron para hazarla campana a la sierra de los ladrones, Año de 1715, Spanish Archives of New Mexico (SANM), doc. 224.

5. The ranges of the bands are identified in Max L. Moorhead, *The Apache Frontier* (Norman, 1968).

6. Father Juan Augustín de Morfi, Desordenes que se advierten en al Nuevo Mexico, AGN, Historia, 25.

7. Autos de Guerra de la primera Campaña que N.S. Marq. de la Nava de Brazinas gobernador y capitán general de la Provincia de la Nueva Mexico En persona sale. . ., March 3 to April 2, 1794, SANM, doc. 99.

8. Robert Ryal Miller, "New Mexico in the Eighteenth Century: A Report Based on Governor Velez Cachupín's Inspection," *Southwestern Historical Quarterly* 79 (December 1975): 166-81.

9. All land grant documents noted by Ralph Emerson Twitchell, *The Spanish Archives of New Mexico*, 2 vols. (Cedar Rapids, 1914), 1 (SANM I), and the records of the Surveyor General of New Mexico (SG) in addition to the Court of Private Land Claims (PLC) are located in the State Archives and Records Center, Santa Fe, New Mexico.

10. Decree of Don Tomás Vélez Cachupín Governor and Captain General, Santa Fe, February 6, 1763, SG, 150. Initial settlers were Cristóbal Jaramillo, Juan Moya, Bernardino Moya, Juan Moya the younger, Josef Molina, Antonio Molina, Gregorio Gutiérrez, Juan Jaramillo, Juan Gutierrez, Juan de Díos Torres, Josef Vallejo, Juan Ulibarri, Rafael Pacheco, Feliciano Hurtado, Francisco Griego, Manuel Armijo, Josef Antonio Baca, Juan Candelaria and Ventura López. For a succinct description of the grant-making procedure in New Mexico see Myra Ellen Jenkins, "The Baltazar Baca 'Grant': History of an Encroachment," *El Palacio* 61 (Spring 1961): 47-64.

11. Decree of Vélez Cachupín, February 6, 1763.

12. Antonio Baca, Act of Possession, San Miguel de Laredo, February 12, 1763, SG, 150. While the given name of this settlement was San Miguel de Laredo, its contemporarily used alias was San Miguel de Carnué.

13. Ibid. The vara was a common linear measure equivalent to approximately 33 inches. The cordel, a larger unit of linear measure equal to 50 varas was commonly used in measuring land parcels.

14. Don Tomás Vélez Cachupín, Santa Fe, February 20, 1763, SG, 150. See also Elizabeth Nelson Patrick, "Land Grants During the Administration of Spanish Colonial Governor Pedro Fermín de Mendinueta," NMHR, 51 (January 1976): 5-18. For a discussion of Spanish law relating to the foundation of settlements see Frank W. Blackmar, *Spanish Institutions of the Southwest* (Baltimore, 1891).

15. Books of Marriages, Villa de San Felipe de Albuquerque, 1726-1776, May 3, 1764, Archives of the Archdiocese of Santa Fe.

16. Don Facundo Melgares, Report and Account of Produce, Santa Fe, November 13, 1819, SG, 150.

17. Petition to Governor Mendinueta, April, 1771, SG, 150.

18. Decree of Governor Mendinueta, Santa Fe, April 12, 1771, SG, 150. Genízaros were not, as they have sometimes been identified, half-breeds. Rather they were Indians of nomadic tribes surrounding New Mexico who, after capture or ransom, were incorporated into colonial society. Thus they were ethnically Indian and culturally Hispanic.

19. Decree of Mendinueta, April 12, 1771.

20. Order of Francisco Trebol Navarro, April 16, 1771, SG, 150.

21. Report of Francisco Trebol Navarro, April 24, 1771, SG, 150. The abandonment of San Miguel de Carnué was not unique. See E. Boyd, "Troubles at Ojo Caliente, A Frontier Post," *El Palacio* 64 (November-December 1957): 347-60.

22. Report of Francisco Trebol Navarro, May 27, 1771, SG, 150.

23. Eleanor B. Adams and Angelico Chávez, trans. and ed., *The Missions of New Mexico, 1776* (Albuquerque, 1956), p. 254.

24. Ralph Ogle, *Federal Control of the Western Apaches, 1848-1886* (Albuquerque, 1970), pp. 18-21. Documents relating to Anza's efforts are translated and edited in Alfred B. Thomas, *Forgotten Frontiers: A Study of the Spanish Indian Policy of Don Juan Bautista de Anza, Governor of New Mexico, 1777-1787* (Norman, 1932).

25. Decree of Governor Pedro María de Allande, February 27, 1817, SG, 150.

26. Juan Durán to Governor Facundo Melgares, Albuquerque, November 1, 1818, SG, 150.

27. Josef Mariano de la Peña to Don Pedro Bautista Pino, Albuquerque, November 4, 1818, SG, 150. Peña was familiar with a number of the 1763 grantees and referred to the grant asked for in the petition as "the same jurisdiction as it was formerly" thus identifying the two grants with one another geographically.

28. Juan Ignacio Tafoya to Don Facundo Melgares, Albuquerque, January 1819, SG, 150.

29. Josef Mariano de la Peña to Don Facundo Melgares, February 5, 1819, SG, 150.

30. Decree of Governor Melgares, Santa Fe, February 11, 1819, SG, 150.

31. Josef Mariano de la Peña, Certification, March 5, 1819, SG, 150.

32. Josef Mariano de la Peña, Act of Possession, SG, 150. See also Act of Possession, February 25, 1819, SG, 150. Acting under his own authority Peña admitted additional grantees making a total of twenty-three who received lands at San Miguel.

33. Josef Mariano de la Peña, Act of Possession, SG, 150. At Peña's discretion, twenty-two persons were allotted lands at San Antonio.

34. Josef Mariano de la Peña to Juan Bautista Durán, Albuquerque, April 14, 1819, SG, 150.

35. Josef Mariano de la Peña to Juan Bautista Durán, Albuquerque, April 21, 1819, SG, 150.

36. Antonio Chaves *et al.* to Josef Mariano de la Peña, Los Padillas, February 4, 1819, SG, 150. There are a number of documents in this location relating to this grant and its approval by Governor Melgares.

37. Josef Mariano de la Peña, Act of Possession, Cañon de Carnué, March 26, 1819, SG, 150.

38. Report and account made of the produce from the third promised by the settlers of Carnué, November, 1819, SG, 150.

39. Report . . . of the produce . . . of Carnué, November 1819.

40. Loose Documents 1823, #21; 1829, #5; 1830, #18, Archive of the Archdiocese of Santa Fe.

41. Final Decree in the Court of Private Land Claims, September 28, 1894, PLC, 74.

42. Deposition of Andrés Nuañez. Albuquerque, May 20, 1885, SG, 150.

43. See Depositions of Salvador García, Pablo Crespín, Abad Nieto and Francisco Martínez, Albuquerque, July 18, 1882, SG, 150.

AN APPRAISAL OF THE 1862 NEW MEXICO CAMPAIGN: A CONFEDERATE OFFICER'S LETTER TO NACOGDOCHES

MARTIN HARDWICK HALL

At the conclusion of the disastrous Confederate New Mexico campaign of the Civil War, most of the Texan survivors viewed their commander, Henry Hopkins Sibley, with utter disgust and contempt. There was much validity for such feeling, as the general's drunken incompetence had been manifest from beginning to end. One officer, in a letter to a prominent friend back home, undoubtedly expressed the sentiments of the bulk of his compatriots. His account also reveals the destitute condition of the Confederate Army of New Mexico after its arrival in the Mesilla–El Paso area prior to its 700-mile return march to San Antonio, Texas. Since unofficial correspondence of this nature has special value to historical study it is worth presenting in its original form with editorial additions for clarity.

Captain William Lee Alexander, the fourth of six children of William Julius and E. Catherine (Wilson) Alexander, was born in North Carolina (probably Mecklenburg County) on May 21, 1833. Alexander's family was one of prominence: his grandfather was a graduate of Princeton and his father, after graduating from the University of North Carolina in 1816, became a lawyer and a Jacksonian politician. The elder Alexander, upon leaving the superintendency of the branch mint at Charlotte in July, 1849, took his family to McDowell County to engage in the practice of law.[1] The census of 1850 shows that nineteen-year-old William Lee was a student residing in the home of his parents.[2] Young Alexander enrolled in the University of North Carolina, where his father was a trustee, and was awarded the bachelor of arts degree in 1854,

Appendix III

Management of Ponderosa Pine Forests to Increase Water Yield in the Southwest: A Literature Review

Many people in the Southwest are concerned about the condition of forests as it relates to water supply. Common beliefs about water include that dense forests result in decreased water flow and that fuel reduction treatments will increase water flow. This paper reviews the research to date on water yield.

Summary Points:

- The potential for increased water yield is related to the level of harvesting. Clearcutting is more likely to have an effect than thinning.
- The length of the effect of increased water yield varies by the amount of removal and rate of recovery of vegetation.
- Light harvesting, such as thinning or selective cutting, typically does not affect the water table or increase water yield. Few watershed studies have evaluated the effect of thinning, since research was historically focused on maximizing water yield.
- Winter precipitation accounts for the majority of water yield. Vegetation typically uses summer precipitation.
- Low severity fires, such as prescribed burns, show little or no hydrologic impacts

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INTRODUCTION

The availability of water has always been important to communities in the arid Southwest, affecting settlement patterns and the sustainability of communities. As development pressures rise, the demand for water for domestic and agricultural use increases. People in some rural communities have observed declines in the amount of water in ephemeral streams and acequias over the last fifty years. One possible explanation have offered for this decline, besides the obvious increase in demand, is the heavily forested condition of watersheds. Similarly, "it is hypothesized that the increase in tree cover in the (Santa Fe) Watershed over the past 80 years could be the apparent reduction in water yield" (USDA Forest Service 2000: 60-61).

Watershed health is included in the discussion about the current condition of ponderosa pine forests in the Southwest. Forests are more dense than they were historically (Covington and Moore 1994). Fuel reduction and restoration treatments are proposed throughout the West to reduce the potential for crown fires and restore ecological processes to the forest (Weatherspoon and Skinner 1996). These treatments may affect watersheds and water yield from forests. The focus of this paper is to explore the connection between the management of ponderosa pine forests and potential water yield from these forests.

Ponderosa pine covers millions of acres in New Mexico and Arizona, found on the landscape between 5000-8500 feet. The average annual precipitation varies from 15-25 inches, with 15 inches being the minimum necessary to maintain ponderosa pine as a vegetation type (Baker 1988). Precipitation is only in excess of potential evaporation during a portion of the year. Annual water yield averages 2-6 inches (Baker 1988). (Water yield refers to the amount of water not utilized by vegetation in the forest which flows into streams.) Streams in the ponderosa pine zone are typically ephemeral, running dry in the summer. Winter provides an opportunity to recharge the soil by intermittent snowmelt and occasional rain events (Baker 1988). Two-thirds or more of the annual precipitation in the Rocky Mountains is stored in the winter snowpack (Troendle 1983 citing Troendle and Leaf 1980) and released in the spring.

Water is lost in a forest through *evapotranspiration*, which is a combined term for water lost as vapor from soil or an open water surface (evaporation) and water lost from the plant's leaves, mainly via the stomata (transpiration). Because it is difficult to distinguish between water vapor from these two sources, the combined term evapotranspiration is used. Land managers are interested in evapotranspiration because it represents the amount of water that will not be available for on-site and downstream use (Zwolinski 2000).

Highest water yields usually occur in ponderosa pine forests in the spring (Baker 1988). This is because low evapotranspiration demands during the early spring period favor higher water yields from melting snows. In Arizona Rich (1972) determined 80% of annual streamflow in a ponderosa pine forest occurred between February and April. Data based on 112 years of records for Beaver Creek ponderosa pine watersheds in Arizona showed the highest stream flow in March and April (Brown et al. 1974). For the year as a whole, 20% of precipitation became streamflow (Brown et al. 1974). For October through April, streamflow was 28% of precipitation; for May through September it was 3% (Brown et al. 1974). This suggests precipitation during the summer months is utilized by the forest, rather than flowing into streams.

Water yield can be manipulated to reduce evapotranspiration losses through two processes:

- Reduce the number of trees, which reduces transpiration. Research has shown with a larger number of trees, there is more leaf area, and therefore more water lost through evapotranspiration. This can reduce the net water yield from a watershed.

- Create openings in forest cover. This reduces the amount of *interception* by trees. Interception is the capture of precipitation by vegetation from which the water evaporates and is thus prevented from reaching the water-table and contributing to surface run-off, soil moisture, or groundwater recharge. Forest openings will also redistribute snow, concentrating the snow to reduce evaporation and increase snowmelt contribution to streamflow.

Studies in Arizona and New Mexico indicate that openings created in forest overstories can increase snowpack accumulations within the cleared areas. However, this doesn't necessarily mean that the total amount of snowpack water equivalent increases on the watershed level, just that harvesting redistributes the snow. An important point concerning the redistribution of snow following clearcutting is that no watershed scale study shows a statistically significant change in total snowpack water equivalent as a result of harvest (Troendle 1983). It is difficult to isolate the percentage of the increase in forest openings that can actually be attributed to depositional differences during the event, redistribution following the event, and interception savings – regardless of how wet or dry the snow is (Troendle 1983). In ponderosa pine forests of Arizona and New Mexico, most intercepted snow eventually reaches the ground by snowslide, wind erosion, or canopy melt (Folliot et al. 1989 cites Tennyson et al. 1974). Therefore, interception may not represent a significant loss in terms of the water budgest, contracting commonly held assumptions (Folliot et al. 1989 cites Tennyson et al. 1974).

EXAMPLES

Timber harvest can reduce evapotranspiration and interception losses (Baker 1988). Therefore, harvesting may translate into flow changes. Removal of vegetation reduces the evapo-transpiration loss in rough proportion to the extent of the removal and the ability of remaining plants to use water (Baker 1988). The effect of basal area reduction on water yield is complicated by effects of soil depth, storm size, frequency, and distribution. Results of studies for the ponderosa pine forest type are summarized below, organized by geographic region. Studies explore different intensities of harvesting. Between the 1950's and 1960's numerous watersheds were studied to investigate the effects of vegetative clearings, thinnings, and conversion of vegetation on water yields (Baker and Ffolliott 2000).

Beaver Creek Watershed

Treatments in the Beaver Creek watershed in northern Arizona have provided long-term data on the interaction between forest management and water yields (Brown et al. 1974). Several different treatments with different basal area (BA) removal were implemented. (The basal area of trees is measure in square feet per acre.) The percent increase in water yield is based on the difference between predicted and actual streamflow after treatment. The following treatments were applied at Beaver Creek:

- Clearcut. 100% BA removed. 35 % increase over 6 years.
- Strip clearcut. 32% BA removed. 16% increase over 6 years.
- Thinning. 75% BA removed. 22% increase over 6 years.
- Irregular strip clearcut, with thinning between strips. 50% BA removed. 21% increase over 6 years.
- Irregular strip clearcut, with thinning between strips. 65% BA removed. 103% increase over 6 years.

Streamflow increased most by clearcutting, followed by thinning and strip clearcuts. Water yield increases of 1 to 2 inches per year over a 5-year period were realized with the above levels of timber reduction (Brown et al. 1974). In all cases, streamflow varied directly with the amount of winter precipitation. Beaver Creek watershed study. Harvesting was efficient in some areas for increasing the concentration of snowmelt, increasing storm runoff in clear areas and reducing evapotranspiration losses. However, a clear relationship between degree of timber reduction and water yield increase or duration did not emerge. It is too difficult to separate out all the factors determining water yield.

A follow-up study in the Beaver Creek watershed was undertaken to assess the effects over a longer period of time (Baker, Jr. 1986). The treatments resulted in large variation in water flow, determined largely by precipitation timing and amount. With basal area reductions of 30-100%, one can expect initial mean increases of 15-45% on shallow, basalt-derived soils. However, water yield response can be lost as quickly as 3 years with strip-cut or thinning, and 6-10 years with a clearcut. The decline in water yield was due to the recovery and growth of Gambel oak and herbaceous vegetation.

Castle Creek

Research in the ponderosa pine forests of the Colorado River Basin was conducted on Castle Creek in eastern Arizona by Rich (1972). The West Fork of Castle Creek received treatment, while the East Fork was a control. Basal area reduced from 235 to 63 ft^2/acre with a commercial timber harvest. The harvest included clearcut blocks on one-sixth of the watershed and selective harvesting in other areas. Water yield was measured after the timber harvest and improvement cut.

Seven years of data indicated a significant increase in annual water yields from the West Fork. In a high runoff year 13.0 inches of water was yielded from the control with an increase of 1.55 inches on treated watershed (Rich and Thompson 1974). In a low runoff year, 0.35 inches was yielded from control with an increase of 0.5 inches on treated watershed (Rich and Thompson 1974). This suggests there are greater increases (proportionally) at low flows and smaller increases at higher flows. Winter precipitation was the major source of water yield. Summer rains (June-September) accounted for 46% of the annual precipitation but less than 10% of the streamflow (Rich 1972). Baker (1999) found that an average water yield increase of 30% remained stable for 20 years after treatment.

Workman Creek

The forest vegetation on the Workman Creek watersheds in Arizona are ponderosa pine, Douglas fir, white fir, and Gambel oak. The North and South Fork watersheds of Workman Creek received different treatments

- The North Fork dry-site cut replaced 100 acres of ponderosa pine with grass. This treatment increased the average water yield by 56% when the control watershed yielded 7.0 inches (Rich and Thompson 1974).

- Results for the North Fork dry-site cut were similar to a conversion cut on the South Fork, which removed all merchantable ponderosa pine, leaving a stocking level of 40 ft^2 of basal area, all in ponderosa pine saplings and seedlings.

- A selection harvest on the South Fork removed 46 percent of the basal area and did not significantly increase streamflow. A re-analysis of the data showed a small (0.23 inch) and statistically significant run-off increase (Rich and Gottfried 1976, cited by Gottfriend and deBano 1990). Nevertheless, water demands by the residual stand of trees evidently used most of the additional water made available by the harvest. Selective cuttings within forests have generally shown lesser soil-moisture savings and small or negligible increases in streamflow (Gary 1975 cites Leaf 1975)

Colorado Front Range

The Colorado Front Range is the eastern foothills region of the Rocky Mountains, extending from southern Wyoming to Canon City, Colorado. Gary (1975) summarized past studies in this region and evaluated the watershed management knowledge for ponderosa pine forests. He found that water yield might be increased from north exposures by commercially clearcutting mature stands of ponderosa pine and Douglas fir (Love 1960 & Berndt 1961 cited in Gary 1975). In general, hydrologic studies showed that clearcut openings are necessary to significantly increase water yields on the Colorado front range (Gary 1975).

Black Hills

In second growth ponderosa pine stand in the Black Hills, thinning reduced the stand from 190 ft^2 of basal area and 2000 trees per acre to 80 ft^2 of basal area and 435 trees per acre. The treatment did not induce free water seepage to ground water in dry years. However, on a clearcut site (basal area reduced to zero), free water seepage occurred even in dry years (Orr 1968 as cited in Gary 1975).

Oregon

In Oregon, thinned stands of ponderosa pine saplings used 1 to 2 inches less water during the growing season than untreated stands (Anderson et al. 1967). Heavy thinning of a 70 year old ponderosa pine in central Oregon reduced summer soil moisture depletion by 2.4 to 4.5 inches, but only during the first three years after treatment (Anderson et al. 1967).

PREDICTIVE MODELS

One tool to assess the potential impact of forest management on watersheds is the use of predictive computer models. The ECOSIM system was developed by Rogers et al. (1982) to estimate multiple resource outputs from Southwestern forests and woodlands under alternative management regimes. The system simulates forest growth and yield including mortality, herbage yield, water yield, soil loss, forest floor accumulation, and decomposition of snags, logs, and debris, wildlife habitat, and scenic quality.

The Baker-Kovner streamflow regression model can be used with the ECOSIM system. The model was developed from 148 observations from 12 watersheds in the ponderosa pine type in Beaver Creek (Brown et al. 1974). The purpose was to create a model that incorporates the physical characteristics that influence the hydrology of watersheds. Variables included in the model are precipitation, insolation, soil, geology, and timber density. Timber density parameters included number of trees, basal area, and volume per acre. After some refinement the model was tested in Castle Creek. The test indicated that average streamflow can be estimated within 20-30 percent of the actual streamflow in the pine type with volcanic soils and climate similar to Beaver Creek (Brown et al. 1974). Further tests with additional data in other regions could improve the model so that it could be used to inform forest management decisions.

PRESCRIBED BURNING

Prescribed burning is often a component of fuel reduction or restoration treatments, with the goal of reducing the amount of dead organic material. The amount of vegetation and litter removed by a fire determines the magnitude of the watershed response (DeBano et al. 1996, as cited in Zwolinski 2000). Low severity fires, such as prescribed burns, show little or no hydrologic impacts (Zwolinski 2000) since enough litter and duff material is left on site to protect the soil surface. A high severity fire can reduce postfire infiltration rates and increase erosion potential.

Because prescribed burns usually reduce the amount of interception by the lower canopy vegetation and the amount of water storage capacity of the forest floor, there is the potential for an increase in water yield (Baker 1990). A prescribed fire on East Fork of Castle Creek burned 43% of a previously undisturbed ponderosa pine watershed (Gottfriend and deBano 1990). The damage to the forest stand was minimal (5% of the trees per acre and 1% of the preburn basal area per acre were destroyed) and the forest floor remained intact even though surface fuels were adequately consumed. The burn did not result in statistically significant increases in annual or seasonal streamflow over the 6 years for which data was analyzed.

DISCUSSION

It can be difficult to draw conclusions from the numerous studies that have been conducted. Bosch and Hewlett (1982) reviewed 94 catchment experiments in a number of different forest types. They conclude than an increase in water yield following forest operations can be predicted. From the data, they estimate the approximate magnitude of water yield changes. In general, in pine forest types they predict that a 10% change in cover can cause an average 40-mm

change in water yield. They conclude that reductions in forest cover of less than 20% cannot be detected by measuring streamflow (Bosch and Hewlett 1982). Post and Malanson (1994) reanalyze the data presented Bosch and Hewlett (1982) and conclude that the response of water yield to vegetation treatment is unpredictable. While clearing vegetation increases the absolute stream flow, the *proportional* change is not significant. Stednick (1996) also reviewed 85 catchment studies in the U.S. Like Bosch and Hewlett (1982), he found that changes in annual water yield from harvesting of less than 20% catchment area or forest cover cannot be determined by streamflow measurements. A contributing factor is that there is little available data since the reduction of forest cover by less than 20% is seldom used in paired catchment studies.

As a general rule, uniform thinning of forest and brush stand in the Rocky Mountains and the Southwest must remove about 50% of the crown cover before water yield appreciably increases (Hibbert 1979). Similarly, density reduction of 30-100% in ponderosa pine will result in a water yield increases (Baker 1988). Short-term increases of 1-3 inches may be expected from clearcutting ponderosa pine with 100 basal area or greater, although the increases can't be maintained unless the site remains clearcut (Hibbert 1979). If basal area is reduced to 70-80 in ponderosa pine, evapotranspiration won't be reduced for very long (Baker 1988). For this reason, shelterwood or individual tree selection methods of harvest do not produce as much water as harvest systems that create openings in the forest cover (Hibbert 1979). However, small increases in water yield (0.5 to 1.0 inch) are attainable on deeper soils by selection cutting (Anderson et al 1967).

One factor to consider in predicting water yield after harvesting is the recovery of vegetation, which will affect water flows. When density is reduced in ponderosa pine forests, usually herbaceous cover increases (Baker 1999). In drier areas, where vegetation recovers slowly, changes in water yield are more persistent. When thinning is conducted, the residual trees, if previously water stressed, will increase the amount of water they take up. In addition, as tree canopies expand after thinning, water lost through transpiration will also increase.

CONCLUSION

Watershed management in the past focused on large-scale vegetation manipulation to increase water yields (Ffolliott et al. 1998 as cited by Long 2000). Societal values have changed, shifting the focus towards forest restoration to sustain ecological functions and biodiversity (Ffolliott et al. 1998 as cited by Long 2000). Future watershed management perspectives in the Southwest will probably reflect a more integrated approach to managing the biological, physical, and social characteristics that contribute to watershed health (Ffolliott et al 2000).

Potential for increasing water flows in ponderosa pine is limited because it grows in a precipitation-limited environment (Baker 1988). The potential for increased yield is greater where precipitation is higher, for example in higher elevation forest types (Baker 1988). When water is not limiting, reducing the vegetation will increase streamflow (Baker 1988).

Where clearcuts and type conversions are not acceptable management practices, the potential for increasing water yield is low (Baker and Ffolliott 2000). Ponderosa pine watershed managed for

multiple uses, in which timber, range, wildlife, recreation, and water are all considered, long-range increases of 0.1 to 1 inch are realistic expectations (Brown et al. 1974). In the Santa Fe Watershed, even though increased tree density may have reduced water yield over time, hydrologists predict that the effect of proposed fuel reduction treatments on water yield will be minor and brief (USDA FS 2000).

The potential benefits of fuel reduction treatments in the Southwest are many, including increasing forage and water yield potential while decreasing fuel hazards. Based on a review of the literature, thinning will have only a minor positive effect on water flow, if any. hile localized runoff can be anticipated to occur in the short-term following thinning, the change in yield relative to annual runoff is typically quite *small* (Huff et al. 2000). Therefore, increasing waterflow should be considered a potential short-term side effect of fuel reduction and restoration treatments, not an objective.

LITARTURE CITED

Anderson, H.W.; Hoover, M.D.; Reinhart, K.G. 1976. Forests and water: effects of forest management on floods, sedimentation, and water supply. GTR PSW-18, USDA FS. 115 p.

Baker, M.B. 1986. Effects of ponderosa pine treatments on water yield in Arizona. Water Resources Research 22 (1): 67-73.

Baker, M.B. 1988. Selection of silvicultural systems for water. In: Ponderosa Pine – the species and its management. U. of Wash. Coop. Ext.: 201-211.

Baker, Jr., M.B. 1990. Hydrologic and water quality effects of fire. In: Effects of fire management of southwestern natural resources. Gen. Tech. Rep. RM-191. Fort Collins, CO: USDA, Forest Service, Rocky Mountain Forest and Range Experiment Station: p. 31-42.

Baker, Jr.; M.B. 1999. History of watershed research in the Central Arizona Highlands. Gen. Tech. Rep. RMRS-GTR-29. Fort Collins, CO: USDA, Forest Service, Rocky Mountain Forest and Range Experiment Station.

Baker, Jr., M.B.; Ffolliott, P.F.; 2000. Contributions of watershed management research to ecosystem-based management in the Colorado River Basin. USDS Forest Service Proceedings RMRS-P-13. P. 117-128.

Berndt, H.W. 1961. Some influences of timber cutting on snow accumulation in the Colorado Front Range. USDA For. Ser. Res Note 58, 3 p. Rocky Mt. For. & Range Exp. Stn., Fort Collins.

Bosch, J.M.; Hewlett, J.D. 1982. A review of catchment experiments to determine the effects of vegetation changes on water yield and evapotranspiration. J. Hydrology 55 (1/4): 2-23.

Brooks, K.N.; Ffolliot, P.F.; Gregerson, H.M.; Thames, J.L. 1991. Hydrology and the management of watersheds. Iowa State University. 392 p.

Brown, H.E.; Baker Jr., M.B.; Rogers, J.J.; Clary, W.P.; Kovner, J.L.; Larson, F.; Avery, C.C.; Campbell, R.E. 1974. Opportunities for increasing water yields and other multiple use values on ponderosa pine forest lands. USDA FS. Res. Pap. RM-129, 36 p. Rocky Mt. For. & Range Exp. Stn., Fort Collins.

Connaughton, C.A. 1935. Forest Fires and accelarated erosion. Journal of Forestry. 33: 751-752.

Covington, W.W.; Moore, M.M. 1994. Postsettlement changes in natural fire regimes and forest structure: ecological restoration of old-growth ponderosa pine forests. J. Sust. For., 2:153-181.

DeBano, L.F.; Ffolliott, P.F.; Baker, Jr., M.B. 1996. Fire severity effects on water resources. P. 77-84. In: Proceedings of a Symposium on Effects of Fire on Madrean Province Ecosystems; March 11-15, 1996, Tucson, AZ; USDA Forest Service Gen. Tech. Rep. RM-GTR-289; Rocky Mountain Forest and Range Experimental Station; Fort Collins, CO; 277 p.

Ffolliott, P.F.; Baker, Jr., M.B.; Lopes, V.L. 2000. Watershed management perspectives in the Southwest: past, present, and future. USDS Forest Service Proceedings RMRS-P-13. P 30-36.

Ffolliott, P.F.; Brooks, K.N. 1996. Process studies in forest hydrology; a world-wide review. In: Singth, V.P. and Kumar, B., editors. Surface-Water Hydrology. Kluwer Academic Publishers, The Netherlands. p. 1-18.

Ffolliott, P.F.; DeBano, L.F., Baker, M.B. 1998. History of the Arizona Watershed Program. Pages 85-86 in the Proceedings of the 11th Annual Symposium of the Arizona Hydrologic Society.

Ffolliott, P.F.; Gottfried, G.J.; Baker Jr., M.B. 1989. Water yield from forest snowpack management: research findings in Arizona and New Mexico. Water Resources Research 25: 1999-2007.

Ffolliot, P.F.; Guertin, D.P. 1988. Prescribed fire in Arizona ponderosa pine forests: a 24-year case study. In: Effects of fire management of southwestern natural resources. Gen. Tech. Rep. RM-191. Fort Collins, CO: USDA Forest Service, Rocky Mountain Research Station: 250-254.

Gary, H.L. 1975. Watershed management problems and opportunities for the Colorado Front Range ponderosa pine zone: the status of our knowledge. Rocky Mt. For. & Range Exp. Stn., Fort Collins. Res. Pap. RM-139, 32 pp.

Gottfried, G.J; DeBano, L.F. 1990. Streamflow and water quality responses to preharvest prescribed burning in an undisturbed ponderosa pine watershed. In: Effects of fire management of southwestern natural resources. Gen. Tech. Rep. RM-191. Fort Collins, CO: USDA, Forest Service, Rocky Mountain Forest and Range Experiment Station: p. 222-228.

Hernandez, M.; Miller, S.N. 2000. Integrated landscape/hydrologic modeling tool for semiarid watersheds. USDS Forest Service Proceedings RMRS-P-13. P 320-324.

Hibbert, A.R. 1979. Managing vegetation to increase flow in the Colorado River Basin. USDA FS GTR RM-66. Rocky Mt. For. & Range Exp. Stn., Fort Collins.

Huff, D.D., Hargrove, B.; Tharp, M.L.; Graham, R. 2000. Managing forests for water yield – the importance of scale. Journal of Forestry Vol. 98 (12): 15-19.

Kittredge, J. 1948. Forest influences. New York: McGraw Hill Book Company.

Leaf, C.F. 1975. Watershed management in the Rocky Mountain subalpine zone: The status of our knowledge. USDA For. Serv. Res. Pap. RM-137, 31 p. Rocky Mt. For. & Range Exp. Stn., Fort Collins.

Long, J.W. 2000. Cibecue Watershed Projects: Then, now and in the future. USDS Forest Service Proceedings RMRS-P-13. P 227-233.

Love, L.D. 1960. Water yield from mountain areas. p. 3-15, In: Water yield in relation to environmenta in the southwestern United States. Am. Assoc. Adv. Sci., Southwest and Rocky Mt. Div., Desert and Arid Zones Res. Comm. [Alpine, TX, May 1960] Symp., 74 p.

Orr, H.K. 1968. Soil-moisture trends after thinning and clearcutting in a second-growth ponderosa pine stand in the Black Hills. U.S. For. Ser. Res. Note RM-99, 8 p. Rocky Mt. For. and Range Exp. Stn., Fort Collins, CO.

Rich, L.R. 1965. Water yields resulting from treatment applied to mixed conifer watersheds. Arizona Watershed Symposium Proceedings, 9, 12-15, 1965.

Rich, L.R. 1972. Managing a ponderosa pine forest to increase water yield. Water Resource Research. 8: 422-428.

Rich,, L.R; Gottfried, G.J. 1976. Water yields resulting from treatment on the Workman Creek experimental watersheds in central Arizona. Water Resources Research. 12: 1053-1060.

Rich, L.R.; Thompson, J.R. 1974. Watershed management in Arizona's mixed conifer forests: the status of our knowledge. USDA FS Res. Pap. RM-130, 15 p. Rocky Mt. For. & Range Exp. Stn., Fort Collins.

Stednick, J.D. 1996. Monitoring the effects of timber harvest on annual water yield. J. of Hydrology 176: 79-95.

Tennyson, L.C.; Ffolliott, P.F.; Thorud, D.B. 1974. Use of time-lapse photography to assess potential interception in Arizona ponderosa pine. Water Resources Bulletin, 10, 1246-1254.

Thompson, P. 1998. Upper Santa Fe Watershed Existing Conditions Report. Santa Fe National Forest, Espanola Ranger District.

Troendle, C.A. 1983. The potential for water yield augmentation from forest management in the Rocky Mountain region. Water Res. Bull. 19: 359-373.

Troendle, C.A.; Leaf, C.F. 1980. Hydrology, Chapter III. In: An approach to water resources evaluation of non-point silvicultural sources. Environmental Research Laboratory, Athens, Georgia, EPA 600018-80-012, 173 pp.

U.S.D.A Forest Service, Southwestern Region. 2001. Santa Fe Municipal Watershed Project Draft Environmental Impact Statement – Santa Fe National Forest. March 2001.

Weatherspoon, C.P.; Skinner, C.N. 1996. Landscape-level strategies for forest fuel management. In: Status of the Sierra Nevada: Sierra Nevada Ecosystem Project Final Report to Congress Volume II. Wildland Resources Center Report No. 37. Center for Water and Wildland Resources. University of California, Davis: 1471-1492.

Wright, H.A.; Churchill, F.M.; Clark, S.W. 1976. Effect of prescribed burning on sediment, water yield, and water quality from dozed juniper lands in central Texas. J. Range Mmgt. 29 (4): 294-298. (CITED, but don't have)

Zwolinski, M.J. 2000. The role of fire in management of watershed responses. USDS Forest Service Proceedings RMRS-P-13. P 367-370.

Recommended Resources:

Baker, Jr, M.B.; Ffolliot, P.F.; Edminster, C.F.; Mora, K.L.; Dillon, M.C. 2000. Watershed management contributions to land stewardship: A literature review. USDA For. Serv. Gen. Tech. Rep. RMRS-GTR-71WWW, 60 p. Rocky Mt. For. & Range Exp. Stn., Fort Collins.

University of Arizona. 1999. University of Arizona Watershed Management in the Southwest web site: http://ag.arizona.edu/OALS/watershed.

Ziemer, R.R. 1986. Water yields from forests: An agnostic view. In Proceedings of the California Watershed Management Conference, eds. R.Z. Callahan and J.J. DeVries. Wildland Resources Center report 11. Berkeley: University of California.

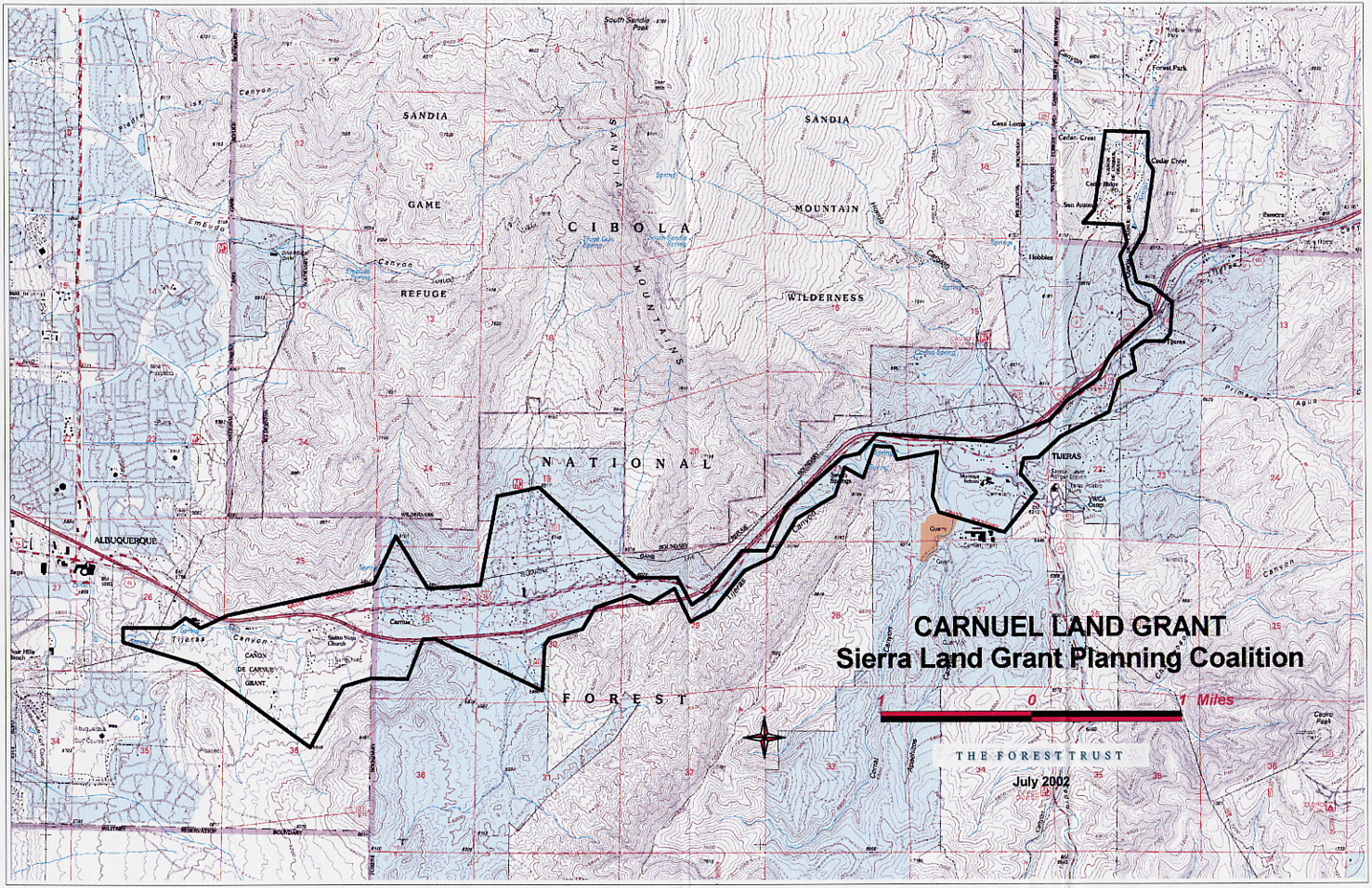
Appendix IV

Appendix IV

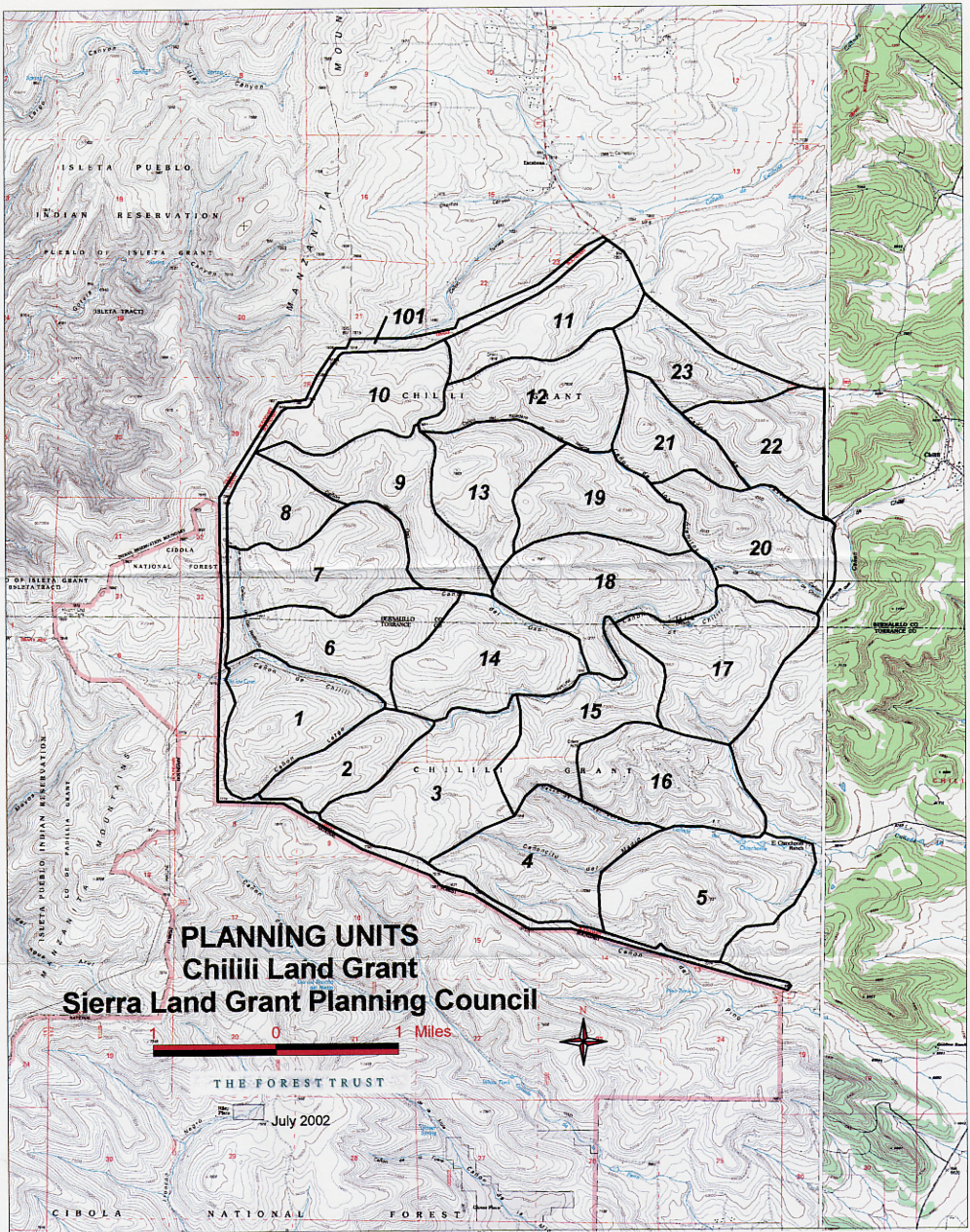
Unit Breakdown of the Chilili Land Grant

Unit	Area (in ft^2)	Acres	Hectares
1	2350302.352	580.760	235.030
2	1388561.813	343.114	138.856
3	2994953.064	740.053	299.495
4	2892271.554	714.680	289.227
5	3567443.664	881.515	356.744
6	2341694.903	578.633	234.169
7	2441722.988	603.350	244.172
8	1253531.963	309.748	125.353
9	2435215.135	601.742	243.522
10	2142784.122	529.482	214.278
11	2121832.244	524.305	212.183
12	2396171.026	592.094	239.617
13	2063247.166	509.828	206.325
14	2725310.881	673.424	272.531
15	2225379.747	549.891	222.538
16	2564249.381	633.626	256.425
17	2935675.105	725.406	293.568
18	3053060.582	754.411	305.306
19	2138633.966	528.456	213.863
20	2625175.526	648.681	262.518
21	1356822.846	335.271	135.682
22	1842217.470	455.212	184.222
23	1623743.924	401.227	162.374
101	1907210.930	471.272	190.721

Appendix V


CARNUEL LAND GRANT
Sierra Land Grant Planning Coalition
1 0 1 Miles
THE FOREST TRUST
July 2002
SANDIA
GAME
REFUGE
CIBOLA
SANDIA MOUNTAINS
SANDIA
MOUNTAIN
WILDERNESS
NATIONAL
FOREST
ALBUQUERQUE
TIJERAS
Forest Park
Cedar Crest
San Antonio
Hobbies
Canyon
Embudo
Tijeras
CAÑON DE CARNUE GRANT
Carnue
Quarry
South Sandia Peak

Appendix VI


ISLETA PUEBLO
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(ISLETA TRACT)
MANZANITA MOUNTAINS
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CIBOLA NATIONAL FOREST
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PLANNING UNITS
Chilili Land Grant
Sierra Land Grant Planning Council
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THE FOREST TRUST
July 2002